Covid-19's adverse effects on a stock market index

Kang Hua Cao[a,*], Qiqi Li[b], Yun Liu[c], Chi-Keung Woo[d]

[a] Department of Economics, Hong Kong Baptist University (kanghuacao@hkbu.edu.hk)

[b] Department of Asian and Policy Studies, Education University of Hong Kong (aki.li.qiqi@gmail.com)

[c] School of Accounting and Finance, Hong Kong Polytechnic University (yun-lyndon.liu@polyu.edu.hk)

[d] Department of Asian and Policy Studies, Education University of Hong Kong (ckiwoo@eduhk.hk)

[*] Corresponding author

JEL codes: G10, G18, I10, I18

Keywords: Covid-19, daily stock market index, market index elasticities, panel data analysis

Abstract

We perform a panel data analysis of 14 daily stock market indices during 01/21/2020 – 06/30/2020 to document a stock market index's negative responsiveness to Covid-19's spread variations. We find that a stock market index's elasticity estimate is -0.028 (p-value < 0.01) for local cumulative confirmed cases. As a stock market index tends move with Covid-19's local and non-local spreads, international efforts of containment are expected to pare stock market losses.

1. Introduction

Since its initial detection in China in early December 2019,[1] Covid-19 is now a global pandemic (WHO, 2020). In response to Covid-19's outbreaks across the world, governments have adopted various containment measures, including business and school shutdowns, public event cancelations, travel restrictions, home isolations, mandatory quarantines, social distancing, and mask wearing (WHO, 2020). While these measures are expected to curb economic activities that can accelerate Covid-19's spread (Adda, 2016), they also adversely affect stock prices. Fig.1 shows the losses suffered by 14 stock markets, chosen herein to reflect geographic variations in Covid-19's spread over time.

Our goal is to estimate a stock market index's responsiveness to Covid-19's spread variations. Hence, we perform a panel data analysis of the 14 daily stock market indices listed in Fig.1 during 01/21/2020 – 06/30/2020, yielding two key findings that we believe are new, chiefly because of our data's recentness. First, a stock market index's elasticity estimate is -0.028 (p-value < 0.01) for local cumulative confirmed cases. Second, a stock market index is found to move with Covid-19's local and non-local spreads, implying international efforts of containment are likely to pare stock market losses.

2. Materials and methods

2.1 Data construction

To construct our panel data, we use 14 daily stock indices for markets listed in Fig.1 and daily Covid-19 data available from Johns Hopkins University (JHU) for confirmed cases, deaths, and recoveries. The sample period is 01/21/2020 – 06/30/2020, whose beginning date is when JHU first published the Covid-19 data and ending date reflects the Covid-19 data available at the time of our writing. Our newly constructed sample of 1,545 daily

[1] https://www.theguardian.com/world/2020/mar/20/chinese-inquiry-exonerates-coronavirus-whistleblower-doctor-li-wenliang

observations differentiates our paper from extant studies of viral outbreaks of SARS and Ebola (e.g., Nippani and Washer, 2006; Ichev and Marinč, 2018).

2.2 Regression specification

Since our focus is a stock market index's responsiveness to Covid-19's spread variations, we assume the data generating process for daily market indices in the presence of Covid-19 is the following double-log regression with random error ε_{kt}:[2]

$$\ln(I_{kt}) = \Sigma_j \ \alpha_j \ln(X_{jkt}) + \Sigma_j \ \beta_j \ln(Y_{jkt}) + \Sigma_j \ \phi_j \ln(Z_{jkt}) + \text{Fixed effects} + \varepsilon_{kt};^{3} \qquad (1)$$

where I_{kt} is market k's stock index on day t, (X_{jkt}, Y_{jkt}, Z_{jkt}) are variables defined below for characterizing Covid-19's local and non-local spreads, and fixed effects are controls for market location, day of week and month of year.[4] These fixed effects aim to account for such factors as country-specific vaccine developments, economic relief packages, and Covid-19 suppression efforts.

We choose the double-log specification for three reasons. First, its coefficients (α_j, β_j, ϕ_j) are elasticities, measuring a stock market index's responsiveness to changes in (X_{jkt}, Y_{jkt}, Z_{jkt}). Second, it resolves population differences among countries because a country with a large population tends to have more confirmed cases, more deaths, and more recoveries than a country with a small population. Third, it resolves the scale differences among market indices (e.g., the US index S&P 500 < 3,400 and the Hong Kong index HSI > 20,000 during 01/21/2020 – 06/30/2020). Whether equation (1) is empirically reasonable is best judged by the regression results to be reported in Section 3 below.

We now define the variables for characterizing Covid-19's local spread:

---

[2] We decide not to use a CAPM-based approach (e.g., Ramelli and Wagner, 2020) that does not yield elasticity estimates that are of our primary interest.

[3] To address concerns of spurious regression (Davidson and Mackinnon, 1993), we use the panel unit root test proposed by Im et al. (2003) to reject the hypothesis that the regression residuals follow a random walk.

[4] We perform the Hausman test (Wooldridge, 2010, Chapter 10) to reject the hypothesis that equation (1) should be based on random effects.

- X_{1kt} ≡ local cumulative cases = (1 + market k's number of cumulative cases on day t) to avoid missing data caused by ln(0) being undefined.[5] Reflecting its likely damaging effect on a market index, we expect $\alpha_1 < 0$.[6]
- X_{2kt} ≡ local cumulative survivals = (1 + market k's number of cumulative survivals on day t), where cumulative survivals = (cumulative recoveries – cumulative deaths).[7] Mirroring its likely positive effect on a market index, we expect $\alpha_2 > 0$.

As international stock markets tend to comove (Rua and Nunes, 2009), we use Y_{1kt} and Y_{2kt} to account for Covid-19's nearby spread's effect on market index k. For example, if market k is the Hong Kong Stock Exchange (HKSE), Y_{1kt} and Y_{2kt} are the respective sums of (1 + number of cumulative cases) and (1 + cumulative survivals) for Asia's non-Hong Kong markets. We expect $\beta_1 < 0$ and $\beta_2 > 0$.

To characterize Covid-19's distant spread, we use Z_{1kt} and Z_{2kt} that are based on the aggregate Covid-19 data for other continents. Continuing with the HKSE example, Z_{1kt} and Z_{2kt} are the respective sums of (1 + number of cumulative cases) and (1 + number of cumulative survivals) for all non-Asian markets. We expect $\phi_1 < 0$ and $\phi_2 > 0$.

2.4 Testable hypotheses

Denoting equation (1) as Model 0, we use the F-test to test three hypotheses for a better understanding of Covid-19's adverse effects:

- H_1: No distant spread effect, which implies Model 1 with $\phi_1 = \phi_2 = 0$.
- H_2: No nearby spread effect, which implies Model 2 with $\beta_1 = \beta_2 = 0$.

---

[5] The number of cumulative cases in January 2020 is zero for European countries, see Fig.2 below.
[6] If $X_{1kt} > 100$, $\alpha_1 = \partial\ln(I_{kt})/\partial\ln(X_{1kt})$ is identical (within two digits) to the traditionally defined elasticity. To illustrate this point, consider the simple example of $\ln(y) = b\ln(1 + n)$ where n is a non-negative number. As $d\ln(y)/d\ln(n) = b\,[n / (1 + n)]$, $b = 0.99\, d\ln(y)/d\ln(n)$ when $n = 100$.
[7] We have considered treating cumulative deaths and cumulative recoveries as separate regressors. However, ln(1 + number of cumulative cases) is highly correlated ($r > 0.9$) with ln(1 + number of cumulative deaths) and with ln(1 + number of cumulative recoveries), causing severe multicollinearity that leads to imprecise and counter-intuitive coefficient estimates.

- H_3: No nearby and distant spread effects, which implies Model 3 with $\beta_1 = \beta_2 = \phi_1 = \phi_2 = 0$.

3. Results

3.1 Initial exploration

For the four countries most affected by Covid-19: the US, the UK, Spain, and Italy as of 06/30/2020, Fig.2 shows their stock market indices tend to decline with Covid-19's local spread severity. It also highlights that these four countries' cumulative numbers of confirmed cases began to surge in March 2020 when Covid-19's spread had already peaked China, Hong Kong and Taiwan. The geographically varying patterns of Covid-19's spread over time aid our detection of Covid-19's adverse effect on a stock market index.

3.2 Regression results

Table 1 reports our regression results, leading to the following findings. First, Model 0's within R^2 value is 0.74, suggesting that equation (1) reasonably fits the market index data. Further, all of Model 0's six elasticity estimates have correct signs. The two estimates with p-values < 0.01 are -0.028 for local cumulative confirmed cases and 0.011 for nearby cumulative recoveries. The two estimates with p-values < 0.1 are -0.079 for nearby cumulative confirmed cases and -0.008 for distant cumulative confirmed cases.

Second, Model 1's F-test result associated with H_1 indicates a market index's statistically insignificant (p-value > 0.1) dependence on Covid-19's distant spreads. However, Model 2's and Model 3's F-test results decisively (p-values < 0.01) reject H_2 and H_3, thus lending support to Covid-19 spread's non-local influence on a local market's stock index. Remarkably, the elasticity estimates for local cumulative confirmed cases based on Models 1 – 3 are virtually identical to the elasticity estimate based on Model 0. Hence, we infer that the estimated elasticity of -0.028 is insensitive to the choice of model specification.

4. Conclusion

We perform a panel data analysis to document the statistically significant adverse effects of Covid-19's local and non-local spreads on a stock market index. The main message of our elasticity estimates for retail investors is "don't panic" because stock markets will likely recover in response to improved survival of Covid-19 patients, natural development of herd immunity,[8] and projected success in vaccine development in the next 18 months.[9]

Acknowledgements

C.K. Woo's research is funded by research grants (#4388 and #4400) from the Education University of Hong Kong. Without implications, all errors are ours.

References

Adda, J., 2016. Economic activity and the spread of viral diseases: Evidence from high frequency data. The Quarterly Journal of Economics 131, 891-941.

Davidson, R., Mackinnon, J.G., 1993. Estimation and Inference in Econometrics. Oxford Press.

Ichev, R., Marinč, M., 2018. Stock prices and geographic proximity of information: Evidence from the Ebola outbreak. International Review of Financial Analysis 56, 153-166.

Im, K. S., Pesaran, M. H., Shin, Y. 2003. Testing for unit roots in heterogeneous panels. Journal of Econometrics 115(1), 53-74.

Nappani, S., Washer, K.M., 2006. SARS: a non-event for affected countries' stock markets? Applied Financial Economics 14(15), 1105-1110.

[8] For better or worse, Covid-19's spread will naturally subside when a large percentage (e.g., 80%) of the surviving population have developed herd immunity, thus reducing the chance of an uninfected person becoming infected (https://time.com/5810454/coronavirus-immunity-reinfection/).

[9] "While the official 12- to 18-month timeframe still stands, experimental Covid-19 inoculations for high-risk groups could be rolled out much earlier" (https://www.theguardian.com/world/2020/apr/12/when-will-we-have-a-coronavirus-vaccine).

Ramelli, S., Wagner, A., 2020. What the stock market tells us about the consequences of COVID-19; available at https://voxeu.org/article/what-stock-market-tells-us-about-consequences-covid-19 (accessed March 23, 2020).

Rua, A., Nunes, L.C., 2009. International comovement of stock market returns: A wavelet analysis. Journal of Empirical Finance16(4), 632-639.

WHO, 2020. Daily situation reports; available at https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports (accessed on various days in March to June in 2020).

Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data, MIT Press.

Table 1. Results from a panel data (fixed effects) analysis of 1,545 daily observations in the sample period of 01/21/2020 – 06/30/2020; robust standard errors in parentheses; significance indication: *** for $p < 0.01$, ** for $p < 0.05$ and * for $p < 0.1$

Variable [expected market effect]	Model 0: Equation (1) that includes nearby and distant spread effects	Model 1 under H_1: No distant spread effect	Model 2 under H_2: No local spread effect	Model 3 under H_3: No nearby and distant spread effects
R^2: within	0.7740	0.7681	0.7606	0.7563
R^2: between	0.0937	0.128	0.1175	0.1364
R^2: overall	0.0539	0.0599	0.0539	0.0514
ln(1 + number of local cumulative confirmed cases) [-]	-0.0275***	-0.0258***	-0.0263***	-0.0237***
	(0.0045)	(0.0045)	(0.0043)	(0.0042)
ln(1 + number of local cumulative survivals) [+]	0.0033	0.0027	0.0043	0.0040
	(0.0041)	(0.0040)	(0.0048)	(0.0047)
ln(1 + number of nearby cumulative confirmed cases) [-]	-0.0079*	-0.0040		
	(0.0044)	(0.0039)		
ln(1 + number of nearby cumulative survivals) [+]	0.0108***	0.0087***		
	(0.0026)	(0.0028)		
ln(1 + number of distant cumulative confirmed cases) [-]	-0.0080*		-0.0025	
	(0.0043)		(0.0037)	
ln(1 + number of distant cumulative survivals) [+]	0.0011		-0.0034	
	(0.0037)		(0.0031)	
p-value of the F-statistic statistic for testing H_m for $m = 1, 2, 3$		0.1195	0.0037	0.0067

Notes: (1) For brevity, this table omits the estimated intercept and fixed effects that are not of our primary interests.
(2) We use robust standard errors clustered by market that are heteroskedasticity-autocorrelation-consistent to determine the coefficient estimates' statistical significance.

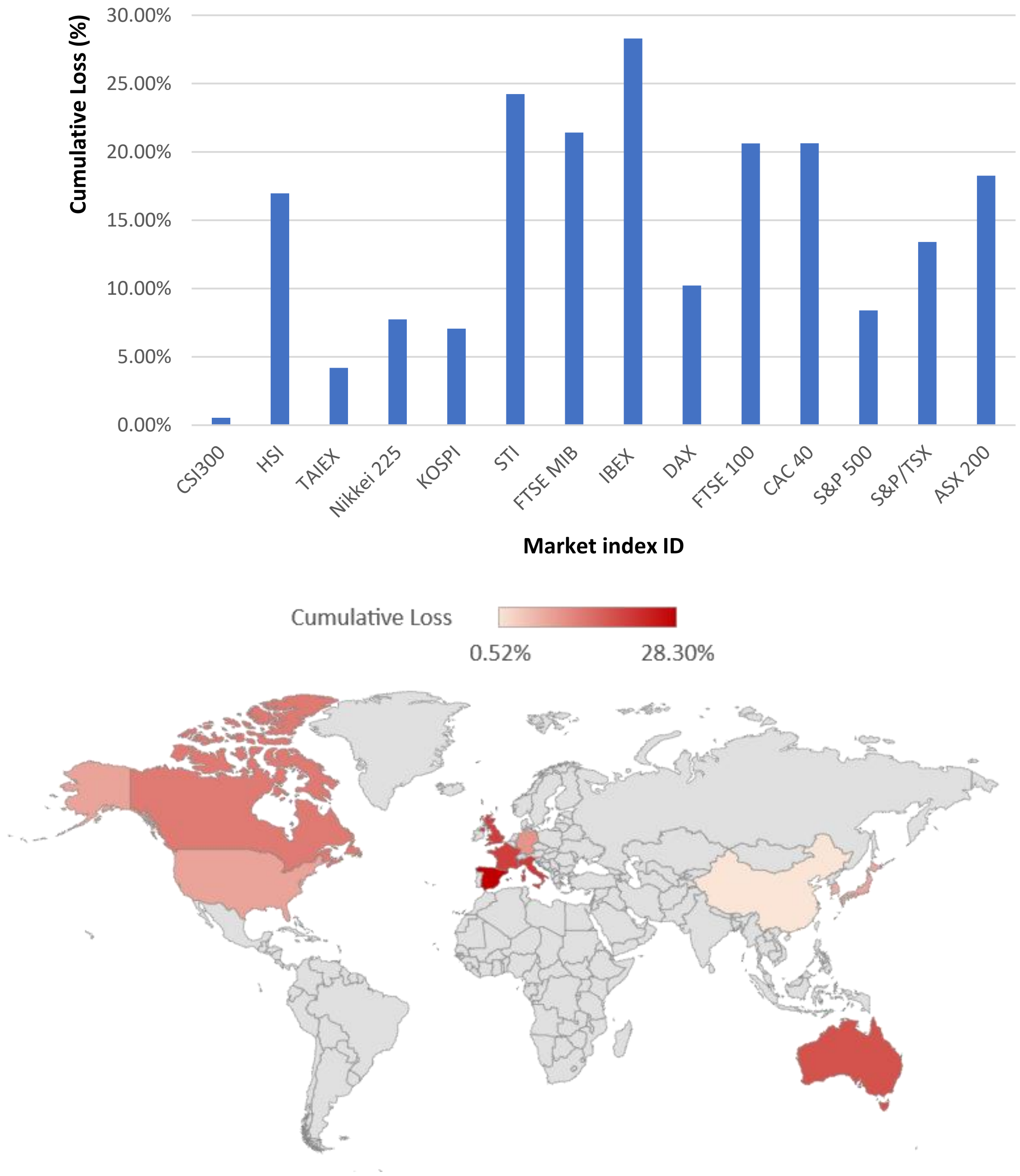
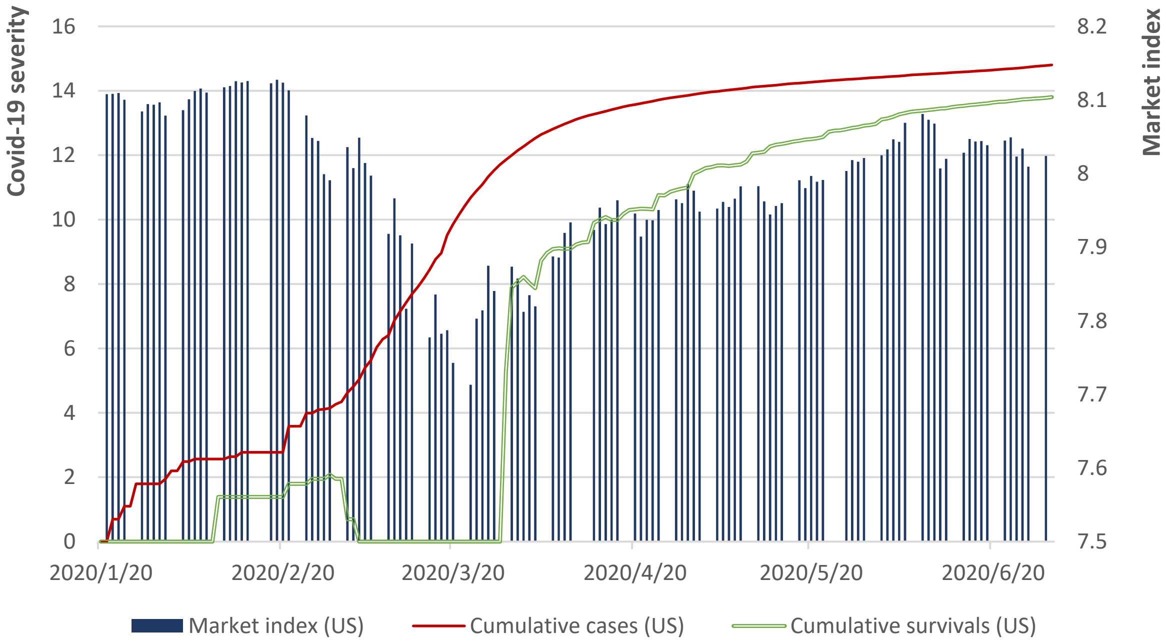
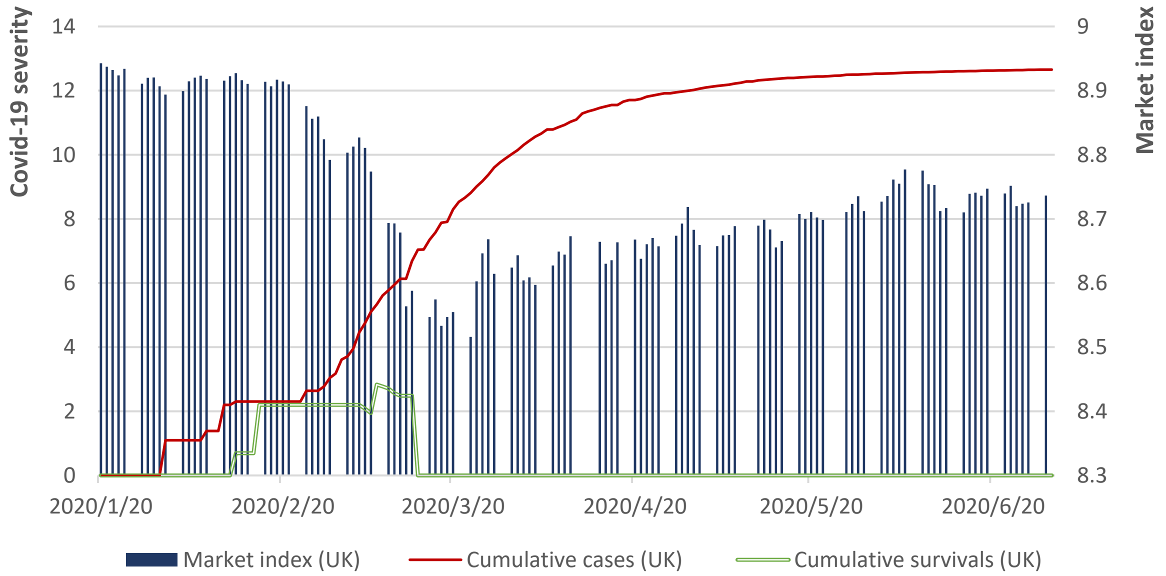


Fig. 1: Cumulative losses by market for the period of 01/21/2020 –06/30/2020

Notes: (1) Cumulative loss = ln(closing index level on 01/20/2020) – ln(closing index level on 06/30/2020).
(2) The 14 market indices are: (a) Asia - CSI300 (China), HSI (Hong Kong), TAIEX (Taiwan), STI (Singapore), Nikkei 225 (Japan), KOSPI (South Korea); (b) Europe – DAX (Germany), FTSE 100 (UK), CAC 40 (France), IBEX (Spain), FTSE MIB (Italy); (c) North America – S&P 500 (US), S&P/TSX (Canada); and (d) ASX 200 (Australia)


Covid-19 severity
Market index
16
14
12
10
8
6
4
2
0
8.2
8.1
8
7.9
7.8
7.7
7.6
7.5
2020/1/20
2020/2/20
2020/3/20
2020/4/20
2020/5/20
2020/6/20
Market index (US)
Cumulative cases (US)
Cumulative survivals (US)


Covid-19 severity
Market index
14
12
10
8
6
4
2
0
9
8.9
8.8
8.7
8.6
8.5
8.4
8.3
2020/1/20
2020/2/20
2020/3/20
2020/4/20
2020/5/20
2020/6/20
Market index (UK)
Cumulative cases (UK)
Cumulative survivals (UK)

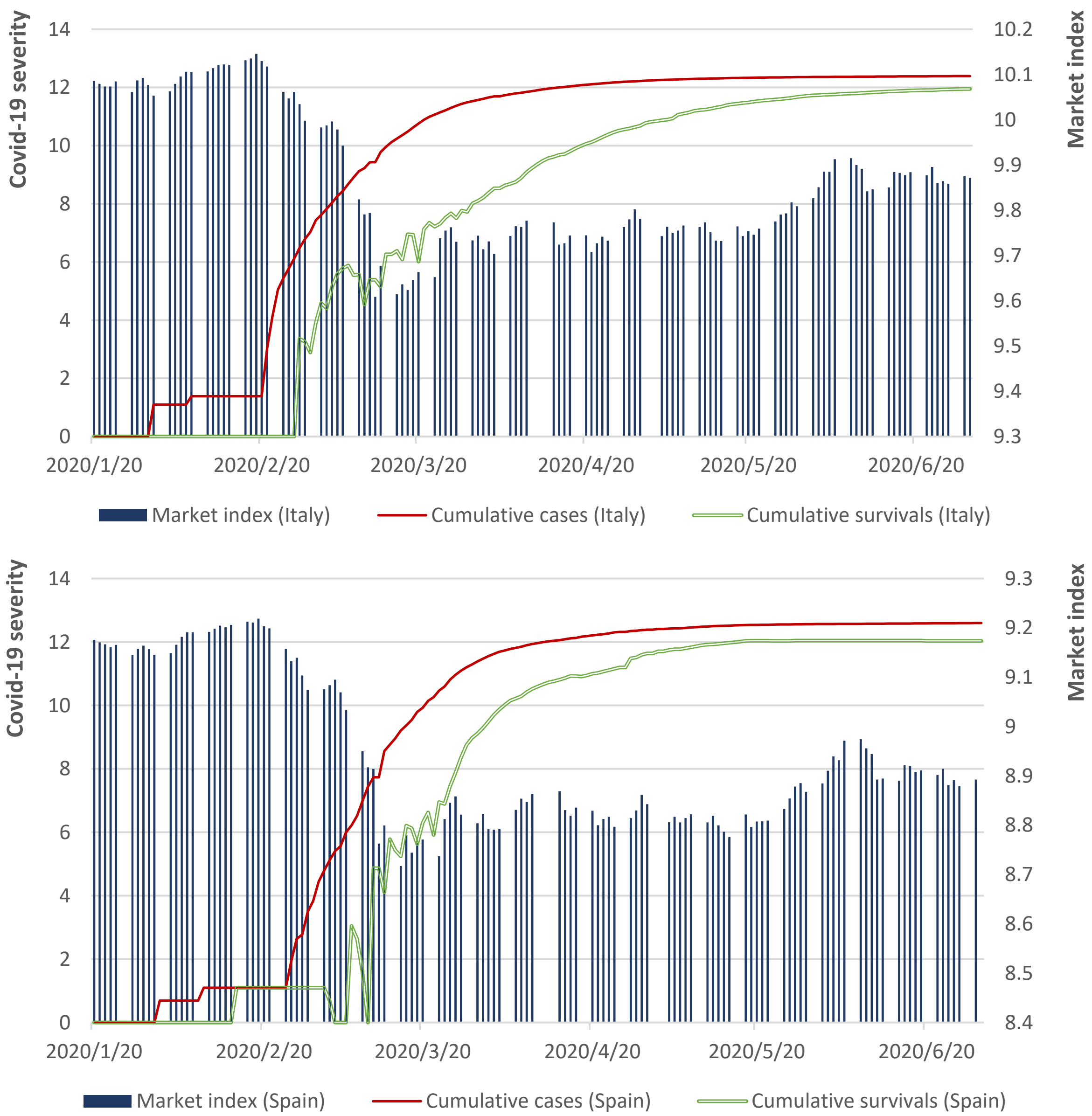


Fig. 2: Graphic representation of country-specific natural-log values of market index, local cumulative confirmed cases and local cumulative survivals