WORKING PAPER

Public Insurance Expansions and Provider Capital Investments

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Capital expenditures can enhance firms' long-run performance but are also sensitive to financial uncertainty due to high fixed costs. Policies that reduce this uncertainty may consequently stimulate such investments. We study this dynamic in the healthcare context, where technology adoption often lags other economic sectors. Our empirics focus on hospitals' information technology investments following public insurance expansions. We find that greater Medicaid coverage—and hence lower uncompensated care—increases hospitals' adoption of clinical and administrative technologies. The effects begin during policy announcement and grow over time. Supplementary analyses suggest that changes to perceptions of financial uncertainty drive hospitals' capital investments. (*JEL* H42, I11, I13, I18, L21, L23, L24)

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Whaley acknowledges funding from Arnold Ventures. The authors have no conflicts of interest to disclose.

A variety of sectors operate within a mixed economy to supply goods and services to private as well as public markets. Having the government as a key purchaser necessarily allows policy to shape market dynamics and profitability for relevant firms. Expansions or contractions of public purchasing can subsequently influence firms' decision-making through several channels: changing their overall income, shifting the composition of goods and services they produce, or altering the financial uncertainty that they face. Any downstream responses by firms, such as changes to production inputs or strategic activities, thus contribute to the overall social welfare impact of a policy change. The consequences of such effects could also extend beyond the public market, which underscores the value of related empirical investigations to better inform *ex post* policy evaluation and debate.

Of the economic channels by which policy directly or indirectly affects firms' behavior, one of the potentially more important but also less well-studied roles is that of uncertainty—and in particular its influence on firms' long-run decision-making. A key example of such long-run decisions are firms' capital expenditures ("capex"). These investments are often sources of productivity growth and improved efficiencies over time. However, they also tend to require significant upfront costs as well as difficult-to-reverse commitments, while positive impacts on profitability mostly materialize in the long-run—when firms' knowledge over demand, competition, and production is inherently less certain. Firms' challenges in forecasting future events and financial circumstances can consequently restrain these potentially beneficial, but risky, business actions (Bloom, Bond, and Van Reenen 2007; Bloom 2009; Bloom 2014; Cadara and Iacoviello 2022).[1] Quantifying the role uncertainty plays in firm decisions is likewise challenging, especially when trying to disentangle changes in uncertainty from changes in the broader business cycle. Usefully, policy shocks can alter prevailing perceptions of uncertainty and simultaneously offer tractable empirical opportunities (i.e., "natural experiments") to measure uncertainty's influence on firms' strategic decisions (Bloom 2014).[2]

In this paper, we add to a small but growing literature leveraging such natural experiments by examining how expanding a publicly provided good for consumers—health insurance—

[1] The literature often refers to firms' weaker affinity for costly and (at least partially) irreversible physical capital investments as reflecting "precautionary delays" in business decision-making.

[2] Of note, doubts around policy permanence may also lead to weaker investment and encourage further "precautionary delays" (Rodrik 1991).

indirectly affects the capex decisions among private suppliers—hospitals. Our primary focus is on firms' capital investments devoted to health information technology (IT), which is a market worth hundreds of billions of dollars itself.[3] The US hospital industry is likewise significant since it is home to high-complexity care and captures over $1 trillion (~30%) of medical spending annually––the largest share of spending among the provider types.[4] The health IT adoption decision is particularly relevant for our empirical purposes since hospitals must commit to substantial upfront investment while accepting potentially large adjustment costs and sunk costs tied to health IT procurement. The question of how to promote health IT adoption is also salient to policymakers since hospitals have been the recipients of targeted and costly subsidization programs intending to encourage greater health IT use, with only mixed success.[5] Policies shaping the broader market environment could have similar (indirect) impacts on the industry when compared to narrow subsidization strategies or even amplify subsidization efforts.

The public insurance program we focus on is Medicaid. This means-tested insurance benefit has been a prominent fixture of the US healthcare system for nearly 60 years, but Medicaid's size has also fluctuated over time due to state and federal policymaking. The potential benefits to individuals and households from access to a heavily subsidized insurance program are straightforward. Yet, the downstream benefits to hospitals are not immediately obvious and depend on two important and interdependent aspects of the US healthcare system: comparatively high rates of uninsurance and a high prevalence of unpaid medical bills.[6] The resulting incidence of "uncompensated care" costs—resources devoted to the provision of medical services not financed

[3] For example, see a related industry report available here: https://finance.yahoo.com/news/healthcare-market-size-soaring-usd-123600574.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAM-SBOg8xxg09IiUG4gKAAkYqlarGT4XHL9G5NjtXj3SlpHuyPwR_lP4nwW_NJugxVLFaRvDuX-86QEzSLjy09AkAunGLvrt1I7BrRz-IWe-A_tlhyyCmc_6qi7XjOayy-7eSVRYnEPvxm-fLchuqKYDenUTd3BeFeb5M6NiOEkS, as well as here: https://www.acumenresearchandconsulting.com/healthcare-it-market

[4] National health expenditures are summarized by the Centers for Medicare and Medicaid Services (CMS) here: https://www.cms.gov/files/document/nations-health-dollar-where-it-came-where-it-went.pdf.

[5] Information on federally legislated efforts, such as the Health Information Technology for Economic and Clinical Health (HITECH) Act, can be found here: https://www.healthit.gov/topic/laws-regulation-and-policy/health-it-legislation. https://www.brookings.edu/articles/where-hitechs-28-billion-of-investment-has-gone/

[6] Both are often lamented features of the US system, with the latter also receiving increased attention by researchers, consumer advocates, and policymakers in recent years (Batty, Gibbs, and Ippolito 2022; Kumar and Adashi 2023; Kluender *et al*. 2024).

by the patients receiving them—ultimately determines the incidence of benefits from economic policies that lower these costs.

Existing research makes clear that the uncompensated care burden is largely borne by the hospital industry and that the Medicaid program plays a mitigating role. Garthwaite, Gross, and Notowidigdo (2018) estimate that an additional uninsured person in a hospital's catchment area will cost it $800 annually and that uncompensated care strains hospitals' finances due to their inability to pass along the full costs to their employees or other customers. Related findings further demonstrate that shrinking state Medicaid programs exacerbates hospitals' uncompensated care burden (Garthwaite, Gross, and Notowidigdo 2018) while expanding Medicaid coverage lessens these costs for hospitals (Blavin 2016; Blavin and Ramos 2021). Estimates from the most recent Medicaid expansions tied to the Affordable Care Act (ACA)—the policy shock we focus on—suggest an approximately 25-50% decline in unpaid medical bills for affected hospitals, relative to pre-expansion levels, and improved finances overall (Blavin 2016; Dranove, Garthwaite, and Ody 2016; Kaugman *et al*. 2016; Lindrooth *et al*. 2018; Rhodes *et al*. 2020; Blavin and Ramos 2021; Callison *et al*. 2021; Dunn, Knepper, and Dauda 2021; Duggan, Gupta, and Jackson 2022; Santos, Singh, and Young 2022).

We can reproduce these patterns using our difference-in-difference analysis comparing expansion and non-expansion states following the 2014 ACA Medicaid expansions (fully described in Sections IB and IC). Figure 1 provides estimates of the changes in hospital-level uncompensated care burden measured in charges (panel (a)) as well as adjusted costs (panel(b)).[7] Both treatment group measures were trending in parallel with hospitals in non-expansion states during the five years preceding the 2014 policy shocks but sharply diverge once the expansion policies are implemented. The peak decline among expansion state hospitals of approximately $4 million per year in uncompensated care costs (panel (b)) translates to a 60% reduction relative to their pre-expansion average over the 2009-2013 period (Figure 1). Coupled with the evidence from the literature, Figure 1 illustrates that hospitals face considerable financial risk tied to fluctuations in the rate of uninsurance present in their local market. Consequently, expanding coverage to

[7] Our measures of uncompensated care burden are derived following the methodology listed in https://github.com/asacarny/hospital-cost-reports.

medical care consumers effectively shields healthcare providers from high and hard-to-predict uncompensated care costs in the present and for the foreseeable future.[8]

Despite Medicaid's potential impact on healthcare providers, supply-side studies of public insurance expansions are relatively rare while demand-side studies are numerous.[9] Even less attention has been given to healthcare providers' capital investment behavior, specifically. Meille and Post (2023) find no effects in terms of hospitals' fixed assets (i.e., land, buildings, and leased assets) from the recent expansions. Duggan, Gupta, and Jackson (2022) examine an aggregate measure of capex but are limited to a single state (California), which requires a considerably different identification strategy. The authors also fail to detect any within-state ACA impact for California's hospital industry. We are unaware of any other ACA-related empirical studies examining provider capex decisions, especially in relation to one of the fastest growing areas of market and policy interest: health IT.

We therefore shed new and needed light on an understudied component of these large and regularly debated policy interventions. We study the effects of the ACA expansions using a rich and underutilized data set on hospital-level health IT procurement and a difference-in-differences research design. Our primary data allow us to capture aggregate health IT investments as well as granular measures based on IT purpose (e.g., back-office versus clinical care delivery solutions). To explore mechanisms, we also supplement our health IT data with complementary data on hospitals' hiring behavior and direct-to-consumer ad spend to capture more short-term expenses as opposed to longer-term investments. While these hospital spending margins could be affected by improved cash flow following Medicaid expansions, they are less likely to be restrained by prevailing levels of uncertainty facing the industry, making them a useful benchmark for any observed changes in capital investments.

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[8] Medicaid is known to be countercyclical—bolstering medical care demand during economic downturns (Benitez, Perez, and Chen 2021; Benitez, Perez, and Seiber 2021). Existing research also calculates that a substantive portion of Medicaid spending operates as a transfer from government coffers to the hospital industry (Garthwaite, Gross, and Notowidigdo 2018; Finkelstein, Hendren, and Luttmer 2019). The relative permanence of Medicaid expansions is also important for our purposes. For example, other work finds that temporary price shocks have limited impact on provider behavior (Chen *et al*. 2018; Chen *et al*. 2022). Public insurance expansions are rarely reversed, however.

[9] Of note, French *et al*. (2016), Gruber and Sommers (2019), and Soni, Wherry, and Simon (2020) provide extensive ACA literature reviews, especially with respect to healthcare access, utilization, and health outcomes. We also review the modest economics literature examining Medicaid expansion effects on healthcare providers in Section IA.

We find that hospitals within expansion states begin to invest more in health IT during the policy announcement period and that the effect increases with time. By 2017, affected hospitals have adopted nearly 10% more technology solutions overall in comparison to hospitals in non-expansion states. Importantly, the uptick in these capital investments spans a variety of health IT genres, including clinical service-line management, laboratory management, and multiple administrative functions (e.g., back-office management, financials, information systems, and utilization review). The relative effect sizes typically range between 5-10% for a given technology purpose; however, some increases are by as much as 30% over baseline levels. These behavior changes are also concentrated among for-profit and not-for-profit hospitals exposed to the expansions. Government-run hospitals generally show limited to no clear change in health IT procurement when located within an expansion state.

Our heterogeneity and supplementary analyses further suggest that these health IT capital investments are due to changes in perceived financial uncertainty stemming from the Medicaid expansions. We are able to rule out that the behavior changes are fully explained by a pure income shock. Financially weaker hospitals are not more responsive to the public insurance expansions—if anything, their responses are more muted. And hospitals with relatively greater exposure to the size of the Medicaid expansions do not engage in greater health IT adoption compared to other hospitals in affected states. The observed increases in IT investment are also not mirrored along more variable hospital spending margins (i.e., nurse labor inputs and marketing expenditures), which contrasts with recent economics work focused on policy-induced revenue shocks to the hospital industry and short-run spending behavior (e.g., Gross *et al*. 2022; Gupta, La Forgia, and Sacarny 2024). Moreover, the positive effects on capital investments we capture coincide with expansion policy *announcement*, which is before any direct effects on hospital revenues occur. It also does not appear that health IT adoption is simply a matter of accommodating an influx of Medicaid patients and associated payer contracts. Our results are not driven by hospitals with greater exposure to more challenging Medicaid payment environments (i.e., higher denial rates), which might otherwise incentivize more IT use to minimize reimbursement delays or losses tied to Medicaid business. Taken together, these results point to the reduction in expected financial uncertainty as the main mechanism driving these changes in long-run investment decisions.

Our paper ultimately makes three important contributions. First, we extend recent empirical economics work (Handley and Limão 2015; Baker, Bloom, and Davis 2016; Gulen and Ion 2016)

demonstrating the linkage between various policy levers and firms' willingness to commit to greater capex activity. We do so by examining a new and vital industry as well as a new source of improved certainty for affected private businesses relative to existing studies. Second, we add to a modest economics literature on the drivers of technology adoption within the healthcare sector, which is an area of ongoing inquiry and exploration (e.g., Acemoglu and Finkelstein 2008; Miller and Tucker 2009; Richards, Shi, and Whaley 2024). Much of the related economics literature has paid less attention to healthcare providers' upstream technology adoption decision and instead focused on the downstream consequences following adoption (e.g., Miller and Tucker 2011; Lee, McCullough, and Town 2013; Agha 2014; Dranove *et al*. 2014; Horn, Sacarny, and Zhou 2022). Yet, a better understanding of the forces shaping health IT utilization is needed since hospitals, along with other healthcare industries, chronically lag firms in other sectors of the economy when it comes to technology adoption and adaptation (Litwin 2020; Glaser, Vaezy, and Guptill 2024). Finally, Medicaid expansions remain a source of political debate and controversy. Ten states have refused to expand their Medicaid programs, as of 2024—a decade since the original expansion opportunity was offered. Informed policymaking around the preservation of existing expansions as well as the implementation of new expansions requires a comprehensive understanding of the public insurance program's costs and benefits (i.e., its tradeoffs). Our evidence makes clear that at least one meaningful supply-side benefit has been previously overlooked.

I. Empirical Strategy

A. Brief Overview of ACA Medicaid Expansions and Related Literature

The ACA became law in 2010 and arguably represented the most substantial health policy reform in the US healthcare system since the founding of the Medicare and Medicaid programs a half-century prior. The legislation included a variety of policy levers to ultimately shrink the share of the US population lacking health insurance. One of the most influential mechanisms to accomplish this policy priority was a national expansion of the public insurance program for low-income individuals and households (i.e., Medicaid). Medicaid is a state and federal partnership program in terms of its financing and administration; however, the ACA intended to bring more uniformity to Medicaid eligibility across states and to have the federal government shoulder the vast majority of the financial burden from program expansion. The expansions were originally intended to take place across the country in January of 2014 (or before in some circumstances), but during the

summer of 2012, the US Supreme Court ruled that states must be allowed to opt-out of the proposed ACA Medicaid expansions—an option that many states decided to exercise. Further details of the ACA insurance provisions and subsequent estimates of coverage take-up can be found within Frean, Gruber, and Sommers (2017), Gruber and Sommers (2019), among others.

Regarding the Medicaid program and provider behavior, earlier work took interest in how pediatric labor markets and supply responded to public insurance provision targeting children in the 1990s and early 2000s (Garthwaite 2012; Chen, Lo Sasso, and Richards 2018). Related work from Buchmueller, Miller, and Vujicic (2016) explored practice substitution behavior toward lower skilled labor use (i.e., dental hygienists) following greater Medicaid involvement in dental service markets. And more recently, a growing, but still small, literature has focused on the most recent policy changes linked to the ACA. Specifically, Matta, Chatterjee, and Venkataramani (2024) find that high-earning health workers benefited from improved compensation following their states' ACA Medicaid expansions. Meanwhile, Dillender (2022) documents increased job postings by healthcare firms, especially those tied to lower skilled work, and DiNardi (2021) finds evidence consistent with more licensed practical nurses and registered nurses shifting into full-time positions in ACA expansion states. Results from Tarazi (2020) and Meille and Post (2023) are likewise consistent with positive impacts of Medicaid expansions on hospitals' nurse retention and/or hiring. Though, Barnes *et al*. (2023) show that primary care physician practices actually slow their hiring of non-physician clinicians (e.g., nurse practitioners) when facing greater exposure to the Medicaid market following the recent expansions. Notwithstanding the known impact on hospitals' uncompensated care burden, there is no existing evidence that recent ACA Medicaid expansions forestalled obstetric unit closures within hospitals, improved circumstances for safety net hospitals, or translated to more community benefit spending (Kanter *et al*. 2020; Stoecker *et al*. 2020; Chatterjee, Qi, and Werner 2021; Chatterjee, Werner, and Joynt Maddox 2021; Carroll *et al*. 2022). However, Lindrooth and colleagues (2018) find a lower likelihood of full hospital shutdown following the public insurance expansions, and Nikpay (2022) shows that a post-expansion increase in Medicaid volumes can trigger other Medicaid-linked subsidies for hospitals. As noted previously, only limited empirical work has examined hospitals' capex decisions following Medicaid expansions, with no known work on health IT investments, specifically.

B. *Data*

Our primary data come from the Health Information Management Systems Society (HIMSS) annual survey, which provide detailed information on hospital-level health IT use across a variety of business domains (e.g., clinical care and tracking, revenue cycle management, and back-office functions). As previously noted, we view hospitals' health IT adoption as a useful test case for understanding the effects of uncertainty on capital investments due to the accompanying high adjustment costs and sunk costs tied to these investments. The former costs reflect the potentially high switching costs attached to new personnel training and/or replacement technology as well as contracting with new vendors. The latter costs reflect the low-to-no resale value belonging to a purchased health IT solution. For these reasons, this domain of capex could be sensitive to the financial uncertainty facing the hospital industry and contrast with other prominent sources of hospital business spend (e.g., clinical hiring and direct-to-consumer advertising) that are plausibly less influenced by uncertainty perceptions due to shorter payoff periods and smaller adjustment frictions (i.e., more variable than fixed costs).

We rely on HIMSS survey years 2009 through 2017 and construct a hospital-level measure of aggregate number of software health IT solutions implemented and operational in a given year to reflect overall adoption activity over time. We also benefit from granular information on the purpose of a given health IT investment, which we use to construct a complete set of mutually exclusive categories for IT functionality. To keep the estimation and results reporting tractable, we collapse some health IT purposes into an overarching business function. For example, we have a broader measure of 'financials' which captures multiple HIMSS reported purposes, including financial decision support, general financials, and revenue cycle management. Likewise, our constructed category of 'back-office' health IT solutions includes business office software, customer relations management, business intelligence, document management, regulation and standards, and transcription. However, most of our outcome measures map to a single or few reported specific IT purposes. Another interesting feature of these data is the ability to observe information on health IT vendors. We leverage these rich data details to construct a measure of total unique vendors a given hospital contracts with in a given year. As far as we are aware, these data are a novel contribution to the supply-side focused public insurance expansion literature.[10]

[10] We do note that the data do not contain transaction prices or cost estimates for the health IT solutions. While this is one drawback for the HIMSS data, it is also not surprising, given the very detailed information on each hospital,

We supplement our primary data with information on hospital ownership status and financial status contained within the American Hospital Association (AHA) annual survey and publicly-available data from the CMS Hospital Cost Reporting Information System (HCRIS), respectively.[11] For the latter information, on an annual basis, all hospitals participating in the Medicare system are required to certify and report information on hospital financial measures, including operating revenues and expenses. We use these components to measure hospital-specific operating margin in a given year.

C. Difference-in-Differences and Triple Differences Estimation

Our primary estimation strategy is a standard difference-in-differences (DD) research design, which we also extend using triple differences (DDD) estimation. Our implementation closely follows Brevoort, Grodzicki, and Hackmann (2020) where the authors leverage the 2014 Medicaid expansions in isolation to examine effects on household finances and medical debt. More specifically, the authors consider control, comparison states to be those that have not expanded their Medicaid program as of 2017 (19 states) and exclude "early" and "late" adopting states (13 states, plus the District of Columbia)—leaving 19 treatment group states that all implemented their ACA Medicaid expansions on January 1st, 2014. The simultaneous implementation of these policies across states avoids the empirical complications from differential timing in treatment.

The resulting geographic spread of our treatment and control group states is displayed in Figure 2. Additionally, we can see in Table 1 the levels of our health IT investment measures averaged over the 2009-2012 period for each set of analytic hospitals corresponding to their 2014 Medicaid expansion status. At baseline, the average hospital within each group has nearly sixty health IT solutions operational in a given year and contracts with more than a dozen unique IT vendors. The number of solutions tied to a given business purpose ranges from less than one to as many as fourteen, on average (Table 1). Importantly, hospitals' health IT adoption patterns closely mirror each other across the Medicaid expansion divide prior to our 2014 policy shocks of interest.

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the IT each hospital has invested in, and with whom the hospital contracts for its IT solutions. In other words, reporting on costs (even in ranges) would likely be viewed as information for a given hospital-vendor negotiation as too proprietary (i.e., "trade secrets") to report in the HIMSS survey.

[11] We restrict to hospitals in the HIMSS data that report a valid Medicare identification number (CCN) that we can use to link to the AHA and HCRIS data sources. This requirement sacrifices approximately 10% of the total available HIMSS data.

For our primary outcomes, we conduct a "2x2" DD estimation that is then followed by an event study specification. The estimating equations are as follows:

$$Y_{ht} = \alpha_h + \theta_t + \delta(Treated_h \times Post_t) + \varepsilon_{ht} \quad (1)$$

$$Y_{ht} = \alpha_h + \theta_t + \sum_{\substack{j=-5 \\ j\neq -2}}^{3} \delta_j \, (Treated_h \times time = j) + \varepsilon_{ht} \quad (2)$$

Equations (1) and (2) each include hospital (α_h) and year (θ_t) fixed effects. *Treated* is equal to one for hospitals operating in 2014 Medicaid expansion states and zero otherwise. The *Post* variable is set to one for the 2014-2017 period, which we view as conservative since hospitals knew their respective state's policy decision in late 2012—making 2013 a policy announcement year. However, the event study estimation belonging to Equation (2) allows us to formally examine any anticipatory behavior by hospitals prior to the expansions taking place. We estimate both models on a balanced panel of hospitals present in the HIMSS data for the full nine years belonging to our analytic period (2009-2017).[12] Standard errors are clustered at the state level, which we confirm as being more conservative than clustering at the individual hospital level.

Since previous work finds that the incidence of uncompensated care is uneven across hospitals (e.g., Dranove, Garthwaite, and Ody 2016; Garthwaite, Gross, and Notowidigdo 2018; Blavin and Ramos 2021; Callison *et al*. 2021), we adapt Equation (1) to formally test for heterogeneous responses via DDD estimation. The resulting specification is as follows:

$$\begin{aligned} Y_{ht} = \alpha_h + \theta_t + \lambda_1(Treated_h \times Post_t) + \\ \lambda_2(BaseCharac_h \times Post_t) + \\ \lambda_3(Treated_h \times Post_t \times BaseCharac_h) + \varepsilon_{ht} \end{aligned} \quad (3)$$

[12] Conducting the estimation on an unbalanced set of hospitals has no material impact on the estimates or inferences (results available by request).

We initially focus on three sources of potential heterogeneity: hospital ownership, hospital financial performance, and health system affiliation. For the former, we create a separate indicator for hospitals that are government-owned in 2012, as opposed to being a privately operated for-profit or not-for-profit entity. For hospital financial performance, we calculate the annual operating margin per hospital and construct an indicator for non-government hospitals that average a negative margin (i.e., lost money on net) over the 2009-2012 period. And for system affiliation status, we construct an indicator for 'standalone' hospital that is equal to one for any non-government hospital lacking any system affiliation as of 2012. The *BaseCharac* variable in Equation (3) represents a general placeholder for any third 'D' indicator used in our DDD estimation. All other features from Equation (1) remain the same.

D. Additional Heterogeneity Analyses

To help rule out competing interpretations for why hospitals would increase capital investments and/or other business expenses following Medicaid expansions, we subsequently use our DDD estimation described via Equation (3) to explore if hospitals plausibly more exposed to a direct income shock as well as those plausibly more exposed to a challenging Medicaid contracting environment drive any observed behavior changes.

First, we follow related studies (e.g., Dranove, Garthwaite, and Ody 2016; Lindrooth *et al*. 2018; Dunn, Knepper, and Dauda 2021) and leverage geographic variation in the likely impact of ACA Medicaid expansions. To do so, we use information from the Census Small Area Health Insurance Estimates for 2013 to create an indicator equal to one for hospitals operating in counties that are above the national median in terms of share of the adult (age 18-64) population below 138% of the Federal Poverty Level and zero otherwise. Hospitals in these localities should be disproportionately exposed to the expansion in terms of the size of the potential market affected by the policy change. Following this, we leverage state-level Medicaid payment denial rates provided by Dunn *et al*. (2024) to assess any heterogeneous effects for hospitals in plausibly more difficult contracting and payment regimes with respect to their state's Medicaid program. The former DDD analysis speaks to the potential role of improved cash flow post-expansion to drive increased hospital spending while the latter focuses on a more subtle potential influence (i.e., more

demanding contracting requirements that could incentivize stronger IT capital spending to minimize transaction costs and/or losses of payment).

II. Effects on Health IT Investments

Table 2 provides our first set of DD estimates for aggregate health IT adoption and number of contracted health IT vendors. Hospitals affected by the 2014 Medicaid expansions demonstrate a differential and statistically significant increase in the number of purchased IT solutions as well as the number of vendors used in comparison to hospitals in non-expansion states. The relative change over baseline levels (Table 1) for treated hospitals is approximately 6% and 10%, respectively. The corresponding event study estimates in Figure 3 reinforce the interpretations from Table 2. Treatment and control hospitals are trending in parallel over the 2009-2012 period, and then in 2013 (i.e., the policy announcement period), the divergence begins and grows over time. By 2017, Medicaid expansions have caused exposed hospitals to make 10% more capital investments tied to health IT and to utilize 18% more health IT vendors than the counterfactual scenario where no Medicaid expansions occur—and hence the size of the current uncompensated care burden and the risk of a future burden persist.

Tables 3 and 4, along with Figures 4 and 5, provide a decomposition of the overall Medicaid expansion effect according to the specific health IT purpose. The "2x2" DD estimates in Table 3 reveal increases in IT focused on specific clinical service lines (e.g., cardiology care or emergency department care) as well as laboratory services that are statistically significant at conventional levels. The remaining DD estimates in Table 3 are positively signed but insufficiently precise. The event studies in Figure 4 also support a causal interpretation for Medicaid effects for these specific types of health IT adoption, and mirroring the findings from Figure 3, the positive effects materialize during policy announcement and become larger with time. An even broader range of IT purposes tied to more administrative—as opposed to clinical—functions demonstrate positive policy responses to the 2014 Medicaid expansions (Table 4). Back-office management, financial-focused, information systems, and utilization review software solutions all show substantive and statistically significant policy effects in Table 4. Staffing (i.e., human resource management) and supply chain IT margins also have positive DD coefficients in Table 4 but fail to reach statistical significance. The resulting event study findings for the four key outcomes in Table 4 again lend themselves to a causal interpretation for Medicaid expansion effects. There are no differential

upward trends for affected hospitals during the 2009-2012 pre-period, and following the individual states' announcement to participate in the 2014 expansions (i.e., the 2013 period in our analytic data), we witness a divergence between hospitals in the expansion states when compared to those whose state legislatures decided to forgo the ACA's expansion offer. There are also dynamics in the effects across all four health IT types, with back-office management and information system-related IT showing more pronounced gains over time. By the end of our study period, these two genres of IT solutions have increased by roughly 30% and 25% over baseline levels (Table 1), respectively, in response to the policy shock. The relative effect sizes by 2017 for financial IT and utilization review IT adoption measures are approximately 5% and 10%, respectively.

In Table 5, we move to our first DDD heterogeneity analyses for health IT capital investments using Equation (3) (Section IC). We specifically examine if, and how, government owned hospitals (i.e., public hospitals) responses to Medicaid expansions differs from those of private hospitals (i.e., for-profit and not-for-profit providers). The estimates in Table 5 for overall health IT adoption and number of IT vendors demonstrates the pattern consistently observed across all of our outcome measures (Tables 5-7). Specifically, the DDD coefficient for government owned hospitals is negatively signed and typically substantive in magnitude—though not always statistically significant at conventional levels. The DDD estimates for government owned hospitals do not always fully offsett the positive expansion effect estimates in Tables 5-7, but they do for several outcome measures. More importantly, the collection of DDD findings in Tables 5-7 makes clear that public hospitals do not drive the previously observed Medicaid expansion effects. This is also unsurprising since government hospitals can have "soft budget constraints" and are more reliant on predictable public funding to finance their operations. Meanwhile, private hospitals—whether for-profit or not-for-profit—are more likely to be the marginal firms in this industry and hence more sensitive to policy shocks to the market.

Tables 8, 9, and 10, restrict our focus to nongovernmental hospitals, given the findings from Tables 5-7, and explore any heterogeneous public insurance expansion effects for 'standalone' hospitals (i.e., hospitals with no health system affiliation as of 2012) and 'financially weak' hospitals (i.e., hospitals averaging a negative operating margin over the 2009-2012 period) in sequence.[13] We again rely on the estimation belonging to Equation (3) from Section IC. While the effect sizes and corresponding estimates' precision do vary across outcomes in these three

[13] Of note, these two versions of the third 'D' measure are correlated but not completely overlapping.

tables, the pattern is strongly consistent. Namely, the DDD coefficients belonging to either subgroup of expansion state hospitals overwhelmingly tends to be negatively signed and meaningful in size. These results indicate that, among the nongovernment hospital group, smaller and more financially vulnerable hospitals do not drive the observed expansion effects documented in Tables 2-4 and Figures 3-5. The DDD estimates in Table 11, which returns to our uncompensated care outcomes used in Figure 1, also show a corresponding pattern whereby the level changes in the uncompensated care burden are actually smaller among standalone and financial weaker hospitals.

Appendix Tables A1-A3 offer analogous heterogeneity analyses for nongovernmental hospitals when focused on their surrounding market circumstances. Here, we focus on the subgroups of hospitals that either have plausibly greater exposure to the expansions (i.e., the potential Medicaid market is larger) or that operate in a state with known high rates of Medicaid payment denials for providers. The former aims to capture any differential response by those potentially experiencing larger revenue effects from the public insurance expansion while the latter focuses on any heterogeneous effects among those facing more difficult contracting environments as Medicaid claims a larger share of their underlying payer mix. Both could incentivize greater capital investments that would be independent of prevailing perceptions of uncertainty within the industry. However, the evidence in Appendix Tables A1-A3 does not support such inferences. Neither subgroup demonstrates a stronger response to the policy shock. The DDD estimates are even negatively signed more often than not.

Taken together, the patterns across our various DDD findings reported in Section II, coupled with the anticipatory behavior changes (i.e., policy announcement effects) previously highlighted in our main DD event study results, go against a pure income shock interpretation for our findings. Something beyond immediate increases in cash flow or managing more Medicaid billing causes system-affiliated and financially stronger hospitals to engage in greater capital investment activity tied to health IT.

III. Other Hospital Spending Margins

A. Data and Estimation

To further enhance our interpretations for health IT adoption effects, we extend our DDD estimation to other hospital spending margins that are both salient to hospital managers and more

variable cost in nature. Low-to-no fixed costs allow these margins to be more flexibly adjusted as hospitals' short-run financial circumstances change—certainly more so than capital investment decisions.

The analytic data come from the AHA annual hospital survey and Kantar Media (now Vivvix) and correspond to the 2009-2017 period as well. For our purposes, the former provides measures of full-time and part-time nurse labor stratified by skill level (i.e., registered nurses (RNs) and licensed practical nurses (LPNs)), which we merge with our analytic sample of hospitals drawn from the HIMSS data. Importantly, nurses are some of the most numerous and vital labor inputs for most hospital operations, but efficient nurse staffing is also a perennial challenge for many hospitals. Our subsequent estimations can formally test if policy-induced cash infusions translate to more aggressive nurse hiring by hospitals. The DDD estimation and interpretations are otherwise identical to those belonging to Section II.

Regarding advertising behavior, the underlying proprietary data are not structured for economics research purposes, so there are no traditional hospital-level identifiers, such as those used in common research databases and transaction data. Instead, we know that a given observation of advertising has been classified as pertaining to the hospital industry, the geographic location of the advertising (i.e., the media market, known as "DMAs"), the amount spent for the advertising (in nominal thousands of dollars terms), and the name of the advertising entity—which is consistent over time in the data. Thus, simply matching the advertising data to our existing hospital-level data is exceedingly difficult for multiple reasons, including severe ambiguities around common hospital names used by separate organizations (e.g., "St. Luke's") and allocating system-level reported advertising to underlying system-affiliated hospitals across geographies. We therefore adapt our DD estimation from Section II to be at the distinct hospital industry advertising entity level and aggregate the total spending by the advertiser on television and outdoor (e.g., billboards) mediums to the annual level. We also stratify a given advertiser entity's spending as taking place in our treatment or control Medicaid expansion states.[14] Doing so allows specific hospital systems that span the 2014 expansion status divide to enter the data twice since the

[14] For media markets (DMAs) that span state borders (e.g., the St. Louis media market), we classify the media market as being in the treatment group if any of the media market's included states participated in the 2014 Medicaid expansions. Likewise, media markets are those that exist within a state or states that all satisfy control group inclusion criteria described in Section I.

geographic location of the advertising is clear in the data—and hence can be correctly attributed to and reflective of a policy response. The corresponding DD event study estimation is as follows:

$$Y_{at} = \eta_a + \theta_t + \sum_{\substack{j=-5 \\ j\neq -2}}^{3} \delta_j \left(Treated_a \times time = j\right) + \varepsilon_{at} \tag{4}$$

The estimation closely follows that belonging to Section II, with the main difference being the substitution for advertiser fixed effects (η_a) in place of hospital fixed effects and standard errors clustered at the advertiser level.

B. Results

Table 12 reports the DDD findings for nurse labor inputs. None of the estimates for either type of nurse labor (i.e., RN or LPN) or for either type of job (i.e., full-time or part-time) offers even suggestive evidence of an increase in hiring in response to the Medicaid expansions.[15] Any positive coefficients tend to be small in magnitude and nowhere near statistical significance. Most of policy effect estimates are also negatively signed—though still imprecise, with the exception of one coefficient in column 4 of Table 12. The DD event study findings in Figure 6 are likewise consistent with null effects from the policy shock. Hospital industry advertisers' spending patterns in expansion states track those in non-expansion states in the lead up to and during the years following the 2014 Medicaid policy event. In sum, we fail to detect any hospital responses to the Medicaid expansions in terms of nurse hiring or direct-to-consumer advertising activity—two spending domains that are important to hospitals and also relatively easy to adjust with changes to firms' budget constraints. These findings also sharply contrast with the policy effects on health IT capital investments documented in Section II.

IV. Medicare Market Billing and Care Delivery

Our final empirical exercise investigates any short-run spillover effects related to care delivery and billing efficiencies tied to the traditional Medicare market. Our hospital-level and annualized information on average length of stay (LOS) and associated payment processing comes from 100%

[15] We do not report part-time LPN results because they rarely exist in the data.

inpatient Medicare fee-for-service claims data, spanning 2009 through 2017. Tracking these measures over time facilitates a detailed examination of hospitals' core business (i.e., caring for patients within an inpatient setting) and its contracting/payment interactions with the Medicare program, which include audits around inappropriate billing by hospitals, including for excessively short stays (see Shi 2024). We can then determine if the increase in health IT adoption following Medicaid expansions has any downstream impact in the non-Medicaid market—at least in the short-run. To do so, we combine these supplementary outcome measures with our analytic sample of hospitals from the HIMSS data analyses and conduct otherwise identical DD and DDD estimations. The results are displayed in Appendix Table A4. We do not find any evidence consistent with shorter length of stay, shorter claims processing lags, fewer denials of claims, or improved in-hospital mortality rates for care devoted to the Medicare patient population. Though, it remains a possibility that the 2014-2017 post-period is too short of a time horizon for detectable spillover effects along these margins to emerge.

V. Conclusions

Theoretical and empirical economics research demonstrates that uncertainty shapes firms' capex decisions and that uncertainty's influence is distinct from fluctuations in the business cycle (Bloom 2014). Economic policy can also be a mechanism to reduce the uncertainty facing industries, including policies not directly targeting the affected firms. We demonstrate and quantify such an impact within the healthcare context where firms operate within a mixed economy.

Exogenous shocks to hospitals' financial outlook via public insurance expansions leads them to make more long-term capital investments related to health IT. Medicaid expansion-exposed hospitals purchase 10% more health IT solutions overall within three years of policy implementation, and their uptick in technology adoption spans a variety of genres that relate to clinical, financial, and general administrative functions. The effects also emerge with policy announcement and grow in subsequent years. When combined with the results from Figure 1 (panel (b)), the implied elasticity with respect to changes in hospitals' uncompensated care costs is approximately 0.17. Importantly, the results are not driven by lower-resourced hospitals or specific market environments. And we find no clear evidence that hospitals engage in more aggressive nurse hiring or direct-to-consumer marketing following the expansions. As previously noted in the literature, when adding or shedding workers is relatively frictionless, there is little

option value from delaying hiring in the face of greater uncertainty (Bloom 2014). Our supplementary evidence tied to a key hospital labor input (i.e., nurses) does not imply greater financial uncertainty restraining hospitals' hiring. It is also difficult to attribute the positive effects on health IT investments and lack of effects along other business margins to solely relaxed budget constraints following a positive income shock. We would generally expect an outward shift in the budget constraint to affect a variety of spending domains—not just capital investments. Taken together, we interpret the observed behavior change for hospitals' health IT procurement as more consistent with a response to perceptions of financial uncertainty facing the industry.

Beyond being of economic interest, the effects we identify carry substantive policy relevance. Garthwaite, Gross, and Notowidigdo (2018) calculate that the implied "savings" for states refusing to expand Medicaid through the ACA is smaller in magnitude than the size of the uncompensated care costs imposed on their hospitals by not expanding. We additionally show a previously overlooked (indirect) consequence of state policymakers' decisions—namely, they are restraining technological progress for their own hospital industry. Doing so further challenges ongoing attempts by US healthcare firms to catch up to other economic sectors in terms of leveraging technology advancements to improve performance. Likewise, while Carey *et al*. (2020) and Barkowski, Jun, and Zhang (2024) find no spillover effects from Medicaid expansions onto the care received by other patient groups, the health IT investments we document have the potential to generate positive externalities to other patient-payer groups over time. The deployment of health IT is typically not payer-specific so economies of scope belonging to these capital investments could enhance access, foster more efficient care delivery, and/or streamline scheduling/billing services for all patients receiving care from affected hospitals and health systems. Ignoring these downstream consequences from Medicaid expansions with respect to suppliers necessarily understates the economic benefits from these policy interventions.

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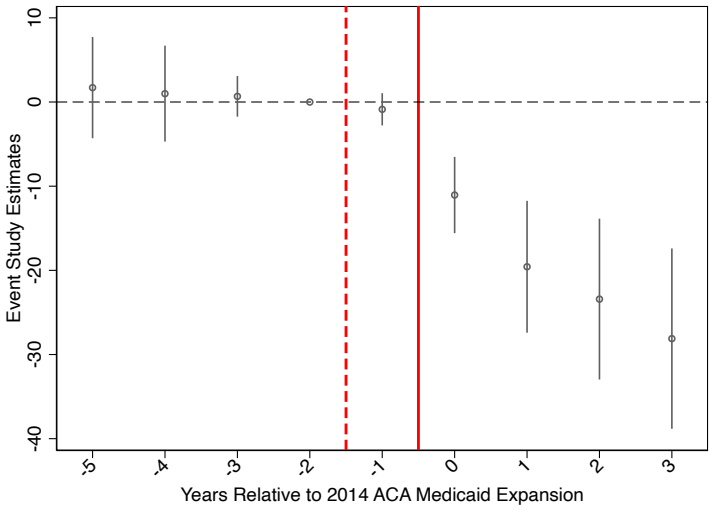
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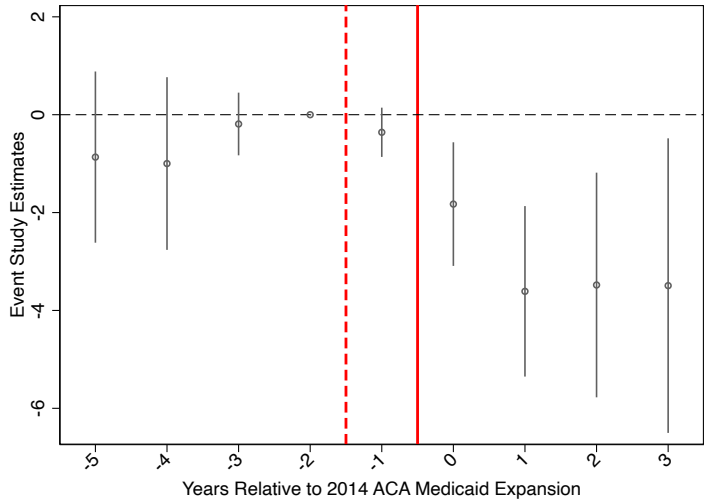
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(a) Uncompensated Care Charges ($millions)



(b) Uncompensated Care Costs ($millions)

FIG 1. EVENT STUDY ESTIMATES FOR MEDICAID EXPANSION EFFECTS

Notes: Uncompensated care measures constructed from HCRIS data. Solid vertical bar indicates the start of the Medicaid expansions in 2014. The dashed vertical bar represents the period between the summer 2012 Supreme Court decision and 2014 expansion implementation. The treatment group average for each outcome during the 2009-2012 period is $19.2 million and $6.5 million, respectively. Underlying analytic sample and difference-in-differences estimation fully described in Section IC.

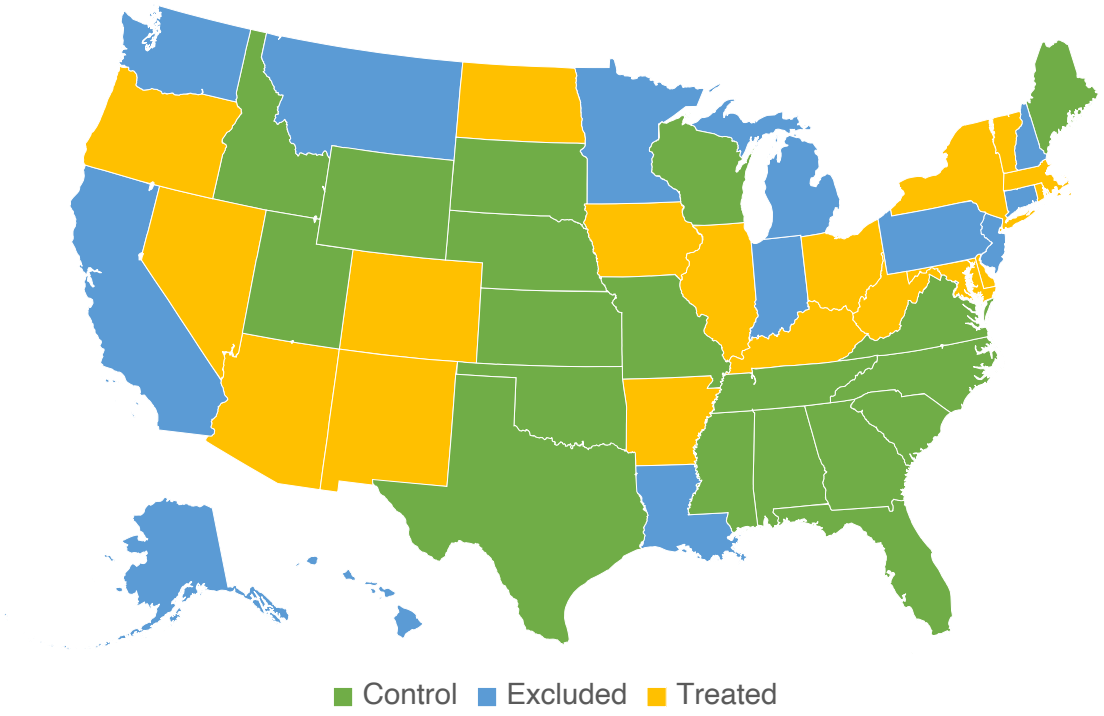


FIG 2. STATE LEVEL ANALYTIC SAMPLE INCLUSION STATUS BY MEDICAID EXPANSION STATUS THROUGH 2017

Notes: Treatment, control, and exclusion criteria follow Brevoort, Grodzicki, and Hackman (2020). There are 19 treatment states in total and 19 control states in total. Excluded states are a mixture of early and late expansion adopters.

TABLE 1—SUMMARY STATISTICS FOR HEALTH IT SOLUTIONS ADOPTION 2009-2012 STRATIFIED BY ACA MEDICAID EXPANSION STATUS

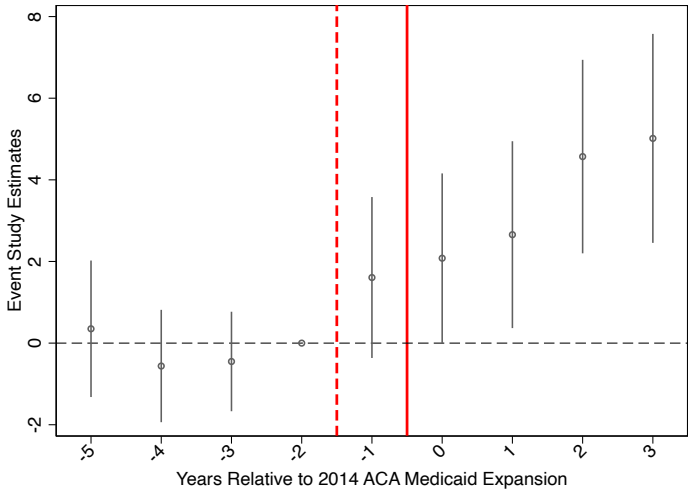
	2014 Medicaid Expansion States	**Non-Expansion States**
	Mean (SD)	Mean (SD)
Total Health IT Solutions	57.3 (18.1)	55.9 (21.1)
Total Health IT Vendors	13.7 (6.4)	13.6 (7.5)
Care Delivery Health IT Solutions		
Clinical Service Line	14.4 (6.3)	13.3 (7.0)
EHR	4.0 (2.1)	3.9 (2.1)
Laboratory	3.5 (1.6)	3.1 (1.7)
Pharmacy	0.9 (0.3)	0.9 (0.3)
Telemed	0.2 (0.4)	0.2 (0.4)
Administrative Health IT Solutions		
Back-Office	2.0 (1.1)	1.9 (1.2)
Financials	11.5 (3.6)	11.7 (4.0)
Info Systems	10.2 (4.0)	10.4 (4.7)
Staffing	7.9 (3.1)	7.7 (3.4)
Supply Chain	1.2 (0.6)	1.2 (0.6)
Utilization Review	1.8 (1.1)	1.8 (1.2)
Hospitals (N)	1,181	1,737

Notes: Analytic data are from HIMSS and span 2009-2012 for a balanced panel of hospitals used in the main difference-in-differences estimations.

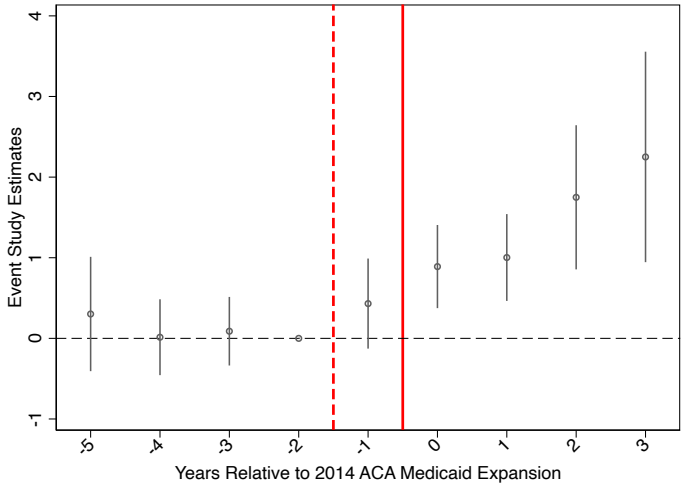
TABLE 2—MEDICAID EXPANSION EFFECTS ON HEALTH INFORMATION TECHNOLOGY (IT) ADOPTION AND CONTRACTING

	Total Health IT Solutions	Total Health IT Vendors
	(1)	(2)
Expansion State x Post	3.391***	1.306***
	(0.827)	(0.395)
Hospital FE	Yes	Yes
Year FE	Yes	Yes
Hospitals	2,918	2,918
Observations	26,262	26,260

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level.
*** P value at 0.01 ** P value at 0.05



(a) Total Health IT Solutions



(b) Total Health IT Vendors

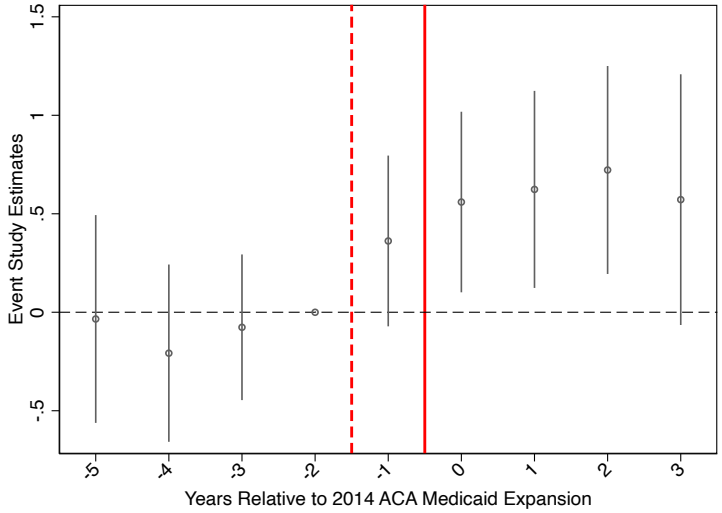
FIG. 3. EVENT STUDY ESTIMATES FOR MEDICAID EXPANSION EFFECTS

Notes: Solid vertical bar indicates the start of the Medicaid expansions in 2014. The dashed vertical bar represents the period between the summer 2012 Supreme Court decision and 2014 expansion implementation.

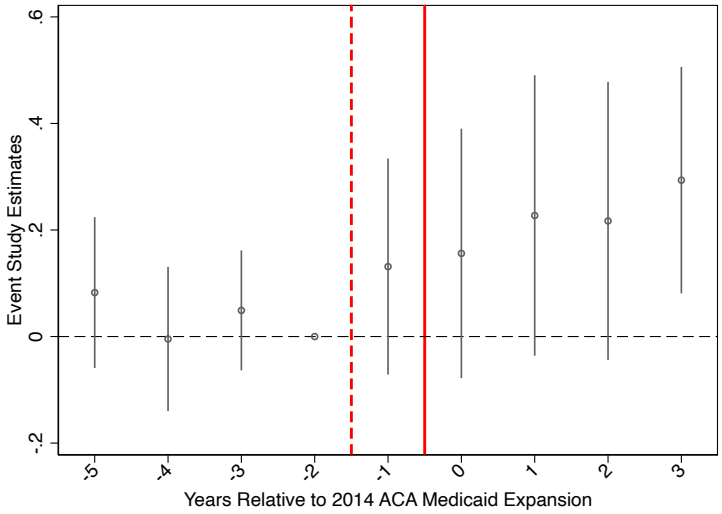
TABLE 3—MEDICAID EXPANSION EFFECTS ON CARE DELIVERY HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION

	Clinical Service Line	EHR	Laboratory	Pharmacy	Telemed
	(1)	(2)	(3)	(4)	(5)
Expansion State x	0.611***	0.037	0.172**	0.037	0.058
Post	(0.183)	(0.157)	(0.080)	(0.025)	(0.035)
Hospital FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Hospitals	2,918	2,918	2,918	2,918	2,918
Observations	26,262	26,262	26,262	26,262	26,262

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05



(a) Clinical Service Line



(b) Laboratory

FIG. 4. EVENT STUDY ESTIMATES FOR MEDICAID EXPANSION EFFECTS

Notes: Solid vertical bar indicates the start of the Medicaid expansions in 2014. The dashed vertical bar represents the period between the summer 2012 Supreme Court decision and 2014 expansion implementation.

TABLE 4—MEDICAID EXPANSION EFFECTS ON ADMINISTRATIVE HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION

	Back-Office	Financials	Info Systems	Staffing	Supply Chain	Utilization Review
	(1)	(2)	(3)	(4)	(5)	(6)
Expansion	0.320***	0.611***	1.260***	0.049	0.071	0.166***
State x Post	(0.124)	(0.227)	(0.367)	(0.131)	(0.047)	(0.062)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,918	2,918	2,918	2,918	2,918	2,918
Observations	26,262	26,262	26,262	26,262	26,262	26,262

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05

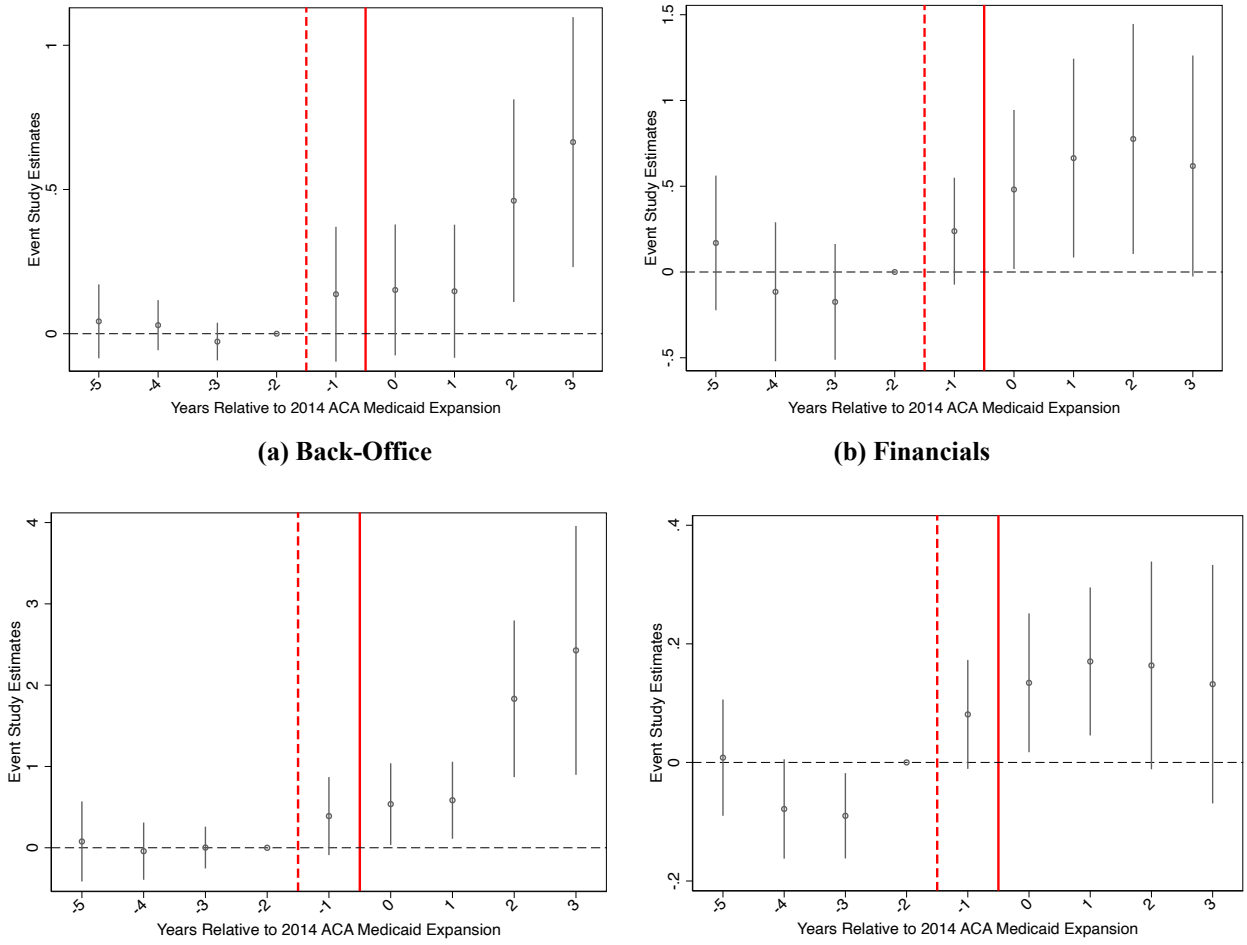


FIG. 5. EVENT STUDY ESTIMATES FOR MEDICAID EXPANSION EFFECTS

Notes: Solid vertical bar indicates the start of the Medicaid expansions in 2014. The dashed vertical bar represents the period between the summer 2012 Supreme Court decision and 2014 expansion implementation.

TABLE 5—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON HEALTH INFORMATION TECHNOLOGY (IT) ADOPTION AND CONTRACTING

	Total Health IT Solutions	Total Health IT Vendors
	(1)	(2)
Expansion State x Post	4.085***	1.378***
	(0.987)	(0.407)
Expansion State x Post x Government Hospital	–3.643**	–0.775
	(1.832)	(0.494)
Hospital FE	Yes	Yes
Year FE	Yes	Yes
Hospitals	2,869	2,869
Observations	25,821	25,821

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05

TABLE 6—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON CARE DELIVERY HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION

	Clinical Service Line	EHR	Laboratory	Pharmacy	Telemed
	(1)	(2)	(3)	(4)	(5)
Expansion State x Post	0.718***	0.202	0.185	0.066**	0.074**
	(0.221)	(0.170)	(0.102)	(0.031)	(0.035)
Expansion State x Post x Government Hospital	–0.803**	–0.531	–0.161	–0.119	–0.100***
	(0.400)	(0.444)	(0.183)	(0.067)	(0.033)
Hospital FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Hospitals	2,869	2,869	2,869	2,869	2,869
Observations	25,821	25,821	25,821	25,821	25,821

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05

TABLE 7—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON ADMINISTRATIVE HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION

	Back-Office	Financials	Info Systems	Staffing	Supply Chain	Utilization Review
	(1)	(2)	(3)	(4)	(5)	(6)
Expansion	0.311**	0.804***	1.313***	0.127	0.059	0.225***
State x Post	(0.134)	(0.274)	(0.398)	(0.152)	(0.046)	(0.069)
Expansion	–0.218	–0.738	–0.329	–0.310	–0.047	–0.288
State x Post x	(0.171)	(0.600)	(0.458)	(0.315)	(0.058)	(0.155)
Government						
Hospital						
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,869	2,869	2,869	2,869	2,869	2,869
Observations	25,821	25,821	25,821	25,821	25,821	25,821

Notes: Analytic data are from HIMSS. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05

TABLE 8—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON HEALTH INFORMATION TECHNOLOGY (IT) ADOPTION AND CONTRACTING BY NON-GOVERNMENT HOSPITALS ACCORDING TO HOSPITAL CHARACTERISTICS

	Total Health IT Solutions	Total Health IT Solutions	Total Health IT Vendors	Total Health IT Vendors
	(1)	(2)	(3)	(4)
Expansion State x Post	4.943***	4.924***	1.357***	1.539***
	(1.380)	(1.103)	(0.454)	(0.429)
Expansion State x Post x Standalone	–3.871		–0.099	
	(2.095)		(0.579)	
Expansion State x Post x Financially Weak		–2.773**		–0.375
		(1.292)		(0.510)
Hospital FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hospitals	2,218	2,098	2,218	2,098
Observations	19,962	18,882	19,962	18,882

Notes: Analytic data are from HIMSS. Government hospitals are excluded from the sample. "Standalone" is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. "Financially Weak" is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. 40% and 37% of the treatment and control group hospitals are standalone facilities, respectively. 36% and 39% of the treatment and control group hospitals are in the financially weak category, respectively. The correlation coefficient (ρ) between the "Standalone" and "Financially Weak" indicators is 0.13 and 0.08 for the treatment group and control group hospitals, respectively. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

TABLE 9—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON CARE DELIVERY HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION BY NON-GOVERNMENT HOSPITALS ACCORDING TO HOSPITAL CHARACTERISTICS

	Clinical Service Line	Clinical Service Line	EHR	EHR	Laboratory	Laboratory	Pharmacy	Pharmacy	Telemed	Telemed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Expansion	1.021***	0.882***	0.255	0.246	0.310**	0.294**	0.080	0.097***	0.049	0.060
State x Post	(0.303)	(0.253)	(0.214)	(0.158)	(0.141)	(0.126)	(0.042)	(0.036)	(0.047)	(0.042)
Expansion	–1.083**		–0.417		–0.400		–0.068		0.079	
State x Post	(0.527)		(0.238)		(0.204)		(0.056)		(0.052)	
x Standalone										
Expansion		–0.697**		–0.247		–0.393**		–0.106**		0.046
State x Post		(0.346)		(0.252)		(0.155)		(0.044)		(0.036)
x Financially Weak										
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,218	2,098	2,218	2,098	2,218	2,098	2,218	2,098	2,218	2,098
Observations	19,962	18,882	19,962	18,882	19,962	18,882	19,962	18,882	19,962	18,882

Notes: Analytic data are from HIMSS. Government hospitals are excluded from the sample. "Standalone" is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. "Financially Weak" is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. 40% and 37% of the treatment and control group hospitals are standalone facilities, respectively. 36% and 39% of the treatment and control group hospitals are in the financially weak category, respectively. The correlation coefficient (ρ) between the "Standalone" and "Financially Weak" indicators is 0.13 and 0.08 for the treatment group and control group hospitals, respectively. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

TABLE 10—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON ADMINISTRATIVE HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION BY NON-GOVERNMENT HOSPITALS ACCORDING TO HOSPITAL CHARACTERISTICS

	Back-Office	Back-Office	Financials	Financials	Info Systems	Info Systems	Staffing	Staffing	Supply Chain	Supply Chain	Utilization Review	Utilization Review
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Expansion State x Post	0.371**	0.380***	1.106***	1.020***	1.146**	1.267***	0.319	0.304	0.076	0.113**	0.300***	0.263***
	(0.151)	(0.137)	(0.369)	(0.308)	(0.456)	(0.440)	(0.221)	(0.158)	(0.053)	(0.050)	(0.087)	(0.078)
Expansion State x Post x Standalone	–0.100		–0.996**		0.125		–0.714**	–0.620***	–0.010		–0.285**	
	(0.167)		(0.480)		(0.560)		(0.306)	(0.210)	(0.071)		(0.114)	
Expansion State x Post x Financially Weak		–0.203		–0.596**		0.331				–0.162**		–0.125**
		(0.164)		(0.204)		(0.362)				(0.081)		(0.053)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,218	2,098	2,218	2,098	2,218	2,098	2,218	2,098	2,218	2,098	2,218	2,098
Observations	19,962	18,882	19,962	18,882	19,962	18,882	19,962	18,882	19,962	18,882	19,962	18,882

Notes: Analytic data are from HIMSS. Government hospitals are excluded from the sample. "Standalone" is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. "Financially Weak" is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. 40% and 37% of the treatment and control group hospitals are standalone facilities, respectively. 36% and 39% of the treatment and control group hospitals are in the financially weak category, respectively. The correlation coefficient (ρ) between the "Standalone" and "Financially Weak" indicators is 0.13 and 0.08 for the treatment group and control group hospitals, respectively. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

TABLE 11—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON HOSPITAL UNCOMPENSATED CARE BURDEN FOR NON-GOVERNMENT HOSPITALS ACCORDING TO HOSPITAL CHARACTERISTICS

	Uncompensated Care Charges ($millions)		**Uncompensated Care Costs ($millions)**	
	(1)	(2)	(3)	(4)
Expansion State x Post	–28.940***	–30.082***	–3.123**	–3.379**
	(5.784)	(6.732)	(1.415)	(1.458)
Expansion State x Post x Standalone	19.051***		1.158	
	(6.202)		(1.486)	
Expansion State x Post x Financially Weak		18.614***		1.532
		(5.126)		(1.403)
Hospital FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hospitals	2,216	2,098	2,216	2,098
Observations	19,404	18,709	19,404	18,709

Notes: Outcomes data are derived from HCRIS. Government hospitals are excluded from the sample. "Standalone" is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. "Financially Weak" is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

TABLE 12—TESTING FOR HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON HOSPITAL EMPLOYMENT BY NON-GOVERNMENT HOSPITALS ACCORDING TO HOSPITAL CHARACTERISTICS

	Full-Time RNs (logs)		**Part-Time RNs (logs)**		**Full-Time LPNs (logs)**	
	(1)	(2)	(3)	(4)	(5)	(6)
Expansion State	0.0002	–0.009	–0.088	–0.126***	–0.020	0.030
x Post	(0.020)	(0.015)	(0.053)	(0.044)	(0.059)	(0.058)
Expansion State	–0.028		–0.053		0.082	
x Post x	(0.022)		(0.071)		(0.074)	
Standalone						
Expansion State		–0.004		0.064		–0.027
x Post x		(0.027)		(0.073)		(0.058)
Financially						
Weak						
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,206	2,091	2,206	2,091	2,206	2,091
Observations	19,741	18,724	19,741	18,724	19,741	18,724

Notes: Outcomes are derived from AHA data. Government hospitals are excluded. “RN” stands for registered nurse. “LPN” stands for licensed practical nurse”. “Standalone” is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. “Financially Weak” is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

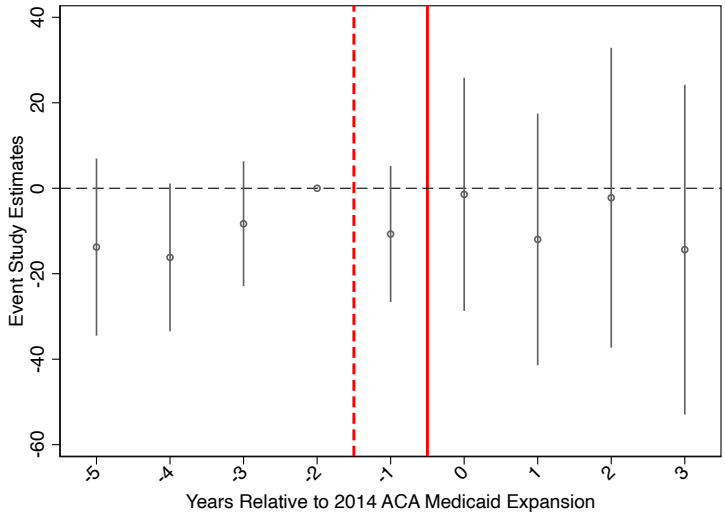


FIG. 6. EVENT STUDY ESTIMATES FOR MEDICAID EXPANSION EFFECTS ON HOSPITAL INDUSTRY ADVERTISING

Notes: Solid vertical bar indicates the start of the Medicaid expansions in 2014. The dashed vertical bar represents the period between the summer 2012 Supreme Court decision and 2014 expansion implementation. Treatment group advertisers spent $97.9 (‘000 nominal dollars) on average during the 2009-2012 period. Control group advertisers spent $111.8 (‘000 nominal dollars) on average during the same period. Analytic sample includes a balanced panel of 1,501 distinct advertising entities.

Appendix

APPENDIX TABLE A1—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON HEALTH INFORMATION TECHNOLOGY (IT) ADOPTION AND CONTRACTING BY NON-GOVERNMENT HOSPITALS THAT ARE NOT FINANCIALLY WEAK AT BASELINE AND ACCORDING TO GEOGRAPHIC MARKET

	Total Health IT Solutions	Total Health IT Solutions	Total Health IT Vendors	Total Health IT Vendors
	(1)	(2)	(3)	(4)
Expansion State x Post	6.411***	6.508***	1.108	1.353**
	(1.894)	(1.863)	(0.560)	(0.544)
Expansion State x Post x High Potential Market	–2.043		0.803	
	(2.403)		(0.639)	
Expansion State x Post x High Medicaid Denial State		–1.253		0.552
		(2.480)		(1.031)
Hospital FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hospitals	1,071	1,071	1,071	2,243
Observations	9,639	9,639	9,639	20,185

Notes: Analytic data are from HIMSS. Government hospitals as well as "Financially Weak" hospitals are excluded from the sample. "High Potential Market" is binary variable equal to one for hospitals located in counties in the top quartile of uninsured 18–64-year-olds under 138% FPL in 2013 and zero otherwise. "High Denial State" is a binary variable equal to one for hospitals located in states in the top quartile of Medicaid denial rates for submitted provider reimbursements and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

APPENDIX TABLE A2—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON CARE DELIVERY HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION BY NON-GOVERNMENT HOSPITALS THAT ARE NOT FINANCIALLY WEAK AT BASELINE AND ACCORDING TO GEOGRAPHIC MARKET

	Clinical Service Line	Clinical Service Line	EHR	EHR	Laboratory	Laboratory	Pharmacy	Pharmacy	Telemed	Telemed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Expansion State x Post	1.010***	1.210***	0.665***	0.608***	0.573***	0.651***	0.138***	0.131**	–0.003	–0.008
	(0.302)	(0.315)	(0.230)	(0.226)	(0.212)	(0.222)	(0.048)	(0.052)	(0.070)	(0.061)
Expansion State x Post x High Potential Market	0.306		–0.873**		–0.414		–0.023		0.100	
	(0.521)		(0.369)		(0.322)		(0.095)		(0.080)	
Expansion State x Post x High Medicaid Denial State		–0.035		–0.442		–0.749***		0.018		0.156
		(0.591)		(0.477)		(0.262)		(0.095)		(0.109)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071
Observations	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639

Notes: Analytic data are from HIMSS. Government hospitals as well as "Financially Weak" hospitals are excluded from the sample. "High Potential Market" is binary variable equal to one for hospitals located in counties in the top quartile of uninsured 18–64-year-olds under 138% FPL in 2013 and zero otherwise. "High Denial State" is a binary variable equal to one for hospitals located in states in the top quartile of Medicaid denial rates for submitted provider reimbursements and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

APPENDIX TABLE A3—HETEROGENEOUS MEDICAID EXPANSION EFFECTS ON ADMINISTRATIVE HEALTH INFORMATION TECHNOLOGY (IT) SOLUTIONS ADOPTION BY NON-GOVERNMENT HOSPITALS THAT ARE NOT FINANCIALLY WEAK AT BASELINE AND ACCORDING TO GEOGRAPHIC MARKET

	Back-Office	Back-Office	Financials	Financials	Info Systems	Info Systems	Staffing	Staffing	Supply Chain	Supply Chain	Utilization Review	Utilization Review
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Expansion State x Post	0.387	0.508***	1.433***	1.277**	1.083	1.067	0.727***	0.610**	0.118	0.168**	0.279**	0.295**
	(0.211)	(0.185)	(0.508)	(0.551)	(0.601)	(0.628)	(0.267)	(0.277)	(0.089)	(0.082)	(0.120)	(0.132)
Expansion State x Post x High Potential Market	0.085		–0.914		0.064		–0.591		0.058		0159	
	(0.294)		(0.648)		(0.906)		(0.372)		(0.160)		(0.179)	
Expansion State x Post x High Medicaid Denial State		–0.209		–0.173		0.233		–0.042		–0.097		0.080
		(0.355)		(0.739)		(0.997)		(0.468)		(0.111)		(0.195)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071
Observations	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639	9,639

Notes: Analytic data are from HIMSS. Government hospitals as well as "Financially Weak" hospitals are excluded from the sample. "High Potential Market" is binary variable equal to one for hospitals located in counties in the top quartile of uninsured 18–64-year-olds under 138% FPL in 2013 and zero otherwise. "High Denial State" is a binary variable equal to one for hospitals located in states in the top quartile of Medicaid denial rates for submitted provider reimbursements and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.

TABLE A4—TESTING FOR MEDICAID EXPANSION EFFECTS ON HOSPITAL CLINICAL AND BILLING EFFICIENCY AS WELL AS CARE QUALITY TIED TO THE MEDICARE PROGRAM

	Length of Stay (LOS)			**Claim Processing Days**			**Share of Claims Denied**			**In-Hospital Mortality Rate**		
	All	Non-Gov	Non-Gov	All	Non-Gov	Non-Gov	All	Non-Gov	Non-Gov	All	Non-Gov	Non-Gov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Expansion State x Post	0.064	0.048	0.046	9.041**	7.586	10.741**	–0.001	–0.001	–0.0002	0.0013**	0.0015***	0.0011
	(0.057)	(0.076)	(0.047)	(4.169)	(4.351)	(5.383)	(0.001)	(0.001)	(0.0006)	(0.0005)	(0.0006)	(0.0006)
Expansion State x Post		–0.001			3.892			–0.001			–0.0012	
		(0.156)			(2.913)			(0.001)			(0.0008)	
x Standalone												
Expansion State x Post			–0.044			–0.331			–0.0021			–0.0004
			(0.060)			(4.783)			(0.0011)			(0.0008)
x Financially Weak												
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals	2,103	1,748	1,660	2,104	1,748	1,660	2,094	1,743	1,657	2,094	1,743	1,657
Observations	18,603	15,587	14,807	18,613	15,594	14,814	18,208	15,261	14,728	18,209	15,262	14,728

Notes: Government hospitals are excluded from columns 2, 3, 5, 6, 8, 9, 11, and 12. “Standalone” is binary variable equal to one for hospitals not system-affiliated as of 2012 and zero otherwise. “Financially Weak” is a binary variable equal to one for hospitals averaging a negative operating margin during the 2009-2012 period and zero otherwise. Standard errors clustered at the state level. *** P value at 0.01 ** P value at 0.05.