The Health Scare of COVID-19: Implication of Pandemics and the immune-related pharmaceutical products spillovers in USA

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Abstract

In view of the sector-wide effect of the nCOVID-19 pandemic in the United States and the probable effect on certain over-the-counter (OTC) pharmaceutical products, the current study examined potential inflation in the pharmaceutical industry due to uncertainty in pandemics. In this case, the United States' producer price indexes vis-à-vis inflation of the immune-related pharmaceutical items: multivitamin, vitamins nutrients and hematinic (V-N-H), other vitamins (other-V), antidepressant, and antidiabetic were examined alongside the uncertainties arising from the world pandemic and economic policy. Thus, the Diebold and Yilmaz (2012) result implied that the world pandemic uncertainty contributed a significantly huge shock to the entire elements such that the shocks to V-N-H and multivitamins are larger than the other examined pharmaceutical compounds. Importantly, the statistical evidence implied that uncertainty arising from pandemic is responsible for the severity of shock received by the indicated pharmaceutical products as against economic policy uncertainty. Thus, a relevant policy inference is posited from the result of the study.

Keyword: nCOVID-19; pandemic; vitamins; uncertainty; United States

JEL codes: C53, F64, H15

1. Introduction

After more than 100 years that the influenza pandemic commonly called ‘Spanish Flu’ of 1918 ravaged the world, the novel severe acute respiratory syndrome coronavirus 2 (known as nCOVID-19 or SARS-CoV-2) that has affected more than 216 countries and territories has remained a prevailing mystery. Currently, about 600,000 human lives has been lost and almost 14 million confirmed cases has been recorded globally (World Health Organization, WHO, 2020). Since the emergency of the nCOVID-19 pandemic, governments across the globe and the collaborating effort of both the intergovernmental agencies and the private institutions have extensively deployed various measures to mitigate the spread of the virus or ‘flatten the curve’. In addition to some of the measures that have been implemented (such as ‘lockdown’, ‘social distancing, travel restriction/suspension across borders and other measures), scientists have proposed a few inference. So far, the proffered pathogenesis of nCOVID-19 has obviously presented in three phases: (1) the asymptomatic (2) symptomatic but a not severe phase, and (3) the symptomatic stage with a severe and high viral load (Shi et al., 2020). As such, among other factors, the pandemic is expected to have impacted both the manufacturing and the over-the-counter (OTC) pharmaceutical products demand through the application of prevention mechanisms (Singh & Avikal, 2020; Srivastava & Wagh, 2020).

Accordingly, the nCOVID-19 has been associated with the human immune system (Li et al., 2020; Russell et al., 2020; Shi et al., 2020). In specific, Li et al (2020) opined that the body’s humoral and cellular is stimulated by the immunity Antigens in the human cells, thus expectedly preventing the advancement of the nCOVID-19 disease to the severe stage. Indicatively, the appropriateness of human genetic structure, depicting a good health status, is responsible for the response of the endogenous protective immune that is potentially capable of inhibiting the nCOVID-19 viral replication as an antiviral immunity (Shi et al., 2020). This is because ongoing studies have noted cases of nCOVID-19 sufferers that are either impervious to nCOVID-19 or immunocompromised (Centers for Disease Control and Prevention, CDC, 2020; Nature, 2020). As such, scientists and medical experts have consistently outlined the role of individuals in maintaining a boosted immune system (Brand South Africa, 2020; DW, 2020; Tufan, GÜLER & Matucci-Cerinic, 2020). In this perspective, in addition to living a healthy lifestyle, and the 'phobia' for COVID-19, the use of supplements and nutritional medications or compounds such as vitamin C, antioxidants and other compounds are being encouraged to booting the human immune system (Amin, 2020; Brand South Africa, 2020).

In view of the above motivation, the current study look at the performance of the pharmaceutical industries, especially those associated with the production of vitamins and other immune-related drugs in the framework of the United States' COVID-19 situation. Although Nicola et al (2020) and Mason-D'Croz et al (2020) have earlier suggested the likelihood of spillover effect of the COVID-19 pandemic to the socio-economic aspects, there is no study that specifically noted a pharmaceutical sector-specific effect from the nCOVID-19 pandemic. Hence, the novelty of the current study is that it offers a highlight of a few important contribution to the existing nCOVID-19 literature in a unique pattern. Foremost, the study offers explanation on the probable vulnerability of the producer price index (PPI) vis-à-vis inflation associated with the production of the immune-related pharmaceutical compound or supplements: Vitamins nutrients, hematinic, multivitamin. In context, the United States has reported an overall relative rise in import and export prices since May 2020. In addition, the uncertainty associated with the economic policy and the pandemic (i.e. the economic policy uncertainty and pandemic uncertainty) are employed in examining the vulnerability of the aforementioned pharmaceutical compounds. Thus, with the aforementioned novel approach and considering that United States has reported more cases and number of death from COVID-19 than any other country in the world (~3.7 million reported cases and ~140,000 deaths) according to the Johns Hopkins University and Medicine (2020), this study is capable of providing a new significant insight.

In the other section of this study, the material employed, theoretical concept, the discussion of the results, and the conclusion of the study are all described sequentially in section two. The discussion of the results and conclusion remarks are rendered in section three and section four respectively.

2. Material and Theoretical concept

2.1 Material

The theoretical concept of the study is based on the use of the producer price indexes of pharmaceutical items: multivitamin, vitamins nutrients and hematinic (V-N-H), other vitamins (other-V), antidepressant, and antidiabetic. The indexes of the aforementioned pharmaceutical materials were retrieved from the Federal Reserve Economic Data, FRED (2020)[1]. In addition, the employed world pandemic uncertainty index (denoted as WPU) and economic policy uncertainty index (denoted as EPU) were retrieved from the world pandemic index (2020) and FRED (2020) respectively. The aforementioned dataset covers the period of June 2001 to February 2020.

2.2 Theoretical Concept

In Table 1, the descriptive statistics of the employed aforementioned materials are presented. With 223 observations, the volatility is observed to be highest in index of antidiabetic, and followed by

[1] The Federal Reserve Economic Data, FRED (2020) is available on https://fred.stlouisfed.org/.

antidepressant, EPU, other vitamins, V-N-H, WPU, and lastly by multivitamins. Therefore, we proceed to employ the Diebold Yilmaz spillover index approach (Diebold & Yilmaz, 2012).

Table 1: Statistical Inference

Common Statistics

	WPU	**V-N-H**	**OTHER-V**	**MULTIVATMINS**	**EPU**	**ANTIDIABETIC**	**ANTIDEPRESSANT**
Mean	4.782463	116.2614	123.1605	170.9700	104.7842	733.7027	714.6274
Median	1.882653	117.4000	127.9000	172.1000	90.93871	570.5000	670.2000
Maximum	141.5323	137.8000	151.3000	184.4000	253.9187	1506.400	1153.100
Minimum	-18.83425	98.60000	97.80000	155.3000	38.20903	312.5000	264.8000
Std. Dev.	11.84658	13.37791	19.01948	9.681883	47.09574	392.0075	308.3119
Skewness	8.133492	0.246458	0.010960	-0.124159	1.136607	0.719962	0.048979
Kurtosis	87.24622	1.607648	1.437808	1.591436	3.727792	1.987633	1.426031
Jarque-Bera	68405.62	20.27080	22.68026	19.00809	52.93633	28.78807	23.10812
Probability	*(0.00000)*	*(0.00004)*	*(0.00001)*	*(0.00008)*	*(0.00000)*	*(0.000001)*	*(0.00001)*
Observations	223	223	223	223	223	223	223

Note:

2.2.1 Spillover effect approach

In this part, the Diebold and Yilmaz (2012) approach is employed to illustrate the Total, Directional, Net, and Net Pairwise Spillovers as the categories of spillover effects. This approach is employed through the covariance stationary VAR (p) of each variable *y* that can be represented as

$$y_t = \sum_{i=1}^{p} \Phi_i y_{t-1} + \varepsilon_t \sim (0, \Sigma) \tag{1}$$

such that

$$y_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-1} \tag{2}$$

is the moving average of the covariance stationary process and yt = $(y_{1t}, y_{2t}, \ldots, y_{Nt})'$ is N x 1 vector of the individual return and volatility series. Also, Φ is N x N , ε is the vector of disturbance that are assumed to be independent (not necessarily identically) distributed over time such that $A_i = \Phi_1 A_{i-1} + \Phi_2 A_{i-2} + \ldots + \Phi_p A_{i-p}$. A_0 is the identity matrix with N x N dimension, and $A_i = 0$ for all $i < 0$.

In determining the magnitude of the spillovers among the pharmaceutical items, WPU and EPU, we adopt the conventional VAR framework such that the H-step-ahead forecast error variance contribution becomes

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' A_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \Sigma A_h e_i')^2} \tag{3}$$

Such that the variance matrix of the error vector is Σ, σ_{jj} is the standard deviation of the error term for variable j, e_i is the selection vector with *1 = ith* element and *0* = otherwise. Then, the diagonally centralized elements (the own variance shares of shocks to variable y_i) is the fraction of the H-step-ahead error variance in forecasting y_i, given that $i = 1, 2, \ldots N$. Also, the off-diagonal (cross variance shares or spillovers) are the fractions of the H-step-ahead error variances in forecasting *y*i that are due to shocks to y_j, given that $j = 1, 2, \ldots N$ and i is not equal j. Furthermore, to use the full information, each entry of the variance decomposition matrix is normalized by taking the row sum such that

$$\theta_{ij}^{g}(H) = \frac{\theta_{ij}^{\ g}(H)}{\sum_{j=1}^{N}\theta_{ij}^{\ g}(H)} \qquad (4)$$

where $\sum_{j=1}^{N}\theta_{ij}^{g}(\mathrm{H})$ (sum of the contributions to the variance of the forecast error) is not equal to 1, but $\sum_{j=1}^{N}\tilde{\theta}_{ij}^{\ g}(H)=1$ and $\sum_{i,j=1}^{N}\tilde{\theta}_{ij}^{\ g}(H)=N$

Consequently, the Total spillover index among the examined commodity markets is provided as

$$S^{g}(H) = \frac{\sum_{\substack{i,j=1 \\ i\neq j}}^{N}\tilde{\theta}_{ij}^{\ g}(H)}{\sum_{i,j=1}^{N}\tilde{\theta}_{ij}^{\ g}(H)}\times 100 = \frac{\sum_{\substack{i,j=1 \\ i\neq j}}^{N}\tilde{\theta}_{ij}^{\ g}(H)}{N}\times 100 \qquad (5)$$

But, the Total directional spillover exhibits two indicators: “To others” and “From other”. Then, the directional spillover index from others is computed as

$$S_i^{g}(H)=\frac{\sum_{\substack{J=1\\ j\neq 1}}^{N}\tilde{\theta}_{ij}^{g}(H)}{\sum_{i,J=1}^{N}\tilde{\theta}_{ij}^{g}(H)}\times 100=\frac{\sum_{\substack{J=1\\ j\neq 1}}^{N}\tilde{\theta}_{ij}^{g}(H)}{N}\times 100, \quad (6)$$

While the directional spillover index to others is calculated as

$$S_i^{g}(H)=\frac{\sum_{\substack{J=1\\ j\neq 1}}^{N}\tilde{\theta}_{ji}^{g}(H)}{\sum_{i,J=1}^{N}\tilde{\theta}_{ji}^{g}(H)}\times 100=\frac{\sum_{\substack{J=1\\ j\neq 1}}^{N}\tilde{\theta}_{ji}^{g}(H)}{N}\times 100 \quad (7)$$

Moreover, the difference between the 'to other' and 'from others' indicators is calculated using

$$S_i^{g}(H)=S_{.i}^{g}(H)-S_{i.}^{g}(H) \quad (8)$$

In addition, the net pairwise directional spillovers is also computed from

$$S_{ij}^{g}(H)=\{\frac{\tilde{\theta}_{ji}^{g}(H)}{\sum_{i,\mathrm{k}=1}^{N}\tilde{\theta}_{ik}^{g}(H)}-\frac{\tilde{\theta}_{ij}^{g}(H)}{\sum_{\mathrm{j,k}=1}^{N}\tilde{\theta}_{jk}^{g}(H)}\}\times 100=\{\frac{\tilde{\theta}_{ji}^{g}(H)-\tilde{\theta}_{ij}^{g}(H)}{N}\}\times 100 \quad (9)$$

Thus, the current study measures the total spillover index, the contributions of spillovers of the WPU, EMU, and the inflation (producer price indexes) of pharmaceutical items: multivitamin, vitamins nutrients and hematinic (V-N-H), other vitamins (other-V), antidepressant, and antidiabetic. As revealed, the indicated spillover indices and other results are presented in Table 2 while respective rolling windows are illustrated in Figure 1.

Table 2: Spillover indexes for cases of Economic Policy and World Pandemic Uncertainties

With Economic Policy (Panel A)

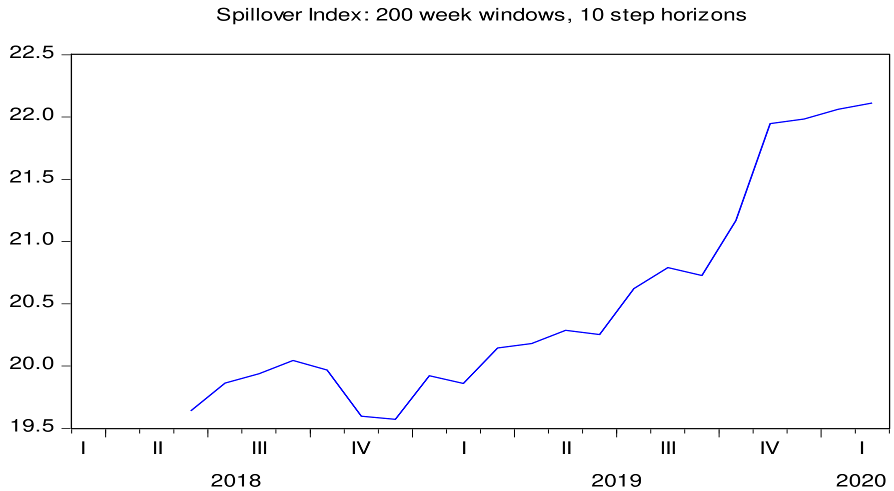
	EPU	V-N-H	OTHER-V	MULTIVATMINS	ANTIDIABETIC	ANTIDEPRESSANT	From Others
EPU	**90.9**	3.5	0.9	0.1	1.4	3.1	9.1
V-N-H	0.2	**81.0**	7.4	2.8	7.6	0.9	19.0
OTHER-V	0.4	29.3	**54.1**	13.4	1.9	0.9	45.9
MULTIVATMINS	2.7	14.3	1.6	**79.7**	0.2	1.4	20.3
ANTIDIABETIC	0.1	0.2	0.4	0.4	**95.5**	3.4	4.5
ANTIDEPRESSANT	6.7	0.5	0.1	5.2	1.6	**85.9**	14.1
Contribution to others	10.1	47.8	10.5	21.9	12.8	9.8	**113.0**
Contribution including own	101.1	128.8	64.5	101.6	108.3	95.6	**(18.8%)**

With Pandemic (Panel B)

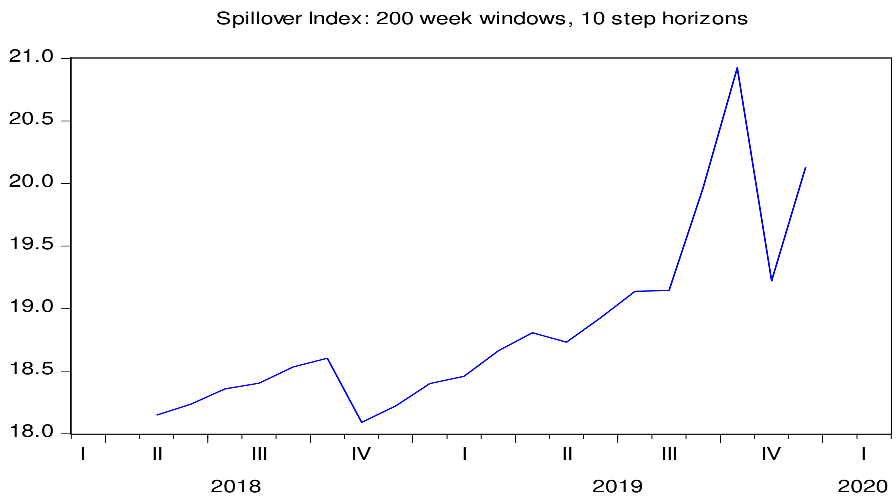
	WPU	V-N-H	OTHER-V	MULTIVATMINS	ANTIDIABETIC	ANTIDEPRESSANT	From Others
WPU	**98.4**	0.6	0.3	0.1	0.4	0.2	1.6
V-N-H	16.3	**69.4**	5.5	1.9	6.1	0.8	30.6
OTHER-V	24.4	23.6	**40.3**	9.3	1.6	0.8	59.7
MULTIVATMINS	2.1	13.5	1.4	**81.3**	0.2	1.6	18.7
ANTIDIABETIC	58.2	0.2	0.6	0.1	**39.9**	0.9	60.1
ANTIDEPRESSANT	14.5	0.3	0.2	5.6	1.7	**77.6**	22.4
Contribution to others	115.5	38.3	8.0	17.0	10.0	4.3	**193.1**
Contribution including own	213.9	107.7	48.3	98.3	50.0	81.9	**(32.2%**

With both Pandemic and Economic Policy Uncertainties (Panel C)

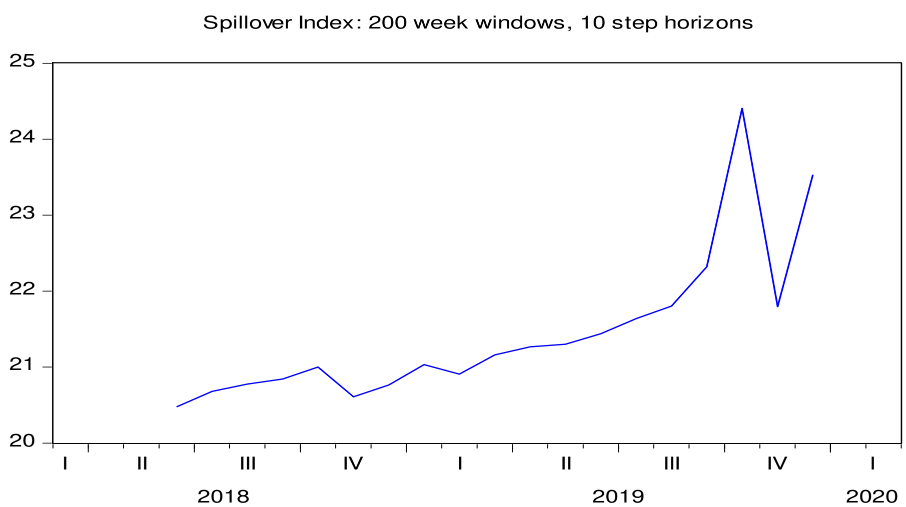
	WPU	V-N-H	OTHER-V	MULTIVATMINS	EPU	ANTIDIABETIC	ANTIDEPRESSANT	From Others
WPU	**98.3**	0.6	0.4	0.1	0.0	0.4	0.2	1.7
V-N-H	20.0	**66.6**	5.1	1.8	0.1	5.7	0.8	33.4
OTHER-V	23.9	23.8	**40.1**	9.4	0.5	1.5	0.8	59.9
MULTIVATMINS	1.0	13.4	1.8	**81.6**	0.6	0.2	1.4	18.4
EPU	91.1	1.3	0.1	0.2	**6.9**	0.4	0.1	93.1
ANTIDIABETIC	57.0	0.2	0.6	0.1	0.2	**40.9**	0.9	59.1
ANTIDEPRESSANT	8.3	0.5	0.0	5.5	3.6	1.5	**80.6**	19.4
Contribution to others	201.2	39.8	8.1	17.1	5.0	9.6	4.2	**285.0**
Contribution including own	299.5	106.4	48.2	98.7	11.8	50.6	84.8	**40.7%**



A: Rolling window with Economic Policy Uncertainty



B: Rolling window with the World Pandemic Uncertainty



C: Rolling window with Pandemic and Economic Policy Uncertainties

Figure 1: A, B and C are respective visual evidence of

3. Findings and discussion

By employing the step-step procedures (equation 1 to 9) above, the approach is employed for three different categories: (1) using the EPU (result in panel A of Table 2), (2) using the pandemic uncertainty index (result in panel B of Table 2), and (3) employing with both the EPU and WPU (result in panel C of Table 2). In the panel A, where the EPU was employed with the PPI of the pharmaceutical materials, the total spillover index that signifies the total transfer of information among the variable is 113.0%. However, with the inclusion of the EPU, the total spillover index increased to 193.1% (see panel B). This implies that the uncertainty caused by the world pandemic is capable of causing the spread of higher level of uncertainty as compared with the uncertainty caused by economic policy (EPU).

In specific, as seen in panel B of Table 2, the world pandemic uncertainty contributes 115.5% shock to other element of the estimation. In this context, antidepressant receives the highest shock, followed by vitamins nutrients and hematinic (V-N-H) with 38.3% and multivitamins (5.6%). In addition, these elements also received the three largest shock from others. Furthermore, the result of the panel C (Table 2) provides an additional supporting evidence. This result implies that when both EPU and WPU are employed along with the pharmaceutical compounds, the contribution of shock from the WPU to other elements now increased to 201.2%. In this case, vitamins nutrients and hematinic (V-N-H) and multivitamins receives the highest shocks with respective values of 39.8% and 17.1%. More importantly, the total spillover index (transfer of shock among the estimated elements) now increased to 285.0%. This is an indication that world pandemic uncertainty such as the COVID-19 is capable of contributing a significant amount of shock to the production of pandemic-related medications.

4. Concluding Remark

This study examined the potential and magnitude of shock associated with production of immune-related pharmaceutical products or compounds especially in the context of COVID-19 pandemic. Considering that the severity of COVID-19 has been largely linked with the sufferers' immune system and evidence of underlying illness, the industrial production of immune-related pharmaceutical drugs such as the multivitamin, vitamins nutrients and hematinic (V-N-H), antidepressant, and antidiabetic is expected to increase during the pandemic. As such, the current study examined the spillover effect arising from the world pandemic uncertainty and economic policy uncertainty to the producer price indexes of pharmaceutical items: multivitamin, vitamins nutrients and hematinic (V-N-H), other vitamins (other-V), antidepressant, and antidiabetic in the United States. The result posited that the uncertainty arising from the world pandemics such as the COVID-19 in the United States is responsible for high shock in the producer price index of all the examined pharmaceutical items. The study further showed that the shock arising from the world pandemic uncertainty is significantly higher than that of the economic policy in the United States.

By implication, if the United States is interested in curbing the adverse effect of inflation associated with the immune-specific pharmaceutical compounds, the government should foster policy that target the COVID-19 scenario in the United States. With such effective policy, potential surge in inflation in the pharmaceutical industry can be curbed, thus reducing the burden the consumers.

Reference

Amin, S. (2020). The psychology of coronavirus fear: Are healthcare professionals suffering from corona-phobia?. International Journal of Healthcare Management, 1-8.

Brand South Africa (2020). The importance of your immune system in fighting COVID-19 and how to keep it healthy. https://www.brandsouthafrica.com/covid19/the-importance-of-your-immune-system-in-fighting-covid-19-and-how-to-keep-it-healthy?gclid=EAIaIQobChMI59j8jvaB6gIVdoBQBh0xLQHJEAAYASAAEgLv4fD_BwE. (Accessed 18 July 2020).

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. International Journal of Forecasting, 28(1), 57-66.

DW (2020). COVID-19: How to boost the immune system with vitamins. https://www.dw.com/en/coronavirus-and-how-to-boost-the-immune-system-with-vitamins/a-53360766. (Accessed 18 July 2020).

The Federal Reserve Economic Data, FRED (2020). https://fred.stlouisfed.org/.(Accessed 18 July 2020).

Li, X., Geng, M., Peng, Y., Meng, L., & Lu, S. (2020). Molecular immune pathogenesis and diagnosis of COVID-19. Journal of Pharmaceutical Analysis.

Johns Hopkins University and Medicine (2020). https://coronavirus.jhu.edu/map.html. (Accessed 16 May 2020).

Mason-D’Croz, D., Bogard, J. R., Herrero, M., Robinson, S., Sulser, T. B., Wiebe, K., . & Godfray, H. C. J. (2020). Modelling the global economic consequences of a major African swine fever outbreak in China. Nature Food, 1(4), 221-228.

Nature (2020). Coronavirus research updates: Antiviral antibodies peter out within weeks after infection doi: 10.1038/d41586-020-00502-w. (Accessed 18 July 2020).

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., ... & Agha, R. (2020). The Socio-Economic Implications of the Coronavirus and COVID-19 Pandemic: A Review. International Journal of Surgery.

Russell, B., Moss, C., George, G., Santaolalla, A., Cope, A., Papa, S., & Van Hemelrijck, M. (2020). Associations between immune-suppressive and stimulating drugs and novel COVID-19—a systematic review of current evidence. ecancermedicalscience, 14.

Shi, Y., Wang, Y., Shao, C., Huang, J., Gan, J., Huang, X., & Melino, G. (2020). COVID-19 infection: the perspectives on immune responses.

Singh, R., & Avikal, S. (2020). COVID-19: A decision-making approach for prioritization of preventive activities. International Journal of Healthcare Management, 1-6.

Srivastava, R. K., & Wagh, S. (2020). Factors impacting consumer purchase behaviour for pharmaceutical products. International Journal of Healthcare Management, 13(2), 113-121.

Tufan, A., GÜLER, A. A., & Matucci-Cerinic, M. (2020). COVID-19, immune system response, hyperinflammation and repurposing antirheumatic drugs. Turkish Journal of Medical Sciences, 50(SI-1), 620-632.

WHO (2020). Coronavirus disease (COVID-2019) situation reports. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports. (Accessed 16 May 2020).

World Pandemic Index (2020). https://worlduncertaintyindex.com/data/. (Accessed 19 July 2020).

Figures

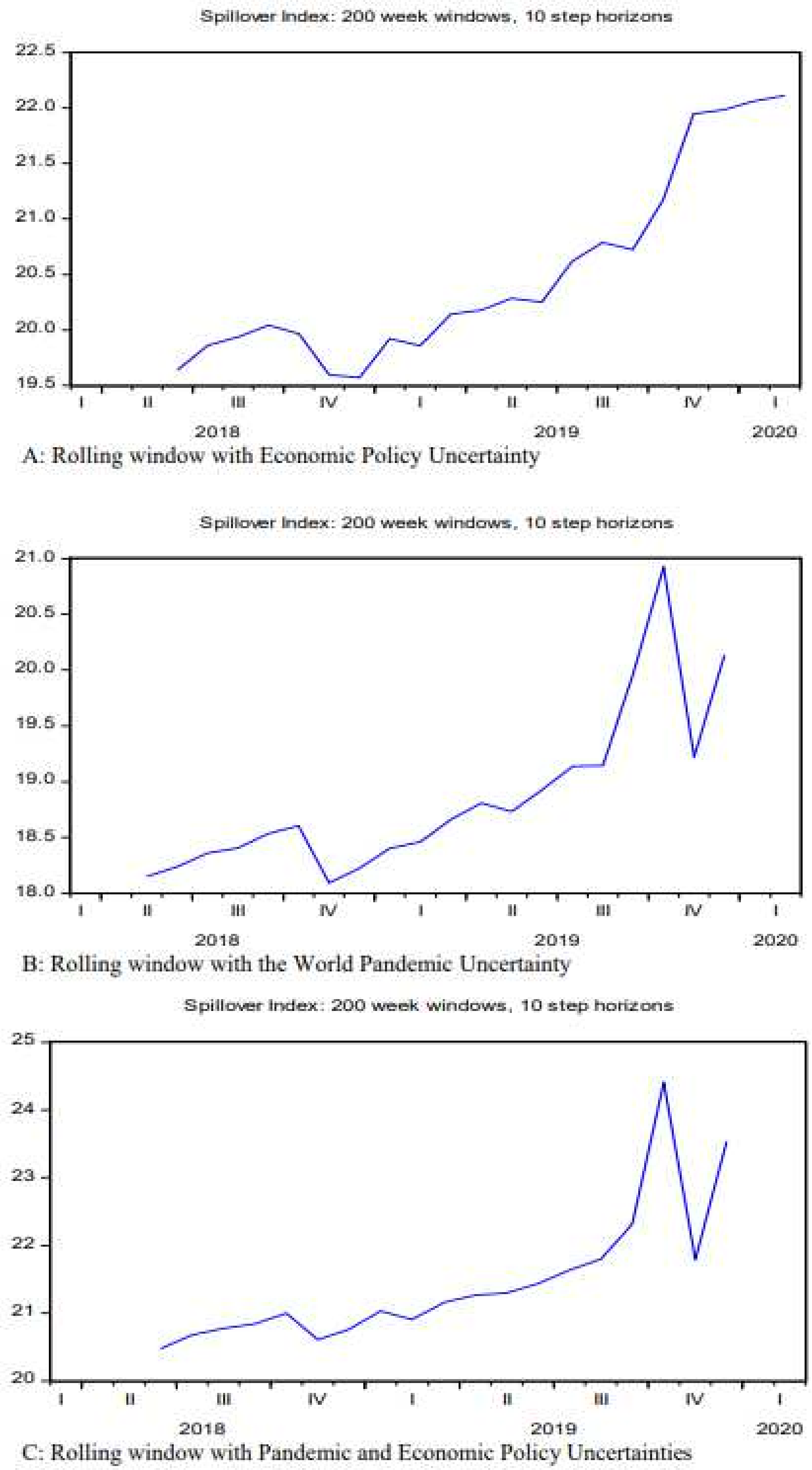


Figure 1

A: Rolling window with Economic Policy Uncertainty. B: Rolling window with the World Pandemic Uncertainty. C: Rolling window with Pandemic and Economic Policy Uncertainties