A Prescription for Manipulation? The 340B Drug Discount Program and *Ex Ante* Strategic Behavior

By Sayeh Nikpay, Melinda Buntin, and Rena Conti

Abstract

The 340B program entitles certain public, non-profit hospitals to discounted outpatient drugs, and substantial price-cost margins when discounts are not passed onto payers. Previous work suggests 340B increases ex post strategic behavior. Using hospital administrative data from 1996-2016, we show that 340B also results in ex ante strategic behavior through manipulation of eligibility criteria. Non-parametric density tests show marked discontinuities in the eligibility criterion around the eligibility cutoff. The non-parametric hazard of manipulating eligibility for 340B is higher among hospitals with larger returns to participation. Finally, within-hospital trends in the 340B eligibility criterion break after hospitals meet the minimum eligibility criteria.

* Nikpay: Vanderbilt School of Medicine, 2525 West End Avenue, Suite 1275-F, Nashville, TN, 37205 (e-mail: Sayeh.s.nikpay@vanderbilt.edu); Buntin: Vanderbilt School of Medicine, 2525 West End Avenue, Suite 1200, Nashville, TN, 37205 (e-mail: melinda.buntin@vanderbilt.edu); Conti: Questrom School of Business, Boston University, 595 Commonwealth Avenue, Boston, MA, 02215 (e-mail: rconti@bu.edu)

The authors would like to thank the following individuals: Kitt Carpenter, Partha Deb, David Ennis, Andrew Goodman-Bacon, Gaby Gracia, David Tawes, and participants of the Cornell Policy and Management and Vanderbilt University Health Economics Seminars. The authors were supported by a grant from the Commonwealth Fund (FP066219) to conduct this research.
In 1992, Congress created the 340B program to support struggling safety-net hospitals by defraying the costs of drug-based care for low-income and uninsured patients. 340B provides acquisition discounts for drugs administered in an outpatient clinic or dispensed in an outpatient pharmacy (Health Resources and Services Administration 2017), and places no limits on what hospitals charge payers for discounted drugs. Previous work found that payer payments to providers for 340B purchased drugs substantially exceeded the providers’ costs (Office of the Inspector General 2015). The program’s intention was to reduce the costs of uncompensated drug-based care and allow hospitals to cross-subsidize other activities with the positive, price-cost margin on outpatient drugs.

Th 340B price-cost margin can be substantial (Drug Channels 2018). A recent analysis of five chemotherapy drugs found that 340B profits from Medicare ranged from $5,749 to $13,336 per patient (Office of the Inspector General 2015). Hospital participation in the program is also voluntary (with some exceptions we discuss below); 340B eligibility for most hospitals depends on just one criterion: whether the adjusted disproportionate share (DSH) patient percentage (the fraction of a hospital’s inpatient days attributable to low-income Medicare and Medicaid patients) exceeds 11.75 percent.

Consequently, qualified hospitals face an incentive to become eligible for the 340B program. However the extent to which participation arises from *ex ante* strategic behavior is unknown. Studies from the grey literature (Lyons 2017; Quality Reimbursement Services 2013; Healthcare Payment Specialists 2017; Southwest Consulting Associates 2016), previous empirical economic studies (Barnes and Harp 2018; Barnes, Buchheit, and Parsons 2017; Duggan 2000) and government reports (Office of the Inspector General 2015) have demonstrated hospitals do manipulate criteria used for public subsidy qualification for their own financial gain. There also appears to be a cottage industry of firms selling products aimed at “optimizing” hospitals’ DSH patient percentages; one advertises on their website “leave no stone unturned” in the pursuit of Federal reimbursements (Quality Reimbursement Services 2013).

Whether or not hospitals act strategically to qualify for 340B is important to understand for several policy-related reasons. Hospital participation in the program has grown rapidly (S. Nikpay, Buntin, and Conti 2018b), fueling a national debate regarding whether and how to reform 340B (Energy & Commerce Committee 2018). Most reforms focus on reducing empirically documented *ex post* strategic behavior among already qualified 340B hospitals including increased use of 340B eligible drugs (Government Accountability Office 2015; S. Nikpay, Buntin, and Conti 2018a), strategic location of 340B clinics and pharmacies in high-income communities (Conti and Bach 2014), and higher rates of consolidation between physicians and hospitals (Desai and McWilliams 2018; Jung, Xu, and Kalidindi 2018). If 340B participation itself is a product of manipulation, policy makers might be more inclined to invalidate selected hospitals’ participation, consider alternative metrics for program participation or both. Yet, determining which hospitals are manipulators poses an important challenge, because 340B hospitals comprise a diverse group including a mix of public hospitals, “honest” non-profits with little scope for manipulation, and non-profit hospitals that are “for-profits in disguise,” seeking to maximize price-cost margins through manipulation of 340B eligibility criteria (Hirth 1997).

This paper provides the first evidence of *ex ante* strategic behavior in the 340B program. First, using hospital administrative data from 1996-2016, we estimate several non-parametric and semi-parametric tests for manipulation in the density of hospitals’ adjusted DSH patient percentage, the criterion that determines eligibility for the program (Degeorge, Patel, and Zeckhauser 1999; Cattaneo, Jansson, and Ma 2018; Chetty et al. 2011). These tests show that hospital adjusted DSH patient percentages disproportionately fall just above the cutoff for 340B eligibility. Second, we estimate the hazard of 340B participation, accounting for right censored outcomes of hospitals that may eventually participate but have not yet. We find that the hazard of participating in 340B is higher among hospitals that would enjoy higher returns to participating in 340B as predicted in our theoretical model. Third, we estimate within-hospital pre-trends and trend breaks among hospitals ineligible for 340B six years before participating and thus have an incentive to engage in *ex ante* strategic behavior to become eligible for the program. We find that after a positive trend in the 340B eligibility criterion and its components, the trend significantly diminishes after participation. In contrast, hospitals that were already eligible for 340B before participating in 340B show no evidence of this trend break. This pattern of results suggests that hospitals seek to become eligible with the minimum adjusted DSH patient percentage required.

We also explore the characteristics of hospitals that appear to manipulate program eligibility criteria. Drawing upon the longstanding debate over whether non-profits seek to maximize price-cost margins, we estimate the relationship between measures of safety-net orientation such as uncompensated care and hospital characteristics. We find that hospitals that appear to be manipulators are less likely to offer unprofitable services, such as psychiatric care, are less likely to located in competitive hospital markets, and less likely to be public hospitals.

We explore two possible mechanisms for *ex ante* strategic behavior. The first mechanism is changes in inpatient service provision to groups that would mechanically increase a hospital’s DSH percentage without adding significantly to the hospitals fixed costs. Specifically, we look at increases in the number of labor and deliveries among Medicaid-covered women, which has been shown in the past to be a low-cost method of increasing the DSH patient percentage (Duggan 2000). The second mechanism is misreporting or reclassification of care to artificially increase Medicaid inpatient utilization. We find no evidence to support the first mechanism but do find that equivalent Medicaid statistics reported for the DSH patient percentage calculation differ significantly from those reported for other purposes among 340B participants. These findings suggest that hospitals might use post hoc methods to optimize the DSH patient...
percentage. Our findings suggest that the eligibility criteria for 340B create unintended consequences related to hospitals exhibition of both ex post and ex ante strategic behavior.

I. Background

A. Background on 340B

Congress’ goal in passing 340B was to reduce the burden of unreimbursed prescription drug spending for safety-net hospitals and clinics. The drug price discounts are sizable; a recent analysis of 340B discounts by the Office of the Inspector General finds that for most drugs administered in an outpatient clinic, the 340B discount ranges from 25-49 percent of the average manufacturer price (AMP) (Office of the Inspector General 2015). Congress intended for the 340B discounts to be similar in effect to those required by pharmaceutical companies for the purchase of drugs by state Medicaid programs (Duggan and Morton 2006). Under the Medicaid Drug Rebate Program, pharmaceutical manufacturers must provide a discount equal to 23.1 percent of the AMP or the difference between the best price available and the AMP for all drugs used on the Medicaid population (Baghdadi 2017). In this way, the rebate program reduces both state and federal spending on drugs in the Medicaid program. 340B also provides participants with discounts equal to a percentage of the AMP. However, there are two important differences. First, unlike the Medicaid Drug Rebate Program, 340B drug discounts are not tied to a patient insurance status. Consequently, participating providers can use discounted drugs to treat uninsured, but also insured patients, for whom they collect full payment. Second, savings from the program accrue to the providers, not the state or federal government. This feature of the program was intentional: the Veteran’s Health Care Act, which created the program, states that the 340B program should enable hospitals to “stretch scarce federal resources as far as possible, reaching more eligible patients and providing more comprehensive services” (Health Resources and Services Administration 1996). Although hospitals are not required to report net revenue they generate from charging Medicare and private payers full prices for discounted drugs, some self-reported estimates range from 22-43 percent of patient care revenue (Garber 2017).

The program has grown substantially since 1992 when only 50 general acute care hospitals participated. In 2018, 1,279 hospitals participated in 340B, covering 40 percent of all nonprofit and public hospitals and over half of all hospital outpatient drug spending (Nikpay, Buntin and Conti 2018). Recent estimates suggest that 340B-eligible drug sales are outpacing overall drug sales, increasing 40 percent between 2012 and 2017 (Vandervelde and Blalock 2017). We have little evidence on why hospital participation grew so dramatically, but it is likely related to the increasing value of discounts as the cost of drugs have grown (Martin et al. 2016) and hospital eligibility for other sources of unrestricted revenue, such as Medicare and Medicaid DSH payments, have become increasingly tied to the provision of unreimbursed care (Mills and Raines-McNally 2014; MACPAC 2016).

B. Empirical Evidence of Ex Post Strategic Behavior among Hospitals

Most research on 340B focuses on how hospital behavior changes after participation in the program. Cross-sectional studies from both the Government Accountability Office and the Medicare Payment Advisory Commission show that 340B hospitals treat Medicare patients more intensively with chemotherapy than non 340B hospitals and that they spend more on chemotherapy overall (MedPAC 2015; Government Accountability Office 2015). Conti and Bach (2014) and Nikpay, Buntin, and Conti (2018) show that hospitals tend to establish clinics and pharmacies that use 340B drugs in communities with higher incomes and lower uninsured rates, presumably to maximize the price-cost margin by charging the full price for discounted drugs.

Several studies take a quasi-experimental approach to estimating whether 340B participation leads hospitals to consolidate with outpatient provider groups in order to extend drug discounts (and higher hospital-specific Medicare reimbursements) to additional sites of care (Desai and McWilliams 2018; Winegarden 2017; Koch, Wendling, and Wilson 2017). The findings across these studies are mixed. Comparing Medicare treatment in hospital outpatient clinics in markets that do and do not gain a new 340B participant after program expansions under the ACA, Jung, Xu and Kalidindi (2018) find evidence of increased consolidation. However, Alpert, Hsi, and Jacobson (2017) take a similar approach using practice-level data and find no evidence of consolidation in oncology, where 340B discounts are thought to be the most lucrative (Blalock and Vanderbelde 2017). Desai and McWilliams (2018) use regression discontinuity to compare rates of physician-hospital consolidation and eligible drug utilization among Medicare beneficiaries between hospitals just above and below the cutoff for eligibility. They find that 340B increased both consolidation and spending.

The empirical evidence is more consistent across studies, data sources and time periods on hospitals’ ex post responses to other public policies impacting their financial position. Hospitals under-report revenues in response to rate regulation (Blanchard, Chow, and Noreen 1986), strategically manage financial measures to maintain nonprofit status (Burgstahler and Dichev 1997; James A. Brickley and R. Lawrence Van Horn 2002; Krishnan and Yetman 2011; L. G. Eldenburg, Gaertner, and Goodman 2015), and alter capital investments (Barniv, Danvers, and Healy 2000), change medical coding practices, and increase the share of patients treated in the outpatient setting in response to Medicare reimbursement policy (Soderstrom 1990; L. Eldenburg and Soderstrom 1996; Kallapur and Eldenburg 2005; Lambert and Larcker 1995; Lynch 2003; McMahon and Billi 1988; Feinglass and Holloway 1991).

C. Empirical Evidence of Ex Ante Strategic Behavior among Hospitals

The extent to which current 340B participation among hospitals comes from ex ante strategic behavior is unknown but previous empirical economic studies and government reports have demonstrated hospitals do manipulate the criteria used for public subsidies for their own financial gain. For example, Barnes et al. (2017) and Barnes and Harp (2018) show discontinuities in the density of the
undeclared DSH patient percentage and the number of beds around eligibility thresholds for Medicare DSH payments. Duggan (2000) finds that when California implemented a DSH program in 1990, non-profit hospitals slightly below the eligibility threshold of 15 percent that had the strongest incentive to raise their DSH patient percentage, did so by increasing Medicaid-covered births. Federal government audits also routinely find evidence of hospital strategic behavior related to these statistics. At the hospital level, the most common oversights are misclassifying Medicaid days and geographic locations by the hospitals’ administrators. For example, a 2010-2012 audit found that Missouri providers improperly claimed 7,132 Medicaid days resulting in $3 million in overpayments from DSH (Office of Inspector General 2017). Similarly, a 2008-2010 audit found that a group of 48 providers in Indiana who comprised 82 percent of DSH payments improperly claimed 14,325 Medicaid days for a DSH overpayment of $6,110,157 (Office of Inspector General 2016). Examples of geographic misclassifications generally involved hospitals being classified as urban vs. rural areas for specific timeframes resulting in overpayments.

Additional support for the possible existence of ex ante strategic behavior comes from the fact that consulting firms routinely sell services that help hospitals manipulate their DSH patient percentage. The title of one management consultant article lays this incentive bare: “Maximizing Your Medicare DSH Payment Stream - By proactively managing five key factors, hospitals may be able to increase—or qualify for—DSH payments” (Lyons 2017). Another management consultant group declared: “Dedicate 2013 to maximizing your uncompensated care, uncovering every possible inpatient Medicare and SSI day. Leave no stone unturned” (Quality Reimbursement Services 2013). Another advertisement, citing a case study, noted that a 108-bed Midwestern hospital had “[d]espite a concerted effort by the hospital’s internal accounting department, … found that it had not identified a sufficient number of days to qualify for DSH payments” (Healthcare Payment Specialists 2017). As this consultancy boasts, the client purchased their services and shortly after qualified for DSH. Other consulting companies advertise specific services that may quickly and cost effectively increase the DSH patient percentage, such as “newborn assistance services”, and “maternal-child services” (Southwest Consulting Associates 2016). These advertisements are consistent with Duggan’s (2000) findings that hospitals can disproportionately recruit certain kinds of Medicaid patients in order to increase their DSH patient percentages.

D. A Conceptual Framework for Ex Ante Strategic Behavior

When hospitals become eligible for the 340B program, the cost of drug-based treatments falls for non-Medicaid patients, which should increase the use of 340B-eligible drugs (ex post strategic behavior). Among hospitals not eligible for 340B, the decision of whether to pursue eligibility (ex ante strategic behavior) depends on the costs of pursuing eligibility relative to the benefits of receiving discounts. The following model formalizes this relationship. Assume that the total amount of net revenue gained from 340B, which we will call “profit” (eq1) is a function of Medicaid reimbursements (RM), Medicaid patients (M), reimbursements for non-Medicaid patients (RN), and non-Medicaid patients, (Q), as well as two payer-specific cost functions. The first, c(pR,M), expresses Medicaid costs as a function of the prices of drug (D) and non-drug (N) care. The second, c(d(m)pR,RN) expresses non-Medicaid costs as a function of drug and non-drug prices, although drug prices are reduced by 340B discounts, represented by a nonlinear function, c. These advertisements

\[ \Pi = (RM(M + RN) + c(pR,M)) + (RNQ - c(d(m)pR,RN)) \]

Per-patient “profits” can be written as in eq(2):

\[ \Pi_{m\max Q} = m(RM - c(pR,RN)) + (1 - m)(RNQ - c(d(m)pR,RN)) \]

Assuming total volume (M+Q) is fixed, patient volume can be expressed in terms of m, the Medicaid inpatient fraction. Differentiating eq(2) with respect to m illustrates that “profits” are decreasing in the hospital’s Medicaid population (eq3):

\[ \frac{\partial \Pi_{m\max Q}}{\partial m} = \left( \frac{RM - c(pR,RN)}{M+Q} - \left( RNQ - c(d(m)pR,RN) \right) \right) < 0 \]

Because Medicaid reimburses below cost and each additional Medicaid patient displaces a non-Medicaid patient, increasing m lowers “profits”. Yet, even though “profits” decrease in the Medicaid share of patients, the availability of 340B discounts, once a threshold level of m is reached, results in a discontinuity in costs per patient (eq4): \[ \Pi^+ - \Pi^- = m^+(RM - c(pR,RN)) + (1 - m^-) \left( RNQ - c(d(m)pR,RN) \right) - m^- \left( RM - c(pR,RN) \right) - (1 - m^-) \left( RNQ - c(d(m^-)pR, RN) \right) \]

Because m^- and m^+ , the Medicaid fraction just above and below the threshold qualifying level of m, are approximately equal, the size of the discontinuity, \[ \Pi^+ - \Pi^- \] , can be re-written as eq(5):

\[ (1 - m^+)(c(d(m)pR, RN) - c(d(m^-)pR, RN)) \]

Substituting payer specific cost functions for the product of prices and demand for drug and non-drug care, the discontinuity can be written as a difference in costs, \[ \Delta \] :

---

* Because nonprofit and public hospitals are subject to a non distribution constraint, net revenues can not be retained as profits. However, the price-cost margin or net revenues for the purposes of increasing salaries, investments, and other activities.
Equation 5 illustrates the importance of engaging in \textit{ex post} strategic behavior in determining the value of the 340B program. The change in costs depends on both the mechanical value of 340B, provided by the reduction in costs for a given level of pre-340B eligible demand for drug related care, \( D^- \), but also the ability to shift care towards drugs, the cheaper input. Hospitals must weigh the potential value of 340B at this discontinuity against the costs of undertaking efforts to gain eligibility.

Because the size of the discontinuity depends upon the ability of hospitals to engage in \textit{ex post} strategic behavior, the discontinuity may not be the optimal amount of Medicaid recipients. Dividing the Medicaid share of patients into two pieces \( - (i) \) the hospital’s Medicaid share were the hospital to voluntarily treat no other Medicaid recipients, \( m^* \) and \( (ii) \) additional Medicaid patients to get to the threshold, \( m^+ \).

Hospitals choose to manipulate if the “profits” from treating Medicaid patients at the discontinuity, \( m^+ \) are greater than “profits” and the nonmanipulated level of Medicaid patients, \( m^* \):

\[
(7) \ m^i \left( [R^M - c(p^D, p^N)] + (1 - m^i) [R^0 - c(d(m^i)p^D, p^N)] \right) - m^i[R^M - c(p^D, p^N)] - (1 - m^i)(R^0 - c(d(m^i)p^D, p^N)) > 0
\]

Equation 7 can further be rewritten in terms of how much more to participate, revenue associated with additional patients, and costs associated with additional patients:

\[
\frac{\text{profit per Medicaid patient (maybe-ex posed)}}{(m^* - m^i)|} \frac{\text{profit per private patient (just if volume fixed)}}{(1 - m^i)[c(d(m^i)p^D, p^N) - c(d(m^i)p^D, p^N)] > 0}
\]

Rewriting this inequality illustrates the factors that affect whether manipulation is “worth it” in eq(9):

\[
(9) \ (m^* - m^i)dr < (1 - m^i)\Delta c
\]

Equations 9 and 6 suggest that manipulation is more likely for several types of hospitals:

(i) hospitals that are closer to the threshold to begin with (small \( m^* - m^i \));

(ii) hospitals that have larger demand for drug care \( D^- \);

(iii) hospitals that are more able to engage in \textit{ex post} strategic behavior \( D^+ = D^- \) and finally;

(iv) hospitals with a small difference between Medicaid and non-Medicaid reimbursements, \( dr \).

\[\text{II. Methods}\]

The goal of our analysis is to test whether hospitals manipulate their adjusted DSH patient percentages to participate in the 340B program. To do so, we implement a series of nonparametric, cross-sectional density tests and semiparametric, within-hospital event studies to evaluate trend breaks in the adjusted and unadjusted DSH patient percentage and its components around the timing of participation. Further, secondary goals include describing the characteristics of probable manipulating hospitals, and testing for mechanisms by which hospitals manipulate their DSH patient percentages to gain eligibility.

A. Nonparametric, Cross-Sectional Density Tests

We test for manipulation of the adjusted DSH patient percentage in three ways. First, we use a parametric density test used by DeGeorges, Patel, and Zeckhauser (1999) in which we bin the data into two percentage point bins and use the neighboring points around each bin to estimate what the density level should look like without manipulation, and then compare the height of the density at the discontinuity to the expected density. To assess statistical significance, we compare the statistic for all points in the density, normalized by the standard deviation of the neighboring points. The estimated statistic at the cutoff of interest, a DSH patient percentage of 11.75 percent, is considered statistically significant if the statistic is larger than statistics for all other points in the distribution.

A second way we test for discontinuities in the adjusted DSH patient percentage distribution is to use the bunching estimator proposed by Chetty et al. (2011) to quantify how many excess hospitals were present at the eligibility threshold. Briefly, this estimator uses a local high-order polynomial to estimate the expected distribution at the discontinuity and then compares the actual to the expected number of hospitals. We estimate the bunching estimator over 0.0125 percentage point bins of the adjusted DSH patient percentage and estimate the local polynomial over a region of +3 or -3 percentage points around the discontinuity. To estimate whether the excess mass at the discontinuity differs from the expected value we boot strap standard errors.

A third way we test for discontinuities in the adjusted DSH patient percentage distribution is to use a formal test for manipulation in a regression discontinuity based on Cattaneo, Jannson, and Ma (2018). This test estimates a local polynomial on either side of the discontinuity and tests for a statistically significant change at the density.
We perform all three analyses on annual cross sections of data between 1996 and 2016.

B. Semiparametric, Within-Hospital Hazard Models

Our theory suggests several hypotheses that can be tested in our data. Specifically, we can test whether the time to participation depends on distance to the threshold, the hospitals ability to engage in ex post strategic behavior through increasing the use of drug-based care, and, finally, the difference between Medicaid and non-Medicaid reimbursments. To assess closeness, we divide hospitals by the distance between their adjusted DSH patient percentage in 1996 and the eligibility threshold: above median (far) and below median (near). To assess the ability to engage in ex post strategic behavior we look at hospitals with above median shares of outpatient drug spending and outpatient intravenous therapy spending. Finally, to proxy for the difference between Medicaid and non-Medicaid, we divide hospitals into those with below median Herfindahl-Hirschman Indexes (HHIs) and above median with the idea that non-Medicaid reimbursments should be lower in more competitive markets.

We estimate differences in hazards in two ways. First, we estimate nonparametric Nelson-Aalen cumulative hazard functions for each group: high versus low. We also estimate Cox proportional hazard models that test the difference between a baseline hazard and the group that theory predicts would be more likely to pursue ex ante strategic behavior.

C. Semiparametric, Within-Hospital Trend Break Models

Hospitals that do and do not chose to participate likely differ in important ways, and therefore a within-hospital design for manipulation is desirable. We conceptualize such a test by estimating a pre trend over the six periods before hospitals participate in 340B and then a trend break between the pre period and the six years after the hospital begins participating in 340B. Importantly, we estimate pre trends and trend breaks on two separate groups of hospitals. Those that were ineligible six years before they began to participate (i.e. their adjusted DSH patient percentage was less than 11.75 percent), and those that were already eligible six years before they began to participate (i.e. their adjusted DSH patient percentage was more than 11.75 percent six years prior to participating). The idea behind dividing the sample into these two groups is that hospitals with adjusted DSH patient percentages below the threshold prior to participating have a strong incentive to engage in ex ante strategic behavior, while those who are above the threshold do not. Upon gaining eligibility, however, those initially ineligible hospitals face no incentive to report higher DSH patient percentages. Thus, we find evidence of manipulation if the trend break coefficient is negative and statistically significant.

Our approach is summarized in equation 10.

\[
(10) \, ADSH_{hp} = \beta_0 + \beta_1 \text{Period}_h + \beta_2 \text{POST}_p + \beta_3 \text{Period}_p \times \text{POST}_p + X_{hp} + F_h + G_t + \psi_{hpt}
\]

Here \(ADSH_{hp}\) represents the adjusted DSH patient percentage for hospital \(h\), in period \(p\), expressed relative to the year before the hospital began participating. \(\text{Period}\) is a continuous variable equal to the number of years relative to the year before participation. Among baseline ineligible hospitals \(\beta_1 > 0\) by definition: hospitals that eventually participate but have low adjusted DSH patient percentages must eventually raise their percentage to become eligible. The interaction between \(\text{POST}\), is a dummy variable equal to 1 if the hospital has begun participating, and \(\text{Period}\) is the parameter of interest. If hospitals engage in ex ante strategic behavior, we expect \(\beta_3 < 0\) suggesting that the positive trend in the adjusted DSH patient percentage levels off. Importantly, we only expect this trend among baseline ineligible hospitals. Among hospitals already eligible we expect no such trend break. \(X_{hp}\) is a vector of time-varying hospital-level characteristics, including the number of beds, hospital ownership, and case mix. The vectors \(F_h\) and \(G_t\) represent hospital and year fixed effects and \(\psi_{hpt}\) is an idiosyncratic error. In selected models we replace \(G_t\) with state-by-year fixed effects to account for differential non-linear time trends across states.

Our review of the academic and grey literature suggested that hospitals may increase their DSH patient percentages by investing in services that increase the number of Medicaid patients, or they may pursue accounting strategies to increase the DSH patient percentage. A relatively low-cost way to increase the DSH patient percentage is through adding labor and delivery services (Personal Communication David Ennis, 2018). Births to Medicaid women are relatively uncomplicated and occur commonly: 40 percent of all births in the U.S. are covered by Medicaid. By attracting Medicaid-covered births, the Medicaid fraction of total patient days would increase. Another low-cost way to increase the adjusted DSH patient percentage would be to contract with consulting companies to audit the hospitals’ accounting of days for purposes of the DSH calculation. Many consulting companies offer these services promising increase DSH patient percentages. At best, these services assist hospitals in more carefully accounting for days and services which belong in the DSH patient percentage calculation. At worst, they could facilitate misclassification of visits and days and therefore represent fraud.

To test for mechanisms of manipulation, we use equation 10 to estimate trend breaks in two outcome variables that describe manipulation. These mechanisms include expenditures on labor and delivery services, and the discrepancy between the Medicaid share of total inpatient days reported for the purposes of the DSH patient percentage calculation and statistical purposes. The construction of both measures is described below. As above, we expect that there will be a break in the trend in each outcome after hospitals become eligible for the program. For both outcomes, we would expect \(\beta_3 < 0\).

D. Descriptive Analysis of Characteristics of Manipulators
Finally, we describe the characteristics of hospitals that meet two alternative definitions of manipulators related to our two manipulation tests. The first definition is 340B hospitals with adjusted DSH patient percentages that do not exceed 13.75 percent after participating. The second definition is hospitals with adjusted DSH patient percentages below 11.75 percent 6 years before they began participating in 340B. Characteristics include offering unprofitable service lines Horwitz (2005), whether the hospital spends at least 5 percent of the operating budget on uncompensated care, the number of beds, the presence of for-profits within the health services area, and the Herfindahl index of the health services area.

III. Data

We use several sources of administrative data collected by the Department of Health and Human Services. The first consists of Medicare Hospital Cost Reports ("cost reports"), which provide information on the adjusted DSH patient percentage and its components as well as hospital characteristics between 1996 and 2016, the latest year of complete data (Research Data Assistance Center 2017; Centers for Medicare & Medicaid Services 2018).

We link these data to the 2018 340B Disproportionate Share Hospital Provider List (Health Resources and Services Administration 2018). These data provide a complete list of hospitals participating in the 340B program as well as the dates of registration for each clinic and pharmacy that dispenses discounted drugs under the hospital’s 340B program. We also link all hospitals in our dataset to the Medicare Impact Files, which contain information on each hospital’s urban status designation (Medicare, Baltimore, and Usa 2012). Appendix 1 describes the process to create the sample and the number of hospitals linked across datasets. We linked all datasets using each hospital’s CMS identifier.

We create two analysis samples. The first consists of 1379 nonprofit and public general acute care, urban hospitals with at least 100 total bed days available2 (N=17824). We employ these selection criteria because it allows us to identify ex ante strategic behavior effects on a group of hospitals that do not experience any changes in eligibility criteria over our period of study. For-profit hospitals are excluded because they are not eligible to participate in 340B (Health Resources and Services Administration 1996). Adjustments to the DSH patient percentage have occurred many times over the past 20 years for smaller hospitals, rural hospitals, and hospitals with special designations. However, the adjustment factor for urban hospitals with 100 or more available bed days has not changed since 1992 when the 340B program was created3 (Cornell Legal Information Institute 2018). Available bed days are defined as total days of care divided by the number of days in the cost reporting period (Barnes, Buchheit, and Parsons 2017; Barnes and Hap 2018). We therefore restricted our sample to urban hospitals with at least 100 available bed days or more. We also exclude hospitals with any special designation, such as Medicare dependent hospital, rural referral center, or sole community status.

The second consists of hospitals that never participate in 340B or start participating between 2000 and 2011 and are not missing information on our key independent variables. We limit the sample in this way because we wish to measure a balanced panel of time periods in our trend break analysis before and after hospitals begin participating. This sample consists of 604 nonparticipants, 304 participant hospitals that have adjusted DSH patient percentages below the eligibility threshold six periods before participating, and 196 participant hospitals that have adjusted DSH patient percentages above the eligibility threshold six periods before participating. We divide the sample in this way because the adjusted DSH patient percentage before hospitals begin participating determines its incentive to engage in ex ante strategic behavior: those not already eligible must pursue strategies to become eligible, while those already eligible do not.

A. Key Variable Definitions

The Adjusted DSH Patient Percentage—The most important variable in our analysis is the adjusted DSH patient percentage. The unadjusted DSH patient percentage is equal to the Medicaid share of total hospital days and the SSI-eligible Medicare share of total Medicare days. Hospitals report both components as well as the adjusted DSH patient percentage in the hospital cost reports starting in 1996. The unadjusted percentage is then adjusted based upon the hospital’s CMS urban designation and the number of “available bed days.”

340B Participation—Another important variable in our analysis is when each hospital began participating in the 340B program. We define the year each hospital began participating in 340B as the earliest year of registration across all affiliated clinics. Hospitals are considered to have started participating in 340B if the hospital fiscal year is greater than or equal to the year the hospital first began participating. We create a 340B indicator equal to one in the years between when the hospital began participating in the program through the last year of participation. 340B is observed to be an almost entirely absorbing state for hospitals – 99.4 percent of hospitals in our sample remain eligible for 340B once they qualify. All event time variables are defined relative to the year before the first year of participation.

B. Manipulation Mechanisms

---

2 Total bed days available is equal to the number of days of care, less swing bed days divided by the number of days in the cost reporting period, 365. The official adjustment formula for the adjusted DSH patient percentage varies for hospitals with total bed days available greater or lesser than 100.

3 The adjustment factor for urban hospitals with 100 or more beds is 0.0250 + (0.650*(unadjusted DSH patient percentage-0.150)) if the unadjusted DSH patient percentage is between 0.150 and 0.202 and 0.0568 + 0.825*(unadjusted DSH patient percentage-0.202) if the unadjusted DSH patient percentage is greater than 0.202.
We explore two mechanisms for manipulation. First, we create a measure of labor and delivery services spending using the hospital cost reports. Specifically, we measure the hospitals’ expenditures on labor and delivery services during the hospital fiscal year. Second, we create a measure of Medicaid utilization from a section of the hospital cost report not used for the DSH calculation. The idea is that if there is accounting-based manipulation, patterns in Medicaid utilization that are not used to calculate the adjusted DHS patient percentage should not display the same pattern. We create a measure of Medicaid visits and days share of total hospital visits and days for comparison.

C. Other Controls and Hospital Characteristics

We created variables from the cost reports describing hospital-specific ownership (public vs. nonprofit), number of beds and an indicator for whether the hospital administers infused drugs. We also use data from the Medicare Impact Files to create a measure of hospital case mix in each year. We identified the state of location and the federal fiscal year and included them as controls in our regression. State-by-year fixed effects are included in our preferred specifications to control for differential changes in the policy environment and economic conditions across states and over time. The primary threat to internal validity addressed by the inclusion of state-by-year fixed effects is Medicaid expansion across states and over time. As states expand Medicaid, hospitals “automatically” treat more Medicaid patients and the adjusted DSH patient percentage increases as a result. This kind of increase in the adjusted DSH patient percentage does not represent manipulation and therefore we wanted to eliminate it as a factor in our estimates.

We also create measures that describe hospital characteristics for our descriptive analysis of hospitals likely to engage in ex ante strategic behavior and our hazard model analyses. These characteristics include whether the hospital offers key non-fee-for-service as defined by Horwitz (Horwitz 2005), whether the hospital is in a hospital service area that contains at least one for-profit hospital, hospital service area Herfindahl Index, and whether the hospital is government-operated, or public owned. We use information from the American Hospital Association Annual Member Survey to assess whether the hospital inpatient, outpatient, and emergency psychiatric care, dental, AIDS/HIV, trauma and drug and alcohol treatment.

IV. Results

Table 1 presents descriptive characteristics of our samples. For our distribution-based and hazard analyses, we use a sample that includes nonprofit and public hospitals observed between 1996 and 2016. The first column shows that the average adjusted DSH patient percentage in this sample is 19 percent, which is higher than the eligibility criterion of 11.75 percent. The next three columns present the sample for the three groups compared in our within-hospital analyses: never participants, participants between 2000 and 2011 that are initially ineligible, and participants over the same time period that are already eligible before participating. Comparing across these three groups of hospitals, we find that adjusted and unadjusted DSH patient percentages increase across the three groups. Labor and delivery expenditures were also lowest among non-participants, followed by initially ineligible hospitals, and already eligible hospitals. The same gradient was observed for hospital case-mix index and the discrepancy between the Medicaid share of total days for purposes of the DSH patient percentage and simply for statistical purposes. These differences highlight the importance of within-hospital comparisons for estimating pretends. Hospitals across the three groups were similar in terms of case mix index and total bed days available.

We begin by considering trends in the distribution of the adjusted DSH patient percentage over time. The higher the adjusted DSH patient percentage, the more low-income patients the hospital care for. Figure 1 plots the 50th, 25th, and 75th percentiles of the adjusted DSH patient percentage in the year hospitals began participating in 340B from 1996 onwards, the earliest year reported in the data. The left-hand panel shows that before 2001 over three quarters of participants had a DSH patient percentage of approximately 20 percent or higher. Starting in 2005 all three points in the distribution began to fall, compressing so that the top half of hospitals beginning to participate in each year fell from 20 percent to just above 11.75 percent by 2010. Meanwhile, the bottom 25 percent of participants qualified with an adjusted DSH patient percentage of 11.75 percent before 2010. Qualifying DSH patient percentages increased slightly after 2014, likely as a result of the Affordable Care Act’s Medicaid expansion, which should have increased hospital’s Medicaid inpatient fractions and therefore also their eligibility for 340B. The right-hand panel suggests the possibility of manipulation, although it is not sufficient evidence for it. It shows the adjusted DSH patient percentage three years before the hospital began participating in the. For example the median plotted in 2010 in the right hand panel portrays the median adjusted DSH patient percentage for hospitals that began participating in 2010 from 2007, three years before. For hospitals in the bottom quartile, and even at the median in later years, they would not have been able to participate in 340B three years earlier. This suggests that among many later participants, adjusted DSH patient percentages would have had to rise in order for hospitals to participate.

A. Distribution-Based Tests for Manipulation

The purpose of these tests is to assess whether the increase in the adjusted DSH patient percentage described in the last set of test results from ex ante manipulation.

Figure 2 presents a histogram of the adjusted DSH patient percentage among CMS-designated urban hospitals with at least 100 available bed days in each year between 1996 and 2016. Following Desai and McWilliams (2018) and Barnes et al. (2017)we cut the data into two percentage point bins, centered around the 340B eligibility cutoff of 11.75 percent. The picture presents histograms for
each year between 1996 and 2016. If hospitals do not manipulate the DSH patient percentage, we would expect the histogram to be approximately smooth in the area around the cutoff. This pattern is visible in each year from 1996 through 2003. However, starting in 2004, the density around the cutoff is no longer smoothly declining. Except for 2007-2010, the bin just above 11.75 percent continues to rise until 2014 when it becomes the modal bin in the distribution. This pattern is suggestive of strategic behavior – relative to the bins around it there are approximately 50 more hospitals at the discontinuity in 2014-2016 than if there would be if it was smooth. We formalize this visual analysis with the non-parametric discontinuity test following DeGeorge et al. (Degeorge, Patel, and Zeckhauser 1999). The rank of the bin just above 11.75% is printed above each bar in each year.

Table 2 presents the results of all three distributional tests for manipulation by year. The first column replicates the DeGeorges et al. (1996) test for discontinuity rank printed above each bar on Figure 2, as well as two additional statistics: the excess number of hospitals based on the bunching estimator method proposed by Chetty et al. (2011), and a robust non-parametric regression discontinuity test for manipulation proposed by Cattaneo, Jansson, and Ma (2018). All three statistics present a similar pattern: before 2004, there is little evidence of manipulation at the 11.75 percent cutoff. However, after 2004 the mass at 11.75 percent grows. By 2016, there were 10 more hospitals than expected using the Chetty et al. bunching estimator and five additional hospitals using the Cattaneo, Jansson, and Ma (2018) estimator. Relative to the expected number of hospitals at the discontinuity in 2016 (11), the excess number of hospitals estimated using the bunching estimator (21) amounts to an 116% increase, or doubling of the expected mass.

Taken together, these results suggest that, over time, hospitals gaining access to 340B discounts appear to be more marginally dedicated to the safety net. The increasingly marginal nature of institutions over time is apparent in Figures 1, 2, and 3: adjusted DSH patient percentages have fallen over time and hospitals display more evidence suggestive of strategic behavior.

B. Within-Hospital Hazard Estimates

Figure 3 presents evidence consistent with our theoretical model: The top panel compares hospitals in less competitive markets (above median HHIs) to those in more competitive metro areas. The idea behind this comparison is that hospital reimbursement rates should be closer to cost (and thus closer to Medicaid reimbursement rates) in more competitive markets than less competitive markets. Our theory predicts that manipulation should be more likely among those hospitals that have private rates closer to Medicaid, and the panel shows evidence consistent with this prediction: the hazard of participation is lower among hospitals in less competitive markets (0.98, SE=0.02). In the next panel, we compare hazards of participation between hospitals that are closer (above median) and farther (below median) away from the eligibility threshold of 11.75 percent at baseline (six periods before). We find that the hazard of participation is greater among those hospitals close to the threshold (1.28, SE=0.04). Although this is a prediction from our theory, it is not surprising that hospitals closer to the eligibility threshold would have a higher hazard of participation than hospitals farther away.

The bottom two panels provide evidence for the third prediction of our theory: the estimated hazard is higher among hospitals with higher demand for drug-based care or a greater ability to pursue ex post manipulation through shifting care from nondrug to drug sources. We look at hazards of participation between hospitals with high and low outpatient drug spending at baseline and hospitals with high and low outpatient infusion spending at baseline. We find that those hospitals with higher shares of resources devoted to outpatient and infused drugs became eligible for 340B at a faster pace than other hospitals. The hazard was 1.5 times higher (SE=0.03) among hospitals with higher baseline drug spending and 1.4 times higher (SE=0.041) among hospitals with high outpatient infusion spending. While these figures provide evidence consistent with manipulation, they are not definitive proof of ex ante strategic behavior.

C. Within-Hospital Trend Break Analysis

Figure 4 plots within-hospital event study estimates comparing the adjusted DSH patient percentage, or the unadjusted components in each period before or after the year before participation. Among hospitals that are baseline ineligible, the adjusted DSH patient percentage increased by slightly less than one percentage point per year. After becoming eligible, the slope decreases, although it is positive to slightly more than a quarter of a percentage point per year. Among hospitals already eligible at baseline, the trend is very small and negative and does not change around the year in which the hospital begins participating in 340B. The pattern for the Medicaid component of the unadjusted DSH patient percentage displays a similar pattern to that of the adjusted DSH patient percentage, however the pattern for the Medicare component is relatively flat.

Table 3 presents estimated linear trends and the trend break between the pre- and post-period. If hospitals engage in manipulation, we would expect to see a trend break coefficient that is negative and statistically significant. In our base model with only hospital and year fixed effects, we find the baseline pre trend is positive and statistically significant for the adjusted and unadjusted DSH patient percentage, and both components. This positive trend is by construction: hospitals with low baseline adjusted DSH patient percentages must eventually reach the threshold. Consistent with manipulation, however, the trend break coefficients are negative and statistically significant indicating that hospitals stop taking efforts to increase 340B eligibility after becoming eligible. Expressed as a percentage of the pre 340B trend, the drop ranges from over 60 percent of the original trend for the DSH patient percentage to 50 percent for the Medicare component. The results are similar across specifications. In our preferred specification, which includes state-by-year

The pattern of manipulation temporarily diminishes in 2007-2010. This temporary change can be explained by the release of formal guidance regarding state DSH audits in 2006, effective 2007. Because the audits required hospitals to pay back any DSH funds that exceeded the hospital’s uncompensated care, the DSH audits created a penalty for over-reporting the adjusted DSH patient percentage. The pattern reappears in 2010 because the Affordable Care Act included measures that reduced DSH payments to hospitals through both the Medicaid and Medicare programs as well as increased the returns to 340B participation by allowing hospitals to establish an unlimited number of contract pharmacy arrangements through which discounted drugs could be dispensed.
fixed effects, the unadjusted DSH patient percentage falls by 70 percent after hospitals begin to participate in 340B. In contrast, there is no statistically significant pre trend, nor is there a difference from the baseline trend after hospitals participate in 340B. This result suggests that the pattern of manipulation is unique to baseline ineligible hospitals.

In the final two columns of Table 3 we present results suggestive of the possible mechanisms through which hospitals could engage in ex ante strategic behavior. These include increasing labor and delivery services to increase Medicaid inpatient volume and using accounting techniques to boost the Medicaid share of total days. Contrary to predictions, we find that labor and delivery spending does not change significantly in the six years prior to beginning 340B, although the point estimate is negative. With respect to manipulation, we find that the discrepancy is increasing in the years prior to becoming eligible across all models. However, we do not find evidence of a trend break in the discrepancy after hospitals become eligible.

Table 4 presents differences in hospital characteristics between hospitals that are likely manipulators defined as 340B providers with adjusted DSH patient percentages that never rise beyond 13.75% and a comparison set of hospitals that do have adjusted DSH patient percentages that are above 13.75%. Relative to this comparison group, hospitals with adjusted DSH patient percentages that never rise above 13.75% are less likely to offer inpatient (-11.7%, SE=0.048), outpatient (-15.9%, SE=0.048), and emergency (-7.1%, SE=0.051) psychiatric care. They were also less likely to offer dental services (-11.8%, SE=0.046), AIDS/HIV care (-8.1%, SE=0.052), and trauma care (-8.9%, SE=0.05). These hospitals were more likely to offer drug and alcohol treatment, however (11%, SE=0.057). Likely manipulators were also located in less competitive hospital service areas (higher HHI: 0.254, SE=0.078), and were less likely to be public owned (-12%, SE=0.053). There were no statistically significant differences between the two groups in the presence of for-profits in the market.

D. Robustness Tests

To test whether and how our chosen sample, variable creation procedures, and regression specifications affect the results, we perform a variety of robustness tests. First, we repeat our density-based analysis cut now into one percentage point bins and find similar but more pronounced results: relative to the expected distribution, the actual number of hospitals in the 11.73-13.73 percent bin is significantly larger than the rest of the distribution in 2006 and 2016 (Appendix 2). Second, we relax the requirement that we exclude hospitals with non-CMS urban designations and fewer than 100 total bed days available. We chose not to include these hospitals in our main results because they experienced changes in the adjusted formula. Furthermore, the adjustment formula introduces caps at 12 percent for rural hospitals and hospitals with less than 100 total bed days available. As a test of whether our results are determined by the particular sample restrictions, we follow Desai and McWilliams (2018) and recode the adjusted DSH patient percentage for hospitals that are subject to these caps by disregarding the caps. Appendices 3 and 4 show that our results are qualitatively similar using the recoded variable.

V. Discussion and Conclusion

Our paper tests for evidence of ex ante strategic behavior pursued by hospitals related to the benefits of 340B program in several different ways and finds similar results for all methods: hospitals that would not otherwise qualify for 340B program undertake efforts to qualify. The pattern of manipulation varies across years, beginning in 2004, temporarily disappearing in between 2006 and 2010, and remerging after 2010. The extent of manipulation was also large: our non-parametric estimates also suggest that there were twice as many hospitals as expected with adjusted DSH patient percentages at the cutoff for eligibility in 2016. We also found that hospitals that were more likely to engage in ex ante strategic behavior were less likely to offer unprofitable service lines, and also less likely to be located in more competitive hospital markets.

Our results have several empirical and policy implications. First, we find evidence that hospitals may not increase their adjusted DSH patient percentages through providing more care to Medicaid patients. Rather, they appear to engage in some form of reclassification of visits after the fact. Distinguishing between these two possible mechanisms is important because if manipulation also results in better access to care for Medicaid patients, then the distortion created by ex ante selection may be offset by some welfare gains. For the services we studied, this does not appear to be the case. Our comparisons of the Medicaid fraction of total days, likely the most malleable of the two components of the unadjusted DSH patient percentage, as it is reported for purposes of DSH payment and for solely statistical purposes is striking. Not only does the component reported for reimbursement always exceed the nonmanipulated component, it also appears that manipulation of this component is larger among hospitals that need to increase their adjusted DSH patient percentage to qualify (“baseline ineligible” hospitals).

Second, we show that the current pool of 340B participants includes both hospitals that were always eligible because of their high DSH patient percentages as well as more marginal hospitals, which may have gained entry to the program related to their pursuit of ex ante strategic behavior. This heterogeneity is consistent with the longstanding literature on the diverse objectives of non-profits. Specifically, non-profits may seek to maximize outputs, quality, or the price-cost margin (Sloan 2000). Most relevant to our study is Hirth’s (1997) theory of a mixed hospital sector in which some non-profit hospitals have altruistic goals of providing safety-net care and others are simply “for-profits in disguise.” The ex-ante manipulation demonstrated among some hospitals in this paper provides support for the existence of the latter sort of non-profit hospital. We observe that the hospitals that appear most likely to be manipulators reside in less competitive markets, but were no more likely to be located in markets with for-profits. This finding is contradictory to the
numerous studies that find that non profits are more likely to behave like for-profits when faced with competitive pressure (Hirth 1999), especially from for profit hospitals (Hughes and Luft 1990; Silverman and Skinner 2004; Schlesinger et al. 1997; Horwitz 2007; Horwitz and Nichols 2009). Other factors that may be associated with manipulation but could not be examined in this study include the structure of executive compensation (Ballou and Weisbrod 2003) or the extent of the hospital’s altruism (Rose-Ackerman 1996). Importantly for the ongoing debate about how to regulate and monitor 340B hospitals, an implication of Hirth (1997) is that in the absence of enforcement of a non-distraction constraint (i.e. monitoring and requiring hospitals to provide charity care), subsidies equally available to both kinds of non profits are unlikely to “achieve[ ] the social goals that justify subsidies in the first place.” Indeed, probable manipulating hospitals are less likely to offer several unprofitable service lines including a variety of psychiatric services, AIDS care, dental care trauma services, and drug and alcohol treatment services.

Third, the increasingly marginal nature of institutions over time is apparent in Figures 1, 2, and 3: adjusted DSH patient percentages have fallen over time as well as displayed more evidence of manipulation over time. The challenge for policymakers is how to parse existing providers to identify those that are using the program as it was intended and those who are not. In the recent “Blueprint to Lower Drug Prices,” the Trump Administration proposed to identify good actors by only allowing those hospitals that provide at least 1 percent of their operating revenues in uncompensated care to continue to draw discounts from the program. A recent analysis suggests that this metric would not cull that many participants from the program because the majority of 340B hospitals provide at least 1 percent of their budget as uncompensated care (S. S. Nikpay, Bach, and Conti 2018). Consequently, segregating manipulators from nonmanipulators using this metric will likely prove challenging.

Fourth, and finally, our results also highlight the potential importance of the Medicaid DSH audits, which were enacted in 2006 and have been previously unexplored. Although we find evidence that hospitals begin manipulating the DSH percentage as early as 2004, an interesting deviation from this trend occurs between 2007 and 2010 when the pattern of manipulation disappears. The pattern coincides with the introduction of Medicaid DSH audits, which require hospitals to repay DSH payments in excess of the audited amount of uncompensated care provided in the same year (Simmons 2010; Levinson 2006; Buchmueller, Ham, and Shore-Sheppard 2015; Centers for Medicare & Medicaid Services 2008). Penalties for Medicaid DSH overpayments became effective in 2006, and the threat of repayment should have discouraged manipulation of the DSH patient percentage. Although they continue to be in effect today, the passage of the Affordable Care Act should have diminished the effectiveness of the DSH audits for two reasons. First, the law proposed cuts to Medicaid and Medicare DSH payments that would disproportionately affect hospitals that provide little uncompensated care. These cuts likely reduced the expected value of DSH payments to hospitals that were less safety-net oriented. Second, the law allowed 340B hospitals to establish an unlimited number of contract pharmacies through which to dispense discounted outpatient drugs. The expected price-cost margin from expanded pharmacies combined with the reduced value of Medicaid DSH payments should outweigh the costs of Medicaid DSH repayments. We find that the pattern of manipulation appears again in 2010.

In addition to encouraging unintended consequences, reliance on the DSH patient percentage as the sole criterion for eligibility results in poor target efficiency of the program (Schuck and Zeckhauser 2006). Whether such a criterion can discriminate between hospitals that do and do not manipulate the program, is a question ripe for policy analysis and simulation. For DSH hospitals, which constitute the majority of hospital participants, the eligibility criteria have not been revisited since 1992. What is more, because the DSH patient percentage depends on the availability of Medicaid patients, some hospitals my passively become eligible for the program because more of their patient population is eligible for Medicaid, as under the Affordable Care Act (S. Nikpay, Buchmueller, and Levy 2016). In 1992, fewer than 20,000 Americans were covered by Medicaid. That fraction has risen steadily since 1992, tripling to over 60,000 by the passage of the Affordable Care Act in 2010 (Buchmueller, Ham, and Shore-Sheppard 2015). As the Medicaid population continues to rise under Medicaid expansion, policymakers should consider revising this threshold, or better still – condition eligibility on actual provision of safety-net care rather than arbitrary thresholds.


Table 1: Descriptive Sample Statistics

<table>
<thead>
<tr>
<th>Statistics</th>
<th>All Hospitals (N=17824)</th>
<th>Non Participant Hospitals (N=5142)</th>
<th>Baseline Ineligible Hospitals (N=4839)</th>
<th>Baseline Eligible Hospitals (N=3448)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Unique Hospitals</strong></td>
<td>137</td>
<td>604</td>
<td>304</td>
<td>196</td>
</tr>
<tr>
<td><strong>Adjusted DSH Patient %</strong></td>
<td>0.19</td>
<td>0.15</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Unadjusted DSH Patient %</strong></td>
<td>0.36</td>
<td>0.19</td>
<td>0.23</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Medicaid Component</strong></td>
<td>0.25</td>
<td>0.13</td>
<td>0.16</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Medicare Component</strong></td>
<td>0.11</td>
<td>0.08</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Labor and Delivery Expenditures ($M)</strong></td>
<td>6.23</td>
<td>5.35</td>
<td>5.10</td>
<td>5.04</td>
</tr>
<tr>
<td><strong>Hospital Case-Mix Index</strong></td>
<td>1.54</td>
<td>0.25</td>
<td>1.52</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>Total Bed Days Available</strong></td>
<td>320.05</td>
<td>545.53</td>
<td>284</td>
<td>976</td>
</tr>
<tr>
<td><strong>Public Ownership</strong></td>
<td>0.17</td>
<td>0.37</td>
<td>0.08</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>Medicaid Day Share Discrepancy</strong></td>
<td>0.08</td>
<td>0.09</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Source: CMS hospital cost reports linked to 340B participation data and Medicare Impact Files, 1996-2016. The figure presents descriptive statistics for four groups of hospitals used in our analysis. The first group is nonprofit and general acute care hospitals with a CMS urban designation and at least 100 total bed days available (N=17824). Nonprofit status, hospital type, and total bed days available was assessed using the hospital cost reports. CMS urban designation was assessed using the Medicare Impact files. The second group of hospitals consists of those that never participate in 340B (N=5142). The third group of hospitals consists of those that participate in 340B between 2000 and 2011 but have adjusted DSH patient percentages below the eligibility threshold six years before their first year of participation (N=3448). The final group consists of hospitals that participate between 2000 and 2011 but have adjusted DSH patient percentages above 11.75 percent six periods before participating. The adjusted DSH patient percentage is defined as the sum of the Medicaid and Medicare components of the adjusted DSH patient percentage, adjusted for total bed days available and urban status. The Medicaid component is defined as the Medicaid share of total days of inpatient care. The Medicare component is defined as the SSI-eligible Medicare share of total inpatient Medicare days. Labor and delivery expenditures are defined as charges for labor and delivery services deflated by a cost-to-charge ratio. Total bed days available is defined as total inpatient days divided by the number of days in the cost reporting period. The Medicaid day share discrepancy is the difference between the Medicaid share of total days as reported for the purposes of the DSH calculation and the share reported for statistical purposes.
Figure 1: Trends in the Distribution of Adjusted DSH Patient Percentages Among 340B Hospitals in the Year of Participation and Three Years Before, 1996-2016

Panel A: Year of Participation
(Adjusted DSH Patient Percentage)

Panel B: 3 Years Before Participation
(Adjusted DSH Patient Percentage)

Source: CMS hospital cost reports linked to 340B participation data and Medicare Impact Files, 1996-2016. The figure plots percentiles of the adjusted DSH patient percentage in each year between 1996 and 2016. The left figure plots the adjusted DSH patient percentage in the contemporaneous year. The right panel plots percentiles from 3 years before. The sample includes non-profit and public general acute care hospitals that are both urban and have 100 total bed days available (N=17824).
Figure 2: Distribution of the DSH Patient Percentage among Non-Profit and Public General Acute Care Hospitals: 1996-2016

Source: CMS hospital cost reports linked to 340B participation data and Medicare Impact Files, 1996-2016. The figure plots percentiles of the adjusted DSH patient percentage in each year between 1996 and 2016. The sample includes non-profit and public general acute care hospitals that are both urban and have 100 total bed days available (N=17824). The figure plots the number of hospitals that fall into each two percentage point bin around 11.75 percent. The red line represents the eligibility cutoff, 11.75 percent. The dark bar identifies the bin that contains the mass immediately above 11.75 percent. The number above the bar represents the rank of bar in terms of how much the actual height exceeds the expected distribution (DeGeorges et al. 1997). A rank of 1 indicates that the bar is the most extreme discontinuity in the distribution. The year 2000 is omitted from the figure because of a high rate of missing data in that year.
### Table 2: Distributional Tests for Discontinuities at 11.75%

<table>
<thead>
<tr>
<th>Year</th>
<th>Discontinuity Rank</th>
<th>Excess Hospitals</th>
<th>SE</th>
<th>Discontinuity</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>4</td>
<td>-0.51</td>
<td>0.10</td>
<td>0.82</td>
<td>1.91</td>
</tr>
<tr>
<td>1997</td>
<td>8</td>
<td>3.09</td>
<td>0.19</td>
<td>0.64</td>
<td>2.08</td>
</tr>
<tr>
<td>1998</td>
<td>7</td>
<td>3.89</td>
<td>0.23</td>
<td>5.18</td>
<td>2.56</td>
</tr>
<tr>
<td>1999</td>
<td>9</td>
<td>-2.72</td>
<td>0.13</td>
<td>-2.03</td>
<td>1.85</td>
</tr>
<tr>
<td>2001</td>
<td>8</td>
<td>1.31</td>
<td>0.22</td>
<td>-0.59</td>
<td>2.11</td>
</tr>
<tr>
<td>2002</td>
<td>10</td>
<td>-3.02</td>
<td>0.15</td>
<td>-3.00</td>
<td>2.11</td>
</tr>
<tr>
<td>2003</td>
<td>10</td>
<td>-2.49</td>
<td>0.17</td>
<td>0.62</td>
<td>1.99</td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>4.36</td>
<td>0.25</td>
<td>2.68</td>
<td>1.44</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>3.28</td>
<td>0.27</td>
<td>3.09</td>
<td>1.99</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>9.47</td>
<td>0.30</td>
<td>4.58</td>
<td>1.47</td>
</tr>
<tr>
<td>2007</td>
<td>6</td>
<td>0.18</td>
<td>0.22</td>
<td>-1.22</td>
<td>1.71</td>
</tr>
<tr>
<td>2008</td>
<td>5</td>
<td>-1.79</td>
<td>0.17</td>
<td>1.97</td>
<td>1.81</td>
</tr>
<tr>
<td>2009</td>
<td>5</td>
<td>4.12</td>
<td>0.27</td>
<td>-3.39</td>
<td>2.19</td>
</tr>
<tr>
<td>2010</td>
<td>3</td>
<td>-2.04</td>
<td>0.19</td>
<td>-6.02</td>
<td>2.05</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>4.87</td>
<td>0.27</td>
<td>3.34</td>
<td>1.13</td>
</tr>
<tr>
<td>2012</td>
<td>1</td>
<td>5.31</td>
<td>0.27</td>
<td>2.89</td>
<td>1.74</td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>3.98</td>
<td>0.27</td>
<td>2.70</td>
<td>1.16</td>
</tr>
<tr>
<td>2014</td>
<td>2</td>
<td>4.64</td>
<td>0.25</td>
<td>2.82</td>
<td>1.76</td>
</tr>
<tr>
<td>2015</td>
<td>1</td>
<td>14.24</td>
<td>0.34</td>
<td>2.94</td>
<td>1.59</td>
</tr>
<tr>
<td>2016</td>
<td>2</td>
<td>10.02</td>
<td>0.32</td>
<td>5.35</td>
<td>2.11</td>
</tr>
</tbody>
</table>

Source: 1996-2016 Medicare hospital cost reports and Medicare impact files linked to the 2018 340B provider list. The table shows the number of hospitals in each year, and three different statistics to test for discontinuities around the 340B cutoff of 11.75 percent. The discontinuity rank is the rank of each bar in the histogram in Figure 2, ranked by the difference between the height of the bar and its expected distribution based upon averaging the neighboring bins based on DeGeorges et al. (1997). The Chetty et al. (2011) bunching estimator is another method of quantifying the number of excess hospitals at the eligibility cutoff. The results here are estimated over a histogram with 0.25 percentage point bins and a 7th order polynomial is used to fit the distribution. Finally, we present the discontinuity and robust standard error from Cattaneo, Jansson, and Ma (2018). The year 2000 is excluded because of a high fraction of missing values.
Figure 3: Estimated Hazards of 340B Participation by Hospital Characteristics, 1996-2016

Panel A: Market Concentration (HHI)  
(Cumulative Hazard Rate)  
Hazard Ratio: 0.432 (S.E.=0.015)  

Panel B: Proximity to 11.75% at Baseline  
(Cumulative Hazard Rate)  
Hazard Ratio: 1.320 (S.E.=0.041)

Panel C: Outpatient Drug Spending  
(Cumulative Hazard Rate)  
Hazard Ratio: 1.366 (S.E.=0.042)  

Panel D: Outpatient Infusion Spending  
(Cumulative Hazard Rate)  
Hazard Ratio: 1.291 (S.E.=0.053)

Source: 1996-2016 CMS Hospital cost reports and Medicare impact Files linked to the 2018 340B Provider List. The sample includes non-profit and public hospitals with an urban CMS designation at least 100 total bed days available. The figures plot the non-parametric, Nelson-Aalen cumulative hazard function for 340B participation among baseline ineligible hospitals and non-participating hospitals compared between two characteristics. The upper left figure compares hospitals with above and below median market concentration, measured by the HHI of hospital discharges within the hospitals core based statistical area. The upper right figure compares the hazard of participation for hospitals that are close (above median) and far (below median) in their proximity to the eligibility threshold. The lower left panel compares the hazard of participation between hospitals with above median and below median outpatient drug spending as a share of total spending. Finally, the lower right-hand panel presents the same hazards for outpatient infusion spending as a share of total spending. Each graph also prints the estimated hazard ratio from a Cox proportional hazard model comparing the hazard between the two groups shown. The corresponding standard error is also displayed.
Source: 1996-2016 CMS Hospital Cost Reports and Medicare Impact Files linked to the Health Resources and Services Administration 340B provider list. The data are limited to nonprofit and public general acute care hospitals with a CMS designation of “urban” for the purposes of the DSH patient percentage calculation and at least 140 available bed days. The sample is also limited to hospitals that participate in 340B and began participating after 2000 in order to have a balanced panel of hospitals in the five years before hospitals began participating in 340B.

Each point represents an estimate of the period dummies interacted with the low DSH indicator and a 95 percent confidence interval. The dependent variable is the adjusted DSH patient percentage. Each estimate is generated by ordinary least squares regression and the omitted category is the year before the hospital began participating in 340B (indicated by the red line). Each point estimates represents the difference between the period estimates of low DSH hospitals and high DSH hospitals, defined by whether their adjusted DSH patient percentage in period -5 was lower or higher than 11.75 percent.
The dependent variables include the total visits reported for purposes of the cost reports and the Medicaid share reported for statistical purposes. The Medicaid component is the adjusted DSH patient percentage. The unadjusted DSH patient percentage is also included in the model. The sample includes nonprofit and public general acute care hospitals with a CMS urban designation and at least 100 bed days available.

The sample is also limited to hospitals that have never participated in the 340B program, as well as hospitals that began participating between 2000 and 2011. Models 1, 2, and 3 are estimated on a sample of hospitals that includes nonparticipants as well as hospitals that have adjusted DSH patient percentages less than 11.75 percent six years before participating. Model 4 is estimated on a sample of hospitals that includes nonparticipants and hospitals that have adjusted DSH patient percentages more than 11.75 percent six years before participating. Robust standard errors clustered at the hospital level are presented below each estimate. Model 1 includes hospital fixed effects and year fixed effects, which replace year fixed effects. Model 2 adds state- by-year fixed effects, which replace year fixed effects. Model 4 is the same as Model 3, but estimated on a different set of hospital: baseline ineligible hospitals. The dependent variables include that adjusted DSH patient percentage, the unadjusted DSH patient percentage, and the Medicaid and Medicare components that are summed to create the unadjusted DSH patient percentage. The Medicaid component is the Medicaid share of total inpatient hospital days. The Medicare component is the SSI-eligible Medicare share of total Medicare days. The last two columns include dependent variables that describe possible mechanisms through which hospitals could engage in ex ante strategic behavior. They include labor and delivery spending and the difference between the Medicaid share of total visits reported for purposes of the cost reports and the Medicaid share reported for statistical purposes.

Table 3: Event Studies Trend Analysis – DSH Patient Percentage and Its Components

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted DSH %</td>
<td>Unadjusted DSH %</td>
<td>Medicaid Component</td>
<td>Medicare Component</td>
<td>Labor and Delivery</td>
</tr>
<tr>
<td>Pre-Post Difference</td>
<td>0.00787</td>
<td>0.00927</td>
<td>0.00709</td>
<td>0.00218</td>
<td>-0.00961</td>
</tr>
<tr>
<td></td>
<td>(0.00061)</td>
<td>(0.0008)</td>
<td>(0.00065)</td>
<td>(0.00039)</td>
<td>(0.00737)</td>
</tr>
<tr>
<td></td>
<td>Pre-Post Difference</td>
<td>0.00959</td>
<td>0.00117</td>
<td>0.00095</td>
<td>0.00057</td>
</tr>
<tr>
<td></td>
<td>(0.00089)</td>
<td>(0.00116)</td>
<td>(0.00095)</td>
<td>(0.00057)</td>
<td>(0.01075)</td>
</tr>
<tr>
<td></td>
<td>Pre-Post Difference</td>
<td>-0.00463</td>
<td>-0.00583</td>
<td>-0.00333</td>
<td>-0.0025</td>
</tr>
<tr>
<td></td>
<td>(0.00062)</td>
<td>(0.00079)</td>
<td>(0.00065)</td>
<td>(0.00039)</td>
<td>(0.00737)</td>
</tr>
<tr>
<td></td>
<td>Pre-Post Difference</td>
<td>-0.00525</td>
<td>-0.00671</td>
<td>-0.00405</td>
<td>-0.00266</td>
</tr>
<tr>
<td></td>
<td>(0.0009)</td>
<td>(0.00117)</td>
<td>(0.00096)</td>
<td>(0.00056)</td>
<td>(0.01144)</td>
</tr>
<tr>
<td></td>
<td>Pre-Post Difference</td>
<td>-0.00095</td>
<td>-0.00181</td>
<td>-0.00232</td>
<td>0.00051</td>
</tr>
<tr>
<td></td>
<td>(0.00127)</td>
<td>(0.00168)</td>
<td>(0.00143)</td>
<td>(0.00089)</td>
<td>(0.00861)</td>
</tr>
<tr>
<td></td>
<td>Pre-Post Difference</td>
<td>-0.0008</td>
<td>-0.00098</td>
<td>-0.0018</td>
<td>0.00082</td>
</tr>
<tr>
<td></td>
<td>(0.0016)</td>
<td>(0.00213)</td>
<td>(0.0018)</td>
<td>(0.00112)</td>
<td>(0.01114)</td>
</tr>
</tbody>
</table>

Source: 1996-2016 CMS Hospital Cost Reports and Medicare Impact Files linked to the Health Resources and Services Administration 340B provider list. The sample includes nonprofit and public general acute care hospitals with a CMS urban designation and at least 100 bed days available.
Table 4: Differences in Characteristics of Probable Manipulators and Non-Manipulators

<table>
<thead>
<tr>
<th></th>
<th>Participants with adjusted DSH patient percentages never exceeding 13.75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offers Inpatient Psychiatric Care</td>
<td>-0.117 (0.048)</td>
</tr>
<tr>
<td>Offers Outpatient Psychiatric Care</td>
<td>-0.159 (0.048)</td>
</tr>
<tr>
<td>Offers Emergency Psychiatric Care</td>
<td>-0.071 (0.051)</td>
</tr>
<tr>
<td>Offers Dental Care</td>
<td>-0.118 (0.046)</td>
</tr>
<tr>
<td>Offers AIDS Care</td>
<td>-0.081 (0.052)</td>
</tr>
<tr>
<td>Offers Trauma Care</td>
<td>-0.089 (0.050)</td>
</tr>
<tr>
<td>Offers Inpatient/Outpatient Drug Treatment</td>
<td>0.110 (0.057)</td>
</tr>
<tr>
<td>Competes with For-Profits</td>
<td>-0.050 (0.048)</td>
</tr>
<tr>
<td>Herfindahl Index</td>
<td>0.254 (0.078)</td>
</tr>
<tr>
<td>Public Ownership</td>
<td>-0.120 (0.053)</td>
</tr>
</tbody>
</table>

Source: 1996-2016 CMS Hospital Cost Reports and Medicare Impact Files linked to the Health Resources and Services Administration 340B provider list and American Hospital Association Member Surveys (N=379). The sample is limited to 340B DSH hospitals with adjusted DSH patient percentages that never exceed 13.75% (manipulators) and those that have adjusted DSH patient percentages that never exceed 15.75% (comparison group). Inpatient, outpatient, and emergency psychiatric care, dental care, AIDS care, trauma care, inpatient or outpatient drug treatment care are defined as offer the service at the hospital facility as reported in the American Hospital Association member survey (2002-2015). Competes with for-profits is defined as having at least one for-profit within the hospital service area. The Herfindahl index is defined as the sum of the squared market share of total facility beds. Public ownership is defined as state, federal or local hospitals. Each estimate is generated using a probit model with a dependent variable equal to manipulator status (1 if 11.75%-13.74% and 0 if otherwise). Marginal effects and standard errors using the delta method are presented.
### Appendix 1: Sample Selection

<table>
<thead>
<tr>
<th>Step</th>
<th>Criterion</th>
<th>Number</th>
<th>Unique Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Starting Sample</td>
<td>131,416</td>
<td>9514</td>
</tr>
<tr>
<td>1</td>
<td>Exclude non-general acute care hospitals</td>
<td>85,818</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Exclude reports that aren't the most recent</td>
<td>84,157</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Exclude hospitals with reports representing &gt;1 year</td>
<td>79,025</td>
<td>5619</td>
</tr>
<tr>
<td>4</td>
<td>Exclude hospitals that are missing geographic information and U.S. territories</td>
<td>77,671</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Exclude for-profits</td>
<td>61,955</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Exclude hospitals that ever have a specific designation</td>
<td>39,908</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Exclude hospitals that change urban status</td>
<td>35,716</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Exclude Rural hospitals</td>
<td>31,803</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Exclude hospitals with less than 100 bed days available</td>
<td>23,417</td>
<td>1533</td>
</tr>
<tr>
<td>10</td>
<td>Exclude hospitals missing information on the dependent variables</td>
<td>17,824</td>
<td>1379</td>
</tr>
<tr>
<td>11</td>
<td>Exclude hospitals that started before 2000 or after 2011</td>
<td>13,429</td>
<td>1105</td>
</tr>
<tr>
<td></td>
<td><strong>Final Sample for distribution and hazard estimates</strong></td>
<td><strong>23,417</strong></td>
<td><strong>1533</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Final Sample for within-hospital analysis</strong></td>
<td><strong>13,429</strong></td>
<td><strong>1105</strong></td>
</tr>
</tbody>
</table>

Source: CMS Hospital Cost Reports. From an original sample of 131,416 hospitals in the cost report data for federal fiscal years 1996-2016, we limit our sample to general acute care hospitals, which are identified using the last four digits of the CMS hospitals identifier (0000-0879) following the CMS Manual Processing System. We eliminated duplicate cost reports by selecting the most recently processed cost report for each hospital’s fiscal year and eliminated hospitals with cost reports that represent more or less than one year. We also excluded hospitals that could not be matched to a health services area, including those from the U.S. territories (American Samoa, Guam, Marianas Islands, Puerto Rico, or U.S. Virgin Islands). In our main results, we excluded hospitals that were ever designated rural referral centers, Medicare dependent hospitals, or sole community hospitals, as well as non-CMS urban designated hospitals and hospitals with less than 100 total bed days available because these hospitals have alternative adjustments to the DSH patient percentage, alternative criteria for eligibility for 340B, or both. We also excluded hospitals that change CMS urban status over our sample period. Finally, we excluded for-profit hospitals because they are not eligible for 340B. For our within-hospital trend break estimates, we further limited the sample to those that do not have any missing values for the adjusted DSH patient percentage, its components, labor and delivery expenditures, or the Medicaid fraction of total days measured for statistical purposes. Additionally, we limited to hospitals that began participating between 2000 and 2011 because this allowed us to observe six full years before and six full years after hospitals began participating in 340B.
Appendix 2: Density Estimates, 1 percentage point bins

Source: CMS Hospital Cost Reports linked to the 340B Provider List and Medicare Impact Files. Appendix 1 re-estimates the DeGeorge et al (1997) method to estimate discontinuities in the density of the adjusted DSH patient percentage in one percentage point bins as opposed to two percentage point bins. The red line indicates the eligibility cutoff for 340B and the rank of the discontinuity just above the cutoff is printed above the bar.
Appendix 3: Density Estimates, Recoded Adjusted DSH Patient Percentage

Source: CMS Hospital Cost Reports linked to 340B Provider List and Medicare Impact Files. Appendix 3 reproduces the DeGeorge et al. (1997) method to estimate discontinuities in the density of the adjusted DSH patient percentage in two percentage point bins for not just urban hospitals with 100 or more total bed days available, but also for rural and small hospitals. To include these hospitals in the analysis, we recoded the adjusted DSH patient percentage using the statutory formula and disregarding caps, following Desai and McWilliams (2018). The red line indicates the eligibility cutoff for 340B and the rank of the discontinuity just above the cutoff is printed above the bar.
Appendix 4: Trend Break Estimates, Recoded DSH Adjusted Patient Percentage

<table>
<thead>
<tr>
<th></th>
<th>Hospital, Year FE</th>
<th>Hospital, Year FE, + Controls</th>
<th>Hospital, StateXYear FE, + Controls</th>
<th>Hospital, StateXYear FE, + Controls</th>
<th>Above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>0.00859</td>
<td>0.00842</td>
<td>0.00826</td>
<td>0.00122</td>
<td></td>
</tr>
<tr>
<td>Period X Post</td>
<td>-0.00668</td>
<td>-0.00654</td>
<td>-0.00689</td>
<td>-0.00173</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.00098</td>
<td>0.00098</td>
<td>0.00099</td>
<td>0.00161</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11434</td>
<td>11434</td>
<td>11434</td>
<td>3706</td>
<td></td>
</tr>
</tbody>
</table>

Source: CMS Hospital Cost Reports linked to the 340B Provider List and Medicare Impact Files. Appendix 4 reestimates the trend break analysis for not just urban and large hospitals but also hospitals with less than 100 total bed days available and hospitals with a non-urban CMS designation. For these hospitals we use the statutory formula for the adjusted DSH patient percentage, disregarding caps on the adjustment, following Desai and McWilliams (2018).