Does Market Power Encourage or Discourage Investment? Evidence from the Hospital Market

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ABSTRACT

Does market power encourage or discourage investment? This is an open question due to theoretical ambiguity and empirical difficulties. The answer to this question is particularly important in the hospital market, where market power has increased dramatically since the 1990s. To answer this, we exploit an investment tax shock and data on the universe of US hospitals. We find a negative relationship between competition and investment. In particular, hospitals in concentrated markets increased investment by 6.4% ($2.7 million) more in response to tax incentives than firms in competitive markets. Further, firms' investment responses monotonically increased with market concentration.

Keywords : Market concentration, oligopoly and other imperfect markets, nonprofit, corporate investment, business taxes, hospitals

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1. Introduction

The effect of market concentration on investment is a classic question in economics. Theoretical investigations have yielded models with conflicting predictions (Schumpeter, 1942; Gilbert, 2006; Cohen, 2010; Sacco and Schmutzler, 2011). On the one hand, competition can deter investment by lowering monopoly profits (Salop, 1979; Dixit and Stiglitz, 1977). On the other hand, competition can spur investment depending on whether the underlying market competition is one of strategic complements or substitutes (Fudenberg and Tirole, 1984; Vives, 2008). These different predictions amplify the importance of empirical evidence within industries.

Hospitals are a particularly interesting industry to investigate the relationship between market concentration and investment because the hospital market has undergone a massive consolidation since the mid-1990s. In the last fifteen years, there have been more than 1,000 mergers, which has led to a substantial increase in the Herfindahl-Hirschman Index (HHI) (Martin and Town, 2012). In this paper, we exploit a quasi-natural experiment created by a tax policy change and unique features of the hospital market to identify the relationship between competition and tangible capital investment.

An ideal experimental setting would randomly alter the incentives for hospital investment across concentrated and competitive markets. We exploit a tax policy change and the fact that the hospital industry is split between for-profit and nonprofit hospitals to create a nearly ideal setting. In 2002, the US government changed the way that for-profit firms were able to deduct investment from their taxable income; this policy is known as bonus depreciation. This change created an incentive for for-profit firms to increase investment by lowering their user cost of capital. This incentive was not directly relevant for nonprofit hospitals because nonprofit hospitals are not subject to income taxation. Therefore, we use the introduction of

bonus deprecation as an exogenous increase in the incentive for for-profit hospitals to invest, where nonprofit hospitals serve as a natural control group.

We find a negative relationship between competition and investment. Specifically, for-profit hospitals in concentrated markets increased investment by 6.4% ($2.7 million) more than hospitals in competitive markets between 2002 and 2004. Moreover, we find that the impact of competition on investment monotonically increases with market power. Said differently, bonus depreciation is most impactful in inducing hospital investment in the most concentrated markets. This evidence suggests that while an increase in market concentration may decrease consumer welfare through higher markups, it may also increase welfare through higher investment in innovation, quality, and cost reductions.

Our empirical evidence uses three dimensions of variation. First, the marginal cost of capital investment for taxable firms is reduced by bonus depreciation in 2002. Second, the hospital market is comprised of for-profit and nonprofit hospitals, and only the former was eligible for the investment tax incentive. Third, there are 306 separate hospital markets in the US with market concentrations that range from 166 HHI to 8,849 HHI.[1] To break the link between investment and market concentration, we measure concentration within markets in 1996, five years before the introduction of the investment tax incentive. The implementation of the investment tax incentive provides plausibly exogenous variation in the incentive to invest across time. Variation across hospital type (for-profit and nonprofit) and markets (concentrated and competitive) allow us to net out differences across time, hospital type, and market concentration. Nonprofit and for-profit hospitals differ in some dimensions. Critically, however, a vast literature finds for-profit and nonprofit hospitals behave similarly along an extensive list of performance metrics (Dranove and Satterthwaite, 2000; Martin and Town, 2012; Adelino

[1] A hospital market is defined as a Hospital Referral Region (HRR) by the Dartmouth Atlas of Health Care. In 2002, the Department of Justice defined a market to be highly concentrated if it had an HHI greater than 1,800.

et al., 2015). Further, we find investment made by nonprofit hospitals looks similar to the investment made by for-profit hospitals before the policy change.

In addition, our evidence provides new insights into the debate on the effectiveness of investment tax incentives. As Hines (1998) asserts, "the apparent inability of tax incentives to stimulate aggregate investment spending is one of the major puzzles in the empirical investment literature." We propose an answer to this puzzle by identifying a new link between tax incentives and market concentration based on strategic incentives affecting corporate investment policies. Bonus depreciation was passed to boost investment during a recession. To plausibly control for the underlying trends in investment due to the macroeconomy, we exploit investment by nonprofit hospitals. Our finding that investment increases in concentrated markets due to bonus depreciation reconciles mixed empirical results in the literature (Cohen and Cummins, 2006; House and Shapiro, 2008; Zwick and Mahon, 2017). Previous attempts have relied on cross-industry variation, a mechanism that conflates the endogeneous relationship between competition and investment. We replicate previous findings when we fail to account for this relationship.

The heterogeneous investment response that we find across markets of different competitive pressures has implications for tax policy evaluation and implementation. For example, the federal government spent $30 billion in implementing bonus depreciation in the first year of the program. This expenditure was among the top ten expenditures for the federal government in 2003. Our evidence suggests that most of this cost was infra-marginal and that tagging policies to market characteristics, potentially by market concentration, could increase investment per dollar spent in a way that boosts the effectiveness of the fiscal stimulus.

The rest of this paper proceeds as follows. We provide background on the hospital market, the policy change we exploit as a natural experiment (bonus depreciation), and a review of previous work studying concentration and investment in section 2. We discuss our data and

identification in section 3. Section 4 reports our evidence on whether competition encourages or discourages investment. We provide evidence of our identifying assumption and sensitivity of results in section 5. Section 6 provides a discussion of how investment is affected by market power and tax incentives and section 7 concludes.

2. Background: Hospitals, Bonus Depreciation, Competition, and Investment

In this section, we outline the basic features of the hospital industry and the industrial organization of hospital care, both of which lend themselves to a clean empirical setting in which we investigate the relationship between market power and investment. In addition, we review theoretical models and empirical studies of the relationship between competition and investment. Finally, we provide a background on the specifics of the investment tax credit that we exploit for empirical identification of the relationship between competition and investment.

2.1. The U.S. Hospital Market

There are approximately 6,000 hospital facilities in the U.S., spanning the geography of the U.S. roughly in proportion to population. Unlike many other industries, the hospital industry is dominated by the nonprofit ownership form: roughly two-thirds are nonprofit, and the remainder is split between for-profit and government ownership (Bayindir, 2012; Capps et al., 2017). Nonprofit entities do not have shareholders and are not permitted to distribute accounting profits to controlling individuals. In exchange for an exemption from federal income

tax and most local property taxation, these hospitals are required to provide a "community benefit," the details of which are captured as part of their annual federal tax filings.[2]

There is a deep theoretical literature exploring theories of nonprofit ownership, although there is no unified consensus on the exact nature of nonprofit governance. Early literature examined the role of asymmetric information and risk as an explanation of the dominance of nonprofits in the health care sector (Arrow, 1963; Hansmann, 1980; Weisbrod, 1977). In addition, there is a variety of models for nonprofit behavior in which optimization depends upon a mix of profit, quality, quantity, and social welfare maximization. In a seminal and often-cited work, Newhouse (1970) suggests that nonprofits maximize a convex combination of quality and quantity conditional on a zero-profit constraint. A competing theory is that nonprofits are merely for-profits "in disguise," operating according to a for-profit objective function (Pauly and Redisch, 1973; Hirth, 1997, 1999).

Given the lack of coalescence in defining the objective function of nonprofit entities, empirical work provides crucial insight into any differential behavior of nonprofit hospitals. To this end, there is a deep empirical literature studying hospital ownership, focusing on financial outcomes and performance (Sloan, 2000), quality of care (Keeler et al., 1992; Sloan et al., 2001), and the provision of uncompensated or charitable care (Duggan, 2000; Capps et al., 2017). Broadly, the empirical literature finds little evidence of differential behavior across hospital types. Focusing explicitly on the impact of hospital competition on prices narrows in on a rich literature that harnesses the substantial industry consolidation in conjunction with variation in ownership forms. The overwhelming conclusion of these studies finds no difference in pricing behavior of nonprofit and for-profit hospitals; both hospital types respond to a relaxation of competitive pressure by increasing prices (Capps et al., 2003; Gaynor and Vogt, 2003; Dranove and Ludwick, 1999; B.Keeler et al., 1999; Melnick et al., 1999; Krish-

[2] See IRS Form 990 Schedule H.

nan, 2001; Haas-Wilson and Garmon, 2011; Tenn, 2011; Thompson, 2011a; Duggan, 2002; Horwitz and Nichols, 2009).[3]

At a high level, horizontal competition among providers can be summarized reasonably well under a model of monopolistic competition with product differentiation based on quality attributes (Dranove and Satterthwaite, 2000). Traditional models of competition have been updated to capture several unique institutional features of health care markets. Precisely, these models capture dynamics related to contract negotiation between insurers and providers, elements of competition across insurers for patients, and the ultimate choice of provider once a patient realizes an adverse health event. These elements are jointly captured in a three-stage model outlined by Martin and Town (2012) and based on work by Town and Vistnes (2001); Capps et al. (2003); Gaynor and Vogt (2003); Haas-Wilson and Garmon (2011); Lewis and Pflum (2015).[4] This model predicts that equilibrium hospital prices are increasing in costs, bargaining ability, and competitor's pricing.

Our empirical strategy builds on this hospital literature to investigate the impact of competition on investment. First, based on prior empirical evidence, we identify nonprofit hospitals as a potential control group in terms of investment behavior. We employ statistical tests to support the hypothesis that nonprofit and for-profit hospitals have similar investment trends. Second, a deep theoretical literature supports the hypothesis that hospitals act strategically, these strategic actions are likely to influence investment and innovation, and the sign and magnitude of this strategic effect are ambiguous. As a result, we must rely on empirical evidence to determine the sign of the relationship between competition and investment. Finally, the empirical literature demonstrates that there is considerable cross-sectional variation in con-

[3]Several sources for detailed literature reviews include Sloan (2000), Martin and Town (2012), and Gaynor et al. (2015).

[4]In this model, long-run hospital competition is based on a multi-stage game: first, hospitals negotiate with insurers over network inclusion and reimbursement pricing; second, patients opt into insurance networks, and finally patients realize illness shocks and choose among the hospitals in their network.

centration across markets. These features make the hospital industry an ideal industry to study the impact of competition on investment.

2.2. The Impact of Competition on Investment

The relationship between investment and competition has been a fundamental question in economics. Schumpeter (1942) motivated a large empirical literature to investigate his claim that competitive markets dampen investment by decreasing future rents in the industry. Canonical models of competition in industrial organization predict that competition can deter investment—particularly in innovation—because, for example, competition lowers monopoly profits (Salop, 1977; Dixit and Stiglitz, 1977).[5] On the other hand, a large game-theoretic literature considers the relationship between competitive intensity and investment in a two-period setting, generally finding the relationship to be ambiguous depending on the oligopolistic nature underlying the market in question (for example, strategic complements or substitutes) (Fudenberg and Tirole, 1984; Aghion et al., 2005; Gilbert, 2006; Vives, 2008; Sacco and Schmutzler, 2011). The ambiguity of these predictions underscores the importance of empirical estimation.

Our investigation of tangible capital investment complements a deep empirical literature that focuses on the relationship between competition and innovation.[6] In this literature, there is no clear consensus. Work by Geroski et al. (1995), Nickell (1996), Blundell and Van Reenen (1999), and Carlin et al. (2004), for example, finds a positive relationship between concentration and innovation. However, the relationship between competition and investment is endogenous because investment is one of the strategies by which incumbent firms maintain market power. To overcome this, Levin (1988), Aghion et al. (2005), and Hashmi (2016) provide

[5]The theoretical prediction that competition dampens investment is also found by Romer (1990); Aghion and Howitt (1992); Grossman and Helpman (1991) in the endogenous growth literature.

[6]For surveys of the empirical literature see: Cohen and Levin (1989); Gilbert (2006); Cohen (2010).

compelling evidence using instrumental variables that account for the endogeneity of market structure and find a negative relationship between competition and innovation. Recent work by Hashmi (2016) uses a structural model that can explicitly incorporate the evolution of market structure and finds a positive relationship. The lack of consistent evidence suggests there is value to new estimates using different methods.

Finally, there is a recent literature that considers how competition affects investment using insights from real-option theory (Caballero, 1991; Leahy, 1993; Dixit et al., 1994; Grenadier, 2002; Trigeorgis, 1996; Novy-Marx, 2007). Bulan et al. (2009) find that the option to delay irreversible investment is eroded by competition in the market of condominiums. Bontempi et al. (2010) find that competition decreases the effect of uncertainty on investment decisions in the Italian manufacturing sector.

2.3. Investment Tax Incentive: Bonus Depreciation

In 2001, Congress enacted an investment tax incentive known as bonus depreciation that changed how firms deduct capital investments from taxable income. Before 2001, when a firm made a capital investment, it was allowed to deduct the cost from its taxable income according to a class-life dependent depreciation schedule (MACRS). Bonus depreciation accelerates the depreciation schedule beyond MACRS, which allows firms to deduct a larger portion of their investment in the year they make the investment. This policy, therefore, lowers the marginal cost of investment. We analyze the period immediately following the introduction of bonus de-

preciation, 2002 to 2004, as a quasi-natural experiment to examine the associated investment responses.[7,8,9]

We combine the introduction of bonus depreciation and the industrial organization of the hospital market to provide insights into the relationship between investment and competition and to test the effectiveness of tax incentives. The introduction of bonus depreciation provides an exogenous shock to the user cost of capital that is limited to for-profit hospitals after 2002. In particular, the timing of taxable income deductions for tangible capital investment was accelerated under bonus depreciation. Nonprofit hospitals, however, are not taxable and, therefore, are not directly affected by adjustments to taxable income like investment tax incentives. This shock to the user cost of capital is ideal because it is orthogonal to market concentration. This is especially true when we measure market concentration based on levels in 1996—five years before the introduction of bonus depreciation. Moreover, nonprofit hospitals allow us to explore the effectiveness of investment tax incentives by controlling for time-varying trends in investment that would otherwise occur across markets.

3. Empirical Design and Data Collection

We use the quasi-natural experiment produced by the introduction of bonus depreciation and the unique features of the hospital market to identify a clean test of how corporate investment is affected by market concentration. This test also provides insight into the effectiveness of in-

[7] Kitchen and Knittel (2016) provides a detailed review of the implementation of bonus depreciation.

[8] An illustrative example of the mechanics of bonus depreciation and a brief legislative background are provided in Appendix Section B.

[9] We limit our analysis to the first period of bonus depreciation 2002 to 2004 because of several complications to causal inference in later periods. Specifically, bonus depreciation has been available to businesses for all but three years during the period 2002-2017 through an annual extension. The near-continuous extension of this investment incentive has eroded its "temporary" nature. Further, the second wave of bonus depreciation legislation began in response to the severe economic downturn in 2007, complicating the identification of causal investment impacts.

vestment tax incentives. Section 3.1 documents the source of hospital investment data, including our identification of hospital investment. Section 3.2 explains our difference-in-differences empirical strategy that exploits the variation in tax incentives across time and tax status across hospitals to identify the impact of investment tax incentives. Section 3.3 describes our strategy for identifying hospital markets, and Section 3.4 explains our triple differences empirical strategy that exploits variation across markets to determine the relationship between competition and investment.

3.1. Hospital Data

We assemble a panel of facility-level hospital microdata from 1998 to 2004 from the Healthcare Cost Report Information System (HCRIS), which is administered and maintained by the Centers for Medicare and Medicaid Services (CMS). This dataset has several unique features that make it advantageous for studying investment responses to tax incentives. First, these data distinguish between investment that is and is not eligible for the tax incentive. Specifically, parts I and II of Worksheet A-7 require hospitals to document annual investment and capital stocks broken down by land (not eligible), buildings and fixtures (not eligible), and fixed and movable equipment (eligible).[10] Second, this data set includes all Medicare-certified hospitals in the United States, which is the near universe of hospitals.[11]

We refine these data in several ways. First, we collect data on Certificate of Need (CON) laws, which were put in place in the 1960s and 1970s to curb wasteful health care spending and

[10] Part I identifies new capital, and Part II identifies old capital, where old capital is defined as put in service before 1991. We combine data on old and new capital. Lines 1 through 4 are defined as structures, and lines 5 and 6 are defined as equipment.

[11] Hospitals report on Worksheet S-2 their facility type. We drop control types 7-13, which we classify as government hospitals, from this analysis. Note that VA Hospitals are not included in the HCRIS database.

may introduce frictions to the typical investment process.[12] Second, we restrict the sample to hospitals that report investment between 1998 and 2004. This refinement is required due to a temporary relaxation in capital disclosure requirements within HCRIS that was coincidentally made during a subset of our window of analysis. Our results are robust to removing this restriction by weighting the refined sample to look like the full population of hospitals in years before the reporting change. We provide a thorough comparison of our sample to the universe of hospitals in Appendix C.1.

To analyze hospital capital investment, we require detailed capital accounting data, which is uniquely available in the HCRIS database. We take a three-pronged approach to assess the quality of the HCRIS data in Appendix D. For example, HCRIS and the California Office of Statewide Health Planning and Development (OSHPD) both report financial and utilization data. We confirm the validity of the HCRIS data in Appendix D.1 by matching the OSHPD data along an alternative reporting dimension. Next, we review the literature on HCRIS financial reporting in Appendix D.2, finding no evidence of a systematic misreporting of capital accounting data. Finally, we review the legal disclosure requirements associated with the Medicare Cost Report Appendix D.3. Taken together, we are reassured that the quality of the HCRIS capital data is sound.

Table 1 provides descriptive statistics for our sample in 1998, 2000, 2002, and 2004. The average hospital held roughly $29 million in assets throughout the window. In 2000, the average hospital had 2,019 discharges and employed 282 full-time equivalent employees. The average hospital held $35 million in capital and invested approximately 6% of its capital stock.

Insert Table 1 about here.

[12] Certificate of Need laws require a hospital to get approval from a state before undertaking a broad class of investment, including infrastructure and significant investments in equipment (for more information see Salkever (2000)).

3.2. Double Difference: Tax Incentives to Invest

The first step in our empirical analysis is to test whether investment tax incentives increase investment. To do this, we use variation in time (before and after a policy change) and across organization types (for-profit and nonprofit hospitals). Our dependent variable is the log of new equipment investment, $log(I_{i,t})$, which we refer to below as simply investment.[13] We focus on new equipment investment because it is the only type of investment eligible for the tax incentive.[14]

We use a difference-in-differences empirical design that controls for differences across time (e.g., macroeconomic fluctuations) and across for-profit and nonprofit hospitals using time fixed effects λ_t and an indicator variable that equals one for for-profit hospitals and zero otherwise, $\mathbb{1}(\text{for-profit})$. Some specifications control for hospital specific covariates, $\mathbf{x}_{i,t}$, such as assets and net income, and market specific coefficients $\mathbf{z}_{i,t}$, such as the fraction of the market that is nonprofit and region fixed effects. The difference-in-differences estimate, β_1, is the coefficient on the indicator variable $DD_{i,t} = \mathbb{1}(\text{for-profit}) \times \mathbb{1}(\text{post-2002})$, which equals one for for-profit hospitals after 2002 and zero otherwise, giving the specification:

$$log(I_{i,t}) = \beta_0 + \beta_1 DD_{i,t} + \lambda_t + \eta \mathbb{1}(\text{for-profit})_i + \delta' \mathbf{x}_{i,t} + \gamma' \mathbf{z}_{i,t} + \varepsilon_{i,t}. \quad (1)$$

This empirical strategy relies on the assumption of common trends in the equipment investment of nonprofit hospitals and for-profit hospitals. As we have previously outlined, a deep empirical literature examining the behavior and performance of nonprofit and for-profit hospitals finds little evidence of differential behavior. For example, Adelino, Lewellen and

[13] The results are the same if we scale investment by assets, capital, or other firm size measures, which we use as controls. We chose this baseline specification because using size variables as controls is a more flexible empirical specification than scaling investment.

[14] Investment is transformed so that all values are positive. The results are similar when we use a Tobit model to account for the censored nature of investment, see Table A.5.

Sundaram (2015) find that nonprofit hospitals have similar investment frictions as for-profit hospitals. Similarly, Horwitz (2003) and Horwitz and Nichols (2009) show that nonprofit hospitals perform similarly to for-profit hospitals along a variety of financial metrics. We find statistical support of this assumption, which we describe in detail in Section 5.2. We also loosen this assumption in three ways. First, we model dynamic differences between nonprofit and for-profit hospitals directly by adding for-profit by year fixed effects. Second, we use a synthetic control method, described in Section 5.3, that weights nonprofit hospitals to look like for-profit hospitals. Finally, we use additional variation across markets in a triple differences specification, described below.

We address concerns of auto-correlated errors driven by the panel nature of our data by clustering at the firm level (Bertrand et al., 2004). Appendix C.5 also reports estimates clustered at the market level. All estimates remain statistically significant.

3.3. Market Data

To analyze the link between market concentration and tax incentives, we need a measure of competition that each firm faces. We overcome several empirical hurdles typically faced in this literature. First, the definition of market boundaries is of critical importance to any exposition of market structure. The ambiguity of optimal market definitions has played an integral role in the outcome of regulatory hospital merger challenges in the past decade (Garmon, 2017; Gaynor and Pflum, 2017). Potential geographic market definitions include Hospital Referral Regions (HRR), Hospital Service Areas (HSA), and Metropolitan Statistical Area (MSA). The Dartmouth Atlas of Health Care defines 306 hospital referral regions, which, "represent[s] regional health care markets for tertiary medical care that generally requires the services of a major referral center. The regions were defined by determining where patients were referred

for major cardiovascular surgical procedures and for neurosurgery." Hospital referral regions are well-supported in the empirical literature, are a relatively conservative measure from the perspective of merger analysis, and are directly appropriate for high-acuity services (Garmon, 2017; Cutler and Morton, 2013; Kilaru et al., 2015). For these reasons, we follow the empirical literature and use hospital referral regions for our baseline estimates. We also report estimates using hospital service areas to ensure that this decision does not drive our results.

Second, market concentration is endogenous to other decisions such as investment. To overcome this, we exploit an exogenous shock to investment caused by a tax policy change in 2002, and we measure market concentration based on their 1996 levels. This measure allows us to ensure that investment decisions after 2002 do not affect market concentration. As an additional test of sensitivity, we also measure market concentration as of 2000 and find the estimates are robust.

Third, a hospital's market share can be measured at the facility level or system level. The correct measure is at the level of investment decisions, which is some mix of the two. Fortunately, market concentration, when measured at the hospital level, is highly correlated with market concentration measured at the system level. We use market share at the facility level, defined as the facility-share of total market discharges. This measure is conservative; by ignoring system affiliation, it is necessarily a lower bound on concentration within a market. Moreover, this measure biases us against finding a nonzero result because it adds noise to our measure. We are able, however, to check whether lowering the threshold for defining a concentrated market impacts our results. The Department of Justice defined a market to be highly concentrated if its Herfindahl-Hirschman Index (HHI) was greater than 1,800 during this period. We report estimates using HHIs between 1400 and 2,200 and find that the effect is monotonic, which alleviates some concerns about market boundary and market-level definitions.

Figure 1 maps the 306 hospital referral regions across the United States, where more concentrated markets are shown in a darker blue. Across markets, in our sample, 50% are concentrated, with an average HHI of 3,171 in concentrated markets and 1,058 in competitive markets. These markets are spread across the country with concentrated markets in both urban and rural settings and all regions of the United States.

Similarly, Figure 2 maps the percentage of nonprofit hospitals in each market, where markets with a larger percentage of for-profit hospitals are shown in a darker blue. These markets are spread across the country, with slightly more markets with a high percentage of for-profit hospitals in the south. Because investment is a strategic outcome, there are indirect spillover effects that impact both for-profit and nonprofit hospitals. To allow the spillover effects to differ for for-profit and nonprofit hospitals, we add a control for the percentage of the market that is nonprofit. Our difference-in-differences design, therefore, isolates the direct effect that affects only for-profit hospitals.

We control for several other observable characteristics, including whether the hospital is in an urban area, the number of teaching hospitals, and whether the hospital is subject to certificate of need regulations.

Insert Figure 1 and Figure 2 about here.

3.4. Triple Difference: Does Market Concentration Encourage Investment

To precisely estimate the relationship between market concentration and investment, we extend our empirical analysis by using variation across markets with different levels of market

concentration. As in the difference-in-differences specification, the dependent variable of interest in the triple differences specification is the log of equipment investment. The triple differences empirical specification interacts the difference-in-differences indicator with an indicator variable that equals one for hospitals in concentrated markets and zero otherwise, $DDD_{i,t} = DD_{i,t}\mathbb{1}(\text{concentrated})$, where market concentration is defined in 1996. The triple differences specification controls for differences across time and for-profit and nonprofit hospitals using time fixed effects, λ_t, and an indicator variable that equals one for for-profit hospitals and zero otherwise, $\mathbb{1}(\text{for-profit})$. The triple differences specification also controls for differences across markets before and after 2002 and between nonprofit and for-profit hospitals using indicator variables for being in a concentrated market, being in a concentrated market after 2002, and being in a concentrated market as a for-profit hospital as controls in $\mathbf{z}_{i,t}$:

$$\begin{aligned} log(I_{i,t}) = {} & \beta_0 + \beta_1 DD_{i,t} + \beta_2 DDD_{i,t} \\ & + \beta_3 \mathbb{1}(\text{concentrated})_i \times Post_t + \beta_4 \mathbb{1}(\text{for-profit})_i \times \mathbb{1}(\text{concentrated})_i \\ & + \lambda_t + \eta_1 \mathbb{1}(\text{for-profit})_i + \eta_2 \mathbb{1}(\text{concentrated}))_i + \delta' \mathbf{x}_{i,t} + \gamma' \mathbf{z}_{i,t} + \varepsilon_{i,t}. \end{aligned} \tag{2}$$

The coefficient β_1 captures the tax incentive to invest. The coefficient β_2 captures the additional investment response to tax incentives in concentrated markets, which captures the link between market concentration and tax incentives to invest. By exploiting the implementation of an investment tax incentive through a triple differences specification, we avoid the underlying endogeneity between competition and investment. Specifically, our identification strategy allows market structure and investment incentives to be correlated. The implementation of bonus depreciation provides a shock to investment incentives that is exogenous to

market concentration. All investment incentives other than the tax change that may be correlated with market structure are netted out through the difference-in-differences comparison of nonprofit hospitals. Any difference in investment captured by the triple differences, therefore, is due to the interaction between the tax change and market concentration. In this way, we can determine whether market concentration amplifies or damps investment incentives.

4. Empirical Evidence

In this section, we present empirical evidence that identifies the impact of investment tax incentives and the relationship between competition and investment in the hospital industry. In Section 4.1, we describe and discuss the results that come from our primary difference-in-differences and triple differences specifications. Section 4.2 provides further evidence by varying the intensity of competition. In Section 4.3, we investigate the sensitivity of our results to alternative market concentration measures. Finally, section 4.4 provides further evidence by using different market definitions and measures of ownership structure.

4.1. Evidence on Whether Market Concentration Affects Investment

Table 2 reports firm investment responses in three samples to test the overall impact of investment tax incentives and whether market concentration affects investment. Columns (2), (4), and (6) include controls for discharges, assets, net income, the percentage of the market that is nonprofit, an indicator for urban markets, indicators for the certificate of need restrictions, local market concentration as measured by the HHI within smaller HSA markets, and region fixed effects. The final row reports the p-values from our common trends test, described in more detail in section 5.2.

Insert Table 2 about here.

Columns (1) and (2) report the investment response in all markets, omitting the possibility of heterogeneous responses due to the link between market concentration and tax incentives. When we fail to account for the differential impact by market concentration, the estimated effect of investment tax incentives is small and statistically insignificant. This evidence is consistent with earlier studies that failed to find an increase in investment due to the implementation of bonus depreciation when omitting the link between market concentration and tax incentives (see, e.g., Cohen and Cummins, 2006).

Columns (3)–(6) report evidence on firm investment responses across competitive and concentrated markets to test whether market power encourages or discourages investment.[15] The estimates of firm investment responses to tax incentives are small, negative, and statistically insignificant in competitive markets (columns 3 and 4). In concentrated markets (columns 5 and 6), however, the estimates of firm investment response to tax incentives are large, positive, and statistically significant at the 1% level based on a specification with control variables. These estimates suggest that tax incentives led to a 4.6% increase in equipment investment in concentrated markets, relative to for-profit investment in competitive markets: $e^{\beta_{DD}} - 1$.[16]

Table 3 reports estimates based on our triple differences specifications, providing a direct test of whether investment responses are larger in concentrated markets. As before, columns (2), (4), and (6) include hospital and market control variables. In our baseline specification, the triple differences estimate suggests that tax incentives led to a 6.2–6.4% (columns 1 and 2, respectively) increase in equipment investment in concentrated markets, relative to com-

[15] A market, defined by an HRR, is categorized as concentrated if it has an HHI greater than 1,800 in 1996 and is otherwise competitive. The results are robust to using different HHI thresholds to identify concentrated and competitive markets. These results are reported in Table 4.

[16] We also use a Tobit model to account for the lumpiness in investment, and our results are robust, see Table A.5.

petitive markets. In other words, we find a negative relationship between competition and investment in the hospital industry. The magnitude of this estimate implies that, on average, for-profit hospitals in concentrated markets increased equipment investment by $2.7 million in response to tax incentives, relative to competitive markets.[17] We include hospital facility fixed effects to control for confounding factors that are time-invariant at the facility level in columns (3) and (4). We include hospital market fixed effects to control for confounding factors that are time-invariant at the market level in columns (5) and (6). Our results are robust to these additional control variables, where we find that for-profit hospitals increase investment in concentrated markets by 4.3–5.1%, or $2.0-2.6 million[18].

Insert Table 3 about here.

The stark contrast in the investment responses between concentrated and competitive markets suggests that the effectiveness of investment tax incentives is differentially successful across the competitive landscape. Our results underscore the importance of taking market structure into account when evaluating tax policy. Our results also suggest the potential role for tagging policies to market characteristics to increase efficiency. We discuss these implications further in section 6.

4.2. Varying the Intensity of Competition

As we have previously highlighted, there is both a theoretical and empirical ambiguity as to the nature of the relationship between competition and investment. To further test this relationship in the hospital industry, we vary the HHI threshold that defines a concentrated

[17]The $2.7 million estimate comes from estimates using level specifications, reported in column 2 of Table A.2, which also shows our estimates are robust to a level specification.

[18]Columns 3–6, Table A.2

market. Specifically, we re-estimate the triple differences estimates varying the HHI threshold, as defined by the 1996 market structure, from 1,400 to 2,200.[19] These results are reported in Table 4.

Insert Table 4 about here.

Firms' investment responses to tax incentives in concentrated markets monotonically increase from 4.2% with a threshold of 1,400 to 7.1% with a threshold of 2,200, reported in columns (1)–(4) of Table 4.[20] This monotonic relationship, however, might be driven entirely by hospitals in the most concentrated markets. We further explore this by breaking down concentrated markets into subgroups and interacting these subgroups with our triple differences indicator variable. In particular, Column (5) divides concentrated markets in half (markets with an HHI $\in (1800, 2560)$ and markets with an HHI $>$ 2,560), and Column (6) divides concentrated markets in quarters. Both specifications reject a null hypothesis that the monotonic relationship is entirely driven by firms in the most concentrated markets. Instead, we see a negative monotonic relationship between competition and investment.

4.3. Sensitivity: Market Concentration Measures

We define market concentration in our baseline specifications based on market conditions in 1996, five years before the implementation of bonus depreciation. We use a lagged market measure to ensure that our empirical specification does not suffer from classic simultaneity

[19] Varying the HHI threshold also addresses a limitation to our market measurement that comes from a limitation of the HCRIS dataset: identification of hospital systems is not provided. This limitation will cause us to underestimate the HHI in any particular market because multiple hospitals can belong to the same hospital system.

[20] We report estimates using our triple-differences specification. Our findings are similar when we use a synthetic control.

bias between investment and market conditions. However, 1996 is in the heart of the 90s merger wave, which saw hundreds of hospital transactions and generally led to an increase in concentration in the industry as a whole. For this reason, we test the sensitivity of our results to this measure in two ways: (1) we measure HHI in 2000, which is near the end of the merger wave but is still before the implementation of bonus depreciation, and (2) we measure HHI contemporaneously through our analysis period. These results are shown in panels A and B, respectively, of Table 5.

These different measures of market concentration produce similar estimates to our baseline estimates. In particular, using the 2000-based measure, we find that investment increased for for-profit hospitals in concentrated markets by 6.2% (panel A, column 2), which is similar to our baseline estimate of 6.4% (Table 3 column 2) based on the 1996 HHI measure. Moreover, when we allow HHI to be defined contemporaneously, we estimated that investment increased by 6.1% (panel B, column 2). As before, these results are robust to the inclusion of facility or market fixed effects (columns 3–6), which control for other confounding factors.

Insert Table 5 about here.

4.4. Sensitivity: Market Definition and Ownership Structure

Our baseline estimates rely on HRR-based markets.[21] In addition to HRRs, Garmon (2017) highlights the possibility of defining a market according to the Dartmouth Atlas' Hospital

[21] We use HRRs in our baseline estimates for several reasons. First, they are similar to a hospital's 90% service area and are appropriate in the context of high-acuity services. Second, Kilaru et al. (2015) has shown that HSAs do not properly capture patient flows: for more than half of all HSAs, fewer than half of all hospital patients originated within the same HSA as the admitting hospital. Third, by relying on HRRs, which are geographically larger than HSAs, we bias ourselves against finding a negative relationship between competition and investment. This is mechanically true since HHIs when measured according to HSAs, will necessarily be larger than when measured according to HRRs. Fourth, we can control for the impact of local market pressures by including the HHI as measured within HSAs in our analysis.

Service Area (HSA). HSAs are a smaller geographic area and capture markets for low and medium acuity services. There are 306 HRRs in the U.S. compared to 3,436 HSAs. Column (2) of Table A.6 reports our estimate based on a triple differences specification when we use HSAs to define markets. As expected, when we rely on smaller geographic boundaries to define hospital markets, our results appear stronger. In particular, for-profit hospitals in concentrated HSA-based invest 10.2% more than in competitive HSA-based markets. This compares with a 6.4% increase based on our preferred HRR-based market definition (Column 1).

To test for sensitivity of our results to ownership structure, we measure market concentration that accounts for system ownership, as identified by the AHA 1996 survey. Columns (3) and (4) of Table A.6 report our estimate based on a triple difference specification for HRR-based and HSA-based markets, respectively. These results are similar to our baseline analysis; investment increases by 4.5% when markets are defined by HRR boundaries, and by 6.5% when HSA boundaries define markets.

The AHA survey is the only database that identifies system affiliation. However, these data are subject to important limitations: the AHA data infers hospital location from the mailing address provided by the administrator who completed the survey. This could lead to mis-identification of facility location whenever the administrator is not co-located with the hospital facility. This may be especially problematic for identifying the locations of multiple facilities within a hospital system. Since we use facility ZIP codes to assign hospitals to markets, any error in facility address reporting will lead to mismeasured market power.

5. Identification and Sensitivity

Our difference-in-differences model provides estimates by using within-group variation. This model removes bias from omitted variables that determine whether a hospital is a for-profit or nonprofit and whether a market is competitive or concentrated. Said differently, we recover the treatment effect even if there are level differences between groups. In our setting, reverse causality is a limited concern because investment after 2002 is unlikely to (1) determine ownership type (for-profit and nonprofit), which is determined before 2002, or (2) impact a market concentration measure that is determined in 1996. As usual in these models, the difference-in-differences coefficient captures the causal effect in the absence of omitted factors that cause differential trends between groups (Cameron and Trivedi, 2005).

5.1. Identifying Investment Responses: The Common Trend Assumption

All difference-in-differences specifications rely on the identifying assumption that treatment and control groups have common outcome trends, and in the absence of the policy change would have continued to have common trends. This assumption allows empirical researchers to identify the unobserved post-treatment outcome, absent the treatment. Differences-in-differences is particularly powerful because it effectively identifies firms' investment response even when the error term is not conditionally zero. This implies the investment effect is identified even when the coefficients on the mean and time effects are biased.

To formalize this point, consider our dependent variable, the log of equipment investment $log(I_{i,t})^j$, which is observed for nonprofit and for-profit hospitals, $j = \{0,1\}$ respectively, before and after the implementation of investment tax incentives, $t = \{0,1\}$. Following the notation of Cameron and Trivedi (2005), we define D^j, D_t, and D_t^j such that $D^j = 1$ if $j = 1$,

and $D^j = 0$ otherwise; $D_t = 1$ if $t = 1$, and $D_t = 0$, otherwise; $D_t^j = 1$ if both t and j equal 1, and $D_t^j = 0$ otherwise. We define the zero-mean constant-variance error term as $\varepsilon_{i,t}^j$. Our dependent variable then can be written as

$$log(I_{i,t})^j = \alpha + \alpha_j D^j + \alpha_t D_t + \beta D_{i,t}^j + \varepsilon_{i,t}^j. \tag{3}$$

The coefficient β captures the investment response of interest, which we refer to as the difference-in-differences coefficient. To make concrete the assumptions necessary to identify β, consider the outcomes for each of our four groups,

$$log(I_{i,1})^0 = \alpha + \alpha_t + \varepsilon_{i,1}^0 \tag{4}$$

$$log(I_{i,1})^1 = \alpha + \alpha_t + \alpha_j + \beta + \varepsilon_{i,1}^1 \tag{5}$$

$$log(I_{i,0})^0 = \alpha + \varepsilon_{i,0}^0 \tag{6}$$

$$log(I_{i,0})^1 = \alpha + \alpha_j + \varepsilon_{i,0}^1. \tag{7}$$

This derivation highlights that investment differs after 2002 by α_t, for for-profit hospitals by α_j, and for for-profit hospitals after 2002 by β. The coefficients α_j and α_t capture investment differences between non-profit and for-profit hospitals and over time, respectively. The impact of investment tax incentives on for-profit hospital investment is captured by β.

The difference-in-differences specification empirically isolates β by differencing outcomes across groups,

$$log(I_{i,1})^1 - log(I_{i,1})^0 = \alpha_j + \beta + \varepsilon_{i,1}^1 - \varepsilon_{i,1}^0 \tag{8}$$

and

$$log(I_{i,0})^1 - log(I_{i,0})^0 = \alpha_j + \varepsilon_{i,0}^1 - \varepsilon_{i,0}^0. \tag{9}$$

The level effect of changes in investment after 2002 is eliminated in the differences in equations (4) and (5). Similarly, the level effect of changes in investment for for-profit hospitals is eliminated by taking the difference *between* equations (8) and (9). The investment response captured by β is recovered by taking the difference between equations (8) and (9),

$$(log(I_{i,1})^1 - log(I_{i,1})^0) - (log(I_{i,0})^1 - log(I_{i,0})^0) = \beta + (\varepsilon^1_{i,1} - \varepsilon^0_{i,1}) - (\varepsilon^1_{i,0} - \varepsilon^0_{i,0}) \tag{10}$$

under the necessary identification assumption that $E[(\varepsilon^1_{i,1} - \varepsilon^0_{i,1}) - (\varepsilon^1_{i,0} - \varepsilon^0_{i,0})] = 0$. While this identifying assumption, known as the common trends assumption, is not directly testable, we provide a battery of tests that support this assumption and alleviate potential threats to identification.

In section 2.1, we reviewed a deep empirical literature examining the hospital market and, in particular, how hospital ownership impacts behavior. Broadly, this literature finds that for-profit and nonprofit hospitals act similarly across a variety of outcome measures including financial measures, efficiency measures, pricing behavior, and investment frictions (Sloan, 2000; Keeler et al., 1992; Sloan et al., 2001; Duggan, 2000; Capps et al., 2003; Gaynor and Vogt, 2003; Dranove and Ludwick, 1999; B.Keeler et al., 1999; Melnick et al., 1999; Krishnan, 2001; Haas-Wilson and Garmon, 2011; Tenn, 2011; Thompson, 2011a; Duggan, 2002; Horwitz and Nichols, 2009; Capps et al., 2017). These similarities suggest that trends in nonprofit hospital investment are a reasonable control for trends in investment of for-profit hospitals. In addition to this empirical literature, we next provide statistical evidence that supports the common trends assumption.

5.2. Statistical Evidence of Common Trends

To evaluate potential threats to identification, we use an event study analysis to investigate trends between groups before 2002. While a direct test of the identifying assumption is not possible, this standard approach alleviates some concern over potential confounding factors (Kahn-Lang and Lang, 2018). In the following event study, the year fixed effects, λ_t, capture the common trend between groups and the interaction of the year fixed effects and an indicator for being in the treated group, $\lambda_t \times \mathbb{1}(\text{treated})_i$, captures the differential trend,

$$log(I_{i,t}) = \beta_0 + \mathbb{1}(\text{treated})_i + \lambda_t + \lambda_t \times \mathbb{1}(\text{treated})_i + \varepsilon_{i,t}. \tag{11}$$

A failure to reject the null hypothesis that the coefficients on the interactions $\lambda_t \times \mathbb{1}(\text{treated})_i$ are jointly zero supports the common trend assumption. Specifically, finding common trends in the pre-period is evidence that there does not exist any shock before the policy change that differentially affects for-profit and nonprofit hospitals in a way that would conflate our difference-in-differences estimate. We run similar tests for our triple differences specifications, where the coefficient of interest is the interaction of year fixed effects and an indicator variable that equals one for for-profit hospitals in concentrated markets and zero otherwise. Figure 3 reports our test for common trends in our difference-in-differences and triple differences specifications. Panels A–C test for differential trends between for-profit and nonprofit hospitals in all markets (Panel A), competitive markets (Panel B), and concentrated markets (Panel C). Panel D tests for differential trends between for-profit hospitals in concentrated markets and for-profit firms in competitive markets and nonprofit hospitals in competitive and concentrated markets. Before 2002, the coefficients are all near zero and never statistically significant at the 95% level. In comparison, the coefficients after 2002 capture the treatment effect of the tax incentive—which increases for for-profit hospitals in concentrated markets

and not in competitive markets. Panels A–D add credibility to the common trend assumption in our setting by showing the absence of potential confounding factors before 2002.

Insert Figure 3 about here.

We formally test for common trends and report the p-values in Tables 2 and 3 for the difference-in-difference and the triple differences specifications, respectively. Specifically, we test that the coefficients on $\lambda_t \times \mathbb{1}(\text{treated})_i$ are jointly zero. For each specification in our baseline table, we fail to reject the null hypothesis of common trends. For example, we fail to reject that for-profit and nonprofit hospitals have common trends in all markets with p-values of 0.546 without controls and 0.921 with controls based on the difference-in-differences specification (Columns 1 and 2, Table 2) and with p-values of 0.526 and 0.924 based on the triple-difference specification (Columns 1 and 2, Table 3).

5.3. Relaxing Common Trends: Time Trends, Entropy Weights

In a series of other tests, we loosen the common trend assumption to investigate the sensitivity of the estimates. Table 6 reports these tests. Columns (1)–(4) adds for-profit hospital-specific linear and quadratic time trends; $\mathbb{1}(\text{For-Profit})_i \times t$ and $\mathbb{1}(\text{For-Profit})_i \times t^2$. The estimates are very similar to our baseline estimates, which suggest that other confounding factors are unlikely to explain our results.

Insert Table 6 about here.

Columns (5) and (6) use entropy weights proposed by Hainmueller (2012), which is "a generalization of the conventional propensity score weighting approach" (p. 31 Hainmueller

(2012)).[22] These specifications allow unobservable factors that are potentially correlated with our covariates to vary cross-sectionally. The advantage of this approach is that the investment response is identified even when there is substantial cross-sectional variation in the unobserved factors, as long as the investment response is within the convex hull of the control groups' predicted investment response.

Hainmueller (2012) states that the nonparametric balancing procedure, "exactly adjusts inequalities in representation with respect to first, second, and possibly higher moments of the covariate distribution." The procedure uses maximum entropy to balance covariates between control and treatment groups. We balance the mean and variance of discharges, liabilities, net income, the percentage of the market that is nonprofit, the number of teaching hospitals in a market, an indicator for urban markets, and indicators for the certificate of need restrictions between for-profit and nonprofit hospitals. Table A.7 in Appendix C.4 reports the balance of the observable factors using entropy weights. The similarity of these estimates to our baseline estimates suggests that unobserved differences between for-profit and nonprofit hospitals and competitive and concentrated markets cannot explain our results.

5.4. Placebo Test: Long-Lived Capital Investment

The placebo test reported in this section investigates our concern about potential confounding factors. Specifically, our concern that some confounding factor differentially affected for-profit hospital investment in concentrated markets relative to competitive markets and non-profit hospitals only after 2002.[23]

[22] Athey and Imbens (2017) in their review of applied econometrics state, "The synthetic control approach developed by Abadie et al. (2010, 2015) and Abadie and Gardeazabal (2003) is arguably the most important innovation in the policy evaluation literature in the last 15 years. This method builds on difference-in-differences estimation, but uses systematically more attractive comparisons."

[23] A specific example of a threat to identification would be if nonprofit hospitals all decreased investment after 2002 due to similar shocks to their endowments. If this was the case, then we should expect a similar decrease

Our data provides details on investment that allows us to run our analysis using investment in structures, which was not eligible for the tax incentive. If our results are identifying the investment response to the link between market concentration and tax incentives, and not other confounding factors, then we should expect to observe no differential change in structure investment.

Columns (7) and (8) of Table 6 reports the results of the placebo test. We find no evidence that for-profit firms differentially increased investment in structures after 2002. In contrast to the positive, large, and statistically significant triple differences estimates using equipment investment, the estimates using structure investment are negative, small, and not statistically significant.[24]

5.5. Caveats to the Empirical Evidence

In general, we can never rule out the possibility of a contemporaneous unrelated change that affected the control group or that a common change differentially affected the control group. While section 5 does provide a battery of tests that support the estimates, there are several limitations to the empirical design we employ that warrant further discussion.

Our study relies on a policy experiment that occurred during a mild recession in 2002. Popular and political discussion around this policy suggested that its objective was to create a macroeconomic stimulus. Since policymakers aimed to spur investment during what would have otherwise been a period of low investment, a plausible counterfactual is that investment levels would have decreased without the policy. Our analysis relies on a difference-

in structure investment as we saw in equipment investment. This placebo test, therefore, provides a crisp test of other potential conflating factors.

[24]The placebo test might be contaminated if the incentives to invest in structures are affected by investing in equipment. For example, additional investment in equipment may crowd out investment in structures. Additional equipment investment, however, may also encourage investment in structures if these two types of investments are complementary.

in-differences specification that includes year fixed effects to control for these types of time trends. To the extent, however, that these controls do not fully capture the time trends or that the time trends differentially affected for-profit and nonprofit firms, then this would confound our difference-in-differences estimates. Our triple-differences specifications account for differences in investment: (1) in competitive vs. concentrated markets; (2) for for-profit vs. nonprofit hospitals in concentrated markets; and (3) before vs. after the tax policy change in concentrated markets. Given that it is unlikely that the recession imposed a differential effect on particular hospital types in particular markets, the triple-difference approach likely mitigates the confounding influence of the recession on our results.

Additionally, changes in market power within the hospital industry or within industries that interact with the hospital industry could confound our results. For example, increased market power in the insurer market might simultaneously lead to hospital consolidation as a bargaining mechanism and increased investment as a deterrence mechanism. For this to be problematic, these changes would have to affect for-profit hospitals in a way that differs from nonprofit hospitals and differentially in concentrated and competitive markets. There is no *a priori* reason to believe that this is true. Moreover, our baseline analysis relies on a concentration measure from 1996, before our analysis, to limit this type of confounding factor. To be thorough, however, we consider several robustness checks of our hospital concentration measure. To this end, Table 5 reports estimates using concentration measures that reflect the competitive landscape in 2000 (Panel A) and contemporaneously (Panel B) to investigate the extent that time-varying concentration confounds our estimates. The estimates in both panels are similar to the baseline estimates in Table 3, which suggests that these types of concerns may be less of a concern in practice. This may be the case because our panel is over a short window around the policy change.

6. Discussion

6.1. Does Market Power Discourage Investment?

We find a negative relationship between competition and investment in the hospital industry. Despite a deep theoretical and empirical literature, there is a lack of coalescence about the nature of the relationship between competition and investment. A primary reason for this is that investment is a strategic variable in oligopolistic markets, so these incentives are intricately intertwined. This relationship makes it difficult to find exogenous variation. We leverage an investment tax policy that creates this exogenous variation in the hospital industry. Specifically, we use the introduction of an investment tax incentive that reduces the user cost of capital for a subset of firms in a way that is orthogonal to market concentration.

While our evidence is based on a particular industry, it is informative for the broader question of whether market power discourages investment. In particular, we find that market power encourages investment for an industry that is large enough to account for 5% of GDP in 2016. This evidence is consistent with the Schumpeterian hypothesis that market power encourages investment, and this evidence may be consistent with the type of u-shaped relationship between competition and investment posited by papers like Aghion et al. (2005) and Vives (2008). Studies that consider industries in isolation have the advantage of holding fixed unobserved strategic variation related to investment, such as industry-specific barriers to entry. More industry-specific empirical work is needed in order to understand which features of market organization predict a negative relationship between competition and investment.

Understanding the relationship between competition and investment is particularly relevant to the hospital industry, where innovation and market power are frequent policy topics. Our evidence suggests that market power, perhaps in small doses, could be an important chan-

nel for innovation. This revelation has implications for the welfare consequences of on-going hospital consolidation.

6.2. Are Investment Tax Incentives Effective?

When the impact of competition on investment is ignored, we find that bonus depreciation had a weak effect on investment in the hospital industry. This result is consistent with early empirical work that found little to no impact of bonus depreciation (Cohen and Cummins, 2006). The heterogeneous investment response across markets potentially explains large discrepancies in estimates of the effectiveness of bonus depreciation (House and Shapiro, 2008; Zwick and Mahon, 2017). However, a difficulty in this literature comes in finding cleanly identified quasi-natural experiments because i) investment tax incentives are typically passed during periods of economic downturn to boost otherwise depressed investment, ii) there is rarely a control group of firms that are unaffected by the policy, and iii) investment and competition are strategically linked. Empirical estimates must overcome these identification issues.

We exploit two features of the hospital industry to address these identification issues. First, the pervasive existence of nonprofit hospitals provides us with a control group of firms to net out macroeconomic conditions impacting aggregate investment. Second, the hospital industry is subdivided into 306 separate markets, and the introduction of bonus depreciation was orthogonal to the pre-existing intensity of competition in the hospital industry. These advantages allow us to provide a cleanly identified estimate of the effect of investment tax incentives in the hospital industry.

Our findings suggest that there may be a role for tagging investment policies towards markets where they are expected to be the most impactful. Tax policy represents an important and potentially powerful tool available to the legislature. In our case, bonus depreciation was

first passed as a macroeconomic stimulus tool to combat the effects of the 2001 recession. In 2002, the tax expenditure on bonus depreciation was approximately $30 billion, just behind mammoth expenditures such as the tax exclusion on employer-sponsored health insurance, and the mortgage interest deduction.[25] Understanding the effectiveness of investment tax policies is of critical importance, especially in light of the enormous fiscal opportunity cost of such programs. Moreover, investment in the hospital market, which encapsulates 5% of the US economy, can have real impacts on the health and well-being of consumers.

7. Conclusion

This paper proposes and assesses the hypothesis that market power, strategic incentives, and tax incentives jointly affect corporate investment policy. To determine the importance of market concentration, we use a quasi-natural experiment created by the introduction of an investment tax incentive known as bonus depreciation. Variation in exposure to investment tax incentives allows us to test whether firms in concentrated markets have larger responses to tax incentives than firms in competitive markets. To control for potentially conflating time-varying changes, we exploit a unique feature of the hospital market in the United States, where over half of all hospitals are nonprofit organizations that do not qualify for investment tax incentives.

We find that increasing the Herfindahl-Hirschman Index (HHI) from 1,078 (average competitive market) to 3,255 (average concentrated market) leads to an increase in investment of $2.7 million dollars per firm (6.4%) in response to investment tax incentives. This finding provides strong evidence that (1) there is a negative relationship between competition and in-

[25] https://home.treasury.gov/policy-issues/tax-policy/tax-expenditures, FY2002 Tax Expenditures and Kitchen and Knittel (2016).

vestment in the hospital industry and (2) there is a potential role for tagging tax policies to features of market organization.

The importance of the link between market concentration and tax incentives on corporate investment policies has several implications. First, this link clarifies that firms do respond to investment tax incentives. Second, market concentration provides a channel for strategic and tax incentives to heterogeneously affect corporate investment policies. Third, we show that the link between product market competition and corporate investment decisions can reconcile the mixed evidence on whether firms respond to investment tax incentives. These implications provide timely and practical considerations for policymakers who are currently debating the effectiveness of investment tax incentives.

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Figure 1: Market Concentration

Figure 1 shows the geographic variation in the concentration of hospital markets across the 306 markets defined by Dartmouth Atlas of Health Care's definition of a Hospital Referral Region (HRR). Darker blue represents a market with a higher market concentration, defined as a market's Herfindahl-Hirschman Index (HHI). There are high and low concentrated markets in all regions of the United States and in rural and urban areas.

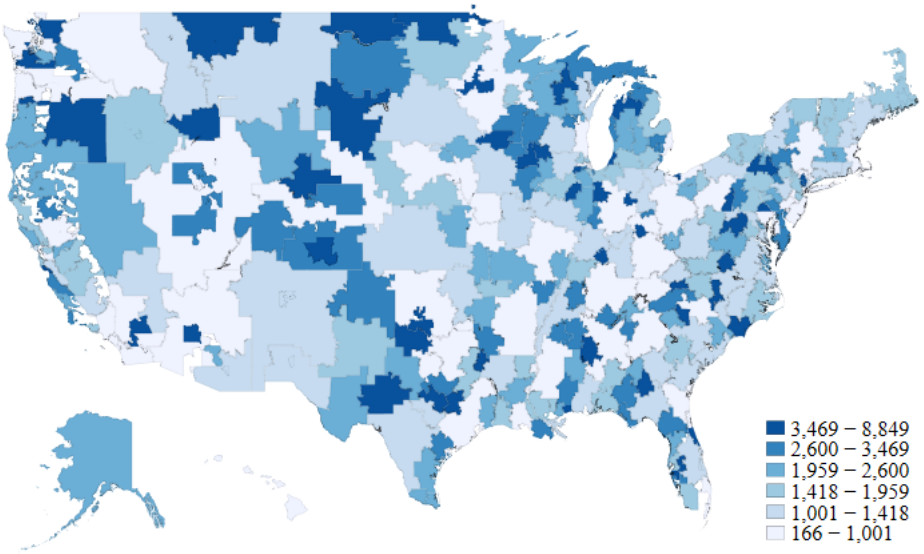

Figure 2: Share of Market Covered by For-Profit Hospitals

Figure 2 shows the geographic variation in the percentage of a hospital market covered by for-profit hospitals. Darker blue represents a market with a higher percentage of for-profit hospitals. There are for-profit and nonprofit hospitals throughout the 306 markets defined by Dartmouth Atlas of Health Care's definition of a Hospital Referral Region (HRR).

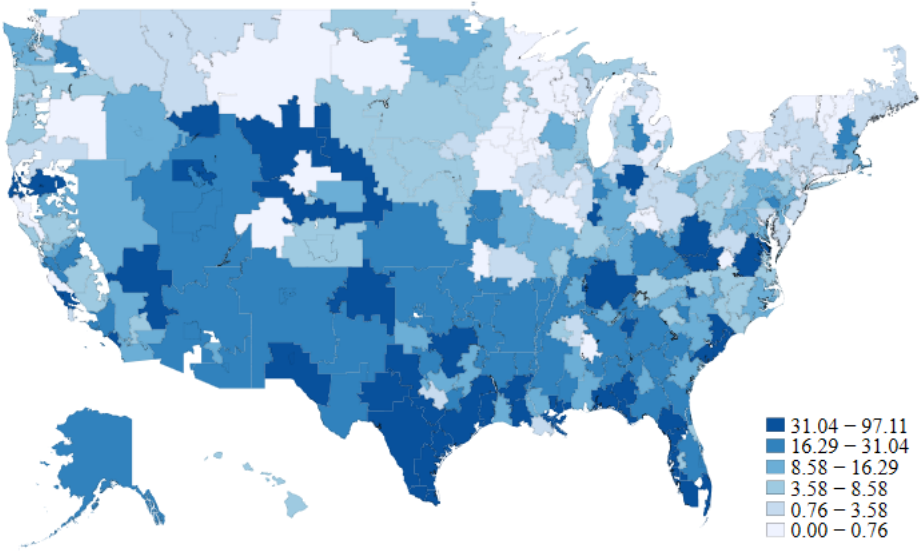

Figure 3: For-Profit and NonProfit Investment Trends

This figure reports an event study analysis of the difference in trends of log equipment investment between for-profit and nonprofit hospitals in all markets (Panel A), competitive markets (Panel B), concentrated markets (Panel C), and using the triple differences specification (Panel D). Each panel reports the coefficient and 95% confidence interval from the specification $log(I_{i,t}) = \beta_0 + \mathbb{1}(\text{treated})_i + \lambda_t + \lambda_t \mathbb{1}(\text{treated})_i + \varepsilon_{i,t}$, where $\mathbb{1}(\text{treated})_i$ is an indicator for for-profit hospitals in Panels A–C and the interaction between the indicator for for-profit hospitals and concentrated markets in Panel D. Failure to reject these coefficients are zero before 2002 provides support for the common trends assumption.

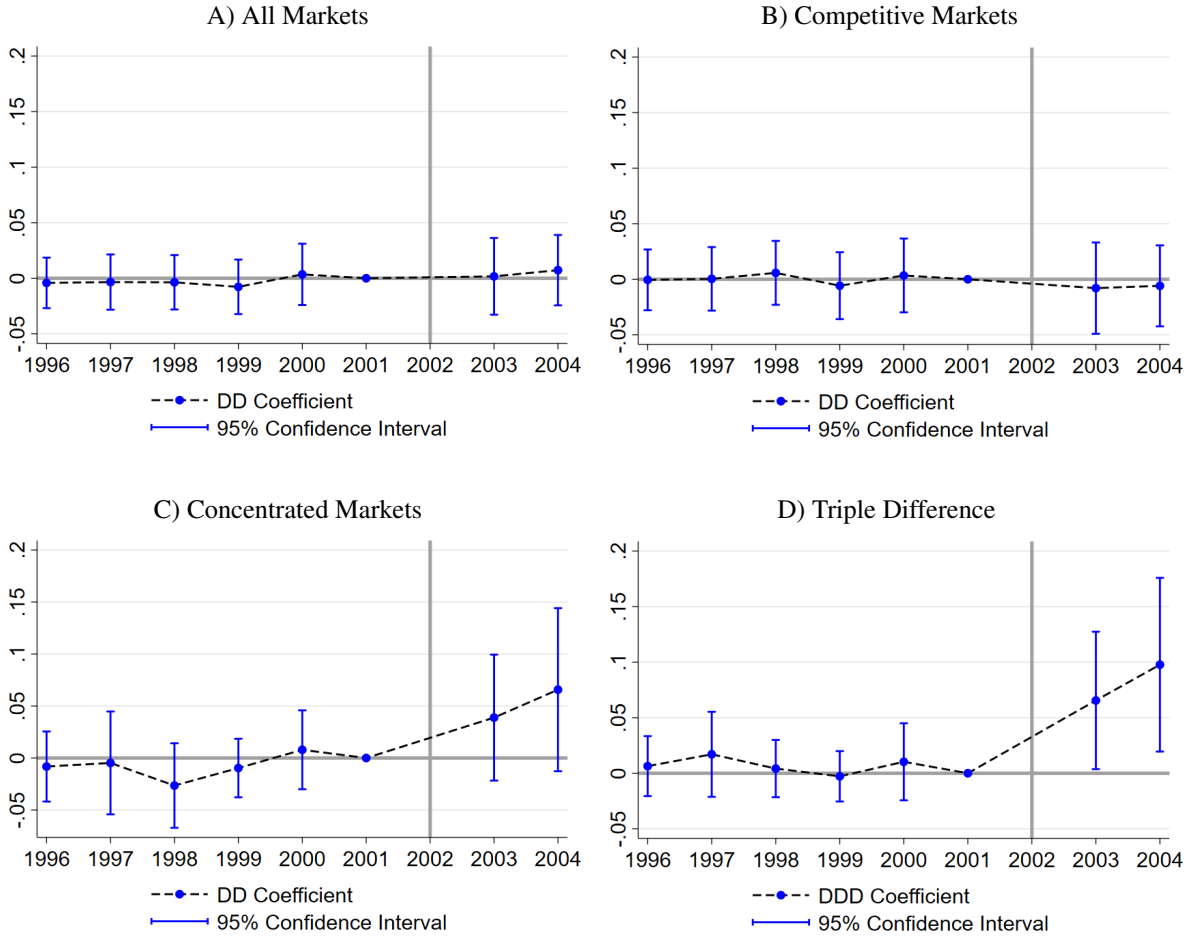

Table 1
Mean HCRIS Hospital Facility

This table reports mean values for the subsample of hospitals that continue to report capital stock throughout the bonus depreciation period. Capital stock is generated through a perpetual inventory method of accounting, necessarily decoupling this measure from any financial measure of assets.The discount factor is measured as 1 - (contractual discounts / total patient charges) and reflects an aggregate measure of pre-negotiated discounts for private insurers. All values have been winsorized at the 5 and 95% levels for reporting means.

	1998	2000	2002	2004
	(1)	(2)	(3)	(4)
Panel A: Financial ($ Thousands)				
Net Income	122	206	684	1,480
Assets	30,816	28,866	28,604	28,853
Liabilities	15,532	15,875	16,952	17,052
Panel B: Capital ($ Thousands)				
All	35,526	34,213	36,135	36,344
Equipment	6,336	6,025	6,095	7,259
Structures	28,206	26,852	28,512	29,659
Panel C: Investment (% of Capital)				
All (%)	6	6	7	7
Equipment (%)	10	11	13	14
Structures (%)	4	4	4	4
Panel D: Utilization				
Discharges	2,234	2,019	2,048	1,942
Medicare Share	49	53	54	54
Beds	90	79	70	65
Employees	292	282	270	270
Discount Factor (%)	0.44	0.43	0.44	0.44
Non-Profit Share	60	67	67	66

Table 2
Firm Investment Responses to Tax Incentives: Difference-in-Differences

This table reports the difference-in-differences specifications of the form:

$$log(I_{i,t}) = \beta_0 + \beta_1 DD_{i,t} + \lambda_t + \eta \mathbb{1}(\text{for-profit}) + \delta' x_{i,t} + \gamma' z_{i,t} + \varepsilon_{i,t}.$$

The dependent variable $log(I_{i,t})$ is the natural log of equipment investment. The coefficient of interest is the DD indicator which is equal to one for for-profit hospitals in the years with the tax incentive, denoted FP $\times$ TI Years (DD). We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. Standard errors clustered by firm are reported in parentheses. Our common trend test is reported in the bottom row. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	All Markets		Competitive HHI $<$ 1,800		Concentrated HHI $\geq$ 1,800	
	(1)	(2)	(3)	(4)	(5)	(6)
FP $\times$ TI Years (DD)	-0.003	-0.004	-0.018*	-0.019*	0.045**	0.045***
	(0.008)	(0.008)	(0.009)	(0.010)	(0.020)	(0.017)
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓
Adj. R-Square	0.011	0.393	0.018	0.400	0.013	0.385
Observations	5,463	4,631	4,187	3,542	1,276	1,089
P-Value (Common Trend)	0.546	0.921	0.113	0.298	0.261	0.142

Table 3
Firm Investment Responses to Tax Incentives: Triple Differences

This table reports the triple differences specification of the form:

$$log(I_{i,t}) = \beta_0 + \beta_1 DD_{i,t} + \beta_2 DDD_{i,t} + \lambda_t + \lambda_i + \eta\,\mathbb{1}(\text{For-profit}) + \mathbb{1}(\text{Concentrated})_i + \mathbb{1}(\text{Concentrated})_i \times \mathbb{1}(\text{post-2002}) + \mathbb{1}(\text{Concentrated})_i \times \mathbb{1}(\text{For-profit})_i + \delta' x_{i,t} + \gamma' z_{i,t} + \varepsilon_{i,t}.$$

The dependent variable $log(I_{i,t})$ is the natural log of equipment investment. The coefficient of interest is the DDD indicator which is equal to one for for-profit hospitals, in tax incentive years, in concentrated markets, denoted Con Mkt × FP × TI Years (DDD). This specification also includes an indicator variable that equals one for concentrated markets, an interaction between the concentrated market indicator variable and an indicator variable that equals one for tax incentive years after 2002, and an interaction between the concentrated market and for-profit indicator variables. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Columns (3) and (4) include hospital fixed effects. Columns (5) and (6) include market fixed effects. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. Standard errors clustered by firm are reported in parentheses. Our common trend test is reported in the bottom row. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)
Con Mkt × FP × TI Years (DDD)	0.060***	0.062***	0.050***	0.050**	0.050**	0.042**
	(0.021)	(0.020)	(0.019)	(0.020)	(0.022)	(0.018)
Hospital Facility Fixed Effects			✓	✓		
Market Fixed Effects					✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓
Adj. R-Square	0.018	0.396	0.577	0.579	0.110	0.413
Observations	5,463	4,631	5,008	4,225	5,403	4,585
P-Value (Common Trend)	0.526	0.924	0.087	0.692	0.352	0.675

Table 4
Sensitivity: Market Concentration Definitions

This table reports the triple differences specification with the natural log of equipment investment as the dependent variable. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1400, 1600, 2000, and 2200, in columns (1)–(4) respectively. Columns (5) and (6) are interacted models that split concentrated markets into 2 or 4 equal sized groups, respectively. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the HSA level. Standard errors clustered by firm are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	HHI				Interacted	
	1400	**1600**	**2000**	**2200**		
	(1)	(2)	(3)	(4)	(5)	(6)
Con Mkt $\times$ FP $\times$ TI Years (DDD)	0.041***	0.055***	0.062***	0.069***		
	(0.016)	(0.018)	(0.020)	(0.023)		
DDD Con Mkt $\in (1800, 2560)$					0.032	
					(0.022)	
DDD Con Mkt > 2560					0.079***	
					(0.027)	
DDD Con Mkt $\in (1800, 2150)$						0.041*
						(0.022)
DDD Con Mkt $\in [2150, 2560)$						0.030
						(0.030)
DDD Con Mkt $\in [2560, 3200)$						0.079***
						(0.029)
DDD Con Mkt ≥ 3200						0.080*
						(0.045)
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Adj. R-Square	0.395	0.395	0.396	0.396	0.396	0.396
Observations	4,631	4,631	4,631	4,631	4,631	4,631

Table 5
Sensitivity: HHI Definitions

This table reports the triple differences specification with the natural log of equipment investment as the dependent variable. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Columns (3) and (4) include hospital fixed effects. Columns (5) and (6) include market fixed effects. Concentrated markets are defined as markets in 2000 (panel A) and contemporaneously (panel B) where an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. Standard errors clustered by firm are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: HHI Defined in 2000						
Con Mkt × FP × TI Years (DDD)	0.060***	0.061***	0.050***	0.049**	0.050**	0.042**
	(0.021)	(0.020)	(0.019)	(0.020)	(0.022)	(0.018)
Adj. R-Square	0.018	0.397	0.577	0.582	0.110	0.416
Observations	5,460	4,571	5,006	4,194	5,401	4,523
Panel B: HHI Defined Contemporaneously						
Con Mkt × FP × TI Years (DDD)	0.053**	0.059***	0.042***	0.042***	0.051**	0.038**
	(0.022)	(0.017)	(0.015)	(0.016)	(0.023)	(0.015)
Adj. R-Square	0.021	0.394	0.577	0.579	0.111	0.412
Observations	5,461	4,700	5,006	4,287	5,401	4,654
Hospital Fixed Effects			✓	✓		
Market Fixed Effects					✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓

Table 6
Sensitivity: Identifying Assumption of Common Trends

This table reports triple differences specifications with the added time controls (columns 1–4), entropy weights (columns 5 and 6), and a placebo test (columns 7 and 8). The first two columns add a linear time trend and columns 3 and 4 add a linear and quadratic time trend interacted with an indicator variable that equals one for for-profit hospitals and zero otherwise; $\mathbb{1}(\text{For-Profit})_i \times t$ and $\mathbb{1}(\text{For-Profit})_i \times t^2$. These specifications are given by

$$log(I_{i,t}) = \beta_0 + \beta_1 DD_{i,t} + \beta_2 DDD_{i,t} + \lambda_t + \eta \mathbb{1}(\text{For-profit}) + \mathbb{1}(\text{Concentrated})_i + \mathbb{1}(\text{Concentrated})_i \times \mathbb{1}(\text{TI Years})_t$$
$$+ \mathbb{1}(\text{Concentrated})_i \times \mathbb{1}(\text{For-profit})_i + \delta' x_{i,t} + \gamma' z_{i,t} + \mathbb{1}(\text{For-Profit})_i \times t + \mathbb{1}(\text{For-Profit})_i \times t^2 + \varepsilon_{i,t}.$$

Columns 5 and 6 weight nonprofit hospitals to look similar to for-profit hospitals using entropy weights (Hainmueller, 2012). The dependent variable $log(I_{i,t})$ is the natural log of equipment investment for columns (1)–(6) and structure investment in columns (7) and (8), which is a placebo test. The coefficient of interest is the DDD indicator which is equal to one for for-profit hospitals, in tax incentive years, in concentrated markets, denoted Con Mkt $\times$ FP $\times$ TI Years (DDD). The triple differences specification also includes an indicator variable that equals one for concentrated markets, an interaction between the concentrated market indicator variable and an indicator variable that equals one for tax incentive years after 2002, and an interaction between the concentrated market and for-profit indicator variables. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. Standard errors clustered by firm are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Additional Time Trends				Entropy Weights		Placebo	
	Linear		Quadratic				Structure Investment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Con Mkt × FP × TI Years (DDD)	0.060***	0.060***	0.060***	0.059***	0.058**	0.060***	0.018	0.018
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓	✓	✓
Adj. R-Square	0.019	0.397	0.019	0.397	0.034	0.289	0.368	0.368
Observations	5,463	4,631	5,463	4,631	4,700	4,631	4,630	4,630

Table A.1
Annual Means: Estimating and Full Sample

This table reports mean values for the subsample of hospitals that continue to report capital stock throughout the bonus depreciation period, in addition to the full sample of hospitals. Capital and investment variables are not reported for the full sample in periods where data is not reported. All values have been winsorized at the 5 and 95% level. Financial information is reported in $ thousands. The baseline estimates use the subsample of firms that continue to report capital stock throughout the period. The estimates are robust to using the full sample of firms and to weighting the subsample of firms to look like the full sample of firms.

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Panel A: Subsample							
Net Income	122	192	206	282	684	1,114	1,480
Assets	30,816	28,909	28,866	27,452	28,604	28,027	28,853
Beds	90	85	79	75	70	67	65
Discharges	2,234	2,095	2,019	2,013	2,048	2,038	1,942
Equipment (K)	6,330	5,737	6,025	6,143	6,085	6,295	7,234
Structures (K)	28,146	26,698	26,686	28,107	28,467	28,077	29,552
% Equipment (I)	0.10	0.11	0.11	0.12	0.13	0.13	0.14
% Structures (I)	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Observations	1,085	1,023	907	810	719	797	942
Panel B: Full Sample							
Net Income	2,140	2,088	2,223	2,120	2,220	2,654	2,902
Assets	64,782	65,915	66,982	68,248	68,652	70,097	70,766
Beds	133	129	124	122	123	122	121
Discharges	5,103	5,066	5,279	5,293	5,312	5,293	5,222
Equipment (K)	14,558	14,063	13,504	NA	NA	NA	NA
Structures (K)	54,694	56,185	58,282	NA	NA	NA	NA
% Equipment (I)	0.12	0.14	0.15	NA	NA	NA	NA
% Structures (I)	0.05	0.05	0.05	NA	NA	NA	NA
Observations	4,502	4,508	4,471	4,493	4,491	4,549	4,624

Table A.2
Firm Investment Responses to Tax Incentives: Level Specifications

This table reports the estimates using the level, instead of the log, of investment in equipment for the specifications in Table 3. The coefficient of interest is DDD indicator which is equal to one for for-profit hospitals, in the years with the tax incentive, in concentrated markets and zero otherwise, denoted Con Mkt $\times$ FP $\times$ TI Years (DDD). We control for year fixed effects, λ_t, and a vector of contemporaneous controls, $z_{i,t}$. Controls include an indicator for urban, discharges, assets, net income, percentage nonprofit, certificate of need, year fixed effects, region fixed effects, and HSA HHI. Columns (3) and (4) include hospital fixed effects. Columns (5) and (6) include market fixed effects. Standard errors clustered at the hosptial level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Con Mkt $\times$ FP $\times$ TI Years (DDD)	2.552***	2.692***	2.503***	2.598***	2.151**	1.956**
	(0.954)	(0.906)	(0.889)	(0.976)	(0.994)	(0.848)
Hospital Facility Fixed Effects			✓	✓		
Market Fixed Effects					✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓
Adj. R-Square	0.009	0.253	0.387	0.379	0.053	0.256
Observations	5,464	4,631	5,009	4,225	5,404	4,585

Table A.3
Sensitivity Tests: Clustered Standard Errors

This table reports standard errors clustered at the market level for the specifications in table 3. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Con Mkt × FP × TI Years (DDD)	0.059***	0.062***	0.051***	0.051***	0.050**	0.042**
	(0.020)	(0.018)	(0.018)	(0.016)	(0.022)	(0.017)
Hospital Facility Fixed Effects			✓	✓		
Market Fixed Effects					✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓
Adj. R-Square	0.018	0.396	0.577	0.579	0.110	0.413
Observations	5,413	4,596	4,964	4,192	5,403	4,585

Table A.4
Firm Investment Responses to Tax Incentives: Sample Selection

This table reports the synthetic control estimates for the specifications in Table 3. The dependent variable $log(I_{i,t})$ is the natural log of equipment investment, the only type of investment subject to the tax incentive. The coefficient of interest is the DDD indicator which is equal to one for for-profit hospitals, in tax incentive years, in concentrated markets, denoted Con Mkt × FP × TI Years (DDD). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Con Mkt × FP × TI Years (DDD)	0.133***	0.075**	0.062*	0.054	0.090**	0.056*
	(0.041)	(0.032)	(0.037)	(0.035)	(0.036)	(0.030)
Hospital Facility Fixed Effects			✓	✓		
Market Fixed Effects					✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓
Adj. R-Square	0.091	0.554	0.687	0.696	0.307	0.598
Observations	4,706	4,630	4,294	4,224	4,660	4,584

Table A.5
Firm Investment Responses to Tax Incentives: Tobit Model

This table reports the difference-in-differences and triple differences specifications using a Tobit model. The dependent variable $log(I_{i,t})$ is the natural log of equipment investment, the only type of investment subject to the tax incentive. In our sample, investment is zero or negative 10% of the time. Our baseline analysis transforms investment before taking the log to not drop any data. An alternative, reported here, is to run a Tobit model in levels with censoring at zero. The coefficients of interest are on the DD and DDD indicators which are equal to one for for-profit hospitals in the years with the tax incentive and zero otherwise, denoted FP $\times$ TI Years (DD), and equal to one for for-profit hospitals, in tax incentive years, in concentrated markets, denoted Con Mkt $\times$ FP $\times$ TI Years (DDD). The triple differences specification also includes an indicator variable that equals one for concentrated markets and zero otherwise, an interaction between the concentrated market indicator variable and an indicator variable that equals one for tax incentive years after 2002, and an interaction between the concentrated market and for-profit indicator variables. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. Standard errors clustered by firm are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	All Markets		Competitive		Concentrated		All Markets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FP $\times$ TI Years (DD)	0.173	0.027	-0.543	-0.693	2.570***	2.489***	-0.547	-0.684
	(0.432)	(0.396)	(0.502)	(0.467)	(0.974)	(0.916)	(0.500)	(0.465)
Con Mkt $\times$ FP $\times$ TI Years (DDD)							3.202***	3.138***
							(1.041)	(0.965)
Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls		✓		✓		✓		✓
Pseudo R-Square	0.002	0.048	0.002	0.049	0.004	0.047	0.003	0.048
Observations	5,464	4,631	4,188	3,542	1,276	1,089	5,464	4,631

Table A.6
Sensitivity to Using Hospital System Concentration Measures

This table reports the difference-in-differences and triple differences specifications using measures of concentration that incorporates hospital systems. The dependent variable $log(I_{i,t})$ is the natural log of equipment investment. The coefficients of interest are on the DD and DDD indicators which are equal to one for for-profit hospitals in the years with the tax incentive and zero otherwise, denoted FP $\times$ TI Years (DD), and equal to one for for-profit hospitals, in tax incentive years, in concentrated markets, denoted Con Mkt $\times$ FP $\times$ TI Years (DDD). The triple differences specification also includes an indicator variable that equals one for concentrated markets and zero otherwise, an interaction between the concentrated market indicator variable and an indicator variable that equals one for tax incentive years after 2002, and an interaction between the concentrated market and for-profit indicator variables. We control for year fixed effects, λ_t, and a vector of contemporaneous hospital and market controls controls, $x_{i,t}$ and $z_{i,t}$; discharges, assets, net income, an indicator for urban, percentage of the market that is nonprofit, certificate of need, region fixed effects, and HHI at the hospital service area level. Concentrated markets are defined as markets in 1996 with an HHI $\geq$ 1800, and competitive markets are defined as markets with an HHI $<$ 1800. The percent change in investment is given by $e^{\beta_1} - 1$ and $e^{\beta_2} - 1$. Standard errors clustered by firm are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	HCRIS		AHA	
	HRR	HSA	HRR	HSA
	(1)	(2)	(3)	(4)
Con Mkt $\times$ FP $\times$ TI Years (DDD)	0.062***	0.097***	0.044***	0.063***
	(0.020)	(0.029)	(0.016)	(0.024)
System Identifiers			✓	✓
Year Fixed Effects	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Adj. R-Square	0.396	0.408	0.402	0.408
Observations	4,631	4,631	4,300	4,300

Table A.7
Balance Test: Synthetic Control Group

This table reports the balance test of the entropy balancing technique following Hainmueller (2012). This technique balances the mean and variance of the observed characteristics between two subsets. This table shows the balance for nonprofit and for-profit hospitals. The balance is close before the reweighting and becomes closer after.

		Mean		Variance	
Variable	Sample	Treated	Control	Treated	Control
Certificate of Need	Unmatched	0.612	0.647	0.238	0.229
	Matched	0.612	0.612	0.238	0.237
Certificate of Need 2	Unmatched	0.279	0.310	0.201	0.214
	Matched	0.279	0.279	0.201	0.201
Log Discharges	Unmatched	-1.823	-1.280	2.027	2.248
	Matched	-1.823	-1.823	2.027	2.028
Log Liabilities	Unmatched	0.845	0.975	0.307	0.0607
	Matched	0.845	0.845	0.307	0.308
Log Net Income	Unmatched	0.863	0.862	0.00281	0.00724
	Matched	0.863	0.863	0.00281	0.00292
Percentage NonProfit	Unmatched	52.48	72.92	1046	411.1
	Matched	52.48	52.48	1046	1046
Teaching	Unmatched	1.243	1.179	0.870	0.702
	Matched	1.243	1.243	0.870	0.870
Urban	Unmatched	0.771	0.674	0.177	0.220
	Matched	0.771	0.771	0.177	0.177

Table A.8
Balance Test: Sample Selection

This table reports the balance test of the entropy balancing technique following Hainmueller (2012). This technique balances the mean and variance of the observed characteristics between two subsets. This table shows the balance for our subsample and the full sample of hospitals. The balance is close before the reweighting and becomes closer after.

		Mean		Variance	
Variable	Sample	Treated	Control	Treated	Control
Certificate of Need	Unmatched	0.654	0.607	0.226	0.239
	Matched	0.654	0.654	0.226	0.226
Certificate of Need 2	Unmatched	0.322	0.255	0.218	0.190
	Matched	0.322	0.322	0.218	0.218
Concentration	Unmatched	0.227	0.235	0.176	0.180
	Matched	0.227	0.227	0.176	0.176
Log Liabilities	Unmatched	0.985	0.892	0.0653	0.119
	Matched	0.985	0.986	0.0653	0.0658
Log Net Income	Unmatched	0.866	0.849	0.00795	0.00285
	Matched	0.866	0.866	0.00795	0.00797
Percentage NonProfit	Unmatched	71.23	72.85	479.9	470.0
	Matched	71.23	71.23	479.9	479.9
Teaching	Unmatched	1.221	1.042	0.665	0.876
	Matched	1.221	1.220	0.665	0.665
Urban	Unmatched	0.700	0.604	0.210	0.239
	Matched	0.700	0.700	0.210	0.210

Table A.9
Comparison of Summary Statistics: HCRIS vs OHSPD

This table compares summary statistics for 400 California hospital facilities in 2001 using the OHSPD 2001 Annual Hospital Financial Data and the 2001 HCRIS data. The HCRIS summary statistics are a subset of those summarized in Table 1 of our paper. In the OHSPD data, Beds refers to licensed beds and discharges reflect total discharges. Financial information is reported in thousands.

	OHSPD	HCRIS
	(1)	(2)
Beds	156	187
Discharges	7,224	7,686
Employees	738	785
Total Patient Revenue	287	264
Total Operating Expenses	96	91
Total Assets	104	102

APPENDICES

FOR ONLINE PUBLICATION

A. Data Appendix

Our data relies on hospital facility-level cost reports, the Healthcare Cost Report Information System (HCRIS), made publicly available by the Center for Medicaid and Medicare Studies (CMS). These microdata provide a wide range of information on each facility, including utilization and production statistics. Worksheet A-7, Parts I and II, provide detailed annual investment and capital stock data for each hospital facility broken down into several categories. However, for a period between late 2001 and early 2004, worksheet A-7 was not required, and, as a result, only about 20% of hospital facilities continued to report this information.

In this section, we compare our estimating subsample to the full sample of hospitals. Table A.1 shows annual means for a variety of financial, utilization, and size measures. This table shows that the average hospital in our estimating sample is smaller than the average hospital in the full sample. For example, our average hospital provided care to 2,095 discharges with roughly 85 hospital beds in 1999, whereas the average hospital in the full sample cared for 5,066 discharges with 129 hospital beds. Furthermore, the assets held by the average hospital in the estimating sample in 1999, $28.909 million, were roughly half of the average hospital in the full sample, $65.915 million.

B. Additional Background Information

B.1. Bonus Depreciation Example

If a for-profit hospital purchases a new computer system with a tax-life of five years for $100,000, it would be permitted to deduct $20,000 from its taxable income in the first year (20%), $32,000 in the second year (32%), and so on, according to the MACRS schedule. Under a bonus depreciation regime, firms can depreciate a bonus amount in the first year for qualifying investments. The remaining amount is depreciated according to the typical schedule. In the previous example, with 50% bonus depreciation, the same for-profit hospital would be permitted to deduct a bonus $50,000 in the first year from its taxable income. It would depreciate the remaining $50,000 according to the typical MACRS schedule.

B.2. Brief Legislative Background

Since 2001, Congress has re-enacted bonus depreciation legislation nearly continuously under the guise of providing economic stimulus. The first enactment, The Job Creation and Work Assistance Act of 2002, allowed for a 30% bonus depreciation on qualified equipment and software investment put in service on or after September 11, 2001. The Jobs Growth Tax Relief Recovery Act of 2003 increased the allowable bonus depreciation to 50% for the investment made after May 5, 2003, and before January 1, 2006, after which bonus depreciation expired.

In the wake of the Great Recession, Congress again enacted bonus depreciation legislation with several year-long measures: the Economic Stimulus Act of 2008, the American Recovery and Reinvestment Act of 2009, the Small Business Jobs Act of 2010, the Tax Relief, Unem-

ployment Insurance Reauthorization and Job Creation Act of 2010, the American Taxpayer Relief Act of 2012, the Tax Increase Prevention Act of 2014, and the Protecting Americans from Tax Hikes Act of 2015. Finally, the 2017 Tax Cuts and Jobs Act provided for a five year period of 100% bonus depreciation beginning in 2018, followed by a five-year phase-out. Given the recent Congressional pattern of stringing together year-long bonus depreciation extensions including retroactive implementation, the concept of bonus depreciation is no longer new to the business community and carries the general expectation of perpetuation.[26]

[26]The interested reader should refer to Kitchen and Knittel (2016) for a complete discussion of bonus depreciation legislation.

C. Additional Empirical Specifications

C.1. Robustness of Results to Sample Selection

In our baseline estimates, we limit our sample to hospitals that continuously reported capital stocks throughout this period. To test the sensitivity of the estimates to this sample selection, we implement an entropy-weighted difference-in-differences specification where the weights are based on the mean and variance of the distribution of observable characteristics of hospitals in the full sample.[27] Our sample differs from the full sample of hospitals due to an unrelated relaxation of capital reporting requirements by the US Department of Health and Human Services. Table A.1 reports a complete data comparison of the baseline sample and the full sample of hospitals.

Table A.4 reports the investment response to tax incentives controlling for differences in the sample of hospitals. Our estimate of the investment response in concentrated markets is 6.2% when our sample is weighted to look like the full sample. This estimate is slightly larger than our 4.1% difference-in-differences estimate.[28] Our estimates in all markets and competitive markets are small, statistically insignificant, and similar to our difference-in-differences estimates. Our triple differences estimate is 7.1%, which is slightly larger than our 5.0% difference-in-differences estimate. The similarity and, in some cases, larger estimates controlling for differences in sample provides further evidence supporting a negative relationship between competition and investment.

Insert Table A.4 about here.

[27] Table A.8 in Appendix A.8 provides the balance test and the full set of variables used in the matching.

[28] The percent change in investment is given by $e^{\beta_{DD}} - 1 = 0.060$.

C.2. Level Specifications

Tables A.2 reports the estimates based on specifications Table 3, where the level of real investment is the dependent variable. Similarly, the control variables; discharges, assets, and net income are also given in levels. This table demonstrate that our estimates in the level specification are consistent with the specification given in Table 3 with the log-transformed variables.

C.3. Tobit Specifications

Investment is typically a lumpy decision that can be modeled via a latent variable interpretation. These types of models have data mass points at real values, zero in this case, and are more appropriately modeled via a Tobit estimator. However, the introduction of nonlinear maximum likelihood models can introduce complexity in interpretation and implementation. In Table A.5, we report estimates of the difference-in-differences and triple differences specifications based on a Tobit model. Our results based on a Tobit model are consistent with our baseline results: we find that firms in concentrated markets increased investment in response to bonus depreciation.

C.4. Synthetic Control Balance Test

The synthetic control approach constructs a control group to balance a set of moment conditions. This section reports the balance test, demonstrating the difference between covariates. We construct the control group using entropy weights, following Hainmueller (2012), matching the mean and variance of the covariates. The balance test, including mean and variance before and after weighting, are provided in Tables A.7 and A.8.

In the first synthetic control group, we use weights nonprofit hospitals to look like for-profit hospitals. Before the samples are weighted, the covariates are close in mean and variance. After the samples are weighted, the balance increase. The second synthetic control group we use weights our sample to look like the full sample of hospitals. This analysis provides a test of the sensitivity of the estimates to using a restricted sample for a balanced panel. The full set of variables include urban, discharges, liabilities, net income, percentage nonprofit, whether the hospital is a teaching hospital or not, and certificate of need (two measures).

C.5. Robustness: Clustered Standard Errors

Table A.3 reports the results of the difference-in-differences specifications in logs and levels, where the standard errors are computed using a multi-way clustered robust estimate similar to Acemoglu and Pischke (2003) and methods presented in Cameron et al. (2011), Petersen (2009), and Thompson (2011b). Clustering at the state and year level allows for an arbitrary covariance structure within states and over time, addressing concerns of serial correlation. The pattern of empirical results remains the same between the multi-way clustered standard errors in Columns (2), (4), and (6), and the standard errors are very similar to the robust standard errors reported in Table 3 and A.2.

D. Review of HCRIS Data Integrity

In this section, we undertake a review of the evidence on the accuracy of the capital reporting data available in the HCRIS. Ultimately, we believe that the data reported in the HCRIS provides several advantages among the set of commonly used hospital data sources, which also includes the American Hospital Association (AHA) survey data, hospital financial reports (HFRs), and the California Office of Statewide Health Planning and Development (OSHPD). To begin and most important, detailed capital accounting is not reported in any of the alternatively listed data sources. On the other hand, it is impossible to corroborate this particular element of the HCRIS because it is not elsewhere reported. For this reason, we have taken several steps to evaluate the integrity of the HCRIS as a whole, which we will discuss in greater detail below. In particular, we compare summary statistics based on data from the OSHPD and the HCRIS in section D.1. This analysis confirms reporting consistency amongst a set of jointly reported utilization and financial data for the subset of California hospital facilities. In addition, we reviewed the literature that scrutinizes the accuracy of the HCRIS data in Section D.2. In summary, this literature is concerned with the accuracy of the HCRIS Financial Statements (Worksheet G), which is not the source of data for capital investments (Worksheet A-7). Finally, we provide a more in-depth background on the HCRIS reporting requirements in Section D.3. A more thorough discussion of the legal requirements to file, the incentives associated with data reporting, the penalties associated with inaccurate data reporting, and the additional safeguard of regular CMS audits provide reassuring evidence on the expected accuracy of the database. Taken together, we are reassured that the quality of the HCRIS capital data is sound.

D.1. Comparing HCRIS and OSHPD

In this section, we corroborate the HCRIS reporting with other data sources, and in particular, hospital financial data made publicly available by the California Office of Statewide Health Planning and Development. The data reported to the state should face the same incentives for accuracy in light of penalties for misinformation. To this end, we acquired the 2001 Annual Hospital Financial Data, and we matched this to the HCRIS data via the reported Medicare Provider Number. The match rate was reassuringly high at 98%. We cannot directly compare the capital investment reporting as this reporting only exists in the HCRIS. However, we compare a host of utilization and financial data across the two sources in Table A.9, and the consistency reassures us.

D.2. Related Literature on the Accuracy of HCRIS: Financial Data

While there is sparse peer-reviewed evidence analyzing the relative accuracy of cost-accounting information in the HCRIS, such as utilization and cost-charges, there is a larger literature examining the accuracy of a particular subset of financial data contained in the HCRIS: worksheet G. The basic research question underlying these papers is whether and how to interpret the various sources of financial reporting for hospitals, and most primarily in hospital financial statements retained in some state data repositories and the universally available MCRs. This thread of accounting research highlights two issues. First, the only universally available financial reporting data is contained in the MCRs, but these data are not required to be prepared according to best practices in accordance with the U.S. Generally Accepted Accounting Principles (GAAP). Second, hospital financial statements, which are more likely to conform to GAAP requirements, are available only on an ad-hoc basis in just 18 states that collect them. In light of the importance of the hospital industry, several papers have highlighted a

myriad of inconsistencies in financial reporting across these and other sources, advocating for improvements in financial reporting requirements in the MCR (Kane and Magnus, 2001; Ozmeral et al., 2012; Lamboy Ruiz et al., 2018). In fact, the MedPAC supported changes to the MCR to improve "reporting of hospitals' overall financial condition more consistent with their audited financial statements."[29] We fully agree with these proposed changes to the MCR to bring financial reporting in line with GAAP requirements.

In light of this literature, we want to underscore that the capital investment data upon which our analysis relies is not reported on worksheet G and is not the focus of the criticisms. Instead, capital investment is reported for the purposes of cost-allocation. In general, the literature does not take issue with the integrity of these data, and we find no additional evidence to suggest otherwise. Finally, we concur with you that the literature analyzing hospital investment is very sparse. However, Kim and McCue (2008) examine factors that influence hospital capital investment, including market pressures, operational pressures, and financial factors. In this paper, the authors rely on capital investment as reported in the HCRIS for a similar reporting period: 1998–2001.

D.3. Additional Background on Medicare Cost Reports

Medicare-certified institutions are required to file a Medicare Cost Report (MCR) on an annual basis with the Medicare Administrative Contractor (MAC) for the Centers for Medicaid and Medicare Services (CMS) to determine reimbursable costs. These reports are completed at the facility level and contain information on demographic characteristics, utilization, charges, wage indexing, and financial measures. CMS collects this information in the HCRIS in separate databases for hospitals, skilled nursing facilities, home health care agencies, hospices,

[29] Available at http://67.59.137.244/documents/june04$_9$90$_D$*ataNeeds.pdf*

renal dialysis centers, and independent rural health and free-standing federally qualified health centers. Our analysis relies on the hospital database, which includes the universe of medicare certified hospitals excluding federal hospitals (Veterans Hospitals and Indian Health Services) and Emergency Hospitals operating outside of the United States.

Because the MCR is the basis upon which hospitals reconcile Medicare reimbursements, hospitals have an incentive to report all costs. In the case of capital expenses, these are considered ”overhead,” or fixed costs, that are allocated across the various cost centers. Moreover, the MCR must be filed with the MAC within five months of the close of the fiscal year. There are no exemptions for this filing requirement, and medicare payments are terminated within 30 days of insufficient filing. For these reasons, the provider is incentivized to comply in a timely manner.

At the same time, the federal government, including the Medicare Payment Advisory Commission (MedPAC), has an incentive to ensure that the data contained in the MCR is accurate because it is used as the basis for annual Medicare rate-setting and policy analysis. For example, MedPAC makes biannual reports to Congress containing an analysis of the Medicare program and recommendations for changes. In these reports, chapters on Hospital Inpatient and Outpatient Services rely on the HCRIS. To this end, the CMS conducts frequent and routine audits of annual MCR submissions. An early study of the impact of audit on cost report variables, Cowles (1991), finds that the impact of the review processes to be “quite small.”