See You at Night: Emergency Department Response to Financial Incentives in Taiwan

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Abstract

This paper studies a plausibly exogenous policy change in the Taiwanese universal healthcare system and tests hospital responses to financial incentives. A subsidy policy increased diagnostic fee bonuses for night emergency department admissions by 30% in 2010. Using an event study, we find evidence of manipulation—the night admission share increased by 39% among the least urgent patients but not the most urgent ones. The increase implies that hospitals delayed the least urgent admissions in order to increase profits. However, this policy led to insignificant improvements in care capacity, treatment intensity, and health outcomes. Evidence also suggests no substitution effects between emergency care and primary care.

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1 Introduction

Ensuring consistent performance quality within an emergency department (ED) has been a significant challenge. Limited resources often result in EDs experiencing crowding, which is associated with lower care quality and negative outcomes (Fee et al. 2007, Kulstad et al. 2010, Cha et al. 2011, Forero et al. 2011, Hong et al. 2013, Stang et al. 2015). This is particularly problematic during nighttime, as wait times tend to be longer, leading to adverse effects (Goodacre & Webster 2005, Kim 2010). Several measures have been proposed to alleviate this widespread issue, including setting wait time targets and implementing financial incentives such as pay-for-performance programs. However, their effectiveness depends on how hospitals and individuals respond to them, and sometimes these measures can result in unintended consequences.[1]

This paper examines how hospitals respond to financial incentives as a measure to improve ED care provision and quality during the night. The National Health Insurance (NHI) in Taiwan has imposed a subsidy program for 24-hour EDs, where hospitals receive extra diagnostic fees as a bonus when they admit a patient during the nighttime bonus window, between 10 pm and 6 am. In 2010, the diagnostic fee bonus increased by 30%, and this policy amounted to over five million US dollars in the same year.[2] Yet, it is unclear whether this policy has brought improvements in emergency care, especially when this ongoing policy is not tied to a specific expenditure.

In this paper, we investigate how EDs respond to the subsidy program at the institutional level using administrative data from Taiwan. The identification strategy relies on an event study design that compares the pre-policy and post-policy periods. This paper explores several research questions. Firstly, we test whether EDs improved their care capacity (the number of doctors) and care intensity (total expenditure) at night in response to the subsidy. Secondly, we explore the potential substitution effects between emergency and primary care and whether patients opt for EDs for the additional resources provided by the subsidy without having to pay more for their visits. Thirdly, we test the possibility of manipulation by hospitals, where they may have moved more patients into the night bonus window to increase profits. Lastly, we examine the policy impact on health outcomes in terms of mortality after an emergency department visit. In Appendix A, we further test whether hospitals respond differently across ownership types.

To employ an event-study estimation, this paper brings together hospital registry files and full-count claim records from the National Health Insurance Research Database

[1] For example, instituting the length of ED stay can control patient flows, but it can also lead to gaming or effort substitution (Propper et al. 2010, Mason et al. 2012, Perera et al. 2014).

[2] Nighttime diagnostic fee bonus increased from 20% to 50% in 2010.

(NHIRD) of Taiwan for the period of 2009–2010. we focused on claim records from hospitals that underwent the policy change and were continuously providing 24-hour emergency care. This resulted in a balanced panel of 59 hospitals, with a final sample size of 3.9 million ED claim records for the two-year period. The utilization of rich data from a healthcare-for-all environment offers an excellent opportunity to obtain generalizable estimations.

We find that the policy change has no significant impact on care capacity, treatment intensity, or care quality during nighttime hours. Specifically, our estimation shows that, after the increase in the diagnostic fees, the numbers of ED doctors, total treatment expenditure, and mortality rates seven days and 30 days after ED admissions did not change significantly. We do not observe patients substituting primary care with emergency care as a result of the policy change. However, we find patterns consistent with strategic manipulation by hospitals—we observe a 39% increase in the night admission share among the least urgent patients, but not among the most urgent. This result suggests that hospitals may be engaging in profit-maximizing behavior by admitting more nonurgent patients during the period between 10 pm and 6 am. Moreover, Appendix A shows that hospitals of different ownership types do not respond differently for all outcomes examined.

Our findings contribute to the literature on how financial incentives cause behavioral changes at the healthcare institutional level. Healthcare providers commonly take two reactive measures in response to financial incentives: increasing care provisions, no matter whether necessary or not (Currie & Gruber 2001, Clemens & Gottlieb 2014, Einav et al. 2018) and upcoding to yield a higher reimbursement from the insurer (Ginsburg & Carter 1986, Steinwald & Dummit 1989, Carter et al. 1990, Cutler 1995, Silverman & Skinner 2004, Dafny 2005). In this paper, we study a subsidy program that increased diagnostic fees when a patient is admitted at night. Given that diagnostic fees vary depending on the triage level, this policy may incentivize hospitals to upcode the triage level rather than provide more procedures. However, EDs represent a unique healthcare environment in which upcoding (the triage level) may not be preferred, especially when they are always overcrowded, and the triage level regulates the wait time. This paper demonstrates that EDs in Taiwan respond to financial incentives in a way that does not involve increasing unnecessary inputs or upcoding. Instead, we find that EDs admit more nonurgent patients during a specific time frame to increase profits. These results highlight the need to consider the unique characteristics of different healthcare environments when designing financial incentive programs.

This paper also adds to the existing literature that examines policies aimed at improving emergency care quality and outcomes. Previous research has reviewed different policies in various settings (Morgan et al. 2013, Stang et al. 2015, Yarmohammadian et al. 2017).

These studies mostly evaluate ED policies focusing on one or a few hospitals and reach inconsistent results. For instance, many policies are proposed to address overcrowding in EDs because longer wait times in EDs are associated with more adverse outcomes. One well-known policy is the four-hour rule (in the UK, New Zealand, part of Australia, etc), which mandates that hospitals must discharge patients within four hours. Some studies have found that implementing the four-hour rule significantly reduces wait times (Kelman & Friedman 2009, Propper et al. 2010, Geelhoed & de Klerk 2012, Sullivan et al. 2016). However, other studies have found the opposite, where EDs might engage in gaming or cheating, leading to less precise diagnoses and more readmissions (Mason et al. 2012, Perera et al. 2014). In this paper, we document the effectiveness of a subsidy program that aims to improve emergency care quality. We find no evidence of improvement in care provision and care quality. Meanwhile, we find EDs engage in gaming the system, which is consistent with some of the previous literature.

Finally, this paper sheds light on whether hospitals behave differently according to their own ownership types. Previous literature finds conflicting results.[3] Some studies find that nonprofit hospitals are profit maximizers (e.g., Duggan (2000)), while some find nonprofit hospitals more altruistic (e.g., Dafny (2005)). Sometimes, nonprofit hospitals change behaviors based on how competitive the local market is (Silverman & Skinner 2004). Meanwhile, most studies show that public hospitals are not profit maximizers because of soft budget constraints. In this paper, we include public and nonprofit hospitals in our sample. We show that public and nonprofit hospitals do not respond to financial incentives differently under the NHI system. This finding is reasonable since all hospitals are subject to the same payment schemes, regardless of their ownership, which is one advantage of the single-payer system.

The findings of this paper provide relevant policy implications for policymakers and hospital administrators. By shedding light on the incentives that drive hospital behavior, this study can help inform future policy decisions aimed at improving emergency care services. Additionally, it provides evidence that policymakers and regulators need to consider the possibility of hospitals engaging in strategic behavior when designing and implementing policies related to emergency care. To avoid these unintended consequences and improve care provision in EDs, tying the subsidy program to a specific expenditure is one method policymakers can consider.

[3] The objective function of nonprofit hospitals has been unclear, and thus researchers have proposed different models (Newhouse 1970, Pauly & Redisch 1973, Lakdawalla & Philipson 1998).

2 Institutional Background

2.1 The National Health Insurance (NHI) program in Taiwan

The NHI program in Taiwan covers over 99% of the 23 million residents and affiliates with 93% of medical facilities. Launched in 1995, the single-payer system aims to enhance social equity and improve the quality of healthcare services by charging progressive premiums based on household income. Notably, the program does not feature a gate-keeping system, allowing the insured to select healthcare providers freely. Patients are responsible for out-of-pocket expenses such as co-payments and registration fees, which are regulated according to four different accreditations of medical institutions: major teaching hospitals, minor teaching hospitals, community hospitals, and clinics.[4] Additionally, co-payments are waived for some patient groups.[5]

NHI adopts a global budget system that is divided into five categories: general hospital, clinic, dentistry, Chinese medicine, and hemodialysis. The budgets for each division are approved at the end of the previous fiscal year. Services such as diagnosis, treatment, and prescription are assigned "points" according to an annual handbook, and the total points issued in a given quarter determine the value per point for that period. As a result, all registration and claim data per visit are recorded for administrative purposes. Importantly, medical institutions of all ownership types are subject to the same payment system. We exploit this feature, along with the fact that the insured face the same payment scheme across ownership types, to study hospital responses to changes in providers' financial incentives.

2.2 Emergency Departments and Policy Changes in 2010

EDs have been regarded as unprofitable sectors in hospitals for two main reasons: (1) the services provided are primarily reimbursed through insurance rather than self-pay, and (2) when patients require hospitalization for further procedures, separate claims are filed for additional treatments and fees are paid to the relevant departments but not to the ED. Upon entering an ED, patients undergo a triage evaluation, register with their NHI identification cards, and receive diagnosis and treatment. Diagnostic fees depend on patients' assigned triage levels, and the time of registration defines the official admission time.

To support EDs in maintaining care quality, the NHI has been subsidizing night (10

[4]Medical facilities are assigned to one of the four categories of accreditations based on their missions, capacities, and the variety of specialty services.

[5]For instance, individuals with catastrophic illnesses, children below aged three (or six in certain cities), and those aged over 65 years old are exempt from paying co-payments.

pm to 6 am), weekend, and national holiday admissions by providing a 20% diagnostic fee bonus to hospitals since the beginning of the program. Hospitals receive the bonus when patients register during these specific time frames, while patients' out-of-pocket expenses remain unchanged. In 2010, the NHI further increased nighttime diagnostic fees by 30% (from 20% to 50%) in teaching hospital EDs to improve the quality of care provided during these hours.[6] Table 1 presents the bonus scheme for non-rural teaching hospital EDs before and after the policy change, categorized by patients' age. Notably, EDs earn extra bonuses when diagnosing children below six years old. Table 1 shows that, for instance, the total diagnostic fee bonus an ED receives when admitting an adult at night went up from 20% to 50% in 2010. Meanwhile, an ED receives only the night bonus when a patient is admitted on holiday nights, not an additional holiday bonus.

In addition to the policy change regarding diagnostic fees, another reform, the Taiwan Triage and Acuity Scale (TTAS) Reform, was also implemented in 2010. This reform increased the number of triage categories from four to five levels. The TTAS system designates level one as the most urgent cases and level five (previously level four before 2010) as the least urgent cases. This system directly governs the speed at which patients should be treated based on the severity of their condition. One important thing is to show that this reform has no impact on the demand for emergency care. Figure 1 displays hospital-level monthly visit volumes and it appears fluctuations within a certain range but no discontinuity in 2010. This suggests that the TTAS reform is unlikely to confound our findings.

3 Data and Sample Construction

Our primary data, obtained from the National Health Insurance Research Database (NHIRD) of Taiwan, includes hospital register files, full-count outpatient claim records, and death records from 2009 and 2010. To link the records, we use three scrambled but unique identifiers: hospital identifiers, personal identifiers, and doctor identifiers. The hospital register files provide information on hospital identifiers, ownership types, accreditation, and location (city and district).[7] Outpatient claim records contain patients' personal identifiers, gender, age, residency (city and district), admission dates, ICD-9 codes, co-payments, triage level, diagnostic fees (in points), medical expenditure (in points), and

[6]This policy change only applies to major and minor teaching hospitals. We do not discuss rural hospitals because they are subject to other subsidy programs, and their classification as rural hospitals varies annually.

[7]A district is located within a city and is similar to a zip-code-level geographic area in the US.

doctor identifiers.[8] Lastly, death records include personal identifiers and dates of death.

3.1 Outcome Variable Construction

One important thing is to identify admissions during the nighttime bonus window. However, since the admission time is not available in the data, we rely on the differences in diagnostic fees to determine whether a patient was admitted during the night bonus window. Table 1 provides further details on the differences in diagnostic fees, which indicates that the diagnostic fee scheme does not allow us to differentiate night admissions from holiday admissions before 2010. We discuss this in Section 3.2 when we make sample restrictions.

We construct several outcome variables to capture EDs' different responses to the financial incentives introduced by the policy change. To measure whether EDs improve care provision, care intensity, and care quality, we used three key variables: the number of doctors, the total expenditure, and mortality rates within certain periods during the nighttime bonus window. To calculate the number of doctors, we identified the unique doctor identifiers in the ED claim records during the specific time frame of the nighttime bonus window. For the total expenditure among night admissions, we subtracted diagnostic fees from the overall medical expenditure since the policy change arbitrarily increased diagnostic fees in 2010. Lastly, we use mortality rates as a measure of EDs' care quality. Specifically, we calculate mortality per 10,000 admissions within seven days and 30 days after being admitted to EDs during the nighttime bonus window.

To examine whether patients were substituting primary care with emergency care in response to the policy change, we calculate the share of nonurgent admissions in EDs using the formula in Equation 1. We define nonurgent admissions by applying the ED admission categories developed by the NYU Center for Health and Public Service Research.[9] Their algorithm assigned each ICD-9 code a probability of being in each of the four urgency categories. In our analyses, we classify claim records with ICD-9 codes assigned at least 80% probability of being in the non-emergent as "nonurgent admissions". We chose this

[8] Under the global budget system, all services are assigned points according to an annual handbook, and the total points issued in a given quarter determine the value per point for that period.

[9] NYU Center for Health and Public Service Research reviewed approximately 6 million ED claims of New York City hospitals in 1994 and 1998 and developed an algorithm classifying the ED utilization into four categories: non-emergent, emergent/primary care treatable, emergent–ED care needed–preventable/avoidable, and emergent–ED care needed–not preventable/avoidable. The description of each category can be found here: https://wagner.nyu.edu/faculty/billings/nyued-background

threshold to avoid having an extremely low percentage of nonurgent admissions.[10]

$$the\, share\, of\, nonurgent\, admissions = \frac{the\, number\, of\, nonurgent\, admissions}{the\, number\, of\, total\, admissions} \quad (1)$$

Additionally, to examine whether EDs admitted more patients during this time frame to increase profits, we calculate the share of admissions within the nighttime bonus window using the formula in Equation 2. Furthermore, we test the heterogeneous effects. We stratify our sample by urgency and calculate the share of night admissions for two groups: patients with Acute Myocardial Infarction (AMI) and patients who were triaged as least urgent.[11] These two groups represent patients who should be treated right away and patients who could wait, respectively. This allows me to examine whether EDs respond to financial incentives differently based on patients' urgency levels.

$$the\, share\, of\, night\, admissions = \frac{the\, number\, of\, nighttime\, admissions}{the\, number\, of\, total\, admissions} \quad (2)$$

3.2 Sample Restrictions

The main restriction we make is to only include non-holiday claim records in our sample.[12] This is because the data do not provide information on the admission time, and we rely on differences in diagnostic fees to determine if a patient was admitted during the night bonus window. As shown in Table 1, the diagnostic fee scheme does not allow us to distinguish between night and holiday admissions before 2010. Therefore, our final sample is limited to only non-holiday claim records. Additionally, we have imposed other restrictions on our sample.

we begin with making sample restrictions on patients. First, we exclude patients below age six because (1) the diagnostic fee bonus scheme varies across ages below six (see Table 1), and (2) they may pay different co-payments based on cities of residency. Second, we exclude patients with catastrophic illnesses because hospitals are paid more (by the NHI) for treating them. In the full count claim records, patients with catastrophic illnesses make up around 5% of the sample. Third, we exclude patients who visited the ED for influenza and influenza-like illness because of the H1N1 pandemic in late 2009.[13] Figure 1

[10] We did not choose 100% as the assignment criteria because we would have only 0.8% of ED admissions defined as nonurgent in that case.

[11] Although triage levels specifically regulate how quickly a patient should be treated, we use AMI to define the most urgent patients because the Taiwan Triage and Acuity Scale (TTAS) went from four to five levels in 2010, as described in Section 2.2. For the same reason, we use the least urgent triage levels (triage level 4 in 2009 and level 5 in 2010) to define patients who could wait. These two groups should have been less affected by the TTAS reform.

[12] Holidays include weekends and national holidays, which mostly follow the lunar calendar.

[13] We use ICD-9 codes 480-488 to define influenza and influenza-like illness because there was no specific

displays hospital-level monthly visit volumes. By restricting the sample, the spike driven by the pandemic in late 2009 was mitigated while the pattern across time persists.[14]

We also make some sample restrictions at the hospital level. Only major and minor teaching hospitals with 24-hour EDs were treated by the change in the subsidy program. First, among teaching hospitals, we exclude hospitals that did not constantly provide 24-hour emergency care in 2009 and 2010. Second, we exclude rural hospitals because they are subject to other subsidy programs at the same time, and their patients have particular characteristics. In addition, the classification of rural hospitals changes on an annual basis. Third, we exclude for-profit hospitals because there are at most five for-profit non-rural teaching hospitals at one time and not all of them constantly provided 24-hour emergency care during our study period. Given that they might have different objective functions, including only a handful of for-profit hospitals might introduce broad variation(Newhouse 1970, Pauly & Redisch 1973, Lakdawalla & Philipson 1998).

These restrictions leave us a balanced panel with 59 non-rural teaching hospitals: 20 public and 39 nonprofit. Our final sample contains approximately 3.9 million claim records. Table 2 provides the summary statistics of patient characteristics for 2009 and 2010 separately. The number of claims remained similar between the two years, and patients' gender, age, and share of visiting nonprofit hospitals also did not vary much across the years. For our analyses, we construct our data points at the hospital-week level.[15] Table 3 provides the summary statistics for means of outcomes for 2009 and 2010 separately. Note that we subtract diagnostic fees from total expenditure and that we present total expenditure using the NHI point.[16] Table 3 does not display significant differences between the pre- and post-policy samples except for one variable: the share of night admission among the least urgent patients increased by almost 10%. This implies that EDs might be admitting more least urgent patients during the nighttime bonus window for more profits.

Figure 2 displays the monthly average of the daily ED doctor numbers, total expenditure, visit volume (nonurgent, least urgent, and AMI), and deaths between 2008 and 2011. We include two more years to demonstrate that our findings are not driven by discontinuities that appear at all year cutoffs. As discussed in Section 2.2, the only exception to

code for H1N1 at the beginning. We also conduct all analyses without excluding influenza and influenza-like illness and find robust results.

[14]Notably, month-fixed effects do not help with seasonality perfectly because most national holidays, e.g., the lunar new year, follow the lunar calendar. Removing holidays helps account for the seasonality issue.

[15]We use hospital-week-level data instead of hospital-day-level data to avoid introducing noise from the broad variation.

[16]One NHI point translated to NT$ 0.9419 in 2009 and NT$ 0.9445 in 2010. US$1 is approximately NT$30.

the smooth trends is the visit volume among the least urgent admissions due to the TTAS reform. In Figure 3 presents the means of the outcome variables over the study period. Consistently, Figure 3e shows that the share of night admissions among the least urgent patients increased significantly around 2010.

4 Methodology

Using hospital-week-level data from 2009 and 2010, we adopt an event study to investigate the effects over months. There are 24 time periods: 12 months in the pre- and post-policy periods, respectively. we estimate

$$Y_{hw} = \alpha + \sum_{p=-11}^{12} \beta_p \times \mathbf{1}_{m=p} + \gamma NP_h + \tau_m + \tau_c + \epsilon_{hw} \tag{3}$$

where h denotes hospital, w week, m month, and c city. NP is an indicator for nonprofit hospitals. τ_m represents month fixed effects, and τ_c city fixed effects. ϵ_{hw} represents idiosyncratic shocks that are not observed and assumed to be independent of all observable and unobservable factors. Y denotes our outcomes of interest, including the number of doctors at night, total treatment expenditure at night, the share of nonurgent admissions among all admissions, the share of night admission (among all, AMI, and least urgent admissions), and 7-day and 30-day mortality per 10,000 night admissions. Estimates are clustered at the hospital level. The coefficient of December 2009 (β_0), the last month in the pre-policy period, is normalized to zero.

In Appendix A, we conduct further tests to determine whether EDs respond differently based on their ownership types. Previous literature has suggested that hospitals of different ownership types exhibit different behaviors. We therefore interact the month indicator, $\mathbf{1}_{m=p}$, with the indicator for nonprofit hospitals, NP. The coefficients of this interaction term capture how much reactive nonprofit hospitals are compared the public hospitals.

The specification requires some assumptions. First, we assume that the admission time of each patient is random. This is true for most ED admissions since it is how an emergency is defined—patients cannot predict when they will need to be admitted to EDs. Second, the randomness of ED admission time should not be affected by any policy changes faced by hospitals.[17] This is reasonable since these policy changes should not have an impact on the probability of an emergency happening. These changes mainly affect the hospital administration on the supply side but not the (potential) patients on the demand

[17] Besides the subsidy for diagnostic fees, Taiwan Triage and Acuity Scale (TTAS) went from four to five levels in 2010. We discuss how this reform had no impact on our findings in Appendix 2.2.

side. Third, we assume that patients do not choose specific hospitals to visit when an emergency happens. Instead, with random accident locations, patients are admitted to the nearest hospitals. It is worth noticing that these assumptions might not hold for nonurgent cases. We consider this possibility in Section 5.2, and we show that the share of nonurgent cases among ED admissions did not change in response to the change in the increase in diagnostic fees.

5 Results

5.1 Direct Policy Impacts on Care Provision

The main objective of this policy is to ensure sufficient night care provisions by subsidizing night admissions in 24-hour EDs. To understand the effectiveness, we examine two outcomes as direct responses: the number of doctors as care capacity and total expenditure as treatment intensity during the nighttime bonus window.

The Number of Doctors During the Nighttime Bonus Window

Care capacity in the healthcare system is defined as the availability of healthcare providers. Long wait times in EDs have been a worldwide issue due to inadequate capacity, which is particularly concerning for extremely urgent cases. With the policy change, hospitals might have incentives to place or reallocate more doctors during night shifts, as night admissions have become more profitable than daytime admissions. Using unique doctor identifiers from the claim records, we calculate the number of doctors available during the nighttime bonus window. We plot the event-study estimates, β_p, with 95% confidence interval in Figure 4a. The estimation shows that there might be a trend break—the number of doctors at night was decreasing before 2010 but became increasing after 2010. However, the trend break is statistically insignificant.

Total Expenditure among Nighttime Admissions

Total expenditure, length of stay, numbers of procedures, intensive care unit (ICU) days, and in-hospital deaths are common measures of treatment intensity. Specifically, total expenditure predicts longer length of stay, more procedures, and more ICU days in EDs. However, the reverse might not be true. In the NHI system, when an ED patient is transferred to another department for further procedures, other claims will be filed, and fees will be paid to those relevant departments. Therefore, we focus on total expenditure among night admissions as an intensity proxy to investigate EDs' local responses.[18] meanwhile, we examine mortality as policy impacts on care quality in Section 5.4. One advantage of our data is that all treatments, procedures, and drug usages are given fixed "points" based on the NHI payment guideline, as explained in the institutional background section. Instead of using the nominal value of total charges, point amounts matching total expenditure (subtracting diagnostic fees) could better predict the treatment intensity. Event-study results in Figure 4b suggest that total expenditure among night admissions did not respond to the policy change.

5.2 Substitution Effects Between Emergency Care and Primary Care

Since the policy change increased resources given to EDs, one concern is that patients might substitute primary care with emergency care because they expect better quality care. Using outpatient claim records from all accreditations of medical facilities between 2008 and 2011, two years before and after the policy change, Figure 5 displays the monthly average of the daily visit volume. The figure shows the daily volume always peaked during winter months, implying that the fluctuation might be driven by seasonality. Overall, there does not appear to be a discontinuity in primary care utilization associated with the policy change. The virtual evidence suggests that patients did not substitute from primary care to ED care in response to the policy change.

To statistically test the substitution effects, we further estimate Equation 3 using the share of nonurgent admissions in EDs (defined as Equation 1) as the outcome. We apply the ED admission categories classified by the NYU Center for Health and Public Service Research to determine nonurgent admissions, and we define claim records with ICD-9 codes assigned at least 80% probability of being category non-emergent as nonurgent admissions.[19] In Figure 6, we focus on both all-day and night-only admissions and do not detect substitution effects. Consistently, the results rule out the concern of patients self-selecting into the nighttime bonus window.

5.3 Impacts on the Share of Night Admissions

The 30% increase in the nighttime diagnostic fee bonus provides financial incentives for hospitals to admit more patients during the night bonus windows. Specifically, the admission time is determined by when a patient registers with an NHI ID card after being

[18] Diagnostic fees are subtracted because the fees arbitrarily increased by 30% after the policy change.

[19] See Section 3.1 for the details. Note that only 0.8% of ED admissions are defined as 100% nonurgent in the full count claim data.

assigned a triage level.[20] Since patients still have to wait to receive diagnosis and treatment after registry, it is feasible that EDs register patients slightly later when it is almost 10 pm, without affecting the real wait times. In this case, EDs can admit more patients during the nighttime bonus window without an increase in the total admission. Therefore, we test whether EDs increase the share of night admissions (defined as Equation 2) in response to the policy change. Figure 7a reports the results for the impact on night admission shares using the event study shown in Equation 3. There appears to be seasonality at the beginning of the year, possibly due to the lunar new year. Meanwhile, the point estimates are not significantly different from the reference month, suggesting no policy impact on the share of night admission.

Heterogeneous Effects

Previous literature has found that hospitals react to financial incentives by upcoding or manipulation. Therefore, we explore whether the policy impact on the share of night admissions differs between the least urgent and the most urgent patients. The triage level directly regulates how quickly a patient should be treated. Given that patients only register after being assigned a triage level and that when patients register might not affect their wait times, EDs might respond differently based on how long a patient can wait. Specifically, for the least urgent cases, we focus on patients who can wait for the longest according to their triage levels. This includes patients in triage level four in 2009 and in triage level five in 2010. For the most urgent cases, we focus on AMI patients. We choose these criteria because the TTAS reform increased the triage categories from four levels to five levels in 2010 (discussed in Section2.2). In Figure 1, we show no discontinuity around 2010 when we plot the average volume at the month level between 2008 and 2011, suggesting that this reform did not affect the overall demand for emergency care.

First, we test how EDs respond when handling the least urgent patients. Although the TTAS reform did not affect the total emergency visit number, it redistributed the number of cases categorized in each triage level. As a result, the reform had an effect on the denominator when we use the share of night admissions among the least urgent patients as an outcome variable. In Figure 2e, we plot the average daily ED volume among the least urgent patients (level four before 2010 and level five after 2010). Figure 2e shows that the all-day and nighttime volumes both increased significantly around January 2010 and started to return to the pre-2010 level. We further plot the raw data on the outcome variable—the share of night admissions at the month level among the least urgent patients—between 2008 and 2011. Figure 3e presents a significant and clear jump in

[20] As discussed in Section 2.2, upon entering an ED, patients undergo a triage evaluation, register with their NHI identification cards, and receive diagnosis and treatment.

January 2010. The share fluctuated within a certain range both before and after the policy change and does not reflect the pattern of the denominator from Figure 2e. The flat trends before and after 2010 support our assumption that the time a patient enters an ED is random and not affected by the policy changes in 2010.

Some may argue that the observed jump in Figure 3e is because the TTAS reform has prompted EDs to categorize more patients in the least triage level during the nighttime bonus window. However, EDs have little incentive to do this, as they receive higher diagnostic fees when caring for higher triage-level patients. Moreover, the subsidy program incentivizes hospitals to treat more higher triage-level patients at night. Given that the number of total admissions remained stable (as shown in Figure 1), it is unlikely that hospitals deliberately downgrade patients' triage levels.

After ruling out the plausible concern from the TTAS reform, we estimate Equation 3 using the share of night admissions among the least patients as the outcome. The estimation in Figure 7b shows that the share of night admission increased significantly among the least urgent patients after the policy change, which is consistent with the observed jump in Figure 3e. To precisely quantify the effect sizes, we adopt a difference-in-differences (DID) approach by estimating

$$Y_{hw} = \alpha + \beta POST_y + \gamma NP_h + \tau_m + \tau_c + \epsilon_{hw} \tag{4}$$

In Equation 4, y denotes the year, $POST_y$ is an indicator for the year 2010, and all other notations follow Equation 3. β is the coefficient of interest. Results in Table 4 Column (2) report a 9.6 percentage points (39%) increase in the preferred specification.[21] Our findings suggest a pattern consistent with manipulation. Note that patients do not necessarily wait longer. It is likely that, after patients got assigned to the least urgent triage level, hospitals registered these patients later to fit these records in the nighttime bonus window.

Second, we test how EDs respond when handling the most urgent patients. Besides the fact that EDs have little incentive to delay admitting the most urgent patients, some may also wonder if admitting significantly more least urgent patients around the time transitioning into the nighttime bonus window would distort admitting the most urgent patients who arrived at a similar time. In the same fashion, we estimate Equation 3 using the share of night admissions among AMI patients as the outcome. Figure 7c reports the results of the estimation. In Figure 7c, there seems to be a hint of policy impact in the first couple of months after 2010. However, most point estimates are not significantly different from zero, suggesting no evidence of EDs admitting more AMI patients during

[21] Some studies find that hospitals of different ownership types respond to financial incentives differently (Duggan 2000, Dafny 2005, Silverman & Skinner 2004). However, we do not detect significant differences when considering hospital ownership types in all specifications for all outcomes.

the nighttime bonus window among all AMI patients.

Similarly, we estimate Equation 4 to further statistically estimate the policy impact on the share of night admissions among AMI patients. Table 4 Columns (3) and (4) report the results. Consistently, the preferred specification in Column (4) shows the share of night admissions among AMI patients decreased by 0.9 percentage points. This implies that EDs might be able to prioritize treating some AMI patients around the time transitioning into the nighttime bonus window by delaying a significant number of the least urgent patients. However, the effects are statistically insignificant. This is reasonable given that delaying treating these patients might lead to larger hospital costs and harm their evaluation.[22] Additionally, the possibility of admitting AMI patients around this specific time is much lower.[23]

5.4 Impacts on Care Quality

Health outcomes of ED patients are an important indicator of emergency care quality. There are two mechanisms by which increasing diagnostic fees can affect health outcomes. First, hospitals may increase medical inputs and thus improve health outcomes. Second, admitting more least urgent patients at night might crowd out resources for urgent patients who were admitted right after 10 pm and leads to adverse health outcomes. Although we find no evidence of these mechanisms, it is still plausible that this policy improves health outcomes through some unobserved channels. For instance, hospitals might invest in ED equipment using the subsidy. Thus, we examine the 7-day and 30-day mortality rates per 10,000 cases among patients who were admitted within the night bonus windows. The estimation in Figure 8 shows all point estimates are not statistically different from the reference month, suggesting that the policy change has imprecise impacts on mortality rates.

6 Conclusion

This paper examines a plausibly exogenous shock to the payment scheme for healthcare providers. Specifically, the Taiwanese National Health Insurance program increased the emergency department diagnostic fee bonus among nighttime admissions from 20% to 50% in 2010. This policy aims to improve care provision and care quality by subsidizing ED admissions between 10 pm and 6 am.

[22] The NHI program provides incentives for hospitals to improve care quality and evaluates hospitals annually.

[23] On average, there are approximately 6 admissions per day for acute myocardial infarction (AMI) cases, whereas the daily admission for the least urgent cases is around 15 cases.

We show that providing EDs with financial incentives does not necessarily lead to better care quality or outcomes. In response to a 30% increase in the diagnostic fee bonus, we find that hospitals did not improve the care capacity and treatment intensity. The policy change has no impact on the number of ED doctors nor the total expenditure (subtracting diagnostic fees) during the nighttime bonus admissions. Evidence shows that the overall inflow to EDs did not change, and patients did not substitute primary care with emergency care following the new policy.

However, we find evidence consistent with manipulation. The registry time determines admission time. Since patients are assigned a triage level before the registry, EDs can delay registering the least urgent patients without a cost. Therefore, EDs may behave differently according to patients' severity. Our estimation shows EDs admit more least urgent patients during the nighttime bonus window to increase profits. Meanwhile, the policy change has no significant impact on the share of night admission among the most urgent patients (i.e., AMI patients). For health outcomes, we find no effects on mortality within seven and 30 days after night admissions. Lastly, Appendix A shows that within the NHI program, nonprofit hospitals do not respond to financial incentives differently from public hospitals. This coincides with the fact that hospitals of different ownership types have the same financial incentives when they face identical payment schemes.

The findings in this paper are policy-relevant. To conclude, the increase in diagnostic fees led to unintended consequences, where EDs responded to financial incentives by engaging in manipulation. Although this reactive measure might not prolong wait times among the least urgent patients nor hurt any patients, these extra revenues did not result in any improvements in their care provision. One possibility is that some hospitals could have stopped offering nighttime emergency care without the subsidy. However, it would have been more efficient if this policy change only targeted 24-hour EDs that were struggling. While the amount of money involved in this policy change in a single year may have been small—it amounted to five million US dollars in 2010, it becomes significant when considering that this expense may have been an average annual program expense over the past 12 years. Therefore, these findings suggest that subsidy programs should be evaluated more thoroughly, taking into account the potential for strategic behavior change, especially when they are not tied to a specific expenditure.

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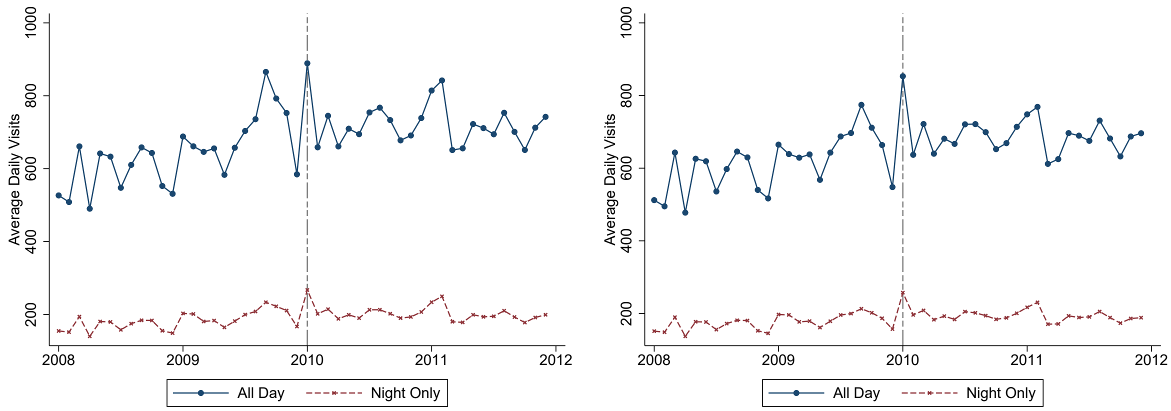
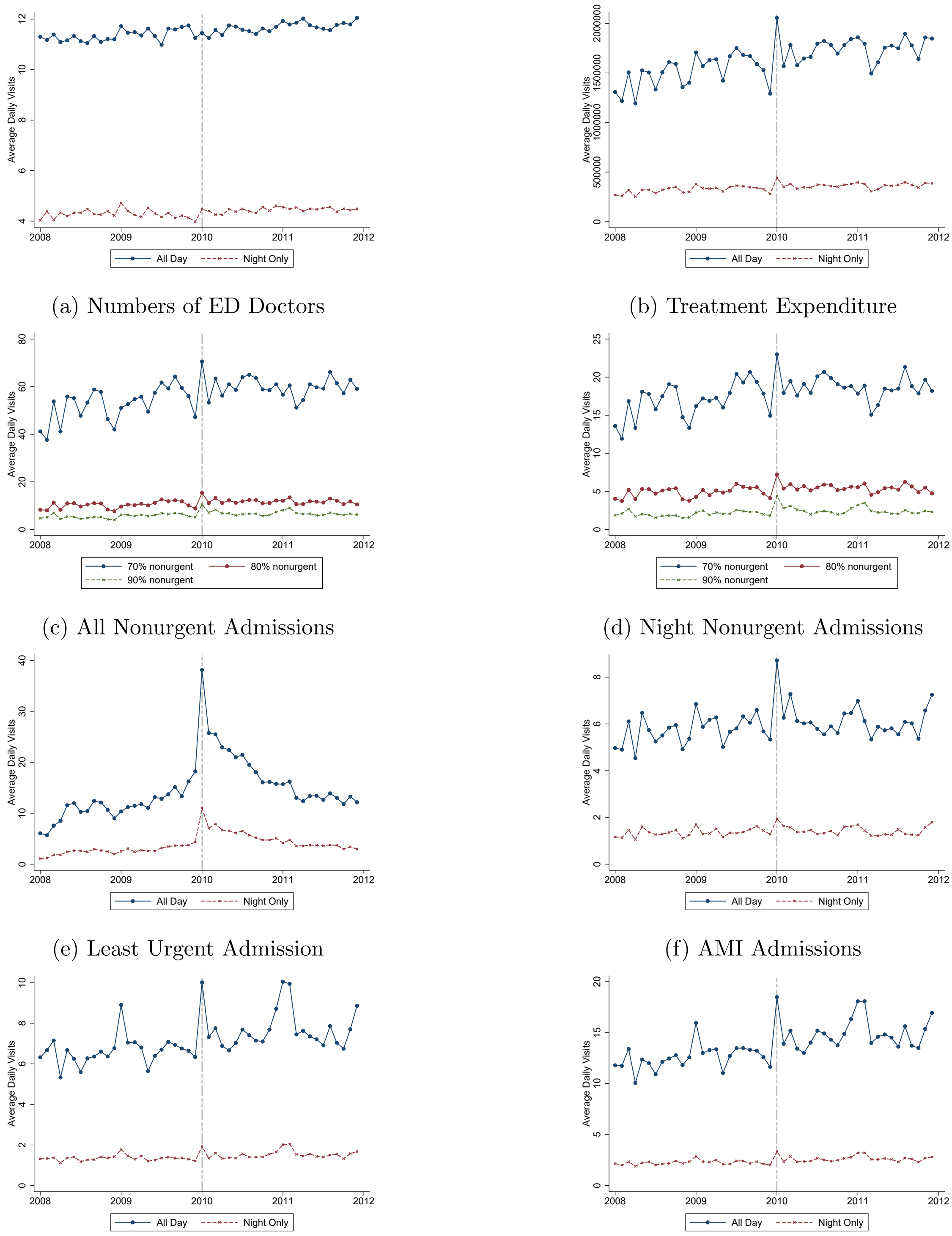


(a) Including Influenza Related

(b) Excluding Influenza Related

Figure 1: Hospital-Level Monthly Visit Volume



(a) Numbers of ED Doctors

(b) Treatment Expenditure

(c) All Nonurgent Admissions

(d) Night Nonurgent Admissions

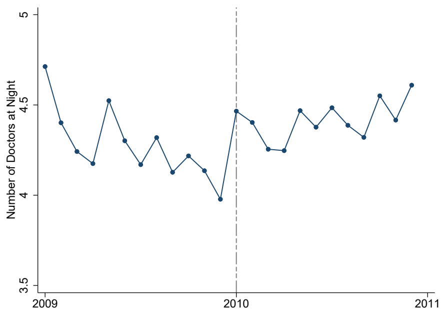
(e) Least Urgent Admission

(f) AMI Admissions

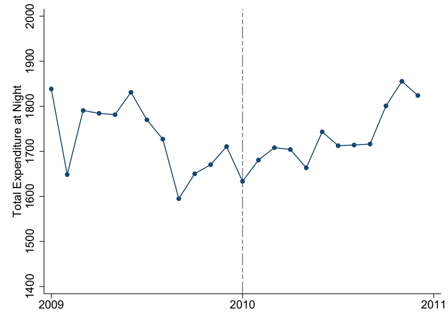
(g) 7-Day Death

(h) 30-Day Death

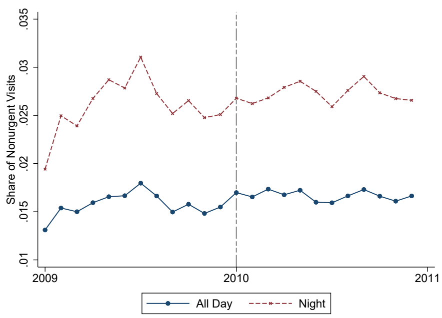
Figure 2: Average Daily Visits in Different Admission Categories



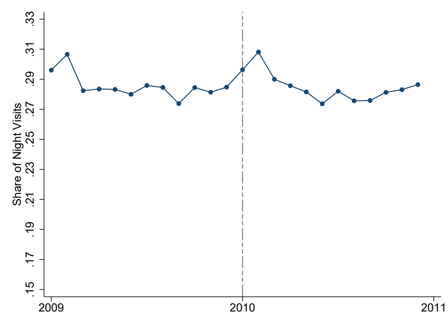
(a) Numbers of Night ED Doctors



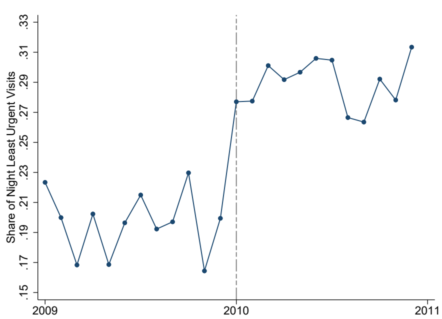
(b) Treatment Expenditure at Night



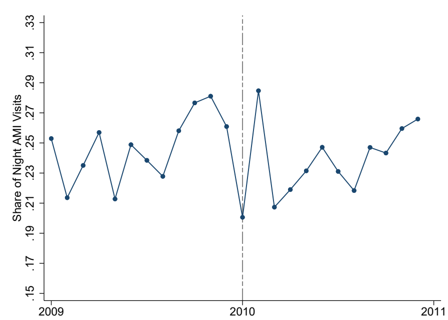
(c) Share of Nonurgent Admissions



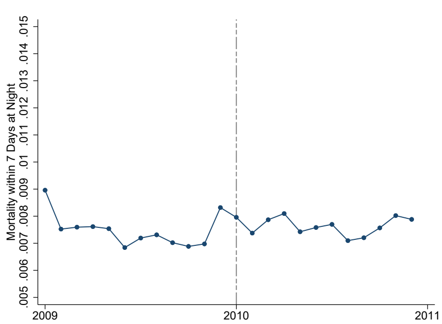
(d) Share of Night Admissions



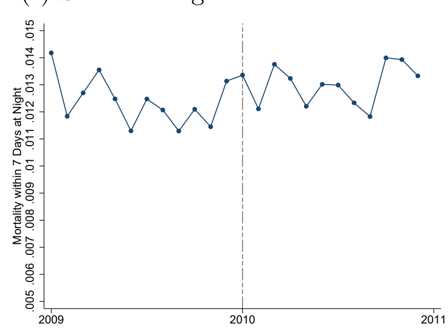
(e) Share of Night Least Urgent Admission



(f) Share of Night AMI Admissions

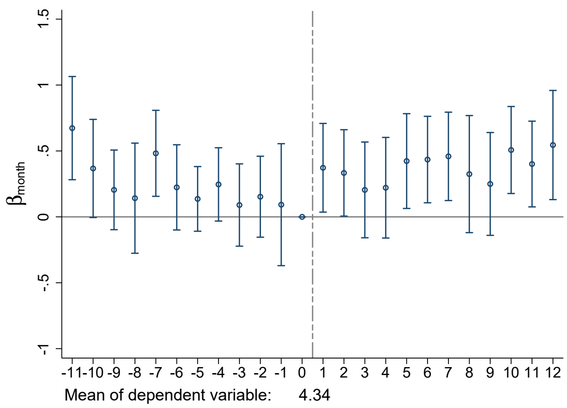


(g) 7-Day Mortality at Night

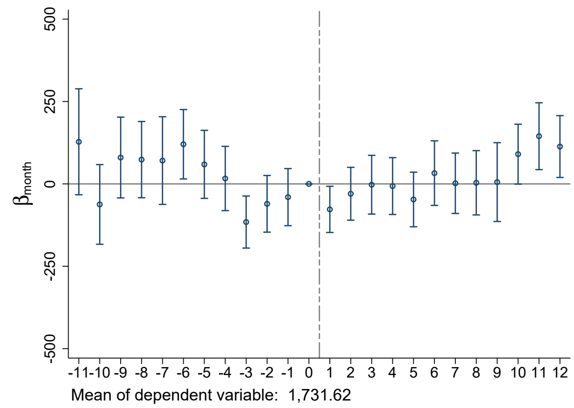


(h) 30-Day Mortality at Night

Figure 3: Trends in Means of Outcomes



(a) Numbers of ED Doctors at Night



(b) Treatment Expenditure at Night

Figure 4: Direct Impacts on Inputs

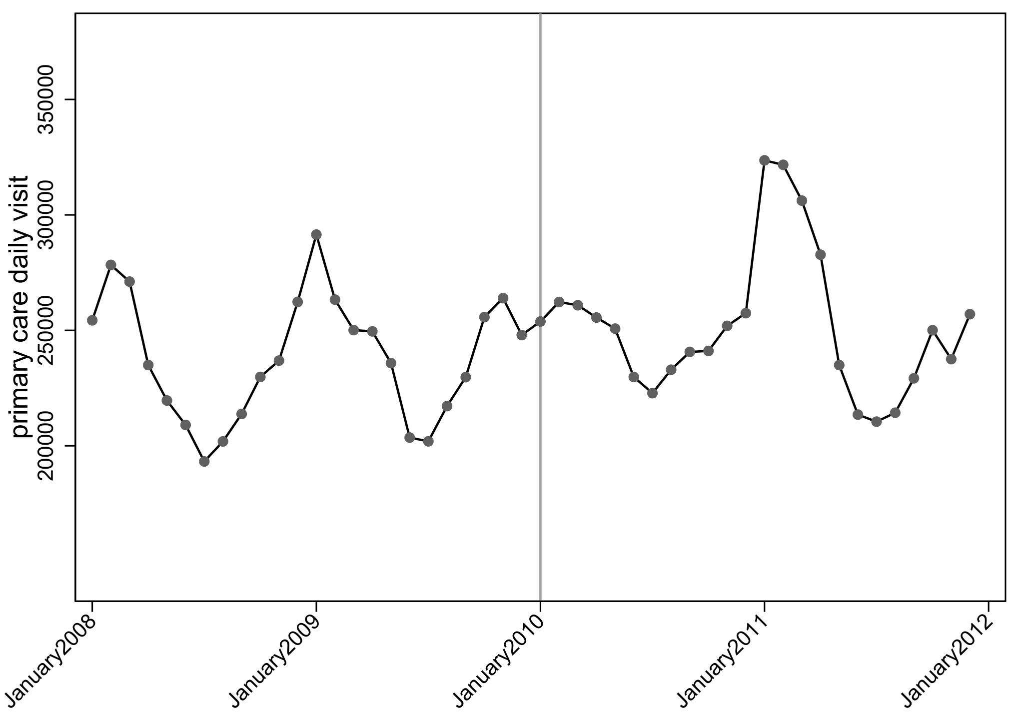
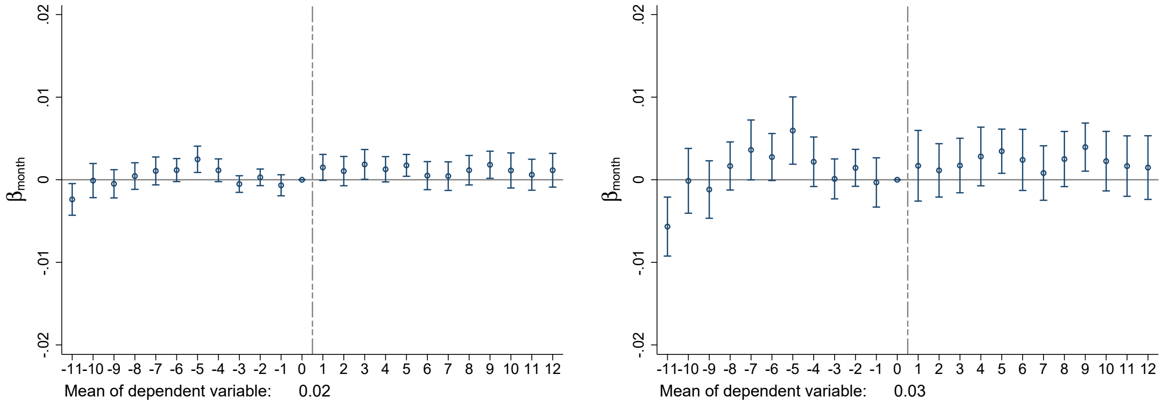


Figure 5: Primary Care Daily Visit

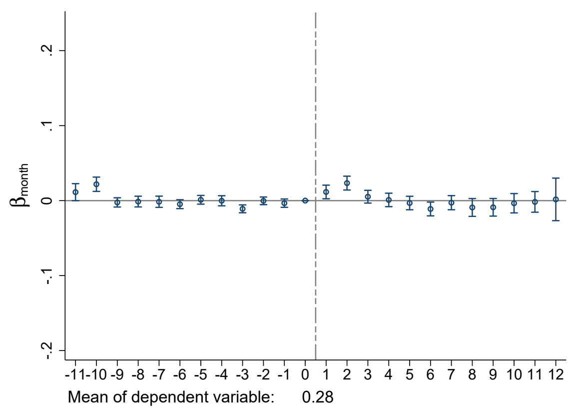
Notes: For data consistency, we only include non-holiday visits of patients above age 6 without catastrophic illness. The fluctuation is driven by seasonality, and thus the volumes always peak in winter.



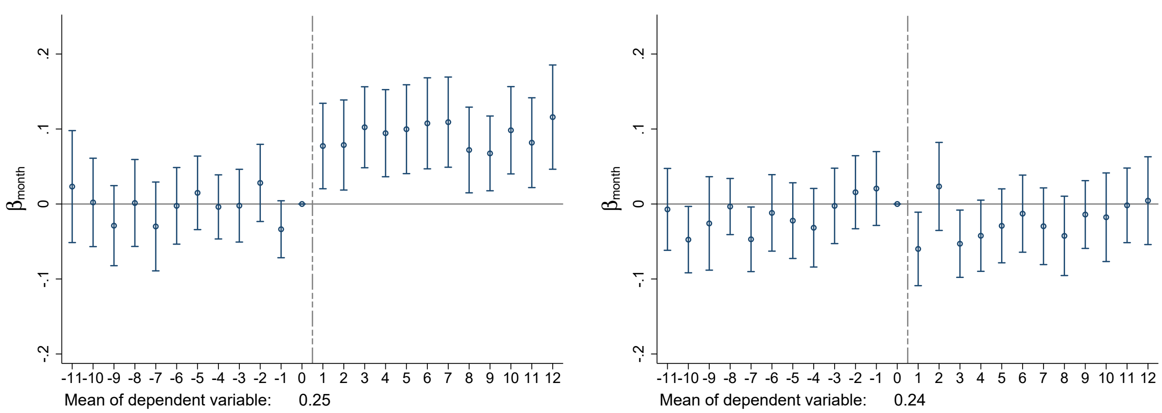
(a) All Day

(b) Night Only

Figure 6: Substitution Effects between EDs and Primary Care



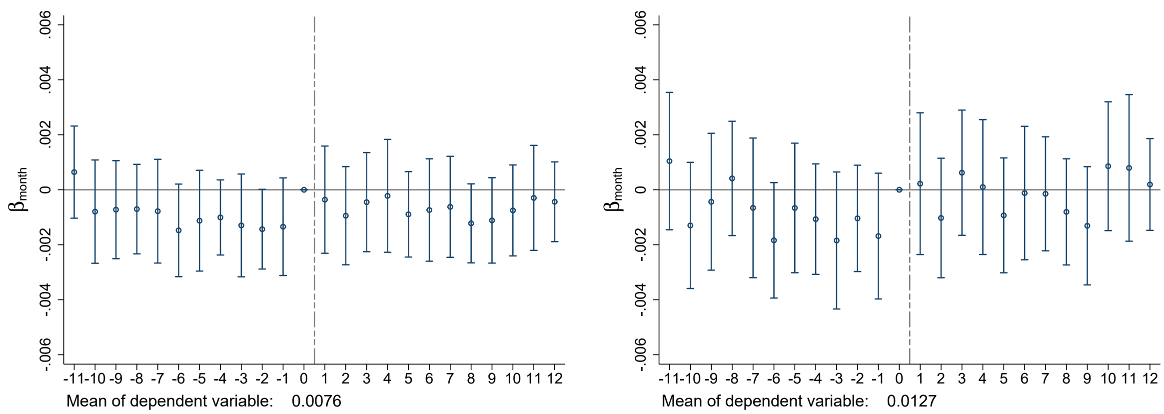
(a) Overall Night Admissions



(b) The Least Urgent Admissions

(c) AMI Admissions

Figure 7: Impacts on Shares of Night Admissions Among Different Groups



(a) 7-Day Mortality

(b) 30-Day Mortality

Figure 8: Impacts on Mortality at Night

Table 1: Diagnostic Fee Bonus Scheme Of Non-Rural Hospitals

	Bonus Before 2010			Bonus After 2010		
Age	Day	Holiday	Night	Day	Holiday	Night
0 to 6m	100%	120%	120%	100%	120%	150%
6m to 2yrs	30%	50%	50%	30%	50%	80%
2 to 6yrs	20%	40%	40%	20%	40%	70%
6yrs and above	0%	20%	20%	0%	20%	50%

Notes: The nighttime bonus window is between 10 pm and 6 am. Holidays include weekends and national holidays, which mostly follow the lunar calendar. A hospital receives only the nighttime bonus when a patient is admitted during holiday nights.

Table 2: Summary Statistics for the Final Sample at the Patient Level

	2009		2010	
	Mean	S.D.	Mean	S.D.
The Number of Claims	1,937,099		1,937,895	
Male	0.52	0.50	0.51	0.50
Age	43.73	22.98	45.31	22.77
Above Age 85	0.04	0.18	0.04	0.20
Visited Nonprofit Hospitals	0.65	0.48	0.66	0.48

Notes: Age is capped at 85.

Table 3: Summary Statistics for the Final Sample at the Hospital-Week Level

	2009		2010	
	Mean	S.D.	Mean	S.D.
The Number of Doctors at Night	4.26	3.43	4.42	3.46
Total Expenditure at Night (NHI point)	1730.45	722.65	1732.84	697.74
The Share among All Admissions				
Nonurgent Admissions	0.02	0.01	0.02	0.01
Night Admissions	0.29	0.05	0.28	0.06
The Share of Night Admissions among				
Nonurgent Admissions	0.03	0.02	0.03	0.02
Least Urgent Admissions	0.20	0.26	0.29	0.23
Most Urgent (AMI) Admissions	0.25	0.26	0.24	0.25
Mortality per 10,000				
7-Day after Admission	0.0105	0.0060	0.0110	0.0062
30-Day after Admission	0.0195	0.0107	0.0209	0.0105
7-Day after Night Admission	0.0075	0.0085	0.0076	0.0087
30-Day after Night Admission	0.0124	0.0112	0.0130	0.0117

Notes: Night admissions are patients registered between 10 pm and 6 am. We subtract diagnostic fees from the total expenditure because diagnostic fee bonuses increased in 2010 by the policy, while all expenditures are recorded in the unit of the NHI point. The least urgent admissions are patients who were assigned to triage level four in 2009 and triage level five in 2010. The most urgent admissions are those of patients with acute myocardial infarction (AMI) using ICD-9 codes 410-414.

Table 4: DID: Impact on Night Admission Shares among Least Urgent Patients

	Least Urgent		Most Urgent (AMI)	
	(1)	(2)	(3)	(4)
Post 2010	0.099***	0.096***	-0.010	-0.009
	(0.017)	(0.017)	(0.010)	(0.010)
Nonprofit	0.073***	0.078***	-0.004	0.009
	(0.021)	(0.023)	(0.017)	(0.018)
Month FE	No	Yes	No	Yes
City FE	No	Yes	No	Yes
Mean of dep var	0.247	0.247	0.250	0.250
Observations	4,064	4,064	4,613	4,613

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Night admissions are patients registered between 10 pm and 6 am. The least urgent admissions are patients who were assigned to triage level four in 2009 and triage level five in 2010. The most urgent admissions are those of patients with acute myocardial infarction (AMI) using ICD-9 codes 410-414.

Appendix

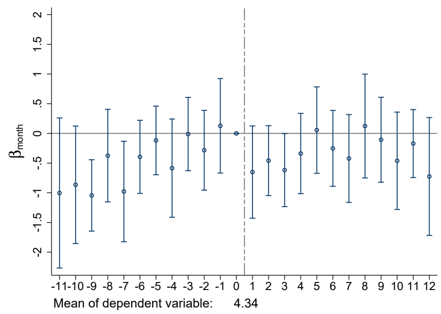
A Do Hospitals of Different Ownership Types Respond to Financial Incentives Differently?

Our sample contains public and nonprofit hospitals. We test whether hospitals of different ownership types respond to the subsidy program differently by estimating

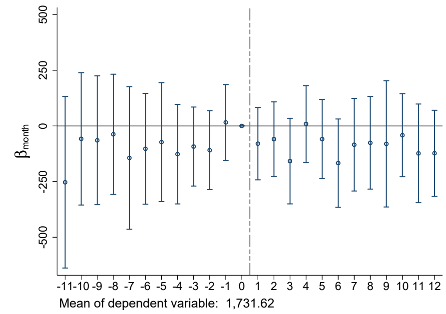
$$Y_{htw} = \alpha_0 + \sum_{p=-11}^{12} \beta_p \times \mathbf{1}_{t=p} \times NP_h + \alpha_1 NP_h + \tau_h + \tau_m + \epsilon_{htw} \tag{5}$$

Here, notations follow Equation 3. h denotes hospital, t time, w week, and m month. NP is an indicator for nonprofit hospitals. τ_h represents hospital fixed effects and τ_m month fixed effects. ϵ_{htw} represents hospital-specific idiosyncratic shocks that are not observed, and assumed to be independent of all observable and unobservable factors. Estimates are clustered at the hospital level. The coefficient of December 2009 (β_0), the last month in the pre-policy period, is normalized to zero.

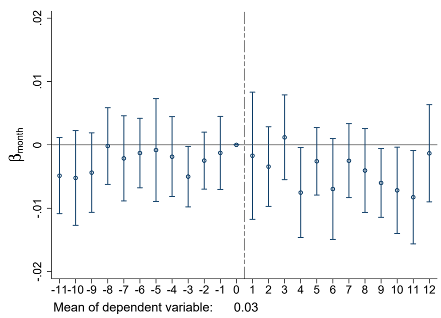
Coefficients of interest, β_p, estimate how nonprofit hospitals respond differently from public hospitals. We focus on the same set of outcomes—numbers of doctors at night, treatment expenditure at night, shares of nonurgent visits, shares of night admission, and 7-day and 30-day mortality at night. We plot estimates, β_p, for all outcomes in Figure A1. Our estimation concludes that nonprofit hospitals behave similarly to public hospitals in response to this specific policy. This is reasonable given that all hospitals face the same payment schemes despite their ownership types under the Taiwanese National Health Insurance program.



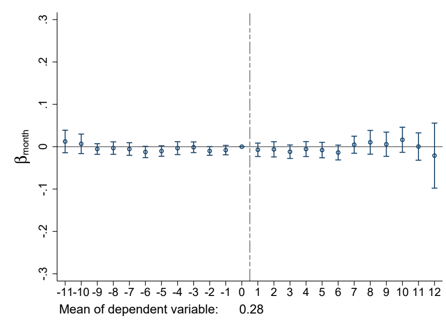
(a) Numbers of ED Doctors



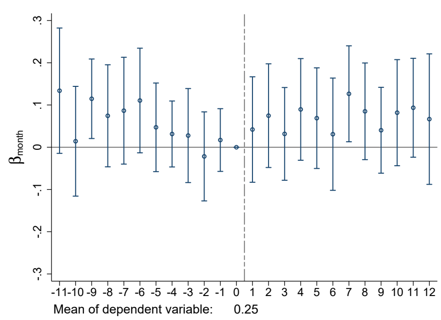
(b) Treatment Expenditure



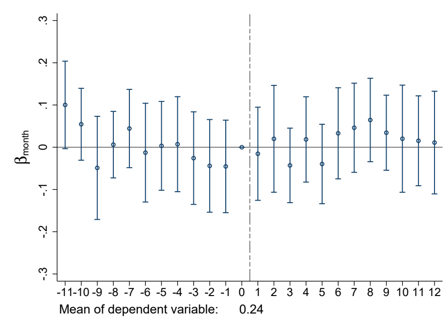
(c) Substitution between EDs and Primary Care



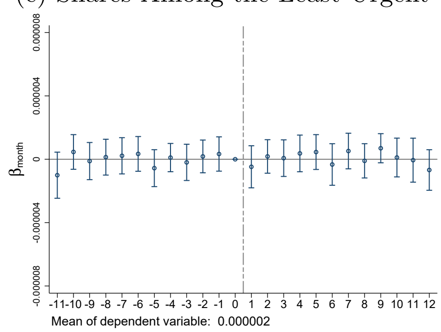
(d) Shares of Admissions



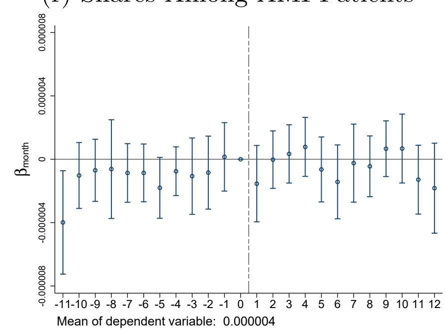
(e) Shares Among the Least Urgent



(f) Shares Among AMI Patients



(g) 7-Day Mortality



(h) 30-Day Mortality

Figure A1: Impacts on Admission at Night by Ownership Types