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Investment, Q and epidemic diseases

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ABSTRACT

We study the effects of epidemic diseases on corporate investment. Epidemic diseases tend to be unanticipated and exogenous to firms’ decisions. Using difference-in-difference estimation strategy and a firm-level exposure to an epidemic disease measure, we find that corporate investment declines significantly following the onset of an epidemic disease. We also show that the COVID-19 pandemic has the strongest negative impact on investment when compared to the other most recent epidemic diseases.

1. Introduction

The extant literature has focused on macroeconomics shocks and their impacts on corporate real decisions. But little attention has been paid to the effects of epidemic-induced shocks on corporate decisions. Epidemic diseases tend to be unexpected and are exogenous to firms’ real decisions. The potential widespread of an epidemic disease impacts firms’ willingness to take on risks during a market wide shock; creating financing frictions which affects the relative attractiveness of current period’s investments vis-a-vise future investments. Managers might delay investments in the face of epidemic-induced market wide uncertainty shock.

In this paper, we focus on the impact of epidemic diseases on corporate investment amongst U.S firms. We focus on the five most recent epidemic diseases: COVID-19, SARS, H1N1, Ebola and Zika virus. To test our hypothesis, we employ two estimation strategies. First, since not all firms are impacted equally during an epidemic-induced shock, we use a firm-level measure of exposure to an epidemic disease extracted from Hassan et al. (2021). Second, so as take into account the aggregate effects of epidemic diseases, we use staggered difference-in-difference estimation strategy. Our second approach effectively compares the investment of firms before and after the onset of an epidemic disease. We find that corporate investment declines on average by about 7% to 10% relative to the unconditional mean, following the onset of an epidemic disease. We also find that COVID-19 has the strongest negative impact on corporate investments when compared to the other most recent epidemic diseases under study. Our results show that not all epidemic diseases are created equal; the duration and intensity of an epidemic disease are important considerations when evaluating the potential impacts on firms’ real decisions.

Our paper contributes to the literature on the impacts of macroeconomics shocks and the impacts of the COVID-19 pandemic on corporate policy; (Eichenbaum et al., 2020; Ding et al., 2020; Au et al., 2020; Atkeson, 2020; Barrero et al., 2020; Guerrieri et al., 2020).

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1 See: Jaffee and Russell (1976), Dixit and Pindyck (1995), Abel and Eberly (1996), Bloom (2006), Caballero (1991), Tirole (2006), Holmstrom and Tirole (1997).
Table 1
Summary statistics: Firm-level variables.

|                | Mean   | Median | Std. dev | 25th  | 75th  |
|----------------|--------|--------|----------|-------|-------|
| **PANEL A:**   |        |        |          |       |       |
| Investment     | 0.0292 | 0.0154 | 0.0436   | 0.006 | 0.03363|
| Tobin Q        | 2.0938 | 1.6266 | 1.4084   | 1.1999| 2.4472 |
| Size           | 6.7299 | 6.6958 | 1.9081   | 5.4514| 7.9593 |
| Cashflow       | 0.01719| 0.02744| 0.0744   | 0.0102| 0.0426 |
| Leverage       | 0.2585 | 0.2128 | 0.3047   | 0.0361| 0.3809 |
| Dividend dummy | 0.06236| 0.000   | 0.2418   | 0.000 | 0.000  |
| Net working capital | 0.0376 | 0.0386 | 0.2494 | −0.0468 | 0.1412 |
| **PANEL B:**   |        |        |          |       |       |
| COVID-19 exposure | 1.3604 | 1.0329 | 1.3245 | 0.3862 | 1.9462 |
| COVID-19 risk    | 0.1016 | 0.000  | 0.1854 | 0.000  | 0.1530 |
| SARS exposure   | 0.0436 | 0.000  | 0.1708 | 0.000  | 0.000  |
| H1N1 exposure   | 0.0150 | 0.000  | 0.1378 | 0.000  | 0.000  |
| Ebola exposure  | 0.0048 | 0.000  | 0.0869 | 0.000  | 0.000  |
| Zika exposure   | 0.0028 | 0.000  | 0.0742 | 0.000  | 0.000  |

This table presents summary statistics for the sample, which consists of non-financial and non-utility U.S. incorporated firms in COMPUSTAT’s quarterly files for the period 2002Q1–2021Q1. Investment is estimated as capital expenditure scaled by total assets. Tobin Q is estimated as the book value of total assets plus the market value of equity, less book value of equity scaled by total assets. Dividend is a dummy equal to “1” if a firm paid or issued dividends during period t. Net working capital is net working capital minus cash and marketable securities scaled by total assets. Leverage is estimated as short-term debt plus long-term debt scaled by total assets. Data on epidemic diseases is based on Hassan, Hollander, Van Lent, Schwedeler and Tahoun, 2021 measure. Panel A presents summary statistics for firm-level controls. Panel B presents summary statistics for firm-level exposure to epidemic diseases, for the timeline during which each epidemic disease was most intense and active in the U.S.

2020; Li et al., 2021; Krieger et al., 2020) and the literature on epidemiology and financial markets (Philipson, 2000). We show that epidemic-induced shocks have a real impact on corporate decisions.

2. Data

2.1. Firm-level controls

Our sample consists of quarterly firm-level data extracted from COMPUSTAT for the period 2002Q1–2021Q1. We require that a firm be incorporated in the U.S. We exclude financial firms (SIC 6000–6999) as it is difficult to assess liquidity levels and we exclude utilities (SIC 4900–4999) as they are subjected to heavy regulatory requirements from the government. We also require that a firm has positive asset levels.

Table 1 Panel A, presents summary statistics for the sample. Our main variable of interest is “Investment”. Investment is estimated as capital expenditure (CAPXY) scaled by total assets (ATQ). Investment has a mean (median) of 0.029(0.0154). Observe that during our sample period, there is considerable variation in investments across firms. In particular, the bottom 25th percentile investment is about 0.6% of total assets and the top 75th percentile investment is about 3.3% of total assets. Our statistical distribution is consistent with the extant literature (Gulen and Ion, 2016; Duchin et al., 2010).

The remaining firm-level variables, determinants of investments are constructed as follow: Firm size is estimated as the natural logarithm of total assets, Tobin Q is estimated as the book value of total assets plus market value of equity less book value of equity scaled by total assets and bounded above 10, so as to control for outliers. Leverage is the sum of short-term debt and long-term debt scaled by total assets. Net working capital is estimated as net working capital less cash and marketable securities scaled by total assets. Dividend dummy takes the value of “1” if a firm pays dividend and zero if otherwise.

2.2. Measuring firm-level exposure to epidemic diseases

We use the text-based measure of firm-level exposure to epidemic diseases from Hassan et al. (2021). The measure is constructed from quarterly earnings conference calls and captures each firm’s exposure to a given epidemic disease, making it appropriate for our analysis. The measure is constructed in a series of steps. First, the authors identify the most common symptoms associated with each epidemic disease. This step would then be followed by a human audit, subsample analysis, to sure the algorithm in use correctly classifies words or combinations of words associated with each epidemic disease in question. Hassan et al. (2021) exposure measure is then constructed as the number of times a combination appears in the transcript, scaled by the total words in each transcript. We report the summary statistics of firm-level exposure to an epidemic disease in Table 1 Panel B.²

² See Hassan et al. (2021) for detailed construction of the measure.
3. Identification strategy

In order to estimate the effects of firm-level exposure to an epidemic disease on corporate investments, we use the following augmented model of Investment-Tobin Q, commonly used in investment literature.\(^3\)

\[
\text{Investment}_{it} = \beta_0 + \beta_1 \text{Exposure}_t + \beta_2 \text{Tobin Q}_t + X' \beta + \delta_i + \epsilon_{it}
\] (1)

where “Exposure” is firm-level exposure to a given epidemic disease and the measure is extracted from Hassan et al. (2021). \(X\) is a vector of firm-level variables, determinants of investment, which include: Tobin Q, Firm Size, Leverage, cash flow, Capex, Net working capital, and a dividend dummy. In particular, consistent with extant literature, Tobin Q and cash flow controls for contemporaneous investment opportunities. All our firm-level variables are constructed as outlined in the data section above. \(\delta_i\) are firm-level fixed effects. And \(\epsilon_{it}\) is the error term. Standard errors are heteroskedasticity-consistent and clustered at the firm-level (Petersen, 2009; Bertrand et al., 2004). In order to check whether parallel trends assumption holds in our identification strategy, we follow the recommendation(s) in Goodman-Bacon and Marcus (2020), we first pre-match firms on size, MB and leverage at the end of 2018 and then sub-divided into “treated” and “control” groups based on the likelihood of exposure to the COVID-19 pandemic.\(^5\) Underlying this exercise is the assumption that pre-treatment differences in trends are informative about post-treatment differences (counterfactuals).\(^6\) The key idea being that if common trends assumption fails, the average investment for our treated group would have changed differently even without exposure to the pandemic itself. Fig. 1 demonstrate that while the treated group, on average, had higher level of investment before the COVID-19 pandemic relative to the control group, the difference is relatively small. Note that once the pandemic set in, the average investment for treated firms significantly declined and there is a noticeable divergence in the average investment between the treated group and the control group. The treated firms on average had much lower average investment following the onset of the pandemic.

4. Empirical results

Our central argument in this paper is that epidemic-induced shocks have a negative impact on corporate investment. We first examine the effect of each epidemic disease on corporate investment amongst U.S firms. We focus on the most recent epidemic

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\(^3\) See Fazzari et al. (1988), Gulen and Ion (2016), Alti (2003), Erickson and Whited (2006) and Duchin et al. (2010).

\(^4\) We find similar results when we use alternative measures of corporate investments such as SG&A.

\(^5\) Note that we recognize that “timing” is still an important consideration, thus we are focusing on the relative exposure and not assuming that our control sample remains unexposed even at the later stages of the pandemic. See: Goodman-Bacon (2021) for some important discussion on timing in difference-in-difference set up.

\(^6\) See: Cunningham (2020), Manski and Pepper (2018), Rambachan and Roth (2019), Lovenheim and Willén (2019) and Greenstone and Hanna (2014).
Where "value of '0' for the timeline: 2019Q1-Q4. We employ a staggered difference-in-difference estimation strategy, our specification is as follows:

\[
\text{Investment}_{it} = \beta_0 + \beta_1 \text{Epidemic dummy}_i + \beta_2 \text{TobinQ}_i + \text{X}_i' \beta + \delta_i + \epsilon_{it}
\]  

(2)

Where "Epidemic dummy" is an indicator variable that takes a value of "1" for the timeline during which each disease was most active in the US: COVID-19 [2020–21], H1N1 [2010–12], SARS [2003], Ebola [2014–15], and Zika [2015–16]. The "Epidemic dummy" takes a value of zero if otherwise. Effectively, "Epidemic dummy" captures the average effect of the epidemic diseases under study on corporate investment amongst U.S firms. \text{X} is a vector of firm-level variables. Construction of each variable is outlined in the data section above. \delta_i are firm fixed-level effects. Standard errors are heteroskedasticity-consistent and clustered at the firm-level.

Table 2 presents our estimate from our base specification described in equation [2] above. Our results are consistent with those reported in Table 3, in particular columns [2–3] show that quarterly investments as a fraction of total assets declined by about 10% on average, following the onset of an epidemic disease.

4.1. The COVID-19 pandemic

The COVID-19 pandemic serves as an unanticipated and widespread exogenous economic shock. In order to take into account the aggregate effects of the COVID-19 pandemic on corporate investment, we use a difference-in-difference estimation strategy. We compare the investment of firms before and after the onset of the COVID-19 pandemic. Our specification is as follows:

\[
\text{Investments}_{it} = \beta_0 + \beta_1 \text{COVID19 dummy}_i + \text{X}_i' \beta + \delta_i + \eta_i
\]  

(3)

Where “COVID19 dummy" is an indicator variable that takes a value of “1” for the timeline: 2020Q1 to 2021Q1. And takes the value of “0” for the timeline: 2019Q1-Q4. \text{X} is a vector of firm-specific variables. \delta_i and \eta_i are firm fixed effects. Standard errors
Table 3
Corporate investment and exposure to epidemic diseases.

|                | (1) Investment | (2) Investment | (3) Investment | (4) Investment |
|----------------|----------------|----------------|----------------|----------------|
| Epidemic_dummy | −0.00298***    | −0.00282***    | −0.00282***    | −0.00282***    |
|                | (−17.27)       | (−16.33)       | (−16.33)       | (−11.20)       |
| Tobin_Q        | 0.00185***     | 0.00212***     | 0.00212***     | 0.00212***     |
|                | (19.68)        | (21.78)        | (21.78)        | (12.69)        |
| Size           | −0.00101***    | −0.00231***    | −0.00231***    | −0.00231***    |
|                | (−7.08)        | (−13.85)       | (−13.85)       | (−4.80)        |
| Leverage       | −0.0145***     | −0.0167***     | −0.0167***     | −0.0167***     |
|                | (−24.66)       | (−27.17)       | (−27.17)       | (−10.34)       |
| Cash_flow      | 0.0115***      | 0.00380*       | 0.00380*       | 0.00380*       |
|                | (5.69)         | (1.82)         | (1.82)         | (0.41)         |
| Dividend_dummy | −0.000138      | −0.00104**     | −0.00104**     | −0.00104**     |
|                | (−0.27)        | (−1.98)        | (−1.98)        | (−0.77)        |
| NWC            | −0.00548***    | −0.00472***    | −0.00472***    | −0.00472***    |
|                | (−6.39)        | (−5.22)        | (−5.22)        | (−2.39)        |
| Constant       | 0.0363***      | 0.0462***      | 0.0462***      | 0.0462***      |
|                | (35.00)        | (40.05)        | (40.05)        | (14.37)        |

Firm F.E | NO | YES | YES | YES |
Clustered Std Errors | NO | NO | YES |
N | 144209 | 144209 | 144209 | 144209 |
R² | 0.0215 | 0.0281 | 0.0281 | 0.0281 |

This table presents estimates from panel regressions. Investments (CAPXY/ATQ) is the dependent variable. Firm-level epidemic exposure are based on Hassan et al. (2021) firm-level exposure to epidemic diseases measure. All regressions include firm fixed effects. All standard errors are clustered at the firm-level. Within R² is reported.

NOTE: Statistics in parentheses: *p:0.10, **p:0.05, ***p:0.01.

Table 4
Corporate investment and COVID-19 pandemic.

|                | (1) Investment | (2) Investment | (3) Investment |
|----------------|----------------|----------------|----------------|
| COVID-19_dummy | −0.00851***    | −0.00853***    | −0.00853***    |
|                | (−28.46)       | (−27.49)       | (−17.99)       |
| Tobin_Q        | −0.00229       | 0.0106***      | 0.0106***      |
|                | (−1.13)        | (4.47)         | (5.07)         |
| Size           | 0.00134***     | 0.00197**      | 0.00197*       |
|                | (5.85)         | (2.40)         | (1.71)         |
| Leverage       | −0.00162       | −0.00443**     | −0.00443**     |
|                | (−1.28)        | (−2.50)        | (−2.22)        |
| Cash_flow      | 0.00935***     | 0.00264        | 0.00264        |
|                | (2.62)         | (0.65)         | (0.27)         |
| Dividend_dummy | 0.0483***      | 0.0568***      | 0.0568***      |
|                | (3.92)         | (3.57)         | (3.08)         |
| NWC            | −0.00828***    | −0.0108***     | −0.0108***     |
|                | (−4.91)        | (−5.21)        | (−3.76)        |
| Constant       | 0.0150***      | 0.00935        | 0.00935        |
|                | (6.61)         | (1.57)         | (1.13)         |

Firm F.E | NO | YES | YES |
Clustered Std Errors | NO | NO | YES |
N | 17347 | 17347 | 17347 |
R² | 0.0511 | 0.0528 | 0.0528 |

This table presents estimates from panel regressions. Investments (CAPXY/ATQ) is the dependent variable. Firm-level epidemic exposure are based on Hassan et al. (2021) firm-level exposure to epidemic diseases measure. All regressions include firm fixed effects. All standard errors are clustered at the firm-level. Within R² is reported.

NOTE: t-statistics in parentheses: *p:0.10, **p:0.05, ***p:0.01.

are heteroskedasticity-consistent and clustered at the firm-level. We report our estimates in Table 4, and find that the COVID-19 pandemic has a strong and statistically negative effect on corporate investments.

4.2. Falsification test: Placebo test

One potential concern might be that the results are potentially due to an ongoing trend in corporate investments amongst U.S firms and not due the Covid-19 pandemic. For external validation and in order to add credibility to our results, we have carried out
Table 5
Falsification test: Placebo.

|                  | (1) Investment       | (2) Investment       | (3) Investment       |
|------------------|----------------------|----------------------|----------------------|
| Placebo_epidemic | 0.00124 (0.26)       | −0.00221 (−0.53)     | −0.00221 (−0.39)     |
| Tobin_Q          | −0.00231 (−0.70)     | −0.00231 (−0.66)     |                     |
| Size             | 0.00523*** (5.10)    | 0.00523*** (3.27)    |                     |
| Leverage         | −0.0162*** (−6.92)   | −0.0162*** (−2.75)   |                     |
| Cash_flow        | −0.0297*** (−6.12)   | −0.0297 (−0.84)      |                     |
| Dividend_dummy   | 0.00781*** (3.84)    | 0.00781* (1.86)      |                     |
| NWC              | −0.0149*** (−5.53)   | −0.0149** (−2.49)    |                     |
| Constant         | 0.0276*** (84.22)    | −0.00312 (−0.43)     | −0.00312 (−0.27)    |

Firm F.E       YES       YES       YES
Clustered Std Errors   YES       NO       YES

This table presents estimates from panel regressions. Investments (CAPXY/ATQ) is the dependent variable. Our Placebo_Epidemic dummy takes the value of “1” for the period 2017Q1 to 2018Q4 and “0” for 2015Q1 to 2016Q4. All regressions include firm-level fixed effects. All standard errors are clustered at the firm-level. Within $R^2$ is reported.

Note: t-statistics in parentheses: *p: 0.10, **p: 0.05, ***p:0.01.

5. Conclusion

“Do epidemic-induced shocks affect corporate investments?” We argue that epidemic diseases are generally unanticipated and their impacts can be widespread leading to uncertainty, increasing financing frictions and thus affecting the relative attractiveness of current period’s investments when compared to future periods’ investments. In anticipation of fluctuations in aggregate demand and supply, managers might delay investments as the option to do so during a period of high uncertainty is valuable.

Using difference-in-difference estimation strategy and a firm-level exposure to an epidemic disease measure, we find that corporate investment declined significantly following the onset of an epidemic disease. We also document that the COVID-19 pandemic has the strongest negative impact on investments when compared to the other most recent epidemic diseases. Our results show that epidemic-induced shocks have first-order effect on corporate decisions.

CRediT authorship contribution statement

Daniel Tut: Conceptualization, Formal analysis, Methodology, Data analysis, Software, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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