Local Dependence, Exogenous Shock, and Firm Value: Evidence from Korea's 2020 Coronavirus Crisis

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Abstract

The 2020 Coronavirus pandemic is exerting an enormous shock on the Korean economy. Using data on the location of a firm's headquarters and main bank branch, I find that the value of firms located in Daegu is being affected negatively since the announcement of a mass infection at the Shincheonji Daegu church. In particular, using proptech, I show that the distance between the infection's epicenter and a firm's headquarters affects the stock market reaction negatively. Furthermore, I find that the exogenous shock the Coronavirus crisis is causing has stronger negative effects on firms with high information asymmetry and those not Chaebol-affiliated. This study sheds light on our understanding of the economic effects of a city's paralysis using a unique world event. My results suggest also the potential risk of clustered headquarters and factories attributable to unpredictable community quarantines.

Keywords: Coronavirus crisis; Exogenous Shock; Financial Uncertainty; Proptech

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I. Introduction

The total number of cases [of Coronavirus] rose to 833 on Monday afternoon, compared to the 31 reported as of Feb. 18, according to the Korea Centers for Disease Control and Prevention. Death toll in the country reached seven. Economic difficulty is imminent, Citi economists wrote in a Monday morning note. (Published SUN, FEB 23 2020 EST)

CNBC (Reporter, Saheli Roy Choudhury)

The 2020 Coronavirus crisis constitutes the greatest shock to the Korean economy during the first quarter of this year. In particular, more than half of the cases in the country have been traced to a Daegu branch of Shincheonji, referred to formally as "the Temple of the Tabernacle of the Testimony." The branch is located in the center of Daegu Metropolitan City (hereafter, Daegu), the fourth largest city in Korea.[1] Chun (2015) shows the eight different industrial complexes in the Daegu Metropolitan Area, and several public firms within these industrial complexes depend on the local economy, such as human resources, raising capital, and consumer markets. Tuzel and Zhang (2017) suggest that a firm's location affects its risk because of local price factors, such as wages and real estate prices (rents). In this study, I show the relation between local firm value and the change in local risk using the exogenous shock attributable to the Coronavirus crisis.

Using an event study approach, I examine the effect on local firms of the exogenous shock associated with the mass infection at the Shincheonji Daegu church (hereafter, church). Several public firms' headquarters and factories are located in Daegu, and this location information is available readily through such proptech services as NAVER Maps and Google Maps. Thus, I expect that investors recognize the change in local risk associated with the community quarantine immediately. In particular, on 20 February, news related to the "Mass infection at Shincheonji Daegu branch" was in the headlines of most newspapers and broadcasts in Korea. As a result, Daegu is coming to a standstill as shops, businesses, and schools close to prevent the spread of Coronavirus since the announcement. For example, the number of passengers on Daegu subway lines 1, 2, and 3 has decreased rapidly after the announcement, and the volume of traffic via Daegu from 22 February to 23 February is now 42.6% less than last week.[2]

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[1] The Ministry of the Interior and Safety reports the population of each city every month. Daegu was the fourth largest city in Korea in February 2020 [Seoul (9,736,962), Busan (3,410,925), Incheon (2,954,955), Daegu (2,432,883)].

[2] *Maeil Business Newspaper* (published 26 Febrary) reported the number of Daegu subway passengers [305,790 (19 February), 227,543 (20 February), 183,211 (21 February), 97,918 (22 February), 58,350 (23

I attempt to examine the negative influence of local risk by considering the case of mass infection. Although some previous studies show that a firm's location affects its risk, they concentrate on local economic factors, such as wages and real estate prices, and local economic shocks (Tuzel & Zhang, 2017; Decker, McCollum, & Upton, 2018; Giroud & Mueller, 2019). However, these previous studies do not examine the effect of exogenous shock that is not caused by the economic cycle. My study contributes to the literature that examines the pandemic's economic effects. In particular, using early-stage pandemic data, I show the relation between the level of local dependence and local firms' value when they are exposed to this deadly epidemic. I also show that negative economic effects caused by mass infection spill over seriously to the neighboring province within two weeks. In particular, my research sheds light on which factors affect local firms' value during the early-stage pandemic period.

Ⅱ. Literature Review

1. The Progress of Korea's 2020 Coronavirus crisis

Since the Coronavirus (COVID-19) was reported first on 12 December 2019, the most serious problem has been the way to prevent its spread from Wuhan to other provinces (Peeri et al., 2020; Wang et al., 2020; Khan et al., 2020). Thus, the Chinese government imposed a lockdown in the epicenter, Wuhan city in Hubei province (Ku et al., 2020). However, as of 8 February, 33,738 confirmed cases and 811 deaths have been reported in China (Liu et al., 2020). Therefore, the World Health Organization (WHO) declared Coronavirus a "Public Health Emergency of International Concern (PHEIC)" on 30 January, and the situation is only likely to deteriorate. WHO reported that there are more than 118,000 cases in 114 countries currently, and 4,291 people have lost their lives since 11 March. As of the morning of 12 March, WHO reported that there are more than 20,000 confirmed cases and there have been almost 1,000 deaths in Europe.[3,4]

The first imported COVID-19 case was detected in Korea on 20 January 2020, and the epidemic curve increased steadily until 15 February (Zhuang et al., 2020). Table 1 shows that the number of confirmed cases was lower from 30 January until 16 February. Specifically, no infection clusters were reported until February 20, and there was no confirmed case in Daegu

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February)]. Korea Expressway Corporation (76,374)] reported the volume of traffic [February 15-16, North interchange (124,245)/West interchange (128,387) on February 22-23, North interchange (68,562)/West interchange.

[3] "WHO announces COVID-19 outbreak a pandemic" (12 March, 2020). Full text of WHO announcement is included in Appendix A.

[4] The distribution of COVID-19 cases Reuters reported in more detail is included in Appendix B.

until February 17. Thus, there was no difference between Daegu and other regions until February 20. However, on 20 February, Korea Centers for Disease Control and Prevention first reported a cluster of COVID-19 cases in Daegu.[5] News related to the "Mass infection at Shincheonji Daegu branch" was in the headlines of most newspapers and broadcasts, and the day was the starting point for the contagion's progress. The number of confirmed cases in Daegu was 4,328 just two weeks after the announcement, and those confirmed cases comprised 75.1 percent of all cases in Korea. Overall, I define "Korea's 2020 Coronavirus crisis" as that during the period from 20 February to 12 March. After that period, it is difficult to determine what exactly is causing the reduction in local firms' value because Coronavirus is spreading globally.

The World Health Organization (WHO) is in close touch with South Korea regarding a "cluster" of COVID-19 cases around the central city of Daegu, a WHO spokesman said on Thursday after authorities there described it as a 'super-spreading event'. South Korea reported 20 new cases of the coronavirus on Wednesday, including 14 people involved in an outbreak traced to several church services in Daegu."WHO is in close communication with the Government of the Republic of Korea responding to a cluster of COVID-19 cases that have been confirmed in the area of Daegu," WHO spokesman Tarik Jasarevic said in a reply by email. "WHO does not use 'super-spreading' as a technical term. However, there can be incidents of transmission where a large number of people can become infected from a common source. This can occur for a range of environmental and epidemiological reasons," he added. (Published SUN, FEB 20, 2020)

Reuters (Reporter, Stephanie Nebehay)

Because China is Korea's largest trading partner (Young & Park, 2013), Korea is highly vulnerable to the Coronavirus crisis. Kang (2018) suggests that China is the final destination of intermediate goods that are made in Korea, and the number of Chinese passengers increased by 22.6% from the same period a year ago. The Korea Tourism Organization reported that the number of Chinese passengers during January of 2020 was 481,681.[6] There is some concern

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[5] Appendix C includes the distribution of COVID-19 cases in Korea.

[6] The Korean government began border control after 4 February, and declared an entry ban for foreigners with a recent travel history to Hubei, China. "With effect from 04 February 2020 (0000 hrs), the Korean government suspended the entry into Korea of all foreign nationals who have visited or stayed in Hubei province of China in the past 14 days prior their attempted entry in Korea, regardless of whether they arrive in Korea directly from China or via a third country." The Korean government also declared an entry ban of Chinese nationals with passports issued in Hubei. "With effect from 04 February 2020 (0000 hrs), Chinese nationals with passports issued in Hubei will not be admitted into Korea, unless there is proper

that a delayed entry ban may be associated with an increased potential risk of events such as mass infections.

[Insert Table 1]

2. Local Economic Effects of Mass Infection

Daegu is the fourth largest city in Korea. Although the size of the textile industry, which is its major industry historically, is smaller than before, there are eight major industrial complexes in Daegu, and many manufacturers, such as textile, automobile parts, and mechanics (Kim., 2014; Han et al., 2016).[7] Furthermore, several public firms' headquarters are located in Daegu. In particular, the Kim and Kim (2005) local bank plays an important role in local firms' business in Korea. Choi and Roh (2006) also suggest that local clusters may have homogeneous characteristics in Korea. An et al. (2016) suggest that local firm-specific risk affects investors' behaviors, while Firth et al. (2013) suggest that local government policy affects the value of local firms. Overall, previous studies suggest that the local government emergency plan for the mass infection at the church may be increasing the business uncertainty of the local economy, and affecting local firms' value adversely.[8]

The local newspaper, *Daegu Ilbo*, reported that there are no customers in the streets, and the usually crowded shopping malls are empty because officials are urging citizens to stay home to contain the contagion. Many stores and restaurants are also closed temporarily to prevent mass infection. In particular, Glass et al. (2006) examine social distancing to mitigate pandemic influenza, and indicate that the local government is trying to reduce traffic in the area through a large social distancing campaign. Reluga (2010) also suggests that reducing contact rates between susceptible and infected individuals is most beneficial for prevention in the absence of vaccination. Although the central government is not enforcing community-level quarantines, such as closing roads and restricting travel, Daegu citizens follow social distancing rules voluntarily to protect themselves. Although social distancing is an effective counterplan, of course (Kim et al., 2017), Daegu's urban functions are paralyzed at present. In particular,

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evidence to prove that he/she was NOT in Hubei during the said period."

[7] Choi et al. (2009) report that Daegu has many manufacturing firms in the following proportions: 26.8% textile; 18.5% machinery; 15.3% metal engineering; 7.9% automobile parts, and 32.5% others.

[8] *The Guardian* reports that "The South Korean city of Daegu was facing an 'unprecedented crisis' after coronavirus infections that centered on a controversial 'cult' church surged to 38 cases, accounting for nearly half of the country's total. The city of 2.5 million people, which is two hours south of the capital Seoul, was turned into a ghost town after health officials said the bulk of the country's 31 new cases announced on Thursday were linked to a branch of the Shincheonji Church of Jesus."

because the event is unpredictable, local firms cannot cope with the local economic recession efficiently.

Previous studies suggest that local economic conditions affect the change in local firms' value (Aw, 2002; Choi et al., 2015; Cooper & Ovtchinnikov, 2017; Addoum et al., 2019). In particular, using productivity shocks to the top 100 U.S. firms, Jannati (2018) suggests that the occurrence of geographic spillover affects the dominant firm's value significantly. Using the State Street Bank case and Trust Company and Signature Financial Group case, Li (2018) also suggests that local-level exogenous shock can affect local firms' value. In particular, Addoum et al. (2019) suggest a relation between local bankruptcy and geographic contagion. Therefore, in this paper, I show the geographic contagion in nearby Daegu city during the research period as well.

III. Research Methodology

1. Empirical Method

To examine the local economic effects, I use proxies for the stock price reactions of public firms in KOSPI. Because accounting performance takes time to announce, I expect that the stock price is the earliest possible measure of changes in firm value. I follow Mikkelson and Partch's (1986) event study methodology, and use a 249-day estimation period, beginning from day -258 and ending at day -10. I compute firms' daily abnormal returns (AR) by subtracting the expected returns (ER) from realized returns (R), and report AR in Figures 1 and 2:

$$AR_{it}=R_{it} - ER_{it} \qquad (1)$$

[Insert Figures 1 and 2]

Many previous studies in Korea use Cumulative Abnormal Returns (CARs) to measure the influence of a specific event (Yon et al., 2009; Ki, 2010; Shim et al., 2015; Yi, 2016; Kim, 2019). I measure all KOSPI firms' CARs, except for those of financial firms, such as banks, securities, insurance firms, and credit card firms. Other public firms not located in Daegu serve as the control group. I define the event day ("day 0") as February 20, 2020, which is the first trading day after the announcement of the mass infection at the church. I hypothesize that, compared to other firms, if the change in local risk affects local firms' value significantly, this exogenous shock has strong and negative effects on the local firms' stock returns immediately. Using various location data provided in the annual report, I measure the size of the firms' local dependence, and hypothesize that firms with high local dependence are affected more

negatively by this exogenous shock.

Furthermore, I examine the difference between business group-affiliated firms and others. Shin and Park (1999) suggest that the internal capital market of the business group reduces the financial constraints of group-affiliated firms, and Lew (2015) suggests that group-affiliated firms have lower financial constraints compared to other firms in Korea. Hence, I hypothesize that group-affiliated firms are affected less in this unpredictable scenario, the mass infection at the church, because of the payment guarantee. Lastly, I show the relation between the level of information asymmetry and CARs. To measure the level of information asymmetry, I calculate firm idiosyncratic volatility, which Ferreira and Laux (2007) suggest is one of the possible measures of the level of information asymmetry. Idiosyncratic volatility relative to market valuation is the ratio of firm idiosyncratic volatility to total volatility and is calculated with the following formula:

$$\psi_{it} = \ln\left[\frac{1-R_{it}^{2}}{R_{it}^{2}}\right] \qquad (2)$$

This study uses OLS regression methods to examine the relation between local dependence of Daegu city and CARs. In all of my analyses, I compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. The baseline regression model is as follows:

$$\begin{aligned} CAR_{it} = {} & \beta_0 + \beta_1 Location_{it-2} + \beta_2 \ln(\text{Total Assets})_{it-2} \qquad (3) \\ & + \beta_3 \text{Debt/Total Assets}_{i-2} + \beta_4 \text{EBITDA/Total Assets}_{it-2} + \beta_5 \text{Tobin's } Q_{it-2} \\ & + \beta_6 \text{Beta} + \beta_7 \text{R\&D/Sales}_{it-2} + \beta_8 \text{Advertise/Sales}_{it-2} + \text{Industry Fixed Effects} + \varepsilon_{it} \end{aligned}$$

in which ln(Total Assets) is a log of total assets, Debt/TA is total debt divided by total assets, EBITDA/TA represent firms' profitability, Tobin's Q is the market capitalization plus total debt divided by total assets, R&D/Sales is research and development expenses by sales, Advertise/Sales is advertisement expenses divided by sales, and Beta is a market beta obtained from the CAPM with monthly data for three years. I use financial variables published in 2018, except for market capitalization, because the 2019 annual reports are not released yet.

2. Data

I collect data on stock returns, firm characteristics, the location of firms' headquarters, main

bank, and the location of the main bank branch from FnDataguide. There are three proxies of local dependence: (1) the firm's headquarters is located in Daegu; (2) the firm's main bank is a local bank in Daegu (DGB Daegu Bank), and (3) the main bank branch is located in Daegu (i.e., KDB industrial bank, Daegu branch). I also measure the distance between firms' headquarters and the church using NAVER Maps. In particular, firms are categorized into three distinct groups: (1) 30 minutes' drive away; (2) A one hour drive away, and (3) Others (the firm's headquarters is located far from the church). Table 2 reports a summary of these statistics. I show the difference between local firms that are defined as firms' headquarters located in Daegu and others. Financial variables suggest that local firms are smaller and their profitability is less than that of others. In particular, local firms show a lower EBITDA-to-total-assets ratio than others. Overall, these results show that local firms are more vulnerable to shocks than are other public firms in KOSPI.

[Insert Table 2]

IV. Empirical Results

1. Main Results

Table 3 shows the cross-sectional analysis of the CARs after the announcement of the occurrence of the mass infection at the church. I examine the relation between firms' headquarters location and their short-term performance. In Panel A, we find a negative association between location factors and CARs (0,+1) in models (2), (4), and (5). Furthermore, I test another model that includes two additional control variables: R&D expense/Sales and Advertise expense/Sales. In models (6)-(10), the results are consistent with the previous results in models (1)-(5). In model (6), the coefficient of the main independent variable, Daegu headquarters dummy, is –1.753, which is statistically significant at $p < 0.05$.

In Panel B, I use another main dependent variable, CARs (0,+10), which encompasses a relatively longer period than the prior dependent variable, CARs (0,+1). In models (1)-(10), the empirical results are consistent with the previous results in Panel A. Overall, the results reported in Table 3 imply that the local dependence of firms are affected more negatively by the announcement of the occurrence of the mass infection at the church. The empirical results suggest that the change in local risk may affect local firms' value, and the local dependence may affect the influence of an exogenous shock that is not caused by economic cycles. Therefore, local firms may exert more effort to manage their local dependence and their relations with local risk factors.

[Insert Table 3]

In Table 4, I use four alternative location dummy measures: Local Main bank (DGB Daegu Bank); Local Main Bank Brunch; Local Factory, and Headquarters or Local Factory. Local Factory data are collected by FactoryON that is serviced by the Korea Industrial Complex Corporation. These may represent the relation between firms' own businesses and Daegu city. I find that the short-term and relative long-term stock returns of local firms are also negative compared to the market returns. These empirical results support the hypothesis that the local dependence of a firm's business affects the exogenous shock's effect strongly both in the short- and long-term.

[Insert Table 4]

Lastly, in Table 5, I test several possible determinants of exogenous shock. First, I examine the difference between the Seoul metropolitan area and other regions. The Seoul metropolitan area has more than half the number of public firms' headquarters. Therefore, I am concerned that my empirical findings may be contaminated by the capital region concentration effect (Lee & Lee, 2019). I also test the existence of spillover of the Coronavirus crisis using a contiguous region dummy. The contiguous regions include Daegu, Ulsan, Busan, Gyeongsangbuk-do, and Gyeongsangnam-do. Kim (2014) suggests that these regions have close business links with each other. Therefore, I expect that negative effects spill over into nearby regions after some time. Lastly, I hypothesize that business group-affiliated firms (Chaebol-affiliated firms) and firms with low information asymmetry may experience less shock. Local risk can be alleviated because business group membership guarantees business group affiliates (Locorotondo et al., 2014),. Meanwhile, I expect that the level of business uncertainty may increase rapidly under high information asymmetry (Kim, 2016). Thus, I examine the relation between the level of information asymmetry and CARs, as Ferreira and Laux (2007) report that idiosyncratic volatility is a good measure of the level of firms' information asymmetry.

In Table 5, I find that there is no effect of the Seoul metropolitan area. Therefore, the empirical findings may be not contaminated by this potential effect (capital region effect). The result in both panels A and B in Model (2) suggests the existence of negative spillover in nearby regions of Daegu. In Model (3), I show that negative effects may be alleviated by business group membership; however, the effect is not statistically significant in the short-term. Lastly, in

both panels A and B in Model (4), I find that this exogenous shock may strongly affect firms with high information asymmetry strongly.

[Insert Table 5]

2. Robustness Tests

I perform various robustness checks to investigate the influence of industry clustering. In this paper, I argue that the effect of the local risk change will influence the local firms' values. However, I am concerned that some specific industries may more suffer from the Coranavirus crisis. In particular, the industrial complex consists generally of firms within similar industry categories. If local firms are included in specific industries that are influenced strongly by the Coronavirus crisis,[9] my findings are contaminated by the industry cluster effect, after controlling industry dummy.

To check for the presence of the industry clustering effect, I rerun the baseline regression model using a different event day, January 28, on which the Korea Centers for Disease Control & Prevention (KCDC) increased the level of Infectious diseases crisis alert from Caution to Alert. This announcement suggests that the level of the Coronavirus crisis' severity is greater than that of the Middle East Respiratory Syndrome (MERS) crisis in 2015. Thus, the Korean government declared officially that we face a critical situation with respect to the Coronavirus crisis. However, this is not related to the level of Daegu's local risk. In models (1)-(5) in Table 6, I rerun the main regression model, models (6)-(10) in Table 3, and find no statistically significant results. These results indicate that the influence of the news affects all public firms regardless of region. Accordingly, local firms and others do not differ because it is not a local issue yet, and the industrial clustering effect is not a reasonable explanation of local firms' lower CARs in Daegu on 20 February.

[Insert Table 6]

Lastly, in models (1)–(5) in Table 7, I rerun the main regression model, as in models (6)-(10) in Table 3, with subsamples obtained based on firm size. In Table 2, I show that the local firms' average size is lower than that of others. Thus, I exclude large-sized firms, which are defined as those with total assets over 2 trillion Korean Won. The results show that the influence of local

[9] For example, the Coronavirus crisis is affecting firms that produce masks and hand sanitizers strongly.

dependence on the subsample with the large-sized firms excluded supports my previous expectations.

[Insert Table 7]

V. Summary and Conclusions

The 2020 Coronavirus pandemic is exerting an enormous shock on the Korean economy. Using an event study approach, I attempt to identify the effect of this exogenous shock on local firms associated with the mass infection at the Shincheonji Daegu church. My empirical results support the hypothesis that the exogenous shock the mass infection at the church caused is affecting local firms' value negatively. The social distancing recommended and effects of unpredictable community quarantines may impose a significant burden on local firms' business. My empirical results indicate that the two-day CARs for local firms with headquarters in Daegu/Gyeongsan/Cheongdo is -1.844%, which is significant at $p < 0.01$. Furthermore, this exogenous shock has strong adverse effects on local firms with headquarters located near the church.

I conduct a cross-sectional analysis of the local firms and find that this exogenous shock affects stock market reactions negatively. Based on the local risk perspective, increasing the local risk in Daegu has a strong influence on the local firms' value both in the short- and long-term. Furthermore, using main bank branch data and industrial complex data, I find that the businesses' local dependence is affecting local firms' value negatively as well. Meanwhile, I examine the presence of negative spillovers during the research period, and the empirical results show that the negative spillover has occurred in the immediate regions around Daegu. Lastly, I find that these adverse effects can be alleviated if the firm has business group membership or lower levels of information asymmetry.

This study has some limitations. Firstly, no recent financial data can be collected because the 2019 annual report is not available until March 30. Secondly, because the number of local firms is quite small, some models do not show a statistically significant association between location measures and CARs. Thirdly, I use stock return data only until March 5. After March 8, the Coronavirus crisis emerged in Western European countries, and the number of confirmed cases and death rates is rising rapidly among the elderly in Italy. As a result, the FTSE MIB index, which is a major Italian stock index, dropped 11.2% in just one day. Therefore, the Korean stock

market reaction may be affected strongly by the global stock market collapse after March 5. Thus, I cannot access stock market returns available after March 5, and accordingly, this study concentrates only on the early-stage of the pandemic. This limitation suggests that future studies should investigate in depth the economic effect of negative spillover at the national, rather than the local level.

References

"Citi says fear of coronavirus in South Korea is spreading 'at a much faster rate' than the virus itself", *CNBC*, FEB 23 2020

"WHO says in touch with South Korea on 'cluster of COVID-19 Cases'", *Reuters*, FEBRUARY 20, 2020

Addoum, J. M., Kumar, A., Le, N., & A. Niessen-Ruenzi, "Local Bankruptcy and Geographic Contagion in the Bank Loan Market," (2019), *Available at SSRN 2637026.*

An, Z., Li, D., Huang, G., & S. Xiao, "Corporate Risk-Taking, Foreign Institutional Ownership and the Role of Macro Corporate Governance," (2016), *Foreign Institutional Ownership and the Role of Macro Corporate Governance*.

Aw, B. Y., "Accumulating Technology and Location Spillovers among Firms in Taiwan's Electronics Industry," *Journal of Development Studies*, Vol. 39, No. 1 (2002), pp. 94-117.

Choi, D. K., & H. S. Roh, "A Study on the Effect of Factory Automation Level on Cost Structure and Business Performance," *Korean Business Education Review*, Vol. 41, (2006), pp. 127-148.

Choi, J. J., Jiang, C., & O. Shenkar, "The Quality of Local Government and Firm Performance: The Case of China's Provinces," *Management and Organization Review*, Vol. 11, No. 4 (2015), pp. 679-710.

Choi, S. W., Park, S. W., Lee, C. S., Kim, H. J., Bae, S., & H. I. Inyang, "Patterns of VOC and BTEX Concentration in Ambient Air around Industrial Sources in Daegu, Korea," *Journal of Environmental Science and Health, Part A*, Vol. 44, No. 1 (2009), pp. 99-107.

Chun, K. Ku., "The Effects of Metropolitan Industrial Complexes on the Relocation of Firm : Focused on Daegu Metropolitan Area", *Journal of Korea Planning Association*, Vol. 50, No. 2 (2015), pp. 33-48.

Cooper, M. J., & A. V. Ovtchinnikov, "Geographical Vibrancy and Firm Performance," *HEC Paris Research Paper*, (2017), No. FIN-2015-1090.

Decker, R. A., McCollum, M., & G. B. Upton Jr, "Firm Dynamics and Local Economic Shocks: Evidence from the Shale Oil and Gas Boom," (2018), *FMA Conference paper*.

Ferreira, M. A., & P. A. Laux, "Corporate Governance, Idiosyncratic Risk, and Information Flow," *The Journal of Finance*, Vol. 62, No. 2 (2007), pp. 951-989.

Firth, M., Gong, S. X., & L. Shan, "Cost of Government and Firm Value," *Journal of Corporate Finance*, Vol. 21, (2013), pp. 136-152.

Giroud, X., & H. M. Mueller, "Firms' Internal Networks and Local Economic Shocks," *American Economic Review*, Vol. 109, No. 10 (2019), pp. 3617-3649.

Glass, R. J., Glass, L. M., Beyeler, W. E., & H. J. Min, “Targeted Social Distancing Designs for Pandemic Influenza,” *Emerging Infectious Fiseases*, Vol. 12, No. 11 (2006), pp. 1671–1681.

Han, J. H., Na, J. G., & C. B. Kim, “Network Analysis of Technology Convergence on Decentralized Energy by Using Patent Information: Focused on Daegu City Area,” *Journal of the Society of Korea Industrial and Systems Engineering*, Vol. 39, No. 3 (2016), pp. 156-169.

Jannati, S., (2018). “Geographic Spillover of Dominant Firms' Shocks,” *In 8th Miami Behavioral Finance Conference.*

Kang, H., “The Time-varying Impact of China’s Economic Rebalancing on Korea’s Exports to China,” *International Economic Journal*, Vol. 32, No. 1 (2018), pp. 31-42.

Khan, Z., Muhammad, K., Ahmed, A., & H. Rahman, “Coronavirus outbreaks: prevention and management recommendations,” *Drugs & Therapy Perspectives*, (2020), pp. 1-3.

Ki, H. H., “Security Price Reactions on Corporate Divertiture Announcement and Corporate Characteristics,” *Korean Business Education Review*, Vol. 61, (2010), pp. 43-66.

Kim, B. M., “Managerial Opportunism, Overconfidence and Stock Price Crash Risk,” *Asian Review of Financial Research*, Vol. 29, No. 2 (2016), pp.193-233.

Kim, J. D., “Effect Collaborative Activities of Large Enterprise on Performance of SMEs in Supply Chain,” *Korean Business Education Review*, Vol. 29, No. 4 (2014), pp. 365-389

Kim, S. C., & J. Y. Kim, “The Role of Local Banks to Small Businesses,” *Korean Business Education Review*, Vol. 38, (2005), pp. 381-400.

Kim, S., Lee, J., & E. Jung, (2017). “Mathematical Model of Transmission Dynamics and Optimal Control Strategies for 2009 A/H1N1 Influenza in the Republic of Korea,” *Journal of Theoretical Biology*, Vol. 412, (2017), pp. 74-85.

Kim, Y. G., “Corporate Social Responsibility Index Additions and Market Response,” *Korean Business Education Review*, Vol. 34, (2019), pp. 327-345.

Ku, C. C., Ng, T. C., & H. H. Lin, “Epidemiological Benchmarks of the COVID-19 Outbreak Control in China after Wuhan’s Lockdown: a Modelling Study with an Empirical Approach,” (2020), *Available at SSRN 3544127*.

Lee, H. L. & M. H. Lee, “Reginal Balanced Development Policy Leverage in the Capital and Non-Capital Areas,” *Journal of the Korea Academia-industrial Coopertation Society*, Vol. 20, No. 12 (2019), pp. 502-512.

Lew, S. H., “Financial Policies between Chaebol and Non-chaebol Firms,” *Korean Business Education Review*, Vol. 30, (2015), pp. 317-355.

Li, K., “Innovation Externalities and the Customer/Supplier Link,” *Journal of Banking & Finance*, Vol. 86, (2018), pp. 101-112.

Liu, Y., Gayle, A. A., Wilder-Smith, A., & J. Rocklöv, “The Reproductive Number of COVID-19 is Higher Compared to SARS Coronavirus,” *Journal of Travel Medicine*, Vol. 27, No. 2 (2020), pp. 1-4.

Locorotondo, R., Dewaelheyns, N., & C. Van Hulle, “Cash Holdings and Business Group Membership,” *Journal of Business Research*, Vol. 67, No. 3 (2014), pp. 316-323.

Mikkelson, W. H., & M. M. Partch, “Valuation Effects of Security Offerings and the Issuance Process,” *Journal of Financial Economics*, Vol. 15. No 1-2 (1986), pp. 31-60.

Park, Y. K. & B. B. Ki, "The Price Discovery and Volatility Transmission between Korean Won, Chinese Yuan, and Japanese Yen," *Asian Review of Financial Research*, Vol. 26, No. 4 (2013), pp.447-483.

Peeri, N. C., Shrestha, N., Rahman, M. S., Zaki, R., Tan, Z., Bibi, S., ... & U. Haque, “The SARS, MERS and Novel Coronavirus (COVID-19) Epidemics, the Newest and Biggest Global Health Threats: What Lessons Have We Learned?,” *International Journal of Epidemiology*. (2020), *Forthcoming*.

Reluga, T. C., “Game Theory of Social Distancing in Response to an Epidemic.” *PLoS Computational Biology*, Vol. 6, No. 5 (2010).

Sang Y. Y., Ku. B. N, Eom, Y. H., & J. H. Hahn., "The Cross-section of Stock Returns in Korea : An Empirical Investigation," *Asian Review of Financial Research*, Vol. 22, No. 1 (2009), pp.1-44.

Shim, D. S., Cheon, C. S., & C. S. Yang, “The Effect of the Price Ceiling Regulation on Stock Price of Construction Firms,” *Korean Business Education Review*, Vol. 30, (2015), pp. 45-65.

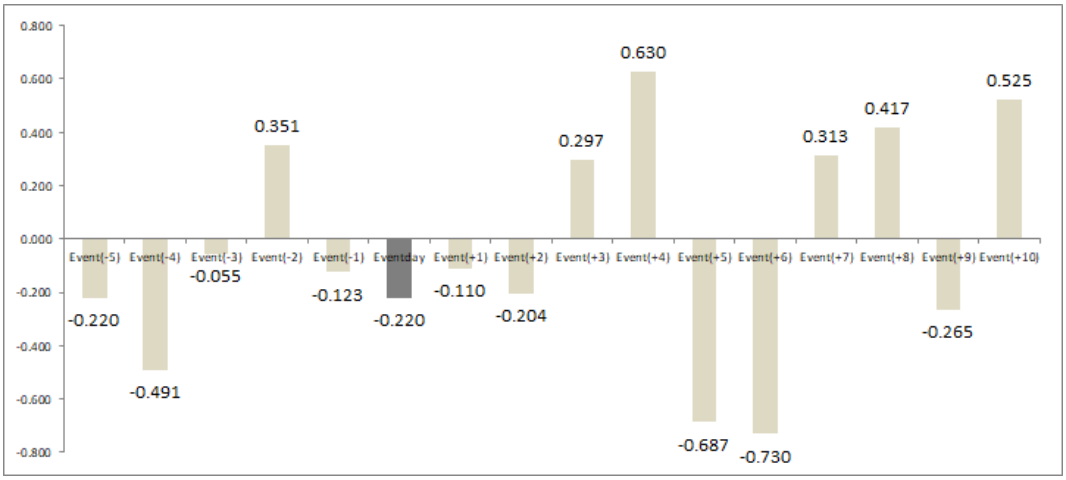
Shin, H. H., & Y. S. Park, “Financing Constraints and Internal Capital Markets: Evidence from Korean Chaebols'. *Journal of Corporate Finance*, Vol. 5, No. 2 (1999), pp. 169-191.

Tuzel, S., & M. B. Zhang, “Local Risk, Local Factors, and Asset Prices,” *The Journal of Finance*, Vol. 72, No. 1 (2017), pp. 325-370.

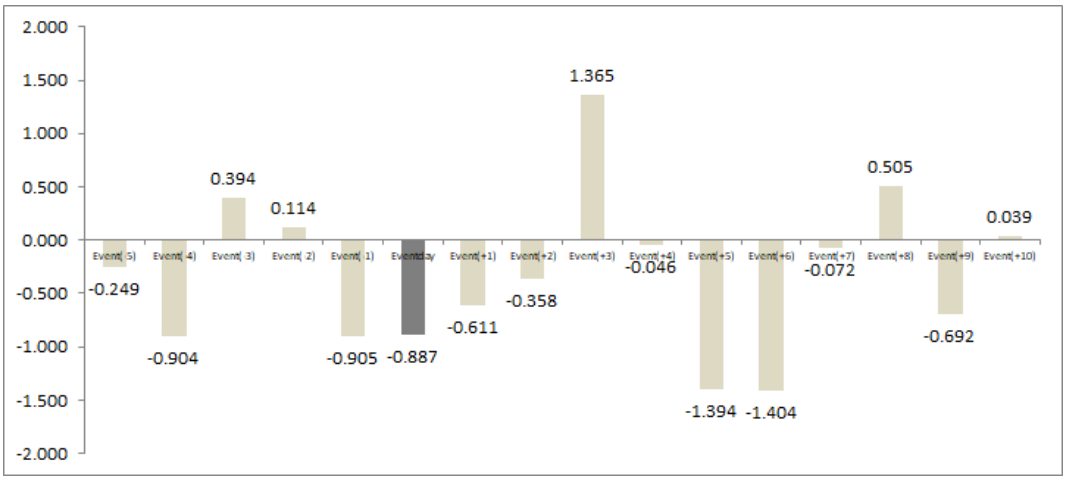
Wang, Y., Wang, Y., Chen, Y., & Q. Qin, “Unique Epidemiological and Clinical Features of the Emerging 2019 Novel Coronavirus Pneumonia (COVID-19) Implicate Special Control Measures,” *Journal of Medical Virology*, (2020), *Forthcoming*.

Yi, J. S., "Information Value of a Credit Watchlist," *Asian Review of Financial Research*, Vol. 29, No. 1 (2016), pp.113-148.

<Figure 1> Abnormal Returns of Full Samples



<Figure 2> Abnormal Returns of Local Firms



<Table 1> Korea's Coronavirus Cases (2020-01-20 – 2020-03-12)

This table reports Korea's Coronavirus Cases during the research period. Korea Centers for Disease Control & Prevention (KCDC) release the data through Kaggle because of sharing information for researchers and experts around the world. Test is the number of people tested. Confirmed is the number of confirmed cases of Coronavirus. Daegu is the number of confirmed cases in Daegu. Other is the number of confirmed cases in other regions (Seoul, Gyeonggi-do, Gyeongsangnam-do, Busan, Chungcheongnam-do, Incheon, Gyeongsangbuk-do, Ulsan, Chungcheongbuk-do, Daejeon, Gwangju, Jeollanam-do, Jeollabuk-do, Gangwon-do, Sejong, Jeju-do).

Date	Event Day	Test	Confirmed		
			Total	Daegu	Others
2020-01-20	-23	1	1	0	1
2020-01-21	-22	1	1	0	1
2020-01-22	-21	4	1	0	1
2020-01-23	-20	22	1	0	1
2020-01-24	-19	27	2	0	2
2020-01-25		27	2	0	2
2020-01-26		51	3	0	3
2020-01-27	-18	61	4	0	4
2020-01-28	-17	116	4	0	4
2020-01-29	-16	187	4	0	4
2020-01-30	-15	246	6	0	6
2020-01-31	-14	312	11	0	11
2020-02-01		371	12	0	12
2020-02-02		429	15	0	15
2020-02-03	-13	490	15	0	15
2020-02-04	-12	607	16	0	16
2020-02-05	-11	714	18	0	18
2020-02-06	-10	885	23	0	23
2020-02-07	-9	1,352	24	0	24
2020-02-08		2,097	24	0	24
2020-02-09		2,598	27	0	27
2020-02-10	-8	3,110	27	0	27
2020-02-11	-7	4,325	28	0	28
2020-02-12	-6	5,624	28	0	28
2020-02-13	-5	6,511	28	0	28
2020-02-14	-4	7,242	28	0	28
2020-02-15		7,734	28	0	28
2020-02-16		8,161	29	0	29
2020-02-17	-3	8,718	30	0	30
2020-02-18	-2	9,772	31	1	30
2020-02-19	-1	11,173	51	11	40
2020-02-20	0	13,202	104	30	74
2020-02-21	1	16,400	204	110	94
2020-02-22		21,586	433	193	240
2020-02-23		26,179	602	310	292
2020-02-24	2	32,756	833	483	350
2020-02-25	3	40,304	977	543	434
2020-02-26	4	53,553	1,261	710	551
2020-02-27	5	66,652	1,766	1,132	634
2020-02-28	6	81,167	2,337	1,580	757
2020-02-29		94,055	3,150	2,236	914
2020-03-01		98,921	3,736	2,704	1,032
2020-03-02	7	109,591	4,212	3,081	1,131
2020-03-03	8	125,851	4,812	3,601	1,211
2020-03-04	9	136,707	5,328	4,007	1,321
2020-03-05	10	146,541	5,766	4,328	1,438
2020-03-06	11	164,740	6,284	4,694	1,590
2020-03-07		178,189	6,767	5,084	1,683
2020-03-08		188,518	7,134	5,381	1,753
2020-03-09	12	196,618	7,382	5,571	1,811
2020-03-10	13	210,144	7,513	5,663	1,850
2020-03-11	14	222,395	7,755	5,794	1,961
2020-03-12	15	234,998	7,869	5,867	2,002

<Table 2> Summary Statistics

This table reports the summary statistics for firms' financial characteristics and Distribution of firms' headquarters in KOSPI. All financial variables are at the end of 2018, except for market capitalization. There are two different groups: Local and Others. Local firms defined as "firms' headquarter is located in Daegu". All financial variables are collected by FnDataguide. Tobin's Q is the sum of total debt and market capitalization divided by total assets. T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A: Financial distribution of sample

	Total	Local	Others
Total Asset (Million KRW)	4,097,432*** (5.486)	2,470,534 (1.260)	4,147,108*** (5.404)
Total Sales (Million KRW)	3,015,117*** (6.170)	1,722,876 (1.336)	3,054,575*** (6.084)
Market Capitalization (Million KRW)	1,603,212*** (4.343)	373,548 (1.722)	1,640,759*** (4.314)
Total Debt (Million KRW)	2,118,919*** (5.471)	1,815,644 (1.174)	2,128,179*** (5.368)
EBITDA (Million KRW)	410,133*** (3.006)	177,406 (1.161)	417,239*** (2.969)
R&D expense (Million KRW)	86,700* (1.712)	11,449 (1.783)	88,592* (1.707)
Advertise expense (Million KRW)	44,562*** (3.188)	2,290 (1.835)	45,625*** (3.185)
Total Debt /Total Assets (%)	45.728*** (58.364)	58.701*** (14.506)	45.331*** (57.143)
EBITDA /Total Assets (%)	6.049*** (23.751)	5.039*** (5.841)	6.080*** (23.285)
Tobin's Q	1.098*** (30.137)	0.994*** (10.705)	1.102*** (29.413)
Beta(Monthly,3year)	1.194*** (46.234)	0.992*** (7.888)	1.200*** (45.613)
R&D Expenditure /Total Assets (%)	1.570*** (11.005)	1.084** (2.569)	1.583*** (10.849)
Advertise Expenditure /Total Assets (%)	1.021*** (10.824)	0.335 (1.819)	1.039*** (10.767)
Total	675(367)	20(9)	655(358)

Panel B: Distribution of headquarter

Region	Number	Percent
Daegu	20	2.96%
Seoul	324	48.00%
Gyeonggi-do	130	19.26%
Gyeongsangnam-do	38	5.63%
Busan	34	5.04%
Chungcheongnam-do	27	4.00%
Incheon	22	3.26%
Gyeongsangbuk-do	14	2.07%
Ulsan	13	1.93%
Chungcheongbuk-do	13	1.93%
Daejeon	9	1.33%
Gwangju	7	1.04%
Jeollanam-do	7	1.04%
Jeollabuk-do	7	1.04%
Gangwon-do	4	0.59%
Sejong	4	0.59%
Jeju-do	2	0.30%
Total	675	100.0%

<Table 3> Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after Mass Infection Accouncement

This table reports the Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after the Mass Infection Accouncement. In panel A, the dependent variable is the CARs (0, +1). The event day is February 20. In panel B, the dependent variable is the CARs (0, +10). The event day is February 20. All financial variables are at the end of 2018, except for market capitalization. In all my analyses, we compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. Ln(Total Assets) is the natural logarithms of a firm's total assets. Total Debt/Total Assets is total debt divided by total assets. EBITDA/Total Assets is a firm's EBITDA divided by total assets. Tobin's Q is the sum of total debt and market capitalization divided by total assets. Beta is a market beta obtained from the CAPM with monthly data for three years. R&D expense/Sales is a firm's R&D expense reported in income statement divided by total assets. Advertisement expense/Sales is a firm's advertisement expense reported in income statement divided by total assets. There are five different location variables. First, Daegu, Daegu/Gyeongsan/Cheongdo, Daegu/Gyeongsangbuk-do dummy is classified by the location of a firms' headquarter's address. Second, Half hour and One hour dummy is classified by a firm's headquarter located in a half-hour drive and one hour drive respectively. T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A: Short-term stock returns										
Dep: CAR(0,+1)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)
Daegu Headquarter Dummy	-0.801 (-1.350)					-1.753** (-2.381)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-1.053* (-1.918)					-1.844*** (-2.960)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-0.305 (-0.706)					-0.934* (-1.845)		
Distance Dummy (Half-hour)				-2.110*** (-3.000)					-1.877** (-2.364)	
Distance Dummy (One hour)					-1.788*** (-3.420)					-1.792*** (-3.194)
Ln (Total Assets)	-0.152 (-1.359)	-0.158 (-1.410)	-0.148 (-1.322)	-0.151 (-1.360)	-0.149 (-1.346)	0.026 (0.182)	0.021 (0.146)	0.031 (0.218)	0.023 (0.161)	0.020 (0.140)
Total Debt /Total Assets(%)	0.009 (0.937)	0.010 (1.006)	0.008 (0.880)	0.009 (0.950)	0.009 (0.983)	-0.005 (-0.425)	-0.004 (-0.332)	-0.005 (-0.513)	-0.005 (-0.444)	-0.004 (-0.340)
EBITDA /Total Assets(%)	-0.033 (-0.714)	-0.032 (-0.705)	-0.033 (-0.716)	-0.032 (-0.693)	-0.032 (-0.698)	-0.094 (-1.326)	-0.093 (-1.326)	-0.095 (-1.349)	-0.094 (-1.329)	-0.093 (-1.332)
Tobin's Q	-0.232* (-1.675)	-0.231* (-1.672)	-0.233* (-1.682)	-0.230* (-1.667)	-0.229* (-1.660)	-0.331 (-0.983)	-0.330 (-0.981)	-0.334 (-0.992)	-0.332 (-0.986)	-0.336 (-1.000)
Beta(Monthly, 3year)	0.366 (1.612)	0.353 (1.555)	0.370 (1.624)	0.368 (1.632)	0.365 (1.613)	0.039 (0.132)	0.031 (0.104)	0.031 (0.106)	0.036 (0.124)	0.027 (0.090)
R&D Expense /Sales(%)						0.112 (0.339)	0.111 (0.338)	0.113 (0.344)	0.112 (0.340)	0.119 (0.360)
Advertise Expense /Sales(%)						-0.041 (-0.188)	-0.040 (-0.179)	-0.047 (-0.211)	-0.041 (-0.186)	-0.043 (-0.196)
Industry	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.188	0.189	0.187	0.190	0.190	0.199	0.200	0.197	0.199	0.201
N	675	675	675	675	675	367	367	367	367	367

<Table 3> Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after Mass Infection Accouncement(Continued)

Panel B: Long-term stock returns										
Dep: CAR(0,+10)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model(10)
Daegu Headquarter Dummy	-1.965 (-1.572)					-4.744** (-2.438)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-2.402** (-2.062)					-4.796*** (-2.871)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-1.412 (-1.606)					-3.182*** (-2.689)		
Distance Dummy (Half-hour)				-4.762*** (-2.628)					-4.740** (-2.227)	
Distance Dummy (One hour)					-4.284*** (-3.515)					-4.375*** (-2.962)
Ln (Total Assets)	-0.222 (-0.875)	-0.234 (-0.921)	-0.223 (-0.879)	-0.218 (-0.867)	-0.215 (-0.856)	-0.018 (-0.063)	-0.030 (-0.104)	-0.010 (-0.035)	-0.023 (-0.081)	-0.029 (-0.101)
Total Debt /Total Assets(%)	0.005 (0.231)	0.006 (0.293)	0.005 (0.208)	0.005 (0.231)	0.006 (0.271)	-0.032 (-1.200)	-0.030 (-1.101)	-0.034 (-1.277)	-0.033 (-1.231)	-0.030 (-1.129)
EBITDA /Total Assets(%)	-0.087 (-0.949)	-0.086 (-0.941)	-0.086 (-0.938)	-0.085 (-0.929)	-0.085 (-0.931)	-0.195 (-1.486)	-0.195 (-1.487)	-0.196 (-1.498)	-0.196 (-1.495)	-0.195 (-1.494)
Tobin's Q	0.776*** (2.573)	0.777*** (2.576)	0.773** (2.562)	0.779*** (2.582)	0.782*** (2.590)	0.700 (1.339)	0.701 (1.342)	0.691 (1.324)	0.698 (1.335)	0.687 (1.317)
Beta(Monthly, 3year)	1.101* (1.887)	1.074* (1.837)	1.087* (1.855)	1.110* (1.917)	1.099* (1.896)	0.211 (0.277)	0.191 (0.251)	0.178 (0.233)	0.207 (0.272)	0.184 (0.242)
R&D Expense /Sales(%)						0.283 (0.611)	0.282 (0.608)	0.289 (0.625)	0.283 (0.612)	0.299 (0.647)
Advertise Expense /Sales(%)						-0.426 (-1.394)	-0.421 (-1.379)	-0.440 (-1.443)	-0.426 (-1.394)	-0.431 (-1.418)
Industry	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.155	0.155	0.154	0.157	0.158	0.225	0.227	0.224	0.224	0.227
N	675	675	675	675	675	367	367	367	367	367

<Table 4> Cross-sectional analysis of using Alternative Location Variables

This table reports the Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after the Mass Infection Accouncement. In panel A, the dependent variable is the CARs (0, +1). The event day is February 20. In panel B, the dependent variable is the CARs (0, +10). The event day is February 20. All financial variables are at the end of 2018, except for market capitalization. In all my analyses, we compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. Ln(Total Assets) is the natural logarithms of a firm's total assets. Total Debt/Total Assets is total debt divided by total assets. EBITDA/Total Assets is a firm's EBITDA divided by total assets. Tobin's Q is the sum of total debt and market capitalization divided by total assets. Beta is a market beta obtained from the CAPM with monthly data for three years. R&D expense/Sales is firm's R&D expense reported in income statement divided by total assets. Advertisement expense/Sales is a firm's advertisement expense reported in income statement divided by total assets. There are four alternative location variables that are related to the business. First, the Local Main bank dummy is the firm's main bank is DGB Daegu Bank. Second, the Local Main Bank Branch dummy is the firm's main bank branch is in Daegu city. Third, the Local Factory dummy is the firm's factories located in industrial complexes of Daegu city. Lastly, Headquarter or Local Factory dummy is the firm's headquarter located in Daegu or the firm's factory is located in Daegu. T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A: Short-term stock returns				
Dep: CAR(0,+1)	Model (1)	Model (2)	Model (3)	Model (4)
Local Main Bank (DGB Daegu Bank) Dummy	-1.913** (-2.192)			
Local Main Bank Branch Dummy		-2.123*** (-3.176)		
Local Factory Dummy			-1.953* (-1.934)	
Headquarter or Local Factory Dummy				-1.862** (-1.983)
Ln (Total Assets)	0.031 (0.218)	0.017 (0.115)	0.023 (0.158)	0.026 (0.179)
Total Debt /Total Assets(%)	-0.005 (-0.448)	-0.005 (-0.495)	-0.004 (-0.405)	-0.004 (-0.383)
EBITDA /Total Assets(%)	-0.095 (-1.332)	-0.094 (-1.341)	-0.097 (-1.391)	-0.097 (-1.386)
Tobin's Q	-0.329 (-0.976)	-0.337 (-1.002)	-0.347 (-1.033)	-0.345 (-1.029)
Beta(Monthly, 3year)	0.046 (0.157)	0.045 (0.154)	0.022 (0.075)	0.025 (0.085)
R&D Expense /Sales(%)	0.107 (0.324)	0.114 (0.346)	0.125 (0.380)	0.124 (0.377)
Advertise Expense /Sales(%)	-0.044 (-0.199)	-0.049 (-0.221)	-0.037 (-0.169)	-0.037 (-0.170)
Industry	YES	YES	YES	YES
R^2	0.196	0.201	0.202	0.201
N	367	367	367	367
Panel B: Long-term stock returns				
Dep: CAR(0,+10)	Model (1)	Model (2)	Model (3)	Model (4)
Local Main Bank (DGB Daegu Bank) Dummy	-2.093 (-0.795)			
Local Main Bank Branch Dummy		-3.745* (-1.815)		
Local Factory Dummy			-3.473* (-1.958)	
Headquarter or Local Factory Dummy				-3.560** (-2.146)
Ln (Total Assets)	0.010 (0.034)	-0.022 (-0.077)	-0.011 (-0.037)	-0.008 (-0.026)
Total Debt /Total Assets(%)	-0.035 (-1.298)	-0.035 (-1.305)	-0.033 (-1.253)	-0.033 (-1.227)
EBITDA /Total Assets(%)	-0.202 (-1.516)	-0.199 (-1.520)	-0.204 (-1.561)	-0.204 (-1.557)
Tobin's Q	0.699 (1.335)	0.688 (1.319)	0.670 (1.285)	0.671 (1.289)
Beta(Monthly, 3year)	0.237 (0.309)	0.233 (0.306)	0.191 (0.250)	0.193 (0.252)
R&D Expense /Sales(%)	0.274 (0.592)	0.285 (0.617)	0.305 (0.658)	0.305 (0.659)
Advertise Expense /Sales(%)	-0.436 (-1.428)	-0.443 (-1.453)	-0.422 (-1.399)	-0.422 (-1.396)
Industry	YES	YES	YES	YES
R^2	0.218	0.222	0.223	0.224
N	367	367	367	367

<Table 5> Cross-sectional analysis of using Alternative Location Variables

This table reports the Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after the Mass Infection Accouncement. In panel A, the dependent variable is the CARs (0, +1). The event day is February 20. In panel B, the dependent variable is the CARs (0, +10). The event day is February 20. All financial variables are at the end of 2018, except for market capitalization. In all my analyses, we compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. Ln(Total Assets) is the natural logarithms of a firm's total assets. Total Debt/Total Assets is total debt divided by total assets. EBITDA/Total Assets is a firm's EBITDA divided by total assets. Tobin's Q is the sum of total debt and market capitalization divided by total assets. Beta is a market beta obtained from the CAPM with monthly data for three years. R&D expense/Sales is a firm's R&D expense reported in income statement divided by total assets. Advertisement expense/Sales is a firm's advertisement expense reported in income statement divided by total assets. There are four different variables First, Seoul/Incheon/Gyeonggi-do dummy is the firm's headquarter located in the Seoul Metropolitan area. Second, the Daegu/Ulsan/Busan/Gyeongsangbuk-do/Gyeongsangnam-do dummy is the firm's headquarter located nearby Daegu city. Third, Chaebol dummy is whether the firm is a business group-affiliated firm or not. Lastly, Idiosyncratic Volatility is proxy as the level of information asymmetry (Ferreira and Laux (2007)). T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A: Short-term stock returns				
Dep: CAR(0,+1)	Model (1)	Model (2)	Model (3)	Model (4)
Seoul/Incheon/Gyeonggi-do Dummy	0.082 (0.229)			
Daegu/Ulsan/Busan/Gyeongsangbuk-do /Gyeongsangnam-do Dummy		-0.413 (-1.140)		
Chaebol Dummy			0.269 (0.347)	
Idiosyncratic Volatility				-0.514*** (-2.849)
Ln (Total Assets)	0.035 (0.246)	0.031 (0.215)	-0.009 (-0.041)	-0.101 (-0.662)
Total Debt /Total Assets(%)	-0.006 (-0.569)	-0.006 (-0.569)	-0.006 (-0.593)	-0.005 (-0.463)
EBITDA /Total Assets(%)	-0.097 (-1.378)	-0.095 (-1.354)	-0.096 (-1.401)	-0.114 (-1.638)
Tobin's Q	-0.331 (-0.986)	-0.333 (-0.990)	-0.349 (-0.972)	-0.353 (-1.043)
Beta(Monthly, 3year)	0.049 (0.164)	0.046 (0.155)	0.053 (0.178)	-0.181 (-0.559)
R&D Expense /Sales(%)	0.109 (0.332)	0.109 (0.332)	0.117 (0.345)	0.111 (0.336)
Advertise Expense /Sales(%)	-0.047 (-0.213)	-0.049 (-0.221)	-0.044 (-0.203)	-0.039 (-0.179)
Industry	YES	YES	YES	YES
R^2	0.195	0.196	0.195	0.210
N	367	367	367	367
Panal B: Long-term stock returns				
Dep: CAR(0,+10)	Model (1)	Model (2)	Model (3)	Model (4)
Seoul/Incheon/Gyeonggi-do Dummy	0.155 (0.181)			
Daegu/Ulsan/Busan/Gyeongsangbuk-do /Gyeongsangnam-do Dummy		-1.968** (-1.967)		
Chaebol Dummy			2.901** (2.028)	
Idiosyncratic Volatility				-1.595*** (-3.183)
Ln (Total Assets)	0.010 (0.034)	-0.025 (-0.086)	-0.504 (-1.390)	-0.417 (-1.496)
Total Debt /Total Assets(%)	-0.037 (-1.396)	-0.036 (-1.341)	-0.036 (-1.372)	-0.032 (-1.266)
EBITDA /Total Assets(%)	-0.203 (-1.541)	-0.197 (-1.503)	-0.191 (-1.525)	-0.257* (-1.935)
Tobin's Q	0.698 (1.336)	0.693 (1.327)	0.519 (0.933)	0.633 (1.199)
Beta(Monthly, 3year)	0.239 (0.312)	0.221 (0.291)	0.273 (0.359)	-0.476 (-0.608)
R&D Expense /Sales(%)	0.276 (0.598)	0.274 (0.593)	0.353 (0.753)	0.280 (0.600)
Advertise Expense /Sales(%)	-0.440 (-1.441)	-0.451 (-1.481)	-0.418 (-1.414)	-0.417 (-1.356)
Industry	YES	YES	YES	YES
R^2	0.217	0.223	0.229	0.256
N	367	367	367	367

<Table 6> Robustness Check on Industry Clustering Effect

This table reports the Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after the Korea Centers for Disease Control & Prevention (KCDC) increased the level of Infectious diseases Alert Crisis from Caution to Alert. In panel A, the dependent variable is the CARs (0, +1). The event day is January 20. In panel B, the dependent variable is the CARs (0, +10). The event day is February 20. All financial variables are at the end of 2018, except for market capitalization. In all my analyses, we compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. Ln(Total Assets) is the natural logarithms of a firm's total assets. Total Debt/Total Assets is total debt divided by total assets. EBITDA/Total Assets is a firm's EBITDA divided by total assets. Tobin's Q is the sum of total debt and market capitalization divided by total assets. Beta is a market beta obtained from the CAPM with monthly data for three years. R&D expense/Sales is a firm's R&D expense reported in income statement divided by total assets. Advertisement expense/Sales is a firm's advertisement expense reported in income statement divided by total assets. There are five different location variables. First, Daegu, Daegu/Gyeongsan/Cheongdo, Daegu/Gyeongsangbuk-do dummy is classified by the location of a firms' headquarter's address. Second, Half hour and One hour dummy is classified by a firm's headquarter located in a half-hour drive and one hour drive respectively. T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A: Short-term stock returns					
Dep: CAR(0,+1)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Daegu Headquarter Dummy	-0.886 (-0.607)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-0.616 (-0.499)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-0.388 (-0.492)		
Distance Dummy (Half-hour)				-0.756 (-0.468)	
Distance Dummy (One hour)					-0.703 (-0.663)
Ln (Total Assets)	-0.275** (-2.070)	-0.274** (-2.059)	-0.271** (-2.032)	-0.275** (-2.068)	-0.276** (-2.065)
Total Debt /Total Assets(%)	0.017 (1.273)	0.017 (1.259)	0.017 (1.234)	0.017 (1.255)	0.017 (1.272)
EBITDA /Total Assets(%)	-0.068 (-1.391)	-0.069 (-1.402)	-0.069 (-1.404)	-0.069 (-1.400)	-0.069 (-1.397)
Tobin's Q	-0.120 (-0.641)	-0.120 (-0.642)	-0.121 (-0.648)	-0.120 (-0.644)	-0.122 (-0.653)
Beta(Monthly, 3year)	0.066 (0.176)	0.065 (0.174)	0.064 (0.170)	0.066 (0.176)	0.063 (0.166)
R&D Expense /Sales(%)	0.081 (0.704)	0.081 (0.701)	0.081 (0.708)	0.081 (0.704)	0.084 (0.725)
Advertise Expense /Sales(%)	-0.282* (-1.827)	-0.283* (-1.828)	-0.285* (-1.846)	-0.283* (-1.829)	-0.284* (-1.838)
Industry	YES	YES	YES	YES	YES
R^2	0.203	0.203	0.203	0.203	0.203
N	367	367	367	367	367
Panel B: Long-term stock returns					
Dep: CAR(0,+10)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Daegu Headquarter Dummy	-1.477 (-0.700)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-0.363 (-0.187)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-0.712 (-0.510)		
Distance Dummy (Half-hour)				-1.318 (-0.565)	
Distance Dummy (One hour)					0.108 (0.063)
Ln (Total Assets)	-0.078 (-0.277)	-0.07 (-0.248)	-0.073 (-0.260)	-0.078 (-0.276)	-0.065 (-0.231)
Total Debt /Total Assets(%)	0.026 (1.134)	0.025 (1.085)	0.026 (1.101)	0.026 (1.119)	0.025 (1.055)
EBITDA /Total Assets(%)	0.082 (1.217)	0.080 (1.185)	0.081 (1.201)	0.081 (1.208)	0.079 (1.173)
Tobin's Q	0.558* (1.694)	0.557* (1.69)	0.556* (1.687)	0.557* (1.691)	0.557* (1.689)
Beta(Monthly, 3year)	0.732 (0.933)	0.738 (0.939)	0.727 (0.926)	0.732 (0.933)	0.743 (0.945)
R&D Expense /Sales(%)	-0.171 (-0.771)	-0.173 (-0.776)	-0.171 (-0.765)	-0.171 (-0.771)	-0.174 (-0.778)
Advertise Expense /Sales(%)	-0.540* (-1.855)	-0.542* (-1.864)	-0.544* (-1.870)	-0.540* (-1.856)	-0.544* (-1.869)
Industry	YES	YES	YES	YES	YES
R^2	0.141	0.140	0.140	0.141	0.140
N	367	367	367	367	367

<Table 7> Robustness Check on Firm Size Effect

This table reports the Cross-sectional analysis of the estimated Cumulative Abnormal Returns (CARs) after the Mass Infection Accouncement, excluding large-sized firms (that have total assets over 2 trillion Korean Won) In panel A, the dependent variable is the CARs (0, +1). The event day is January 20. In panel B, the dependent variable is the CARs (0, +10). The event day is February 20. All financial variables are at the end of 2018, except for market capitalization. In all my analyses, we compute a robust variance estimator based on a list of variables equation-level scores and a covariance matrix. Ln(Total Assets) is the natural logarithms of a firm's total assets. Total Debt/Total Assets is total debt divided by total assets. EBITDA/Total Assets is a firm's EBITDA divided by total assets. Tobin's Q is the sum of total debt and market capitalization divided by total assets. Beta is a market beta obtained from the CAPM with monthly data for three years. R&D expense/Sales is a firm's R&D expense reported in income statement divided by total assets. Advertisement expense/Sales is a firm's advertisement expense reported in income statement divided by total assets. There are five different location variables. First, Daegu, Daegu/Gyeongsan/Cheongdo, Daegu/Gyeongsangbuk-do dummy is classified by the location of a firms' headquarter's address. Second, Half hour and One hour dummy is classified by a firm's headquarter located in a half-hour drive and one hour drive respectively. T-statistics are reported in parenthesis. ***, **, and * denote significance at the 1% 5%, and 10% levels.

Panel A: Short-term stock returns					
Dep: CAR(0,+1)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Daegu Headquarter Dummy	-2.057** (-2.473)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-2.137*** (-3.082)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-1.303** (-2.161)		
Distance Dummy (Half-hour)				-2.057** (-2.473)	
Distance Dummy (One hour)					-2.207*** (-3.484)
Ln (Total Assets)	-0.089 (-0.250)	-0.089 (-0.251)	-0.09 (-0.254)	-0.089 (-0.250)	-0.080 (-0.226)
Total Debt /Total Assets(%)	-0.004 (-0.324)	-0.003 (-0.219)	-0.005 (-0.377)	-0.004 (-0.324)	-0.003 (-0.213)
EBITDA /Total Assets(%)	-0.117 (-1.567)	-0.117 (-1.576)	-0.118 (-1.589)	-0.117 (-1.567)	-0.117 (-1.582)
Tobin's Q	-0.510 (-1.114)	-0.508 (-1.111)	-0.517 (-1.132)	-0.510 (-1.114)	-0.515 (-1.130)
Beta(Monthly, 3year)	-0.108 (-0.346)	-0.118 (-0.378)	-0.125 (-0.398)	-0.108 (-0.346)	-0.126 (-0.405)
R&D Expense /Sales(%)	0.374 (1.060)	0.373 (1.057)	0.377 (1.074)	0.374 (1.060)	0.384 (1.090)
Advertise Expense /Sales(%)	-0.097 (-0.332)	-0.095 (-0.325)	-0.106 (-0.361)	-0.097 (-0.332)	-0.101 (-0.345)
Industry	YES	YES	YES	YES	YES
R^2	0.415	0.416	0.413	0.415	0.418
N	276	276	276	276	276
Panel B: Long-term stock returns					
Dep: CAR(0,+10)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Daegu Headquarter Dummy	-4.703** (-2.004)				
Daegu/Gyeongsan/Cheongdo Headquarter Dummy		-4.952** (-2.499)			
Daegu/Gyeongsangbuk-do Headquarter Dummy			-3.289** (-2.303)		
Distance Dummy (Half-hour)				-4.703** (-2.004)	
Distance Dummy (One hour)					-4.547*** (-2.630)
Ln (Total Assets)	-0.414 (-0.531)	-0.414 (-0.532)	-0.418 (-0.536)	-0.414 (-0.531)	-0.393 (-0.506)
Total Debt /Total Assets(%)	-0.033 (-0.965)	-0.030 (-0.867)	-0.034 (-1.002)	-0.033 (-0.965)	-0.030 (-0.891)
EBITDA /Total Assets(%)	-0.258* (-1.74)	-0.259* (-1.745)	-0.259* (-1.746)	-0.258* (-1.74)	-0.260* (-1.752)
Tobin's Q	0.465 (0.639)	0.469 (0.644)	0.449 (0.618)	0.465 (0.639)	0.453 (0.624)
Beta(Monthly, 3year)	0.002 (0.002)	-0.021 (-0.024)	-0.043 (-0.048)	0.002 (0.002)	-0.034 (-0.038)
R&D Expense /Sales(%)	0.547 (1.052)	0.545 (1.047)	0.558 (1.075)	0.547 (1.052)	0.567 (1.094)
Advertise Expense /Sales(%)	-0.622 (-1.322)	-0.617 (-1.313)	-0.642 (-1.369)	-0.622 (-1.322)	-0.631 (-1.348)
Industry	YES	YES	YES	YES	YES
R^2	0.278	0.281	0.277	0.278	0.281
N	276	276	276	276	276

<Appendix A> WHO media briefing on COVID-19 (11 March 2020)

Title: WHO Director-General's opening remarks at the media briefing on COVID-19
- 11 March 2020

Good afternoon.

In the past two weeks, the number of cases of COVID-19 outside China has increased 13-fold, and the number of affected countries has tripled. There are now more than 118,000 cases in 114 countries, and 4,291 people have lost their lives. Thousands more are fighting for their lives in hospitals. In the days and weeks ahead, we expect to see the number of cases, the number of deaths, and the number of affected countries climb even higher. WHO has been assessing this outbreak around the clock and we are deeply concerned both by the alarming levels of spread and severity, and by the alarming levels of inaction.

We have therefore made the assessment that COVID-19 can be characterized as a pandemic.

Pandemic is not a word to use lightly or carelessly. It is a word that, if misused, can cause unreasonable fear, or unjustified acceptance that the fight is over, leading to unnecessary suffering and death. Describing the situation as a pandemic does not change WHO's assessment of the threat posed by this virus. It doesn't change what WHO is doing, and it doesn't change what countries should do.

We have never before seen a pandemic sparked by a coronavirus. This is the first pandemic caused by a coronavirus. And we have never before seen a pandemic that can be controlled, at the same time. WHO has been in full response mode since we were notified of the first cases. And we have called every day for countries to take urgent and aggressive action.

We have rung the alarm bell loud and clear.

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As I said on Monday, just looking at the number of cases and the number of countries affected does not tell the full story.

Of the 118,000 cases reported globally in 114 countries, more than 90 percent of cases are in just four countries, and two of those – China and the Republic of Korea - have significantly declining epidemics. 81 countries have not reported any cases, and 57 countries have reported 10 cases or less. We cannot say this loudly enough, or clearly enough, or often enough: all countries can still change the course of this pandemic. If countries detect, test, treat, isolate, trace, and mobilize their people in the response, those with a handful of cases can prevent those cases becoming clusters, and those clusters becoming community transmission.

Even those countries with community transmission or large clusters can turn the tide on this virus. Several countries have demonstrated that this virus can be suppressed and controlled. The challenge for many countries who are now dealing with large clusters or community transmission is not whether they can do the same – it's whether they will. Some countries are struggling with a lack of capacity. Some countries are struggling with a lack of resources. Some countries are struggling with a lack of resolve. We are grateful for the measures being taken in Iran, Italy and the Republic of Korea to slow the virus and control their epidemics.

We know that these measures are taking a heavy toll on societies and economies, just as they did in China.

All countries must strike a fine balance between protecting health, minimizing economic and social disruption, and respecting human rights. WHO's mandate is public health. But we're working with many partners across all sectors to mitigate the social and economic consequences of this pandemic. This is not just a public health crisis, it is a crisis that will touch every sector – so every sector and every individual must be involved in the fight. I have said from the beginning that countries must take a whole-of-government, whole-of-society approach, built around a comprehensive strategy to prevent infections, save lives and minimize impact.

Let me summarize it in four key areas.

First, prepare and be ready.
Second, detect, protect and treat.
Third, reduce transmission.
Fourth, innovate and learn.

I remind all countries that we are calling on you to activate and scale up your emergency response mechanisms; Communicate with your people about the risks and how they can protect themselves – this is everybody's business; Find, isolate, test and treat every case and trace every contact; Ready your hospitals;

Protect and train your health workers.

And let's all look out for each other, because we need each other.

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There's been so much attention on one word.

Let me give you some other words that matter much more, and that are much more actionable.

Prevention.
Preparedness.
Public health.
Political leadership.

And most of all, people.

We're in this together, to do the right things with calm and protect the citizens of the world. It's doable.

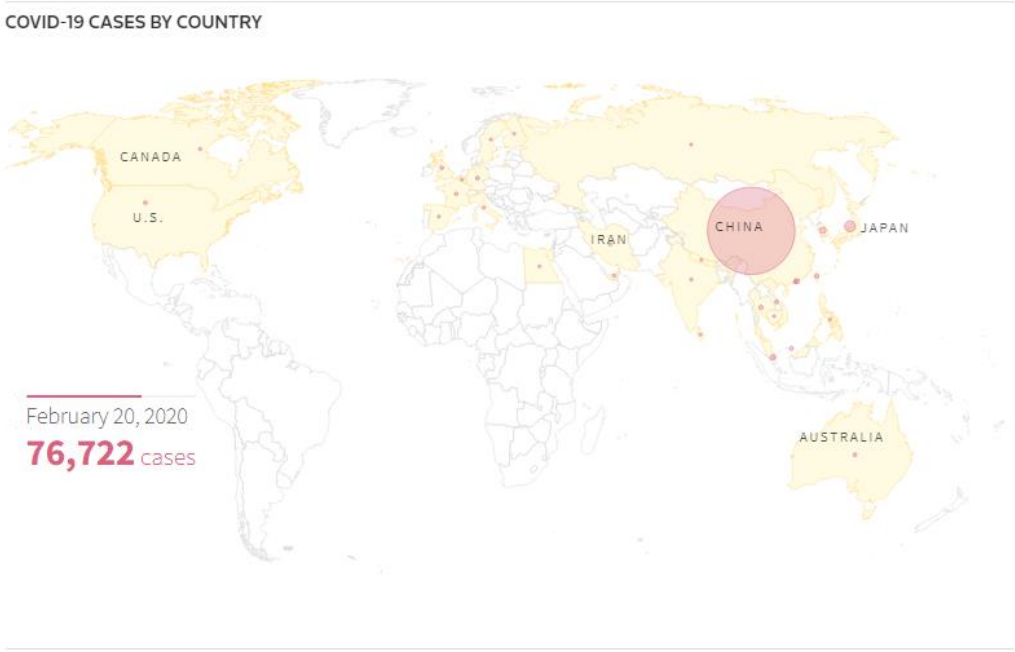
I thank you.

Note: Dr. Tedros Adhanom Ghebreyesus, director-general of the World Health Organization (WHO)

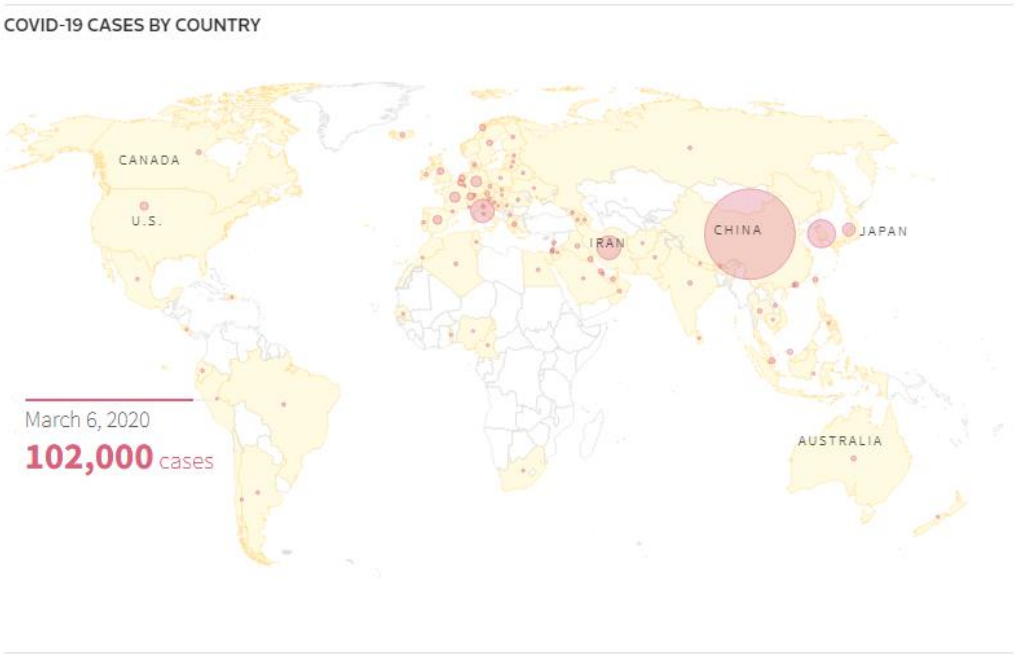
<Appendix B> COVID-19 cases by country (Reuters)

COVID-19 cases by country (January 20, 2020)

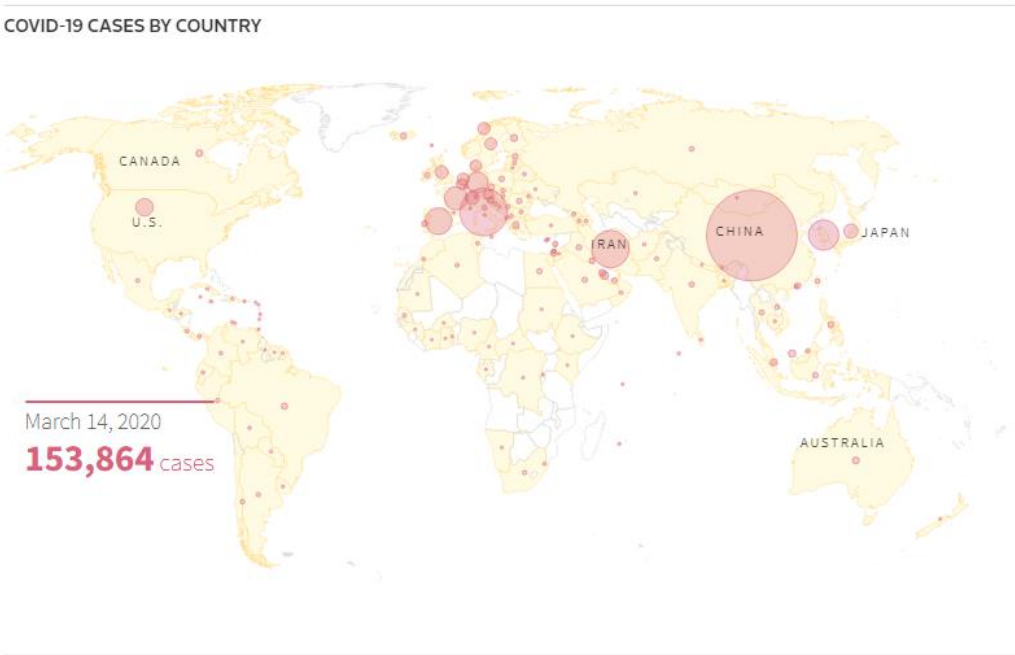
COVID-19 cases by country (February 20, 2020)



COVID-19 cases by country (March 6, 2020)

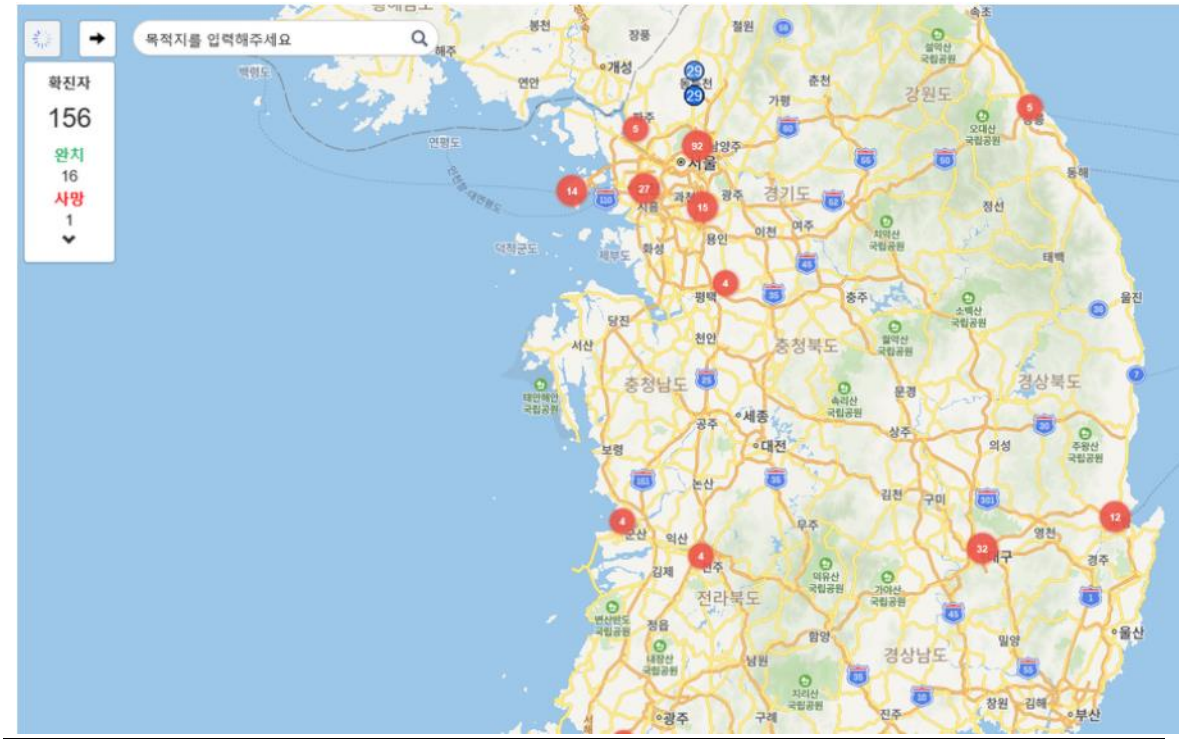
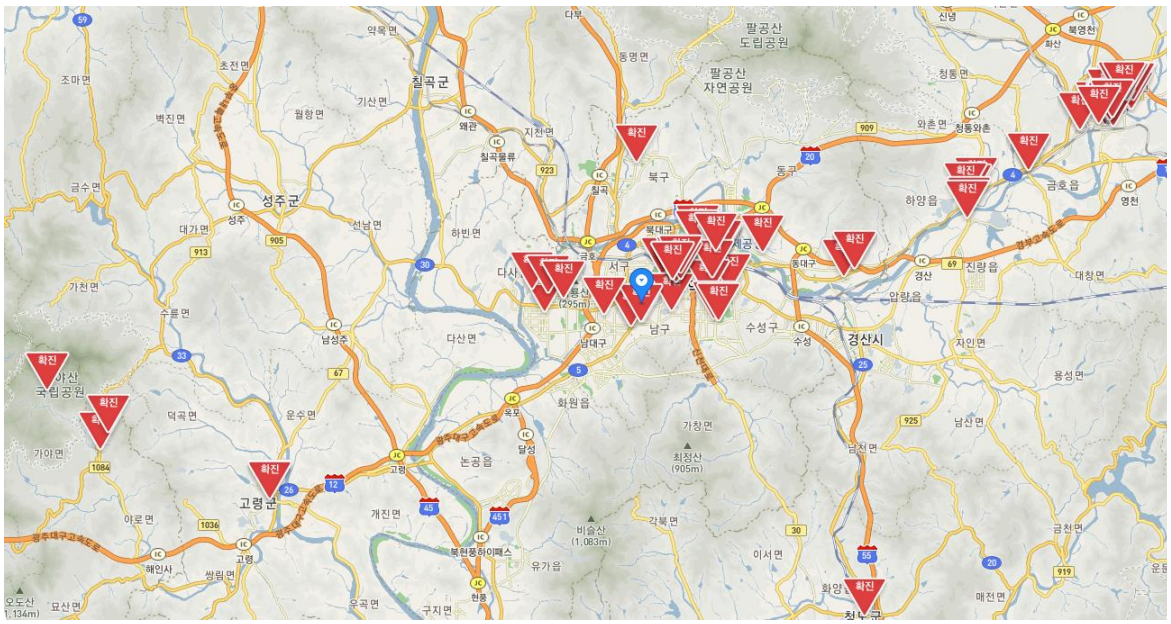


COVID-19 cases by country (March 14, 2020)



<Appendix C> COVID-19 Maps

COVID-19 cases in Korea (February 21, 2020)(Serviced by https://coronamap.site/)



COVID-19 cases nearby Daegu (March 4, 2020)(Serviced by Corona-nearby.com)