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Hospital Efficiency and Consultants' Private Practices: Analysing the Impact of a Voluntary Reform

Xidong GUO*

Abstract

This paper explores the effectiveness of the voluntary reform. It studies a voluntary healthcare reform that was implemented in Ireland in 2008. The analysis is conducted using a theoretical model and empirical evidence. In 2008, in the hope to reduce waiting lists, new contracts were issued which limited the proportion of private patients that consultants could treat while and compensating them with a higher fixed salary. This new contract was optional for consultants hired before 2008. It was compulsory for newly hired consultants. The theoretical model establishes that this reform reduced the overall number of treated patients because the restriction on private practices disincentivises consultants to attend to more patients. A difference-in-differences approach is then employed where inpatients entering through the Emergency Department are considered as the control group. I use micro-level data to access the impact on the Length of Stay (LOS) and control patients' characteristics and medication conditions. Using Little' Law, I establish that the LOS is negatively correlated with the number of admissions. The empirical results also show a 0.28-day increase in the LOS for public patients, which suggests that the 2008 voluntary contract reform led to unexpected adverse impacts and may fail to address the waiting list issue.

Keywords: private practice, consultant's contract, length of stay, voluntary reform.

JEL Classification: I18, I10, H44, J41

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1. Introduction

Voluntary reforms are widely used in public policy reforms. For example, in the healthcare sector, the health authority in Scotland implemented a voluntary General Practitioner cooperation reform in 1999, which aimed to provide a wide range of primary and to boost professional development within general practices (Simoens and Scott, 2005). In the US, the Medicare program conducted a voluntary payment reform in New Jersey (Alexander, 2020), and it implemented another voluntary payment reform for hip and knee replacement in 2016 (Einav et al., 2021). Besides the health sector, voluntary reforms were also implemented in other sectors such as environmental regulation (Bu et al., 2020; Jack and Jayachandran, 2019). Voluntary reforms are gentle, and thus, maybe more acceptable because of the choices given to stakeholders who can decide to participate or not. However, their effectiveness may be a concern. Indeed, some stakeholders will not change their behaviours as they will not sign the new agreement. And, as is the case with any reforms, the new agreement may trigger adverse incentivises. This paper evaluates the effectiveness of a voluntary healthcare reform implemented in Ireland in 2008 labelled the "2008 public medical consultants' contract reform". This paper provides a study of this reform's effectiveness and explores the mechanisms at play relying on a theoretical framework and on empirical evidence.

In Ireland, there is a belief that the reduction of private practices by medical consultants within public hospitals would improve the waiting list issue.[1] Patients attending public hospitals for inpatient care can choose to be treated as public patients or as private patients. The classification of public patients and private patients is based on their payment sources. In particular, public patients are defined as those patients whose medical services are paid by the Irish Government.[2] Thus, public patients can access to inpatient healthcare service free

[1] See Nolan (2006) for more discussions about private practices in Ireland.

[2] Everyone who is living in Ireland (including certain types of visitors) is entitled to a range of healthcare services either free of charge or at reduced cost. Please see the copayment for inpatient services, and more about hospital charges in Ireland here: https://www.hse.ie/eng/about/who/acute-hospitals-division/patient-care/hospital-charges/.

of charge (with some co-payment) but it is subjected to lengthy waiting time. Public patients will be assigned to a public ward which is shared with other patients. Private patients are those patients whose expenses (including the service fee for consultants, and private bed fee for hospitals) are paid by their private health insurance or out-of-pocket money. Private patients can generally access care more promptly. Private patients in public hospitals will be accommodated in designated private beds except few temporary situations (Colombo and Tapa, 2004).[3] The provision of private care within public hospitals does not only exist in Ireland. There are 16 OECD countries allowing this dual practice within public hospitals (Paris et al., 2010), as well as other countries such as Indonesia and China.[4]

Patients accessing to inpatient care are normally through two channels: the unscheduled channel or the scheduled channel. The unscheduled channel is through the Emergency Department (ED). Patients who are admitted through ED are also known as ED admissions. About one third of inpatients in Ireland were admitted through the ED.[5] The ED is not running on a first-come first-served basis, but the priority will be given based on medical needs.[6] In other words, whether a patient is a public patient or a private patient will not affect the admission decision in the ED. The scheduled channel is through the referral by a GP or through outpatient service of a consultant. These patients who are scheduled by consultants are also known as elective admissions.[7]

In 2008, in an effort to reduce the public waiting list, the health authority

[3] For example, Beaumont Hospital (2009) states that, in some situations where a private ward is not available, a private patient may be placed in a public bed temporary. However, this patient will be transferred to a private ward at the earliest time.

[4] Please see a research by Gonzalez et al. (2020) studying Indonesia. Please see a discussion of private care in Chinese public hospitals here (in Chinese): http://www.gov.cn/xinwen/2014-05/19/content_2681874.htm.

[5] For more information about inpatient admission types in Ireland, please see here: https://www.hse.ie/eng/about/who/acute-hospitals-division/patient-care/inpatient-scheduled-care/.

[6] For the admission criteria in the ED, please see here: https://www2.hse.ie/emergencies/the-emergency-department-ed/.

[7] For more about the procedure of elective admissions, please see here: https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/elective-surgery-programme-implementation-support-guide.pdf.

in Ireland (the Health Service Executive, known as the HSE), implemented a nationwide voluntary-based reform targeting public consultants, called "*The 2008 Consultant's Contract Reform"*. The HSE designed a new contract, which limited the proportion of private patients that a consultant could treat within the public hospital by 20% or 30%, depending on the consultant's seniority in exchange for a higher fixed salary. This new contract was optional for consultants contracted before 2008. It is compulsory for consultants hired since 2008. Considering that public hospitals are capacity constrained, the reform was motivated by a decision to request that consultants devote themselves to public patients mostly. The reform was popular as, by July 2009, there were 1,688 out of 1,888 (or about 89.4%) consultants who accepted the new contract (Government of Ireland, 2009).

There is an empirical literature which does not support the optimistic expectation of the HSE. Whyte et al. (2020) study the effectiveness of this reform on reducing the waiting time difference between private patients and public patients. By using two waves of survey data, they compare the waiting time difference between patients who have private health insurance (PHI) and patients who do not, before and after the 2008 reform. They do not find evidence that this reform reduced the difference in waiting time between public and private patients. However, this approach may worth careful consideration if we want to explore the casual effect of the 2008 reform, where a control group (who was not affect by the reform) is needed. Based on the contribution by Whyte et al. (2020), this present paper moves a step forward by studying the causality of this reform, considering the incentives triggered by the reform and by focusing the length of stay of patients. I analyse consultants' motivation, using a theoretical model and empirical evidence based on micro-level data. I employ a difference-and-differences approach using inpatients admitted through emergency department as a control group where the treatment priority is given based on medical needs.

I propose a simple theoretical model to capture the decisions of existing consultants following the reform. I consider that there are two contracts offered to existing consultants: "The old contract" is more flexible in term of private practice while "the new contract" constrains the percentage of private patients but it provides a higher fixed pay. Consultants differ in their reputation which

determines the private fee that they can charge. Consultants care about monetary benefits and are also intrinsically motivated. This is captured assuming that they receive some form of gratitude when attending public patients. They need to make three decisions. Firstly, which contract to choose? Secondly, how many patients to treat? And finally, what is the proportion of private patients that they wish to treat? Their last decision is made subject to the ratio stipulated in the contract that they selected in the first place. The theoretical model establishes the following. Consultants with a "high reputation" who can charge a large private fee choose the old contract. They attend to as many private patients as they are allowed. The reason is that their monetary returns from private practices is high, and it incentivises them to keep the old contract which is more flexible in terms of private practices. The reform has no impact for these consultants who will attend to the same number of patients before and after the reform. Consultants with "moderate reputation" opt for the new contract and treat the maximum proportion of private patients that they can attend to. The higher fixed salary of the new contract is what tempts them. The restriction on private practices has a negative impact as it leads them to treat fewer patients overall. However, the number of public patients that these end up attending to is ambiguous owing to some countervailing effects. These consultants see a higher proportion of public patients but, overall, they attend to fewer patients. Lastly, the consultants with "low reputation" choose the new contract and treat public patients exclusively. For these consultants, the private practice is not attractive because their monetary return from the private practices is lower relative to their intrinsic motivation. The constraint on the ratio of private patients is not binding for them and, therefore, the number public patients seen by these consultants does not change. Overall, the theoretical model conjectures that fewer patients will be attended to after the reform, but it also points to the fact that the number of public patients accessing care is ambiguous.

To test the effectiveness of the policy implemented, I use a difference-in-differences (DiD) approach where inpatients entering through the Emergency Department (ED) are considered as the control group. This is so because admission priority is given according to medical needs and it does not depend on

patients' private status. The inpatients who enter through elective care (scheduled with consultants) are considered as the treatment group. I use administrative inpatients data from Hospital In-Patient Enquiry (HIPE) provided by Healthcare Pricing Office. I focus on the period 2005 to 2013. The DiD result based on the aggregated data shows that, the annual average number of elective admissions dropped by 11% after the reform. It was mainly driven by a reduction of private admissions (which dropped by 20%) but there was also a 4% decline in public admissions. Because above analysis on the number of admissions is based on the aggregated data, this has limitations as I cannot control for individuals' characteristics and their relevant medical conditions. Moreover, using aggregated data does not allow me to explore the heterogeneous effects and potential mechanisms at play.

To address these issues, I use micro data at medical record level, for an in-depth analysis. In particular, I use the Length of Stay (LOS) of each patient as the outcome variable. To build a bridge between the number of admissions and the LOS, I apply Little's Law, which establishes that, given the capacity of a hospital, a higher Length of Stay (LOS) for each patient indicates that fewer patients can be attended to. In other words, the LOS can be a proxy for the number of patients who are cured by consultants in a context where hospitals are operating at capacity. This assumption is typically accepted as correct when considering public hospitals. The concerns relevant to capacity and the quality of care are discussed in the Section 6.4 devoted to robustness checks.

Controlling for the patients' characteristics and considering fixed effects, the empirical results show that the reform let to a 0.31-day increase in the LOS on average. For public patients and for private patients, the increases in the LOS are 0.28-day and 0.38-day respectively. The mechanism analysis suggests that this increase in the LOS is mainly driven by the inpatients who were mildly ill. The above evidence suggests that the 2008 contract reform had some adverse impacts.

The instructional background and research motivation will be explained in Section 2. Section 3 shows the theoretical model. Section 4 provides the application of Little's Law. Data will be described in Section 5. Empirical evidence will be demonstrated in Section 6. Lastly, Section 7 concludes.

2. Background and Motivation

The possibility to conduct private practices within public hospitals has considered controversial for a long time in Ireland. *The 1997 contract* allowed consultants to treat private patients outside or within public hospitals. It provided consultants with abundant flexibility in terms of private practices.[8] At the time, disciplinary action aimed at monitoring the consultants' private practices was very rare.[9] Following mounting concerns surrounding public waiting lists, the Health Service Executive (HSE), which is the agent of Department of Health Ireland, implemented a nationwide reform of consultants' contract in 2008 (*The 2008 Consultants' Contract Reform*). This contract reform offered an alternative set of contracts, which limited the provision of private practices but compensated consultants with a higher fixed wage.[10] However, "the new contract" was offered on a voluntary basis for consultants hired prior to 2008 who could also choose to keep their initial contract (with lower fixed salary but with more flexibility in relation to private practices).[11] A report from the Government of Ireland (2009) stated that over 89% existing consultants decided to switch to *the 2008 Contract* by July 2009. Although the 2008 contract was only optional for existing consultants, it was mandatory for the newly hired consultants who joined the HSE on or after 2008. By implementing this reform, the HSE expected the waiting lists in the public hospital to shorten. The idea was that, given the capacity of public hospitals, public consultants would shift more of their workloads from private patients to public patients. The optimistic expectation of the HSE was based on an assumption that the consultants would treat at least the same number of patients

[8] In *the 1997 Contract*, there is no specified limitation of provision of private practices, but only mentioned "a consultant's overall proportion of private to public patients should reflect the ratio of public to private beds as designated by the Minister at individual hospital level." (HSE, 2007).

[9] For example, a government report (Department of Health and Children, 2001) states that the agreement with hospitals is that 80% of beds should be used for public patients, but only 71% of elective admissions are public patients.

[10] For example, for consultants who had "1997 category 1 contract" and in western area, their annual wage in June 2007 was 181,998 Euro. If they choose "2008 Type B contract", they will have annual wage of 215,955 Euro since 2009; if they choose to keep their old contract, they will have annual wage of 200,772 Euro since 2009. The difference (15,183 Euro) was over 8% of their wage under 1997 contract. For more details, please see the document by the HSE (2009).

[11] If a consultant chooses the new contract by 31st August 2008, then the fixed salary is even higher (HSE, 2008).

after the reform.

According to the theoretical literature, the restriction of private practices has an ambiguous impact on the quality of care and on the length of public waiting list. Gonzalez (2004) establishes that an allowance for private practices is beneficial with consultants who want to build up their reputation to get a higher private revenue. Biglaiser and Ma (2007) consider altruistically motivated consultants and show that consultants who work in the public sector are more devoted to their patients. Based on data from Indonesia, Gonzalez et al. (2020) show, theoretically and empirically, that dual practices increase the number of treated patients but decrease the doctors' working hours in the public sector. Brekke & Sørgard (2007) shows that the provision of private practices leads to a crowding-out effect whereby too little public care would be supplied. Given these controversial findings, the literature reaches a consensus stating that dual practices can increase welfare subject to proper regulation (Garcia-Prado and Gonzalez, 2007; Gonzalez and Macho-Stadler, 2013; Gonzalez, Montes-Rojas and Pal, 2018).

In terms of the effectiveness of voluntary reforms, Gino et al. (2013) use experimental approach and show that a voluntary regulation may be less effective than no regulation at all. Alexander (2020) studies a voluntary Medicare reform program in New Jersey which was set up to reduce the expenditure of Medicare. This program sets benchmark prices paid to the hospitals for each patient. Physicians working in hospitals who join in the program and have their treatment costs below the benchmark price receive a bonus. Physicians can work in more than one hospital. In particular, a physician can work in a participating hospital and in a non-participating hospital at the same time. The author finds that the program was unsuccessful because physicians adopted a strategical admission behaviour sorting low-cost and healthier patients into participating hospitals to generate bonuses. This finding is supported by Einav et al. (2022), who study a voluntary reform in Medicare in 2008 that proposed a "bundle payment system" to hospitals who received a fixed bundle payment for each patient. Previously, hospitals were reimbursed based on what they claimed. Einav et al. (2022) isolate the hospitals who were "self-selected on levels" (those with lower treatment costs

originally) from the hospitals who were "self-selected on slopes" (those who can save on costs substantially by changing their behaviours). They find that this Medicare voluntary reform was not effective because it attracted a disproportionate amount of hospitals self-selected on levels. A more optimistic view is provided considering the potential long-run benefits arising from voluntary regulation. Simoens and Scott (2005) study a voluntary healthcare reform in Scotland, where voluntary co-operative organisations (local health care co-operatives, or LHCCs) were introduced in general practices in 1999. The target of these LHCCs is to provide a wide range of primary care and disease prevention, and to boost the professional development within general practices. In their paper, Simoens and Scott (2005) analyse the potential bias in the selection of participants introduced by these voluntary primary care organisations and the impacts on healthcare inequality. They find that there is a self-selection effect, whereby general practices with larger population in their area or with more people in need of medical services are more likely to join in. This may have a positive impact on welfare in the long run.

3. Theoretical Model

Let $(t_0, \overline{\alpha}_0)$ and $(t_1, \overline{\alpha}_1)$represent the 1997 contract and the 2008 contract respectively, where t is the fixed wage and $\overline{\alpha}$ is the maximum proportion of private patients that the consultant is allowed to treat. To be in line with what happened in practice, I assume that, before the reform, every consultant were subject to the old contract $(t_0, \overline{\alpha}_0)$. After the reform, the new contract $(t_1,\ \overline{\alpha}_1)$ is introduced as an alternative. I consider a situation where $t_0 < t_1$ and $\overline{\alpha}_0 > \overline{\alpha}_1$ to account for the fact that the old contract provides a larger flexibility in terms of private practice but a lower fixed salary. There is a mass of one of consultants who maximise their utilities by making three decisions. Firstly, they decide which contracts to take. Secondly, the HA recognises the expertise and knowledge of medical professionals, so that consultants can decide on how many patients they want to treat and decide on the proportion of private patients they wish to attend

to subject to the restriction stipulated in the contract.[12] Specifically, if consultant i takes contract $(t_j, \overline{\alpha}_j)$ where $j \in \{0,1\}$, this consultant maximises the utility $U_{ij}(n_{ij}, \alpha_{ij})$ with respect to the total number of patients to treat n_{ij}, and the proportion of private patients α_{ij}, subject to $\alpha_{ij} \leq \overline{\alpha}_j$. Consultants differ in their reputation levels $\gamma_i > 0$. I assume that the mass of consultants is uniformly distributed as per their regulation levels γ_i.[13] For each private patient, consultant i receives a private fee $p(\gamma_i)$ that is positively correlated with their reputation. Consultants not only value their monetary income (which includes the fixed wage t_j and the private revenue), they also gain gratification from treating public patients through their devotion to public care. In particular, for each public patient they treat, there is an increase gratification of ψ added to a consultant's utility. I assume that each consultant has the same level of public devotion.[14] I assume that consultants incur a cost from seeing patients. The cost function is given by $\frac{1}{2}(n_{ij})^2$. Thus, the utility maximisation problem that each consultant solves is given as

$$\max U_{ij}(n_{ij}, \alpha_{ij}) \; subject \; to \; \alpha_{ij} \leq \overline{\alpha}_j,$$

where

$$U_{ij}(n_{ij}, \alpha_{ij}) = t_j + p(\gamma_i)\alpha_{ij}n_{ij} + (1 - \alpha_{ij})\psi n_{ij} - \frac{1}{2}(n_{ij})^2.$$

Proposition 1: *Let γ_w be the threshold reputation level defined such that $p(\gamma_w) = \psi$. Consultants with reputation level $\gamma_i > \gamma_w$ will treat the maximum ratio of private*

[12] In practice, the contracts in Ireland only specify the working hours (37-hour) per week, but it does not specify the number of patients a consultant should treat (Government of Ireland, 2009). These two elements are not equivalent, because given working hours, the number of treated patients depends on the average treated time per patient. It will be explained in detail in Section 4.

[13] The parameter γ_i can also be interpreted as working experience or ability. For convenience purpose only, I use "reputation" onwards.

[14] An interesting extension is to let the reputation γ_i be endogenously determined by the public devotion ψ. However, this extension requires an assumption that patients can perfectly observe consultants' intrinsic devotion, which is normally treated as private information. Thus, this paper considers a more realistic setting where the private fee is only determined by consultants' reputation other than public devotion.

patients allowed by the contract. Consultants with reputation level $\gamma_i \leq \gamma_w$ treat exclusively public patients.

Proof of Proposition 1: See Appendix.

Proposition 1 can be best understood noticing that, for any given n_{ij}, the utility is linear in α_{ij}:

$$U_{ij}(n_{ij}, \alpha_{ij}) = t_j + [p(\gamma_i) - \psi]\alpha_{ij} n_{ij} + \psi n_{ij} - \frac{1}{2}(n_{ij})^2.$$

From the expression above it is clear that the optimal value for α_{ij} solely depends on the sign of $[p(\gamma_i) - \psi]$. When this expression is non-negative, meaning that $\gamma_i > \gamma_w$, it optimal for the consultant to attend to the highest possible proportion of private patients. And when $[p(\gamma_i) - \psi] \leq 0$ it is optimal to select $\alpha_{ij} = 0$.

The utility function is concave in n_{ij}, regardless of the value of α_{ij} which means that there is a unique solution to the maximisation problem.

Corollary 1: *The total number of patients treated by consultant i under contract $(t_j, \overline{\alpha}_j)$ is given by*

$$n_{ij}{}^* = \begin{cases} [p(\gamma_i) - \psi]\overline{\alpha}_j + \psi, & if\ \gamma_i > \gamma_w \\ \psi, & otherwise \end{cases},$$

and the consultant's utility is given by

$$U_{ij}(n_{ij}{}^*) = \begin{cases} t_j + \frac{1}{2}\{[p(\gamma_i) - \psi]\overline{\alpha}_j + \psi\}^2, & if\ \gamma_i > \gamma_w \\ t_j + \frac{1}{2}\psi^2, & otherwise \end{cases}.$$

Proof of Corollary 1: See Appendix.

Corollary 1 paves the way to the analysis of the choices between contracts because we can look at consultant's utilities under the new contract $(t_1, \overline{\alpha}_1)$ and

under the old contract $(t_0, \overline{\alpha}_0)$ respectively. The consultant i chooses the contract which maximises their utility such that

$$\max \{U_{i0}({n_{i0}}^*; t_0, \overline{\alpha}_0), U_{i1}({n_{i1}}^*; t_1, \overline{\alpha}_1)\}.$$

Proposition 2: *There exists a threshold of reputation level $\gamma_k > \gamma_w$, defined such that the consultant with reputation level γ_k is indifferent between the old contract $(t_0, \overline{\alpha}_0)$ and new contract $(t_1, \overline{\alpha}_1)$. The old contract $(t_0, \overline{\alpha}_0)$ is more attractive to consultants with reputation higher than γ_k. The new contract $(t_1, \overline{\alpha}_1)$ is more attractive to consultants with reputation lower than γ_k.*

Proof of Proposition 2: See Appendix.

The two thresholds γ_w and γ_k provided in Proposition 1 and Proposition 2 divide consultants into three subgroups: consultants with "low reputation" ($\gamma_i \leq \gamma_w$), consultants with "moderate reputation" ($\gamma_w < \gamma_i \leq \gamma_k$), and consultants with "high reputation" ($\gamma_k < \gamma_i$). According to Proposition 2, "low reputation" consultants opt for the new contract as they are not interested in attending to any private patients. Consultants with a "moderate reputation" choose the new contract as the amount of private revenue they can gather is not as tempting as the compensated fixed wage. Lastly, consultants with a "high reputation" keep the original contract, which allows them to attend to more private patients.

Lastly, we move on to the analysis of the number of public patients treated by consultant i, which is given by $\left(1 - \alpha_{ij}\right){n_{ij}}^*$. The "Low reputation" consultants ($\gamma_i \leq \gamma_w$) only treat public patients and we have ${n_{ij}}^* = \psi$, no matter which contract they choose. The "moderate reputation" consultants ($\gamma_w < \gamma_i \leq \gamma_k$) choose the new contract $(t_1, \overline{\alpha}_1)$, and see a lower proportion $\overline{\alpha}_1$ of private patients. However, we also have ${n_{i1}}^* < {n_{i0}}^*$. Therefore, it is not clear, for these consultants whether they end up seeing more or fewer public patients. Lastly, since the "high reputation" consultants ($\gamma_i > \gamma_k$) choose to keep with their original contract, they will attend to the same number of public patients after the reform as they did before. In conclusion, the voluntary reform only impacts the number of public

patients seen by consultants with a moderate reputation. These "moderate reputation" consultants will see fewer patients in total but will see a high proportion of public patients, which makes the overall effect on the number of treated public patients ambiguous. Below Figure 1 summarises the main insights from the theoretical model.

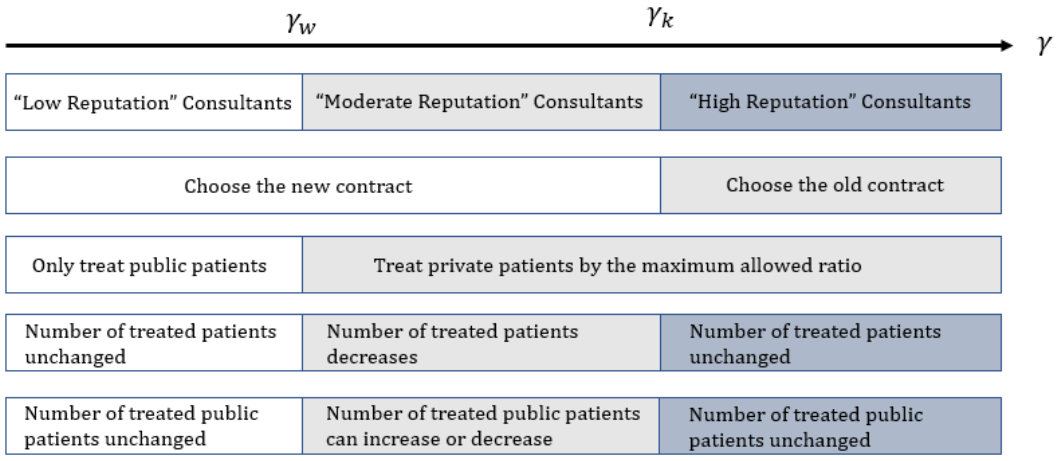

Figure 1: The decisions of consultants (choice of contract, proportion of private patient, number of treated patients, and number of treated public patients) with different levels of reputation

In Ireland, about 89% of the consultants hired prior to the reform chose the new contract. However, we do not have data on their private fee and thus we do not know how many have a "moderate reputation". If this group of consultants is large, then we can infer that the 2008 contract reform will lead to a significant drop of the number of treated patients in total, but it is ambiguous about the number of public admissions. To assess whether the new contact was successful in achieving shorter waiting lists for public patients, I rely on an empirical analysis and test the following two hypotheses.

Hypothesis 1

Fewer patients were attended to following the reform.

Hypothesis 2

Fewer public patients were attended to following the reform.

Although I will show the changes in the number of admissions based on the aggerated data in Section 5.2, this paper mainly concentrates on patients' length of stay based on micro-level data. The reason is stated in the below Section 4.

4. Little's Law

As mentioned above, if I focus the analysis on the number of admissions which is based on the aggregated data (as shown in Section 5.2), it has limited interpretation power. It is because I cannot control patients' characteristics, or split the impact of new consultants hired since 2008, or explore the heterogeneous effects and potential mechanisms at play. Therefore, this section explains how one can use the Length of Stay (LOS) of inpatients as a proxy for the overall number of patients. The LOS is an important efficiency index for hospitals. It has been widely used in the literature.[15]

According to queuing theory, Little's Law stipulates that

$$L = \lambda W.$$

The parameter L is the number of patients in the hospital at any point in time, which matches the bed capacity. The parameter λ is the arrival rate per unit of time, which reflects the number of admissions per unit of time. Finally, the parameter W is the average length of stay for one patient (in terms of a unit of time), which is also referred to as the LOS. This equation shows that, given the capacity of a hospital $L > 0$, a shorter LOS for each patient must be associated with an ability to treat more patients. In Ireland, public hospitals are functioning at capacity.[16] Therefore, we can conclude that a longer LOS can be linked to the fewer treated patients. Furthermore, if one assumes that the demand for hospitalisation is constant over time, then a longer LOS indicates a longer waiting list. Finally, if one finds an increase in the LOS when there is a decreased capacity at the same

[15] For example, please see Dafny (2005), Alexander (2020), Valentelyte et al. (2022), Einav et al. (2022), and more. And please see a discussion of using LOS as an efficient indicator by Walsh et al. (2020).

[16] McKeown et al. (2010) mention in the 2008 National Audit Report that, the average bed occupancy rate of hospitals in the audit is 93%, which is much higher than the OECD average (75%).

time, it means that the decline in the number of treated patients will be more pronounced. This final point enables me to address the confounding impact of the 2008 financial crisis in Section 6.4.

The Little's Law could also predict the heterogeneous effects of the 2008 contract reform on private and public patients. In particular, it is typically the case that private patients will be treated only in the private wards, and public patients will be set only in the public wards.[17] We can rewrite the Little's Law as $L_j = \lambda_j \cdot W_j$, where $j = \{private\ patient,\ public\ patient\}$. Suppose there is an exogenous shock such as the 2008 contract reform, we can rewrite the Little's Law as

$$L_j = \theta_j \lambda_j \cdot \frac{1}{\theta_j} W_j.$$

Here θ_j captures the proportional stock in the number of treated patients, so that the term $\theta_j \lambda_j$ captures the number of treated patients. For example, if a consultant wants to see fewer type j patients than before (from λ_j to $\theta_j \lambda_j$, where $\theta_j < 1$), then this consultant needs to increase the LOS of each type j patient by $\frac{1}{\theta_j} W_j$. According to the prediction from the theoretical model, the proportional reduction of treated private patients is more remarkable owing to the restriction of the new contract, we could set $\theta_{private} < \theta_{public}$. Thus, we should expect that $\frac{1}{\theta_{private}} > \frac{1}{\theta_{public}}$, which means the proportional increase in the LOS is greater for private patients than that of public patients. In other words, the Little's Law states that, if we find a proportional increase in the LOS for private patients is greater, it means that the proportional drop in the number of admissions is also greater for private patients. Therefore, we have the third hypothesis to test in the empirical part.

Hypothesis 3

The proportional increase in the LOS is greater for private patients than that of public patients.

[17] An OECD report (2018) points that this separation of wards in Ireland was active until 2014. Since 2014, the clear separation of beds was removed, which means private patients could be allocated in a shared public ward, and consequently the revenue of public hospitals jumped by 20% than the last year (OECD, 2018).

5. Data and Descriptive Statistics

I rely on the administrative data from Hospital In-Patient Enquiry (HIPE) Database by Health Pricing Office (HPO) Ireland. The HPO collects the data of medical records at discharge level, from public acute hospitals in Ireland. I do not consider private hospitals because I am focusing on the change in the number of public patients.[18] A large range of information on patients' characteristics, their medical conditions and some information about consultants is included in the dataset. The patients' characteristics include their sex, age group (18+, and by 20-year groups), if they have Medical Card, if they were treated as a public patient or as a private patient, and if they have partner.[19] The information on medical conditions includes the LOS, hospitals, major diagnosis categories (MDC), specialties, Diagnosis Related Group (DRG) codes, the number of days under intense care environment, admission year and month, admission source (e.g. from home), discharge year, if this patient was an emergency department (ED) admission or an elective admission, and the discharge destination (e.g. death). Lastly, the information on consultants includes information as to whether each patient was diagnosed by an existing consultant who had worked for the HSE before 2008 or not. It also includes information that when this patient had a procedure treatment (e.g. surgery), whether their main procedure was conducted by a consultant hired prior to 2008 or not.[20]

I consider the period starting from January 2005 because Ireland was using a different classification system (ICD-9-CM) to code discharges before 2005. I consider as a last date December 2013, because in 2014 another reform relevant to private patients in public hospitals was introduced. I exclude some specialties with a very low volume of patients. I also remove a very small fraction of

[18] One may have a concern that consultants may leave the public sector and join private hospitals because of the change of contracts. However, recall that this reform was voluntary based, which means at least consultants can keep their old contract such that they cannot be worse off.

[19] Medical Card in Ireland provide free public care, which is issued considering income, special medical needs, dependants, etc.

[20] Each consultant has a unique code, but this code is protected. The information provided by the HPO is that if this code first appeared in the dataset before 2008 (I refer them as existing consultants) or since 2008 (as new entrants).

observations who were classified as Paediatric relevant specialties as I am focusing on adult inpatients. Inpatients from maternity care, day cases treatment, and a small number of patients from overseas are also excluded. I also exclude the observations who were not admitted through hospitals but from other medical facilities. These cases may lead to duplication because they may have been admitted in other hospitals formerly (Walsh et al., 2020). I also exclude 15 hospitals either because they no longer participate in HIPE due to closures or because they underwent restructuring/reorganisation of services over the time period. Nevertheless, I include those hospitals for a robustness check and the results remain unchanged (see Section 6.4). In term of the LOS, I apply Winsorisation as there are few outliers who staying in hospitals for months.[21]

Ireland is using the Australian Refined Diagnosis Related Group (AR-DRG) hierarchical system on patients' classification, which contains four characters. The first alphabetic letter stands for the Major Diagnosis Category (MDC), which is the highest level for roughly categorising cases along body system lines (HPO, 2019). The second and the third numeric numbers provide information about further partitions: Surgical, Other, or Medical. Patients who required a procedure in the Operating Room (OR) are classified as "Surgical" patients; patients who had a procedure that did not require the OR (e.g. endoscopy) are classified as "Other"; finally, patients did not require any procedure are classified as "Medical". The last alphabetic letter indicates the complexity levels. From the DRG code, I can control for patients' diagnosis categories (using the MDC). I can then analyse the heterogeneous effects on subsamples of patients according to the type of services they experienced (using the DRG partition). However, I cannot control for the levels of complexity because of the changes in coding systems.[22] All in all, the finalised dataset with 3,083,935 observations from 49 hospitals, during January 2005 to December 2013 (details are shown in the below Table 1).

[21] For the observations who stayed in the hospitals longer than 99% of the rest, their LOS will be considered as the LOS of observation at 99% level (which is 36 days).

[22] There was an update of DRG code from version 5.1 to version 6.0 in 2009, where the most important change is the classification in the complexity of illness. The present paper only exploits the information of the MDC and DRG partition (surgical, others, or medical), whose definitions do not change.

Table 1: Summary Statistics

	Total Value	**Elective Admissions**	**Emergency Admissions**
		Distribution of Patients	
Number of Observations	3,083,935	823,517 [26.70%]	2,260,418 [73.30%]
		Dependent Variable	
LOS	6.717 (8.028)	5.956 (7.434)	6.995 (8.216)
		Control Variables	
Male	0.506 (0.500)	0.477 (0.499)	0.517 (0.500)
Public	0.763 (0.425)	0.694 (0.461)	0.788 (0.409)
Has Medical Card	0.586 (0.493)	0.554 (0.497)	0.597 (0.490)
Experienced ITU	0.077 (0.267)	0.068 (0.251)	0.080 (0.272)
Has Partner	0.472 (0.499)	0.553 (0.497)	0.442 (0.497)
Age Group 1 (18 - 27)	Number: 293,940 [9.53% of overall]	Number: 52,440 [17.84% of Age Group 1]	Number: 241,500 [82.16% of Age Group 1]
Age Group 2 (28 - 47)	Number: 672,417 [21.80% of overall]	Number: 179,506 [26.70% of Age Group 2]	Number: 492,911 [73.30% of Age Group 2]
Age Group 3 (48 - 67)	Number: 948,877 [30.77% of overall]	Number: 315,223 [33.22% of Age Group 3]	Number: 633,654 [66.78% of Age Group 3]
Age Group 4 (68 - 87)	Number: 1,048,556 [34.00% of overall]	Number: 263,124 [25.09% of Age Group 4]	Number: 785,432 [74.91% of Age Group 4]
Age Group 5 (88 and over)	Number: 120,145 [3.90% of overall]	Number: 13,224 [11.01% of Age Group 5]	Number: 106,921 [88.99% of Age Group 5]
Diagnosed by a consultant hired prior to 2008	0.879 (0.326)	0.900 (0.299)	0.871 (0.335)
Experienced procedure by a consultant	0.709 (0.454)	0.901 (0.298)	0.640 (0.480)
Experienced procedure performed by a consultant hired prior to 2008	0.614 (0.487)	0.807 (0.395)	0.543 (0.498)

Note: Standard deviations are in parentheses.

The subsections below describe the changes before and after 2008 considering: (i) the proportion of private patients, (ii) the number of admissions, and (iii) the LOS.

5.1 Proportion of private patients

Figure 2.1, below, illustrates that there is a decreasing trend in the proportion of private patients.

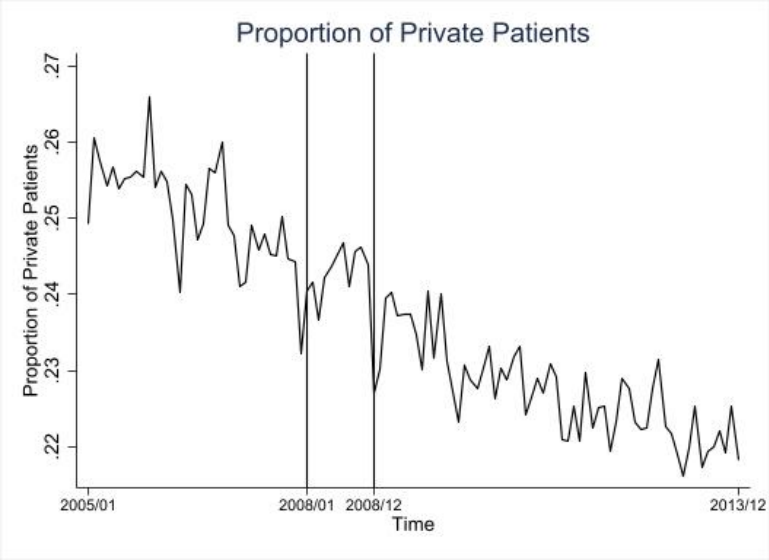

Figure 2.1: Proportion of private patients

If focus on the admission department of inpatients, then we bring to light a remarkable difference. For emergency admissions, the ratio of private patients is stable throughout 2005 to 2013 (as shown in Figure 2.2 below), which means they were not affected by the 2008 reform. This supports the rationale that the inpatients from ED can serve as a control group in the difference-in-differences (DiD) analysis later. One may notice that the trend in the proportion of private patients through elective admissions is decreasing since 2005. However, our outcome variable of interest is the LOS, and associated figures of LOS by elective admissions and emergency admissions will be shown in the Section 5.3. Thus, the main takeaway from Figure 2.2 is that the policy associated with private practices has no impact on the private and public composition through emergency department.

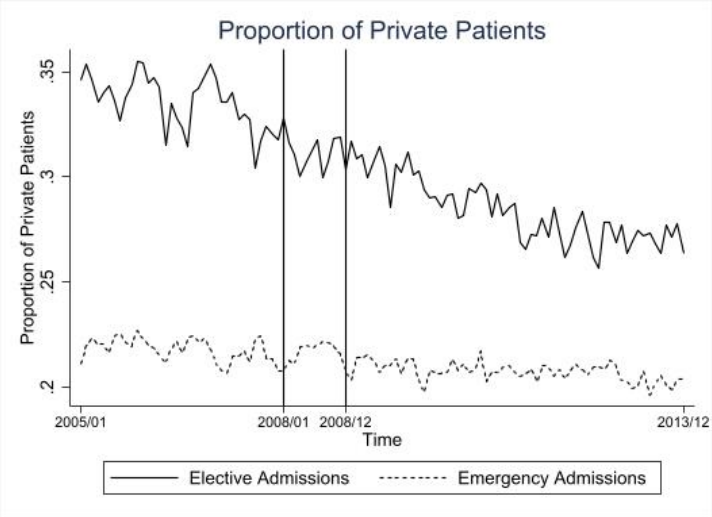

Figure 2.2: Proportion of private patients by admission sources

5.2 Number of Admissions

Figure 3.1 below shows the trend in the total number of admissions, the number of public patients, and the number of private patients throughout the period. A comparison between the number of elective admissions and emergency admissions is shown in Figure 3.2.

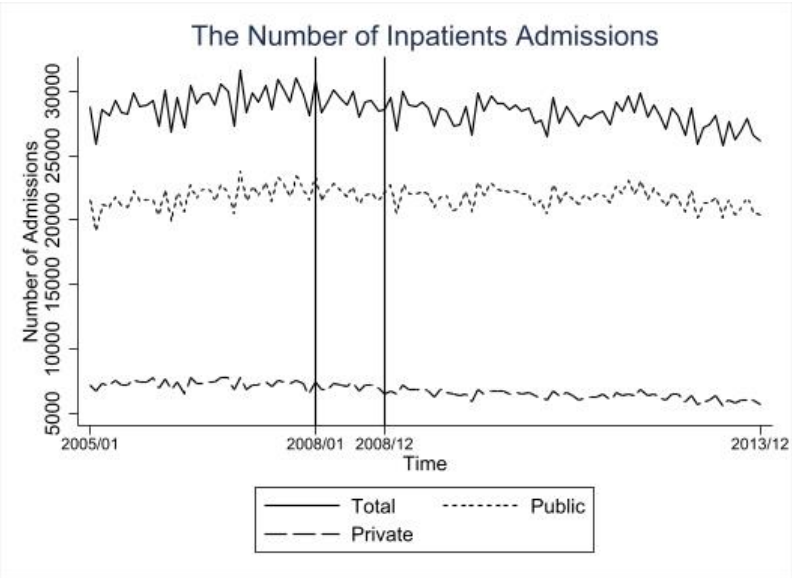

Figure 3.1: Total number of admissions in public acute hospitals in Ireland

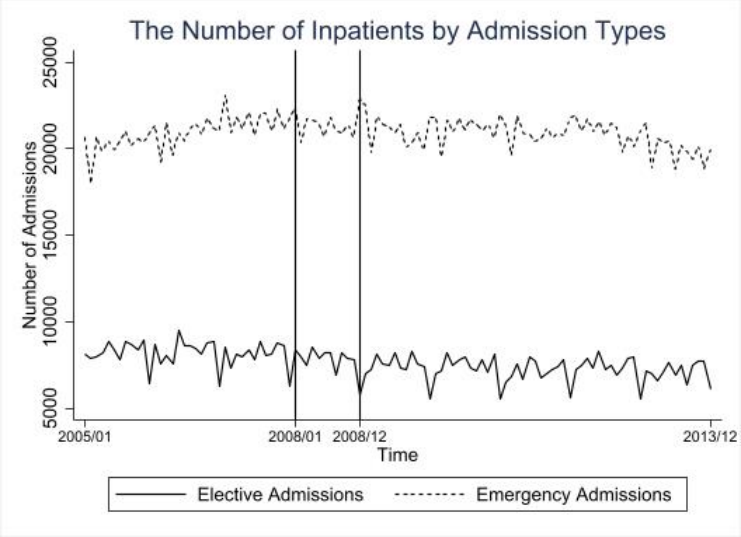

Figure 3.2: The number of inpatients by admission types

A simple two-by-two DiD analysis shows that the annual average number of admissions dropped approximately by 10.50% after 2008. It also shows that the drop in admissions of private patients is about 21.13%. There is approximately a 4.92% decline in the number of public patients. Moreover, I also test the number of admissions at the level of the hospital with DiD approach, and the results are similar. In particular, the hospital level analysis shows that the monthly overall admissions dropped by 11.63% (significant at 10% level), and the monthly public admissions dropped by 4.10% (insignificant), and the monthly private admissions dropped by 20.34% (significant at 1% level).

5.3 The Length of Stay (LOS)

The LOS of inpatients is shown in the below Figure 4.1, which indicates that there was a salient decreasing trend after 2008. In Figure 4.2, one can notice that the LOS of public patients is higher than the LOS of private patients. Figure 4.3 shows that the trends between ED admissions and Elective admissions are similar before 2008, from which we are confident to assume the parallel trends in the main DiD analysis. It also shows that inpatients who came via the ED experience a longer LOS than those who were admitted for an elective care.

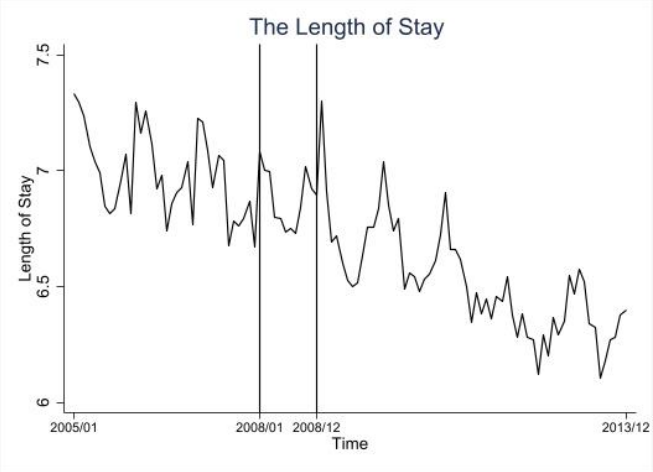

Figure 4.1: Average LOS of inpatients

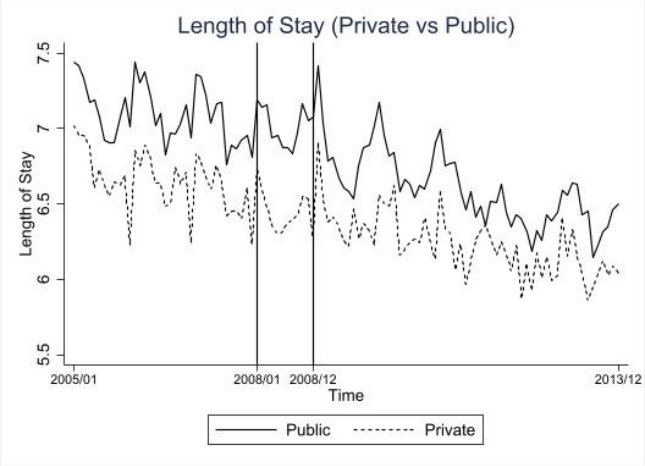

Figure 4.2: Average LOS of inpatients (public and private)

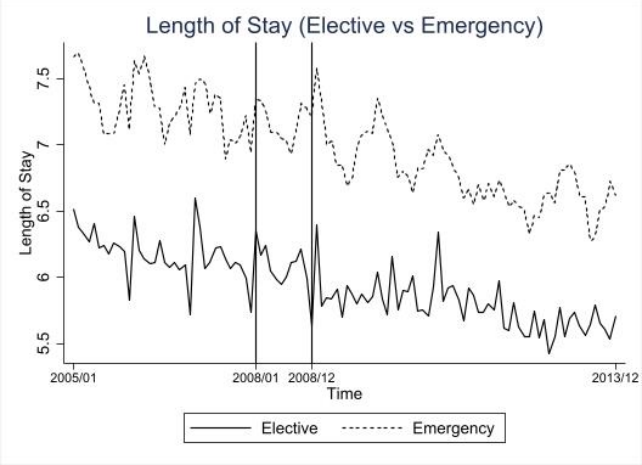

Figure 4.3: Average LOS of inpatients (elective and ED)

6. Empirical Evidence

6.1 Baseline Results

I use a difference-in-differences approach for the empirical analysis. The inpatients admitted through ED will serve as a control group, and inpatients who were electively admitted are in a treatment group. The regression function is given by

$$LOS_{iht} = \beta_0 + \beta_1 ELE + \beta_2 POST \cdot ELE + \theta_t + \theta_y \cdot \lambda_h + \boldsymbol{X} \cdot \boldsymbol{\gamma} + \varepsilon_{iht}.$$

The outcome variable LOS_{iht} is the LOS of medical discharge i from hospital h at time t. The admission time is accurate at monthly level. The treatment variable is ELE, and I let $ELE = 1$ if this patient was admitted electively, and $ELE = 0$ if this patient was admitted through ED. The variable $POST$ is defined such that $POST = 1$ if the year of admission is 2008 onwards, otherwise $POST = 0$. The variables θ_t captures the time fixed effects (year × month). I also consider the fixed effects (hospital × year), which is $\theta_y \cdot \lambda_h$, capturing the changes by year in each hospital (e.g. the change in bed capacity). The matrix $\boldsymbol{X}$ captures the control variables containing the patient's characteristics and their relevant medical information.

The baseline results are shown in Table 2 below. The first column presents the regression results without control variables, which has a limited interpretation power because the patient's personal characteristics and relevant medical information are critical to determine their LOS. The regression containing control variables is shown in column (2). It shows that the 2008 contract reform leads to a 0.237-day increase in the LOS for electively admitted inpatients, compared to the ED admitted inpatients. The regression in column (3) considers hospitals' yearly fixed effect, capturing changes in bed capacity. It illustrates that this increase of LOS is even more significant and greater in magnitude, compared to the results in column (2). Ignoring changes in bed capacity leads to an underestimated outcome, which will be discussed in Section 6.4 later. Together with Little's Law, Table 2 shows that the overall number of admissions dropped. Thus, we do not have evidence to reject **Hypothesis 1**.

Table 2: Baseline Results: Overall Effect of 2008 Reform on the LOS

	Length of Stay			
	(1)	(2)	(3)	(4)
Elective	−1.626***	−2.347***	−2.400***	−2.395***
	(0.189)	(0.178)	(0.174)	(0.175)
Elective × Post	0.012	0.237*	0.310**	0.306**
	(0.157)	(0.121)	(0.121)	(0.121)
Observations	3,083,935	3,083,935	3,083,935	3,083,935
Hospital FE	Yes	Yes	No	No
Year × Month FE	Yes	Yes	Yes	No
Hospital × Year FE	No	No	Yes	Yes
Controls	No	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The critical assumption of a DiD approach is that the counterfactual treatment group (who should have been treated but was not) and the control group should have parallel trends. I perform two approaches for testing these groups' pre-trends. One is the event study coefficients plot (shown in Figure 5), where the baseline point of time is 2007Q4. I do not use a baseline at a yearly level because it will leave only two periods (i.e. 2005 and 2006) before the reform. I do not use a baseline at monthly level because the data of December and January are generally noised by holidays of Christmas and New year.[23] According to Figure 5, one can see that the coefficients are located around zero before the treatment was implemented, and that there is an increase since 2008. Secondly, I perform many placebo tests. Based on the observations before 2008, I conduct 35 DiD regressions for each month between February 2005 to December 2007. In other words, I assume that there was a fictitious treatment at a certain point of time before 2008 and check whether the coefficients are insignificant. All results of placebo tests are insignificant as expected.[24]

[23] Many hospitals in Ireland close for about 10 days in the end of December, or only under partial functions.

[24] The results are available upon request.

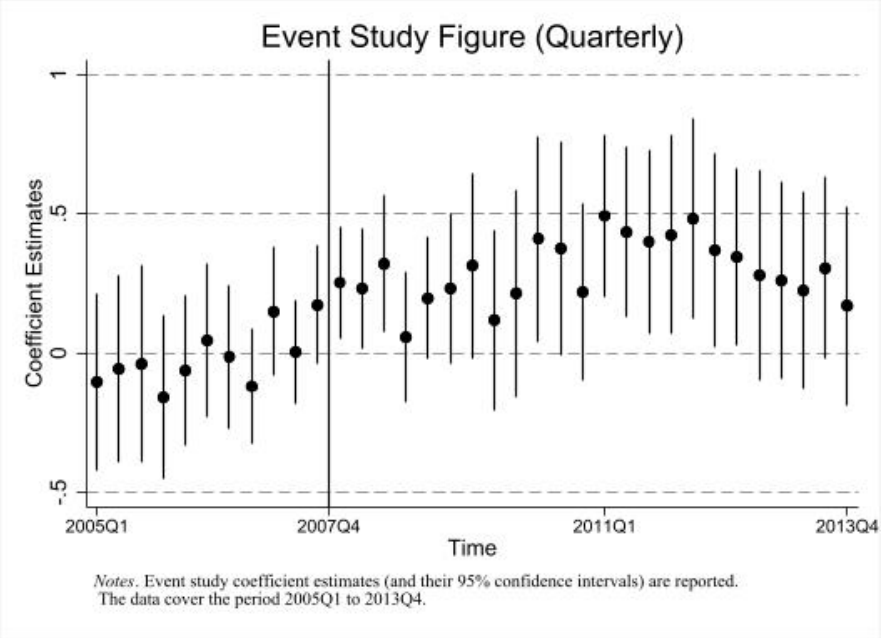

Figure 5: Result of Estimating Equation for Testing Pre-trend

As mentioned, the 2008 contract reform was optional for consultants hired prior to 2008, and was compulsory for new entrants. Therefore, in the following Table 3, I consider the medical cases who were diagnosed or operated by consultants hired prior to 2008. In the first column, I exclude all inpatients who were diagnosed by newly hired consultants. In the second column, the observations are inpatients whose main procedure is performed by consultants hired before the reform. The results show that, compared to the baseline result, the estimate impact is sounder when we only consider these medical cases who were diagnosed or operated by consultants hired before the reform.

Table 3: Patients Treated by Consultants Hired Prior to 2008

	Length of Stay	
	Diagnosis Consultant	Procedure Consultant
Elective	−2.390***	−2.516***
	(0.174)	(0.190)
Elective × Post	0.326***	0.397***
	(0.119)	(0.132)
Observations	2,710,716	1,892,425
Year × Month FE	Yes	Yes
Hospital × Year FE	Yes	Yes
Controls	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, MDC. The first column also controls if they experienced procedures by consultants (and if so, whether they are consultants hired before the reform). The second column also controls if they were diagnosed by consultants hired before the reform. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.2 Heterogeneous Effects Analysis

In this subsection, I analyse the heterogeneous effects triggered by the patients' private status, and by their types of illness. Table 4 highlights the impact on private patients and public patients respectively. From the first two columns, one can notice the increases in the LOS on both public and private patients. Together with Little's Law, Table 4 shows that the number of public admissions dropped. Thus, we do not have evidence to reject **Hypothesis 2**. The third column uses a difference-in-difference-in-differences approach and confirms the above in terms of point estimate, but the difference is not significant. Nevertheless, one should note that no notable change in the level does not indicate no notable change in proportion. Because the LOS of public patients is longer than that of private patients on average, this result is compatible with the prediction from Little's Law: the *proportional* increase in the LOS of public patients is smaller than the *proportional* increase in the LOS of private patients.[25] Thus, we do not have evidence to reject **Hypothesis 3**.

[25] The average LOS of public patients was 7.1 days before 2008. It was only 6.6 days for private patients.

Table 4: Heterogeneous Effects on Public & Private Patients

	Length of Stay		
	Public	Private	DiDiD
Elective	−2.475***	−2.177***	−2.377***
	(0.190)	(0.176)	(0.167)
Elective × Post	0.275**	0.375***	0.384***
	(0.127)	(0.117)	(0.126)
Elective × Post × Public			−0.094
			(0.077)
Observations	2,353,118	730,817	3,083,935
Year × Month FE	Yes	Yes	Yes
Hospital × Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, medical card, intense care unit, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The other heterogeneous effect analysis is based on the Major Diagnosis Category (MDC). In Table 5, one can see that the reform has remarkable heterogeneous impacts on different categories of diagnoses. The 2008 contract reform led to longer LOS for patients with diseases related to the nervous system, the circulatory system, the digestive system, the hepatobiliary system, the kidney and urinary tract, the male reproductive system, and factors influencing health status and other contacts with health service, etc. However, the 2008 reform made the LOS shorter for patients with surface related diseases, such as musculoskeletal system and burns.

Table 5: Heterogeneous Effects on MDC

Nervous	0.894***	Skin	−0.059	Neoplastic	−0.247
	(0.314)		(0.297)		(0.376)
	[272,554]		[131,737]		[40,946]
Eye	−	Endocrine	−0.013	Infectious	−0.551
	−		(0.190)		(0.470)
	−		[65,682]		[37,772]
ENMT	−0.238	Kidney	0.440***	Mental	−0.020
	(0.263)		(0.138)		(0.442)
	[117,809]		[166,035]		[13,159]
Respiratory	0.395	Male	0.599***	Alcohol	0.905
	(0.361)		(0.244)		(0.791)
	[357,187]		[37,503]		[13,159]
Circulatory	0.425**	Female	0.006	Injuries	−0.169
	(0.208)		(0.189)		(0.273)
	[511,567]		[121,407]		[93,697]
Digestive	0.520***	Pregnancy	−	Burns	−4.152***
	(0.180)		−		(1.364)
	[435,617]		−		[3,440]
Hepatobility	0.330*	Newborns	−	Factors	0.673
	(0.170)		−		(0.407)
	[128,653]		−		[66,274]
Musculus	−0.536**	Blood	0.241		
	(0.226)		(0.250)		
	[339,267]		[36,142]		

Note: Only coefficients of interest are reported. Standard errors (in parentheses) are clustered by hospital. The number of observations is shown in brackets. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

I also consider two largest specialties, General Surgery and General Medicine, and perform two subsample regressions. Table 6 elucidates that there is a notable difference of impact between General Surgery and General Medicine. In particular, the increase of LOS in the General Medicine is approximately by 0.875-day, which is much greater and more significant than the estimate of General Surgery (0.234-day).

Table 6: Heterogeneous Effects on GS and GM

	Length of Stay	
	General Surgery	General Medicine
Elective	−2.338***	−1.517***
	(0.161)	(0.276)
Elective × Post	0.234	0.875***
	(0.142)	(0.222)
Observations	611,538	861,975
Year × Month FE	Yes	Yes
Hospital × Year FE	Yes	Yes
Controls	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.3 Mechanism Analysis

Based on the above results, I find evidence that the 2008 contract reform led to fewer patients being treated, and I find some heterogeneous impacts across MDC and specialties. These empirical results would be more compelling if I could establish that there are some subgroups of patients driving this impact. The heterogeneous analysis on MDC and on specialties allows me to propose one potential hypothesis: the mechanism at play depends on the clinical procedures.

To test it, I employ a partition information from the DRG code, which contains the information about their procedure treatment and usage of Operation Room (OR). If a patient experienced a procedure in an OR, they will be classified as "Surgical". Similarly, if a patient experienced a procedure without an OR, they will be classified as "Others". If a patient had no procedure treatment, then they will be classified as "Medicine". Table 7 displays the regression results. For patients who experienced procedures involving the OR, there is no impact from the reform. For patients who experienced procedures that did not require the OR, their LOS increased by about 0.521-day. Finally, for patients who required no procedure, the increase in their LOS is nearly equal to 2 days.

Table 7: Heterogeneous Effects on DRG Partitions

	Length of Stay		
	Surgical (w. OR)	Others (w.o. OR)	Medical
Elective	−2.725***	−1.917***	−1.087**
	(0.196)	(0.271)	(0.525)
Elective × Post	0.063	0.521***	1.916***
	(0.185)	(0.117)	(0.492)
Observations	1,054,773	1,990,236	38,926
Year × Month FE	Yes	Yes	Yes
Hospital × Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A potential explanation is that consultants have less leeway when adjusting their behaviours in relation to severely ill patients who are more likely to require procedures with the OR.[26] To test this hypothesis, I focus on patients with a high severity of illness and patients with low severity of illness. A patient is considered "severely ill" is if she/he had experience in the intense care unit.[27] Table 8 shows that for severely ill patients, the reform has an insignificant impact, as anticipated. Patients who were mildly ill experienced an increase in their LOS which is more pronounced. This result provides evidence that the consultants' behaviour adjustment is subject to potential manipulation.

[26] The overall rate of experience intense care unit is about 7.69%, while this rate is about 12.18% for patients who had procedure with an OR.

[27] For electively admitted inpatients, 6.77% of them had intense care; for ED admitted inpatients, 8.03% of them had intense care.

Table 8: Heterogeneous Effects by Severity of Illness (SOI)

	Length of Stay			
	Severely ill		Mildly ill	
Elective	−1.688***	−2.110***	−2.487***	−2.450***
	(0.418)	(0.415)	(0.174)	(0.152)
Elective × Post	−0.280	0.137	0.346***	0.406***
	(0.302)	(0.351)	(0.111)	(0.120)
Elective × Post × Public		−0.585*		−0.073
		(0.318)		(0.079)
Observations	237,302	237,302	2,846,633	2,846,633
Year × Month FE	Yes	Yes	Yes	Yes
Hospital × Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.4 Robustness Checks

I conduct three robustness checks: by changing the sample of hospitals, by checking the quality of care, and by studying the potential impact of the 2008 financial crisis.

Firstly, I want to show that the results are independent of sample selection of hospitals. I further dropped 4 maternity hospitals from the baseline sample, and the result is unchanged (shown in column 2 of Table 9). Then, I include all the hospitals into the sample and do the analysis again, and the result is still robust (shown in the column 3 of Table 9). Clearly, the effect is independent of the sample selection of the hospitals.

Table 9: Robustness Check by Including Hospitals

	Length of Stay		
	Baseline Sample (excluding 15 structural changed hospitals)	Further excluding 4 maternity hospitals	Full sample of hospitals
Elective	−2.400***	−2.407***	−2.382***
	(0.174)	(0.175)	(0.171)
Elective × Post	0.310**	0.313**	0.302**
	(0.121)	(0.122)	(0.119)
Observations	3,083,935	3,059,520	3,168,531
Year × Month FE	Yes	Yes	Yes
Hospital × Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Secondly, one may have concerns that the increase in the LOS may be due to an increase in the quality of care (i.e. consultants providing more care to patients by keeping them in for longer). By employing a linear probability model, I account for the quality of care using a probability of death. I focus on the diseases relevant to the nervous system, the circulatory system, and the digestive system, which are largely affected by the reform according to previous heterogeneous analysis. Table 10 establishes that the quality of care decreased after the reform. Thus, we cannot find evidence to support the above argument that the increase in the LOS is because of the increase in quality of care.

Table 10: Robustness Check on the Quality of Care

	Probability of Death			
	Overall	Nervous Disorders	Circulatory System	Digestive System
Elective	−0.0221***	−0.0228***	−0.0285***	−0.0233***
	(0.0016)	(0.0035)	(0.0015)	(0.0015)
Elective × Post	0.0034***	0.0049	0.0074***	0.0013
	(0.0009)	(0.0036)	(0.0017)	(0.0012)
Observations	3,083,935	272,554	511,567	435,617
Mean	0.0300	0.0434	0.0281	0.0198
Year × Month FE	Yes	Yes	Yes	Yes
Hospital × Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Lastly, the potential confounding effect of the 2008 financial crisis could contaminate the results through two channels. The first channel is through an individual level: the financial crisis may have led to a situation where fewer patients had a private health insurance (PHI). This may affect the composition of public patients and private patients from the demand side. The second channel is through a decrease in bed capacities that occurred during the crisis.

The first channel may not affect the robustness of the results because of the consideration of time fixed effect. Moreover, according to the data from the Health Insurance Authority, Figure 6 shows that there is very limited change of PHI holders during this period. I also conduct a regression which is based on a normal phenomenon that many people renew their PHI annually. In the year of 2008 and 2009, many patients had access to a PHI that they paid for in the previous year. Thus, it is reasonable to assume that at least for the year 2008 and year 2009, the financial crisis had a very limited impact on patients' PHI status. Table 11 demonstrates the outcomes based on different periods and the outcome is similar to the baseline result.

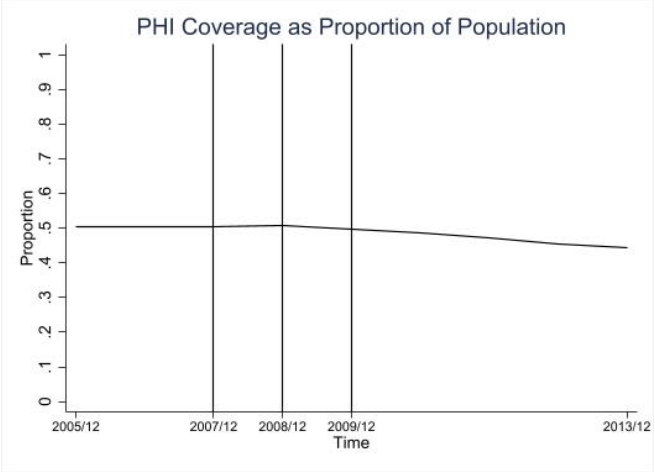

Figure 6: PHI Coverage as Proportion of Population

Table 11: Robustness Check for PHI

	Length of Stay	
	2005 − 2008	2005 − 2009
Elective	−2.331***	−2.347***
	(0.180)	(0.177)
Elective × Post	0.237**	0.239**
	(0.101)	(0.115)
Observations	1,398,126	1,739,285
Year × Month FE	Yes	Yes
Hospital × Year FE	Yes	Yes
Controls	Yes	Yes

Note: Standard errors (in parentheses) are clustered by hospital. Controls: sex, public patient, medical card, intense care unit, partner, age group, specialty, MDC, if they were diagnosed by consultants hired prior to 2008, if they experienced procedures (and if so, whether these were executed by consultants hired prior to 2008). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The second channel has to do with a reduction in the number of nurses and, consequently, a smaller bed capacity. This may have different impacts on elective admissions and ED admissions because of the medical priority of ED inpatients. The results of this paper are still robust for the following reasons. Firstly, Walsh et al. (2021) find that a reduction in bed capacity leads to a decrease in the LOS. This indicates that the estimate in the present paper is a lower bound, and that the unexpected adverse impact could be even worse. Secondly, I have established by applying Little's Law that an increase in the LOS with a reduction in capacity together indicate that the reduction in admissions is even more pronounced. Thirdly, I capture the confounding effect of the change in bed capacities by

considering the hospital by year fixed effect (shown in the third column of Table 1). Compared with column (2) which does not consider the influence of bed capacity, one can find a consistent conclusion that the unexpected adverse impact from the 2008 contract reform is greater when considering the decline of bed capacity.

7. Conclusion

This paper assesses the outcome of a voluntary reform, the 2008 medical consultant's contract reform in Ireland. In this reform, a new contract was offered to consultants but was optional for those who were already contracted. Compared with the old contract, this new contract restricted the proportion of private patients that the consultants could attend to. However, the consultants who accepted this new contract were compensated with a higher fixed salary. This paper provides theoretical and empirical evidence supporting the fact that this reform led to an unexpected adverse outcome whereby fewer public patients were treated. Indeed, the new contract led some consultants to attend to fewer patients.

The theoretical model considers that the consultants' reputation determines their monetary return from private practices. I show that the reform will have no impact for consultants with a high or a low reputation. The former are not interested in the new contract. The latter are interested but they do not attend to any private patients and therefore still attend to the same number of public patients after they opt for the new contract. The new contract has an impact when it comes to the consultants with a middle range reputation. These will choose the new contract but will attend to fewer patients overall. A large proportion will be public patients. It is unclear whether they will treat more or fewer public patients in total.

By employing the data from HIPE, I use a difference-in-differences approach to study the causal impact of the 2008 contract reform. The inpatients admitted through ED serve as a control group. The simple DiD results show that, the annual average number of elective admissions dropped by 11% after the reform. It was mainly driven by a reduction of private admissions (which dropped

by 20%).

To control patients' characteristics and their medical conditions, and to analyse the heterogeneous effects and potential mechanisms at play, I rely on micro-level data. Using Little's Law, I show that a longer LOS is equivalent to fewer patients being treated, which consequently makes the waiting list longer. The analysis based on the Little's Law finds that the proportional change in the LOS of public patients should be smaller than that of private patients. The reason is that consultants who changed their contracts need to comply with the restrictions by treating fewer private patients.

The baseline result shows that the 2008 contract reform significantly increases the LOS of patients by approximately 0.31-day on average, and the increase in the LOS of public patients is 0.28-day. This effect is mainly driven by treatments that do not involve the OR. The reason could be that the patients with procedures with the OR are more severely ill. Thus, they have a less flexible LOS that consultants can adjust. Potential confounding impacts of the 2008 financial crisis, such as the proportional change in PHI holders and the cut of bed capacity, are absorbed by "year by month fixed effect" and "hospital by year fixed effect", and the results are stable under robustness checks.

This paper shows that a voluntary reform may trigger adverse effects. In terms of policy recommendation, it shows that a careful investigation on the stakeholders' motivations should be conducted before implementing a voluntary-based reform. Finally, an important open question remains for future study capturing the long run benefits of the reform. Since the new contract is compulsory for new entrants, it may lead to some self-selection whereby it will be appealing to more public devoted consultants. Thus, it may be successfully reducing the waiting list when these new entrants become the main workforce in the Irish public health sector.

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APPENDIX

Proof of Proposition 1:

$$U_{ij}(n_{ij}, \alpha_{ij}) = t_j + p(\gamma_i)\alpha_{ij}n_{ij} + (1 - \alpha_{ij})\psi n_{ij} - \frac{1}{2}(n_{ij})^2,$$

$$subject\ to\ \alpha_{ij} \leq \overline{\alpha}_j.$$

The partial derivative w.r.t the ratio of private patients is

$$\frac{\partial U_{ij}}{\partial \alpha_{ij}} = [p(\gamma_i) - \psi]n_{ij}.$$

The above result indicates that there are two possible corner solutions which depend on the value of γ_i. Suppose γ_w is such that $p(\gamma_w) - \psi = 0$. If the reputation level is sufficiently large such that $p(\gamma_i) - \psi > 0$ or $\gamma_i > \gamma_w$, the consultant will treat the private patients by the upper bound $\overline{\alpha}_j$. If the reputation is sufficient low such that $p(\gamma_i) - \psi \leq 0$ or $\gamma_i \leq \gamma_w$, the consultant will choose to see public patients only. ■

Proof of Corollary 1:

The partial derivative of utility function w.r.t the number of treated patients is

$$\frac{\partial U_{ij}}{\partial n_{ij}} = p(\gamma_i)\alpha_{ij} + (1 - \alpha_{ij})\psi - n_{ij}.$$

The second derivative is

$$\frac{\partial^2 U_{ij}}{\partial {n_{ij}}^2} = -1 < 0.$$

There is no corner solution as $\frac{\partial U_{ij}}{\partial n_{ij}}|_{n_{ij}=0} = p(\gamma_i)\alpha_{ij} + (1 - \alpha_{ij})\psi > 0$, and $\lim_{n_{ij}\to\infty} \frac{\partial U_{ij}}{\partial n_{ij}} < 0$. Thus, the consultant i will choose the number of patients to treat is

$${n_{ij}}^* = [p(\gamma_i) - \psi]\alpha_{ij} + \psi.$$

According to the finding from Proposition 1, if $\gamma_i > \gamma_w$, we could infer that ${n_{ij}}^* =$

$[p(\gamma_i) - \psi]\overline{\alpha}_j + \psi$. Otherwise, we have ${n_{ij}}^* = \psi$. After substituting ${n_{ij}}^*$ into the utility function, we have

$$U_{ij}({n_{ij}}^*) = \begin{cases} t_j + \frac{1}{2}\{[p(\gamma_i) - \psi]\overline{\alpha}_j + \psi\}^2, & if\ \gamma_i > \gamma_w \\ t_j + \frac{1}{2}\psi^2, & otherwise \end{cases}.$$

■

Proof of Proposition 2:

According to Corollary 1, for consultants with low reputation such that $\gamma_i < \gamma_w$, we have ${n_{i1}}^* = {n_{i0}}^* = \psi$. It means no matter which contract to choose, they will only see public patients and the number of treated patients does not change. They will choose the new contract because $U_{i1}(\psi) = t_1 + \frac{1}{2}\psi^2 > t_0 + \frac{1}{2}\psi^2 = U_{i0}(\psi)$.

For consultants with a higher reputation level such that $\gamma_i > \gamma_w$, which contract to choose depends on how high their reputation levels are. Given the fixed wages, because $p(\gamma_i)$ is increasing in γ_i, there should exist a threshold value of reputation $\gamma_k > \gamma_w$ such that $U_{i1}({n_{i1}}^*) = U_{i0}({n_{i0}}^*)$. In other words, the old contract is more attractive to consultants with a higher reputation. The threshold γ_k should satisfy the following condition:

$$t_0 + \frac{1}{2}\{[p(\gamma_k) - \psi]\overline{\alpha}_0 + \psi\}^2 = t_1 + \frac{1}{2}\{[p(\gamma_k) - \psi]\overline{\alpha}_1 + \psi\}^2,$$

or we can simplify it as

$$p(\gamma_k) = \psi + \frac{-\psi(\overline{\alpha}_0 - \overline{\alpha}_1) + \sqrt{\psi^2(\overline{\alpha}_0 - \overline{\alpha}_1)^2 + 2(\overline{\alpha}_0 + \overline{\alpha}_1)(\overline{\alpha}_0 - \overline{\alpha}_1)(t_1 - t_0)}}{(\overline{\alpha}_0 + \overline{\alpha}_1)(\overline{\alpha}_0 - \overline{\alpha}_1)}.$$

One can note that in an extreme situation when $t_1 = t_0$, the threshold γ_k is such that $p(\gamma_k) = \psi = p(\gamma_m)$, which means for all consultants who are $\gamma_i > \gamma_m$, they will choose the old contract.

■

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