Firm Finances and the Spread of COVID-19: Evidence from Nursing Homes*

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September 15, 2020

Abstract

Residents of senior-care facilities account for over 40% of COVID-19-related deaths in the United States despite making up less than 1% of the population. We show that differences in nursing homes' finances help explain cross-sectional variation in the incidence of COVID-19. Nursing homes were forced to make difficult risk mitigation investment decisions in the face of large drops in revenues and staggering increases in equipment, testing, and labor costs. We find that nursing homes with less liquidity (pre-pandemic days-cash-on-hand) had a higher likelihood of COVID-19 in their facility. Those with larger negative shocks to cash flow also had a higher likelihood of COVID-19, and the relationship is strongest for smaller, financially constrained nursing homes. These results have implications for the role finances can play in the welfare of customers, employees, and for broader public health.

*First Draft: July 23, 2020. We are grateful to Ashvin Gandhi, Umit Gurun, Ralph Koijen, Sahil Raina, and Kandarp Srinivasan for helpful comments on the paper.

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1 Introduction

The COVID-19 pandemic has been a massive negative shock to finances for nearly all parts of society. Organizations including small private businesses, large public firms, the government at various levels, and school and university systems are having to wrestle with tighter finances while facing extremely difficult decisions about health risk mitigation measures for their customers, employees, and the broader public. In this paper, we examine how firm finances are related to the spread of COVID-19 using detailed data on nursing homes – an industry whose finances were already tight before the pandemic and whose customers are the most vulnerable to health risk.

During the first months of the COVID-19 pandemic, there were over 57,000 deaths in nursing homes and other long-term care facilities in the United States. While making up less than 1% of the overall population, nursing homes and their employees have accounted for over 40% of the death toll (NYTimes, 2020). The age and pre-existing health conditions of nursing home residents, their proximity to one another, and their reliance on close-contact physical care make outbreaks in nursing home facilities particularly devastating. As of June 14, 2020, about 40% of skilled nursing facilities (SNFs), which we refer to as nursing homes, had at least one resident with COVID-19. Why do some nursing homes end up with COVID-19 cases, while others do not? While location and the size of the nursing home are important determinants, we provide some of the first evidence that their financial and operational characteristics have also had important roles to play.

A key driver of cross-sectional differences in the incidence of nursing home COVID-19 cases is location. Figure 1 plots a binned scatter plot of the (log) number of nursing home COVID-19 cases at the county level as a function of the county-level (log) number of non-nursing-home COVID-19 cases. There is a strong, positive relationship between nursing home COVID-19 cases and the number of COVID-19 cases in the local population. A regression of whether a nursing home has at least one COVID-19 case on county-level fixed effects shows

that location explains over one-third of the variation of nursing home COVID-19 incidence.

Using data on the characteristics of nursing homes from the Centers for Medicare & Medicaid Services (CMS), we find that larger nursing homes with greater exposure to patients, as measured by the total inpatient days, are more likely to have at least one COVID-19 case. After controlling for county-level fixed effects and exposure to patients, we also find that measures of nursing home quality matter: nursing homes with a 5-star overall quality rating from the CMS are about 5 percentage points less likely to have a COVID-19 case than the lowest-rated nursing homes, with the health inspection rating being the most important driver of this relationship.

After documenting these broad drivers of variation in the incidence of COVID-19 at nursing homes, we turn to examine financial factors. We find that nursing homes with very little liquidity – number of days' worth of expenditure existing cash can cover, called days-cash-on-hand – at the onset of the COVID-19 crisis had higher incidence of COVID-19. We also find that nursing homes whose cash flow is more adversely affected by the sharp drop in hospital elective procedures – a precursor to most nursing home stays – during the pandemic are more likely to have COVID-19 cases, even after controlling for tight geographical fixed effects and other nursing home characteristics. After describing the institutional setting, we will discuss these results in more detail.

The COVID-19 pandemic had a significant adverse impact on the revenues and costs for nursing homes. The inflow of new residents (and the associated revenue) dropped significantly with the halting of elective surgical procedures in most states. At the same time, costs increased significantly due to increased investments in risk mitigation (e.g., additional personal protective equipment, PPE, and high-frequency testing of residents and staff) and increased labor costs (e.g., additional overtime pay for employees). The worldwide demand shock for PPE led to increases in prices for some equipment by over 1,000%, and some nursing homes reported increasing expenditures on PPE by over 4,700% compared to normal times

(Flynn, 2020b).[1]

For nursing homes to undertake the risk mitigation investments to minimize the spread of COVID-19, they needed liquidity – either substantial cash on hand or immediate access to external financing. However, the average nursing home has only about 19 days worth of expenses available in cash and equivalents. For nursing homes desiring external sources of capital, access was severely limited by the combination of broad market turmoil and because the shock of the pandemic itself diminished the creditworthiness of nursing homes. Cash on hand was also particularly important given the need for speed in making investments in risk-mitigation expenditures to stay ahead of the spreading virus. Nursing homes with less cash were likely less able to invest in risk mitigation compared to homes that were not liquidity constrained.

To examine whether lower liquidity translates to a higher likelihood of COVID-19 at a nursing home, we regress an indicator of whether a nursing home had at least one case of COVID-19 on the logarithm of the number of days-cash-on-hand, which is a prominent measure of liquidity in the industry. While controlling for other important determinants of the baseline likelihood of having a COVID-19 case such as a nursing home's size (number of inpatient days), number of employees, facility quality ratings, operating margin and leverage, we find that dropping from the 75th to 25th percentile of days-cash-on-hand corresponds to a 3.2 percentage points higher likelihood of having a COVID-19 case. This result supports the hypothesis that nursing homes with greater access to immediate liquidity were better able to invest in risk mitigation and, in turn, have a lower likelihood of COVID-19.

We next examine if nursing homes that experienced a greater negative cash flow shock from the pandemic were more likely to have a case of COVID-19. A negative cash flow shock

[1]Non-labor costs increased significantly during the early months of the pandemic as homes invested in personal protective equipment (PPE) such as N-95 masks, gloves, and gowns to minimize the spread of COVID-19. Acquiring and properly using PPE (i.e., discarding or cleaning) is expensive, and it was particularly expensive at the onset of the COVID-19 outbreak. Back of the envelope calculations suggested a typical home following CDC guidelines would need to spend over $2,500 per day on PPE during the early months of the pandemic (Society for Healthcare Organization Procurement Professionals, 2020).

can translate to lower future liquidity, as the cash earned from serving such patients will drop with the reduction in their inflow and, all else equal, this reduction in the stream of cash flows will also reduce the value of the firm. To help stem liquidity problems, Medicare introduced a program that allowed nursing homes to take out an advance (effectively a senior debt claim on cash flows) of three month's worth of Medicare payments. While this program mitigates some of the immediate liquidity consequences of the decline in patient inflow, this intervention has been widely viewed as insufficient to fill the massive gap created by the increasing costs and decreasing revenues.[2] Further, it does not make up for the overall negative shock to firm value resulting from the loss of business during this time.

The adverse shock to internally generated funds and firm value can lead to undesirable outcomes related to risk mitigation. Tightening financial constraints may hinder investment in risk mitigation, especially as this need is occurring at the very time that internally generated funds are dropping. Nursing homes may also face debt overhang problems (Myers, 1977) as the industry is characterized by high operating leverage, and the Medicare Advance program gives Medicare a super-senior claim on future revenues (from the Medicare Advance program). These factors may dull the incentives for investment in risk mitigation and inhibit raising new capital because the benefits of such investment accrue mostly to the existing senior claimants. Lastly, costly investment in risk mitigation may be delayed, reduced in scale, or forgone even without financial constraints or debt overhang problems. The decision to invest less in risk mitigation trades off a boost in the short-term cash position against a greater risk of a COVID-19 outbreak. As a nursing home is pushed closer to financial distress, management and equityholders may not fully internalize the costs of greater risk with much of the downside risk of an outbreak borne by debt-holders and nonfinancial stakeholders: residents (customers) and employees. This can be thought of as a manifestation of risk shifting (Jensen and Meckling, 1976).

[2]By August 2020, AHCA NCAL (2020) find that despite about 96% of nursing home receiving some measure of government funding, 55% were operating at a loss, and 72% said they could not sustain operations another year at the current pace.

We use the ex-ante variation in the payor mix as a measure of the severity of nursing homes' shock to cash flows. About 54% of nursing home patients are long-term, Medicaid-paid patients, while about 13% of patients are Medicare-paid patients whose average stay is slightly over a month.[3] Medicare patients are far more profitable and consume services related to post-acute care (PAC), such as recovery from a hip replacement. Crucially for our setting, the flow of Medicare patients sharply dropped as elective procedures were banned or voluntarily stopped across the country near the outset of the pandemic. Thus, nursing homes with a greater reliance on Medicare patients experience a greater negative shock to their business due to the stoppage of elective procedures. Indeed, we confirm that nursing homes with a larger Medicare share (the share of each nursing home's inpatient days that are covered by Medicare) experienced larger declines in resident populations from January to June 2020, and we later use this to trace out the connection between the decline in resident inflow and higher COVID-19 incidence.

We test if nursing homes with greater reliance on Medicare patients and, hence, are those that experienced more adverse cash flow shocks, were more likely to have a case of COVID-19. We find that a one-standard-deviation increase in Medicare share (about 10 percentage points) corresponds to a 2.4 percentage point higher likelihood of COVID-19 at the nursing home. As a second measure of the size of the negative cash flow shock due to the reduced inflow of patients, we consider the pre-crisis average length of stay for the nursing home's residents. The motivation is similar to the use of Medicare share: nursing homes with a shorter average length-of-stay are more skewed toward PAC/rehabilitation and are more dependent on a continuous inflow of patients from elective procedures, and thus more likely to be affected by the surgical ban. We find dropping from the 75th to the 25th percentile of average length-of-stay corresponds to about 2.6 percentage points higher likelihood of incidence of COVID-19 at the nursing home. With the overall average incidence around 40%, these are both sizable effects. Figure 2 presents binned scatter plots illustrating the strong

[3]The remaining share of patients use private insurance or other sources.

relationships between COVID-19 likelihood and our main financial variables.

To further examine the role of financial constraints in our main findings, we examine whether firms that were more likely to be financially constrained had a differential sensitivity between the shock to cash flows and COVID-19. We find a much stronger relationship between the likelihood of COVID-19 and adverse shocks to cash flow among smaller nursing homes. On the other hand, we find relatively little relationship in larger nursing homes who are less likely to face financial constraints. Examining this differential sensitive across differing degrees of financial constraints allow us to directly control for any baseline relationship between Medicare share and COVID-19 and highlight the role of financial constraints in explaining the differences in COVID-19 incidence across nursing homes.

After establishing the main results, we use an instrumental variables approach to more closely trace out the cash-flow-shock channel. To estimate the effect of cash flow shocks on the incidence of COVID-19, we would like to randomly assign cash flow shocks across nursing homes and examine whether there was a differential likelihood of COVID-19 cases. Randomly shocking the number of patients (i.e., paying customers) in a given nursing home would have a similar effect. While we cannot exogenously vary nursing homes' cash flows or residents, we instead instrument for a nursing home's change in residents during the early months of the pandemic using their pre-pandemic business model and examine whether the change in residents is related to COVID-19 incidence.

The average number of residents in nursing homes dropped by about 10% from January to June 2020. Without instrumenting, we find that a larger decline in a nursing home's residents (larger negative cash flow shock) is associated with a greater incidence of COVID-19. To get closer to the randomized ideal, we use Medicare share and average length-of-stay as instrumental variables for the change in residents. This is motivated by the widespread restriction in elective procedures sharply reducing the inflow of those residents. In the first-stage regression, we find that the ex-ante Medicare share and average length-of-stay

strongly predict a nursing home's decline in patients. In the second stage, we estimate that a one percent decline in residents leads to an approximately one percentage point increase in the likelihood of COVID-19 in a nursing home. In sum, nursing homes under greater financial strain related to reduced resident inflow were more likely to have a case of COVID-19.

We discuss potential violations of the exclusion restriction for our instrumental variables and provide evidence supporting their use as instruments. One potential concern is that higher-Medicare share facilities are simply of worse general quality or have lower baseline capability to protect their patients. First, we show that higher Medicare share facilities have superior quality ratings and argue it is unlikely that nursing homes that are systematically better on observables are systematically worse on unobserved dimensions. We also re-examine our tests while controlling for detailed differences in nursing homes' medical capabilities and typical patient mix and find similar results. A related concern is that nursing homes with a higher Medicare share and lower average length-of-stay deliberately choose to admit patients with active COVID-19 for reasons unrelated to their loss in residents.[4] Nursing homes in areas with more-strained hospital ICUs are more likely to face these decisions. Thus, to address the concern, we re-run our main analysis omitting the states that peaked at over 80% occupancy of hospital ICU bed capacity and find similar results. Lastly, we note that in the tests examining the interaction between the shocks to cash flows and financial constraints, we are able to directly control for any level effect that these variables have on COVID-19 incidence and estimate the incremental effect of these variables on financially constrained nursing homes.

Overall, we provide evidence that a nursing home's degree of liquidity (low days-cash-on-hand) and the magnitude of the pandemic's negative shock nurse homes' revenues have economically meaningful relationships with the likelihood of the incidence of COVID-19

[4]If our results were to be driven by willful admittance of COVID-19 patients in response to, for example, state-level bonuses for taking active COVID-19 patients, this would be consistent with risk-shifting. Such choices would increase current cash flows at the expense of increasing the risk of COVID-19 spreading to other residents and employees.

at nursing homes. Federal and state governments have taken some actions to at least partially help address the challenges faced by nursing homes during the pandemic. Many of the programs were established or implemented a month or more after the beginning of the outbreak. These government programs likely helped mitigate the negative relationship between nursing home finances and COVID-19 prevention, but our results suggest the actions were either not early enough or large enough to fully mitigate the relationship between the negative financial shock and COVID-19 incidence. In fact, in August 2020, after the initial wave of government support, over 72% of nursing homes say they will be out of business within one year at the current pace (AHCA NCAL, 2020).

Our paper is related to a growing body of work examining nursing home characteristics and COVID-19 cases. Abrams, Loomer, Gandhi, and Grabowski (2020) and White, Kosar, Feifer, Blackman, Gravenstein, Ouslander, and Mor (forthcoming) also document the relationships between a nursing home's size and location and COVID-19 likelihood. Chen, Chevalier, and Long (2020) show the importance of staff linkages across nursing homes for predicting COVID-19 outbreaks. Prior work is mixed on whether a nursing home's ratings, prior infection violations, and racial composition of residents are related to COVID-19 cases (Abrams et al., 2020; White et al., forthcoming; Konetzka, 2020; He, Li, and Fang, 2020). Controlling for county-level fixed effects, we find no relationship between the racial composition of the Medicare residents and COVID-19 incidence, and we find that nursing home ratings are negatively related to COVID-19 incidence, but only for the very top ratings. Our main contribution to this literature is to document the relationship between the finances of nursing homes and the incidence of COVID-19.

Our paper is also related to the literature examining how firm financing affects non-finance stakeholders. Examining the relationship between firm financing and employee safety, Cohn and Wardlaw (2016) provide evidence that financially constrained firms have higher employee injury rates, and Nie and Zhao (2017) find a negative relationship between a firm's leverage and worker safety. Cohn and Deryugina (2018) provide evidence that financially constrained

firms are more likely to experience environmental spills. A large related literature examines the relationship between firm financing and product quality[5] with a recent example from the healthcare sector of Adelino, Lewellen, and McCartney (2019) who find that treatment choices in nonprofit hospitals are related to financing constraints. We add to this literature by examining a setting where the decisions made by the firm can literally mean life or death for its customers and employees, and where the swift and substantial nature of the COVID-19 shock helps draw a strong link between firm finances and these important outcomes.

2 Nursing Homes and the COVID-19 Pandemic

Our analysis focuses on "skilled nursing facilities," which we call nursing homes. Residents of these facilities have needs such as general rehabilitation after injuries or surgeries, recovery from stroke, Parkinson's care, as well as custodial or terminal illness care. Much of the population of these facilities have one or many of the risk factors that make them most vulnerable to COVID-19: over 84% of nursing home residents are over 65 years of age, one-third of residents have diabetes, over one-third have heart disease, and nearly three-quarters have high blood pressure.[6] These residents require a significant amount of close, in-person, physical interaction with nursing home employees, which makes it impossible to socially distance and amplifies the importance of adequate protective equipment and other preventative, risk mitigation measures to limit residents' and employees' possible exposure and spread of the disease.

The nursing homes that we examine are an important piece of the long-term care services sector in the United States. In 2016, there were 15,600 nursing homes in the United States,

[5]See, for example, Rose (1990); Maksimovic and Titman (1991); Chevalier (1995); Phillips (1995); Chevalier and Scharfstein (1995); Dionne, Gagné, Gagnon, and Vanasse (1997); Campello (2003); Matsa (2011); Phillips and Sertsios (2013); Kini, Shenoy, and Subramaniam (2017)

[6]Characteristic statistics are from Harris-Kojetin, Sengupta, Lendon, Rome, Valverde, and Caffrey (2019), and risk factors are listed on the CDC website: "Assessing Risk Factors for Severe COVID-19 Illness", CDC, `https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/assessing-risk-factors.html`

while there were 4,600 adult day service centers, 12,200 home health agencies, 4,300 hospices, and 28,900 assisted living and residential care communities (Harris-Kojetin et al., 2019). Assisted living and residential care communities are similar to nursing homes on many dimensions (e.g., resident age demographic, high-density living), but do not typically provide the same level of skilled medical care that is provided in a nursing home.[7] We focus on nursing homes with skilled nursing facilities due to data availability – only Medicare and Medicaid-certified nursing facilities have to report their COVID-19 cases to the CMS – but the trade-offs we document are likely to be present in other parts of the elder-care industry.

2.1 Paying for Nursing Home Care

The nursing homes in our sample have three main categories of patient types: short-term residents covered by Medicare, long-term residents covered by Medicaid, and residents covered by private sources. Medicare covers short-term post-acute care following a stint of at least three qualifying days in an inpatient acute care setting.[8] Medicare covers the full cost of post-acute care for up to 20 days. After 20 days residents must pay a daily co-pay (currently $170.50 per day). After 100 days, Medicare no longer provides coverage.[9] The median Medicare stay for a resident in our sample is 35 days. Residents requiring care for longer than the Medicare coverage period transition to "private pay," which is typically out-of-pocket (Brown and Finkelstein, 2011), if they have the financial resources. Those with insufficient financial resources typically transition to Medicaid-coverage. In our sample, 13% of inpatient days are covered by Medicare, 54% are Medicaid, with the remainder private-pay.

Medicare reimbursement rates far exceed the Medicaid reimbursement rates, which vary

[7] Assisted living communities are not Medicare-certified and only around half are Medicaid-certified (Harris-Kojetin et al., 2019). In contrast, 97.5% (95.2%) of nursing homes were Medicare (Medicaid) certified in 2016 (Harris-Kojetin et al., 2019).

[8] This requirement was waived during the pandemic to help relieve bed capacity at hospitals. Although there was confusion about whether the waiver applied to all skilled nursing facilities or only for transfers from hospitals needing to create bed capacity, the waiver technically applied to all skilled nursing facilities in the country (Buck, 2020).

[9] `https://www.medicare.gov/Pubs/pdf/10153-Medicare-Skilled-Nursing-Facility-Care.pdf`

by state. Research by the National Investment Center for Seniors Housing & Care (2020) estimated the average revenue per patient day in the first quarter of 2020 was $540 ($425) for Medicare (Managed Medicare), $220 for Medicaid, and $275 for private-pay . The difference in reimbursement rates means Medicare is a disproportionate source of revenue for nursing homes. In the first quarter of 2020, Medicare accounted for less than 20% of inpatient days and over 30% of revenue (National Investment Center for Seniors Housing & Care, 2020). The low Medicaid reimbursement rate leads many nursing homes to use their more-profitable short-term Medicare business to cross-subsidize their Medicaid residents. In fact, Grabowski and Mor (2020) state "many nursing homes only stay in business by subsidizing long-term Medicaid residents with short-term post-acute care."[10] Below, we discuss how variation across nursing homes in the proportion of pre-pandemic Medicare business is likely strongly related to the nursing home's financial performance during the COVID-19 pandemic.

2.2 The COVID-19 Pandemic Increased Costs for Nursing Homes

The COVID-19 pandemic has dealt a damaging blow to an industry with little financial cushion. Many of the strategies to mitigate the risk of nursing home residents catching COVID-19 require significant capital outlays, and these outlays come at a time of overall flagging cash flow and economic prospects.

2.2.1 Increasing Labor, PPE, and COVID-19 Testing Costs

The AHCA and NCAL (American Health Care Association and the National Center for Assisted Living, 2020) listed a number of ways in which COVID-19 has increased nursing homes costs:

> Labor costs related to overtime, agency costs, new screening requirements for

[10]The differentials in reimbursement rates means nursing homes have an incentive to discriminate in admissions against patients that are Medicaid-eligible with long anticipated stays (Gandhi, 2019).

> staff and outside health care workers, more staff to address communal mean restrictions, staff time for family communication (i.e., assistance with iPad, etc.), staff out due quarantine or school closures, substantial increases in PPE costs and supplier requirements to pay upfront in full for PPE, and new child care costs being paid by SNFs for employees.

Analysis by Argentum (2020) estimated non-labor costs for assisted living facilities would increase 73 percent for homes without COVID-19 and 103 percent for homes with a COVID-19 case. The same report projected labor costs to increase 8 to 18 percent as a result of the pandemic.[11,12]

One important method for risk mitigation is the purchase and proper use of personal protective equipment (PPE). Health care providers, governments, and others across the world competed for scarce PPE resources, and the price of PPE increased dramatically as the pandemic spread, with prices increasing by over 1,000% in some cases (with the price of 3M N95 masks increasing over 6,000%) (Society for Healthcare Organization Procurement Professionals, 2020). In early April, the Society for Healthcare Organization Procurement Professionals estimated that following CDC guidelines for PPE would cost a 100-bed facility $10,000 per day (Flynn, 2020b). For context, this breaks down to $100 per bed per day, which would consume nearly half of the average daily Medicaid reimbursement of $220 per resident. Some nursing homes that usually spend between $20,000-$25,000 per *year* on PPE were spending close to $100,000 per *month* on PPE (Flynn, 2020b). This is a 4,700% increase in PPE expenditures.

Another major expense related to risk mitigation was COVID-19 testing for residents and employees. Guidelines and requirements on testing in nursing homes varied across states, but many states required or strongly recommended testing all residents and staff at

[11] Although the Argentum (2020) report was for assisted living facilities, similar increases were likely experienced at nursing homes.

[12] In one extreme example, a nursing home in Connecticut paid employees extra to live on-site in recreational vehicles in the nursing home's parking lot (Vaidya, 2020).

a high frequency. AHCA and NCAL estimated that testing every nursing home resident and employee in the nation *one time* would cost $440 million. While Medicare reimburses certain COVID-19 tests at a rate of $100 (only $51 until mid-April), the AHCA and NCAL estimated the cost per test at $150, meaning a significant portion of the cost may be born by the nursing facilities, other local government support, or private insurance. Even into June 2020, there remained uncertainty about who would bear the costs associated with testing, especially the testing of employees (Thomas, 2020).

2.2.2 Patient Mix and the Negative Shock to Cash Flows

Almost all nursing homes faced a significant drop in revenue during the early months of the COVID-19 pandemic, but not all were equally affected. The main driver of the loss in revenue was the sharp decline in the inflow of new residents, which occurred for at least two reasons. First, some nursing homes decided to limit or completely ban any new residents as a preventative measure. Second, there was a sharp drop in elective procedures, such as joint replacements, beginning as early as March 2020 due to voluntary and government-mandated restrictions. The significant decline in elective procedures led to a sharp decline in Medicare post-acute care residents for nursing homes, which is both the highest turnover and most profitable customer segment. In addition to the immediate declines in resident inflows, there was significant uncertainty about the duration of the elective procedure bans and how quickly nursing home demand would spring back. There also remain concerns of whether similar actions may be taken in the future if the spread of the virus is not contained or there are additional waves.

In sum, nursing homes experienced adverse shocks to their resident inflows and, in turn, their revenues, cash flows, and firm value. Nursing homes more reliant on short-term post-acute care and especially Medicare-covered post-acute care residents were likely more affected by the stoppage of elective procedures. We use (higher) Medicare share and (lower) average

length-of-stay as two measures of the severity of the shock to nursing home cash flows during the pandemic.

2.2.3 Government Aid to Nursing Homes

Federal and state governments have created new programs and used existing programs to help address the economic impacts of the COVID-19 pandemic. The nursing homes in our sample qualified for a number of these programs. The three main federal programs providing financial assistance to nursing homes were the Medicare Accelerated and Advance Payments Program, the Paycheck Protection Program, and the Provider Relief Fund. The main intervention at the state-level came in the form of increased Medicaid reimbursement rates.

The Medicare Accelerated and Advance Payments Program (MAAPP) is a loan program administered by the CMS to Medicare-certified providers (which includes all of our sample). In previous instances, the program has provided advance and accelerated payments to Medicare providers in locations affected by a natural disaster. On March 28, 2020, the program was expanded to all Medicare providers (e.g., physicians, hospitals, nursing homes, etc.) with the loan repayment to begin 120 days after the date of loan issuance. The purpose of this program was to provide liquidity to healthcare providers at the onset of the pandemic. The maximum loan amount for nursing homes was three month's worth of Medicare payments, so those with greater Medicare revenue were eligible for greater loan amounts through this program. The repayment process is automated, and effectively garnishes payment of future Medicare claims until the balance is repaid. On April 26, 2020, the program was suspended and being re-evaluated as the CARES Act Provider Relief Fund provided a more generous form of government support for Medicare providers.[13]

[13]Further details: https://www.cms.gov/newsroom/press-releases/trump-administration-provides-financial-relief-medicare-providers, https://www.cms.gov/files/document/Accelerated-and-Advanced-Payments-Fact-Sheet.pdf

There are at least three key aspects of this program to observe for our analysis. First, because Medicare could easily observe and confirm prior reimbursements and the reimbursement infrastructure was already in place, this program was able to quickly supply liquidity. Second, this program issued loans – not grants. Third, since repayment is effectively garnishing future revenue, this loan has a super-senior claim on the nursing home's revenues.

Beyond MAAPP, the federal government also provided cash grants to all qualifying small businesses through the Paycheck Protection Program, and specifically provided grants to health care providers through the Provider Relief Fund. The size of the grant was based on either payroll costs (Paycheck Protection Program) or total revenues and the number of beds (Provider Relief Fund). The Provider Relief Fund came into effect relatively late with the main, targeted disbursement to nursing homes occurring on May 22, 2020. Unlike MAAPP, relief from these programs was mainly based on nursing home size and payroll and did not depend on the types of patients at the nursing home. We provide more details on these programs in the Appendix.

At the state level, 24 states had taken actions to enhance Medicaid reimbursement rates for nursing homes as of June 12, 2020 (Flynn, 2020a). The enhanced payments typically took the form of a percentage increase (e.g., Rhode Island, Connecticut, and Oregon increased rates by 10%) or a flat rate increase (e.g., Washington increased the Medicaid rate by $29 per day). The date of the rate increase varied significantly across states (between April and June) and many were applied retroactively. For example, on May 13, California increased rates by 10%, and this rate increase was effective from March 1st through the end of the public health emergency.[14] While these are certainly helpful interventions, most of the states that provided such assistance have done so a month or two after many of the most difficult decisions on risk mitigation were made at the outset of the pandemic.

Finally, in May the Pentagon, FEMA, and CMS coordinated the purchase of PPE to distribute to nursing homes. By all indications, the government-provided PPE came too late

[14]Further details on Medicaid enhancements by state Flynn (2020a)

or was insufficient to address PPE needs for most nursing homes. Reports in the popular press documented significant concerns about both the quality and quantity of the provided PPE (Mathews, 2020).

3 Hypothesis Development

In the face of the spreading COVID-19 pandemic, the management of nursing homes were forced to make some very difficult decisions. Within a relatively short window of time, they had to evaluate the costs and benefits of: (1) increasing spending on preventative measures such as PPE, (2) changing visitation and admittance policies, and (3) the frequency of testing for COVID-19 of residents and staff, among other issues. At the same time, some major drivers of revenues and profits were drying up. Nursing homes faced with these potentially large capital outlays may either choose to or have to delay or forgo investment in COVID-19 risk mitigation.

3.1 Liquidity and COVID-19

The typical nursing home operates with razor-thin margins and has relatively little cash on hand. Nursing homes with insufficient cash on hand may have to raise costly external capital if they wish to invest in a greater amount of risk mitigation. Unfortunately, most nursing homes are likely unable to access large amounts of external capital (especially given the time-sensitive nature of the unfolding pandemic). Not only were many lenders particularly cautious during this time, but the shock itself diminished the creditworthiness of most of the industry. Such factors may hinder quick and significant risk mitigation investments and elevate the likelihood of COVID-19 in a nursing home. This motivates our first hypothesis:

Hypothesis 1: *Liquidity-constrained nursing homes are more likely to have COVID-19 cases.*

3.2 Negative Financial Shocks and COVID-19

The COVID-19 pandemic has been a major negative cash flow and firm value shock to the nursing home business. The effects of the pandemic come on top of the "long-standing issues in how nursing home services are structured and financed" (Grabowski and Mor, 2020). The decline in revenue, profitability, and firm value potentially pushed some nursing homes towards financial distress and bankruptcy. As of early August 2020, a survey of nursing homes showed that despite the fact that almost all nursing homes had received some measure of government relief through the programs described in Section 2.2.3, 72% of nursing homes said they could not sustain operations at their current pace for another year, and 40% said they would last less than six months (AHCA NCAL, 2020). These adverse financial effects of the pandemic can affect investment in risk mitigation and, therefore, the incidence of COVID-19. This situation is even more difficult for nursing homes facing financial constraints.

Alongside any baseline difficulties in raising external capital (i.e., financial constraints), there are at least two additional ways in which these types of financial shocks can translate into a higher incidence of COVID-19. First, most nursing homes have very high operating leverage (fixed salary and lease expenses) and with the prospects of declining revenue and firm value, a form of the debt overhang problem may have led to underinvestment problems in risk mitigation. This shock to firm value could also give rise to "risk-shifting" incentives (Jensen and Meckling, 1976). As a nursing home approaches insolvency or financial distress, the nursing home can save cash by delaying or forgoing high levels of risk mitigation investments with much of the remaining unmitigated risk being borne by stakeholders other than management and equity holders – namely, debt holders, patients, and employees. These factors motivate our second hypothesis:

Hypothesis 2: *COVID-19 is more likely to occur in nursing homes that experience greater adverse shocks to cash flows and thus firm value.*

We examine this hypothesis by using nursing homes' (1) ex-ante Medicare share of patients

and (2) average length-of-stay as measures of the degree of the nursing home's adverse shock to cash flow and firm value during the pandemic. As discussed in Section 2.2.2, nursing homes with greater ex-ante reliance on short-term residents were more affected by the stoppage of elective medical procedures.

Finally, larger nursing homes likely have greater access to external financing (Hadlock and Pierce, 2010) to fund investments in risk mitigation despite the ill effects of negative shocks to cash flow. Smaller nursing homes may have more difficulty investing in risk mitigation as smaller firms are typically more dependent on internally generated funds for investment for reasons such as asymmetric information (e.g., see Fazzari, Hubbard, Petersen, Blinder, and Poterba, 1988; Whited, 1992). The relatively more binding constraints for smaller homes, in turn, would lead to a relatively higher sensitivity of COVID-19 incidence to cash flow shocks.

Hypothesis 3: *The relationship between COVID-19 and the severity of adverse shocks to cash flows is strongest for small, financially constrained nursing home.*

For our empirical tests, we use two measures of size – total inpatient days and revenues – to test for the presence of a differential relationship of shocks to cash flow by the degree of financial constraints.

4 Data Sources and Summary Statistics

The Centers for Medicare & Medicaid Services (CMS) collects and disseminates a significant amount of information about Medicare and Medicaid-certified homes. The majority of our data sources, which we describe below, are from the CMS.

4.1 COVID-19 Cases

The main outcome we study is whether a nursing home has at least one case of COVID-19 during the first months of the pandemic (through June 14, 2020). The delayed onset of COVID-19 symptoms along with the complex, nonlinear-nature of its spread makes empirically modeling the overall number of cases in the nursing home both inherently challenging and more difficult to tightly link to economic incentives. The data on nursing home COVID-19 cases comes from the CMS's COVID-19 Nursing Home Data, which is reported through the CDC's National Healthcare Safety Network (NHSN) system's COVID-19 Long Term Care Facility Module.[15] Reporting is mandatory and those failing to report are subject to enforcement actions. The data are updated weekly with the first week ending May 24, 2020. The nursing homes report both cumulative cases and deaths as well as weekly data.[16] The cumulative data should capture any cases and deaths that occurred before nursing homes were required to report to the CMS.

The CMS performs data quality checks to ensure the nursing homes have not entered incorrect data. If the CMS flags a nursing home as having entered incorrect information, the nursing home is excluded from the dataset. After the initial release of data, a set of nursing homes raised concerns that their data had errors (Clark, 2020). The CMS corrects any identified errors, and so newer vintages of the data are of higher quality. We use data as of the week ending June 14, 2020.

We obtain data on county-level COVID-19 cases from the New York Times to measure the local baseline exposure to COVID-19.[17]

[15] `https://data.cms.gov/stories/s/COVID-19-Nursing-Home-Data/bkwz-xpvg/`

[16] We use *Residents Total Confirmed COVID-19*, which is defined as the "number of residents with laboratory positive COVID-19 (CONFIRMED) since 01/01/2020 as reported by the provider." Some facilities may have chosen to only report cases active at the end of April and then all new cases thereafter. We focus on the presence of any cases at all and not cumulative case counts. To misclassify our main variable, it would have to be the case that a nursing home had cases in March or early April, but no active cases by or after the end of April, which we think is unlikely.

[17] The data are available at `https://developer.nytimes.com/covid`. As a check of the quality of the New York Times data, we correlate the county-level COVID cases variable from their data with the county-level confirmed cases variable from `usafacts.org` and find a correlation of 0.9995.

4.2 Operational and Financial Data

The CMS provides databases that form the Healthcare Cost Report Information System (HCRIS). All Medicare providers are required to annually submit detailed cost reports which include facility identifying information and characteristics; the payor mix of those they serve (e.g., Medicaid, Medicare); capacity and utilization data; cost and charges by cost center; and financial statement data. Specifically, the raw data are collected from form CMS-2540-10. These data consist of nearly 20,000 raw data fields, of which about 1,200 are populated for most nursing homes. The CMS has made efforts to ensure the data are up-to-date and accurate, and we also perform some basic data cleaning to remove obvious data errors. For example, after creating the variables for analysis, we trim values that are more than five interquartile ranges above the 75th percentile or below the 25th percentile. We use the data reported from 2018, which is the most recent year for which the data are widely available.[18]

4.3 Nursing Home Ratings

The CMS uses a star rating system to rate nursing homes. There are four main star ratings: overall, health inspection, quality of resident care, and staffing. The overall rating is based on the nursing home's rating in the other three categories with the health inspection rating being the most important component.[19] The health inspection rating is based on the number of citations identified during standard, annual health inspections or during any complaint or facility-reported incident investigations over the past three years. The health inspection star rating is based on the nursing home's percentile rank within its state (e.g., the top 10% are given 5 stars, the bottom 20% are given 1 star). The staffing rating is based

[18]This data cleaning process is similar to what is used by the RAND Corporation to clean Hospital HCRIS data (`https://www.hospitaldatasets.org/faq`). We trim these rather than winsorize as the algorithm is more likely to capture data errors rather than identify true outliers. The results are not sensitive to using alternative methods of data cleaning.

[19]For details on the exact calculations of the star ratings, see `https://www.medicare.gov/nursinghomecompare/Data/About.html`.

on registered nurse and total staffing hours per resident per day. The quality of resident care star rating is based on a combination of quality measures derived from nursing home reported data and Medicare claims data. CMS calculates separate quality-of-care ratings for short-stay, long-stay, and overall. In our analysis, we examine whether these CMS nursing home ratings are associated with the likelihood of a nursing home having a COVID-19 case.

4.4 Sample Selection and Summary Statistics

We start with a sample of 14,520 skilled nursing facilities (nursing homes) from the most recent complete CMS cost reports data, which is from 2018. We then drop nursing homes that are run by the government (about 1,100), leaving the remaining mix between for-profit and not-for-profit at about 75%/25%. We exclude observations with data values that appear to be erroneous (using the procedure in Section 4.2). We drop nursing homes that are the only nursing home in their county since our main tests include county fixed effects and so require within-county variation. Our final sample consists of 7,089 nursing homes from 1,233 counties.

We use a common industry measure of liquidity and two measures of the cash flow/firm value shock experienced by nursing homes during the pandemic and examine whether these variables are associated with a higher incidence of COVID-19. The liquidity measure is "days-cash-on-hand," which is a widely-used measure in healthcare finance to capture the factors that truly determine the liquidity of the business (Gapenski and Reiter, 2016). Days-cash-on-hand is computed as $\frac{cash\ and\ short\text{-}term\ investments}{(operating\ expenses\ -\ depreciation)/365}$, which is the number of days' worth of real operating expenses that can be supported by the nursing home's most liquid assets.

The two measures of the shock to nursing homes' cash flow and value exploit pre-COVID-19 variation in the types of patients served by the nursing home. The first measure is the share of inpatient days covered by Medicare. Nursing homes with a greater share of their residents

covered by Medicare experience a larger shock to cash flow as the flow of these patients is stemmed by the sharp reduction in elective procedures. Similarly, the second measure is the pre-COVID-19 average length-of-stay. Nursing homes with a lower average length-of-stay face a larger negative shock in cash flow as they are more reliant on the higher-turnover, short term post-acute care patients.

In Table 1, we report summary statistics. 40% of nursing homes in our sample had at least one case of COVID-19 among residents as of June 14, 2020. Examining our main cross-sectional variables of interest, we see the average nursing home in our sample has only 21 days of cash on hand with an interquartile range of 25 days. About 13% of the average nursing home's inpatient days are covered by Medicare. There is also substantial variation in the average length-of-stay across nursing homes, with the interquartile range going from 77 days to 177 days. From January to June 2020, we also see an average drop in residents of about 10% with significant variation around that figure.

Table 1 also provides summary statistics for other variables we use in our main analysis. We control for variables related to the size (*InpatientDays* and *Employees*), operational ratings (*Overall Rating* and *Health Inspection Rating*), as well as other financial variables (*TotalMargin* and *Leverage*[20]) of the nursing home. One notable observation is how tight margins were in the nursing home business leading up to the pandemic, with a median total margin of 0% and the average at -1%.

5 Results

In this section, we begin by establishing the baseline drivers of variation in the incidence of COVID-19. Then, we examine whether a nursing home's liquidity position and the degree of the negative shock to the nursing home's business relates to the likelihood of a COVID-19

[20]Our measure of leverage is based on book values. Unfortunately, we cannot measure true market leverage because the vast majority of nursing homes are not publicly traded.

case in the nursing home. Lastly, we use a two-stage regression to more-directly link the severity of the nursing home's financial shock to the likelihood of a COVID-19 case.

5.1 Baseline Regressions

We begin the analysis by considering some of the baseline factors that represent differences in exposure to COVID-19. The most prominent is the location of the nursing home. Homes in areas with greater community spread of the coronavirus are more likely to be exposed to the virus and to have a case of COVID-19. A second potential factor that drives baseline variation in the likelihood of COVID-19 is the size of the nursing home. Nursing homes with more residents on a given day and more employees will have greater scope for transmission and a COVID-19 case than other homes. We use the (logarithm of the) number of inpatient days (*log(Inpatient Days)*), which is simply the sum across patients of the number of days each patient was served, to capture the size of the nursing home and the (logarithm of the) number of full-time employee equivalents (*log(Employees)*) to capture the size of the nursing home's workforce. We expect a higher number of inpatient days and a higher number of employees to increase the likelihood of COVID-19 incidence. A third potentially important factor is the general quality of the nursing home, which we measure by CMS overall and health inspection ratings.

For most of our analysis, we use the OLS framework below:

$$\textit{COVID-19}_{i,g} = \alpha + \Gamma(\textit{NursingHomeCharacteristics}_i) + \Lambda(\textit{Geography}_g) + \epsilon_{i,g}, \qquad (1)$$

where $\textit{COVID-19}_{i,g}$ is a dummy variable equal to one if nursing home i in geography g has at least one case of COVID-19 by June 14, 2020, $\textit{NursingHomeCharacteristics}_i$ is a set of nursing home characteristics and $\textit{Geography}_g$ are geographical fixed effects. In almost all tests, we include county fixed effects, and we compute standard errors clustered at the county level. County fixed effects account not only for fixed differences in local exposure to COVID-19, but

also differences in local and state-level factors including the degree of restrictions on elective surgeries, labor laws, Medicaid policies, and stay-at-home orders.[21]

We begin the analysis by examining the relationship between a nursing home's location and the likelihood of a COVID-19 case in the nursing home. In Column (1) of Table 2, we only include the logarithm of the number of COVID-19 cases in the county (excluding those in nursing homes) in the regression. There is a strong positive relationship between local COVID-19 cases and the likelihood of a COVID-19 case in a nursing home in that county. This variable alone explains about 20% of the variation as seen by the R^2. In column (2), we regress *COVID-19* on county fixed effects, and the R^2 increases to 41%. These results indicate that location is an extremely important determinant of a nursing home having a COVID-19 case.

In column (3), we include two measures, *log(Inpatient Days)* and *log(Employees)* to capture the size and degree of people and human interactions at the nursing home. We find a strong relationship between *log(Inpatient Days)* and the likelihood of a COVID-19 case, but *log(Employees)* is not significantly related to the likelihood of a COVID-19 case after controlling for location and inpatient days.[22]

We next consider the role of a nursing home's quality ratings as assigned by the CMS. Column (4) includes indicator variables for each level of the CMS 5-star overall rating, with the 1-star dummy omitted. We find variation in the incidence of a COVID-19 case is negatively related to the overall star rating, with 5-star facilities having on average a 5 percentage points lower likelihood than 1-star facilities. This result stands in contrast to previous work using coarser geographical controls that finds that star ratings are unrelated or marginally related to COVID-19 incidence (Abrams et al., 2020; Konetzka, 2020; White et al.,

[21]In Appendix Table A1, we show that all of our main results are robust to using different levels of geographical fixed effects. We find that the relationship between financial variables and COVID-19 is robust to using state, CBSA, or even city-level fixed effects. The variables of interest remain economically and statistically significant across specifications.

[22]If *log(Inpatient Days)* is omitted from the regression, the coefficient estimate on *log(Employees)* is 0.12 (p-value$<$0.01).

forthcoming).[23] The overall star rating is a composite of ratings related to health inspections, staffing, and other quality subratings. The health inspection rating is the most important component of the overall rating. The estimates in column (5) show that the health inspection rating (as of January 2020) is important, with those facilities rated 4- and 5-stars having close to 5 percentage points lower incidence of COVID-19 than the lowest-rated nursing homes. In untabulated tests, we find that when including overall ratings and health inspection ratings, that the effect of health inspection ratings becomes stronger and explains away the effect of the overall rating. We also find no significant difference in COVID-19 incidence across staffing or quality ratings. For the remainder of our tests, we only include indicators for the health inspection ratings.

5.2 Financial Factors and COVID-19

We now examine whether financial factors can help explain the variation in the likelihood of a COVID-19 case in a nursing home as laid out in Hypotheses 1 and 2. To examine the roles of low ex-ante liquidity and the negative cash flow shock on the likelihood of COVID-19 incidence, we include *log(DaysCashOnHand)*, *MedicareShare*, and *log(AverageLengthOfStay)* in our baseline regression model (1). Table 3 presents the results.

Column (1) shows a strong, negative relationship between the nursing home's liquidity position and COVID-19. Moving from the 25th to 75th percentile of days-cash-on-hand corresponds to a roughly 3.2 percentage point drop in the likelihood of COVID-19 at the nursing home. We find that the other financial variables (total margin and book leverage) are not significantly related to the incidence of COVID-19. The negative relationship between days-cash-on-hand and COVID-19 supports Hypothesis 1, that lower liquidity corresponds to a higher likelihood of COVID-19.

Column (2) examines the relationship between COVID-19 incidence and the sharp,

[23] In later tests in Table A1, we find that overall rating is not significantly related to COVID-19 if the specification only controls for state-level fixed effects helping to reconcile the different results.

negative cash flow and firm value shock from having a higher reliance on Medicare patients. The estimates indicate that a 10 percentage point increase in Medicare share corresponds to a 2.4 percentage point increase in the likelihood of COVID-19. Column (3) shows that this relationship is relatively independent of the liquidity result found in column (1). Column (4) shows that nursing homes whose business relies on higher levels of short-term post-acute care (i.e., lower average length-of-stay) have a higher likelihood of a COVID-19 case. Specifically, dropping from the 75th percentile to 25th percentile in the average length of resident stay corresponds to a 2.6 percentage point higher likelihood of COVID-19, and this relationship is independent of the nursing home's days-cash-on-hand liquidity position (column 5). These results provide evidence supporting Hypothesis 2: nursing homes that experienced a greater decline in cash flows, and thus firm value, were more likely to have a COVID-19 case.

5.3 Financial Constraints, Shocks to Cash Flow, and COVID-19

If financial factors are important, then Hypothesis 3 predicts a stronger relationship between *MedicareShare* and COVID-19 for smaller, more financially constrained nursing homes. Larger, less constrained nursing homes are likely more financially equipped to undertake risk mitigation regardless of the size of their shock to cash flow from fewer incoming Medicare patients. These tests also help mitigate concerns that *MedicareShare* is proxying for other baseline factors driving COVID-19 that are unrelated to cash flows (e.g., more doctors or specialists coming through the facility). If such factors are driving the baseline relationship between *MedicareShare* and COVID-19, then we would not expect heterogeneity in that relationship across higher and lower financial constraints.

We test for a heterogenous relationship between *MedicareShare* and COVID-19 incidence by estimating our main regression and including an interaction between *MedicareShare* and

measures of size (*log(InpatientDays)* or *log(Revenue)*).

$$COVID\text{-}19_{i,g} = \beta(Size_i) + \pi(MedicareShare_i) + \chi(Size_i \times MedicareShare_i) + \Gamma(Controls_{i,g}) + \epsilon_{i,g} \tag{2}$$

If smaller, financially constrained nursing homes are more sensitive to shocks to cash flow, this predicts $\hat{\chi} < 0$. Similarly, this predicts $\hat{\chi} > 0$ when using *AverageLengthofStay*. Table 4 presents the results for these measures with size being measured by *log(InpatientDays)* (columns 1 and 2) and *log(Revenue)* (columns 3 and 4). Across all measures, we find statistically significant and economically meaningful estimates of χ.

We present the results of the regression in column (1) graphically in Figure 3 to illustrate the results. We use the estimated coefficients to plot the sensitivity of COVID-19 incidence to *MedicareShare* for nursing homes at the 10th, 50th, and 90th percentiles of the size distribution. In the plot, *MedicareShare* ranges from the 5th to 95 percentile of its distribution. The average difference in COVID-19 incidence across home size reflects the earlier results that more patient exposure predicts higher COVID-19 incidence. While the incidence of COVID-19 in larger nursing homes is relatively insensitive to *MedicareShare*, the figure shows that there is considerable sensitivity to the size of the shock to cash flows on COVID-19 incidence among smaller, more-constrained nursing homes. Said differently, nursing homes that are more likely to be financially constrained are disproportionately impacted by proportionately similar shocks to cash flows.

The difference in COVID-19 incidence between the 90th and 10th percentile sized nursing homes is about 30pps for those with only about 3% of their pre-pandemic patient days from Medicare patients. However, that difference is only 19 pps for those near the top of the *MedicareShare* distribution. This difference (across size) in differences (within the same *MedicareShare*) of about 11 pps supports the notion that the degree of *MedicareShare* (and *AverageLengthofStay*) represent important measures of the financial shocks borne by the

nursing homes, which further translate to differences in COVID-19 incidence.

5.4 Medicare Share, the Number of Residents, and COVID-19

The interpretation of our previous tests assumes that nursing homes with a higher Medicare-share and those with lower average length-of-stay experienced greater declines in revenues during the pandemic. In this subsection, we empirically examine the path from high Medicare-share and lower average length-of-stay to drops in the number of residents to the higher COVID-19 incidence. First, we directly examine the relationship between a nursing home's change in residents (i.e., paying customers) during the pandemic and the likelihood of COVID-19. Second, we trace out the channel by using a nursing home's ex-ante Medicare share and the average length-of-stay to instrument for the change in residents.

In column (1) of Table 5, we regress the COVID-19 indicator on a nursing home's change in residency between January and June 2020 to examine whether homes that experienced a greater decline in residents (revenues) were more likely to have COVID-19. The average nursing home saw a decline in residents of about -11% during this time period (see Table 1). We estimate that a 10 percentage point larger drop in residents corresponds to a 6.5 percentage point higher likelihood of COVID-19. The results indicate a significant relationship between a nursing home's loss of revenue and COVID-19 incidence.

While the realized decreases in residents reflects a greater loss in patient cash flows, the interpretation of these estimates is somewhat clouded by simultaneity concerns. While the negative shock to cash flows may be leading to decisions that increase the relative likelihood of COVID-19, it could also be the case that a COVID-19 case occurrence in a nursing home can lead to a greater drop in the number of residents (e.g., directly through death, or indirectly through residents leaving after detection of a COVID-19 case in the facility). We next address this issue using a two-stage least squares approach.

In the ideal experiment, we would randomly assign shocks to the nursing homes' cash

flows, and examine whether variation in cash flows leads to systematically different degrees of COVID-19 incidence. While we cannot randomize cash flows, we can use a nursing home's reliance on short-term post-acute care business – which sharply dropped because of elective surgery bans – as an ex-ante measure of a nursing home's exposure to the revenue shock that occurs from the reduction in residents. Specifically, we use the ex-ante Medicare share and average length-of-stay of residents to instrument for changes in the nursing home's number of residents in the following two-stage regression (presented using Medicare share as the instrument).

$$\%\Delta Residents_{i,g} = \phi(MedicareShare_i) + \Theta(NursingHomeCharacteristics_i) + \xi_g + \eta_{i,g} \quad (3)$$

$$COVID\text{-}19_{i,g} = \psi(\%\Delta\widehat{Residents}_i) + \Omega(NursingHomeCharacteristics_i) + \zeta_g + \epsilon_{i,g} \quad (4)$$

The first-stage regression (3) estimates whether nursing homes with a higher ex-ante Medicare share indeed suffer greater declines in residents between January and June 2020. Column (2) of Table 5 presents the estimate of ϕ, which indicates that a 10 percentage point higher *MedicareShare* corresponds to a 2.0 percent decline in nursing home residents during that time. This first stage is strong, with an F-statistic of 60. Column (3) presents the reduced-form estimate relating the instrument to COVID-19 incidence (same as column (3) of Table 3). Column (4) presents the two-stage least squares estimate, with the change in residents instrumented with *MedicareShare*. The coefficient estimate of $\hat{\psi}$ indicates that a one percent drop in residents leads to a 1.05 percentage point increase in likelihood of COVID-19 incidence.

Columns (5)-(7) present similar tests with *log(AverageLengthOfStay)* as the instrument for changes in residents. The intuition is similar: nursing homes whose business is tilted toward shorter stays are likely to see greater drops in residents as the inflows sharply decline. The estimates yield similar results: a one percent drop in residents corresponds with a 0.98

percentage point increase in the likelihood of a COVID-19 case at the nursing home.

To the extent that the baseline exposure increases with the number of patients (recall that *log(Inpatient Days)* strongly predicts COVID-19), this baseline exposure is decreasing as the number of residents declined. However, we show here that the drop in residents is *positively* related to the likelihood of COVID-19. Thus, we argue that the negative shock to cash flows – which means, all else equal, negative shocks to liquidity and firm value – is a key explanation for this relationship.

5.5 Discussion of the Exclusion Restriction

To interpret the results above as causal, the exclusion restriction in the two-stage least squares regressions above requires that the only reason that *MedicareShare* or *log(AverageLengthOfStay)* are related to COVID-19 likelihood is through their effect on the number of residents (and the revenue they provide). For example, there may be concerns that higher *MedicareShare* and low *AverageLengthofStay* are simply capturing higher patient turnover and traffic, not financial factors, and the higher turnover and traffic increase the chance that someone brings in COVID. We first recall that the differential sensitivity of COVID-19 to these variables across degrees of financial constraints support their role as shocks to the finances of the firms (Table 4 and Figure 3). Further, the results in Table 5 showed that higher *MedicareShare* and low *AverageLengthofStay* facilities experienced substantially larger decreases in occupancy, which indicates decreased patient traffic during the early months of the pandemic. We also note that nursing homes can refuse patients that put their existing population at risk, though such decisions entail financial costs.[24,25] If the high Medicare share nursing home continue

[24]For example, "some skilled nursing facilities have gone well beyond the measures recommended by the U.S. Centers for Disease Control and Prevention (CDC)... In some cases, nursing homes are requiring COVID-19 tests of new patients or returning residents before they can be readmitted, all the while worrying about false negative results that have been reported in some tests. Some homes are refusing new patients altogether." `https://www.kqed.org/news/11812417/will-california-nursing-homes-be-forced-to-accept-covid-19-patients`

[25]In Subsection 5.5.3. we discuss circumstances of unusual pressure from state governments and show those do not drive our results.

with "business as usual," to maintain their revenues at the risk of exposing their patients to COVID-19, this risk-taking behavior is part of the channel we have in mind. While exclusion restrictions cannot be directly tested, we provide discussion and analysis suggesting the exclusion restriction is likely to be satisfied.

5.5.1 Differences in Observables

One potential concern is that higher-Medicare-share nursing homes may be risk-takers more generally or are of lower average quality. If so, then we might expect higher rates of COVID-19 in high-Medicare-share nursing homes even if these homes did not experience greater negative financial shocks. In Table 6, we split nursing homes into terciles based on their Medicare share and examine mean values for each tercile across several variables. Nursing homes with higher Medicare share have slightly more employees but slightly lower inpatient days, which suggests a higher employee-to-resident ratio. In terms of finances, high-Medicare-share nursing homes have lower cash on hand, but similar operating margins and lower book leverage. Notably, high-Medicare-share nursing homes have higher overall ratings on all dimensions (overall, health inspection, quality of resident care, and staffing), suggesting high-Medicare-share nursing homes are of higher observed quality thus have more to lose by taking risks that would potentially damage quality ratings. In sum, high-Medicare-share nursing homes are of higher average quality than lower-Medicare-share nursing homes on most of these factors. Thus, we argue that it is unlikely that nursing homes that are superior on observable dimensions are systematically riskier or worse quality on unobserved dimensions.

5.5.2 Differences in Capabilities and Patient Demographics

Are differences in the capabilities and demographics – and thus potential differences in baseline susceptibility to COVID-19 – of high-Medicare-share/shorter-average-stay nursing homes driving the results? Next, we examine whether the instrumented change in residents

is still related to COVID-19 likelihood after controlling for important variables related to a nursing home's ability to handle more difficult cases. These variables should account for a nursing home's technology, expertise, and hospital relationships. We also control for the demographics of Medicare residents admitted to the nursing homes (average age, percent male, and percent minority). Table 7 presents the results.

In column (1), we report our base IV regression using the smaller sample (the additional data requirements cause us to lose about 1,000 nursing homes), where we estimate a slightly smaller coefficient compared to the larger sample (-0.822 versus -1.049). In column (2), we include average Hierarchical Condition Categories (HCC), which is a risk adjustment factor where higher HCC usually indicates higher-cost, higher severity patients. The coefficient is positive and significant on HCC. The coefficient estimate on *%ChangeInResidents* increases in magnitude to -0.91 and remains statistically significant. In column (3), we include the demographic variables and find that HCC is no longer significant (those variables partly determine HCC) and none of the demographic variables are statistically significantly related to COVID-19 incidence. Column (4) includes another measure of rehabilitation intensity, *Share>VeryHigh*, which is the share of Medicare patients requiring 720 minutes and in column (5), we include case characteristics controls including timing and nature of their conditions.[26] The coefficient estimate on *%ChangeInResidents* of 0.99 (p-value=0.02) is similar to our full sample baseline 2SLS estimates. We find similar results when using average length-of-stay as the instrument in Columns (6)-(10). In all regressions, days-cash-on-hand remains statistically significant and of similar magnitude. Overall, it does not appear that the relationship between Medicare share and COVID-19 is due to differences in the expertise of high-Medicare-share nursing homes or differences in the demographics of the nursing home's residents.

[26]The additional variables include the share of Medicare patients with stays less than 30 days, longer than 60 days, using Medicare Advantage, and shares with asthma, congestive heart failure, COPD, and whether their primary condition for residency is congestive heart failure, COPD, infection, or injury.

5.5.3 The Pressure or Choice to Admit Active COVID-19 Patients

During a surge of COVID-19 patients, some states have had the capacity of their hospital systems and intensive care units (ICUs) severely strained, which led to direct or indirect pressure for nursing homes to admit patients that had COVID-19. Could our results be driven by this pressure disproportionately falling on higher-Medicare-share nursing homes? In untabulated tests, we re-estimate our main regressions while excluding nursing homes in states that exceeded 80% of hospital ICU capacity during our sample period.[27] We find similar results in magnitude and statistical significance.

We finally note that in some cases, there were strong financial incentives to admit COVID-19 patients. Admitting a COVID-19 resident increases a nursing homes' cash flows (sometimes with a bonus from the state) while necessarily increasing the risk of spread of the coronavirus within the nursing home. Such a tradeoff may seem attractive to managers in a dire financial position, and they may be less likely to internalize the downside risk of taking in such patients. Our measure of COVID-19 cases does not distinguish between deliberately admitted cases and cases that arose from within the nursing home. While our discussion has thus far focused on the effect of liquidity constraints and changes in incentives related to the cash flow shocks on risk mitigation investments, choosing to deliberately admit COVID-19 positive patients is one aspect of the main channel we study in this paper.

6 Conclusion

The COVID-19 pandemic has imposed significant financial hardships across the economy and has required leaders to make a host of difficult decisions. The nursing home industry is a setting where the financial shocks have been severe. Restrictions on elective procedures slowed the flow of their most profitable revenue source, and the need for risk mitigation caused costs

[27] These tests use data from the CDC on hospital ICU utilization.

to skyrocket. After controlling for baseline factors affecting COVID-19 spread such as county fixed effects, we provide some of the first evidence that nursing home finances are important factors in understanding cross-sectional variation in the incidence of COVID-19.

We find the nursing homes with less liquidity (days-cash-on-hand) to deploy for risk mitigation are more likely to have COVID-19 cases. We also show that nursing homes hit with larger negative shocks to cash flow – measured by larger ex-ante share of Medicare business and lower average days of stay – experienced a higher incidence of COVID-19, and the relationship is strongest for nursing homes likely to be financially constrained. These results shed new light on the propagation of COVID-19 and the important role that the financial circumstances of nursing homes have to play in the lives of their patients.

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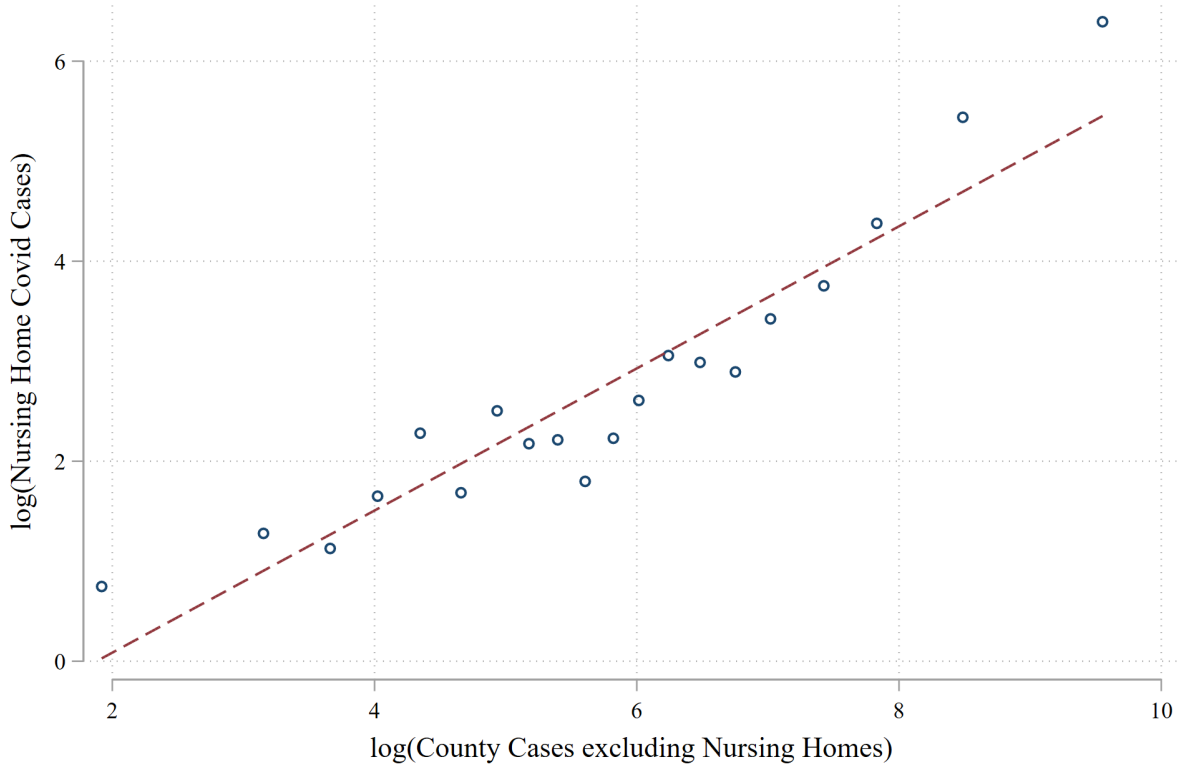
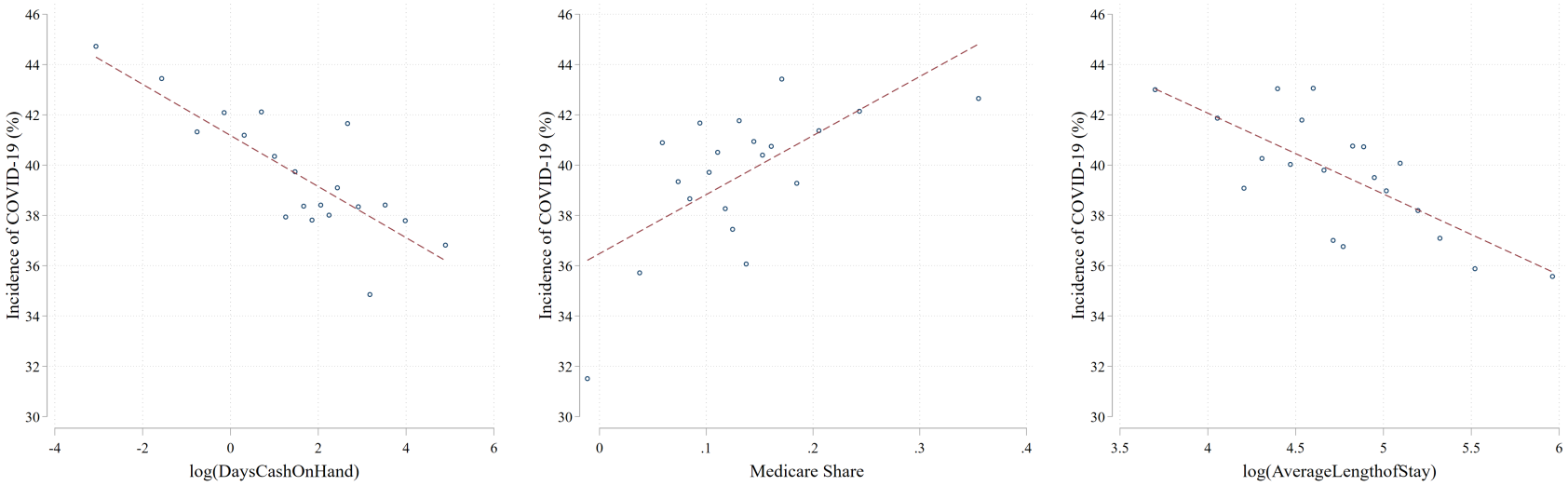


Figure 1: Geographical Exposure and COVID-19 in Nursing Homes
This figure presents a binned scatter plot of the log number of nursing home COVID-19 cases in a county as a function of the number of non-nursing-home COVID-19 cases in that county through June 14, 2020.



(a) log(Days Cash on Hand) **(b)** Medicare Share of Inpatient Days **(c)** log(Average Length of Stay)

Figure 2: Financial Factors and COVID-19

This figure presents binned scatter plots of the likelihood a nursing-home has at least one COVID-19 case by June 14, 2020 as functions of the nursing home's *DaysCashOnHand* (number of days worth of operating expenses that can be covered by cash and equivalents), *MedicareShare* (the share of overall patient days that are reimbursed through Medicare), and *AverageLengthofStay* (the average number of days each resident spends at the nursing home). Each plots controls for the nursing home's *log(InpatientDays)*, *log(Employees)*, *TotalMargin*, *Leverage*, *HealthInsp Rating* fixed effects as well as county fixed effects.

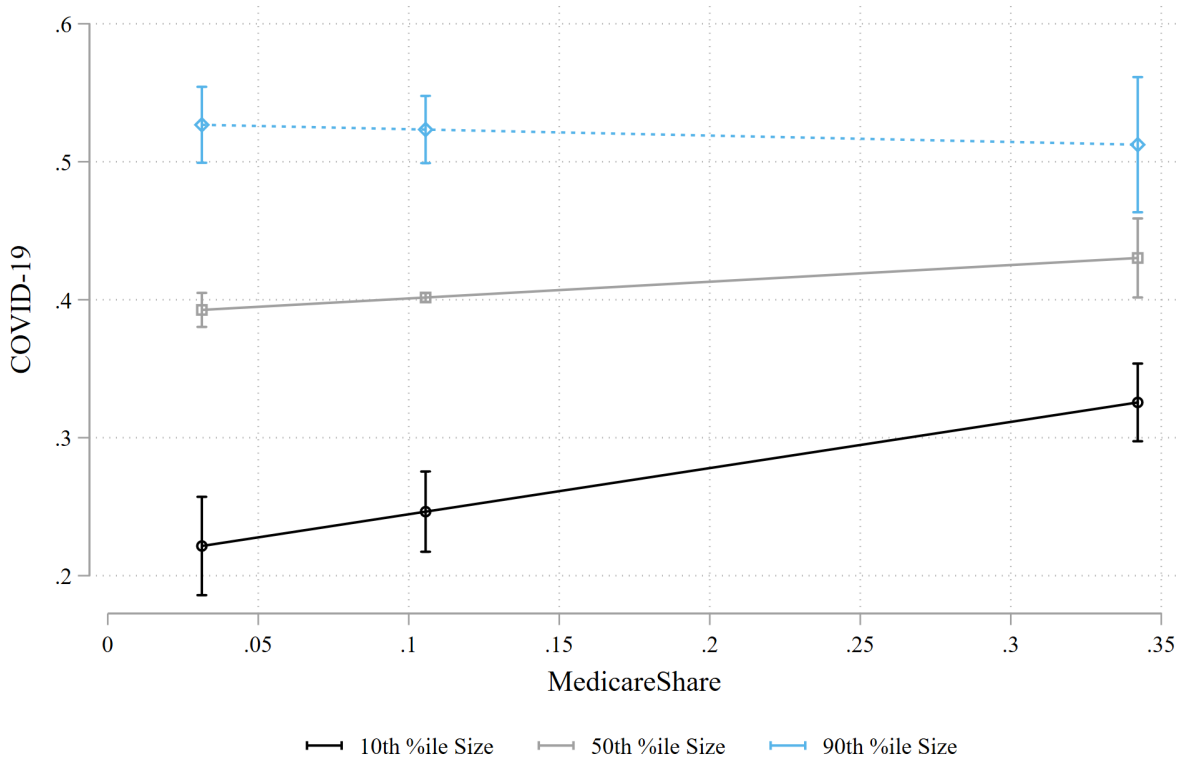


Figure 3: Differential Sensitivity to Shock to Cash Flows
This figure uses the estimated coefficients from regression (2) to plot the sensitivity of COVID-19 incidence to *MedicareShare* for nursing homes at the 10th, 50th, and 90th percentiles of the size distribution for values of *MedicareShare* ranging from the 5th to 95 percentile of its distribution. *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, and *InpatientDays* is the total number of days of service received by patients.

Table 1: Summary Statistics

This table presents summary statistics for the variables used in our analysis. *COVID-19* is an indicator variable equal to one if the nursing home had at least one patient with COVID-19 as of June 14, 2020, *CountyCovid-19Cases* is the number of COVID-19 cases reported in the county as of June 14, 2020 excluding those reported in nursing homes, *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *AverageLengthofStay* is the average number of days each resident spends at the nursing home, *%ChangeInResidents* is the percent change in resident population between January and June 2020, *InpatientDays* is the total number of days of service received by patients, *Employees* is the number of full-time-equivalent employees at the nursing home, *Overall Rating* is the CMS "overall" rating from their five-star quality rating system, *HealthInsp Rating* is the component of the CMS rating program that comes from health inspections in which the top 10% in each state receive a top rating, *TotalMargin* is the net income divided by total revenue, *Leverage* is the net book leverage (net debt divided by total book capitalization). Variables are winsorized at the 1% level to minimize the potential effects of outliers. All estimations include county fixed effects except column (1), and all standard errors are clustered at the county level.

	mean	sd	p25	median	p75	n
COVID-19	0.40	0.49	0.00	0.00	1.00	7,089
CountyCovid-19Cases	656.12	2,626.35	5.00	45.00	311.00	7,089
DaysCashOnHand	21.00	30.79	1.12	8.28	26.33	7,089
MedicareShare	0.13	0.10	0.07	0.11	0.17	7,089
AverageLengthofStay	143.49	99.94	77.46	117.28	176.55	7,089
%ChangeInResidents	-0.11	0.15	-0.19	-0.10	-0.02	7,044
InpatientDays (000s)	33.54	17.15	20.86	31.22	41.24	7,089
Employees	98.85	57.33	58.50	85.34	124.00	7,089
Overall Rating	3.15	1.40	2.00	3.00	4.00	7,089
HealthInsp Rating	2.77	1.26	2.00	3.00	4.00	7,089
TotalMargin	-0.01	0.09	-0.05	0.00	0.05	7,089
Leverage	0.76	0.71	0.28	0.65	1.03	7,089

Table 2: Baseline Drivers of COVID-19

This table presents regression estimates of whether a nursing home had at least one COVID-19 case as of June 14, 2020 on the following variables: *CountyCovidCases* is the number of COVID-19 cases reported in the county as of June 14, 2020 excluding those reported in nursing homes, *InpatientDays* is the total number of days of service received by patients, *Employees* is the number of full-time-equivalent employees at the nursing home, *Overall Rating* is the CMS "overall" rating from their five-star quality rating system, and *HealthInsp Rating* is the component of the CMS rating program that comes from health inspections in which the top 10% in each state receive a top rating. Rating category 1 is the excluded category for the respective rating types. All estimations include county fixed effects except column (1), and all standard errors are clustered at the county level.

	(1)	(2)	(3)	(4)	(5)
log(CountyCovidCases)	0.095***				
	(<0.01)				
log(InpatientDays)			0.193***	0.176***	0.178***
			(<0.01)	(<0.01)	(<0.01)
log(Employees)			-0.007	0.004	0.002
			(0.67)	(0.80)	(0.91)
Overall Rating=2				0.000	
				(0.99)	
Overall Rating=3				0.005	
				(0.81)	
Overall Rating=4				-0.011	
				(0.54)	
Overall Rating=5				-0.049**	
				(0.01)	
HealthInsp Rating=2					-0.008
					(0.61)
HealthInsp Rating=3					-0.019
					(0.25)
HealthInsp Rating=4					-0.048***
					(<0.01)
HealthInsp Rating=5					-0.050**
					(0.03)
Constant	-0.267***				
	(<0.01)				
County FE	No	Yes	Yes	Yes	Yes
Observations	7067	7089	7089	7089	7089
R^2	0.204	0.413	0.438	0.439	0.439

p-values in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Financial Factors and COVID-19

This table presents regression estimates of whether a nursing home had at least one COVID-19 case as of June 14, 2020 on the following variables: *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *AverageLengthofStay* is the average number of days each resident spends at the nursing home, *InpatientDays* is the total number of days of service received by patients, *Employees* is the number of full-time-equivalent employees at the nursing home, *TotalMargin* is the (standardized) net income divided by total revenue, *Leverage* is the (standardized) net book leverage (net debt divided by total book capitalization), and *HealthInsp Rating* is the component of the CMS rating program that comes from health inspections in which the top 10% in each state receive a top rating. Rating category 1 is the excluded category. All estimations include county fixed effects, and all standard errors are clustered at the county level.

	(1)	(2)	(3)	(4)	(5)
log(DaysCashOnHand)	-0.010***		-0.010***		-0.009***
	(<0.01)		(<0.01)		(<0.01)
MedicareShare		0.235***	0.222***		
		(<0.01)	(<0.01)		
log(AverageLengthofStay)				-0.032***	-0.028***
				(<0.01)	(<0.01)
log(InpatientDays)	0.168***	0.205***	0.193***	0.193***	0.181***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
log(Employees)	0.012	-0.014	-0.002	-0.009	0.002
	(0.46)	(0.42)	(0.90)	(0.57)	(0.89)
zTotalMargin	-0.002	-0.004	-0.003	-0.002	-0.001
	(0.75)	(0.57)	(0.68)	(0.80)	(0.89)
zLeverage	-0.005	0.000	-0.004	0.000	-0.004
	(0.36)	(0.97)	(0.45)	(1.00)	(0.44)
HealthInsp Rating=2	-0.008	-0.009	-0.009	-0.008	-0.008
	(0.63)	(0.57)	(0.56)	(0.63)	(0.62)
HealthInsp Rating=3	-0.016	-0.022	-0.020	-0.020	-0.018
	(0.33)	(0.18)	(0.22)	(0.22)	(0.26)
HealthInsp Rating=4	-0.045***	-0.053***	-0.051***	-0.049***	-0.047***
	(0.01)	(<0.01)	(<0.01)	(<0.01)	(0.01)
HealthInsp Rating=5	-0.046*	-0.055**	-0.052**	-0.051**	-0.048**
	(0.05)	(0.02)	(0.03)	(0.03)	(0.04)
County FE	Yes	Yes	Yes	Yes	Yes
Observations	7089	7089	7089	7089	7089
R^2	0.440	0.440	0.441	0.440	0.441

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Financial Constraints, Shocks to Cash Flow, and COVID-19

This table presents regression estimates of whether a nursing home had at least one COVID-19 case as of June 14, 2020 on the following variables with a focus on the interaction between *MedicareShare* and financial constraints as measured by size (*InpatientDays* and *Revenues*). *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *InpatientDays* is the total number of days of service received by patients, *Revenues* is the annual net revenue of the nursing home, and the control variables include *log(Employees)*, *TotalMargin*, *Leverage*, and *HealthInsp Rating* fixed effects. All estimations include county fixed effects, and all standard errors are clustered at the county level.

Measure of Nursing Home Size)	InpatientDays		Revenues	
	(1)	(2)	(3)	(4)
log(DaysCashOnHand)	-0.010***	-0.009***	-0.013***	-0.014***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)
log(InpatientDays)	0.239***	-0.018		
	(<0.01)	(0.75)		
log(Revenues)			0.117***	-0.064
			(<0.01)	(0.31)
MedicareShare	3.087***		3.213**	
	(<0.01)		(0.02)	
MedicareShare×log(InpatientDays)	-0.287***			
	(<0.01)			
MedicareShare×log(Revenues)			-0.204**	
			(0.02)	
log(AverageLengthofStay)		-0.470***		-0.506**
		(<0.01)		(0.02)
log(AverageLengthofStay)×log(InpatientDays)		0.044***		
		(<0.01)		
log(AverageLengthofStay)×log(Revenues)				0.032**
				(0.01)
Rating FE	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
N	7089	7089	7089	7089
R^2	0.443	0.442	0.435	0.434

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: IV Regressions: Linking Patient Revenue to COVID-19

This table presents regression estimates that link the change in residents to the likelihood of a COVID-19 case at a nursing home using the two-stage setup in equations (3) and (4) in the paper. *%ChangeInResidents* is the percent change in resident population between January and June 2020, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *AverageLengthofStay* is the average number of days each resident spends at the nursing home, *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, and the control variables include *log(InpatientDays)*, *log(Employees)*, *TotalMargin*, *Leverage*, and *HealthInsp Rating* fixed effects. In Columns (4) and (7), the instrumental variable is *MedicareShare* and *AverageLengthofStay*, respectively. All estimations include county fixed effects, and all standard errors are clustered at the county level.

	(1) OLS	(2) First Stage	(3) Reduced Form	(4) 2SLS	(5) First Stage	(6) Reduced Form	(7) 2SLS
%ChangeInResidents	-0.655***			-1.049***			-0.979***
	(<0.01)			(<0.01)			(<0.01)
MedicareShare		-0.203***	0.222***				
		(<0.01)	(<0.01)				
log(AverageLengthofStay)					0.029***	-0.028***	
					(<0.01)	(<0.01)	
log(DaysCashOnHand)	-0.010***	-0.000	-0.010***	-0.010***	-0.001	-0.009***	-0.010***
	(<0.01)	(0.91)	(<0.01)	(<0.01)	(0.55)	(<0.01)	(<0.01)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7035	7035	7089	7035	7035	7089	7035
R^2	0.468	0.276	0.441	0.078	0.275	0.441	0.084
First-Stage F-stat				59.829			64.591

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Characteristics of Nursing Homes with Different Medicare Share

This table presents summary statistics across terciles of Medicare share of patients. *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *COVID-19* is an indicator variable equal to one if the nursing home had at least one patient with COVID-19 as of June 14, 2020, *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, *AverageLengthofStay* is the average number of days each resident spends at the nursing home, *%ChangeInResidents* is the percent change in resident population between January and June 2020, *InpatientDays* is the total number of days of service received by patients, *Employees* is the number of full-time-equivalent employees at the nursing home, *TotalMargin* is the net income divided by total revenue, *Leverage* is the net book leverage (net debt divided by total book capitalization), *Overall Rating* is the CMS "overall" rating from their five-star quality rating system, *HealthInsp Rating* is the component of the CMS rating program that comes from health inspections in which the top 10% in each state receive a top rating, *Quality Rating* is the CMS quality of care rating, and *Staffing Rating* is the CMS staffing rating.

	Medicare Share Tercile		
	Low	Medium	High
MedicareShare	0.05	0.11	0.24
COVID-19	0.37	0.40	0.41
log(DaysCashOnHand)	1.70	1.54	1.50
log(AverageLengthofStay)	5.17	4.83	4.26
%ChangeInResidents	-0.09	-0.11	-0.13
log(InpatientDays)	10.32	10.34	10.23
log(Employees)	4.39	4.45	4.49
TotalMargin	-0.01	-0.01	-0.01
Leverage	0.80	0.77	0.71
Overall Rating	2.93	2.96	3.48
HealthInsp Rating	2.66	2.65	2.98
Quality Rating	3.52	3.53	3.96
Staffing Rating	2.76	2.85	3.14

Table 7: IV Regressions: Medicare Demographics and Patient Types

This table presents regression estimates that link the change in residents to the likelihood of a COVID-19 case at a nursing home using the two-stage setup in equations (3) and (4) in the paper. *%ChangeInResidents* is the percent change in resident population between January and June 2020, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *AverageLengthofStay* is the average number of days each resident spends at the nursing home, *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, and the control variables include *log(InpatientDays)*, *log(Employees)*, *TotalMargin*, *Leverage*, and *HealthInsp Rating* fixed effects. The following represent the characteristics of the Medicare patients from Medicare Usage data: case complexity measured by Hierarchical Condition Category (*AverageHCC*), average age, % male, % minority, and *Share>VeryHigh*, which is the percentage of days that are above "very high" rehabilitation (e.g., >720 minutes of therapy per week). Columns 5 and 10 also include controls for the share of patients with stays less than 30 days, longer than 60 days, using Medicare Advantage, and shares with asthma, congestive heart failure, COPD, and whether their primary condition for residency is congestive heart failure, COPD, infection, or injury. The instrumental variable is indicated at the head of the column. All estimations include county fixed effects, and all standard errors are clustered at the county level.

	Instrument=MedicareShare					Instrument=log(AverageLengthofStay)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{\%\text{ChangeInResidents}}$	-0.822***	-0.905***	-0.914***	-0.825**	-0.989**	-0.897**	-0.958**	-0.964**	-0.872**	-1.329**
	(0.01)	(<0.01)	(<0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
log(DaysCashOnHand)	-0.010***	-0.009***	-0.009***	-0.009***	-0.008***	-0.010***	-0.009***	-0.008***	-0.008***	-0.008**
	(<0.01)	(<0.01)	(0.01)	(0.01)	(0.01)	(<0.01)	(<0.01)	(0.01)	(0.01)	(0.01)
Average HCC		0.029**	0.008	0.008	0.012		0.030**	0.008	0.008	0.013
		(0.03)	(0.57)	(0.61)	(0.50)		(0.04)	(0.57)	(0.60)	(0.46)
Average Age			-0.003	-0.003	0.000			-0.003	-0.003	-0.001
			(0.15)	(0.22)	(0.99)			(0.16)	(0.22)	(0.71)
% Male			0.026	0.021	0.063			0.026	0.022	0.074
			(0.59)	(0.66)	(0.29)			(0.60)	(0.66)	(0.24)
% Minority			0.028	0.030	0.023			0.028	0.030	0.018
			(0.55)	(0.53)	(0.64)			(0.56)	(0.54)	(0.72)
Share>VeryHigh				0.032	0.040				0.031	0.035
				(0.36)	(0.26)				(0.38)	(0.34)
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Case Characteristics Controls	No	No	No	No	Yes	No	No	No	No	Yes
N	5966	5966	5966	5966	5966	5966	5966	5966	5966	5966
R^2	0.094	0.091	0.092	0.096	0.090	0.091	0.088	0.089	0.094	0.052
FirstStage Fstat	51.960	47.729	48.878	45.820	29.552	52.309	49.176	52.297	49.438	25.657

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A1: Robustness: Various Geographical Fixed Effects

This table presents regression estimates that link the financial variables of interest and the change in residents to the likelihood of a COVID-19 case at a nursing home using either the ordinary least-squares setup in equation (1) or the two-stage setup in equations (3) and (4) in the paper. *DaysCashOnHand* is the number of days worth of operating expenses that can be covered by cash and equivalents, *MedicareShare* is the share of overall patient days that are reimbursed through Medicare, *%ChangeInResidents* is the percent change in resident population between January and June 2020, and the control variables include *log(InpatientDays)*, *log(Employees)*, *TotalMargin*, *Leverage*, and *HealthInsp Rating* fixed effects. *TotalMargin* and *Leverage* are standardized (z) to zero mean and unit standard deviation. In the 2SLS regressions, the instrumental variable is *MedicareShare*. All estimations include fixed effects and cluster at the level indicated at the head of the column.

	State		CBSA×State		City	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
log(DaysCashOnHand)	-0.009**	-0.010***	-0.010***	-0.011***	-0.011***	-0.011***
	(0.01)	(0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
MedicareShare	0.411***		0.205***		0.201**	
	(<0.01)		(<0.01)		(0.01)	
%ChangeInResidents		-1.652***		-0.906***		-0.996**
		(<0.01)		(<0.01)		(0.02)
log(InpatientDays)	0.251***	0.186***	0.174***	0.145***	0.167***	0.151***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
log(Employees)	0.004	-0.027	0.017	-0.001	0.019	-0.012
	(0.85)	(0.23)	(0.33)	(0.97)	(0.37)	(0.68)
zTotalMargin	-0.010	-0.013*	-0.007	-0.009	0.004	0.002
	(0.11)	(0.10)	(0.23)	(0.18)	(0.64)	(0.82)
zLeverage	0.006	0.006	-0.003	-0.002	-0.009	-0.010
	(0.41)	(0.38)	(0.62)	(0.76)	(0.29)	(0.24)
HealthInsp Rating=2	0.004	0.001	-0.015	-0.017	0.004	0.002
	(0.74)	(0.96)	(0.33)	(0.31)	(0.83)	(0.92)
HealthInsp Rating=3	-0.010	-0.020	-0.025	-0.032**	-0.008	-0.018
	(0.60)	(0.32)	(0.11)	(0.05)	(0.73)	(0.42)
HealthInsp Rating=4	-0.026	-0.042*	-0.052***	-0.061***	-0.042*	-0.051**
	(0.28)	(0.05)	(<0.01)	(<0.01)	(0.07)	(0.03)
HealthInsp Rating=5	-0.016	-0.028	-0.053***	-0.062***	-0.028	-0.044
	(0.60)	(0.25)	(0.01)	(<0.01)	(0.41)	(0.20)
N	7089	7044	7022	6975	4806	4768
R^2	0.223	0.070	0.368	0.090	0.520	0.077
FirstStage Fstat		61.490		61.102		28.267

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A Details on Government Aid to Nursing Homes

Federal and state governments established or used several programs to help address the economic impacts of the COVID-19 pandemic. Skilled nursing facilities (nursing homes) qualified for a number of these programs. In the main text, we detailed the most relevant programs for our setting and analyses. Below we provide further details on two federal programs providing financial assistance to nursing homes.

A.1 Paycheck Protection Program (PPP):

The PPP was established by the Coronavirus Aid, Relief, and Economic Security (CARES) ACT (PL 116-136) to help smaller businesses (fewer than 500 employees) cover their payroll costs in the initial months of the pandemic. Nearly all of the individual nursing homes in the sample have fewer than 500 employees - though large chains and publicly traded companies likely have more than 500 employees and would not qualify. Borrowers must certify in good faith that the "[c]urrent economic uncertainty makes this loan request necessary to support the ongoing operations of the Applicant." Eligible businesses can receive a maximum loan amount equal to 2.5 months of payroll costs (calculated based on 2019 tax filings). If the borrowing business uses the money according to certain rules (e.g., paying employees), then the cash infusion is considered a grant and does not need to be repaid. If not, then the loan must be repaid.

As of June 30, 2020, 6,248 skilled nursing facilities (NAICS 623100) had received a loan of at least $150,000 through the paycheck protection program.[28] Considering there are over 12,000 skilled nursing facilities, this indicates a large portion of the nursing homes did not receive significant relief above $150,000 from the PPP program. Using data provided by the SBA, we estimate $5.7 billion of loans were made to skilled nursing facilities during this time (using mid-points of the loan ranges given in the data). Loans were first approved in the first

[28]Data are provided by the Small Business Administration for loans above $150,000.

week of April. Half of all loans to nursing homes were approved by April 15, 2020 and 81% by the end of April.[29]

While the loans came relatively early, they may not have come quick enough or been large enough to mitigate the effects of the adverse cash flow shocks nursing homes experienced. There was still significant lobbying by the nursing home industry in late April, May and even June for more government assistance suggesting PPP did not solve the economic woes facing nursing homes. In addition, the size of the loans was based on payroll, not the impact of the pandemic of nursing homes' cash flows and firm value. Nursing homes hit especially hard by the pandemic received similar-sized loans as homes that were not as impacted with similar payrolls. In other words, PPP did not address important cross-sectional heterogeneity in the size of the cash flow shock across nursing homes and, therefore, the effects of PPP are unlikely to be correlated with our cross-sectional variables of interest.

A.2 Provider Relief Fund:

Through the CARES Act and the Paycheck Protection Program and Health Care Enhancement Act (PL 116-139), Congress made $175 billion available to healthcare providers. The U.S. Department of Health and Human Services distributed the money through the Provider Relief Fund. The skilled nursing facilities in our sample qualified for some of the disbursements made through this program. Like the Paycheck Protection Program (but unlike the Medicare Accelerated and Advanced Payment Program), the Provider Relief Fund payments did not need to be repaid.

The Provider Relief Fund provided money in stages to Medicare providers. The money was allocated based on gross patient revenues with payments equal to the minimum of 2% of the provider's gross patient revenue (the revenue source was not considered) or the sum of

[29]The SBA PPP loan data does not have an identifier that can be directly matched to our nursing home data. We attempted to fuzzy match based on variations of home location and name and had very low match rates.

incurred losses for March and April 2020.[30] 2% of revenues is relatively small considering the average nursing home experienced a 10% decline in residents between January and June 2020. While nursing homes received some aid from these disbursements, nursing homes received less than 5% of the initial $30 billion (Goldfeder and Bedzow, 2020). The most direct form of aid for skilled nursing facilities came on May 22, 2020, two months after the onset of the pandemic. The Provider Relief Fund allocated $4.9 billion specifically to 13,000 skilled nursing facilities. The payment to each skilled nursing facility was based on the facility's number of certified beds. Specifically, each facility received: $50,000 plus $2,500 per certified bed. For example, a facility with 100 certified beds would receive $300,000.

The provider relief fund disbursements likely did not come quick enough or were not generous enough to mitigate the effects of the adverse cash flow shocks nursing homes experienced. The main disbursements to nursing homes on May 22, 2020 came over two months after the onset of the pandemic. The other disbursements were relatively small (at 2% of revenues) compared to the potential loss in revenues facing many nursing homes. The size of the disbursement was not related to our variables of interest (days-cash-on-hand and Medicare share) – especially after we control for home size – minimizing concerns that our results are capturing unobserved variation in government aid.

[30]The timeline and calculations for the provider relief fund are provided by the HHS here: `https://www.hhs.gov/coronavirus/cares-act-provider-relief-fund/general-information/index.html#eligibility`. $30 billion was distributed between April 10-17 to over 300,000 Medicare Managed Fee-For-Service (MFFS) providers based on each provider's portion of the 2019 Medicare Fee-For-Service (MFFS) payments. On April 24, 2020, an additional $9.1 billion was provided to 15,000 MFFS providers based on revenues from CMS cost report data. Starting April 24, an additional $10.9 billion was made available to MFFS providers based on revenue submissions (only $2.4 billion was distributed as of June 15, 2020). On June 9, HHS expected to distribute approximately $15 billion to Medicaid providers that did not receive a payment from the initial allocation of the Provider Relief Fund, with the payment allocation equal to 2% of their revenues from patient care.