# The quicker the better: Fostering timely responses in public hospitals

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**Abstract**

In most OECD countries, pre-surgery waiting time has become a process indicator of the quality of care for hip fracture patients, and international clinical guidelines recommend hip fracture surgery to be provided within two days of hospitalisation. To help achieve this target, in year 2011 the Italy's Emilia-Romagna region implemented a policy under which hospital performance was monitored and evaluated, allowing the chief executives of Local Health Authorities and hospital Trusts to receive additional rewards if they managed to achieve increases in the proportion of hip fracture patients operated on within two days after hospital admission. In this paper, we empirically test the effect of the policy on shortening waiting times for hip fracture surgery by using a difference-in-differences analysis on patient-level data between 2007 and 2016. We find that the introduction of managerial incentives had the effect to reduce hip fracture surgery delays. The effect is statistically significant from year 2012 onwards, and cumulates over time. Moreover, we find that the policy did not just affect the cases near the incentive threshold of two days, but also induced a shift in the overall distribution of waiting times. Finally, our findings suggest no significant effects in terms of post-operative length of stay. The results may provide useful insights to develop targeted policy interventions in similarly regulated health care settings.

**Key terms**: pre-surgery waiting times, public hospitals, managerial incentives.

**JEL codes:** I11.

## 1. Introduction

Hip fractures are one of the major causes of hospitalization for injuries among the elderly. The risk of falling and loss of skeletal strength from osteoporosis increase with age. As a consequence of this and a rapidly ageing population, hip fractures are becoming a major public health issue in several OECD countries (OECD, 2018).

Patients with hip fracture require urgent surgery. There is general consensus amongst international clinical guidelines that surgery for this type of patients should be provided within two days of hospitalisation in order to achieve better patient outcomes. Numerous studies find, indeed, a positive association between treatment delays and adverse health outcomes as measured in terms of short- and long-term mortality as well as post-operative complications (e.g. thromboses, pneumonia, and urinary tract infections, among others). Treatment delays may also have a positive impact on inpatient costs, as patients with hip fracture must remain in hospital and on medication before surgery.

Among developed countries, Italy has historically been one of those with the lowest proportion of patients operated on within two days following hospital admission (OECD Health Statistics, 2018). To help achieve the recommended target, the Italy's Emilia-Romagna region implemented a policy in 2011 aimed to incentivise hospitals to deliver hip fracture surgery in a timely fashion. Specifically, the initiative saw the introduction of a performance evaluation system, which allowed the chief executives of Local Health Authorities (LHAs) and hospital Trusts to receive additional compensations if they managed to achieve improvements in their performance as measured by a set of indicators including the proportion of hip fracture patients receiving surgery within two days following hospital admission. The new incentive scheme also involved the use of clinical audits and analyses of pre-surgery waiting times for monitoring hospital performance.

In this paper, we use patient-level data over years 2007-2016 in order to examine the effect of the incentives introduced by the policy on the performance of public hospitals as measured in terms of pre-surgery delays for patients with hip fracture. For this purpose, we use a difference-in-differences (DiD) estimation strategy based on comparisons in waiting times for hip and tibia/fibula fracture surgeries before and after policy implementation. While clinical recommendations suggest that timely surgical intervention should be provided also for tibia/fibula fracture patients, they were not included in the new incentive scheme. Because of that, and since we observe the same pre-policy trends in pre-surgery delays for hip and tibia/fibula fracture patients, we use the latter as control group for the main analysis. As a sensitivity check, we also test the robustness of our results to the choice of the control group.

Our paper contributes to the empirical literature on the effect of pay for performance (P4P) schemes in health care (Dranove, 2012). While also previous studies examined the causal effects of economic incentives on the performance of hospitals in treating patients with hip fracture, these papers addressed issues different from the one that motivates our analysis. The most recent issues addressed in this literature include the effect of a tariff change on clinical practice (Papanicolas and McGuire, 2015), the impact of integration and coordination problems between health and social care on delayed hospital discharges (Fernandez et al, 2014), and the role of national- and regional-level factors in explaining differences across European countries about the performance of hospitals in providing hip fracture surgeries (Medin et al, 2015). For Italy, there is some anecdotal evidence showing the association between hospital performance trends and potential explanatory factors. Particularly interesting within this context is the study by Pinnarelli et al (2012). They analyze the effect of a policy recently introduced in Tuscany, linking the financial compensation earned by the chief executives of LHAs and hospital Trusts to the performance of hospitals as measured by a number of different indicators, one of which is the proportion of hip fracture patients receiving surgical intervention within two days following hospital admission. While their analysis is only based on comparisons between years 2006/7 and 2008/9, the main advantage of our empirical strategy is that it allows us to causally identify the impact of the managerial incentives created by the policy. Using a DiD approach based on data spanning over a ten-year period, we are able to control for unobserved heterogeneity and to analyze both the short-term and long-term effects of the new incentive scheme.

Our results show that, from year 2012 onwards, patients with a diagnosis of hip fracture, compared with those with a diagnosis of tibia or fibula fracture, experience a significant increase in the probability of waiting within two days after hospital admission. Such evidence seems to support the effectiveness of the policy in terms of achieving the recommended target of two days for patients requiring a hip fracture surgery. Moreover, we find evidence that the policy did not only affect surgery delays for patients near the incentive threshold of two days, but also induced a shift in the overall distribution of waiting times for hip fracture surgery. This is supported by our finding of a significant reduction in the average waiting time for surgery, and a significant decline in the probability of waiting twice the target or more. The results also reveal that the impact of the policy is not just temporary, but also persists in the long-term. Finally, our analysis shows no evidence of a significant effect in terms of post-surgery length of stay, thus providing no support for the hypothesis that shortening pre-surgery waiting times may allow patients to be ready to be discharged earlier as the result of their better health conditions.

## 2. Institutional background

Established in 1978, the Italian NHS is a tax-financed compulsory insurance system with universal and comprehensive coverage. Most care is provided free of charge at point of delivery.[1] Hospital care represents the largest category in terms of health spending, with almost half of health expenditure related to hospital services. As for the type of care provided in hospital settings, inpatient care represents the most important service, accounting for 61% of hospital expenditure (OECD, 2018). Patients in need of elective (i.e. non-urgent) care must be referred by their general practitioner, while they can access emergency care directly via hospital accident and emergency departments. Although there is no rationing of demand for emergency care, patients undergoing emergency surgeries can experience treatment delays following hospital admission.

In the 1990s, the Italian NHS has been deeply reformed towards a progressive devolution that gave Italian regions political, administrative and financial responsibility for the organization and delivery of health care. Since then, most hospitals have been managed directly by Local Health Authorities (*Aziende Sanitarie Locali*, ASLs), public enterprises mainly funded by the regional government on a capitation basis and responsible for the health care needs of their catchment population. The remaining hospitals, including highly specialized hospitals and University hospitals, enjoy the status of semi-independent Trusts (*Aziende Ospedaliere*, AOs), self-governing public enterprises mostly financed through a prospective payment system.

With regard to the NHS organization, the 1990s' reforms introduced an increasing professionalism at management level, with politicians substituted by professional managers as heads of ASLs and AOs. In this context, national rules on labour contracts

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[1] Co-payments apply for outpatient services and pharmaceuticals.

were modified to grant more flexibility to local organizational arrangements and to allow the introduction of new management functions, such as cost accounting, budgeting, strategic planning, need assessments and performance-based payments.

Under current legislation, the Chief Executive Officers (CEOs) of ASLs and AOs are appointed directly by the regional government under a fixed-term contract. They have to be selected from a list of candidates with a University degree and a solid management experience, not necessarily focused on the health care sector (Ferré et al, 2014). The compensation of the CEOs is determined by decree of the President of the Council of Ministers, which defines the scheme, the content as well as the maximum amounts payable, which, as required by law, cannot be lower than those earned by other senior NHS managers. It is then delegated to the regional government to identify the remuneration level for the CEOs' compensation, based on the size of the health organization where the CEOs are employed. Their compensation is determined on an annual basis and divided into 12 monthly instalments. There is no ancillary compensation of any type and nature recognized to the CEOs, expect for up to 20% of the annual compensation that can be related to performance targets.

In year 2011, the Italian region of Emilia-Romagna, where this study is focused on, implemented a policy aimed to encourage hospitals to improve their performance in accordance with a set of specific objectives to achieve. The regional initiative allows the 20% of health managers' annual compensation (reduced to 10% since 2015) to be linked to the results reached on three different evaluation areas: 30% on the reduction of waiting lists, 20% on the achievement of budget balance, and 50% on a list of selected targets. The targets valid for the CEOs have been defined by Regional decree on an annual basis, and became, in turn, strategic objectives linked to the annual budgets assigned to the internal departments of the health organizations.

One of the objectives set by the region since year 2011 is related to the proportion of hip fracture patients operated on within two days of hospital admission. The score system assigns a number of points ranging between 0 and 10, according to the recorded percentage of hip fracture patients operated on within two days of hospital admission.[2] Penalties are foreseen in case of a reduction from the historical value previously reached. Clinical audits and analyses of data on pre-surgery waiting times have been used as supporting levers to evaluate hospital performance, with information feedback provided to the CEOs. At the same time, the policy did not introduce any targets based on the time taken to initiate tibia or fibula fracture surgery after hospital admission, despite the fact that clinical guidelines recommend providing timely surgical interventions for such patients as well.

## 3. Data and preliminary evidence

Our data source is the administrative hospital discharge dataset (*Schede di Dimissione Ospedaliera*, SDO) provided by the Health Department of Emilia-Romagna. We analyse individual records for acute inpatients who were admitted on an emergency basis to publicly funded hospitals located in the region over the period between 2007 and 2016. The patients we focus on are divided in two groups, depending on whether they were or were not exposed to the incentive scheme of the policy. More precisely, we define treated

[2] More precisely, the score system assigns 10 points if the percentage of surgeries within two days is above 90%; 9 points if the percentage of surgeries within two days is above 80%; 8 points if the percentage of surgeries within two days is above 70%; 5 points if the percentage of surgeries within two days is above 50% and 0 points if the percentage of surgeries within two days is below 50%.

patients to be those with a diagnosis of hip fracture as identified by the International Classification of Diseases (ICD-9 CM codes 820.0-820.9), and control patients as those with a diagnosis of tibia or fibula fracture (ICD-9 CM codes 823.0-823.9).[3] Our final sample includes 59,549 observations, with 50,573 admissions for patients who received a hip fracture surgery, and 8,976 records for those operated on for tibia or fibula fracture.

For each individual patient record, the SDO dataset contains very rich administrative and clinical information. These include the date of admission and the date of surgery, which we use to construct three variables as proxies of hospital performance measured in terms of pre-surgery delays: pre-operative waiting times, given by the number of days elapsing between the admission date to the time at which the surgery was performed, and two dummies indicating whether patients had surgery within two days of their admission to the hospital, or have been waiting twice the target or more (i.e. 4 days or more) for surgery. Information is also available on post-surgical length of stay and patients' characteristics, including age, sex, foreign citizenship, and comorbidities. We use information on comorbidities to construct the Charlson Comorbidity Index (CCI) and a set of dummies equal to 1 if patients suffer from specific chronic disease conditions.[4]

### *3.1 Descriptive statistics*

Table 1 displays variables description and descriptive statistics for each variable used in the empirical analysis. Panel A shows figures for hip fracture patients, while panel B shows those for patients undergoing tibia or fibula fracture surgery. For both these groups,

[3] We exclude from the sample patients aged less than 18 and those aged more than 100. We also exclude patients with a primary or secondary diagnosis of cancer, as well as those with multiple trauma or who were transferred from another hospital.

[4] These include chronic heart disease, dementia, chronic cerebrovascular disease, arthritis, nutritional disease, hemiplegia, blood disease, vascular disease, chronic kidney disease, obesity, and other chronic disease (liver, pancreas, intestine).

we provide summary statistics over two periods of time: the years prior to the introduction of the incentive scheme (i.e. 2007-2010), and the years after policy implementation (i.e. 2011-2016). These statistics provide an initial look at how variables change before and after the introduction of managerial incentives by treatment group. In addition, the last columns of Panels A-B display the results of a formal test for differences in means. Specifically, we use the scale-invariant normalized difference proposed by Imbens and Wooldridge (2009) as a measure to determine whether, within the groups of treated and control patients, there were significant changes in means between the years before and the years after policy implementation.[5] As a rule of thumb, a difference in means greater than 0.25 is considered substantial.

The summary statistics for the dependent variables are reported at the top of Table 1. As the first rows of Panel A show, comparison of the average values of pre-surgery delays for hip fracture patients indicates reductions in their pre-operative waiting times between the pre- and post-policy years. More precisely, we find that, on average, the proportion of patients treated within two days increases from about 47 to 70%, waiting times for surgery decline from 3.3 to 2.3 days, and the proportion of patients waiting twice the target of two days or more falls from 0.34 to 0.16% approximately. Such changes are also significant as suggested by the normalized differences exceeding the threshold value of 0.25. With respect to the control group of tibia/fibula fracture patients, as we show in the first rows of Panel B, pre-surgery waiting times recorded in the years prior to the introduction of the policy scheme are fairly similar to those recorded for hip fracture patients during the same period, while we observe only minor changes in the post-policy years, with the normalized differences being well below the 0.25 critical value. Overall

[5] Such measure is defined as the difference in variable means between post- and pre-policy periods, scaled by the square root of the sum of variances.

these statistics provide some preliminary evidence that the policy was successful in reducing pre-surgery delays for hip fracture patients relative to those for tibia/fibula fracture patients, which is consistent with the managerial incentives created by the policy. For hip fracture patients, moreover, there are some indications of a shift to the left in the overall distribution of waiting times, as suggested by the significant decrease in both the average waiting times for hip fracture surgery and the proportion of hip fracture patients waiting twice the target or more for surgery. At the same time, we do not find evidence of significant changes after policy implementation in terms of post-surgery length of stay for neither group. On average, whilst post-surgery length of stay is higher for patients operated on for a hip fracture compared with that for tibia/fibula fracture patients, it remains stable over time for both groups of treatments.

The bottom panel of Table 1 displays the summary statistics for the covariates used in our analysis. On average, patients' characteristics differ between the treated and control groups both in terms of patient mix and complexity. In terms of patient mix, the treated group is represented by older patients, a much larger proportion of females and a smaller proportion of foreigners. With respect to patient complexity, hip fracture patients are more likely than tibia/fibula fracture patients to have a CCI greater than 0, and to suffer from at least one of the chronic disease conditions considered in our study. However, these dissimilarities seem to remain stable over time, as also suggested by the normalized differences, which are always well below the 0.25 threshold.

*3.2 Graphical analyses*

To give more insight into the changes in waiting times for hip fracture patients occurring after policy implementation, we examine the time trends in pre-surgery waiting times by year and treatment group. Figure 1 plots the temporal trends in the average percentage of patients waiting within two days after hospital admission (on the left-hand side) and in the average pre-surgical waiting times (on the right-hand side) over years 2007-2016 for hip and tibia/fibula fracture patients separately. The vertical lines indicate one year before the new incentive scheme was introduced, i.e. year 2010. As these graphs show, for both measures of pre-surgery waiting times, the treated and control groups of patients appear to trend in a similar way in the years prior to the introduction of the policy, i.e. between 2007 and 2010, thus supporting the common trends assumption required for identification in DiD estimation (Blundell and Costa Dias, 2009; Lechner, 2011). The gap between hip and tibia/fibula fracture patients becomes wider since the first year after policy implementation, and then sharply increases in later years. Such trends are consistent with the hypothesis that hospitals reacted to the incentive scheme by improving the management of hip fracture patients with beneficial effects in terms of shorter pre-surgical waiting times.

In Figure 2, we plot the cumulative percentage of hip fracture patients by number of days waiting for surgery, separately for each year between 2010 and 2016. The vertical line marks the target of two days. This graph suggests that following the introduction of the policy there was not just an increase in the proportion of cases treated within two days of hospitalisation. Instead, we observe a shift in the overall distribution of waiting times, suggesting a potential effect of the policy on pre-surgery delays also for those patients who were far away from the incentive scheme of two days. To focus on such patients, Figures 3 plots the time trends in the proportion of patients waiting twice the target of two days or more, separately for hip fracture and tibia/fibula fracture surgeries. Until the first year before the policy came into effect, highlighted by the vertical line in the graph, we observe similar trends for the two groups. Like for the variables plotted in Figure 1, we can detect divergent trends after policy implementation, thus lending support to the hypothesis that the managerial incentives created by the policy for achieving performance targets had the effect to pull the distribution of pre-surgery waiting times leftwards.

Finally, Figure 4 displays trends in the post-surgery length of stay for the treated and control patients. Over the whole time period, the post-surgery length of stay is higher for hip fracture patients than for those with tibia/fibula fracture. In the period prior to policy implementation, there appears to be only minor changes over time for both groups of patients. After the introduction of the new policy scheme, we still observe small changes for patients undergoing tibia/fibula fracture surgeries, whilst there appear to be a slowly declining trend for patients with hip fracture.

Although the graphs plotted in Figures 1-3 show a positive association between the new incentive scheme and hospital performance, a DiD analysis is required in order to establish a causal link of the policy. We use the regression models described in the next section to examine if these marked changes can be explained by policy implementation.

## 4. Estimation methods

To identify the effect of the policy on hip fracture surgery delays, we use a DiD approach. Precisely, we estimate the following model:

$$y_{iht} = \beta_0 + \beta_1 Year_t + \beta_2 Hip_i + \beta_3 Hip_i \times Year_t + \beta_4 X_i + \alpha_h + \alpha_h \times T_t + \varepsilon_{iht} \qquad (1)$$

where the subscript *i* denotes the *i-th* patient, *h* indicates the *h-th* hospital, and *t* indexes the *t-th* year, with *t* ranging between 2007 and 2016. In our baseline specifications, the dependent variable is either a dummy equal to 1 for patients treated within two days after hospital admission, and 0 otherwise; or the log of the time taken to surgical intervention, expressed in number of days.[6] The use of the latter as dependent variable allows us to test for the effect of the policy in terms of average waiting times, rather than just the probability of waiting within the target of two days.

$Year_t$ is a vector of year dummies with 2010 as the baseline year. $Hip_i$ is a dummy equal to 1 for patients undergoing hip fracture surgeries, and 0 otherwise (i.e. for the control group of patients undergoing tibia/fibula fracture interventions). $X_i$ is a vector of controls for patient characteristics, comprising demographics and co-morbidities, as described in section 3. Also, we control for hospital fixed effects, $\alpha_h$, absorbing any hospital-specific factors that are constant over time and may influence treatment delays, and a set of interactions between hospital fixed effects and a linear time trend, $\alpha_h \times T_t$, ensuring that the estimated effects do not reflect unobserved hospital characteristics affecting the dependent variables in the form of linear time trends.

We estimate a probit model for the binary dependent variable and ordinary least squares (OLS) for the continuous dependent variable. In each model, we use robust standard errors clustered at the hospital level.

The key coefficients of interest are $\beta_3$ on the interactions between $Hip_i$ and $Year_t$. In the OLS regressions, the estimated coefficients (multiplied by 100) give the % differences in pre-operative waiting times between hip and tibia/fibula fracture patients in each year relative to 2010 (i.e. one year before the new incentive scheme was introduced). In the probit model, we calculate, for each year of the analysis, average partial effects (APE), defined as the average difference between the two patient groups in the predicted

[6] There are 3,605 observations (6% of the total sample) for which pre-surgery waiting times are zero. Since the log of zero is undefined, we add 1 day to every observation before taking logs.

probability of waiting within two days after hospital admission. We identify the effect of the new incentive scheme by comparing the estimated differences between hip and tibia/fibula fracture patients in the years before and after policy implementation.

We also investigate whether the policy induced a shift in the overall distribution of pre-surgery delays. For this purpose, we estimate Eqn (1) by using a probit model where the dependent variable is a dummy equal to 1 for patients waiting 4 days or more for hospital surgery, and 0 otherwise. The results of this analysis allow us to test for the effect of the policy on the probability of waiting twice the target of two days or more.

Additionally, we evaluate whether the policy also led to significant changes in post-surgery length of stay. To do so, we estimate Eqn (1) by OLS with the log of the number of days spent by patients as post-surgery length of stay used as the dependent variable.[7] Possible reductions in unnecessary waiting times for surgery may induce a decrease in the post-surgery length of stay as the result of better patient outcomes. If patients are better off following shorter pre-surgery waiting times, we might expect that patients will be ready to be discharged earlier once they have received hospital treatment. Previous research in the medical literature favour the hypothesis that surgical queues for hip fracture affect post-surgery length of stay, although this is not supported by other empirical studies (see Leung et al, 2010, for a review). The log transformation of patients' post-surgery length of stay allows us to account for the skewed distribution of this variable and to interpret the coefficients of interest in terms of semi-elasticities. More precisely, the coefficients on the interactions between $Hip_i$ and $Year_t$ give the % change

[7] The post-surgery length of stay is zero in 603 cases (1% of the overall sample). Such zero observations are dealt with by adding one day to every record, as we do for the dependent variable of pre-surgery waiting times.

in the post-surgery length of stay between hip and tibia/fibula fracture patients in each given year relative to 2010.

Using a DiD strategy, identification of causal effects hinges on the common trend assumption, whereby treated and control patients follow similar pre-policy trends with respect to the outcome variables of interest. The descriptive graphs and statistics presented in section 3 support the validity of this assumption in the context of our study. However, as observed by previous studies, when estimating a DiD model with non-linear specifications, such as the probit models used in this analysis for the binary dependent variables, the common trend assumption is fulfilled only under a set of additional restrictions that usually do not hold in typical applications (Lechner, 2011). To address this issue, we also run linear probability models (LPM) as robustness checks of results. These estimators are found to provide reasonable approximations for binary choice models, although predicted values of the regression functions might fall outside the range zero to one (Jones, 2007).

## 5. Results

In Tables 2-7, we present the DiD results for each outcome variable. Column (1) shows our estimates from the most basic specification, where we control only for demographics among patient characteristics. The remaining columns (2)-(4) sequentially add our controls for patient complexity and hospital-specific linear time trends. Overall, the estimated coefficients appear qualitatively very similar across estimation methods, both in terms of sign and statistical significance. Also, a comparison of the results across columns (1)-(4) shows the robustness of our findings to alternative specifications as well.

Tables 2-3 present the results from the probit and the LPM, using the dummy for patients who have been waiting up to the target of two days as the dependent variable. We find that for hip fracture patients, compared with patients undergoing tibia or fibula fracture surgeries, the probability of waiting within two days from hospital admission significantly increases in the post-policy years 2012-2016, relative to the pre-treatment year 2010. Such effects also cumulate over time, whereas there is no evidence of significant differences in previous years. In terms of size, Table 8 shows the average partial effects derived on the basis of our probit estimates. As the results show, in 2012-2016, we find that on average the probability of a hip fracture patient waiting within two days after hospital admission is from 0.136 to 0.290 higher than that of a tibia/fibula fracture patient. This difference was only equal to 0.045 in 2010.

In Table 4, we show the OLS results when using the log of pre-surgery waiting times as dependent variable. These results show a significant effect of the policy from year 2012 onwards. Relative to the pre-treatment year 2010, the difference in pre-surgery waiting times between hip and tibia/fibula fracture patients decreases by about 10% in 2012, 11% in 2013, 17% in 2014, 18% in 2015 and 23% in 2016. By contrast, there were no significant changes over the years before the new managerial incentives came into effect.

Tables 5-6 display our results when using the probit and the LPM where the dependent variable is a dummy for patients waiting twice the target or more for hospital surgery. These results show evidence that the policy induced a shift also for those cases that were far away from the incentive threshold of two days. Compared with patients undergoing tibia/fibula fracture interventions, hip fracture patients experienced a significant decrease in the probability of waiting 4 days or more in the post-policy period 2012-2016, relative to the pre-treatment year 2010. We also find that these effects are increasing over time, whilst there is no evidence of pre-existing trends.

Finally, in Table 7 we present the OLS results where the log of post-surgery length of stay is regressed on our set of independent variables. As the results show, with respect to this outcome variable, we find no evidence of significant changes between the two groups of patients. Overall, the analysis suggests that the policy achieved its intended effect to reduce hip fracture surgery delays without producing any impact in terms of post-surgery length of stay.

## 6. Robustness to alternative control group

In the analysis above, we used patients with tibia/fibula fracture as our control group by exploiting the fact that they were not part of the incentive scheme and follow pre-policy trends similar to the ones displayed for patients with hip fracture. However, spillovers might also have occurred if hospitals responded to the initiative designed to reduce delays for hip fracture surgeries by introducing organisational changes in the orthopaedic departments from which patients undergoing tibia/fibula fracture interventions might benefit as well. This would lead the control group to be endogenous, and consequently estimates to be biased.

In our context, however, concerns over the potential endogeneity issue are mitigated by looking at the descriptive statistics presented in section 3. As the graphs displayed in Figures 1 and 3 show, surgical delays for tibia/fibula fracture patients appear to follow a roughly linear time trend over the 2007-2016 period. Consistent with this, the normalized differences reported in the first rows of Panel B in Table 1 indicate that there were only minor changes in delays for this type of surgery between the pre- and post-policy periods.

To further address the endogeneity concern, we also test the robustness of our findings by using patients undergoing urgent surgery for cholecystectomy (ICD-9 CM codes 51.21-51.24) as an alternative control group.[8] These patients were out of the incentive scheme as for tibia/fibula fracture patients. Moreover, since they were not treated by the orthopaedic departments, we might expect they to be less likely to be affected by spillover effects. Also for this group of patients, as we show in Figures A1-A3 reported in the online Appendix, we find similar pre-treatment trends to the ones observed for hip fracture patients, thus supporting the common trend assumption underlying the DiD strategy.

Appendix Tables A1-A7 replicate our analysis by using the control group of cholecystectomy patients. Results look very similar to those reported in the main analysis, supporting the robustness of our findings to the definition of the control group. Specifically, in the post-policy years 2012-2016, compared with the baseline 2010, we find that, on average, hip fracture patients, relative to cholecystectomy patients, have a significantly higher probability of waiting within two days after hospital admission. As Table A7 shows, while this difference is only 0.021 in the pre-treatment year 2010, it lies between 0.097 and 0.233 over the post-policy period 2012-2016. Compared to the reference year, we also find that, on average, hip fracture patients, relative to the alternative control group, experienced a significant reduction in surgical delays over years 2013-2016, and a significant decline in the probability of waiting twice the target of two

[8] Also in this case, we exclude patients with a primary or secondary diagnosis of cancer, those with multiple trauma and patients transferred from other hospitals. The list of hospitals included is the same as the one used for our main analysis, with the exception of a hospital that is now excluded from the regressions since it is specialized in orthopaedic procedures only, and so does not treat patients with cholecystectomy.

days or more since 2011 onwards. Finally, as we also find in our main analysis, there is no evidence of significant temporal changes in the post-surgical length of stay between the treated and control groups of patients.

## 7. Conclusions

In this paper, we considered whether and how public sector hospitals responded to the managerial incentives created by a policy implemented in the Italy's Emilia-Romagna region in 2011. The policy introduced a set of strategic objectives against which the performance of hospitals was assessed, allowing the chief executives of LHAs and hospital Trusts to receive additional compensations if they achieve the defined targets. One of the strategic objectives set by the region is related to increasing the proportion of hip fracture patients operated on within two days after hospital admission. Linking the new incentive scheme to this process indicator, the policy aimed to encourage hospitals to achieve more timely surgical interventions for patients with hip fracture.

We exploited the longitudinal dimension of our data to estimate the causal relationship between the policy and hospital behaviour. Precisely, we undertook a DiD analysis by comparing waiting times for patients undergoing a hip fracture surgery, to which the new managerial incentives were applied, with surgery delays for patients undergoing a tibia or fibula fracture surgery. The main analysis identified the latter patients as the control group since they were not exposed to the incentive scheme during the time period covered by our analysis, and showed pretty similar pre-treatment trends in the outcome measures. Following the same estimation strategy, we also examined whether the policy was effective in reducing patients' post-surgery length of stay. As long as reductions in unnecessary waiting times might lead to better patient outcomes, one can expect patients to be discharged earlier as pre-surgery waiting times become shorter.

Our analysis provides evidence that the policy achieved its intended objective to encourage hospitals to increase the proportion of hip fracture patients treated within two days after hospital admission. Since 2012, relative to 2010, the probability of waiting within two days of hospitalisation significantly increased for hip fracture patients compared with patients undergoing tibia/fibula fracture surgeries. Such effect also cumulated over time, with the difference in the estimated probability rising from 0.136 in 2012 to 0.290 in 2016.

Moreover, we find that the policy also affected the average waiting time for hip fracture surgery. Relative to 2010, we find that on average the estimated difference in the waiting time for surgery between treated and control patients substantially decreased in the post-policy years, ranging between 10% in 2012 and 23% in 2016. In addition to this, our results show that the treated group of patients, relative to the control, experienced a significant reduction in the probability of waiting twice or more the target of two days. These findings suggest that the policy did not only affect the cases near the incentive threshold of two days, but also induced a shift in the overall distribution of waiting times.

Finally, we find no evidence of a link between pre-surgery waiting times and post-surgery length of stay. If longer waiting times worsen patient outcomes, then more timely surgeries might allow hospitals to discharge patients earlier given their better health conditions. However, the results of our analysis do not show a policy impact on this indicator, with patient post-surgery length of stay remaining fairly constant over time for both treated and control groups of patients. Nevertheless, the results provided by our study may have important financial implications, given the potential cost savings associated with reductions in surgical delays.

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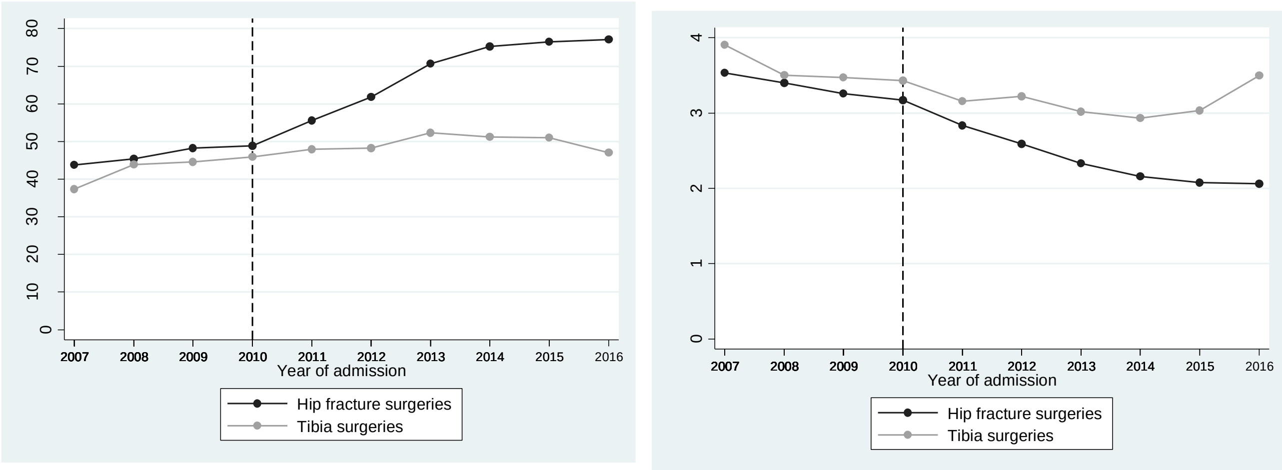
**Table 1**
Summary statistics for dependent variables and controls by treatment groups and policy periods [a]

| Variable name | Variable description | (A) Hip fracture patients (Treated) | | | | | (B) Tibia/fibula fracture patients (Untreated) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre-policy years ($n$ = 19,242) | | Post-policy years ($n$ = 31,331) | | Normalised difference | Pre-policy years ($n$ = 3,801) | | Post-policy years ($n$ = 5,175) | | Normalised difference |
| | | Mean | SD | Mean | SD | | Mean | SD | Mean | SD | |
| *Dependent variables* | | | | | | | | | | | |
| Pre-surgery wait time ≤ 2 days | Dummy = 1 if pre-surgery wait time within 2 days of admission | 0.466 | 0.499 | 0.699 | 0.459 | **0.343** | 0.430 | 0.495 | 0.496 | 0.500 | 0.094 |
| Pre-surgery wait time | Pre-surgery wait times (days) | 3.337 | 3.124 | 2.327 | 2.337 | **-0.259** | 3.573 | 3.484 | 3.142 | 3.307 | -0.090 |
| Pre-surgery wait time ≥ 4 days | Dummy = 1 if pre-surgery wait time equal to 4 days or more | 0.336 | 0.472 | 0.156 | 0.363 | **-0.303** | 0.399 | 0.490 | 0.332 | 0.471 | -0.099 |
| Post-surgery LOS | Post-surgery length of stay (days) | 14.064 | 10.055 | 13.458 | 9.550 | -0.044 | 6.600 | 6.499 | 6.461 | 6.827 | -0.015 |
| *Control variables* | | | | | | | | | | | |
| Age | Patient age in years | 81.092 | 10.814 | 81.698 | 10.661 | 0.040 | 50.431 | 17.500 | 52.596 | 17.060 | 0.089 |
| Female | Dummy = 1 for females | 0.757 | 0.429 | 0.749 | 0.434 | -0.014 | 0.390 | 0.488 | 0.426 | 0.495 | 0.051 |
| Foreigner | Dummy = 1 for foreigners | 0.005 | 0.067 | 0.008 | 0.087 | 0.028 | 0.093 | 0.290 | 0.101 | 0.302 | 0.020 |
| CCI 0 | Dummy = 1 if Charlson comorbidity index = 0 | 0.605 | 0.489 | 0.628 | 0.483 | 0.034 | 0.931 | 0.254 | 0.931 | 0.254 | 0.000 |
| CCI 1 | Dummy = 1 if Charlson comorbidity index = 1 | 0.235 | 0.424 | 0.213 | 0.409 | -0.038 | 0.050 | 0.217 | 0.049 | 0.216 | -0.001 |
| CCI 2 | Dummy = 1 if Charlson comorbidity index = 2 | 0.096 | 0.294 | 0.093 | 0.290 | -0.007 | 0.011 | 0.106 | 0.013 | 0.113 | 0.011 |
| CCI 3 | Dummy = 1 if Charlson comorbidity index = 3 | 0.040 | 0.196 | 0.040 | 0.196 | 0.001 | 0.002 | 0.049 | 0.003 | 0.054 | 0.007 |
| CCI 4+ | Dummy = 1 if Charlson comorbidity index > 3 | 0.025 | 0.156 | 0.026 | 0.160 | 0.005 | 0.006 | 0.078 | 0.004 | 0.065 | -0.018 |
| Chronic heart disease | Dummy = 1 for patients with chronic heart disease | 0.043 | 0.202 | 0.039 | 0.194 | -0.014 | 0.006 | 0.078 | 0.005 | 0.071 | -0.010 |
| Dementia | Dummy = 1 for patients with dementia disease | 0.148 | 0.355 | 0.146 | 0.353 | -0.004 | 0.005 | 0.071 | 0.007 | 0.085 | 0.021 |
| Chronic cerebrovascular disease | Dummy = 1 for patients with chronic cerebrovascular disease | 0.102 | 0.303 | 0.096 | 0.295 | -0.015 | 0.009 | 0.097 | 0.012 | 0.107 | 0.015 |
| Arthritis | Dummy = 1 for patients with arthritis | 0.009 | 0.095 | 0.007 | 0.083 | -0.017 | 0.002 | 0.043 | 0.002 | 0.044 | 0.001 |
| Nutritional disease | Dummy = 1 for patients with nutritional disease | 0.008 | 0.091 | 0.008 | 0.089 | -0.003 | 0.001 | 0.028 | 0.001 | 0.024 | -0.006 |
| Hemiplegia | Dummy = 1 for patients with hemiplegia | 0.010 | 0.098 | 0.007 | 0.081 | -0.024 | 0.002 | 0.049 | 0.004 | 0.065 | 0.023 |
| Blood disease | Dummy = 1 for patients with blood disease | 0.067 | 0.250 | 0.004 | 0.066 | -0.009 | 0.005 | 0.069 | 0.002 | 0.048 | 0.012 |
| Vascular disease | Dummy = 1 for patients with vascular disease | 0.041 | 0.198 | 0.083 | 0.276 | 0.043 | 0.011 | 0.103 | 0.014 | 0.118 | 0.021 |
| Chronic kidney disease | Dummy = 1 for patients with chronic kidney disease | 0.050 | 0.218 | 0.035 | 0.183 | -0.023 | 0.011 | 0.102 | 0.011 | 0.103 | 0.002 |
| Other chronic disease | Dummy = 1 for patients with liver, pancreas or intestine disease | 0.005 | 0.073 | 0.058 | 0.234 | 0.025 | 0.005 | 0.072 | 0.006 | 0.080 | 0.010 |
| Obesity | Dummy = 1 for obese patients | 0.005 | 0.072 | 0.007 | 0.081 | 0.014 | 0.002 | 0.040 | 0.005 | 0.071 | 0.003 |

[a] Pre- and post-policy years include 2007-2010 and 2011-2016, respectively.
The normalised difference is the defined as the difference in variable means between post- and pre-policy periods, scaled by the square root of the sum of variances.

**Figure 1**

Time trends in (a) the average proportion of patients waiting within 2 days of admission, and (b) pre-surgical wait time among hip fracture and tibia/fibula fracture patients over years 2007-2016




(a) (b)

**Figure 2**

Cumulative % of patients with hip fracture, by number of days waiting for surgery between years 2010-2016

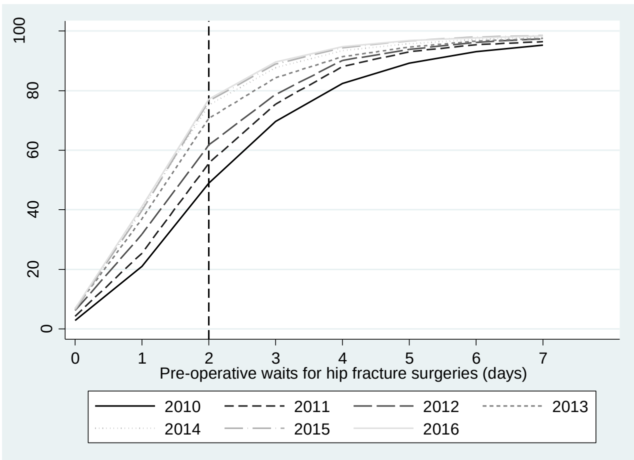


**Figure 3**

Time trends in the proportion of patients waiting 4 days or more for hip fracture surgeries and tibia/fibula fracture surgeries over years 2007-2016

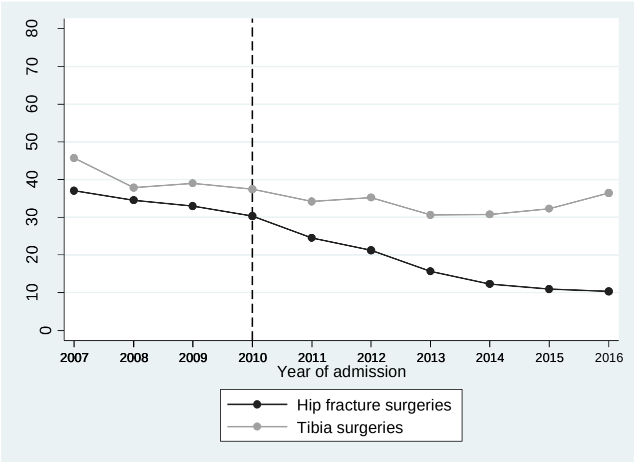



**Figure 4**

Time trends in the post-operative length of stay for hip fracture surgeries and tibia/fibula fracture surgeries over years 2007-2016

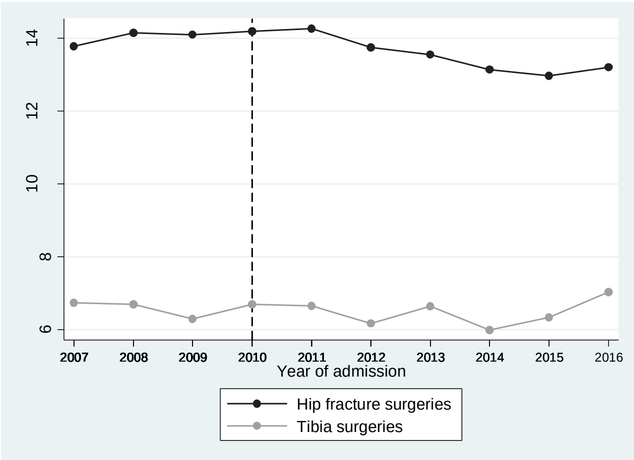


**Table 2**
Difference-in-differences results (Probit).
Dependent variable: dummy = 1 if pre-surgery wait time ≤ 2 days [a]

| Variable | Probit (1) | | Probit (2) | | Probit (3) | | Probit (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.095 | (0.077) | 0.119 | (0.078) | 0.123 | (0.077) | 0.121 | (0.077) |
| Treated × year 2007 | 0.126 | (0.092) | 0.125 | (0.092) | 0.124 | (0.091) | 0.149 | (0.090) |
| Treated × year 2008 | -0.027 | (0.069) | -0.029 | (0.069) | -0.028 | (0.068) | -0.019 | (0.073) |
| Treated × year 2009 | 0.025 | (0.052) | 0.027 | (0.052) | 0.027 | (0.052) | 0.030 | (0.055) |
| Treated × year 2011 | 0.101 | (0.091) | 0.100 | (0.091) | 0.104 | (0.092) | 0.105 | (0.092) |
| Treated × year 2012 | 0.237** | (0.085) | 0.236** | (0.085) | 0.238** | (0.086) | 0.239** | (0.085) |
| Treated × year 2013 | 0.392*** | (0.088) | 0.390*** | (0.090) | 0.392*** | (0.091) | 0.391*** | (0.090) |
| Treated × year 2014 | 0.567*** | (0.111) | 0.568*** | (0.110) | 0.567*** | (0.111) | 0.564*** | (0.115) |
| Treated × year 2015 | 0.568*** | (0.104) | 0.570*** | (0.105) | 0.570*** | (0.106) | 0.582*** | (0.105) |
| Treated × year 2016 | 0.688*** | (0.112) | 0.688*** | (0.113) | 0.691*** | (0.113) | 0.718*** | (0.105) |
| Age | -0.028*** | (0.002) | -0.027*** | (0.002) | -0.026*** | (0.002) | -0.026*** | (0.002) |
| Age squared | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) |
| Female | 0.097*** | (0.010) | 0.074*** | (0.010) | 0.068*** | (0.010) | 0.071*** | (0.010) |
| Foreigner | -0.098* | (0.041) | -0.098* | (0.041) | -0.098* | (0.041) | -0.095* | (0.040) |
| CCI 1 | | | -0.076*** | (0.020) | -0.076*** | (0.019) | -0.078*** | (0.020) |
| CCI 2 | | | -0.167*** | (0.028) | -0.146*** | (0.026) | -0.146*** | (0.024) |
| CCI 3 | | | -0.276*** | (0.032) | -0.221*** | (0.036) | -0.228*** | (0.035) |
| CCI 4+ | | | -0.351*** | (0.055) | -0.248*** | (0.060) | -0.246*** | (0.057) |
| Heart disease | | | | | -0.317*** | (0.045) | -0.326*** | (0.044) |
| Dementia | | | | | 0.102*** | (0.019) | 0.106*** | (0.018) |
| Cerebrovascular disease | | | | | -0.045* | (0.021) | -0.044* | (0.020) |
| Arthritis | | | | | -0.078 | (0.065) | -0.059 | (0.066) |
| Nutritional disease | | | | | 0.027 | (0.076) | 0.033 | (0.078) |
| Hemiplegia | | | | | 0.013 | (0.059) | 0.020 | (0.054) |
| Blood disease | | | | | -0.014 | (0.023) | 0.011 | (0.026) |
| Vascular disease | | | | | -0.090** | (0.033) | -0.100** | (0.033) |
| Kidney disease | | | | | -0.048 | (0.032) | -0.054 | (0.029) |
| Other chronic disease | | | | | 0.103 | (0.082) | 0.088 | (0.083) |
| Obesity | | | | | -0.124* | (0.058) | -0.114 | (0.059) |
| Constant | 0.966*** | (0.121) | 0.969*** | (0.122) | 0.948*** | (0.120) | 1.165*** | (0.124) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table 3**
Difference-in-differences results (LPM).
Dependent variable: dummy = 1 if pre-surgery wait time ≤ 2 days [a]

| Variable | LPM (1) | | LPM (2) | | LPM (3) | | LPM (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.038 | (0.029) | 0.047 | (0.029) | 0.048 | (0.029) | 0.048 | (0.029) |
| Treated × year 2007 | 0.045 | (0.034) | 0.045 | (0.034) | 0.045 | (0.034) | 0.052 | (0.032) |
| Treated × year 2008 | -0.011 | (0.027) | -0.011 | (0.027) | -0.011 | (0.026) | -0.007 | (0.027) |
| Treated × year 2009 | 0.009 | (0.020) | 0.010 | (0.020) | 0.010 | (0.020) | 0.011 | (0.021) |
| Treated × year 2011 | 0.039 | (0.035) | 0.038 | (0.035) | 0.040 | (0.035) | 0.040 | (0.035) |
| Treated × year 2012 | 0.089* | (0.032) | 0.089* | (0.032) | 0.089* | (0.032) | 0.090** | (0.032) |
| Treated × year 2013 | 0.141*** | (0.032) | 0.139*** | (0.032) | 0.139*** | (0.033) | 0.139*** | (0.032) |
| Treated × year 2014 | 0.199*** | (0.039) | 0.199*** | (0.039) | 0.198*** | (0.039) | 0.197*** | (0.041) |
| Treated × year 2015 | 0.198*** | (0.037) | 0.198*** | (0.037) | 0.198*** | (0.037) | 0.201*** | (0.038) |
| Treated × year 2016 | 0.244*** | (0.039) | 0.244*** | (0.039) | 0.244*** | (0.039) | 0.248*** | (0.036) |
| Age | -0.010*** | (0.001) | -0.010*** | (0.001) | -0.009*** | (0.001) | -0.009*** | (0.001) |
| Age squared | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) |
| Female | 0.034*** | (0.003) | 0.026*** | (0.003) | 0.024*** | (0.003) | 0.025*** | (0.003) |
| Foreigner | -0.036* | (0.016) | -0.036* | (0.015) | -0.036* | (0.0152) | -0.034* | (0.015) |
| CCI 1 | | | -0.026** | (0.007) | -0.027*** | (0.007) | -0.027*** | (0.007) |
| CCI 2 | | | -0.058*** | (0.010) | -0.051*** | (0.010) | -0.050*** | (0.009) |
| CCI 3 | | | -0.097*** | (0.012) | -0.078*** | (0.013) | -0.078*** | (0.013) |
| CCI 4+ | | | -0.124*** | (0.020) | -0.088*** | (0.022) | -0.086*** | (0.021) |
| Heart disease | | | | | -0.113*** | (0.016) | -0.115*** | (0.016) |
| Dementia | | | | | 0.036*** | (0.007) | 0.036*** | (0.006) |
| Cerebrovascular disease | | | | | -0.017* | (0.007) | -0.015* | (0.007) |
| Arthritis | | | | | -0.028 | (0.024) | -0.022 | (0.023) |
| Nutritional disease | | | | | 0.008 | (0.027) | 0.010 | (0.027) |
| Hemiplegia | | | | | 0.004 | (0.021) | 0.005 | (0.019) |
| Blood disease | | | | | -0.004 | (0.008) | 0.005 | (0.009) |
| Vascular disease | | | | | -0.033* | (0.012) | -0.036** | (0.012) |
| Kidney disease | | | | | -0.016 | (0.011) | -0.018 | (0.010) |
| Other chronic disease | | | | | 0.034 | (0.030) | 0.029 | (0.029) |
| Obesity | | | | | -0.044* | (0.021) | -0.041 | (0.020) |
| Constant | 0.857*** | (0.0456) | 0.858*** | (0.0457) | 0.849*** | (0.045) | 0.926*** | (0.047) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table 4**
Difference-in-differences results (OLS).
Dependent variable: (log of) pre-surgery wait time (days) [a]

| Variable | OLS (1) | | OLS (2) | | OLS (3) | | OLS (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.027 | (0.040) | -0.038 | (0.041) | -0.040 | (0.041) | -0.037 | (0.041) |
| Treated × year 2007 | -0.063 | (0.049) | -0.063 | (0.050) | -0.063 | (0.049) | -0.069 | (0.049) |
| Treated × year 2008 | 0.011 | (0.032) | 0.012 | (0.032) | 0.011 | (0.032) | 0.008 | (0.033) |
| Treated × year 2009 | -0.018 | (0.017) | -0.018 | (0.017) | -0.019 | (0.017) | -0.021 | (0.017) |
| Treated × year 2011 | -0.030 | (0.037) | -0.030 | (0.037) | -0.030 | (0.037) | -0.032 | (0.037) |
| Treated × year 2012 | -0.098* | (0.036) | -0.098* | (0.036) | -0.098* | (0.036) | -0.101* | (0.036) |
| Treated × year 2013 | -0.113** | (0.033) | -0.111** | (0.033) | -0.111** | (0.033) | -0.114** | (0.033) |
| Treated × year 2014 | -0.169*** | (0.036) | -0.168*** | (0.036) | -0.167*** | (0.036) | -0.171*** | (0.037) |
| Treated × year 2015 | -0.169*** | (0.040) | -0.169*** | (0.041) | -0.168*** | (0.041) | -0.180*** | (0.043) |
| Treated × year 2016 | -0.220*** | (0.042) | -0.219*** | (0.042) | -0.220*** | (0.042) | -0.234*** | (0.037) |
| Age | 0.014*** | (0.001) | 0.014*** | (0.001) | 0.013*** | (0.001) | 0.013*** | (0.001) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.041*** | (0.007) | -0.031*** | (0.006) | -0.028*** | (0.006) | -0.029*** | (0.006) |
| Foreigner | 0.052** | (0.014) | 0.051** | (0.014) | 0.052** | (0.014) | 0.048** | (0.015) |
| CCI 1 | | | 0.041*** | (0.009) | 0.041*** | (0.010) | 0.042*** | (0.010) |
| CCI 2 | | | 0.074*** | (0.009) | 0.063*** | (0.010) | 0.062*** | (0.010) |
| CCI 3 | | | 0.118*** | (0.016) | 0.089*** | (0.017) | 0.090*** | (0.017) |
| CCI 4+ | | | 0.155*** | (0.020) | 0.100*** | (0.023) | 0.097*** | (0.022) |
| Chronic heart disease | | | | | 0.124*** | (0.014) | 0.125*** | (0.014) |
| Dementia | | | | | -0.042*** | (0.006) | -0.042*** | (0.006) |
| Chronic cerebrovascular disease | | | | | 0.016 | (0.009) | 0.013 | (0.009) |
| Arthritis | | | | | 0.011 | (0.025) | 0.005 | (0.026) |
| Nutritional disease | | | | | 0.004 | (0.031) | 0.002 | (0.030) |
| Hemiplegia | | | | | 0.0108 | (0.027) | 0.009 | (0.025) |
| Blood disease | | | | | 0.008 | (0.010) | 0.000 | (0.010) |
| Vascular disease | | | | | 0.054** | (0.016) | 0.056** | (0.016) |
| Chronic kidney disease | | | | | 0.031* | (0.011) | 0.033** | (0.011) |
| Other chronic disease | | | | | 0.003 | (0.039) | 0.008 | (0.039) |
| Obesity | | | | | 0.052* | (0.024) | 0.051* | (0.024) |
| Constant | 0.661*** | (0.0833) | 0.661*** | (0.0840) | 0.671*** | (0.083) | 0.594*** | (0.083) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table 5**
Difference-in-differences results (Probit).
Dependent variable: dummy = 1 if pre-surgery wait time ≥ 4 days [a]

| Variable | Probit (1) | | Probit (2) | | Probit (3) | | Probit (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.226** | (0.073) | -0.261*** | (0.074) | -0.265*** | (0.073) | -0.263*** | (0.072) |
| Treated × year 2007 | -0.066 | (0.094) | -0.063 | (0.095) | -0.062 | (0.094) | -0.085 | (0.096) |
| Treated × year 2008 | 0.092 | (0.073) | 0.095 | (0.073) | 0.095 | (0.072) | 0.078 | (0.078) |
| Treated × year 2009 | 0.022 | (0.045) | 0.021 | (0.046) | 0.020 | (0.045) | 0.014 | (0.050) |
| Treated × year 2011 | -0.074 | (0.069) | -0.073 | (0.069) | -0.078 | (0.069) | -0.079 | (0.069) |
| Treated × year 2012 | -0.188* | (0.076) | -0.187* | (0.077) | -0.188* | (0.077) | -0.189* | (0.076) |
| Treated × year 2013 | -0.284*** | (0.076) | -0.282*** | (0.075) | -0.283*** | (0.077) | -0.282*** | (0.077) |
| Treated × year 2014 | -0.448*** | (0.109) | -0.452*** | (0.108) | -0.452*** | (0.109) | -0.454*** | (0.111) |
| Treated × year 2015 | -0.505*** | (0.098) | -0.509*** | (0.099) | -0.509*** | (0.099) | -0.527*** | (0.101) |
| Treated × year 2016 | -0.650*** | (0.105) | -0.650*** | (0.104) | -0.654*** | (0.104) | -0.683*** | (0.102) |
| Age | 0.027*** | (0.002) | 0.027*** | (0.002) | 0.026*** | (0.002) | 0.026*** | (0.002) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.133*** | (0.017) | -0.105*** | (0.016) | -0.095*** | (0.015) | -0.098*** | (0.015) |
| Foreigner | 0.124** | (0.045) | 0.124** | (0.044) | 0.124** | (0.044) | 0.120** | (0.043) |
| CCI 1 | | | 0.109*** | (0.023) | 0.105*** | (0.024) | 0.106*** | (0.024) |
| CCI 2 | | | 0.209*** | (0.026) | 0.170*** | (0.0282) | 0.172*** | (0.028) |
| CCI 3 | | | 0.344*** | (0.036) | 0.247*** | (0.043) | 0.255*** | (0.042) |
| CCI 4+ | | | 0.443*** | (0.045) | 0.266*** | (0.058) | 0.267*** | (0.054) |
| Chronic heart disease | | | | | 0.357*** | (0.037) | 0.365*** | (0.035) |
| Dementia | | | | | -0.094*** | (0.017) | -0.098*** | (0.017) |
| Chronic cerebrovascular disease | | | | | 0.035 | (0.023) | 0.030 | (0.023) |
| Arthritis | | | | | -0.029 | (0.077) | -0.046 | (0.076) |
| Nutritional disease | | | | | -0.040 | (0.064) | -0.044 | (0.063) |
| Hemiplegia | | | | | 0.018 | (0.052) | 0.018 | (0.049) |
| Blood disease | | | | | 0.005 | (0.026) | -0.017 | (0.029) |
| Vascular disease | | | | | 0.113*** | (0.034) | 0.122*** | (0.035) |
| Chronic kidney disease | | | | | 0.116*** | (0.031) | 0.120*** | (0.031) |
| Other chronic disease | | | | | 0.084 | (0.084) | 0.097 | (0.087) |
| Obesity | | | | | 0.130 | (0.072) | 0.121 | (0.074) |
| Constant | -1.466*** | (0.116) | -1.472*** | (0.117) | -1.450*** | (0.115) | -1.570*** | (0.120) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table 6**
Difference-in-differences results (LPM).
Dependent variable: dummy = 1 if pre-surgery wait time ≥ 4 days [a]

| Variable | LPM (1) | | LPM (2) | | LPM (3) | | LPM (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.082** | (0.026) | -0.091** | (0.026) | -0.093** | (0.026) | -0.091** | (0.025) |
| Treated × year 2007 | -0.028 | (0.034) | -0.028 | (0.035) | -0.027 | (0.034) | -0.033 | (0.034) |
| Treated × year 2008 | 0.032 | (0.028) | 0.032 | (0.027) | 0.032 | (0.027) | 0.027 | (0.028) |
| Treated × year 2009 | 0.007 | (0.017) | 0.006 | (0.017) | 0.006 | (0.017) | 0.004 | (0.018) |
| Treated × year 2011 | -0.020 | (0.024) | -0.020 | (0.024) | -0.021 | (0.024) | -0.022 | (0.024) |
| Treated × year 2012 | -0.056* | (0.026) | -0.056* | (0.026) | -0.056* | (0.026) | -0.057* | (0.026) |
| Treated × year 2013 | -0.068** | (0.023) | -0.067** | (0.022) | -0.067** | (0.022) | -0.068** | (0.022) |
| Treated × year 2014 | -0.105** | (0.032) | -0.105** | (0.031) | -0.104** | (0.031) | -0.105** | (0.031) |
| Treated × year 2015 | -0.118*** | (0.030) | -0.119*** | (0.030) | -0.118*** | (0.030) | -0.126*** | (0.031) |
| Treated × year 2016 | -0.164*** | (0.034) | -0.163*** | (0.033) | -0.164*** | (0.033) | -0.173*** | (0.030) |
| Age | 0.009*** | (0.001) | 0.009*** | (0.001) | 0.008*** | (0.001) | 0.008*** | (0.001) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.038*** | (0.005) | -0.030*** | (0.004) | -0.027*** | (0.004) | -0.028*** | (0.004) |
| Foreigner | 0.040* | (0.016) | 0.040* | (0.016) | 0.040* | (0.016) | 0.038* | (0.015) |
| CCI 1 | | | 0.030*** | (0.007) | 0.030*** | (0.007) | 0.030*** | (0.007) |
| CCI 2 | | | 0.059*** | (0.008) | 0.048*** | (0.008) | 0.047*** | (0.008) |
| CCI 3 | | | 0.099*** | (0.0122) | 0.071*** | (0.013) | 0.072*** | (0.013) |
| CCI 4+ | | | 0.135*** | (0.016) | 0.082*** | (0.018) | 0.081*** | (0.016) |
| Heart disease | | | | | 0.115*** | (0.014) | 0.116*** | (0.013) |
| Dementia | | | | | -0.029*** | (0.005) | -0.028*** | (0.005) |
| Cerebrovascular disease | | | | | 0.010 | (0.007) | 0.009 | (0.007) |
| Arthritis | | | | | -0.011 | (0.023) | -0.015 | (0.022) |
| Nutritional disease | | | | | -0.009 | (0.019) | -0.010 | (0.018) |
| Hemiplegia | | | | | 0.007 | (0.017) | 0.009 | (0.016) |
| Blood disease | | | | | 0.001 | (0.008) | -0.007 | (0.009) |
| Vascular disease | | | | | 0.035** | (0.011) | 0.038** | (0.011) |
| Kidney disease | | | | | 0.033** | (0.010) | 0.035** | (0.009) |
| Other chronic disease | | | | | 0.031 | (0.028) | 0.033 | (0.028) |
| Obesity | | | | | 0.039 | (0.023) | 0.036 | (0.023) |
| Constant | 0.020 | (0.039) | 0.019 | (0.039) | 0.027 | (0.038) | -0.016 | (0.040) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table 7**
Difference-in-differences results (OLS).
Dependent variable: post-surgery length of stay (days) [a]

| Variable | OLS (1) | | OLS (2) | | OLS (3) | | OLS (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.480*** | (0.051) | 0.455*** | (0.050) | 0.452*** | (0.050) | 0.454*** | (0.050) |
| Treated × year 2007 | -0.086 | (0.060) | -0.086 | (0.059) | -0.086 | (0.060) | -0.091 | (0.060) |
| Treated × year 2008 | -0.045 | (0.053) | -0.043 | (0.052) | -0.042 | (0.052) | -0.047 | (0.052) |
| Treated × year 2009 | 0.016 | (0.030) | 0.016 | (0.029) | 0.016 | (0.029) | 0.011 | (0.029) |
| Treated × year 2011 | -0.001 | (0.048) | 0.002 | (0.047) | 0.001 | (0.047) | -0.000 | (0.048) |
| Treated × year 2012 | 0.054 | (0.049) | 0.056 | (0.048) | 0.056 | (0.048) | 0.055 | (0.048) |
| Treated × year 2013 | -0.011 | (0.038) | -0.004 | (0.036) | -0.004 | (0.036) | -0.006 | (0.037) |
| Treated × year 2014 | 0.038 | (0.063) | 0.041 | (0.062) | 0.042 | (0.062) | 0.042 | (0.061) |
| Treated × year 2015 | 0.035 | (0.060) | 0.037 | (0.060) | 0.037 | (0.060) | 0.037 | (0.061) |
| Treated × year 2016 | 0.015 | (0.055) | 0.019 | (0.055) | 0.020 | (0.055) | 0.011 | (0.055) |
| Age | 0.011*** | (0.002) | 0.011*** | (0.002) | 0.010*** | (0.002) | 0.010*** | (0.002) |
| Age squared | -0.000 | (0.000) | -0.000 | (0.000) | -0.000 | (0.000) | -0.000 | (0.000) |
| Female | -0.009 | (0.010) | 0.009 | (0.009) | 0.011 | (0.009) | 0.011 | (0.009) |
| Foreigner | 0.036 | (0.019) | 0.036 | (0.018) | 0.036 | (0.018) | 0.037 | (0.019) |
| CCI 1 | | | 0.124*** | (0.019) | 0.124*** | (0.015) | 0.123*** | (0.015) |
| CCI 2 | | | 0.173*** | (0.029) | 0.173*** | (0.023) | 0.173*** | (0.023) |
| CCI 3 | | | 0.197*** | (0.033) | 0.199*** | (0.030) | 0.197*** | (0.030) |
| CCI 4+ | | | 0.224*** | (0.041) | 0.215*** | (0.037) | 0.214*** | (0.037) |
| Heart disease | | | | | 0.076*** | (0.013) | 0.075*** | (0.012) |
| Dementia | | | | | -0.041 | (0.023) | -0.040 | (0.022) |
| Cerebrovascular disease | | | | | 0.028 | (0.017) | 0.029 | (0.017) |
| Arthritis | | | | | -0.003 | (0.046) | -0.001 | (0.045) |
| Nutritional disease | | | | | 0.010 | (0.030) | 0.019 | (0.029) |
| Hemiplegia | | | | | 0.022 | (0.047) | 0.026 | (0.049) |
| Blood disease | | | | | 0.008 | (0.019) | 0.005 | (0.019) |
| Vascular disease | | | | | 0.037** | (0.011) | 0.037** | (0.011) |
| Kidney disease | | | | | -0.034 | (0.019) | -0.031 | (0.019) |
| Other chronic disease | | | | | 0.106* | (0.039) | 0.110* | (0.040) |
| Obesity | | | | | 0.052 | (0.034) | 0.054 | (0.034) |
| Constant | 1.220*** | (0.100) | 1.220*** | (0.0999) | 1.229*** | (0.101) | 1.230*** | (0.099) |
| N | 59,549 | | 59,549 | | 59,549 | | 59,549 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

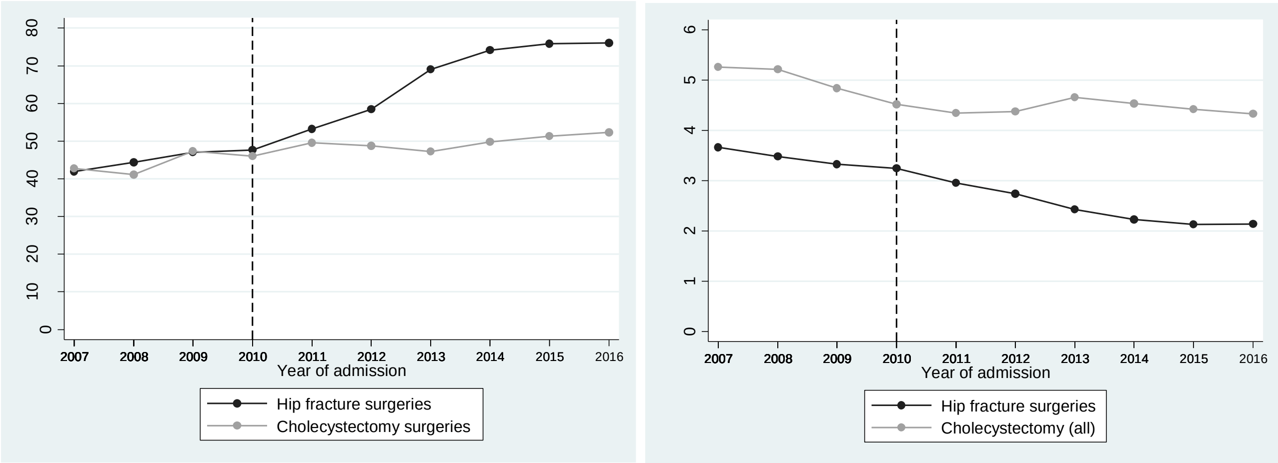
**Table 8**
Size of the impact of the policy on the probability of undergoing hip fracture surgery within 2 days of admission: Average Partial Effects (APE)

| Year | Average Partial Effect (APE) |
|---|---|
| 2010 | 0.045 |
| 2011 | 0.085 |
| 2012 | 0.136 |
| 2013 | 0.185 |
| 2014 | 0.242 |
| 2015 | 0.243 |
| 2016 | 0.290 |

## Appendix

**Figure A1**

Time trends in (a) the average proportion of patients waiting within 2 days of admission, and (b) pre-surgical wait time for hip fracture patients and cholecystectomy patients over years 2007-2016




(a) (b)

**Figure A2**

Time trends in the proportion of patients waiting 4 days or more for hip fracture surgeries and cholecystectomy surgeries over years 2007-2016

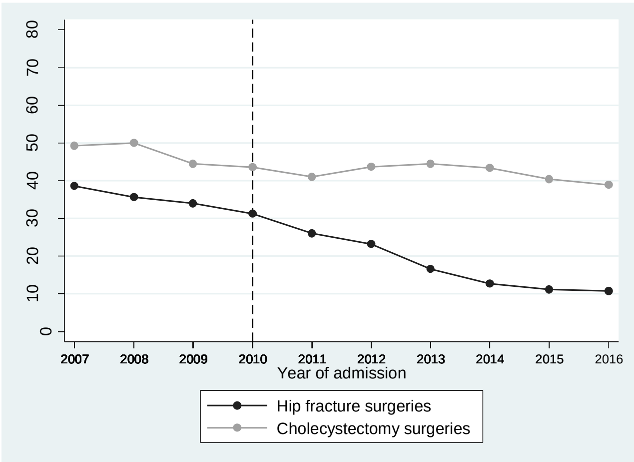



**Figure A3**

Time trends in the post-operative length of stay for hip fracture surgeries and cholecystectomy surgeries over years 2007-2016

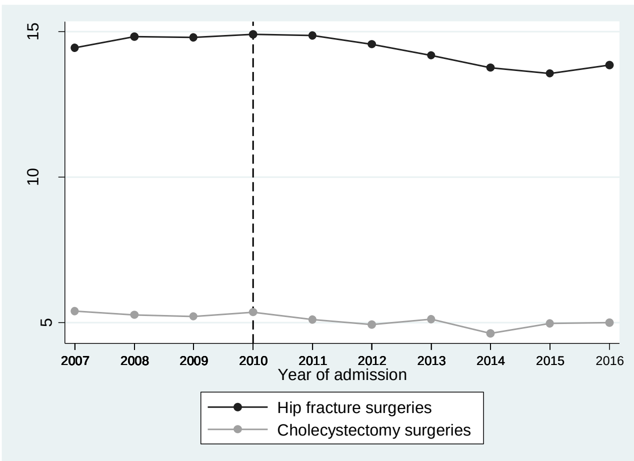


**Table A1**
Difference-in-differences results (Probit).
Dependent variable: dummy = 1 if pre-surgery wait time ≤ 2 days [a]

| Variable | Probit (1) | | Probit (2) | | Probit (3) | | Probit (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.044 | (0.071) | 0.058 | (0.071) | 0.054 | (0.070) | 0.057 | (0.072) |
| Treated × year 2007 | -0.053 | (0.135) | -0.056 | (0.135) | -0.057 | (0.134) | -0.038 | (0.145) |
| Treated × year 2008 | 0.065 | (0.092) | 0.062 | (0.092) | 0.058 | (0.092) | 0.080 | (0.098) |
| Treated × year 2009 | -0.039 | (0.077) | -0.037 | (0.077) | -0.036 | (0.076) | -0.036 | (0.080) |
| Treated × year 2011 | 0.057 | (0.061) | 0.057 | (0.061) | 0.056 | (0.060) | 0.057 | (0.060) |
| Treated × year 2012 | 0.207** | (0.076) | 0.204** | (0.076) | 0.203** | (0.077) | 0.197* | (0.079) |
| Treated × year 2013 | 0.547*** | (0.115) | 0.544*** | (0.116) | 0.546*** | (0.117) | 0.540*** | (0.116) |
| Treated × year 2014 | 0.621*** | (0.113) | 0.620*** | (0.113) | 0.620*** | (0.112) | 0.600*** | (0.109) |
| Treated × year 2015 | 0.653*** | (0.155) | 0.656*** | (0.156) | 0.657*** | (0.157) | 0.650*** | (0.156) |
| Treated × year 2016 | 0.629*** | (0.123) | 0.633*** | (0.122) | 0.632*** | (0.122) | 0.620*** | (0.118) |
| Age | -0.037*** | (0.003) | -0.037*** | (0.003) | -0.035*** | (0.003) | -0.036*** | (0.003) |
| Age squared | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) | 0.000*** | (0.000) |
| Female | 0.077*** | (0.013) | 0.057*** | (0.013) | 0.047*** | (0.012) | 0.051*** | (0.012) |
| Foreigner | -0.087* | (0.036) | -0.082* | (0.0365) | -0.080* | (0.036) | -0.084* | (0.037) |
| CCI 1 | | | -0.084*** | -0.018 | -0.078*** | (0.018) | -0.077*** | (0.018) |
| CCI 2 | | | -0.161*** | -0.027 | -0.127*** | (0.025) | -0.123*** | (0.024) |
| CCI 3 | | | -0.280*** | -0.033 | -0.207*** | (0.035) | -0.212*** | (0.033) |
| CCI 4+ | | | -0.350*** | -0.052 | -0.212*** | (0.056) | -0.206*** | (0.053) |
| Heart disease | | | | | -0.322*** | (0.046) | -0.329*** | (0.045) |
| Dementia | | | | | 0.105*** | (0.021) | 0.106*** | (0.020) |
| Cerebrovascular disease | | | | | -0.051** | (0.019) | -0.053** | (0.017) |
| Arthritis | | | | | -0.133* | (0.065) | -0.108 | (0.068) |
| Nutritional disease | | | | | -0.019 | (0.075) | -0.011 | (0.078) |
| Hemiplegia | | | | | -0.031 | (0.069) | -0.014 | (0.066) |
| Blood disease | | | | | -0.046 | (0.025) | -0.027 | (0.026) |
| Vascular disease | | | | | -0.096** | (0.030) | -0.101** | (0.031) |
| Kidney disease | | | | | -0.056 | (0.031) | -0.068* | (0.028) |
| Other chronic disease | | | | | -0.161** | (0.056) | -0.169** | (0.060) |
| Obesity | | | | | 0.136 | (0.097) | 0.124 | (0.091) |
| Constant | 1.488*** | (0.113) | 1.494*** | -0.111 | 1.457*** | (0.111) | 1.687*** | (0.101) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A2**

Difference-in-differences results (LPM).

Dependent variable: dummy = 1 if pre-surgery wait time ≤ 2 days [a]

| Variable | LPM (1) | | LPM (2) | | LPM (3) | | LPM (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.019 | (0.027) | 0.024 | -0.027 | 0.023 | (0.026) | 0.024 | (0.027) |
| Treated × year 2007 | -0.021 | (0.051) | -0.022 | -0.051 | -0.023 | (0.051) | -0.016 | (0.052) |
| Treated × year 2008 | 0.024 | (0.035) | 0.023 | -0.035 | 0.021 | (0.035) | 0.028 | (0.036) |
| Treated × year 2009 | -0.015 | (0.029) | -0.014 | -0.029 | -0.014 | (0.029) | -0.013 | (0.029) |
| Treated × year 2011 | 0.022 | (0.023) | 0.022 | -0.023 | 0.021 | (0.023) | 0.022 | (0.022) |
| Treated × year 2012 | 0.080* | (0.029) | 0.078* | -0.029 | 0.077* | (0.029) | 0.076* | (0.030) |
| Treated × year 2013 | 0.203*** | (0.041) | 0.201*** | -0.041 | 0.201*** | (0.042) | 0.200*** | (0.042) |
| Treated × year 2014 | 0.224*** | (0.040) | 0.223*** | -0.04 | 0.222*** | (0.039) | 0.215*** | (0.038) |
| Treated × year 2015 | 0.233*** | (0.054) | 0.233*** | -0.053 | 0.233*** | (0.054) | 0.227*** | (0.054) |
| Treated × year 2016 | 0.224*** | (0.043) | 0.225*** | -0.043 | 0.224*** | (0.043) | 0.215*** | (0.041) |
| Age | -0.014*** | (0.001) | -0.014*** | -0.001 | -0.013*** | (0.001) | -0.013*** | (0.001) |
| Age squared | 0.000*** | (0.000) | 0.000*** | -0.000 | 0.001*** | (0.000) | 0.000*** | (0.000) |
| Female | 0.028*** | (0.006) | 0.020*** | -0.004 | 0.017*** | (0.004) | 0.018*** | (0.004) |
| Foreigner | -0.032* | (0.013) | -0.030* | -0.014 | -0.030* | (0.013) | -0.030* | (0.014) |
| CCI 1 | | | -0.030*** | -0.007 | -0.028*** | (0.007) | -0.027*** | (0.007) |
| CCI 2 | | | -0.058*** | -0.01 | -0.045*** | (0.010) | -0.043*** | (0.009) |
| CCI 3 | | | -0.100*** | -0.012 | -0.074*** | (0.013) | -0.074*** | (0.012) |
| CCI 4+ | | | -0.126*** | -0.02 | -0.076** | (0.021) | -0.072** | (0.019) |
| Heart disease | | | | | -0.116*** | (0.017) | -0.116*** | (0.016) |
| Dementia | | | | | 0.037*** | (0.007) | 0.037*** | (0.007) |
| Cerebrovascular disease | | | | | -0.019* | (0.007) | -0.019** | (0.006) |
| Arthritis | | | | | -0.049 | (0.024) | -0.040 | (0.025) |
| Nutritional disease | | | | | -0.007 | (0.027) | -0.003 | (0.028) |
| Hemiplegia | | | | | -0.011 | (0.025) | -0.006 | (0.024) |
| Blood disease | | | | | -0.016 | (0.009) | -0.009 | (0.009) |
| Vascular disease | | | | | -0.035** | (0.011) | -0.037** | (0.011) |
| Kidney disease | | | | | -0.020 | (0.011) | -0.024* | (0.010) |
| Other chronic disease | | | | | -0.061** | (0.021) | -0.063** | (0.022) |
| Obesity | | | | | 0.051 | (0.036) | 0.045 | (0.034) |
| Constant | 1.054*** | (0.043) | 1.055*** | (0.042) | 1.040*** | (0.042) | 1.118*** | (0.038) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A3**
Difference-in-differences results (OLS).
Dependent variable: (log of) pre-surgery wait time (days) [a]

| Variable | OLS (1) | | OLS (2) | | OLS (3) | | OLS (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.128* | (0.047) | -0.136** | (0.047) | -0.132** | (0.046) | -0.133** | (0.047) |
| Treated × year 2007 | -0.026 | (0.079) | -0.025 | (0.079) | -0.024 | (0.078) | -0.030 | (0.079) |
| Treated × year 2008 | -0.072 | (0.057) | -0.070 | (0.057) | -0.069 | (0.056) | -0.076 | (0.057) |
| Treated × year 2009 | 0.004 | (0.037) | 0.003 | (0.037) | 0.002 | (0.036) | 0.001 | (0.036) |
| Treated × year 2011 | -0.013 | (0.038) | -0.012 | (0.038) | -0.011 | (0.038) | -0.011 | (0.038) |
| Treated × year 2012 | -0.071 | (0.051) | -0.069 | (0.052) | -0.068 | (0.052) | -0.067 | (0.052) |
| Treated × year 2013 | -0.199** | (0.069) | -0.196** | (0.069) | -0.195** | (0.069) | -0.194* | (0.070) |
| Treated × year 2014 | -0.215** | (0.063) | -0.212** | (0.063) | -0.213** | (0.063) | -0.208** | (0.062) |
| Treated × year 2015 | -0.207** | (0.063) | -0.207** | (0.063) | -0.207** | (0.063) | -0.203** | (0.063) |
| Treated × year 2016 | -0.175** | (0.060) | -0.175** | (0.059) | -0.175** | (0.059) | -0.167** | (0.058) |
| Age | 0.024*** | (0.001) | 0.023*** | (0.001) | 0.022*** | (0.001) | 0.022*** | (0.001) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.034*** | (0.008) | -0.024** | (0.008) | -0.018* | (0.008) | -0.020* | (0.008) |
| Foreigner | 0.049* | (0.019) | 0.047* | (0.019) | 0.045* | (0.019) | 0.046* | (0.019) |
| CCI 1 | | | 0.054*** | (0.008) | 0.052*** | (0.009) | 0.051*** | (0.008) |
| CCI 2 | | | 0.086*** | (0.012) | 0.067*** | (0.013) | 0.064*** | (0.013) |
| CCI 3 | | | 0.135*** | (0.019) | 0.090*** | (0.019) | 0.089*** | (0.018) |
| CCI 4+ | | | 0.179*** | (0.027) | 0.091** | (0.026) | 0.086** | (0.025) |
| Chronic heart disease | | | | | 0.143*** | (0.022) | 0.144*** | (0.021) |
| Dementia | | | | | -0.046*** | (0.008) | -0.045*** | (0.008) |
| Chronic cerebrovascular disease | | | | | 0.015 | (0.009) | 0.014 | (0.008) |
| Arthritis | | | | | 0.017 | (0.032) | 0.008 | (0.032) |
| Nutritional disease | | | | | 0.019 | (0.035) | 0.015 | (0.033) |
| Hemiplegia | | | | | 0.045 | (0.036) | 0.038 | (0.033) |
| Blood disease | | | | | 0.032* | (0.014) | 0.024 | (0.014) |
| Vascular disease | | | | | 0.057** | (0.016) | 0.059** | (0.016) |
| Chronic kidney disease | | | | | 0.047*** | (0.011) | 0.052*** | (0.010) |
| Other chronic disease | | | | | 0.188*** | (0.025) | 0.191*** | (0.026) |
| Obesity | | | | | -0.079 | (0.056) | -0.073 | (0.053) |
| Constant | 0.288*** | (0.0624) | 0.287*** | (0.062) | 0.309*** | (0.062) | 0.218** | (0.058) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A4**
Difference-in-differences results (Probit).
Dependent variable: dummy = 1 if pre-surgery wait time ≥ 4 days [a]

| Variable | Probit (1) | | Probit (2) | | Probit (3) | | Probit (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.384*** | (0.068) | -0.404*** | (0.068) | -0.398*** | (0.067) | -0.404*** | (0.069) |
| Treated × year 2007 | 0.065 | (0.155) | 0.070 | (0.155) | 0.072 | (0.154) | 0.038 | (0.161) |
| Treated × year 2008 | -0.056 | (0.081) | -0.051 | (0.081) | -0.047 | (0.082) | -0.074 | (0.085) |
| Treated × year 2009 | 0.046 | (0.060) | 0.044 | (0.059) | 0.042 | (0.059) | 0.039 | (0.060) |
| Treated × year 2011 | -0.089 | (0.072) | -0.088 | (0.073) | -0.089 | (0.071) | -0.087 | (0.071) |
| Treated × year 2012 | -0.243** | (0.093) | -0.239* | (0.094) | -0.238* | (0.095) | -0.230* | (0.097) |
| Treated × year 2013 | -0.517*** | (0.137) | -0.514*** | (0.138) | -0.515*** | (0.139) | -0.510*** | (0.142) |
| Treated × year 2014 | -0.640*** | (0.113) | -0.640*** | (0.112) | -0.641*** | (0.112) | -0.625*** | (0.113) |
| Treated × year 2015 | -0.645*** | (0.145) | -0.649*** | (0.145) | -0.651*** | (0.146) | -0.643*** | (0.147) |
| Treated × year 2016 | -0.616*** | (0.122) | -0.621*** | (0.120) | -0.621*** | (0.120) | -0.608*** | (0.122) |
| Age | 0.039*** | (0.004) | 0.038*** | (0.004) | 0.036*** | (0.004) | 0.037*** | (0.004) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.092*** | (0.017) | -0.067*** | (0.016) | -0.055*** | (0.016) | -0.057*** | (0.016) |
| Foreigner | 0.096** | (0.036) | 0.090* | (0.035) | 0.088* | (0.035) | 0.089* | (0.035) |
| CCI 1 | | | 0.113*** | (0.017) | 0.101*** | (0.017) | 0.099*** | (0.016) |
| CCI 2 | | | 0.196*** | (0.024) | 0.139*** | (0.025) | 0.137*** | (0.024) |
| CCI 3 | | | 0.336*** | (0.037) | 0.215*** | (0.042) | 0.218*** | (0.041) |
| CCI 4+ | | | 0.430*** | (0.047) | 0.217*** | (0.054) | 0.211*** | (0.0513) |
| Heart disease | | | | | 0.337*** | (0.040) | 0.342*** | (0.040) |
| Dementia | | | | | -0.087*** | (0.019) | -0.088*** | (0.019) |
| Cerebrovascular disease | | | | | 0.038* | (0.019) | 0.036* | (0.017) |
| Arthritis | | | | | 0.067 | (0.066) | 0.047 | (0.066) |
| Nutritional disease | | | | | 0.019 | (0.062) | 0.014 | (0.060) |
| Hemiplegia | | | | | 0.098 | (0.054) | 0.090 | (0.053) |
| Blood disease | | | | | 0.048 | (0.026) | 0.032 | (0.028) |
| Vascular disease | | | | | 0.121*** | (0.030) | 0.127*** | (0.031) |
| Kidney disease | | | | | 0.127*** | (0.037) | 0.137*** | (0.037) |
| Other chronic disease | | | | | 0.254*** | (0.058) | 0.262*** | (0.061) |
| Obesity | | | | | -0.146 | (0.083) | -0.123 | (0.073) |
| Constant | -1.858*** | (0.140) | -1.867*** | (0.137) | -1.830*** | (0.139) | -1.988*** | (0.135) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A5**
Difference-in-differences results (LPM).
Dependent variable: dummy = 1 if pre-surgery wait time ≥ 4 days [a]

| Variable | LPM (1) | | LPM (2) | | LPM (3) | | LPM (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | -0.143*** | (0.025) | -0.149*** | (0.025) | -0.147*** | (0.024) | -0.146*** | (0.025) |
| Treated × year 2007 | 0.019 | (0.057) | 0.021 | (0.057) | 0.021 | (0.057) | 0.015 | (0.057) |
| Treated × year 2008 | -0.025 | (0.029) | -0.023 | (0.029) | -0.022 | (0.029) | -0.028 | (0.030) |
| Treated × year 2009 | 0.015 | (0.022) | 0.015 | (0.022) | 0.014 | (0.021) | 0.015 | (0.021) |
| Treated × year 2011 | -0.026 | (0.025) | -0.026 | (0.025) | -0.025 | (0.025) | -0.026 | (0.025) |
| Treated × year 2012 | -0.079* | (0.031) | -0.077* | (0.032) | -0.076* | (0.032) | -0.077* | (0.033) |
| Treated × year 2013 | -0.154** | (0.041) | -0.152** | (0.041) | -0.152** | (0.041) | -0.152** | (0.042) |
| Treated × year 2014 | -0.177*** | (0.036) | -0.175*** | (0.035) | -0.175*** | (0.035) | -0.171*** | (0.035) |
| Treated × year 2015 | -0.166** | (0.045) | -0.166** | (0.045) | -0.166** | (0.045) | -0.163** | (0.045) |
| Treated × year 2016 | -0.153*** | (0.038) | -0.153*** | (0.037) | -0.152*** | (0.037) | -0.146*** | (0.037) |
| Age | 0.013*** | (0.001) | 0.013*** | (0.001) | 0.012*** | (0.001) | 0.012*** | (0.001) |
| Age squared | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) | -0.000*** | (0.000) |
| Female | -0.029*** | (0.005) | -0.021*** | (0.005) | -0.017** | (0.005) | -0.018** | (0.005) |
| Foreigner | 0.032* | (0.012) | 0.030* | (0.012) | 0.029* | (0.012) | 0.029* | (0.012) |
| CCI 1 | | | 0.034*** | (0.006) | 0.031*** | (0.006) | 0.030*** | (0.005) |
| CCI 2 | | | 0.059*** | (0.008) | 0.042*** | (0.008) | 0.040*** | (0.008) |
| CCI 3 | | | 0.103*** | (0.013) | 0.066*** | (0.014) | 0.066*** | (0.013) |
| CCI 4+ | | | 0.136*** | (0.018) | 0.068** | (0.018) | 0.065*** | (0.017) |
| Heart disease | | | | | 0.114*** | (0.015) | 0.114*** | (0.014) |
| Dementia | | | | | -0.029*** | (0.005) | -0.028*** | (0.005) |
| Cerebrovascular disease | | | | | 0.012 | (0.006) | 0.011* | (0.005) |
| Arthritis | | | | | 0.019 | (0.021) | 0.013 | (0.021) |
| Nutritional disease | | | | | 0.008 | (0.019) | 0.005 | (0.019) |
| Hemiplegia | | | | | 0.033 | (0.018) | 0.030 | (0.018) |
| Blood disease | | | | | 0.014 | (0.008) | 0.008 | (0.009) |
| Vascular disease | | | | | 0.040*** | (0.010) | 0.041*** | (0.010) |
| Kidney disease | | | | | 0.039** | (0.012) | 0.042** | (0.012) |
| Other chronic disease | | | | | 0.096*** | (0.021) | 0.100*** | (0.022) |
| Obesity | | | | | -0.052 | (0.029) | -0.046 | (0.027) |
| Constant | -0.127* | (0.0466) | -0.128* | (0.0459) | -0.114* | (0.046) | -0.166*** | (0.044) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A6**
Difference-in-differences results (OLS).
Dependent variable: post-surgery length of stay (days) [a]

| Variable | OLS (1) | | OLS (2) | | OLS (3) | | OLS (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | SE | Coeff. | SE | Coeff. | SE | Coeff. | SE |
| Treated | 0.779*** | (0.049) | 0.764*** | (0.047) | 0.770*** | (0.047) | 0.771*** | (0.047) |
| Treated × year 2007 | -0.042 | (0.049) | -0.040 | (0.049) | -0.039 | (0.047) | -0.045 | (0.048) |
| Treated × year 2008 | 0.013 | (0.060) | 0.018 | (0.060) | 0.018 | (0.059) | 0.013 | (0.059) |
| Treated × year 2009 | 0.013 | (0.049) | 0.011 | (0.049) | 0.011 | (0.050) | 0.010 | (0.050) |
| Treated × year 2011 | -0.018 | (0.042) | -0.016 | (0.042) | -0.014 | (0.042) | -0.015 | (0.042) |
| Treated × year 2012 | 0.020 | (0.032) | 0.023 | (0.031) | 0.023 | (0.030) | 0.023 | (0.031) |
| Treated × year 2013 | -0.029 | (0.045) | -0.023 | (0.045) | -0.020 | (0.044) | -0.022 | (0.045) |
| Treated × year 2014 | 0.007 | (0.045) | 0.014 | (0.045) | 0.013 | (0.045) | 0.014 | (0.046) |
| Treated × year 2015 | -0.005 | (0.050) | -0.006 | (0.050) | -0.006 | (0.048) | -0.007 | (0.050) |
| Treated × year 2016 | 0.001 | (0.060) | 0.000 | (0.061) | 0.001 | (0.060) | -0.001 | (0.060) |
| Age | 0.018*** | (0.003) | 0.018*** | (0.003) | 0.020*** | (0.003) | 0.017*** | (0.003) |
| Age squared | -0.000* | (0.000) | -0.000** | (0.000) | -0.000* | (0.000) | -0.000* | (0.000) |
| Female | -0.017 | (0.010) | 0.003 | (0.010) | 0.006 | (0.010) | 0.006 | (0.010) |
| Foreigner | 0.012 | (0.012) | 0.006 | (0.013) | 0.006 | (0.013) | 0.004 | (0.013) |
| CCI 1 | | | 0.135*** | (0.019) | 0.134*** | (0.016) | 0.132*** | (0.016) |
| CCI 2 | | | 0.198*** | (0.026) | 0.194*** | (0.022) | 0.194*** | (0.022) |
| CCI 3 | | | 0.239*** | (0.032) | 0.232*** | (0.032) | 0.230*** | (0.032) |
| CCI 4+ | | | 0.279*** | (0.042) | 0.249*** | (0.042) | 0.250*** | (0.042) |
| Heart disease | | | | | 0.065*** | (0.010) | 0.065*** | (0.010) |
| Dementia | | | | | -0.044 | (0.026) | -0.043 | (0.030) |
| Cerebrovascular disease | | | | | 0.028 | (0.020) | 0.029 | (0.021) |
| Arthritis | | | | | -0.025 | (0.048) | -0.023 | (0.048) |
| Nutritional disease | | | | | 0.052 | (0.031) | 0.060 | (0.031) |
| Hemiplegia | | | | | 0.021 | (0.052) | 0.023 | (0.053) |
| Blood disease | | | | | 0.025 | (0.015) | 0.021 | (0.016) |
| Vascular disease | | | | | 0.032* | (0.014) | 0.031* | (0.014) |
| Kidney disease | | | | | -0.018 | (0.018) | -0.014 | (0.018) |
| Other chronic disease | | | | | 0.239*** | (0.046) | 0.241*** | (0.045) |
| Obesity | | | | | 0.008 | (0.039) | 0.012 | (0.039) |
| Constant | 0.617*** | (0.0731) | 0.617*** | (0.0735) | 0.632*** | (0.073) | 0.641*** | (0.073) |
| N | 59,642 | | 59,642 | | 59,642 | | 59,642 | |
| Year FE | Y | | Y | | Y | | Y | |
| Hospital FE | Y | | Y | | Y | | Y | |
| Hospital time trends | N | | N | | N | | Y | |

[a] Hospital cluster robust standard errors in parentheses.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

**Table A7**

Size of the impact of the policy on the probability of undergoing hip fracture surgery within 2 days of admission: Average Partial Effects (APE)

| Year | Average Partial Effect (APE) |
|---|---|
| 2010 | 0.021 |
| 2011 | 0.043 |
| 2012 | 0.097 |
| 2013 | 0.221 |
| 2014 | 0.235 |
| 2015 | 0.248 |
| 2016 | 0.233 |