The Effect of Competition on Strategic Discharge at Long-Term Acute-Care Hospitals

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Abstract

Because Medicare's prospective payment system for long-term acute-care hospitals (LTCHs) makes a large lump-sum form of payment once patients reach a minimum length-of-stay threshold, LTCHs have a unique opportunity to maximize profits by strategically discharging patients as soon as the payment is received. This analysis explores how the level of competition between LTCHs in geographic markets affects the probability of a patient being strategically discharged. The results show that patients at LTCHs in more competitive markets have a lower probability of being strategically discharged than at those in less competitive markets, suggesting increased competition could help save Medicare funding.

JEL Classification: D22, I11, I18

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I. Introduction

Whether in Presidential debates, Congressional hearings, or just the daily news, the topic of healthcare in the United States has been a hot-button issue for the better part of the last decade. With the public attention and scrutiny given to the Affordable Care Act and other healthcare initiatives recently, one is never far from a discussion on the state of healthcare. Indeed, the state of Medicare, Medicaid, and the United States health expenditure is of worthy concern: in 2015, the national health expenditure was $3.2 trillion – 17.8% of the country's Gross Domestic Product – with $646.2 billion (20%) of that spending dedicated to Medicare alone and with an expectation of the figure to rise to $5.7 trillion by 2026 largely due to Medicare spending increasing by 7.4% per year ("NHE Factsheet," 2017).

As a federally funded health insurance program, Medicare aims to help provide care to its beneficiaries as efficiently as possible, with those beneficiaries in 2015 being the 55.5 million Americans over age 65 or younger with disabilities and/or End Stage Renal Disease ("Total Number of Medicare Beneficiaries," 2015). However, as is all too well known at this point, the difficulties of meeting this goal are many, varied, and sometimes quite convoluted. One such area of Medicare spending that experiences these complex troubles is the prospective payment system (PPS), which "is a method of reimbursement in which Medicare payment is made based on a predetermined, fixed amount" ("Prospective Payment Systems – General Information," 2017) – in essence a lump-sum type of payment. Long-term acute-care hospitals (LTCHs) are one type of provider that is particularly impacted by the PPS. Previous analyses (Kim *et al*., 2015; Eliason *et al*., 2017; Einav *et al*., 2017) have proven how the PPS implementation in LTCHs gives these providers an opportunity to maximize profits by "strategically discharging" patients at their peak profitability. In this paper, I build on existing work to establish the causal effect that the presence or absence of competition between LTCHs in a given market has on the rate of strategic discharge at the corresponding facilities.

In theory, the fixed payment in the PPS is meant to increase the efficiency of the healthcare provider, providing an incentive to avoid unneeded costs like tests, procedures, and drugs, and to have "unproductive resources reallocated, unnecessary ancillaries and days eliminated, and so on" (Coulam and Gaumer, 1991, p. 45). However, given that hospitals, especially for-profit establishments, are profit maximizers by their very nature, the unintended consequence of this new compensation method is for the hospital to now have a novel opportunity through which to potentially maximize their profits and not necessarily to maximize their patients' outcomes; so while "hospitals would not necessarily strike the wrong balance between patient well-being and their income statements, there was nothing intrinsic to the PPS structure to guarantee that the right balance would be struck" (Coulam and Gaumer, 1991, p. 45).

LTCHs are "designed to provide extended medical and rehabilitative care for patients who are clinically complex and have multiple acute or chronic conditions" (Liu *et al*., 2001). A facility must meet all the requirements that Medicare demands of acute-care hospitals, including provisions for and the ability to perform "inpatient medical care and other related services for surgery, acute medical conditions or injuries" ("Hospital Compare: Glossary"). Additionally, its average in-patient length of stay must be greater than 25 days in order to qualify as a LTCH for Medicare reimbursement. In total, Medicare had $5.3 billion worth of payments for care to over 400 LTCHs in 2015 ("Long-term care hospital services," 2017).

LTCHs are a relatively new type of healthcare provider, with the vast majority of facilities having been opened in the last 25 years. Somewhat paradoxically, investigative journalists have found that most LTCHs do not even have any doctors on staff (Berenson, 2010) and serve many patients who have what has been dubbed "chronic critical illness." Essentially, these "chronically critically ill inhabit a kind of in-between purgatory state" (Lamas, 2016), never really getting better but still surviving, requiring the use of ventilators, feeding tubes, and the like.

In regards to their payment structure, LTCHs utilize PPS in a way that seems to highlight the unintended negative incentives of the plan. Prior to 2002, Medicare would reimburse an LTCH "based on their average per discharge costs, subject to limits" (Liu *et al*., 2001). However, this method of payment structure was thought to create inefficiencies in the money Medicare was paying out. Because short-term acute-care hospitals had utilized a PPS payment scheme since 1983, policy makers believed these facilities had an incentive "increase their discharges to long-term care hospitals" (Kim *et al*., 2015, pg. 907). Additionally, the healthcare providers at the LTCH had no real incentive to ensure that the amount of treatment used was effective. Thus, in 2002, the payment structure changed to include a new PPS scheme. Now, Medicare reimburses the care of its patients in LTCHs via a fixed payment amount. Medicare classifies each LTCH patient into a diagnosis related group (DRG), utilizing the same DRGs that are used for its patients in short-term acute-care hospitals. Different DRGs have different payment rates, given the inherent differences in the equipment, drugs, and services needed for a given condition. For patients who do not stay in the LTCH for a genuinely extended period of time (less than a predetermined number of days set by Medicare – usually set in relation to the average length of stay (LOS) for a patient in a given DRG), instead of just paying the full fixed amount up front to the LTCH, Medicare pays a lower, linearly increasing rate to the LTCH for these short-stay outliers (SSOs). Once the patient passes the boundary to no longer be a SSO, Medicare reimburses the LTCH a very substantial fixed amount (Long-Term Care Hospital Prospective

Payment System, 2016). In essence, once the patient reaches this threshold, the LTCH receives a large and final lump sum form of payment, and the profitability of the LTCH for that patient's stay jumps massively on that day. This payment design is represented in figure 1, which shows how the costs and payments progress for DRG 207 (a specific DRG explored further later). Plainly, once the PPS payment is processed at the SSO threshold (the dashed vertical line), there is a huge jump in profitability for the LTCH, and the profitability decreases as the days progress.

This PPS payment clearly provides a novel financial opportunity for an LTCH to maximize its profits by discharging the patient as soon as possible once the SSO threshold is

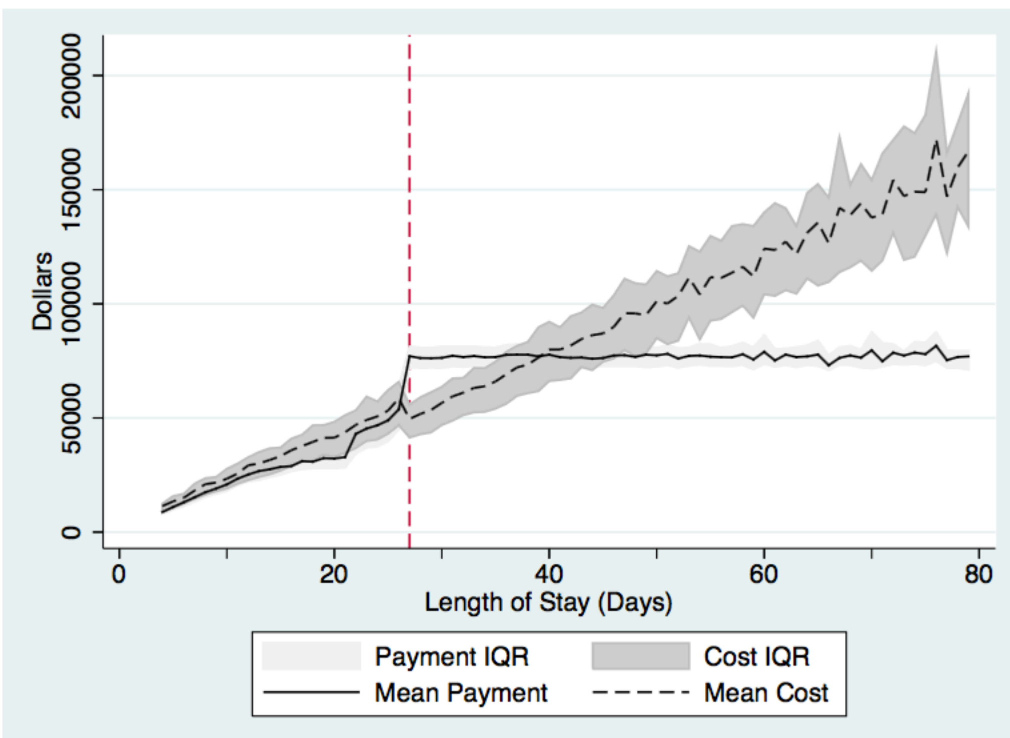
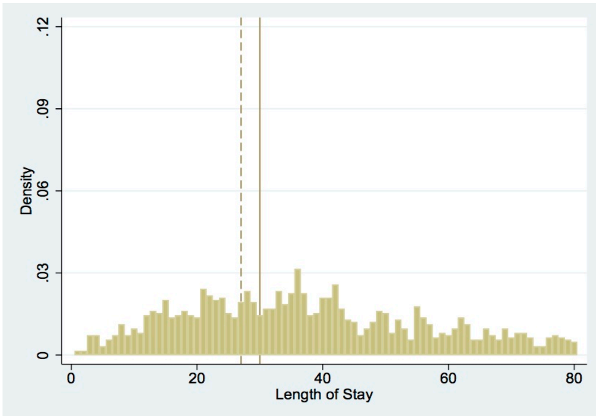


Figure 1: Figures and costs for DRG 207 patients by length of stay, FY 2013. Vertical dashed line is the SSO threshold for 2013.[1]

[1] Eliason *et al*. (2017)



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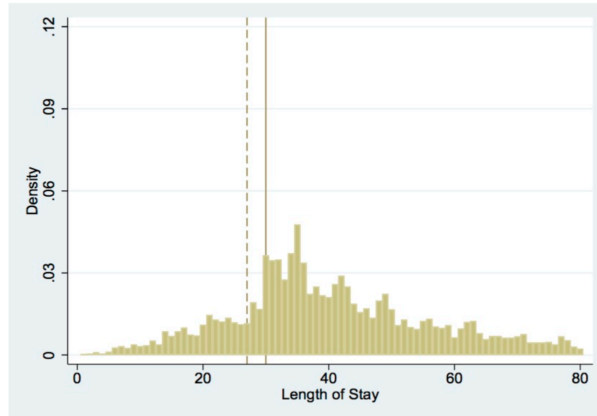

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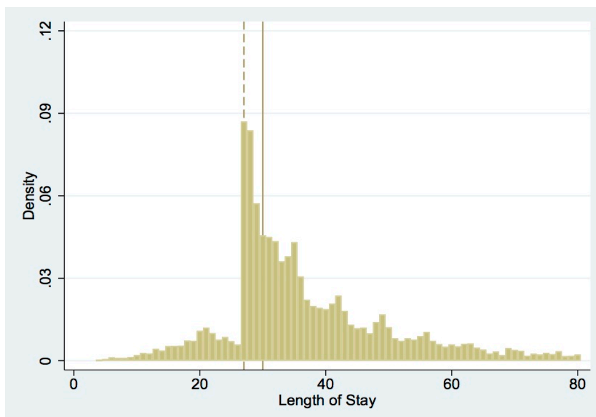

2013

Figure 2: Discharge patterns for DRG 207. Solid vertical line is the SSO threshold in 2004. Dashed vertical line is the SSO threshold in 2013.[2]

reached and the PPS payment has been received (either by incentivizing the LTCH to hold the patient in the facility longer than needed until the payment is received or by discharging them sooner than would be best for the patient once the payment is received). This pattern of behavior is exactly what has been observed to happen in LTCHs since 2002.

Indeed, Eliason, Grieco, McDevitt, and Roberts (2017) studied this phenomenon, what they label "strategic discharge," in depth; the phenomenon is made visually very clear in figure

[2] De-Identified Limited Data Set version of the Long-Term Care Hospital PPS Expanded Modified MEDPAR Data Set, 2002 & 2004-2013

2, which shows how hospitals, prior to the PPS in 2002, had an even distribution of discharges based on LOS before evolving to have a disproportionate amount of discharges immediately after the SSO threshold is reached – shown by the clumping of discharges at the solid and dashed vertical lines (the 2004 and 2013 SSO threshold dates, respectively) in the latter two panes of the figure. Their study, which will be thoroughly analyzed in the next section and used as the basis for my project, in part investigated whether LTCHs respond to the financial incentive created by the PPS by strategically discharging patients to maximize their profits, ultimately worsening patient outcomes in the process and wasting precious Medicare funding. In short, their work proves that LTCHs, regardless of the year or DRG analyzed, do strategically discharge patients once they reach the SSO threshold, causing worse patient outcomes (in the form of hospital acquired conditions such as infections that result from longer-than-necessary stays or by discharging sooner than best for the patient) and costing Medicare over $500 million annually. Clearly, the Medicare PPS system as it relates to LTCHs is worthy of logical scrutiny and has a massive, quantifiable negative effect on Medicare expenditures annually.

One unique characteristic of LTCHs (and, indeed, of most healthcare facility types) is that competition in a given market is typically restricted by regulation – usually at the state level. If there were free entry into the LTCH market and many LTCHs with large amounts of competition were present in a given market, one would expect their profits to be driven down and, ultimately, the profit-maximizing (and often patient outcome-harming) action of strategic discharge to be minimized.

However, there is typically not free entry into any given geographic LTCH market, which causes differing levels of competition depending on the exact location of the facility: most states have Certificate of Need (CON) laws that limit the establishment of certain types of healthcare facilities. CON laws essentially limit the number of healthcare facilities that can be built and operated in a given area, and these laws can be tailored to address particular types of healthcare establishments – they do not always apply to every type of healthcare facility depending on the state's desired effect. These laws were originally implemented as a protection against rising healthcare prices for consumers, with the theory behind the laws being that an over-abundance of healthcare facilities would cause under-utilization of resources and an unsustainable increase in prices in order to cover the high fixed costs incurred by healthcare facilities (Cauchi and Noble, 2016).

Competition is not only important to control costs to consumers: competition also helps produce high product quality. With more firms competing to offer the same goods and services to the same customers, firms must offer high quality products to those consumers in order to win over and maintain their business from other existing firms. Especially with regards to healthcare applications, if no competitive providers are present within a market, an LTCH has much less of an incentive to provide quality care to its patients. It has no incentive to stop strategically discharging, which has been proven to worsen patient outcomes, and it can focus more fully on simply maximizing its profits, which the act of strategic discharge has also been proven to do.

For my analysis, I use a comprehensive CMS data set that is linked with hospital characteristics – the same data set as Eliason *et al*. (2017) – which includes data on "the billed DRG, Medicare payments, covered costs, length of stay, diagnosis and procedural codes, race, age, gender, the type of hospital admission, whether the patient was discharged alive, and, if so, the discharge destination" (Eliason *et al*., 2017, p. 9). The data source contains information from fiscal years 2002 and 2004 through 2013 (Medicare has not released the 2003 data to researchers), and the data is linked to several hospital characteristics from the American Hospital Association guide.

This data allows my analysis to show that higher levels of competition cause lower probabilities of strategic discharge for patients. I test for this relationship by analyzing how two different methods of defining competition affect the probability of a patient being strategically discharged from an LTCH. First, I use the number of LTCHs per Core-Based Statistical Area (CBSA; a proxy for a geographical market explained in detail later) in two ways; second, I define competition as the absence of a CON law. Ultimately, I show how my work can help provide empirical evidence for new policy strategies that would help better patient outcomes and lower Medicare expenditures, such as creating incentives to encourage the creation of more LTCHs in a given market to increase competition and lower strategic discharge rates.

Now, I will provide a thorough review of the relevant literature before explaining the data used and the framework for my analysis; I will conclude with my results and their implications for future work.

II. Literature Review

There has been significant economic and health research done into the incentives (especially financial ones) healthcare providers face, the effectiveness of PPS, the potential presence of strategic discharge in LTCHs, and the effects that CON laws have had on healthcare competition, expenditures, and outcomes. To begin, Chakravarty, Gaynor, Klepper, and Vogt (2005) explored how for-profit and not-for-profit hospitals differed in their response to demand and, consequently, profit incentives. While all firms have an incentive to minimize costs, the authors utilized a model that showed that not-for-profit hospitals had a lower marginal cost than for-profit hospitals; this lower marginal cost is likely due to added incentives and goals the not-for-profit has to maximize community services (and not necessarily just profits). With a custom panel data set of all U.S. hospitals from 1984 to 2000, particularly following changes in demand proxied by changes in elderly population, they employed a probit regression to determine whether changes in profitability affect for-profit or not-for-profit hospitals more; as hypothesized, for-profit hospitals are affected much more dramatically by changes in demand than not-for-profit hospitals are, proving that they respond much more quickly to changes in profit. Their findings help prove that different healthcare providers respond differently to financial incentives, building a base for my research question to expand upon.

Additionally, Ho and Pakes (2014) looked at how financial incentives to physicians, specifically obstetricians, directly affects the cost and quality of care received by the patients. While the provider here is not a LTCH or even a regular hospital, the parallels in the presence of financial incentives and in the decision making process are evident as the provider aims to maximize their profits. The authors analyzed the six largest health maintenance organizations (HMOs) in California, with data from 2003 on hospital discharges, diagnoses, financial information, and outcomes. The authors found that, at least in obstetrics, the new financial incentives to physicians, in the form of capitation payments – which essentially allow the physician to be financially responsible for the patient outcomes, with the physician receiving a bonus of sorts if the patient does well physically and the practice does well financially – would likely reduce costs while not lowering care quality. This implication further fuels the additional necessary analysis that I aim to pursue with my research into the method of providing the most beneficial incentives to providers in order to reduce costs and maintain care quality, goals that these capitation payments have helped achieve for obstetrics patients in California but that the Medicare PPS payments with respect to LTCHs have not accomplished.

In regards specifically to Medicare's PPS, several works have studied the effect that the PPS can have on the price and volume of treatment utilized, as well as on patient outcomes. Grabowski, Afendulis, and McGuire (2011) examined how the implementation of a PPS in 1998 impacted the care at skilled nursing facilities (SNFs). As has been made clear, here (as well as in other PPS implementations) the implementation was meant as an attempt to discourage and lower the use of high-cost rehabilitation services. What the study found was that, though the initial implementation of a PPS at first produced some short-term savings for Medicare, over the long run SNF expenditures have been increasing at a similar rate to the pre-PPS time and not providing much, if any, controlling of costs, showing that the PPS clearly did not have its intended effect.

Furthermore, Altman (2012) described the lessons that policy makers can learn from Medicare's initial implementation of PPS and how it can carry over to other future policy initiatives. He explained how, when he served as chair of the Prospective Payment Assessment Commission, he saw that hospitals were making extremely high profits from the PPS structure because they had an underscored incentive to ensure patients were categorized in high-paying DRGs, obviously an unintended consequence (and is also what has been seen in LTCHs). Altman does give the PPS credit for reducing the length of stay of the average patient, though he acknowledges this result might be due to hospitals using a higher quantity of and more intense treatments in a shorter time frame.

Next, Sood, Huckfeldt, Grabowski, Newhouse, and Escarse (2013) studied how the PPS implementation for inpatient rehabilitation facilities (IRFs) in 2002 impacted the types of patients admitted, the number of patients admitted, and the intensity of care patients received. This was the same time that LTCHs underwent this payment change – LTCHs and IRFs are very related types of facilities. Using Medicare claims data from 2001 to 2003, the authors show how, for the three major diagnoses they examined, average Medicare expenditures at IRFs increased after the PPS structure was put in place. The finding of Eliason *et al*. (2017) that PPS is over costing Medicare $500 million annually runs in similar logic.

Moving now to proving the presence of strategic discharge, Kim, Kleerup, Ganz, Ponce, Lorenz, and Needleman (2015) analyzed how the PPS system for LTCHs impacted the length of stay (LOS) for patients. Utilizing the LTCH PPS Expanded MedPAR data sets from 2002 and 2005-2010, the authors examined how the average LOS changed, especially with regards to discharge location for the patient. After controlling for race, sex, age, and comorbidity burden, the authors found that, "before the short-stay policy was implemented, lengths-of-stay were evenly distributed, with no noticeable spikes" (Kim *et al.*, 2015, pg. 910); however, once the PPS system had been implemented, there was a very distinct evolution of the LOS distribution, with the vast majority of patients being kept until the SSO threshold was reached and being discharged immediately or soon after the PPS payment was received. This result held true whether the discharge location was to the patient's home, to a skilled nursing facility, or back to a short-term acute-care hospital. The authors do find some moral and ethical relief in the fact that the results of strategic discharge occurrences and LOS changes did not hold true for discharges due to death, showing "that long-term care hospitals are not basing their end-of-life care decisions, such as the timing of discontinuation of life support, on financial gains" (Kim *et al*., 2015, pg. 913). These authors make very apparent the fact that strategic discharge is taking place in LTCHs across the country, a revelation that I plan to build upon with my project to explore the causes of the phenomenon further.

The most important study done in relation to strategic discharge and to my topic, as previously mentioned, is an analysis by Eliason *et al*. (2017), and it is their study that I wish to extend with my project. Their work actually extends the work of Kim *et al*. (2015) “by considering a broader set of DRGs, incorporating the health outcomes of patients, and estimating a structural model of LTCH behavior that allows for counterfactual policy analysis” (Eliason *et al*., 2017, pg. 5). In the main body of their paper, they focus on DRG 207, which is a respiratory system diagnosis with prolonged mechanical ventilation, “because it is the most common DRG and also the most highly reimbursable” (Eliason *et al.*, 2017, pg. 10), though in the appendices to their paper they apply their analysis to other DRGs. Their paper first provides statistical data to illustrate how patients are being disproportionately discharged from LTCHs immediately or soon after they pass the SSO threshold; the study then looks to empirically prove causal effect in that LTCHs are now strategically discharging patients and that these incidents are bad for patients.

To prove strategic discharge, they analyze data from the pre-PPS payment structure, in fiscal year 2002, and from after PPS was implemented, from 2004 to 2013. Their data consists of a CMS claims data set in conjunction with hospital characteristics gathered from the American Hospital Association and CMS. In order to prove causal effect of the large jump in payment in PPS on the phenomenon of strategic discharge (and to prove the occurrence is not just coincidental), the authors used six different key variations in characteristics of their data and of their topic, such as variation in the SSO threshold in the same DRG across different years. The message when testing in all these different variations was the same: “the observed discharge patterns in the data stem from deliberate choices made by LTCHs in response to Medicare’s PPS rather than a coincidental improvement in patients’ health that occurs right after they pass the SSO threshold” (Eliason *et al*., 2017, p. 11). Utilizing probit regressions, the authors regressed the probability of a patient’s discharge, holding given the patient’s stay length in relation to the

SSO threshold for their condition. They found that the effect on a patient being strategically discharged is the most impactful in the DRGs with the highest profitability and lump sum payout, as well as very high in for-profit versus not-for profit hospitals and for certain LTCH chains.

The authors then utilized the SSO threshold as an instrument to prove that the longer stays caused by the PPS create a higher likelihood for additional adverse health outcomes for patients, specifically causing an increase in the probability of patients developing a hospital acquired condition (like pressure ulcers and catheter infections), of patients dying while still in the facility, and of patients being transferred back to an acute-care hospital for more intensive treatment. I plan to utilize much of the same analyses that these authors performed; indeed, I want to essentially further their probit analysis of the probability of strategic discharge in an LTCH to study the potential causal effects that the presence of competition in a given geographic market may have.

Einav, Finkelstein, and Mahoney (2017) also look at the effects of the financial incentives present for LTCHs, though they worked independently of and simultaneously to Eliason *et al*. (2017). In their paper, the authors created an empirical model that could explore how alternate payment structure methods, especially ones that do not have the monumental jump in payment that the PPS structure does, could impact patient outcomes and LTCH profits. While their general findings were similar to Eliason *et al*. (2017), these authors also analyzed how patient mortality post-discharge may be affected by the financial incentives. Using the Medicare Provider and Analysis Review as their main source of data, they complemented this extensive data set with information on the health outcomes, specifically mortality, of each person, as well as on different hospital characteristics. While their study was able to show that the marginal patient was healthy, they were not able to detect an impact on patient mortality. In a larger sense, their results showed "that *some* alternative payment schedule should be better for both the Medicare payer and the LTCH" (Einav *et al*., 2017, p. 28). While these authors used similar methods and analysis to Eliason *et al*. (2017) and explored whether alternative payment schedules could help alleviate this problem of strategic discharge, I want to explore how a separate factor, competition, could also provide a similar alleviation.

Finally, studies have analyzed how CON laws affect healthcare. Conover and Sloan (1998) investigated how CON laws affect per capita health spending and other healthcare expenditure measures, as well as how the lifting of CON laws affects expenditures. The authors used Medicare claims data, the American Hospital Association's *Hospital Statistics*, and CON law data to run their analysis. The authors' findings are quite surprising, for their main discovery is that CON laws "had no effect on total personal health expenditures per capita" (Conover and Sloan, 1998, pg. 463). Moreover, not only did the CON laws not have an effect here, but also lifting a CON law had "a positive influence on the for-profit share of the hospital market" (Conover and Sloan, 1998, pg. 466). From their study, CON laws have clearly not had their intended affect on healthcare expenditures, which makes their prevalence across so many states even more puzzling. An investigation, as I aim to do, into whether their alteration or abolishment would aid in healthcare outcomes becomes that much more intriguing.

Last, Wiener, Stevenson, and Goldenson (1998) investigated how CON laws affect the supply of long-term care providers. The authors looked at several metrics to see how the CON laws influenced healthcare, including the effects on expenditures on care, access to care, and quality of care. Utilizing data from thirteen states, they concluded that, "for nursing homes, the supply controls help to reduce competition for residents" (Wiener *et al.*, 1998, pg. 15), though the authors are careful to point out that they are unsure whether this will hold in the long run. While the long-term care providers analyzed in this study are not LTCHs, the main concepts carry over to LTCHs and show how CON laws do have potential to be an appropriate means through which to analyze healthcare competition.

Given these previous studies, it is definitely plausible that healthcare providers – LTCHs in particular – would act in their own best interest of maximizing profits given the circumstances presented within a PPS structure of payments. Now, I plan to build on this intuition to explore whether the presence of competition in a given market has an impact on strategic discharge rates in LTCHs. I believe this research could prove incredibly valuable to policy makers, for if my analysis shows, for example, that increasing competition can decrease the probability of strategic discharge, then policies could be created to encourage the establishment of additional LTCHs in a given market.

III. Data

For the components of my regressions that are carried over from the work of Eliason *et al*. (2017), I use the same full CMS data set linked with hospital characteristics as that team – the De-Identified Limited Data Set version of the Long-Term Care Hospital PPS Expanded Modified MEDPAR Data Set matched with the American Hospital Association guide's and CMS's own hospital characteristics. [3] Working with this data, I have all the necessary means to replicate and build on their previous analysis. For my first three regressions, competition is defined as the number of LTCHs per CBSA (and in similar definitions using dummy variables); here, CBSAs serve as the best available geographic market proxy. This exact measurement is also recorded within the CMS dataset, allowing for a very straightforward use of the data. Regarding these

[3] Special thanks to Professor James Roberts for access to the data set utilized.

CBSAs, the United States' Office of Management and Budget outlines them as "the county or counties or equivalent entities associated with at least one core (urbanized area or urban cluster) of at least 10,000 population, plus adjacent counties having a high degree of social and economic integration with the core as measured through commuting ties with the counties associated with the core" ("Geographic Terms and Concepts," 2012).

I then group CBSAs with 1, 2-3, and 4+ LTCHs to provide quantifiable tiers of competition; the histograms in figure 2 on the next page illustrate the distribution of discharges for these competition types. In the figures, the solid vertical line is the 2004 SSO threshold and the dashed vertical line is the 2013 SSO threshold. For all subgroupings, as one moves from 2004 to 2013, the discharges become more and more condensed to the time immediately after the SSO threshold is reached, in line with the findings of Eliason *et al.* (2017) – most importantly, the facilities in 1 LTCH/CBSA markets have the highest density of discharges once the threshold is reached, with declining values for 2-3 and 4+ LTCHs/CBSA. This is easily discernable in the left column versus the right column of figure 2, where the density for discharges in 2013 is well over .09 for 1 LTCH/CBSA and well below .09 for 4+ LTCHs/CBSA. Clearly, LTCHs with more competition can be seen to utilize strategic discharge less frequently than those with less competition, helping to visually motivate the main analysis of my work.

Regarding the specific data needed to explore CON laws, I have combined customized data with the CMS data set used by Eliason *et al*. (2017). I need to have the relevant information regarding CON laws for all markets; consequently, I have compiled and added data for all fifty states and Washington, D.C., that reports whether the state had a CON law that was applicable

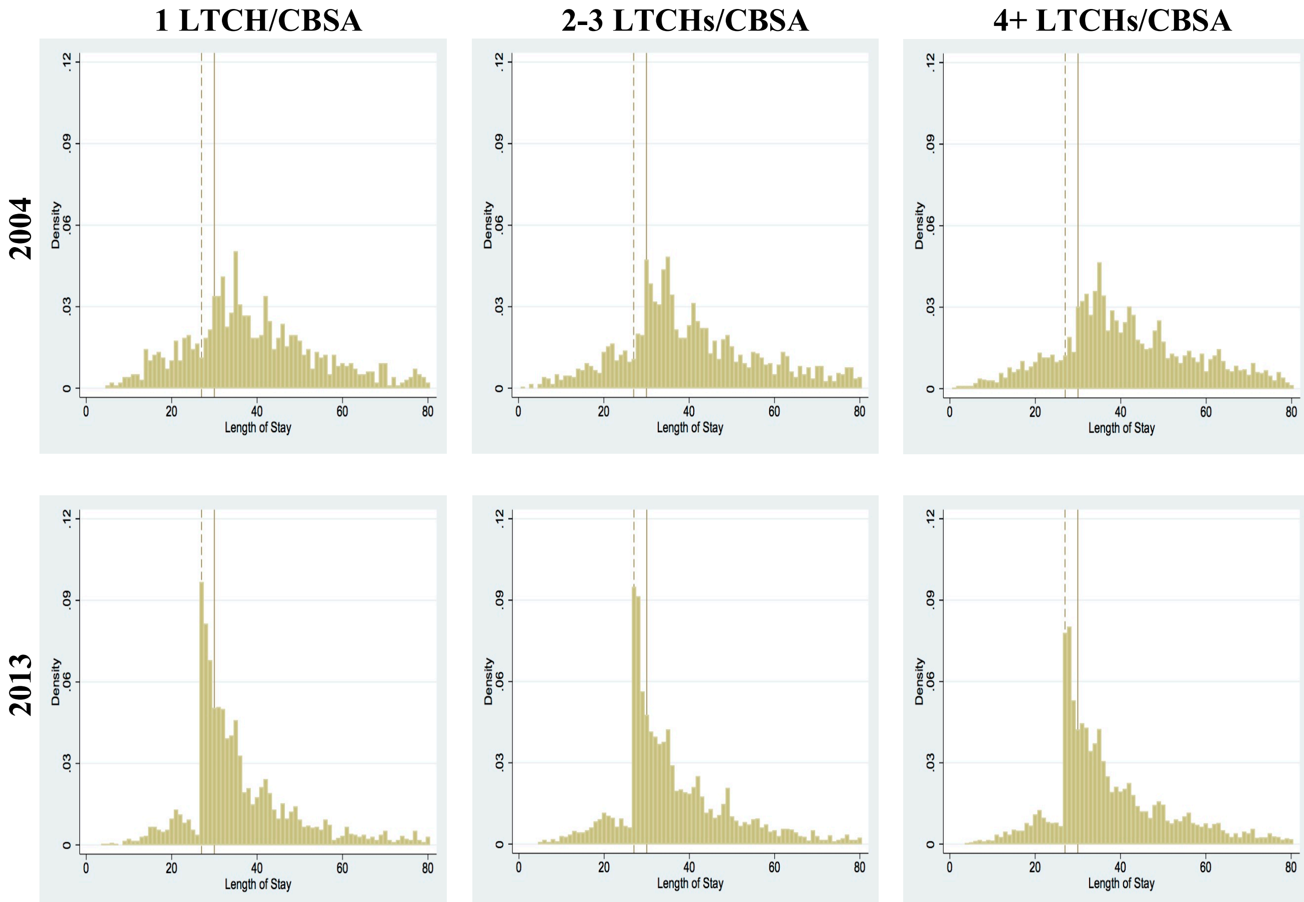

Figure 2: Discharge patterns for DRG 207. Solid vertical line is SSO threshold in 2004. Dashed vertical line is SSO threshold in 2013.

to LTCHs every year from 2002 through 2013, which are the same years for which I have data in the CMS data set. Interestingly, over this twelve year time period, not a single state made a change to its CON laws. Tables 1 and 2 on the following pages show summary statistics regarding CON laws and competition.

Table 1

LTCH per CBSA Summary Statistics (2002-2013)

Variable	Observations	Mean	Std. Dev.	Min.	Max.
LTCHs per CBSA	1,748,589	8.533608	9.910019	0	43
(LTCHs per CBSA)^2	1,748,589	171.0309	376.2533	0	1849
1 LTCH per CBSA	1,858,275	0.1367505	0.3435838	0	1
2-3 LTCHs per CBSA	1,858,275	0.24800887	0.4319037	0	1
4+ LTCHs per CBSA	1,858,275	0.6150823	0.486576	0	1

Note: Observations reported are observations of patients, not of LTCHs.

IV. Theoretical Framework and Empirical Specification

I add an extension to the probit model of Eliason *et al*. (2017), essentially separate terms to account for the competition in the given market of a particular LTCH. One possible difficulty for my analysis is the potential for high multicollinearity among the regressors I utilize; competition would be thought to highly correlate with the error term of this regression, because items included in the error – such as elderly population size in the CBSA – would possibly influence competition levels. Since I want to separate out the effect that competition alone has, I explore using an instrumental variable in order to have an accurate analysis. The best instrument for this purpose would be an indicator variable for the presence or absence of Certificate of Need

(CON) laws in the state or given market of any particular LTCH in consideration. The presence of CON laws that are applicable to LTCHs would, by definition, directly affect the number of LTCHs in a given geographic market, consequently helping to explain the level of competition present while also being uncorrelated with the probability of strategic discharge.

In order to see whether CON laws can potentially help explain the variation in LTCHs per CBSA, looking at the correlation between these variables in the correlation matrix in Table 2 is helpful. In theory, these variables should be highly correlated, as the CON law regulations will impact the number of LTCHs per market. However, problems arise: while the sign of the correlation between these two variables is positive as expected (since we expect the absence of a CON law to drive up the number of LTCHs per CBSA, increasing the amount of competition in

Table 2

CON Laws Summary Statistics (2002-2013)

States & D.C. w/ LTCH CON	35
States w/ out LTCH CON	16
Total	51
# of LTCHs in CON States	265
# of LTCHs not in CON States	155
Total	420

Correlation Matrix

	LTCHs per CBSA	LTCH CON Law Absence by State
LTCHs per CBSA	1.00	0.1424
LTCH CON Law Absence by State	0.1424	1.00

the given market), the magnitude of the correlation is quite low at only 0.1424. Though this correlation is not entirely negligible, it is very notable that the two variables are not more strongly positively correlated. Thus, this low correlation helps solidify the argument against the need for an instrument to conduct my analysis.

Within the main data set I use, geographic location of each of the over 400 LTCHs in the United States is available, allowing for analysis regarding which LTCHs would compete in the same market, though determining the exact borders is difficult. The general form of my extension of the probit model utilized by Eliason *et al*. (2017) is:

$$\Pr(Discharge \mid t, s, Competition) = \Phi(\gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 \mu_s + \gamma_4 Competition)$$

Here, "*t* is the absolute day of the hospital stay and *s* is the day relative to the magic day (the SSO threshold date; *s* = 0 indicates the day is the magic day, *s* < 0 indicates days before the magic day, *s* > 0 indicates days after the threshold day)" (Eliason *et al*, 2017, pg. 17), μ_s captures the strategic behavior of the LTCH, and *Competition* will change based on the definition used in each of the different regressions. The goal of this regression is to determine the causal effect of the level of competition (i.e. γ_4) on the probability that a patient is strategically discharged on that day; including *Competition* in addition to the other regressors – which are carried over from the Eliason *et al*. (2017) – allows my regression to capture the influence that the level of competition has on the probability of discharge. I expect to find that γ_4 will be negative, lowering the probability of strategic discharge as the value of competition becomes larger.

In my first main regression, *Competition* is approximated by the number of LTCHs in a given market – essentially the density of facilities in a geographic region. The challenge with this regression is determining what constitutes an appropriate geographic market for LTCHs. The best proxy that I have determined for differentiating the market borders is, as previously mentioned, to establish the boundaries according to CBSAs.

Furthermore, much as the quadratic implementation for the absolute day of the hospital stay *t* had for Eliason *et al*. (2017), I also explore how a quadratic form for inputting the competition variable provides added flexibility for my model. Using a quadratic form allows for the regression to capture whether the effect of competition increases or decreases with higher competition levels. Thus, this first regression takes the form:

$$(1)\quad \Pr(Discharge|\,t,s,\tfrac{LTCH}{CBSA}) = \Phi(\gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 \mu_s + \gamma_4 \left(\tfrac{LTCH}{CBSA}\right) + \gamma_5 \left(\tfrac{LTCH}{CBSA}\right)^2)$$

The next step of my analysis aims to piece out more discretely and meaningfully how specific levels of competition affect the strategic discharge probability. Specifically, I create dummy variables for CBSAs with one LTCH, two to three LTCHs, and four or more LTCHs. It is important to note here that one firm may theoretically own and operate multiple LTCHs in a given CBSA, but this distinction likely has a low occurrence and is unable to be made here due to the dataset format. I analyze how these varying, discrete levels of competition affect strategic discharge probabilities and determine the simple effect that these groupings may have. This regression takes the form:

$$(2)\quad \Pr(Discharge|\,t,s,\tfrac{2\text{−}3LTCHs}{CBSA},\tfrac{4+LTCHs}{CBSA}) = \Phi(\gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 \mu_s + \gamma_4 \left(\tfrac{2\text{−}3LTCHs}{CBSA}\right) + \gamma_5 \left(\tfrac{4+LTCHs}{CBSA}\right))$$

Moreover, logic would suggest that there might be complex interactions between the level of competition in a market and the other regressors, namely the day to the magic day (s). Utilizing a third regression interacting these variables tests if this theory more accurately depicts how the level of competition truly impacts the strategic discharge probability given the actual time left until the SSO threshold is reached. This regression takes the following form:

$$(3) \quad \Pr(Discharge|\, t, s, \frac{2\text{−}3LTCHs}{CBSA}, \frac{4\text{+}LTCHs}{CBSA}) = \Phi(\gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 \mu_s + \gamma_4 \left(\frac{2\text{−}3LTCHs}{CBSA}\right) + \gamma_5 \left(\frac{4\text{+}LTCHs}{CBSA}\right) + \gamma_6 \left(\mu_s * \frac{2\text{−}3LTCHs}{CBSA}\right) + \gamma_7 \left(\mu_s * \frac{4\text{+}LTCHs}{CBSA}\right))$$

Finally, the last definition of competition for LTCHs that I use is an indicator variable for the absence of a CON law applicable to LTCHs in the state or given market of the particular LTCH in consideration (where the variable equals 1 when there is no applicable CON law). This unique definition of competition may show interesting results that could provide new insights into the assumed effect that CON laws have not only on restricting competition, but also on strategic discharge rates at LTCHs:

$$(4) \quad \Pr(Discharge|\, t, s, CONabsence) = \Phi(\gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 \mu_s + \gamma_4 (CONabsence))$$

The dependent variable in my model is the probability of a patient being strategically discharged on a given day – the output of each of my four regressions. Along the same lines, the independent variables in my analysis are the definition of the level of competition for the respective regressions (number of LTCHs per CBSA; one, two to three, and four or more LTCHs per CBSA; and the absence of a CON law), the day relative to the SSO threshold for the patient's stay, and the absolute day of the patient's stay.

I predict that the coefficients on $\frac{LTCH}{CBSA}$ in the first regression, on $\frac{2-3LTCHs}{CBSA}$ and $\frac{4+LTCHs}{CBSA}$ in the second and third regressions, and on *CONabsence* in the fourth regression to be negative. I believe that higher levels of competition will lower the probability of strategic discharge given economic theory that more competition drives down profits. Given that strategic discharge is an opportunistic way of maximizing the hospital's profits, it would make sense that the frequency and probability of this course of action would go down in the presence of more competition. Additionally, I believe that the coefficient on $\left(\frac{LTCH}{CBSA}\right)^2$ will be positive, for the effect that higher levels of competition have on strategic discharge probability will likely get smaller and smaller (i.e. level out) as the number of LTCHs per CBSA rises. In essence, I predict that having a small to moderate amount of competition is more important than having a lot of competition, for the movement from what is basically a monopoly to a competitive market should be the largest effect on strategic discharge rates.

V. Results and Discussion

My analysis begins by running each of the regressions previously explained in the theoretical framework, with *Competition* defined in the four specified ways. Reported in Table 3 are the coefficients on the corresponding variables for each regression, run for all patients in DRG 207. γ_3 (the coefficient on μ_s) is omitted from the table because the value ranges quite dynamically depending on the day for which the regression is run. Singling in on just one DRG allows for the mitigation of any extraneous effects between DRGs, and DRG 207 – a respiratory system diagnosis with prolonged mechanical ventilation – is specifically chosen, as previously stated, because of its highest rate of both prevalence and compensation amongst all the DRGs.

Table 3

The Effect of Variables on Probability of Strategic Discharge in DRG 207

Variable	Regression (1)	(2)	(3)	(4)
t	-.0513* (.0082)	-.0518* (.0081)	-.0519* (.0081)	-.0533* (.0083)
t^2	.00051* (.00009)	.00052* (.00009)	.00052* (.00009)	.00052* (.00009)
LTCH/CBSA	-.0112* (.0022)			
$(\text{LTCH/CBSA})^2$	.00029* (.00006)			
2-3 LTCHs/CBSA		-.0273** (.0167)	-.0137 (.0264)	
4+ LTCHs/CBSA		-.0575* (.0145)	-.0514* (.02678)	
$\mu_s *$ 2-3 LTCHs/CBSA			-.00036 (.00069)	
$\mu_s *$ 4+ LTCHs/CBSA			-.00016 (.00065)	
CONabsence				.00637 (.0126)
Constant	-1.87* (.0994)	-1.87* (.1006)	-1.87* (.1006)	-1.89* (.0993)
Observations	4,845,296	4,870,303	4,870,303	4,845,296

Note: Standard errors in parentheses. *Significant to 5% level. **Significant to 10% level. Observations reported are observations of patients, not of LTCHs.

As expected for the coefficients on $\frac{LTCH}{CBSA}$ in the first regression and on $\frac{2-3LTCHs}{CBSA}$ and $\frac{4+LTCHs}{CBSA}$ in the second and third regressions, the results are negative, holding to the logic that higher levels of competition will lower the probability of strategic discharge given economic theory that more competition drives down profits. Moreover, nearly all of these results (except for $\frac{2-3LTCHs}{CBSA}$) are statistically significant to a 5 or 10% level. Additionally, as predicted, the coefficient on $\left(\frac{LTCH}{CBSA}\right)^2$ is positive and statistically significant, showing that the effect that higher levels of competition have on strategic discharge probability gets smaller as the number of LTCHs per CBSA rises.

Surprisingly, the coefficient on *CONabsence* for the fourth regression is positive. This result is counterintuitive to what is expected given that the absence of a CON law would drive up competition; this would theoretically drive down strategic discharge probability (and line up with the result of the other regressions). Moreover, this result is statistically insignificant at the 1%, 5%, and 10% levels. Thus, it seems as though CON laws have very little (if any) influence on both the level of competition in a CBSA (shown in the previous section via the correlation matrix) and the probability of strategic discharge from an LTCH for a patient.

More interestingly (and more difficult to interpret) are the coefficients on the interaction terms in the third regression. Given that the only difference between the second and third regressions is the presence of these interaction terms in the third one, it is worth noting that the coefficients on the competition variables in the third regression fall in value, very significantly so for the coefficient on 2-3 LTCHs/CBSA (as well as in statistical significance for this coefficient). Given that the values of the coefficients for the interaction terms and on 2-3 LTCHs/CBSA are not statistically significant at these levels, and that the coefficient on 4+ LTCHs/CBSA did not significantly drop, it is likely that the interaction terms are not helping to explain much of the variance in the data.

Table 4

Probability of Discharge in DRG 207 When Accounting for Competition

Day of Stay (t)	1 LTCH/CBSA		2-3 LTCHs/CBSA		4+ LTCHs/CBSA	
	Pr(Discharge on Magic Day)	Pr(Discharge on Day Before Magic Day)	Pr(Discharge on Magic Day)	Pr(Discharge on Day Before Magic Day)	Pr(Discharge on Magic Day)	Pr(Discharge on Day Before Magic Day)
27	10.3* (.366)	1.27* (.064)	9.86* (.346)	1.19* (.058)	9.34* (.312)	1.09* (.052)
28	9.92* (.353)	1.20* (.064)	9.46* (.342)	1.12* (.059)	8.95* (.298)	1.03* (.052)
29	9.54* (.357)	1.13* (.065)	9.08* (.354)	1.05* (.063)	8.59* (.300)	.97* (.053)
30	9.18* (.373)	1.07* (.069)	8.73* (.375)	.99* (.067)	8.26* (.315)	.91* (.057)

Note: Standard errors in parentheses. *Significant to 5% level. **Significant to 10% level.

Especially because these regressions are probit analyses, the results for the coefficients cannot be taken merely at their apparent value; the regressions and outputs must be given context in order to truly understand whatever meaning they provide. Table 4 is based on the second regression and illustrates how the probability that a patient is strategically discharged changes from the day preceding the magic day to the actual magic day itself (the SSO threshold date). The second regression is chosen because of its strength, for it provides a detailed picture of competition and has all coefficients very statistically significant; however, when this analysis is run for any of the first three regressions, a nearly identical picture arises. The table is conditioned so that results are shown for all three distinct competition levels.

In this table, the first column "Day of Stay (t)" is the absolute length of stay for the patient and shows that if the magic day is also that day (for the first row, the magic day would be the 27th day), then the probabilities of discharge are the next columns respectively given the competition situation presented in each column. As evident in the tables, when taking into consideration all CBSA types, the probability that a patient is discharged increases massively from the day preceding the magic day to the magic day – in line with the logic of the findings of Eliason *et al*. (2017) and numerically very similar to their results.

More important, however, is the finding that the probability of being strategically discharged decreases as the level of competition becomes more intense, and that the strategic discharge probability is significantly higher for CBSAs with only one LTCH versus CBSAs with 2-3 or 4+ LTCHs, regardless of the Day of Stay *t*. This is seen in Table 4, where for each value of *t* (each row), the probability of discharge on the magic day decreases as the level of competition rises (as one moves to the right in the row). Additionally, all results are statistically significant to a 5% level, helping to provide evidence that the level of competition does have an impact on the probability of strategic discharge from an LTCH.

Given the finding by Eliason *et al.* (2017) that extra days in an LTCH increase the likelihood of developing hospital acquired conditions, the level of competition present would also affect patient outcomes in this manner by affecting the probability of being held at an LTCH longer to reach the SSO threshold. For instance, let us perform a very rudimentary analysis utilizing only the first row of results in Table 4. If the magic day is the 27th day, a patient in a CBSA with only one LTCH is roughly 1% more likely to be held an extra day to get to the SSO threshold than a patient in an LTCH in a CBSA with 4+ LTCHs. Using Eliason *et al*.'s (2017) finding that an extra day in an LTCH increases the chances of acquiring a pressure ulcer by between 11.3-15.2%, this would imply that a patient in a CBSA with only one LTCH is 0.113-0.152% more likely to acquire a pressure ulcer than a patient in a CBSA with 4+ LTCHs – a small increase for an individual, but over large samples definitely a quantifiable increase in the number of cases of this condition.

VI. Conclusion

This analysis shows that the presence of competition in these forms in a geographic market does impact the probability of a patient being strategically discharged from an LTCH once the patient has reached the “magic day” threshold. All of the first three regression models paint the same picture: Competition, even just a small to moderate amount, lowers strategic discharge probability – a benefit to both patient outcomes and Medicare expenditures. Given the high monetary cost that strategic discharge comes to for Medicare, legislation to encourage the establishment of more LTCHs in uncompetitive markets could help alleviate wasteful spending at these healthcare providers. Moreover, finding a more optimal, less wasteful form of payment for LTCHs would be a logical way to save roughly half a billion dollars annually (Eliason *et al.*, 2017), and explorations into such alternative payment types as the capitation payments analyzed by Ho and Pakes (2014) seem to be a rational next step to reducing Medicare expenditures in this field of healthcare.

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