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ECONOMIC CONSEQUENCES OF HOSPITAL CLOSURES

Diane E. Alexander
Michael R. Richards

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ABSTRACT

Hospitals anchor much of US health care and receive a third of all medical spending, including various subsidies. Nevertheless, some become insolvent and exit the market. Research has documented subsequent access problems; however, less is understood about broader implications. We examine over 100 rural hospital closures spanning 2005-2017 to quantify the effects on the local economy. We find sharp and persistent reductions in employment, but these localize to health care occupations and are largely driven by areas experiencing complete closures. Aggregate consumer financial health is only modestly affected, and housing markets were already depressed prior to hospital closures.

Diane E. Alexander
The Wharton School
University of Pennsylvania
Locust Walk
Philadelphia, PA 19104
and NBER
dealexa@wharton.upenn.edu

Michael R. Richards
Baylor University
Department of Economics
One Bear Place #98003
Waco, TX 76798
michael_richards@baylor.edu

1. Introduction

US hospitals have evolved over time from philanthropic-dependent entities into a mix of not-for-profit and for-profit firms, with the latter accounting for approximately 25% of all community hospitals at this time.[1] Hospitals currently number more than 6,000 across the US and capture a third of annual health spending (i.e., over $1 trillion per year).[2] Approximately 33 million inpatient stays, 140 million emergency department visits, and 700 million outpatient visits occurred among community hospitals in 2016 alone, underscoring their central role in the nation's health care apparatus and delivery system (AHA 2018). These specialized firms also perform a variety of indirect and socially valuable functions, such as implicitly financing care for the uninsured (Garthwaite, Gross, and Notowidigdo 2018) and even supplying social services in some circumstances (Ross Johnson 2018).

Beyond their direct care provision and charitable actions, hospitals can also be a key source of economic activity in their local communities. Nationally, hospitals employ roughly 4.5 million workers. This total is not far behind full-service restaurant employers, and is more than a third of the number of all US workers currently employed in manufacturing—another industry punctuated by closures over recent decades (Fort, Pierce, and Schott 2018). As is the case in manufacturing, firm closures in the hospital industry raise concerns about broader economic impacts. Some estimate that hospitals collectively generate nearly $3 trillion of economic activity throughout the

[1] Community hospitals are defined as all nonfederal, short-term general, and other special hospitals. Other special hospitals include obstetrics and gynecology; eye, ear, nose, and throat; long term acute-care; rehabilitation; orthopedic; and other individually described specialty services. Community hospitals include academic medical centers or other teaching hospitals if they are nonfederal short-term hospitals. Excluded are hospitals not accessible by the general public, such as prison hospitals or college infirmaries. Information provided by the American Hospital Association (AHA) and found here: https://www.aha.org/statistics/fast-facts-us-hospitals.

[2] Summary statistics regarding US national health expenditures are provided by the Centers for Medicare and Medicaid Services (CMS) here: https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/downloads/highlights.pdf.

US, with two-thirds of that sum stemming from downstream, or "ripple", effects on other industries and sectors (AHA 2018). Such figures suggest that hospitals are not only vital for providing access to acute and discretionary medical services, but they may also serve their surrounding communities as an economic anchor, if not an engine for growth.

Yet, hospitals' duality as a care supplier and key employer does not insulate them against financial struggles. These challenges are often most severely felt within rural communities, where low occupancy rates coupled with high fixed costs can generate negative and unsustainable margins for hospitals (Wishner *et al*. 2016; Frakt 2019; Bai *et al*. 2020; GAO 2020; Kacick 2020). A growing wave of insolvencies and subsequent closures has recently taken place—leading some to declare a crisis for rural America (Chartis Center for Rural Health 2020), and which may worsen with the continued fallout from COVID-19 (Kacick 2020). This wave of closures is also occurring against a backdrop of more pronounced provider shortages, greater disease burden, and lower life expectancy among rural areas when compared to their urban counterparts (Iglehart 2018; Cross *et al*. 2020; Cross, Califf, and Warraich 2021).[3]

Hospitals' market exits have unsurprisingly attracted increasing attention from researchers and policymakers. Contemporary empirical studies find that hospital closures impede patients' access to care, especially for time-sensitive conditions in more rural geographies (Buchmueller 2006; Carrol 2019; Gurjal and Basu 2019; Song and Saghafian 2019; GAO 2020; Miller *et al*. 2020; McCarthy *et al*. 2021; Nikpay *et al*. 2021), and rural hospital closures have emerged as an issue of concern from the Biden Administration.[4,5] Beyond health care access, the broader

[3] Of note, some research suggests that recent Medicaid expansions have benefit rural hospitals' finances to some degree and perhaps forestalled some closure events (Lindrooth *et al*. 2018; Bai *et al*. 2020).

[4] Although, the evidence is mixed (e.g., Rosenbach and Dayhoff 1995, Joynt *et al*. 2015).

[5] https://www.whitehouse.gov/briefing-room/statements-releases/2021/07/09/fact-sheet-executive-order-on-promoting-competition-in-the-american-economy/

economic implications from rural hospital closures are also of research interest, and are often presented as a key rational for policy intervention (e.g., MedPAC 2016; Frakt 2019).

In this paper, we aim to better understand the broader economic ramifications of this contemporary health care phenomenon. We do so by combining a census of rural hospital closures across the US from 2005 through 2017 with a unique collection of granular county-level measures on employment, consumer financial status, and housing market activity. We use generalized differences-in-differences and event study analyses to quantify if, and to what degree, hospital exits in rural areas impact the local economy. We subject our findings to a battery of robustness checks, such as alternative control groups, and alternative estimation strategies to address potential issues with the differential timing in treatment—i.e., closure events—over our analytic period (e.g., see Goodman-Bacon 2018).

While our estimates reveal strong and sharp negative effects on local employment levels, the declines are largely confined to health care jobs. Implications for overall consumer credit worthiness or financial strain in these communities are more muted. Housing markets are depressed in rural areas experiencing closures, but the declines begin in the years leading up to the hospital closure, with no evidence of housing markets further worsening after the market exit. The empirical patterns tied to housing are more consistent with population losses creating financial challenges for rural hospitals, as opposed to the closure of the hospital driving away residents and/or weakening the attraction of new residents to the area.

We also conduct a supplementary analysis to examine heterogeneity in effects according to characteristics of the closure. We find evidence suggesting that the closure of rural Critical Access Hospitals (CAHs), specifically, have larger negative effects on the local health care labor market, as well as local consumer credit worthiness, when compared to the closure other rural

hospitals. We also look at heterogeneity along the dimension of whether any of the hospitals' assets were repurposed, as opposed to a complete shutdown of the health care delivery. The results demonstrate that full closures are associated with stronger economic effects compared to partial, particularly with respect to labor market outcomes. Though these analyses require more circumspect interpretation, they offer some useful nuance that can be informative for policymakers that may be trying to minimize the economic fallout from rural hospital closures. If rural economies are sufficiently resilient to withstand the loss of a local inpatient hospital, especially when some of the health care industry remains, federal funds might witness greater returns when targeting other economic challenges facing these communities, rather than being used to forestall an inpatient facility's market exit.

While other researchers have studied the economic effects of hospital closures in rural communities, the conclusions have been mixed—perhaps partly due to the fact that much of the literature does not account for the potential of reverse causality. Earlier work, for example, estimated lower consumer welfare when a rural community loses a hospital (McNamara 1999), and Holmes *et al*. 2006 finds lower per capita income and higher unemployment when a sole community hospital closes—but the study period is well-before the recent acceleration of rural hospital closures (data covers the 1990s), and the estimation approach does not reveal whether the outcomes were evolving similarly in the lead up to a closure or demonstrate the persistency of any effects. Conversely, looking at a shorter time frame (1998-2000) in three states, Ona, Hudoyo, and Freshwater (2007) fail to detect any economic effects from rural hospital closures, which aligns with equivocal or null results from studies focused on communities in the 1980s (Probst *et al*. 1999; Pearson and Tajalli 2003). A contemporary study from Edmiston (2019) finds closures between 2011 and 2016 to be negatively associated with general employment and wages; however,

the analyses are primarily descriptive, rather than causal, in nature. A recent working paper from Vogler (2021) reports sweeping negative effects of rural hospital closures, primarily focusing on overall labor market outcomes.[6] While we also find significant effects of closures on employment, our industry-level results take this analysis a step farther and show that these effects are limited to the health care sector, with minimal evidence of spillovers. Our comprehensive data on consumer finances and housing markets also allow for a more detailed examination of closures' impacts on local economic activity.

In sum, we offer a highly policy relevant and comprehensive collection of findings for policymakers, which document both the direct and indirect effects of rural hospital closures on local economies. These estimates fill an important gap in the literature, as significant public resources have subsidized rural hospitals for roughly four decades, despite a lack of consensus around the full costs (i.e., health and economic) to communities that experience a hospital closure. The bulk of these funds come from the federal Medicare program, and add more than $4 billion to the public insurer's annual expenditures (MedPAC 2016). While the US health care sector is a considerable source of jobs and employment growth (Baicker and Chandra 2012; Frogner 2018), a substantial portion of the sector's financing comes through taxation. Important tradeoffs must be considered when using public financing to promote the sector's role in employment to avoid fomenting a "wildly inefficient jobs program" (Baicker and Chandra 2012). Our results are also timely, as the US health care sector has been the recipient of large, new funding injections (via the

[6] It is difficult to directly compare our results to those of Vogler (2021), as much of the data, data construction, and regression specifications for closure effects differ across the two papers. The one dataset in common between our analyses and Vogler (2021) is the Quarterly Census of Employment and Wages (QCEW); we both find a decrease in log employment after hospital closures—though Vogler reports non-health care jobs as being a key driver of the employment declines. Our results are not consistent with such an interpretation.

CARES Act and follow-on legislation), with additional support possibly needed in the future. Allocating such funds wisely can ensure their efficient use and maximize their intended benefits.

2. Background

2.1 Rural Hospital Landscape

At this time, just under 2,000 hospitals across the US are considered rural community hospitals.[7] The current regulatory regime for rural hospitals began in 1997, when the Rural Primary Care Hospital (RPCH) program was transformed into the Critical Access Hospital (CAH) program.[8] Receiving the CAH designation requires accepting certain constraints (e.g., maintaining inpatient bed capacity, but fewer than 25 beds, and limiting their average patient length of stay) but also entitles a hospital to generous cost-based reimbursements from Medicare (as opposed to the standard prospective payment system used to reimburse other hospitals) and was developed with the aim of propping up financially ailing rural hospitals. Roughly half of all current rural hospitals across the US are part of the CAH program (MedPAC 2016; Iglehart 2018; Bai *et al*. 2020). Some recent research finds that the CAH program mitigates the risk of rural hospital closure—though the net effects on consumer welfare are not necessarily favorable (MedPAC 2012; Gowrisankaran *et al*. 2018; Carrol 2019).

[7]Around 35% of all community hospitals in the US are rural community hospitals. Information provided by the American Hospital Association (AHA) and found here: https://www.aha.org/statistics/fast-facts-us-hospitals.

[8] Historically, much of the rural hospital infrastructure began and expanded as part of the Hill-Burton Act in 1946 (Wishner *et al*. 2016; Iglehart 2018). To help support and sustain these firms, various forms of transfer programs launched during the 1980s. The Sole Community Hospital program and Rural Primary Care Hospitals (RPCHs) were two of the early interventions. Then, in 1987, the federal government created a new administrative branch solely devoted to health and policy affairs concerning rural areas: the Federal Office of Rural Health Policy. Shortly after, in 1989, the federal government introduced another new hospital classification, the Medicare Dependent Hospital, that intended to target additional attention and resources to these facilities to help ensure their survival.

2.2 Rural Hospital Closures and Policy Considerations

A series of rural hospital closures in recent years has attracted considerable media, industry, and policymaker attention. While issues related to health care access are typically of immediate concern, a wider range of potential negative economic consequences are also often highlighted.[9] Local media reports and isolated case studies of finalized or looming rural hospital closures often remark on the number of individuals previously working for the hospital, as well as community leader concerns over retaining as well as attracting other businesses to the area (Wishner *et al*. 2016; Associated Press 2019, 2020a). It is at least plausible that the compounding loss of high earners, as well as central figures in the local health care industry, could further challenge these communities in the wake of losing their local hospital.

In response, legislation is currently being introduced at both the federal and state levels to stem further losses of rural hospitals. Policymakers are primarily motivated by two salient rationales: preserving access and preserving jobs in these communities (Associated Press 2020b). More specifically, the Coronavirus Aid, Relief, and Economic Security (CARES) Act included special transfers restricted to roughly 1,800 rural hospitals across the US (Brady 2020). The bipartisan Save Rural Hospitals Act—introduced in the US House of Representatives in 2017—would undo spending cuts for these hospitals and possibly increase some of their payments (Sharfstein 2016; Wishner *et al*. 2016).[10]

[9] Research focused on the 1980s argues that rural towns suffer losses of local physicians when a key hospital shuts down (Hart, Pirani, and Rosenblatt 1995). More recently, Drew Germack, Kandrack, and Martsolf (2019) examined physician supply following rural hospital closures and found suggestive evidence of negative economic effects when using American Hospital Association and the Area Health Resource Files databases. Of note, the event study analyses in Germack, Kandrack, and Martsolf (2019) demonstrate substantive differential trending in the years leading up to an observed closure in the AHA data, and statistically significant post-closure effects are not evident until 4–6 years after the county experienced a closure.

[10] The Save Rural Hospitals Act was introduced in the house in 2017, sponsored by Representatives Sam Graves (R-MO) and Dave Loebsack (D-IA).

Yet, it remains an open question as to whether subsidies for rural hospitals are appropriately targeted or the most efficient use of public funds. For instance, 16% of so-called critical access hospitals (CAHs) are within fifteen miles of another hospital (MedPAC 2012)—indicative of readily available substitute facilities and access points for rural consumers at only modest additional travel costs. Furthermore, among CAHs that closed in 2014, their median Medicare payment rate was $500,000 above what these same hospitals would have received under the standard Inpatient Prospective Payment System (IPPS) that has applied to most hospitals in the US since 1983 (MedPAC 2016). In other words, Medicare spent millions of dollars in excess payments for hospitals that still failed to remain solvent under a generous (i.e., cost-based) reimbursement system, and which may have readily available substitutes.

For these reasons, a growing policy chorus has emerged to encourage more tailored interventions that explicitly take into account what services are most needed in rural settings (e.g., emergency and ambulatory medical care), and how best to ensure their availability for rural residents (MedPAC 2016). For example, a recent federal policy initiative, the Rural Emergency Acute Care Hospital (REACH) Act, aims to create a new hospital classification for Medicare reimbursement that would allow a facility to narrow its scope to emergency care and outpatient services only (i.e., no longer maintain inpatient beds) and then receive cost-based payments for these services (Kacick 2020). Proponents argue that such customization can maintain sufficient rural care access while lowering some of the cost burden on public finances.

In what follows, our empirics are able to speak to these arguments by taking a comprehensive look at the economic fallout from rural hospital closures and contrasting the empirical patterns between full and partial hospital closures—with the latter effectively representing a version of what the REACH Act and related policy approaches would aim to do.

3. Data

3.1 Rural Hospital Closures

The Cecil G. Sheps Center for Health Services Research at the University of North Carolina leverages a variety of sources to track rural hospital closures across the US dating back to 2005. A rural hospital is defined as a short-term, general acute care (and non-federal) hospital that operates outside of a metropolitan county, operates within a census rural-urban commuting area (RUCA) type 4 county, or operates as a designated CAH. The center follows the federal Office of Inspector General in defining a closed hospital as "…a facility that stopped providing general, short-term, acute inpatient care." Hospital mergers, changes of ownership, or CAH conversions are excluded from the closure count. Additionally, if a hospital closed and then reopened within the same calendar year and physical location, then it is not recorded as a rural hospital closure in the database. The data also differentiate between full hospital closures and partial closures, whereby the inpatient unit is discontinued but other services (e.g., emergency care, rehabilitation services, or outpatient care) remain. Importantly, each closure (full or partial) event has a precise calendar date and associated county location. These features make our subsequent empirical strategies feasible, and these data are also publicly available.[11]

Figure 1 displays the corresponding trends in national closure counts by the type of closure. Rural hospital closures have accelerated since the Great Recession, and within a typical year, the majority of closures are full market exits. Figure 2 characterizes the geographic dispersion of these closures over the 2005-2019 period. Rural hospitals have ceased operations within most regions

[11] The data and their full description can be accessed here: https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/. Of note, for a minority of closure cases, we had to supplement the Center's information with our own web-based information gathering to determine the exact closure taxonomy (i.e., full or partial) for a given closure event. A few closure events could not be cleanly assigned to a closure type.

of the US; though, certain states (e.g., Texas) have witnessed comparatively larger waves of closures during this time.

2.2 Employment

Our county-level employment information comes from the Quarterly Census of Employment and Wages (QCEW), which is collected and made available by the US Bureau of Labor Statistics. The data provide counts of employment by industry, and are estimated to cover more than 95% of all US jobs. We use the quarterly data beginning in 2001 and going through 2018, and more specifically, the counts of total employment, private sector employment, health and education employment, and non-health and non-education private sector employment. The latter three counts are defined by the accompanying private sectors NAICS codes. One drawback of these quarterly data is the inability to separate education employment from health services employment (i.e., within the combined NAICS 1025 code); however, we believe the estimation advantages of having more granular timing (i.e., quarterly increments) more than offsets this specific data limitation. Moreover, the clear linkage between our market events of interest (i.e., hospital closures) and health care industries suggest that within-county changes in employment levels proximate to these market events should be overwhelmingly driven by adjustments to the local health care workforce, as opposed to education jobs.[12] We also restrict to counties with complete (i.e., non-missing) count information for each employment sector for each of the 72 quarters belonging to our 2001-2018 QCEW data.

[12] Additionally, many of these communities' education industry workers are likely to work in the public sector, rather than the private sector.

3.3 Consumer Financial Health

Our data on consumer financial information comes from the Federal Reserve Bank of New York Equifax Consumer Credit Panel (FRBNY CCP/ Equifax). This dataset consists of detailed credit-report data for a unique longitudinal panel of individuals and households in quarterly increments from the first quarter of 2000 to the first quarter of 2020. The anonymized panel tracks a nationally representative 5% random sample of individuals in the US with a credit file and a social security number. The underlying data are at the individual-quarter level, which we then collapse to the county-quarter level.[13] From the FRBNY CCP/Equifax we construct several summary measures of consumer financial health. In particular, we construct the average Equifax Risk Score (referred to as 'risk score' from here on), the average number of bankruptcies in the last 24 months, the average total balance past due, and the average number of 3rd party collections (i.e., collections not handled by the original creditor) in the past twelve months.[14]

3.4 Housing Market Activity

The Home Mortgage Disclosure Act (HMDA) Database is composed of records from originations and purchases of mortgages, as well as from loan applications that were withdrawn or denied. Included in the data are loan characteristics and outcomes, collateral characteristics, and information on applicant demographics. The data is reported by depository institutions and certain for-profit, non-depository institutions, as required by the original Home Mortgage Disclosure Act

[13] We drop any county-quarter observations with less than 20 underlying observations for privacy concerns.

[14] FRBNY CCP/Equifax data assets are only the source of the analytic data containing these specific outcomes describing consumer financial health; all of the calculations or subsequent findings and interpretations relying on this data source are conclusions of the authors; any mistakes are our own.

legislation from 1975, as well as later amendments.[15] The Federal Financial Institutions Examination Council (FFIEC) compiles the data, which is available annually; the collection effort has been spearheaded by the Consumer Financial Protection Bureau (CFPB) since the 2017 reporting year.

In order to look at county-level housing market activity in the years before and after the hospital closure, we look at the total number of loans originated, denied, and purchased in each county-year from 2001 to 2018. We also construct a measure of the average loan amount for these loan categories, and separate loans into three loan purpose categories (home purchase, home improvement, refinance), and by applicant race categories (white, black, and other) in order to see whether there is any change in the composition of loans over the time period.

4. Empirical Strategy

4.1 Primary Analytic Approach

To examine the effect of rural hospital closures on the local economy, we use a generalized differences-in-differences (DD) estimation approach. This approach is analogous to other recent economics research studying health care market events (e.g., Eliason *et al*. 2019; Prager and Schmitt 2021). Our treated counties are those that experience a rural hospital closure over the 2005-2017 period. We use counties that never experience a closure during this time interval, have at least 25% of the county population classified as rural according to the 2000 Census, and have a hospital present in the county as of 2005 to comprise the control comparison group. The latter

[15] Not all lenders must participate in HMDA reporting. The requirements, which have changed over time, depend on the lender's asset size, whether it participates in residential mortgage lending, and whether it has a home or branch office in a metropolitan statistical area, among other factors.

control group inclusion characteristic is derived from the American Hospital Association annual survey from 2005, and restricts to non-government, general acute care hospitals. While the exact number of counties in the analysis varies slightly by dataset, roughly 120 counties are classified as treated, and more than 1,600 counties as controls (see Table 1).[16]

Table 1 summarizes our outcome variables across our two groups of counties (i.e., the treatment and control groups). The overall population, and hence size of the labor market and housing market activity, is larger, on average, among counties that experience a rural hospital closure during our analytic period when compared to our control group counties. However, the dollar amounts of the housing loans as well as income profiles of borrower applicants is quite similar across the treatment and control groups in Table 1. Similarly, average credit risk scores and bankruptcy rates over the preceding 24 months are for counties losing their hospitals are on par with those from counties that do not experience this market event during our study period.

Our first generalized DD estimating equation takes the form:

$$Y_{cqt} = \delta RuralClosure_{cqt} + \lambda_c + \eta_q + \kappa_t + \varepsilon_{cqt} \quad (1)$$

Our outcomes (Y) are levels of employment for a given worker type for a given county-quarter-year in the QCEW data (and log transformed), and our aggregate consumer financial health and housing market outcomes are as described in Section 2.3 and Section 2.4. Equation (1) also

[16] The large number of never-treated control counties relative to counties experiencing a closure is analytically helpful when using two-way fixed effects estimation to recover a DD estimate since the overwhelming majority of our counties are "never treated" units, meaning that our key 2x2 comparison is almost entirely between treated units and never treated units, which avoids complications from a large number of "always treated" units and/or when most of the units are eventually treated in the presence of treatment effect heterogeneity (see Goodman-Bacon 2018 for a detailed discussion of the generalized differences-in-differences econometric properties).

includes county fixed effects (λ), quarter fixed effects (η), and year fixed effects (κ). The δ parameter for the *RuralClosure* variable is our DD estimate of interest.

To strengthen our inferences, and allow for an investigation of how the economic variables were trending in the treatment and control counties prior to the closure, we further adapt our setup in Equation (1) to an event study model:

$$Y_{cqt} = \sum_{\substack{j=-13^{+} \\ j\neq -4}}^{-1} \gamma_j \left[\mathbf{1}(T_c + j)\right] + \sum_{j=0}^{13^{+}} \delta_j \left[\mathbf{1}\left(T_c + j\right)\right] + \lambda_c + \eta_q + \kappa_t + \varepsilon_{cqt} \quad (2)$$

The variable T_c represents the quarter-year a given treated county (c) experiences a rural hospital closure. We then create a series of quarterly event-time dummies (j) that capture the periods leading up to and following the closure event and span three years in each direction. The omitted time point is four quarters (i.e., one year) prior to the county's closure event at time T_c. We also have a summary time dummy for less (more) than three years before (after) the closure event. Doing so results in a set of pre-closure parameters (γ_j) to inform how the treatment and control counties are trending prior to the closure event.

Parallel trends are needed to support a causal interpretation of the DD research design; however, the behavior of the outcomes in the years before a hospital formally closes can also be of independent empirical interest. Equation (2) allows us to examine any pre-closure changes across our outcomes of interest.[17] Additionally, the series of δ_j parameters can flexibly allow for

[17] For example, previous work demonstrates that rural hospitals financial performance suffers during the lead up to the actual closure event, especially within a year of closure (Kaufman *et al*. 2016; Bai *et al*. 2020; Chartis Center for Rural Health 2020).

any dynamics in the hospital closure effects over time. Across all three analytic data sets and accompanying estimations, the standard errors are clustered at the county level throughout.[18]

We remove counties (32 in total) that experience a rural hospital closure in 2018 or 2019 due to insufficient post-period data, and concerns that their pre-closure labor market changes could distort the behavior of the control group and thereby bias our DD estimates. We are also forced to estimate a modified version of Equation (2) when relying on the HMDA analytic data due to differences in the available data timespan and time intervals of data reporting (i.e., yearly as opposed to quarterly). Specifically, we condense the DD event-time range to [–6, 6] annual time periods relative to the hospital closure event. We still use the year prior to closure (in this case t – 1) as the omitted time period. The application of the event study model is otherwise unchanged from its use on the quarterly analytic data sets for employment and consumer finances.

4.2 Empirical Challenges

Our primary empirical challenge is the differential timing in closure among our treatment group counties. As previously noted, our control group is overwhelmingly comprised of never treated units; yet, there could still be concerns that the generalized DD weighting may be distorting our estimates and/or the pre-closure evolution in our outcomes of interest.

To address this issue, we implement a robustness exercise that relies on a "stacked" event study methodology. First, we only include treated counties where we can observe their outcomes 12 quarters before the hospital closure event and 12 quarters after (i.e., those exhibiting full

[18] Importantly, neither Equation (1) or Equation (2) contain time-varying county characteristics as right-hand-side variables. Given that we are examining the economic impacts of rural hospital closures changes in any commonly used geographic characteristics (e.g., population demographics, unemployment rates, poverty rates, etc.) are potential outcomes from the market shock. Thus, their inclusion in the estimation would risk endogeneity bias from using potential outcomes as covariates (i.e., using "bad controls").

information pre- and post-closure). Next, we take all of our available control group counties from Section 4.1 and randomly assign them a placebo closure date based on the sample of actual closure dates observed within our treated units. Anchored to a control unit's placebo date, we retain the 12 quarters before and after the randomly assigned placebo date. All potential control units without the full [–12, +12] data available are subsequently excluded from the stacked event study regressions—paralleling what is done for the treatment group. This process leaves us with a balanced panel (25 quarters in total) of treatment and control counties where the $t = 0$ time point is either the actual hospital closure quarter (treated units) or a placebo closure quarter (control units) so that all units contribute the exact same amount of analytic information.[19] We then re-estimate Equation (2) on this stacked event study estimation sample to compare to the results from our primary estimation approach (Section 4.1). The only departure is that we no longer require the summary long (i.e., +/– 13 quarters) event time dummies when using this refined analytic sample.

We also thoroughly test the robustness of our main specification from Equation (1) to using different criteria for defining control group counties. Specifically, we adjust the chosen threshold of rurality for analytic sample inclusion from 25% to 50% and then to 75% of the county's population based on the 2000 US census information. Similar estimates across control group options from this exercise, coupled with our main event study and stacked event study results, offer assurances that our empirical inferences are robust and valid.

[19] In other words, we have deliberately imposed an analytic environment where treatment "turns on" at the same time for all treated units and there is no up- or down-weighting of treated units based on their specific timing of treatment during our full study period.

5. Effects on Employment, Consumer Financial Health, and Housing Markets

We find that rural hospital closure is associated with a 2.9% decline in overall employment, and a more precisely estimated 3.7% decline in private sector employment (top panel of Table 2, columns 1 and 2). However, it is clear from columns 3 and 4 in the top panel of Table 2 that the bulk of these employment declines occur within health care related occupations. There is a strongly significant and approximately 10.6% drop in health care employment following a rural hospital closure, whereas the estimate in column 4 demonstrates a statistically insignificant 2.2% decline for all other private sector jobs.[20] The lack of detectable effect in column 4 implies no clear negative spillover effect (i.e., reduced employment in other industries) and no obvious job switching out of health care and into other sectors of the economy—at least over the short-run.

The corresponding event studies in Figure 3 support a causal interpretation of the effects of hospital closures on health care employment found in Table 2. The treatment and control counties track each other closely until the rural hospital closure event. At that point, employment levels sharply fall until roughly one year following closure and remain depressed from then on. The most dramatic changes are again found within health care jobs (Panel C). The post-closure event-time estimates approximately range from 10-to-13% decreases in health care service employment during the first three years after a rural hospital has closed. There is no compelling evidence in Panel D with respect to non-health care related jobs. The event study coefficients are very close to zero in the year preceding and following the hospital closures. The stacked event study estimations produce identical findings (Figure A1), with parallel trending prior to the closure event and then a sharp decline in employment once a rural hospital has closed; the entire decline is again localized in health care related industries. Similarly, altering the inclusion criteria for

[20] Percent changes are calculated by exponentiating the DD coefficient from the top panel of Table 2 since all of the employment outcomes are in logs.

control group counties (Table A2-A4) has no material effect on the DD estimates and inferences described in Table 2.

While we find clear evidence of a causal impact of rural hospital closures on local employment in health care industries, the effect on average consumer financial health is more muted (middle panel of Table 2). We find a 0.7-point decrease in a county's average credit score in the aftermath of a rural hospital closure; however, the estimate is imprecise. Given the sample mean risk score of 690, we can at least rule out large changes in average credit worthiness. The event study result for the risk score outcome (Panel A, Figure 4) demonstrates a pattern suggestive of a rural hospital closure effect; however, the individual post-period estimates again lack sufficient precision at conventional levels. There is no detectable effect on collections or recent bankruptcies—with the latter outcome relatively rare in the data. While there is a statistically significant increase in the average total balance past due in Table 2 (the approximately $62 effect translates to a 7% increase relative to the sample mean), the event study results for the total amount past due (Panel C, Figure 4) show some evidence suggesting a possibility of differing pre-trends.

For both risk scores and total balance past due, the stacked event study results (Figure A2) are equally or better behaved in the pre-period, and offer a more compelling demonstration of post-closure effects. By two years after the closure event, the average credit worthiness is down by 1 point and the total balanced past due is roughly $50-$70 higher within these affected counties. The stacked event study estimations still show no closure effects on recent bankruptcies or the number of collections reported. Re-estimating Equation (1) with the alternative control groups (Table A2-A4) generates a qualitatively similar pattern for the consumer financial outcomes. If anything, our preferred analytic sample may slightly understate the closure effects on consumer risk scores and total debt amounts past due.

Finally, places which experience a hospital closure were already experiencing worsening local housing market economic indicators prior to the closure. While the bottom panel of Table 2 reveals large and statistically significant DD estimates for all three housing market activity outcomes, it is clear in Figure 5 (as well as the stacked versions in Figure A3) that these results reflect strong differing pre-trends, rather than a discrete change at the closure event. These differing pre-trends also align with commonly reported root causes of rural hospital financial struggles—namely, declining populations and high fixed costs. Examining additional and more nuanced housing market outcomes in Table 3 demonstrates a similar pattern of results. Quantities of loans are declining, irrespective of type, but this again reflects depressed housing market activity during the years leading up to the rural hospital closure, rather than a shock to housing markets following closure (Figure A4). The patterns are not obviously different for different ethnic groups of borrowers (Figure A5), and the dollar values of the loans are largely unchanged in the wake of a rural hospital closure (columns 4-6, Table 3, Figure A6).

6. Heterogeneity

6.1 Critical Access Hospital Status

The longstanding CAH program aims to forestall rural hospital closures in order to preserve access for surrounding communities. The program design and its possible targeting suggest that the effects of closing a CAH designated hospital could differ from other, non-CAH facilities (40% of the observed closures in our analytic samples belong to the CAH program).

We investigate this potential heterogeneity by modifying our previous DD estimating equation, Equation (1), to incorporate two separate DD parameters:

$$Y_{cqt} = \beta_1 NonCAHClosure_{cqt} + \beta_2 CAHClosure_{cqt} + \lambda_c + \eta_q + \kappa_t + \varepsilon_{cqt} \quad (3)$$

Specifically, for Equation (3), we categorize each hospital closure as being either a non-CAH closure or a CAH closure. The resulting coefficients (β_1, β_2) then inform whether the overall results displayed in Table 2 are driven by either type of rural hospital closure. The outcomes and remaining elements of Equation (3) are identical to our DD estimations in Section III.

Table 4 reports the results from our CAH heterogeneity exploration across the three domains of economic outcomes. The negative effects on overall and private sector employment are directionally the same and also modest in magnitude across non-CAH and CAH closures in the top panel of Table 5. When focused on health care workers, both hospital types are associated with large and statistically significant negative effects on employment levels—i.e., 9% and 12% reductions for non-CAH and CAH closures, respectively.[21] That the magnitude of the closure effect is one-third larger in relative terms, these results could suggest that the local health care economy is more dependent on the hospital in areas that rely on a CAH. However, the estimate is not sufficiently precise (i.e., the confidence intervals are overlapping across the two DD estimates) to conclude that the labor market impact is, in fact, more severe following a CAH closure. Neither type of rural hospital closure exhibits a detectable impact on private sector employment in non-health related industries.

The consumer financial outcomes in the middle panel of Table 5 do not reveal consistent differences across the two hospital closure types; although, it is clear from the first column of estimates that any county-level credit score reduction is coming from the negative effects felt in

[21] As before, the percent changes are calculated by exponentiating the DD coefficient in the top panel of Table 4 for our employment outcomes.

areas where a CAH closed. The magnitude of the CAH closure effect on local residents' overall credit worthiness is also comparable to some recent findings from public insurance contractions (Argys *et al*. 2020). This empirical pattern could be consistent with these particular hospitals wielding greater influence in the local health care economy and related labor markets, and therefore having stronger local economic ramifications when closing. Interestingly, the housing market declines detailed in Section 5 seem to load more strongly on counties experiencing non-CAH closure events (bottom panel, Table 5). These patterns are suggestive of different mechanisms possibly driving CAH and non-CAH rural hospital closures, where the latter seems more closely linked to overall local economic decline.

6.2 Full versus Partial Closures

Our final empirical exercise examines whether the effects of rural hospital closures on local economic outcomes differ by the degree of closure (i.e., full versus partial). Partial closures or facility repurposing efforts commonly include transitions to emergency services, urgent care, outpatient care, and/or skilled nursing facilities, which could plausibly preserve many of the jobs previously attached to the inpatient care unit. The existing literature has typically not differentiated between true closures and rural hospital conversions (Kaufman *et al*. 2016), which creates some interpretation and policy prescription ambiguity.

These analyses also introduce their own empirical complications, however, as the decision to preserve some service lines, rather than implement a full shutdown, likely reflects a variety of market conditions and possibly their evolution leading up to closure deliberations and decisions. Figure 6, for example, shows the 30-year trends in median household income and prevailing poverty rate for three mutually exclusive county types: 1) those experiencing a partial closure 2)

those experiencing a full closure and 3) those never experiencing either type of rural hospital closure and belonging to our DD control group. Counties that eventually have their rural hospital fully close have consistently lower incomes and higher poverty rates on average, compared to the other two groups, which tend to look more similar. We consequently view these supplementary analyses as largely descriptive. Yet, given the similarity between the partial closures we observe in the data and the goal of recent policy proposals, which have essentially advocated for subsidy programs that would favor partial closures over full closures of rural hospitals, we believe these analyses are still informative (with important caveats).[22]

We modify Equation (1) in the same manner as in Equation (3) to explore any differences across this rural hospital closure taxonomy:

$$Y_{cqt} = \beta_1 PartClosure_{cqt} + \beta_2 FullClosure_{cqt} + \lambda_c + \eta_q + \kappa_t + \varepsilon_{cqt} \quad (4)$$

As before, the sole departure from Equation (1) is the presence of two separate DD indicator variables (i.e., *FullClosure* and *PartClosure*) for full rural hospital closures and partial rural hospital closures, respectively. The model is otherwise unchanged—though as noted, the assumptions needed to ascribe causal interpretations to the DD estimates are stronger.

Table 5 presents the results from investigating heterogeneity by hospital closure type (Equation (4)). Unsurprisingly, the closure effects on local health care related jobs are larger and more precisely estimated for full closures, with the magnitude of the effect more than twice as large as partial closures and translating to an approximately 16% decline in employment levels.

[22] Appendix Table A1 provides summary statistics across all of our closure types underlying our heterogeneity analyses in Section 6.

There is also suggestive evidence in column 4 that full closures lead to a negative spillover effect (4%) on employment in other (non-health care) industries, though this may also stem from differing pre-trends in these areas, which tend to be worse off. Areas experiencing partial closures demonstrate a more modest 6% decline in health care employment and no employment reductions among other job types. For consumer finances and housing market activity the DD coefficients are generally not substantively different across the closure types and typically lack sufficient precision to claim a differential impact on these specific outcomes.

Taken together, there is, at least, suggestive evidence in Table 5 that areas which are able to repurpose an existing hospital into some other type of health care facility may benefit from smaller overall impacts on their local health care industries and economies.[23] Additionally, such an approach, which some recent policy proposals would encourage, may be easier to adapt to local market conditions as well as health needs and priorities than the more rigid CAH requirements that must be met to qualify for enhanced Medicare reimbursements.

7. Discussion and Conclusions

The hospital industry captures the largest share of annual US health care spending among all medical service suppliers; yet, certain members of the industry—namely rural hospitals—have experienced a wave of financial insolvencies during the past decade. While hospitals have clear and vital roles within health care delivery, many argue that their broader economic impacts can be equally important to lower resourced and less populated communities. Empirically, we find weaker employment and consumer credit worthiness following rural hospital closures. However, the former is concentrated almost entirely among health care related jobs, and the latter effect is small

[23] Appendix Tables A5-A8 repeat the descriptive exercise in Section 6.2 for additional housing market outcomes as well as when further stratifying the closures according to CAH or non-CAH status.

in magnitude and only found among counties losing a CAH. In contrast, local housing markets in these areas are suffering both in the lead up to the closure event and its aftermath, but are not further depressed by the local hospital shutting down.

While hospital closures do not cause broad-based negative spillovers to the local economy, to the extent that those losing health care jobs do not find employment in other local industries, there will be a substantial loss of tax revenue for local governments. To quantify the loss in tax base from health care-related job loss, we conduct a simple back-of-the-envelope calculation. From Table 2, we found a 10.6% reduction, on average, in the health care labor force following a rural hospital closure. Examining the labor markets in these same counties one year prior to the closure event in the QCEW reveals a median health care (and education) workforce size of roughly 3,905 individuals, with a median weekly wage of $610 in nominal dollars.[24] Our DD estimate consequently implies an average loss of 414 health care workers in a representative rural county—with each worker making roughly $30,500 annually when assuming 50 working weeks per year.[25] Combining these estimates suggests an average lost tax base of $12.6 million for counties experiencing a rural hospital closure, along with the associated economic activity. Conducting the same calculation using our estimates for the overall labor force reveals a less precisely estimated but larger in magnitude reduction in jobs (roughly 980 jobs, with a 95% confidence interval of 196 to 1791), suggesting that health care workers that lose their job after a hospital closure do not

[24] We use the median worker count because the mean is substantively distorted by a long right tail. The mean weekly wage for health care industry workers in these counties is $618.

[25] As the health care sector is combined with the education sector in the QCEW data, this wage estimate may be biased downwards by the inclusion of relatively lower paying educational workers.

substitute into new jobs within the county.[26] Thus, from the perspective of typical local government, a hospital closure will result in approximately $13 million in lost tax base.

While our analysis of the economic effects of rural hospital closures from 2005-2017 does not reveal economic damage as severe or far-reaching, on average, as sometimes feared or portrayed in media reporting and case studies, it does demonstrate a clear negative shock for local government finances. It is not surprising, therefore, that local politicians often go to heroic lengths to try to forestall hospital closures. When making policy decisions about how much to pay rural hospitals, Medicare's focus is on preserving health outcomes, rather than explicitly trying to save jobs for rural areas. The direction of contemporary policy momentum, however, appears to be towards socially financing a narrower scope of in-person services in rural areas (e.g., emergent and outpatient care), which could impact both the access and economies of local communities. While important empirical caveats apply, our analysis offers suggestive evidence that the main economic harms from a hospital closure—job loss and related income loss for the rural county—might be avoided if there is not a full exit from the market.

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[26] In addition, column 4 of Table 2 does not indicate health care workers are switching into other jobs on net. The change in employment in non-health care industries after a closure shows a relatively small, negative coefficient that is not statistically different from zero.

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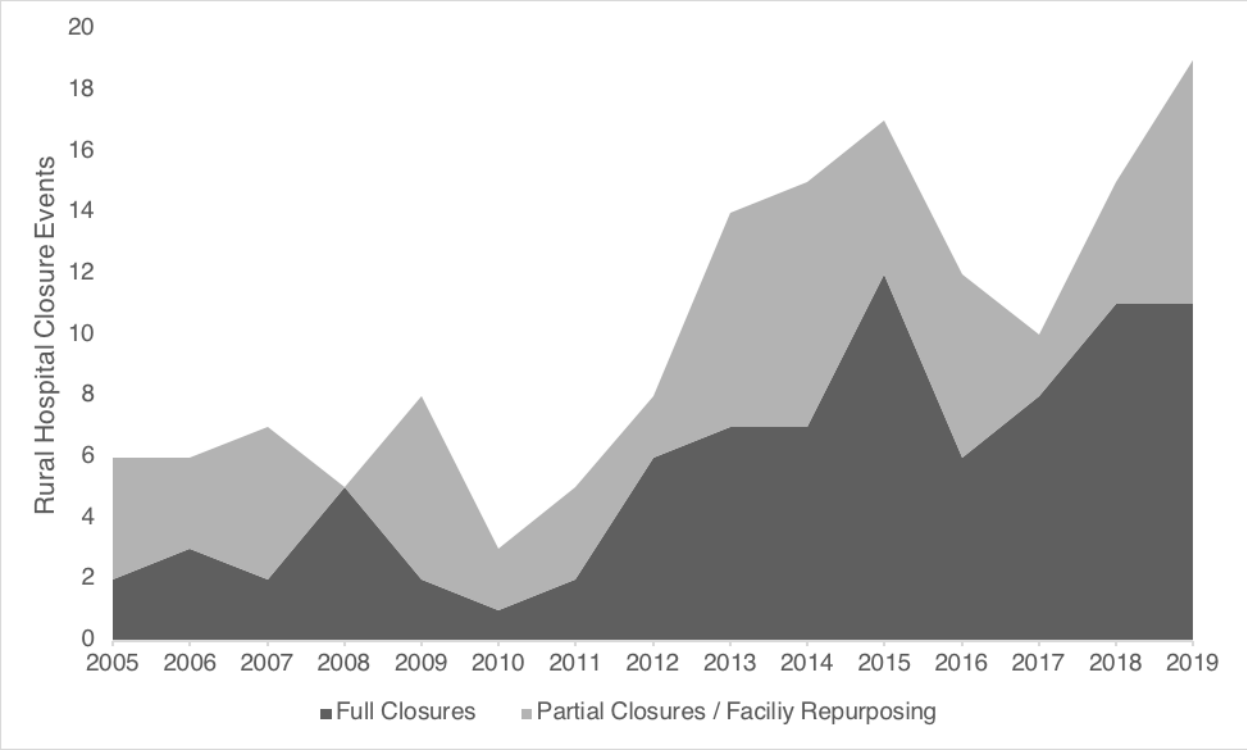
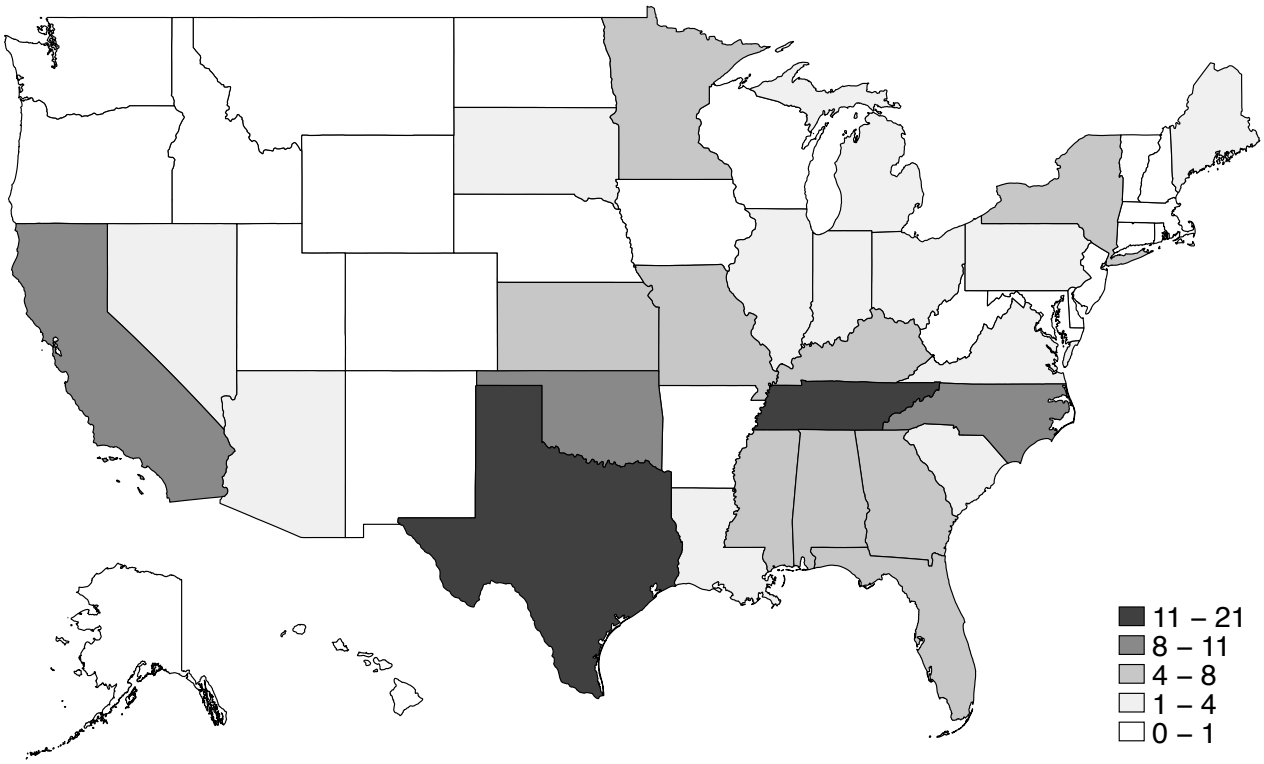
Figures

Figure 1: Rural hospital closure taxonomy, 2005-2019



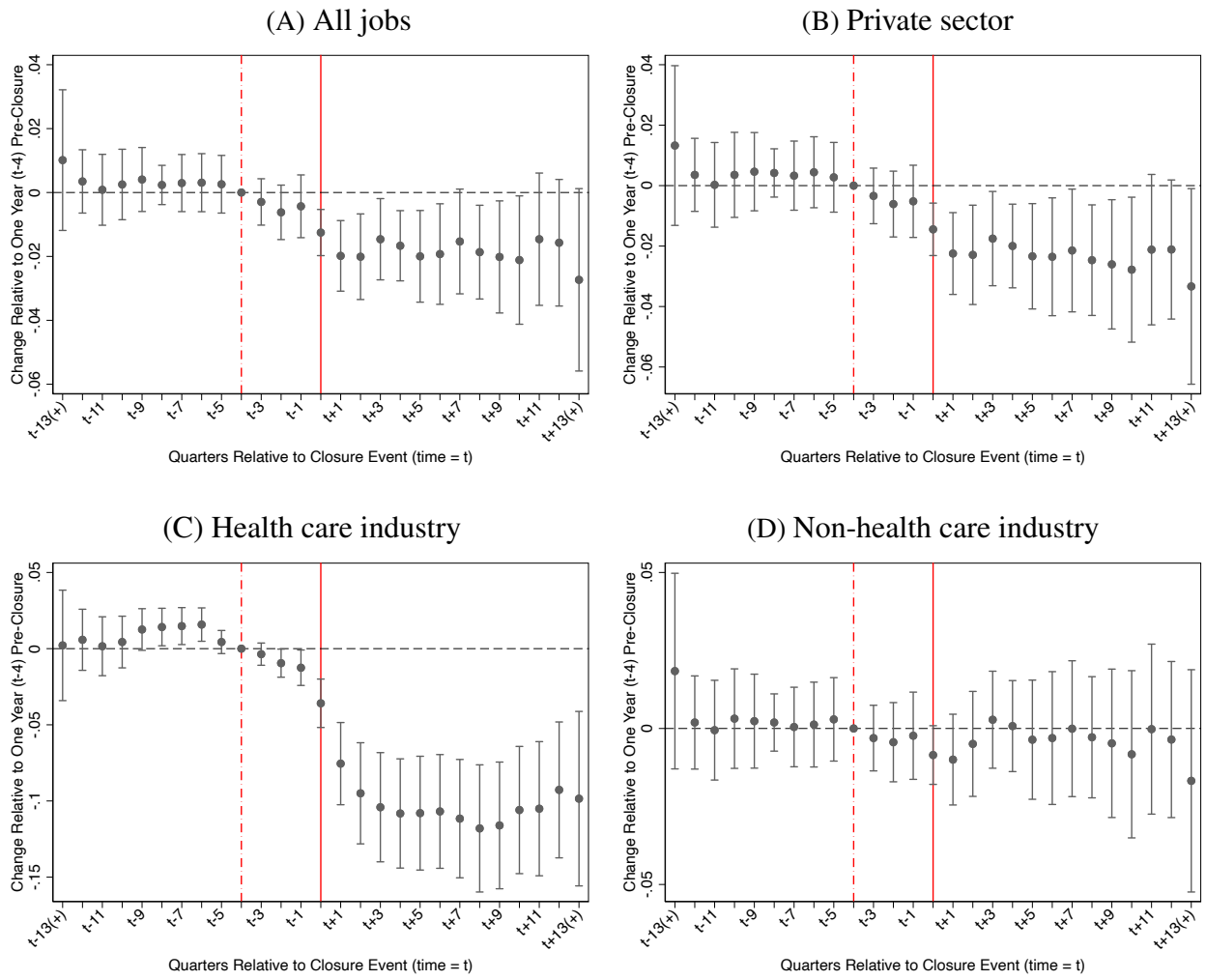
Notes: data from the University of North Carolina Cecil G. Sheps Center for Health Services Research.

Figure 2: Geographic variation in rural hospital closure intensity, 2005-2019



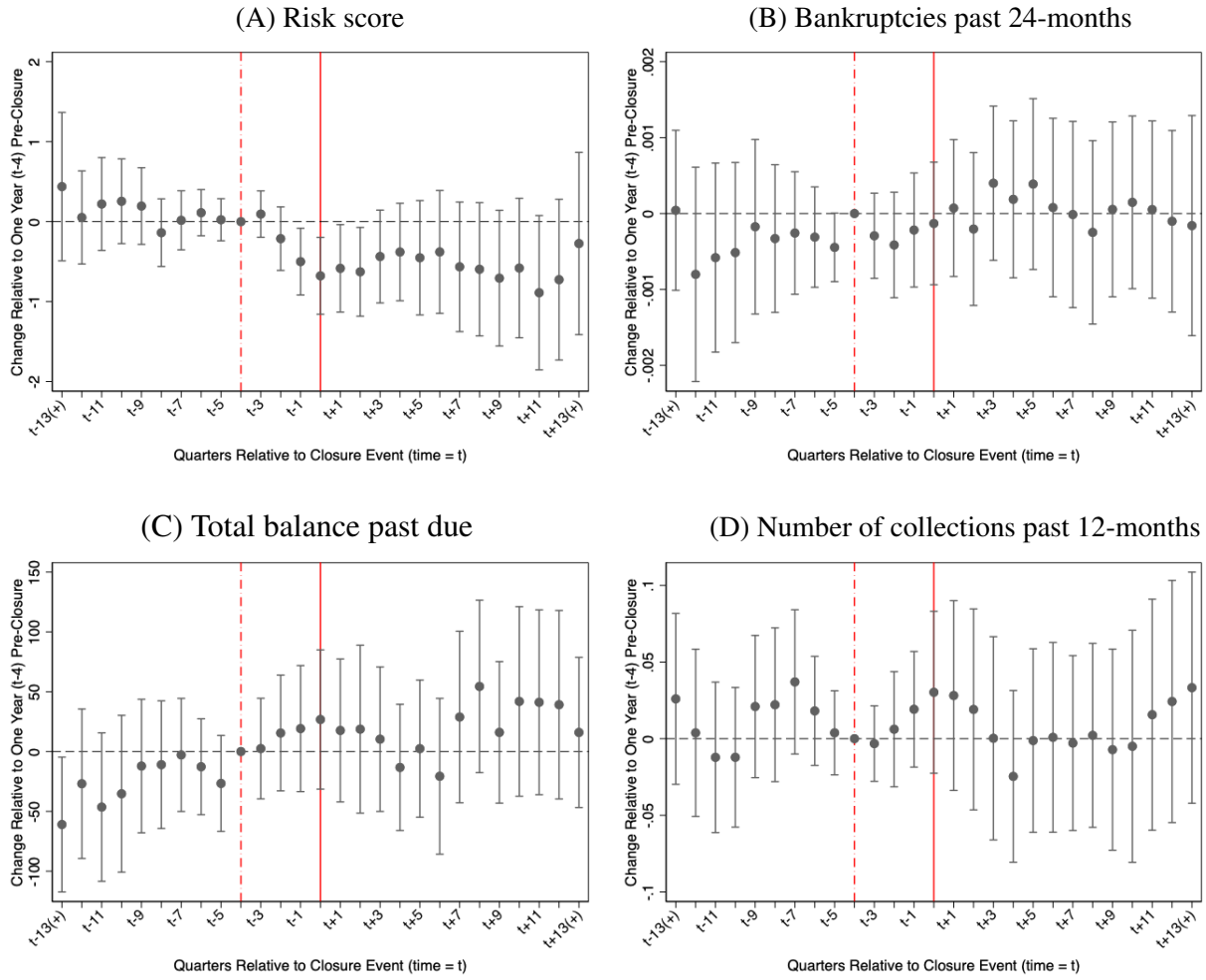
Notes: data from the University of North Carolina Cecil G. Sheps Center for Health Services Research and include full hospital closures as well as partial hospital closures.

Figure 3: Event study results for rural closure effects on county-level employment (in logs)



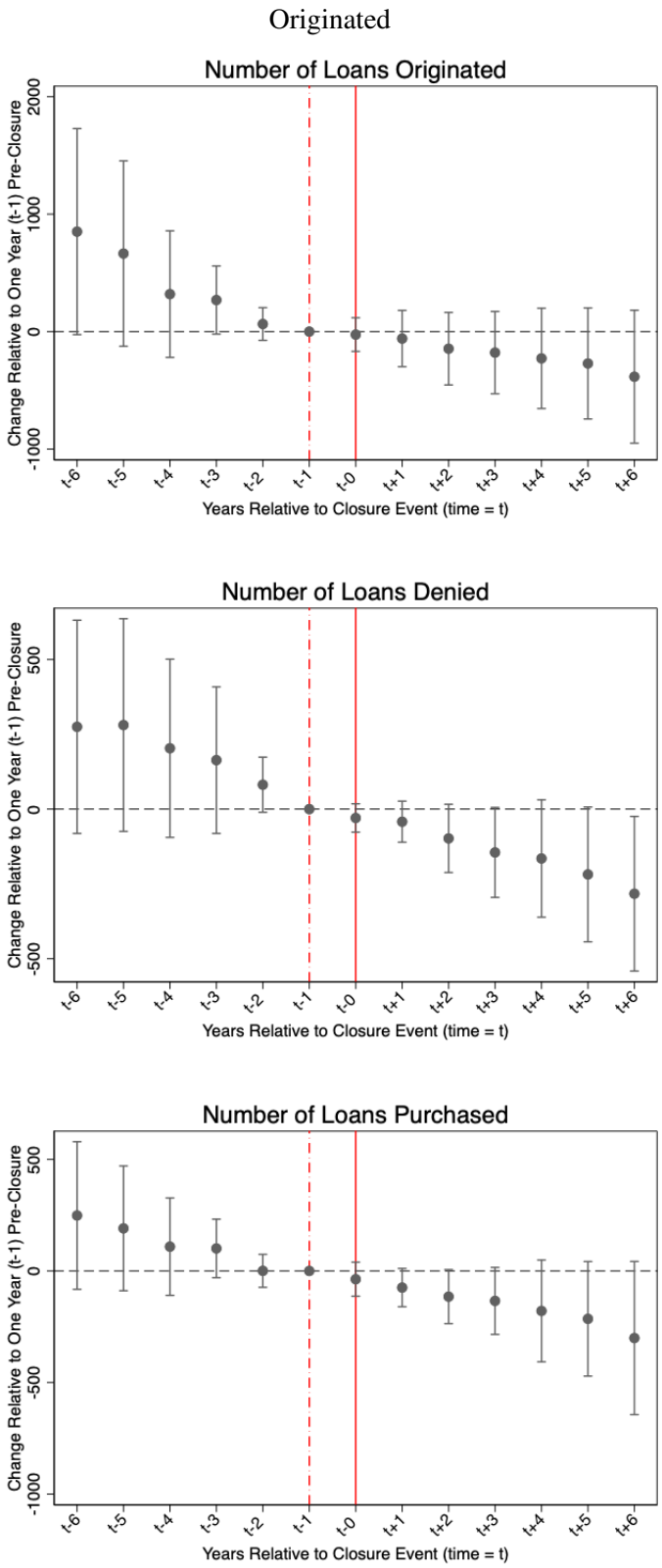
Notes: Analytic sample and estimation parallel to regressions in Table 2, with event time dummies replacing the rural closure indicator variable. The omitted time point is the fourth quarter (i.e., one year) prior to the rural hospital closure.

Figure 4: Event study results for rural hospital closure effects on consumer finances



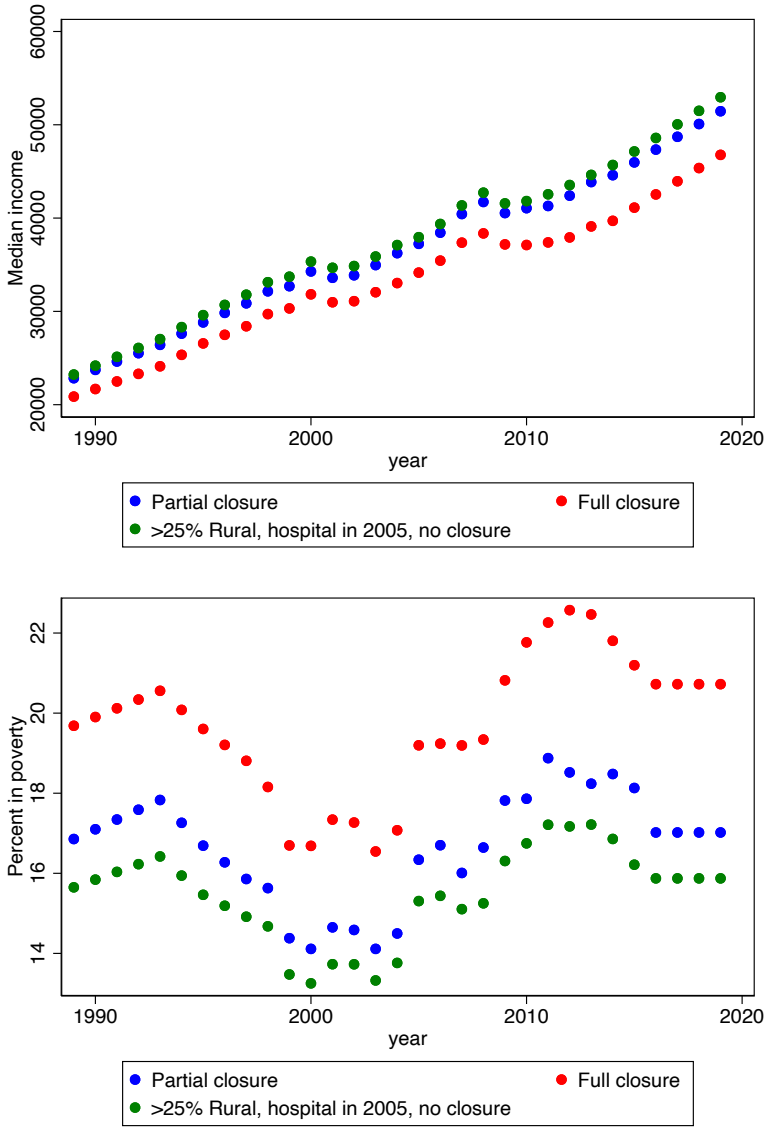
Notes: Analytic sample and estimation parallel to regressions in Table 2, with event time dummies replacing the rural closure indicator variable. The omitted time point is the fourth quarter (i.e., one year) prior to the rural hospital closure.

Figure 5: Event study results for rural hospital closure effects on housing markets: number of loans



Notes: Analytic sample and estimation parallel to regressions in Table 2, with event time dummies replacing the rural closure indicator variable. The omitted time point is one year prior to the rural hospital closure.

Figure 6: County characteristics by type of closure



Notes: data on county-level median income and percent in poverty from the the Census Bureau's Small Area Income and Poverty Estimates. Counties in our sample are classified into three categories: those that ever experienced a partial closure, those that ever experience a full closure, and those that are at least 50% rural, but have never experienced a hospital closure.

Tables

Table 1: Summary statistics

	Ever closure	Never closure
Total employment (median)		
All	33,840	29,794
Private sector	26,934	23,350
Health care	3,868	3,458
Non-health care	22,990	19,597
Unique counties	117	1,642
Observations	8,424	118,224

	Ever closure	Never closure
Consumer financial health		
Risk score	678	691
Total balance past due	1,024	849
# bills sent to collection (12m)	0.914	0.794
Bankruptcy (24m)	0.015	0.015
Unique counties	128	1,869
Observations	9,216	134,549

	Ever closure	Never closure
Loan characteristics		
Loans denied	789	509
Loans originated	1,911	1,288
Loans purchased	652	396
Loans denied: amount	78	81
Loans originated: amount	101	102
Loans purchased: amount	145	137
Applicant income: denied	68	69
Applicant income: originated	94	94
Unique counties	128	1,869
Observations	2,304	33,642

Notes: Employment data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), at the county-quarter level. Data on loans from the Home Mortgage Disclosure Act (HMDA) Database, at the county-year level. Data on consumer financial information comes from the Federal Reserve Bank of New York Consumer Credit Panel (CCP), at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census.

Table 2: Rural hospital closure effects on county-level consumer financial health and housing markets

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
1(Rural closure)	-0.029**	-0.036***	-0.101***	-0.022
	(0.012)	(0.013)	(0.025)	(0.014)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	126,648	126,648	126,648	126,648
R^2	0.07	0.09	0.23	0.09
Mean dep. var.	10.32	10.06	8.16	9.87
Unique counties	1,759	1,759	1,759	1,759

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
1(Rural closure)	-0.730	61.617***	-0.002	0.000
	(0.458)	(20.644)	(0.026)	(0.000)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	143,765	143,765	143,765	143,765
R^2	0.79	0.11	0.07	0.48
Mean dep. var.	690.19	860.20	0.80	0.01
Unique counties	1,997	1,997	1,997	1,997

	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
1(Rural closure)	-524.74**	-285.32**	-224.73*
	(247.99)	(125.14)	(115.17)
FEs: county, year	Yes	Yes	Yes
Observations	35,946	35,946	35,946
R^2	0.18	0.27	0.16
Mean dep. var.	1,327.78	527.31	412.61
Unique counties	1,997	1,997	1,997

Notes: Employment data from the BLS QCEW, at the county-quarter level. Data on loans from HMDA, at the county-year level. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter (if data are quarterly), and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table 3: Rural hospital closure effects on origination loan volumes and amounts by lending purpose

	Number of loans originated			Amount of loans originated (thousands)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Home purchase	Home improvement	Refinancing	Home purchase	Home improvement	Refinancing
1(Rural closure)	-177.24**	-46.56**	-300.35*	6.78	5.84	-4.49
	(79.47)	(20.27)	(157.64)	(8.58)	(4.96)	(4.58)
FEs: county, year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	35,940	35,551	35,920	35,940	35,547	35,920
R^2	0.16	0.15	0.21	0.12	0.06	0.08
Mean dep. var.	536.06	101.02	692.36	113.79	56.64	129.24
Unique counties	1,997	1,997	1,997	1,997	1,997	1,997

Notes: Employment data from the BLS QCEW, at the county-quarter level. Data on loans from HMDA, at the county-year level. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter (if data are quarterly), and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table 4: Heterogeneous rural hospital closure effects on county-level consumer financial health and housing markets: by CAH status

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
0(CAH)	-0.024**	-0.030**	-0.090***	-0.019
	(0.012)	(0.013)	(0.027)	(0.014)
1(CAH)	-0.037	-0.045*	-0.117**	-0.027
	(0.024)	(0.027)	(0.047)	(0.028)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	126,648	126,648	126,648	126,648
R^2	0.07	0.09	0.23	0.09
Mean dep. var.	10.32	10.06	8.16	9.87
Unique counties	1,759	1,759	1,759	1,759

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
0(CAH)	-0.170	70.199***	-0.016	0.000
	(0.572)	(24.092)	(0.033)	(0.001)
1(CAH)	-1.550**	49.056	0.020	0.000
	(0.735)	(35.943)	(0.039)	(0.001)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	143,765	143,765	143,765	143,765
R^2	0.79	0.11	0.07	0.48
Mean dep. var.	690.19	860.20	0.80	0.01
Unique counties	1,997	1,997	1,997	1,997

	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
0(CAH)	-746.96**	-394.66**	-308.98*
	(375.82)	(189.90)	(175.21)
1(CAH)	-193.40	-122.30	-99.10
	(253.67)	(125.74)	(117.03)
FEs: county, year	Yes	Yes	Yes
Observations	35,946	35,946	35,946
R^2	0.18	0.27	0.16
Mean dep. var.	1,327.78	527.31	412.61
Unique counties	1,997	1,997	1,997

Notes: "CAH" stands for Critical Access Hospitals. Hospital classifications are provided within the rural hospitals closure database. Employment data from the BLS QCEW, at the county-quarter level. Data on loans from HMDA, at the county-year level. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter (if data are quarterly), and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table 5: Heterogeneous rural hospital closure effects on county-level consumer financial health and housing markets: by closure type

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
1(Part closure)	-0.003	-0.004	-0.062**	0.006
	(0.018)	(0.020)	(0.027)	(0.022)
1(Full closure)	-0.053***	-0.064***	-0.145***	-0.043**
	(0.017)	(0.019)	(0.044)	(0.020)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	126,000	126,000	126,000	126,000
R^2	0.07	0.09	0.23	0.09
Mean dep. var.	10.31	10.05	8.16	9.87
Unique counties	1,750	1,750	1,750	1,750

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
1(Part closure)	-0.601	8.183	0.017	0.001
	(0.635)	(24.578)	(0.035)	(0.001)
1(Full closure)	-0.802	107.015***	-0.028	0.000
	(0.743)	(33.951)	(0.037)	(0.001)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	143,117	143,117	143,117	143,117
R^2	0.79	0.11	0.07	0.48
Mean dep. var.	690.24	859.97	0.80	0.01
Unique counties	1,988	1,988	1,988	1,988

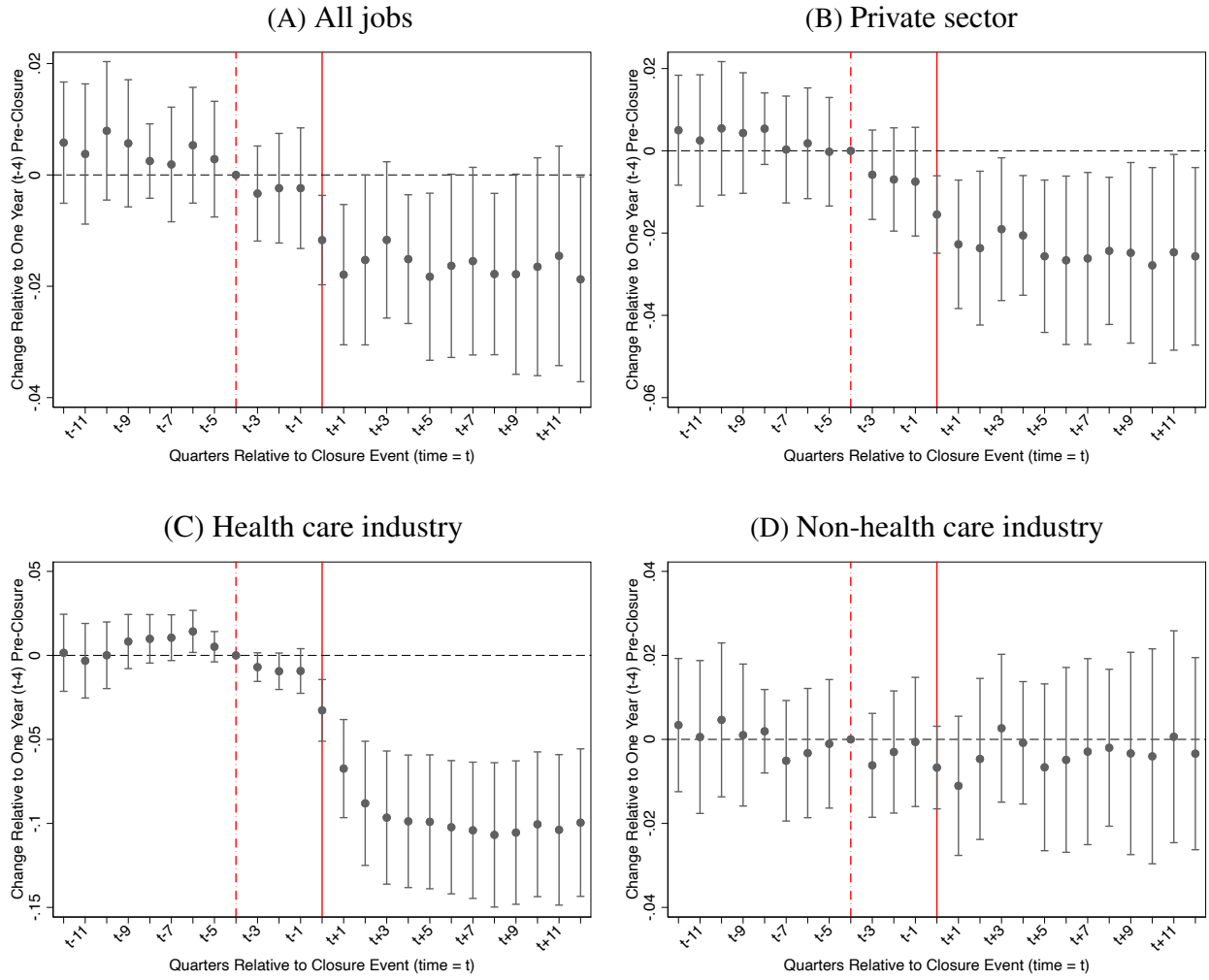
	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
1(Part closure)	-400.11*	-191.87**	-161.04*
	(222.16)	(89.96)	(87.10)
1(Full closure)	-527.95	-339.26	-263.35
	(438.34)	(237.43)	(216.52)
FEs: county, year	Yes	Yes	Yes
Observations	35,784	35,784	35,784
R^2	0.18	0.27	0.16
Mean dep. var.	1,319.09	524.71	409.57
Unique counties	1,988	1,988	1,988

Notes: "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). The 9 hospital closures that we could not assign as full or partial closures are dropped from the sample for this analysis. Employment data from the BLS QCEW, at the county-quarter level. Data on loans from HMDA, at the county-year level. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter (if data are quarterly), and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

A.1 Appendix (for online publication)

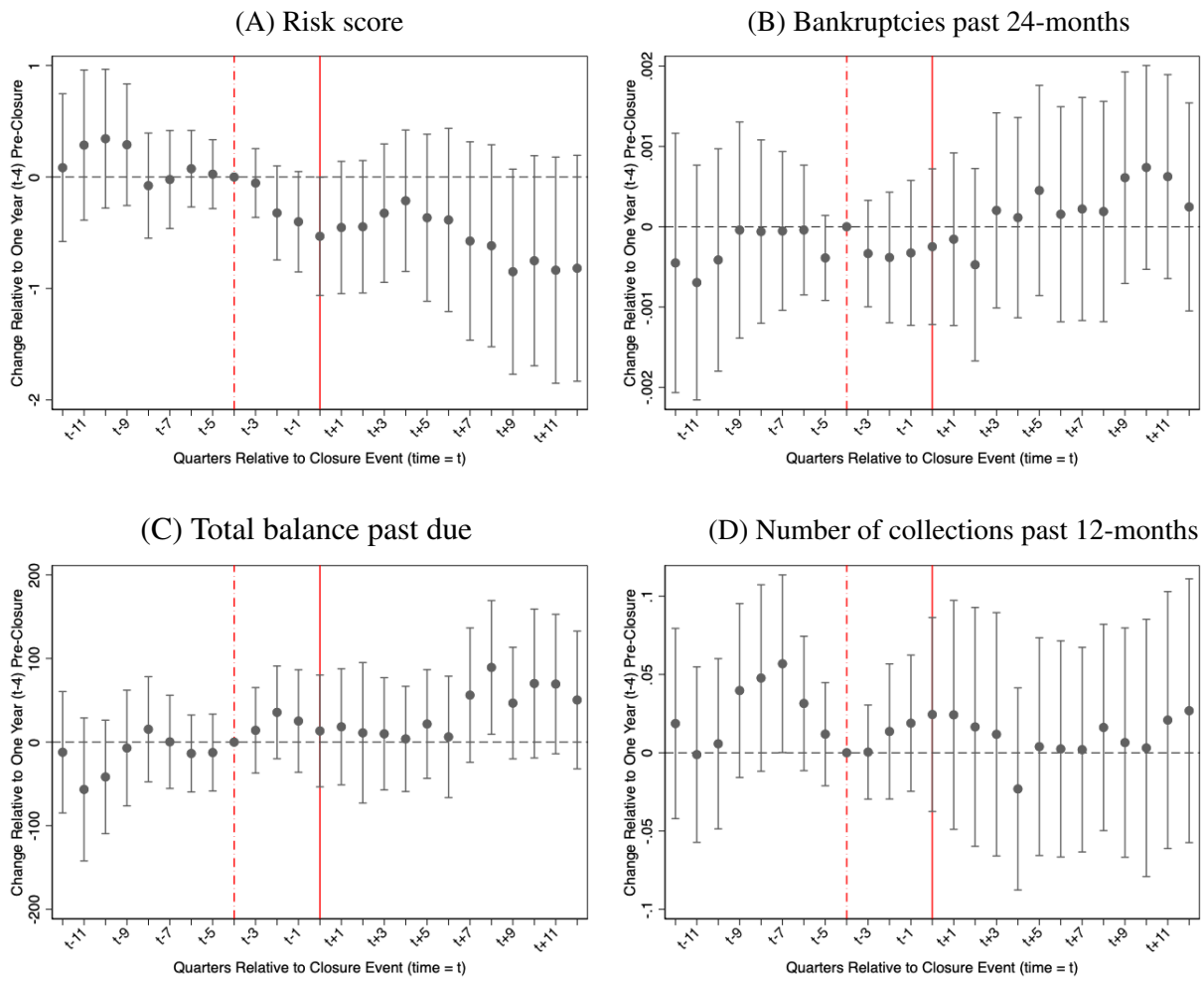
Appendix Figures

Figure A.1: Stacked event study results for rural closure effects on county-level employment (in logs)



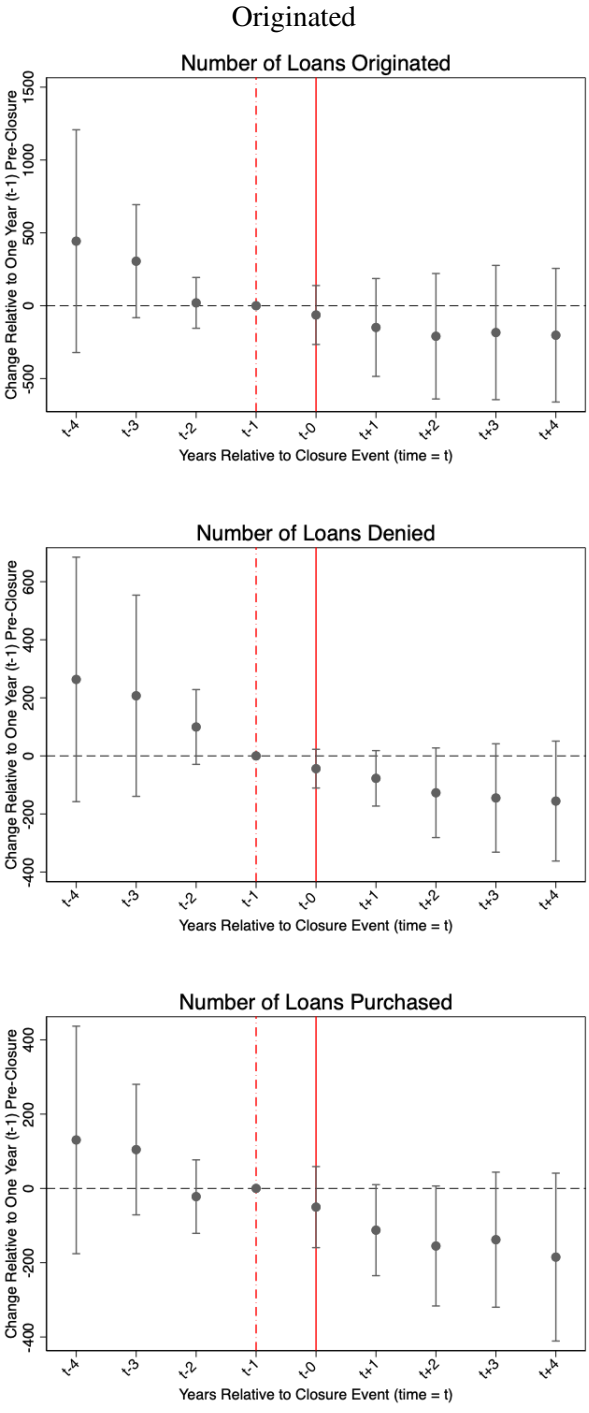
Notes: Control counties are randomly assigned a closure date from the sample of dates of actual closures. Event time dummies are defined based on real dates for actual closures and the assigned closure dates for the control sample. Only counties with observations for the full 12 quarters before and after the closure or assisnged closure are used, and observations that fall outside the -12 to +12 quarter window are dropped. The event time regression is the same as that described in the paper, except the event time dummies are interacted with a dummy for treatment. The event time coefficients plotted are those on the interaction of treatment and event time. The omitted time point is the fourth quarter (i.e., one year) prior to the rural hospital closure.

Figure A.2: Stacked event study results for rural hospital closure effects on consumer finances



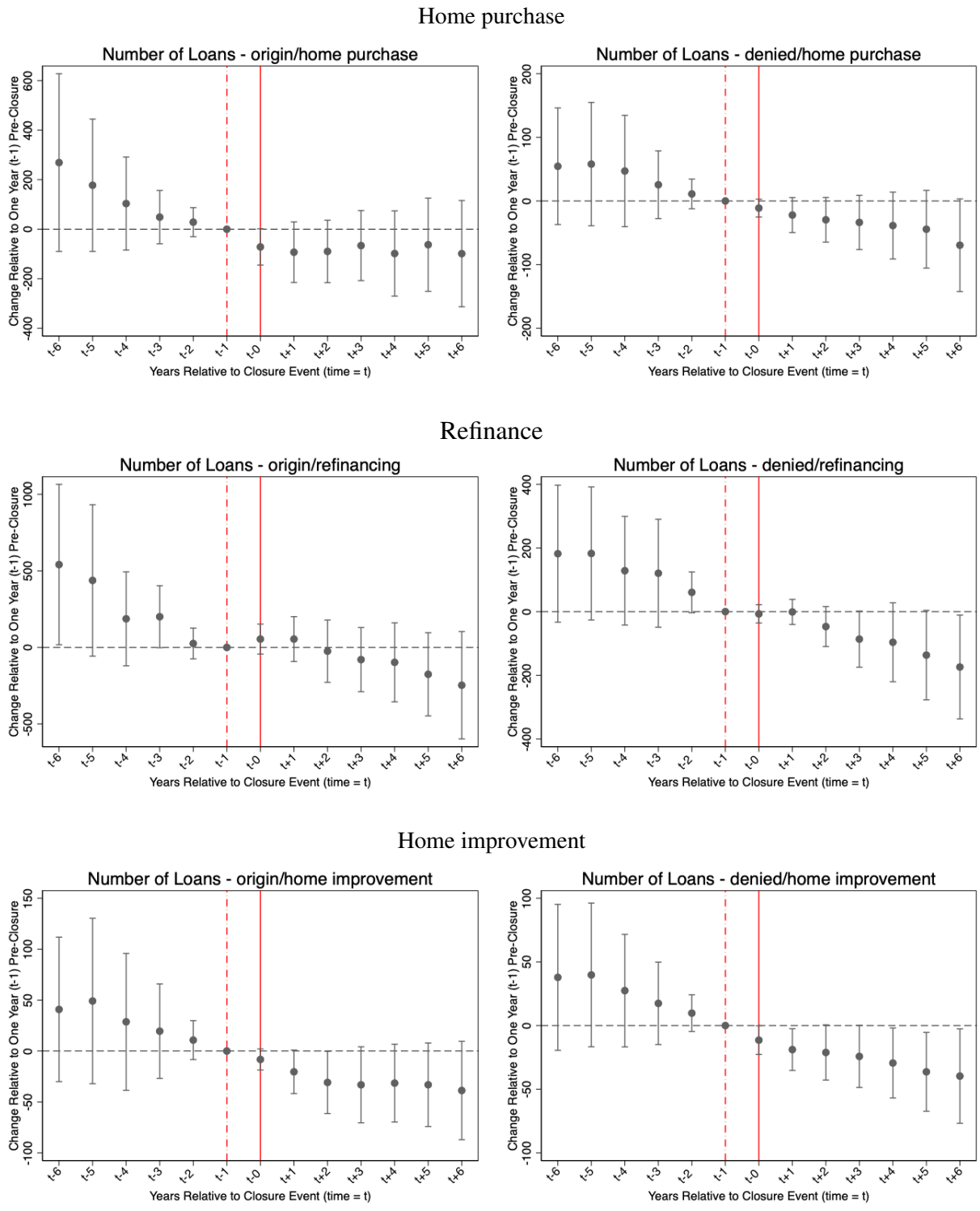
Notes: Control counties are randomly assigned a closure date from the sample of dates of actual closures. Event time dummies are defined based on real dates for actual closures and the assigned closure dates for the control sample. Only counties with observations for the full 12 quarters before and after the closure or assisnged closure are used, and observations that fall outside the -12 to +12 quarter window are dropped. The event time regression is the same as that described in the paper, except the event time dummies are interacted with a dummy for treatment. The event time coefficients plotted are those on the interaction of treatment and event time. The omitted time point is the fourth quarter (i.e., one year) prior to the rural hospital closure.

Figure A.3: Short stacked event study results for rural hospital closure effects on housing markets: number of loans



Notes: Control counties are randomly assigned a closure date from the sample of dates of actual closures. Event time dummies are defined based on real dates for actual closures and the assigned closure dates for the control sample. Only counties with observations for 4 years before and after the closure or assisnged closure are used, and observations that fall outside the -4 to +4 year window are dropped. The event time regression is the same as that described in the paper, except the event time dummies are interacted with a dummy for treatment. The event time coefficients plotted are those on the interaction of treatment and event time. The omitted time point is one year prior to the rural hospital closure.

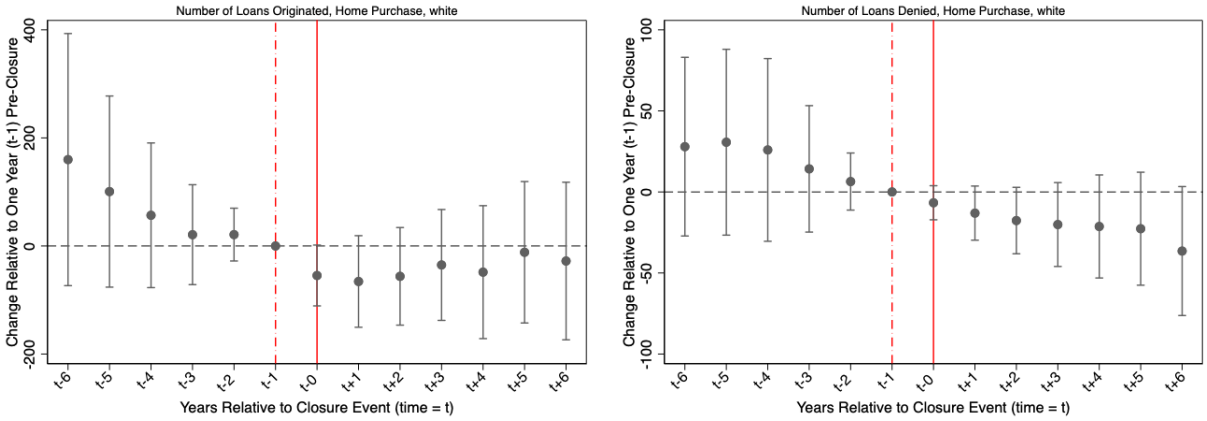
Figure A.4: Event study results for rural hospital closure effects on housing markets: by purpose



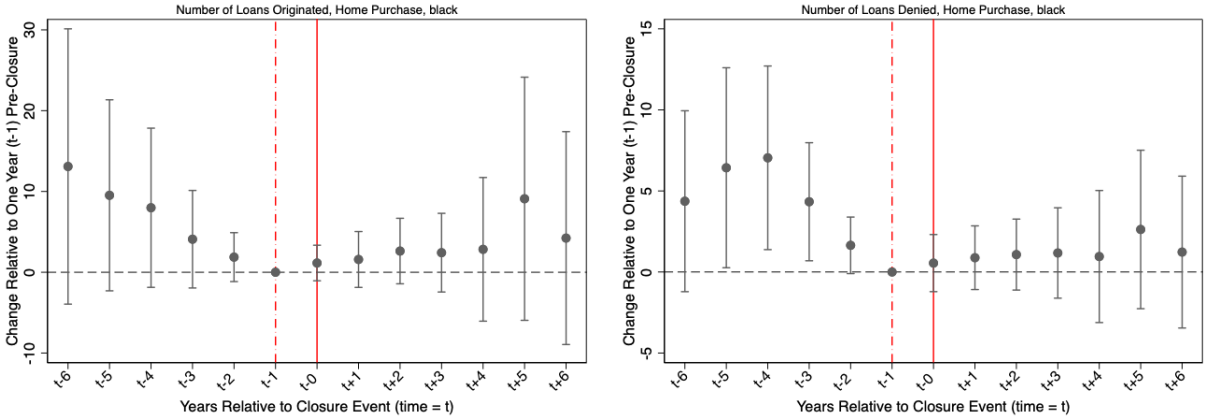
Notes: Analytic sample and estimation parallel to regressions in Table 3, with event time dummies replacing the rural closure indicator variable. The omitted time point is one year prior to the rural hospital closure.

Figure A.5: Event study results for rural hospital closure effects on housing markets: by race

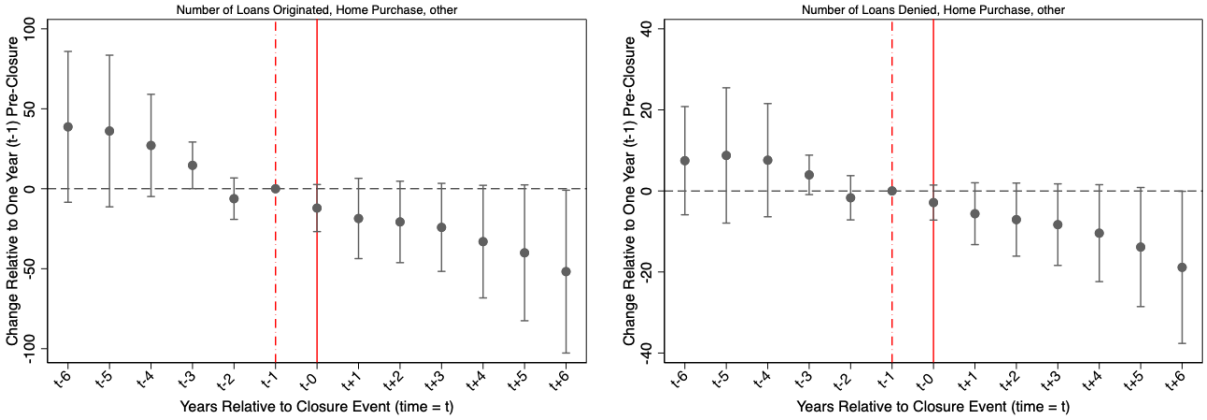
White



Black

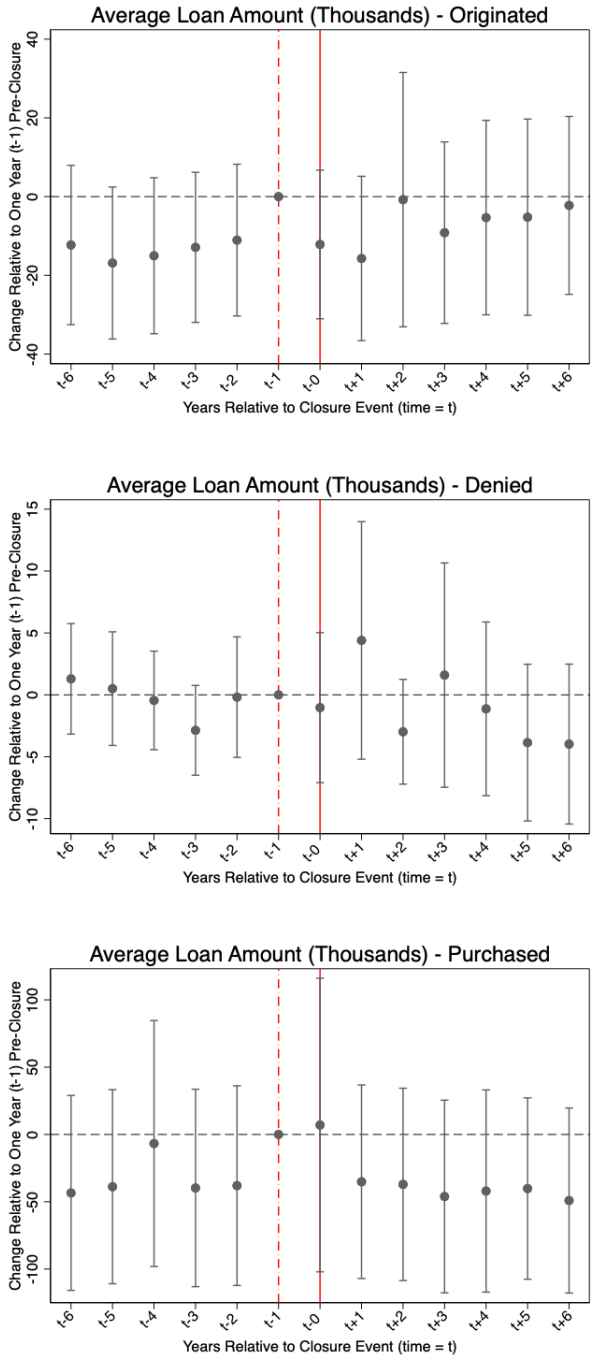


Other



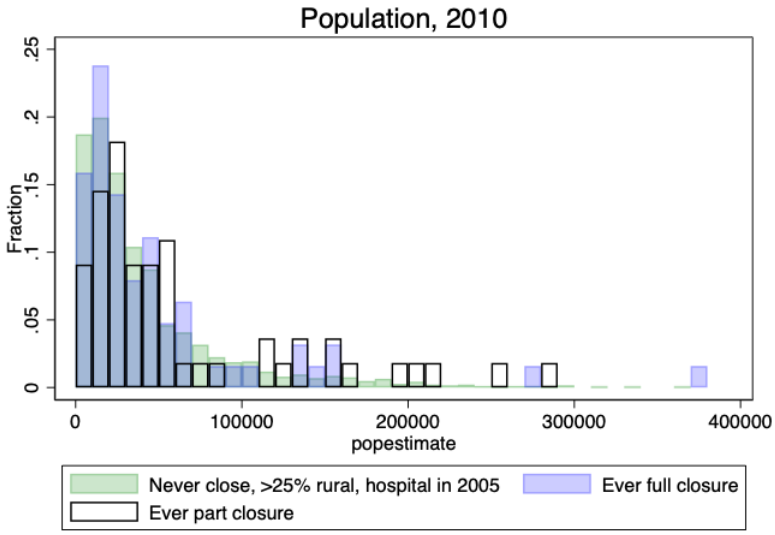
Notes: Analytic sample and estimation parallel to regressions in Table 3, with event time dummies replacing the rural closure indicator variable, but run separately by race of applicant. The omitted time point is one year prior to the rural hospital closure.

Figure A.6: Event study results for rural hospital closure effects on housing markets: average loan amount



Notes: Analytic sample and estimation parallel to regressions in Table 2, with event time dummies replacing the rural closure indicator variable. The omitted time point is one year prior to the rural hospital closure.

Figure A.7: County characteristics by type of closure



Notes: Population data from the Census Bureau's 2010-2019 intercensal county-level population estimates. Counties in are classified into three categories: those that ever experienced a partial closure, those that ever experience a full closure, and those that are at least 50% rural, but have never experienced a hospital closure. "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census.

Appendix Tables

Table A.1: Summary statistics by closure type

	Part closure	Full closure	CAH closure	Not CAH closure	Never closure
Total employment (median)					
All	46,804	24,922	24,356	40,764	29,794
Private sector	36,904	19,702	19,264	32,630	23,350
Health care	5,858	2,708	2,636	5,211	3,458
Non-health care	30,299	17,224	16,032	26,928	19,597
Unique counties	49	59	46	71	1,642
Observations	3,528	4,248	3,312	5,112	118,224

	Part closure	Full closure	CAH closure	Not CAH closure	Never closure
Consumer financial health					
Risk score	687	669	681	675	691
Total balance past due	913	1,136	970	1,061	849
# bills sent to collection (12m)	0.812	0.978	0.819	0.976	0.794
Bankruptcy (24m)	0.015	0.015	0.015	0.016	0.015
Unique counties	55	64	51	77	1,869
Observations	3,960	4,608	3,672	5,544	134,549

	Part closure	Full closure	CAH closure	Not CAH closure	Never closure
Loan characteristics					
Loans denied	769	762	638	888	509
Loans originated	1,911	1,722	1,673	2,068	1,288
Loans purchased	604	631	561	712	396
Loans denied: amount	85	74	78	79	81
Loans originated: amount	108	95	101	100	102
Loans purchased: amount	142	148	138	150	137
Applicant income: denied	72	66	65	70	69
Applicant income: originated	101	89	92	96	94
Unique counties	55	64	51	77	1,869
Observations	990	1,152	918	1,386	33,642

Notes: Employment data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), at the county-quarter level. Data on loans from the Home Mortgage Disclosure Act (HMDA) Database, at the county-year level. Data on consumer financial information comes from the Federal Reserve Bank of New York Consumer Credit Panel (CCP), at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Of the CAH closures, 27 were full closures, 20 were partial closures, and 4 were unknown. Of the non-CAH closures, 37 were full closures, 35 were partial closures, and 5 were unknown.

Table A.2: Rural hospital closure effects on county-level consumer financial health and housing markets: 25% rural threshold

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
1(Rural closure)	-0.028**	-0.036***	-0.104***	-0.021
	(0.012)	(0.013)	(0.025)	(0.014)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	154,656	154,656	154,656	154,656
R^2	0.06	0.08	0.21	0.09
Mean dep. var.	10.13	9.85	7.92	9.67
Unique counties	2,148	2,148	2,148	2,148

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
1(Rural closure)	-1.183**	65.136***	-0.000	0.000
	(0.460)	(20.581)	(0.026)	(0.000)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	187,407	187,407	187,407	187,407
R^2	0.76	0.09	0.05	0.42
Mean dep. var.	689.90	859.37	0.81	0.01
Unique counties	2,605	2,605	2,605	2,605

	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
1(Rural closure)	-615.47**	-334.35***	-258.49**
	(248.31)	(125.23)	(115.27)
FEs: county, year	Yes	Yes	Yes
Observations	47,154	47,154	47,154
R^2	0.16	0.24	0.14
Mean dep. var.	1,114.64	444.74	346.72
Unique counties	2,624	2,624	2,624

Notes: Notes: Control sample limited to counties at least 25

Table A.3: Rural hospital closure effects on county-level consumer financial health and housing markets: 50% rural threshold

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
1(Rural closure)	-0.017	-0.024*	-0.090***	-0.010
	(0.012)	(0.013)	(0.025)	(0.014)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	109,296	109,296	109,296	109,296
R^2	0.05	0.07	0.16	0.09
Mean dep. var.	9.81	9.52	7.58	9.34
Unique counties	1,518	1,518	1,518	1,518

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
1(Rural closure)	-1.512***	77.259***	0.002	0.000
	(0.464)	(20.758)	(0.027)	(0.000)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	139,094	139,094	139,094	139,094
R^2	0.74	0.07	0.04	0.38
Mean dep. var.	689.62	854.65	0.81	0.01
Unique counties	1,933	1,933	1,933	1,933

	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
1(Rural closure)	-807.06***	-423.16***	-335.56***
	(248.02)	(125.27)	(115.01)
FEs: county, year	Yes	Yes	Yes
Observations	35,036	35,036	35,036
R^2	0.13	0.21	0.11
Mean dep. var.	684.89	302.31	203.34
Unique counties	1,948	1,948	1,948

Notes: Notes: Control sample limited to counties at least 50

Table A.4: Rural hospital closure effects on county-level consumer financial health and housing markets: 75% rural threshold

	Employment (in logs)			
	(1) All	(2) Private sector	(3) Health care industries	(4) Non-health care industries
1(Rural closure)	-0.012	-0.020	-0.084***	-0.005
	(0.012)	(0.014)	(0.026)	(0.014)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	56,808	56,808	56,808	56,808
R^2	0.05	0.06	0.13	0.08
Mean dep. var.	9.45	9.14	7.21	8.96
Unique counties	789	789	789	789

	Consumer finances			
	(1) Risk score	(2) Tot. balance past due	(3) Collections (past 12m)	(4) Bankruptcies (past 24m)
1(Rural closure)	-2.237***	89.230***	-0.007	-0.000
	(0.479)	(21.410)	(0.029)	(0.000)
FEs: county, year	Yes	Yes	Yes	Yes
Observations	82,431	82,431	82,431	82,431
R^2	0.71	0.05	0.04	0.32
Mean dep. var.	691.17	835.44	0.80	0.01
Unique counties	1,147	1,147	1,147	1,147

	Housing market activity		
	(1) Originated	(2) Denied	(3) Purchased
1(Rural closure)	-895.13***	-479.84***	-365.68***
	(246.95)	(125.17)	(114.50)
FEs: county, year	Yes	Yes	Yes
Observations	20,910	20,910	20,910
R^2	0.09	0.14	0.08
Mean dep. var.	525.22	234.75	158.83
Unique counties	1,166	1,166	1,166

Notes: Control sample limited to counties at least 75

Table A.5: Rural hospital closure effects on origination loan volumes and amounts by lending purpose and closure type

	Number of loans originated			Amount of loans originated (thousands)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Home purchase	Home improvement	Refinancing	Home purchase	Home improvement	Refinancing
1(Part closure)	-74.73	-27.35**	-297.30*	6.75	19.98**	-0.96
	(70.11)	(12.72)	(159.18)	(7.24)	(9.32)	(7.19)
1(Full closure)	-217.13	-62.35	-248.09	7.35	-7.02	-7.10
	(133.99)	(39.77)	(274.78)	(16.37)	(4.75)	(6.16)
FEs: county, year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	35,778	35,389	35,758	35,778	35,385	35,758
R^2	0.16	0.15	0.21	0.12	0.06	0.08
Mean dep. var.	532.36	100.53	687.86	113.83	56.64	129.27
Unique counties	1,988	1,988	1,988	1,988	1,988	1,988

Notes: "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). The 9 hospital closures that we could not assign as full or partial closures are dropped from the sample for this analysis. Employment data from the BLS QCEW, at the county-quarter level. Data on loans from HMDA, at the county-year level. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter (if data are quarterly), and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table A.6: Heterogeneous rural hospital closure effects on employment: by closure type and CAH status

	All		Private sector		Health care industries		Non-health care industries	
	(1) CAH closures	(2) All others	(3) CAH closures	(4) All others	(5) CAH closures	(6) All others	(7) CAH closures	(8) All others
1(Part closure)	0.003	-0.007	0.005	-0.010	-0.112**	-0.034	0.028	-0.008
	(0.041)	(0.015)	(0.047)	(0.015)	(0.049)	(0.031)	(0.052)	(0.016)
1(Full closure)	-0.078**	-0.035*	-0.094***	-0.043**	-0.140	-0.149***	-0.075**	-0.021
	(0.031)	(0.018)	(0.035)	(0.021)	(0.085)	(0.046)	(0.034)	(0.023)
FEs: county, year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	121,248	122,976	121,248	122,976	121,248	122,976	121,248	122,976
R^2	0.07	0.07	0.09	0.09	0.23	0.24	0.09	0.09
Mean dep. var.	10.30	10.32	10.04	10.06	8.14	8.16	9.86	9.88
Unique counties	1,684	1,708	1,684	1,708	1,684	1,708	1,684	1,708

Notes: "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). The 9 hospital closures that we could not assign as full or partial closures are dropped from the sample for this analysis. "CAH" stands for Critical Access Hospitals. Hospital classifications are provided within the rural hospitals closure database. Employment data from the BLS QCEW, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter, and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table A.7: Heterogeneous rural hospital closure effects on consumer finances: by closure type and CAH status

	Risk score		Tot. balance past due		Collections (12m)		Bankruptcies (past. 24m)	
	(1) CAH closures	(2) All others	(3) CAH closures	(4) All others	(5) CAH closures	(6) All others	(7) CAH closures	(8) All others
1(Part closure)	-1.406	-0.136	-43.430	38.867	0.072	-0.015	0.001	0.000
	(1.029)	(0.794)	(35.451)	(31.255)	(0.065)	(0.038)	(0.001)	(0.001)
1(Full closure)	-1.857	0.022	109.970*	105.670***	-0.024	-0.031	-0.000	0.001
	(1.157)	(0.936)	(59.301)	(38.577)	(0.051)	(0.052)	(0.001)	(0.001)
FEs: county, year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	137,933	139,733	137,933	139,733	137,933	139,733	137,933	139,733
R^2	0.79	0.79	0.10	0.11	0.07	0.07	0.47	0.48
Mean dep. var.	690.82	690.45	852.09	857.14	0.79	0.80	0.01	0.01
Unique counties	1,916	1,941	1,916	1,941	1,916	1,941	1,916	1,941

Notes: "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). The 9 hospital closures that we could not assign as full or partial closures are dropped from the sample for this analysis. "CAH" stands for Critical Access Hospitals. Hospital classifications are provided within the rural hospitals closure database. Data on consumer financial information comes from the Consumer Credit Panel, at the county-quarter level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year, quarter, and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10

Table A.8: Heterogeneous rural hospital closure effects on county-level housing markets: by closure type and CAH status

	Loans originated		Loans denied		Loans purchased	
	(1) CAH closures	(2) All others	(3) CAH closures	(4) All others	(5) CAH closures	(6) All others
1(Part closure)	130.85	-703.13**	46.31	-327.70***	46.35	-278.85**
	(164.51)	(323.81)	(83.66)	(126.01)	(47.82)	(129.53)
1(Full closure)	24.18	-944.52	-70.14	-542.44	-71.14	-408.18
	(194.53)	(743.90)	(177.90)	(389.19)	(166.07)	(355.98)
FEs: county, year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	34,560	34,938	34,560	34,938	34,560	34,938
R^2	0.20	0.19	0.30	0.28	0.17	0.17
Mean dep. var.	1,298.10	1,320.10	512.84	524.73	400.61	409.24
Unique counties	1,920	1,941	1,920	1,941	1,920	1,941

Notes: "Partial Closures" are rural hospital events where some services remained open (e.g., emergency department and lab services) or the facility was repurposed (e.g., transformed to a skilled nursing facility). "CAH" stands for Critical Access Hospitals. Hospital classifications are provided within the rural hospitals closure database. Data on loans from HMDA, at the county-year level. Control group (never closure) counties are those that never experienced a rural hospital closure and had 50 percent or more of the county population living in a rural area according to the 2000 Census. Analytic data restricted to a balanced panel of counties with valid data across all variables for all time periods (2001Q1-2018Q4). Year and county fixed effects included in all regressions. Standard errors are clustered at the county level. *** P value at 0.01 ** P value at 0.05 * P value at 0.10