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Structural Breaks in Global Stock Markets: Are they caused by Pandemics, Protests or other factors?

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Abstract

The aim of this study is to examine the impact of the COVID-19 pandemic and other similar global events on the global stock market. The data used covers 16 countries of the world and a series of quarterly data ranging from 1919Q1 to 2020Q2 for major stock market index was used. The Bai and Perron's multiple structural break approach were adopted. Different number of break dates is noticed across several regions. While selected sample countries in Europe have at least ten break dates under the period of investigation, we observe for US, Canada and Australia, only twelve break dates. Asia and the other bloc of countries report ten and twelve break dates respectively. Notably, one most prominent causes of structural changes in stock markets (with the exclusion of Germany) appears to be from the GFC, which had inverse effects on major market around the world. The most prominent source of structural breaks in the Asian markets appears to be from the 2008-2009 GFC. In addition, we found evidence of structural breaks in several stock markets in the world, resulting from the 2009-2010 Global Pandemic, that is, the H1N1 virus/pigs Swine Flu; 2003 SARS; MERS; and EBOLA. In addition, as explained above, events have the tendency of unfolding over time; hence matching exact breaks in stock market data to precise events is very unlikely.

Keywords: Pandemics; Stock Market Index; Structural Breaks; Bai and Perron multiple break; Global events.

1. Introduction

Market is a crucial part of the society. It has evolved from the concept of exchange of goods by barter to a sophisticated systems, which are built on organizations, procedures, and social interactions that permits evaluation and pricing of goods and services and many more forms of exchange (Cristina et al., 2018; Paulin, 2019). The possibility of pricing and evaluation has made exchange a simpler procedure. Eventually, this evolution has also produced well-structured markets that are governed by regulations (Amadeo, 2020). Regulation and coordination imply the uniformity of causes, effects and policies on all participants in the market and ultimately, on the overall performance of the market. The stock market viably describes this scenario, where the instrument for trade is stocks. Harmilapi & Megha (2012) highlights some of the features of the stock market.

The stock market has experienced an outstanding growth over the decades. Its global capitalization was reported by Mañas (2005) to have tripled in the nineties. This growth cuts across emerged and emerging economies as studied by Bayar (2014) and Mohtadi & Agarwal (2001) with greater effects in the emerging economies. The stock market acts an important role in economic growth of a country. Most financial institutions, the government and policy makers monitors the condition of the stock market (Harmilapi & Megha, 2012). Generally, the stock market has been found by several studies to cause economic growth. Market capitalization growth encountered a standstill between World war I and 1980s, credited to equity price bumps caused by the combined effect of the World wars, the 1970s sag and the Great Depression (Kuvshinov & Zimmermann, 2020).

However, despite the development of stock markets globally, several global events have altered trends and behaviour of the stock market (see tables A.1 and A.2 in appendix). This study sought to find out how such occurrences causes key breaks in the stock market. The effect of a pandemic or epidemic is not just the loss of life nor is it just anti-social, but also a grave and negative influence on the economic stability, growth and development. There has been quite a count of diseases outbreak in history. Influenza pandemics have reportedly been recorded in the last four centuries. In 1918, 1957 and 1968, there were occurrences of pandemics and more potential pandemics. The most recent is this current coronavirus (covid-19). Stock market turnovers for the year 1918 is difficult to get, most likely due to the 1918 pandemic virus. It could also be as a result of the World War I, which happened about this time(International, 2003). In pandemic times, such as the 1918, the primary human concern globally is survival and a chance to live. Hence, many activities, including some economic activities are stopped, disturbed or reduced.

The next section reviews the literature in two streams; firstly, the theoretical framework of the study, the interconnectedness of global events and the stock market is critically examined; and the novelty in the model used to achieve the aim of this study is presented. Section three discusses the data and variables used in addition to the methodology and techniques used in this study. The main findings of this study are presented in section four, while section five concludes the study with vital policy implications and recommendations.

2. Literature review

2.1 Theoretical framework

The chances for abnormalities in global stock markets are necessitated by several factors such as World War II, and 2008 global financial crisis. Apart from the highlighted factors, the market shocks could also be arisen from disease, epidemics (1918 Spanish flu), pandemics (recent coronavirus, and so many other factors. The new Coronavirus outbreak accentuates the requirement for desperation on attempting to check the imaginable financial effect. What is currently known to have begun in the city of Wuhan; China, has caused heat waves to the stock markets around the globe. Before the novel coronavirus, the 1918 – 1919 Spanish flu, is another pandemic which came in three waves, and estimated to have inflected about 27% of the globe's populace, and caused a 2.3% mortality rate worldwide. As of March 2021, World Health Organization reported an active 114,428,211 of COVID-19 cases with 2,543,755 deaths which translates to a death rate of 2.2% of the world's populace.

The Coronavirus circumstance in each angle resembles the Spanish Influenza. Specialists are advancing self-separation strategies, tainted individuals are expanding and diminishing like waves pattern and nobody knows how or when the infection will vanish, even though vaccines are being distributed across the continents. In the midst of all the mayhem, securities exchanges around the globe are falling. Nobody knows whether this is the beginning of another monetary emergency or a market attempting to factor in the pandemic as an amendment, yet for the ignorant financial investors, this could possibly be a truly incredible chance. Based on the information and the theory, it is therefore imperative for investors to acquire adequate knowledge and information as regards the moving of stock market within a particular time period in aforementioned factors. More so, for further policy directions, several researchers have shown avid interest in estimating various micro or microeconomic factors that used to significantly affect global stock markets since ages. This study contributes to the existing research by estimating during which days of the pandemic, epidemic, or other factors did the stock market jump forward.

2.2 Pandemic, Crisis Events and Stock Markets

Stock market crises was studied by Chatzis et al.(2018) and was found to be persistent. For the study, 39 countries were carefully chosen to represent a sizeable stretch of economies. A combination of machine and deep learning algorithms were used for the study.

With the unforeseen outbreak of pandemics and diseases, as recently experienced across the globe and she scrambles through. It is not without effect on various sectors in the global economy. Ashraf (2020) examined the probable effect of government measures, such as the social distancing, public awareness platforms, testing and quarantine methods and policies, and also income support schemes, aimed at managing covid-19 pandemic on stock market returns. The study found out those social distancing measures has a blunt negative influence on stock market returns, resulting from restrictions on economic activities, while others considered factors yield positive influences. Zaremba et al. (2020) examined the effect of non-pharmaceutical mediation during the covid-19 pandemic on global stock market volatility. This is because volatility is a significant force in the financial market, serving as a measure of the risks in financial investment. The study concentrates on the 67 economies which were utilized by the Datastream Global Equity indices. They used the Response Stringent Index, which explains about seven kinds of instruments as stated by Hale et al.(2020) to measure non-pharmaceutical mediation aimed at controlling contagion the pandemic. The outcome indicates that these instruments increased stock volatility to a great extent. Prior to the emergence of the pandemic, SARS-COV-2, also known as COVID-19 in Wuhan China, which later had a widespread globally, there was the outbreak of the SARS-COV-1 in 2003. The spread of the later in contrast with the former was limited to fewer countries. Ru et al. (2020) found that there was a specific pattern in the stock market of some countries which experienced the 2003 SARS-COV-1 for some weeks, before recovery process begins. In essence, recovery was faster in countries who experienced the 2003 SARS-COV-1. This outcome was attributed to the quick response measures put in place by these countries.

Angelovska (2011) investigates further into the cause of structural changes in the volatility of the capital market in Macedonia. Prior to the study, it has been noticed that these changes subsequent to political events and changes. This is noticed particularly after international political event, such as her acceptance into NATO, as well as the European Union (EU). The outcome of the study confirms that political events connected "name issue" invokes responses from the market.

With the rapid growth of the capital market, and its viability over other financial market players in boosting economic development. It has been referred to as the alternative to banking, in the case of a banking crises (Greenspan, 1999). DeLean & Joyce (2014) studied the influence of stock market capitalization, liquidity and returns on the resulting losses of 76 banking predicaments between 1975 and 2008. The study, which covers 66 economies, reveals that the stock market is able to palliate the consequences of banking predicaments on the economy.

Considering ten Asian economies, with that of the United States and Japan, Yang et al.(2003) explored the dynamic-causal interaction between the stock market and financial crises, both in the long term and in the short term. The study specifically focused on the financial crisis which happened in Asia from 1997 to 1998. The study uncovers that the long term co-integral and short-term causal interaction and connection gained strength during the period of the crisis. The study also compared the analysis of the market's integration at pre-crisis, crisis and post crisis periods. It shows that the markets were broadly more integrated at the period subsequent to the crisis than at the period preceding the crisis. The findings explicitly confirmed that the level of integration changes in time, and mostly about times when there is financial crisis.

Kenourgios & Padhi (2012) examined the relationship between emerging markets, the United States, two global indices, and three market crises which occurred towards the end of the 1990s and the 2007 subprime crisis, taking their financial market as focus. The study covers regional, global and isolated effects. Conventional co-integration technique was used coupled with the vector error correction analysis. The outcome reveals that the only the emerging stock markets exhibits both long- and short-term dynamics in the Asian and Russian crises. This was the same for both bonds and stocks. The Argentine crisis reportedly has effect on none of the markets understudied. The multivariate time-variant asymmetric analysis further gives a proof about the Russian crisis having a global influence, the subprime crises having a contagion consequence, the Asian crisis having a regional effect and finally, the Argentine crisis having an isolated feature.

Therefore, the stock market is a significant sector, not just to grow the economy, but also a defence mechanism to maintain a stable economy. It has also been found to persistently encounter crises which are caused by varieties of external influences such as the pandemic, political events, political turmoil and many more.

2.3 Bai and Perron's multiple structural break approach

Sharma et al. (2009) investigated the long-term patterns and structural breaks in the non-renewable resource prices using econometric techniques and specifically, the Bai and Perron's (1998) technique for multiple structural breaks. Prices for nine (9) non-renewables were the data used in the study. Structural breaks and stationarity were found to be present in the data.

Essaadi et al.(2009) tested for the contagion which was a consequence of the July 1997 Thai baht fall. With the Bai and Perron's multiple structural break method, they examined the international spread of financial shag to detect internal interruptions of the co-time-varying correlations existing between Thailand and 7 Asian stock market turnovers. The study also aimed at ascertaining specifications of the crisis window. The outcome also proves that a break-shift exists in the 7 Asian stock markets which is as a result of the break in Thailand.

The long term interaction between bond and stock market turnovers in the Spanish market from 1991 to 2009 was studied by García-Machado (2011), using the Bai and Perron's multiple structural break method. The market risk premium was found to be negative only at three instances between the years 1991 to 1993, 1998 to 2002 and 2007 to 2009, but positive more often. The instances where it is negative, results in shifts in Gross Domestic Product evolution. The study confirms the presence multiple structural breaks in Spanish market risk premium.

Hiang (2011) studied the attitude of interactive movement amidst eleven European real estate securities markets. The study used the data spanning January 1999 to January 2010. Asymmetric dynamic conditional correlation and multiple structural break techniques were used. The Bai and Perron's multiple structural break technique were used to investigate the possibility of average conditional correlations is liable to change in regimes, by checking for structural breaks in the interactive movements of real estate securities revenues. The following are the outcomes: Two structural breaks caused by regime change were found to be inherent in four countries. About the global financial crisis, correlation and volatility are highly related. High correlation signifies high volatility and a lower degree of revenue. The study also discovered little to mild conditional correlations for European real estate securities market, but a higher degree of correlation subsequent to the global financial crisis.

Nur-Syazwani & Bulkley (2015) studied the dividend at the firm level of the United States firms. Using the Bai and Perron's (2003) multiple structural break technique, they examined inconsistencies in dividends based on deterministic econometric methods. Structural breaks were found to be present in the United States dividend processes. Examining unemployment data from Canada and its provinces. Fallahi & Rodríguez (2015) checked if unemployment levels in the provinces are approaching the nation's central level. This convergence was tested using Volgesang (1998) and the Bai and Perron's multiple structural break techniques (1998, 2003). The outcome of the study reveals the presence of random convergence in the provinces but stronger while the provision was made to factor in structural breaks in the trend function. It was concluded that allowance for structural breaks produces more accurate outcomes.

Charfeddine & Benlagha (2016) studied the time-variant conditional dependence between commodity and stock markets, using the rolling sample methods on dependence parameter of copula. They examined 12 closing commodity prices and some indices, such as the SP500, FTSE100, DAX30 and CAC40. The data used spanned the years 1992 to 2015. The Bai and Perron's multiple structural break technique is employed to find the exact interruptions in the movement of the parameter copula. The Bai and Perron's test shows that the attitude of the parameter copula varies in time. Ultimately, the breakpoints were found to the attributed to periods of economic and financial crises and also crude oil instability.

Using Shanghai and Shenzhen composites, and also the Hang Seng China Enterprise index turnovers in some Asian countries, Hong et al.(2018) tested the performance of stock turnovers forecast when structural breaks are allowed in the parameters or not. The Hong Kong market shows a more probable predictability over the Chinese markets when the structural breaks were deferred, and the opposite is the case when break were accounted for. The Bai and Perron's technique signals that multi-structural breaks exist in Shenzhen markets. These breaks are traced to periods of economic activities, political and organizational transition or transfer. The study underlines the essentiality of factoring structural breaks in predicting stock turnovers.

Gil-Alanaet al.(2019) examined the structural model of tourism turnover in Brazil. The study used a monthly data collected over twenty years. The research employed the Bai and Perron's multiple structural break technique, which reveals the presence of structural problems. This problem was discovered to be caused by currency unsteadiness in emerging economies and it may have a negative effect on their sport mega activities.

Investigating the factors that add up to major change in the development of tax returns in India, Rath (2020) provided an answer by investigating structural breaks and analysing main tax regimes using tax rates, tax base and administrative amends. A sixty five-year tax data consisting of direct and indirect taxes were used for the study. Quandt-Andrews and the Bai and Perron's econometric techniques were used the detect single and multiple breaks. More than a single break was found in the tax components by the Bai and Perron's multiple structural break. The factors that were found to add up to tax regimes are economic development, structural economic shifts, simplification and rationalization of tax structure, competition and laws. Also, tax rates are found not to contribute to the shift in tax returns.

Biswas (2020) attempted to conceptualize economic development in the West Bengal state of India using Bai and Perron's multiple structural break technique. Between the periods considered, year 1960 to 2014, two structural breaks were found. The first occurred in 1983, while the second was in 1993. The break in the agrarian and service sectors was also found to be influencers to these two breaks. The study also reflects mild developments after industrial and political stabilities and low developments after instabilities.

Very similar to our study is the Cró & Martins (2017) which examined whether crises and disasters causes structural breaks in international tourism demand. They estimated how many and when structural break occurs in tourism demand, using the Bai and Perron's (1998) multiple structural break technique. 25 nations including the Madeira Island were covered in the study, with the objective of mapping each structural break to tourism crises and disasters if true. They discovered that times of these breaks were characterized by tourism crises and disasters. As seen in literature, Bai and Perron's (1998, 2003) is widely used to detect multiple structural breaks and estimate seasons and periods of breaks in paneltime variant data, even in the financial and economic sector. This study aims to test for structural breaks in the global stock market and to ultimately confirm whether these breaks are caused by pandemics, crises events, and disasters.

3. Data and Methods

3.1 Data and Variables

This study uses the major stock indexes of the various countries grouped in four blocks. In Europe, selected countries include theUK (1983Q3 – 2020Q2); Russia (1997Q3 – 2020Q2); Italy (1997Q4 – 2020Q2); Portugal (1992Q3 – 2020Q2); and Germany (1959Q3 – 2020Q2). Group two includes selected countries in the North America and Australia i.e.US (1966Q3 – 2020Q2); Canada (1919Q1 – 2020Q2); Australia (1992Q2 -2020Q2). Bloc three include countries in Asia i.e.,China (1990Q3 – 2020Q2); Japan (1969Q4 – 2020Q2); India (1990Q2 – 2020Q2). A final bloc is also created to include Mexico, Brazil as well as selected countries in Africa i.e., Mexico – 1994Q1 – 2020Q2; Egypt (1998Q1 – 2020Q2); South Africa (1995Q2 – 2020Q2); Brazil (1991Q1 – 2020Q2); and Nigeria (1998Q1 – 2020Q2). The stock data used are those reported in each country's local currency. For these stock series, the aim is to test whether structural breaks are connected to any of the pandemic events and other major global/national events reported in tables A.1 and A.2 in the appendix.

3.2 Econometrics of Structural Breaks — Bai & Perron

This study adopts similar model used in Adedoyin, et al. (2020), which draws heavily on the work of Bai and Perron (1998, 2003a & b) which consider structural breaks with unknown dates. Bai-Perron (1998) methodology provides the framework to endogenously establish more than one structural change points in the period of a data when the modeler does not know their exact number and dates.

Two or more structural breaks can be tested using the Bai-Perron (1998) procedure at unknown dates, which is capable of being structured within the framework of Andrews (1993). The Bai-Perron (1998) model with m breaks (or $m+1$ regimes) is considered a multiple linear regression model as shown in (1) below:

$$y_t = x_t'\varphi + w_t'\vartheta_l + u_t, \qquad t = T_{l-1}+1,\dots,T_j \qquad 1$$

for $l = 1,\dots,m+1,$; typically $T_0 = 0$ and $T_{m+1} = T$: y_t represents the observed regressor series, the vectors of covariates are $x_t : (p\times 1)$ and $w_t : (q\times 1)$, and φ and $\vartheta_j : (l = 1,\dots,m+1)$ stand for coefficients of the related vectors.

We treat the $(T_1,\dots,T_m)$ break points as unknown. The model is fractionally adjusted if φ is unsusceptible to changes and is efficiently evaluated from the whole sample in the above expression. The model is referred as a pure structural shift model given that every coefficient is likely to adjust when $p = 0$.

First and foremost, our assignment is to consistently evaluate $(\varphi^0, \vartheta_1^0,\dots,\vartheta_m^0, T_1^0,\dots,T_m^0)$, given that the index of '0' represents accurate or zero amounts of the factors. Afterward we check if there exists any structural shift.

Ordinary least squares method is employed for the estimation, in the case of the sample of each *m*-partition $(T_1,\dots,T_m)$, the residuals sum of squares (SSR) are minimised to find the estimates of the factor from equation (1) above. The step-by-step process of the outcome of the break points estimated, $(\widehat{T}_1,\dots,\widehat{T}_m)$ specified as

$$(\widehat{T}_1,\dots,\widehat{T}_m) = \arg\min_{T_1,\dots,T_m} S_T(T_1,\dots,T_m),$$

where $S_T(T_1,...,T_m)$ represent the residuals sum of squares from equation (1) given certain *m*-partition and all partitions are minimised $(T_1,...,T_m)$ where $T_i - T_{i-1} \geq q$.

Further, as shown in Bai-Perron (1998), there are some interesting evaluating and testing issues. The initial test is a *sup F* type test, which test the null of no break point versus the alternative hypothesis of an existing and specific amount of $m = k$ break points. Partitions are defined as $T_i = [T\gamma_i]$, thus the fragments are established as $(\gamma_1,...,\gamma_k)$, where the break points arise within the sample.

Describing a set for the small, arbitrary positive number ε:

$$\Lambda_\varepsilon = \{(\gamma_1,...,\gamma_k); |\gamma_{i+1} - \gamma_i| \geq \varepsilon, \gamma_k \leq 1-\varepsilon\},$$

the *sup F* test is next described as

$$\sup F_T(k;q) = \sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q),$$

for asymptotically divergent breaks and ensuring it does not appear at sample endpoints.

This analysis is a generalised version of the *sup F* test discussed in Andrews (1993) for $k = 1$. Failure to correct for heterogeneity and autocorrelation makes the *sup F* test to suffer from distribution limit that is reliant on them. However, if this is a likelihood hence an adjusted model is recommended, as described in Bai-Perron (1998) and in Bai and Perron (2003a, b), which has a distribution limit without any disturbance factors.[1]

Bai-Perron (1998) discussed a number of generalisations. The first is to relax the postulation of known number of breaks by assuming the break points is unknown given the alternative of an M upper bound. Given this relaxation, the Double Maximum test is therefore identified thus:

$$D_{Max}F_T(M,q,a_1,...,a_M) = \max_{1\leq m\leq M} a_m \sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q) \qquad 2$$

certain weights are described as $\{a_1,...,a_M\}$ to show precedence on the probability of diverse break points.

Also, the UD_{Max} is defined as equation (3), when all the weights chosen are identity (Bai-Perron, 1998):

[1]Critical values that account up to 9 breaks and up to 10 regressors zt whose coefficients can be changed are presented in Bai-Perron (1998).

$$UD_{Max}F_T(M,q) = \max_{1 \le m \le M} a_m \sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q) \quad 3$$

For any constant q the critical values of the particular test $\sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q)$ decline as m rises, the implication for this is that the marginal p-values decline with *m* and are likely result to a low power given the large break points. In addition, Bai-Perron (1998) proposed the employment of the $WD\max$ test to solve the above problem. This test regards a group of weights such that the marginal p-values are equal over values of m. Signifying the level of significance of the test and weights that relies on q.

Assume $c(q,\sigma,m)$ be the asymptotic critical value of the test $\sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q)$ for a level of significance of σ, and $a_1 = 1$ and $a_m = c(q,\sigma,1)/c(q,\sigma,m)$ for $m > 1$, the $WD\max$ is specified thus:

$$WD\max F_T(M,q) = \max_{1 \le m \le M} \frac{c(q,\sigma,1)}{c(q,\sigma,m)} \times \sup_{(\gamma_1,...,\gamma_k)\in\Lambda_\varepsilon} F_T(\gamma_1,...,\gamma_k;q) \quad 4$$

Critical values for UD and WD tests are respectively presented in (Bai & Perron, 1998), however, these were improved upon in Bai and Perron (2003a, b) to include a broader scope of ε values (in this study, trimming parameter - ε, for *UDmax* and *WDmax* statistics is set to 0.05).

4. Results and Discussions

The goal of our current study is to evaluate whether major shifts in the trends of stock markets are caused by pandemics, financial crisis, protests or other factors across the world. To accomplish our aim, we considered groups of markets including Europe, the US, Canada &Australia, Asia and other economies. In order to determine the effect of a major event on the stock market, we aligned the results from the Bai & Perron (1998, 2003a, b) structural breaks estimations with the relevant events presented in Tables 3 - 5. Bai and Perron (2003a) provide critical values for a trimming parameter at 0.05 and k-values from 1 – 9 and 1 – 10 values of q (Bai and Perron, 2003a, pg. 13 – 14). Given the large size of our data sample, we set the trimming parameter for UDmax and WDmax to 0.05 for m break dates from 1 to 12. However, to isolate the effects of the current global Coronavirus pandemic, we conducted two distinctive structural break tests using the pre – COVID-19 sample (i.e., the period ending 2019Q2) and the post – COVID-19 full – sample (i.e., the period ending 2020Q2).[2]

4.1 Results for the full – sample period

4.1.1Europe

Table 2 contains the structural change results for European markets. For the UK, we estimate for at least 10 breaks and the results indicate that there are five break dates caused by the climate change protests over the period of coverage. At 5% level, the value of the supF(m|0) test is statistically significant for all m; the Table documents significance level of 0.05 for every critical value reported. The results further show that the supF(m + 1|m) sequential is significant statistically at m = 10 for the UK. Specifically, with the presence of one break, supF(10|1) = 560.3951 implies the existence of additional breaks. Next, at the tenth break, supF(10|10) = 597.8839 suggests further breaks, but when investigated further, the results did not show any significant difference than m = 10. This indicates that there are only ten relevant breaks for the stock market series in the UK. The evaluated break point for m = 10 are in late periods of 1986Q4, 1992Q4, 1995Q4, 1997Q3, 2001Q3, 2005Q3, 2010Q3, early period of 2013Q1 and late period of 2016Q3. The UDmax and WDmax statistics both allowed for up to ten breaks in the null hypothesis. Our aim is to present the rationale for the structural shifts in stock markets and we found evidence of matching protests to breaks in five periods, which includes 2001Q3, 2005Q3, 2010Q3 and 2013Q1, corresponding to Green Party and Friends of the Earth protest, Stoke Hammond Protest, Kingsnorth Power Station, Royal Bank of Scotland, Hands Off Our Forest Protest and Global Climate March respectively in the UK. In addition, we found evidence of structural breaks in the UK stock market in the third quarter of 2010, resulting from the 2009-2010 Global Pandemic, that is, the H1N1 virus/pigs Swine Flu.

[2]We thank the anonymous reviewer for this valuable suggestion.

Table 2: Bai and Perron Summary of Outcome for Europe

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
UK – 1983Q3 – 2020Q2								
1 *	560.3951	9.63	722.7094	10.17	965.2832	10.91	1986Q4	
2 *	512.2766	8.78					1992Q4	
3 *	560.6130	7.85					1995Q4	
4 *	722.7094	7.21					1997Q3	
5 *	364.4991	6.69					2001Q3	Green Party and Friends of the Earth protest
6 *	567.1091	6.23					2005Q3	Stoke Hammond Protest
7 *	488.3950	5.86					2008Q3	Kingsnorth Power Station GFC
8 *	474.9800	5.51					2010Q3	i. Royal Bank of Scotland ii. Hands Off Our Forest Protest iii. Swine Flu-H1N1 virus/pigs
9 *	495.1950	5.20					2013Q1	Global Climate March
10 *	597.8839	9.10					2016Q3	
Russia – 1997Q3 – 2020Q2								
1 *	320.9485	9.63	885.3105	10.17	1545.565	10.91	2000Q1	
2 *	398.7688	8.78					2003Q2	SARS
3 *	442.6903	7.85					2005Q4	
4 *	575.6666	7.21					2006Q4	
5 *	387.7449	6.69					2008Q3	GFC
6 *	476.4108	6.23					2009Q3	GFC Swine Flu-H1N1 virus/pigs
7 *	493.9474	5.86					2015Q1	Global Climate March MERS
8 *	548.4085	5.51					2016Q1	Global Climate March
9 *	834.5728	5.20					2018Q1	
10 *	885.3105	9.10					2019Q2	i. Youth Climate Strike ii. Second Global Climate Strike iii.Moscow election protests
Italy – 1997Q4 – 2020Q2								
1 *	164.2285	9.63	236.1262	10.17	365.3043	10.91	1998Q4	
2 *	99.24358	8.78					1999Q4	
3 *	108.0055	7.85					2001Q2	
4 *	128.0409	7.21					2002Q2	
5 *	130.1400	6.69					2004Q4	
6 *	148.8196	6.23					2006Q1	
7 *	160.6198	5.86					2008Q1	GFC
8 *	194.6126	5.51					2009Q1	GFC Swine Flu-H1N1

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
								virus/pigs
9 *	197.2567	5.20					2011Q3	
10 *	209.8112	9.10					2013Q4	
Portugal – 1992Q3 – 2020Q2								
1 *	143.0351	9.63	143.0351	10.17	193.1910	10.91	1996Q4	
2 *	98.66957	8.78					1998Q1	
3 *	97.23272	7.85					2001Q2	
4 *	86.18770	7.21					2002Q3	SARS
5 *	92.91620	6.69					2003Q4	SARS
6 *	116.9810	6.23					2005Q4	
7 *	115.7060	5.86					2007Q1	
8 *	102.2690	5.51					2008Q2	GFC
9 *	104.3191	5.20					2011Q3	
10 *	103.1917	9.10					2015Q3	Global Climate March MERS
Germany – 1959Q3 – 2020Q2								
1 *	431.7834	9.63	1177.645	10.17	1695.175	10.91	1982Q2	Anti-WAAhnsinns Festivals
2 *	1093.597	8.78					1985Q2	Anti-WAAhnsinns Festivals
3 *	910.1654	7.85					1989Q1	Anti-WAAhnsinns Festivals
4 *	924.8184	7.21					1993Q4	
5 *	1177.645	6.69					1997Q3	
6 *	1019.807	6.23					2002Q2	SARS
7 *	929.9489	5.86					2005Q3	
8 *	884.3486	5.51					2010Q4	Swine Flu-H1N1 virus/pigs
9 *	831.1228	5.20					2013Q4	
10 *	780.3425	9.10					2016Q4	Global Climate March

* Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Notes: supF statistics estimated using Bai and Perron (1998, 2003) methods. Critical values from the table, Bai and Perron (1998). In choosing the number of breaks, column 8 establishes the existence of at least twelve breaks.

Further, the second economy in Europe we considered is Russia. Similar to the estimations for the UK, we analyse for the break periods at m = 10 in Russia. That means the m = 10 has a supF(m +1|m) that is significant statistically, with supF(10|1) = 320.9485, and supF(10|10) above their critical values. The m = 10 break points are in early 2000Q1, 2003Q2, late 2005Q4, 2006Q4, 2008Q3, 2009Q3, early 2015Q1, 2016Q1, 2018Q1 and 2019Q2. As shown in Table 3, out of the ten break periods, corresponding break effect occurred only in three periods, i.e., 2015Q1 and 2016Q1 for Global Climate March protest, and in 2019Q2 for the Youth Climate Strike and Second Global Climate Strike protests. It is worthy to note that most of these protests have indirect effects on the stock market in Russia since most of them took place within the European continent but not directly in Russia. Furthermore, our results show that the 2008-2009 GFC caused structural breaks in quarter three of both year 2008 and 2009 in Russia. Also, apart from the Youth Climate Strike and the Second Global Climate Strike protests of 2019, the July 2019 Moscow election protests appear to cause break points in the Russian stock market. In terms of disease pandemics, we found evidence of structural breaks in 2003Q2, 2009Q3 and 2015Q1 emanating possibly from SARS, H1N1 virus/pigs Swine Flu and MERS respectively.

Next, in the cases of Italy and Portugal, we also observed ten break points over the period of study. That is, the supF(m + 1|m) is statistically significant at m = 10, where the supF(10|1) = 164.2285 and the supF(10|10) = 209.8112 more than the critical values in the case of Italy. While the supF(m|1) = 143.0351 and the supF(10|10) = 103.1917 above the critical values. Break points evaluated for m = 10 occurred in late 1998Q4, 1999Q4, 2004Q4, 2011Q3 and 2013Q4, whereas it occurred at the early periods in 2001Q2, 2002Q2, 2008Q1, 2006Q1 and 2009Q1 when Italy is considered. For Portugal, the m = 10 examined break points occurred in late 1996Q4, 2002Q3, 2003Q4, 2005Q4, 2011Q3 and 2015Q3, whereas it occurred in early periods of 1998Q1, 2001Q2, 2007Q1 and 2008Q2. Our results are verified by the UDmax and WDmax tests statistics. However, in terms of corresponding protests, the results show no matching date in the case of Italy, while a matching date occurred in Portugal in 2015Q3 from the multi-region Global Climate March that happened in November 2015. Again, this suggests the possibility of spillover effect from neighbouring markets within the continent. In terms of financial crisis, we found evidence of structural breaks in Q1 of 2008 and 2009 in the case of Italy; and in Q2 of 2008 in Portugal being caused by the 2008-2009 GFC. Considering the issue of global pandemics, only the H1N1 virus/pigs Swine Flu appeared to have a structural effect on stock market in Italy in 2009Q1, while SARS and MERS caused breaks points in 2002Q3, 2003Q4 and 2015Q3 in the case of Portugal.

The last result for the European countries in panel A Table 3 is for Germany. When the German stock market is analysed, we accepted the alternative hypothesis of more than one break points after rejecting the null hypothesis of no structural breaks. As suggested by the supF(m|1) tests of the existence of more than one structural break, the supF(m + 1|m) outcomes indicate that there is at least ten breaks in the stock market of Germany. The periods where the F-stat is maximised occurred in early 1982Q2, 1985Q2, 1989Q1 and 2002Q2, whereas it is maximised in late 1993Q4, 1997Q3, 2010Q4, 2013Q4 and 2016Q4. We therefore concluded that the model for Germany has ten structural break dates as listed above. The UDmax and WDmax tests statistics confirmed our results; we reject the null hypothesis of no structural breaks and accept the alternative of ranging from one to ten structural breaks. To appreciate whether structural shifts arose as a result of protests, we matched each break date with a corresponding protest. The rationales for these breaks are likely to arise from Anti-WAAhnsinns Festivals in 1982Q2, 1985Q2, 1989Q1 and from Global Climate March in 2016Q4. When we considered the issue of disease pandemics, our results show that SARS caused structural shift in the second quarter of 2002, while the 2009-2010 H1N1 virus/pigs Swine Flu caused structural breaks in the fourth quarter of 2010 in Germany.

In sum, for all the markets in Europe, we discovered that all the countries have at least ten break dates under the period of investigation. Most of the countries experienced structural breaks in the early 2000s through to mid 2010s with the exception of Germany which had breaks in the early 1980s through to the mid 2010s. Most prominent causes of structural changes in stock markets in Europe (with the exclusion of Germany) appears to be from the GFC, which had inverse effects on major market around the world, followed by the November 29 2015 Global Climate March. In terms of pandemics, our results reveal that structural breaks were caused by the 2009-2010 H1N1 virus/pigs Swine in all the sampled European stock markets except Portugal. SARS on the other hand, seemed to have caused structural changes in Russia, Portugal and Germany but not in the UK and Italy, while MERS appeared to cause structural breaks only in Russia and Portugal. It should be noted that there are no *perfectly* matched dates (an event in a particular period may overlap to the subsequent periods – this provides break points ranges). We observed that the impacts of an event (protests, pandemics, financial crisis, disasters, etc.), may be long lasting, matching periods in the series with the *accurate* occurrence of an event appears to be implausible. For example, the global climate march protest in the late 2015 caused breaks in stock markets in Europe in early 2016. Also, the GFC spanned a period 2008-2009, but the effect took toll on markets at different points. In addition, plausible reason for the observed stock market breaks in Germany in the 1980s was a result of the prolonged Anti-WAAhnsinns Festivals, which started in 1982 through to late 1988.

4.1.2 US, Canada & Australia

We report the results for US, Canada and Australia in Table 3. In the case of the US stock market, we reject the null hypothesis of zero structural breaks in favour of the alternative of more than one structural break. At m = 10, the F-statistics is statistically significant where the supF(10|1) = 423.3369 is greater than the its critical value, also the supF(10|10) = 958.8789 is above the critical value. This indicates that there are more than ten break points within the period of investigation. However, after further analysis, there appeared to be no major difference between m =10 and any additional break dates. We find existing break points at the early periods of 1991Q1, 1198Q1, 2011Q1 and 2017Q2; break dates also occurred at the late periods of 1985Q4, 1995Q3, 2001Q3, 2004Q4, 2008Q3 and 2013Q4. Again, the UDmax and WDmax tests statistics are once more consistent, which both reject the null hypothesis of no structural breaks and accept the alternative of up to ten breaks, although not above ten breaks. To understand the cause(s) of these structural breaks, we also match the break dates with the rationales and found break dates in 2013Q4 and 2017Q2 corresponding to the People's Climate March protests. Aside the People's Climate March protests, the January 2017 Immigration Ban Protests organised by the General public seems to have caused structural change in the second quarter of 2017 in the US. Nevertheless, we also find evidence of the effect of the 2008-2009 GFC.

In the case of Canada, the results indicate the presence of twelve structural break dates. With the presence of a break as revealed by the supF(m|1) tests, the supF(m + 1|m) estimates indicate the existence of up to twelve breaks in the stock market. The structural breaks analysed for stock market in Canada are in early period of 1972Q1, caused possibly by May Day Protest of 1971, in 2014Q1 and 2017Q1, which were explained by the People's Climate March protests. The estimations also reveal that the January 17-18 2019 Strike for the climate, March 15, 2019 Youth Climate Strike and the May 24 2019 Second Global Climate Strike had a negative impact on the stock market in the second quarter of 2019. Our results are further confirmed by the UDmax and WDmax statistics by rejecting the null hypothesis of no structural break. Interestingly, the stock market in Canada seems not to be affected by the 2008-2009 GFC.

When the stock market in Australia was analysed, we rejected the null hypothesis of no structural break and accepted the alternative of more than one break. Similar to the case of Canada, the F-stat is maximised for twelve break points when we judged the null hypothesis of one against the alternative of more than one break, which occurred in the early periods of 1997Q2, 2004Q2, 2013Q1 and 2018Q2, and in the late periods of 1993Q3, 1999Q3, 2005Q3, 2006Q4, 2008Q3, 2009Q4, 2011Q3 and 2016Q4. The UDmax and WDmax tests further verified our results. We find that the structural break in 2004Q2 was due to SARS outbreak in 2003 that took place in most Asian and other advanced economies. In addition to the break that was caused by the GFC in 2008 – 2009, the Kooragang Island protest was also a suspected rationale for structural breaks in Australia in 2008Q3. We also find other culprits for breaks in 2016Q4 and 2018Q2 as a result of the Global Climate March that took place in late 2015 and the twin School strikes for the climate that was carried out in 2018 respectively.

Table 3. Bai and Perron Summary of Outcome for US, Canada and Australia

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
US – 1966Q3 – 2020Q2								
1 *	423.3369	9.63	1318.878	10.17	1925.447	10.91	1985Q4	
2 *	859.6603	8.78					1991Q1	
3 *	1119.902	7.85					1995Q3	
4 *	1318.878	7.21					1998Q1	
5 *	1188.111	6.69					2001Q3	
6 *	1209.596	6.23					2004Q4	
7 *	957.3116	5.86					2008Q3	GFC
8 *	1101.684	5.51					2011Q1	
9 *	951.8732	5.20					2013Q4	People's Climate March
10 *	958.8789	9.10					2017Q2	i. People's Climate March ii. Immigration ban protests
Canada – 1919Q1 – 2020Q2								
1 *	1036.988	9.63	2983.325	10.17	4149.535	10.91	1950Q2	
2 *	1804.306	8.78					1955Q2	
3 *	1799.386	7.85					1964Q2	
4 *	2983.325	7.21					1972Q1	May Day 1971
5 *	2565.736	6.69					1979Q3	
6 *	2491.075	6.23					1986Q1	
7 *	2407.881	5.86					1992Q3	
8 *	2374.241	5.51					1997Q3	
9 *	2227.338	5.20					2005Q3	
10 *	2175.875	9.10					2014Q1	People's Climate March
11 *	2301.303	7.92					2017Q1	People's Climate March
12 *	2041.251	6.84					2019Q2	i.Strike for the climate ii.Youth Climate Strike iii.Second Global Climate Strike
Australia – 1992Q2 -2020Q2								
1 *	386.5014	9.63	527.1937	10.17	885.2224	10.91	1993Q3	
2 *	434.1690	8.78					1997Q2	
3 *	468.1018	7.85					1999Q4	
4 *	291.4505	7.21					2004Q2	SARS
5 *	336.8419	6.69					2005Q3	
6 *	374.7117	6.23					2006Q4	
7 *	378.9386	5.86					2008Q3	Kooragang Island GFC
8 *	355.9846	5.51					2009Q4	GFC
9 *	478.0017	5.20					2011Q3	
10 *	478.8553	9.10					2013Q1	
11 *	426.7695	7.92					2016Q4	Global Climate March
12 *	527.1937	6.84					2018Q2	School strike for the climate

* Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Notes: supF statistics estimated using Bai and Perron (1998, 2003) methods. Critical values from the table, Bai and Perron (1998). In choosing the number of breaks, column 8 establishes the existence of at least twelve breaks.

In the panel for the US, Canada and Australia, we observed twelve break dates each in Canada and Australia. Again, we find the GFC to have serious negative effect on the stock markets in the US and Australia, but surprisingly not in Canada. Aside the GFC, we find the People's Climate March protest to have a serious effect on the stock market in the US and

Canada. We also find multiple events causing structural breaks in Canada in 2019 resulting from Strike for the climate, Youth Climate Strike and Second Global Climate Strike; and in Australia in 2008 from the Kooragang Island protest and the 2008-2009 GFC. In all three countries, structural breaks seem to be more prominent in the late 2000s through to late 2010s.

4.1.3 Asian Countries

The results for Asian markets are presented in panel C of Table 4. In China, the results reveal that there at least ten break dates for the period of the study. In particular, the null hypothesis of no breaks can be rejected, thus accepting the alternative hypothesis of more than one break, and supported by the UDmax and WDmax tests, where each signify that the null can be rejected at the 5% significant level. The break points estimate for the Chinese stock market includes the early periods of 1992Q2, 1997Q1, 2000Q1, 2007Q1, 2008Q2 and 2016Q1, and in the late periods of 2001Q4, 2009Q3, 2011Q3 and 2014Q4. We found evidence of structural breaks resulting from GFC in 2008Q2 and 2009Q3; also, the 2010 Xinfa aluminum plant protest appears to have a long toll on the Chinese market till the third quarter of 2011. However, the cause of break in 2016Q1 was suspected to have resulted from the Global Climate March that took place on November 29 2015. In addition, we also confirmed a global pandemic – the 2009-2010 H1N1 virus/pigs Swine Flu – as a strong rationale for structural shifts in Q2 of 2009 in the Chinese stock market.

Similar to China, we find the presence of ten break dates on the stock market in Japan. As with other markets, we test the null hypothesis of no structural against the alternative hypothesis of more than one structural break. The result was verified by the UDmax and WDmax test statistics for the stock market series, of which both rejected the null hypothesis of one structural break in favour of the alternative of ranging from one to at least ten breaks. Specifically, going by the F-statistics, it was impracticable not to reject the null and therefore we submitted that the stock market displays structural breaks in 1979Q2, 1985Q2, 1987Q4, 1990Q2, 1992Q4, 2000Q4, 2005Q3, 2008Q3, 2013Q2 and 2016Q4. The plausible causes of structural breaks occurred in only two periods, which are 2008Q3 and 2016Q4 with after effects from the GFC in 2008 – 2009 and the Global Climate March.

Table 4. Bai and Perron Summary of Outcome for selected Asian countries

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
China – 1990Q3 – 2020Q2								
1 *	225.7834	9.63	411.3078	10.17	675.9205	10.91	1992Q2	
2 *	208.1548	8.78					1997Q1	AFC
3 *	184.8344	7.85					2000Q1	
4 *	205.2527	7.21					2001Q4	
5 *	183.1429	6.69					2007Q1	
6 *	388.6824	6.23					2008Q2	GFC
7 *	411.3078	5.86					2009Q3	GFC Swine Flu- H1N1 virus/pigs
8 *	374.3738	5.51					2011Q3	2010 Xinfaaluminum plant protest
9 *	322.2278	5.20					2014Q4	
10 *	297.1228	9.10					2016Q1	Global Climate March
Japan – 1969Q4 – 2020Q2								
1 *	395.7290	9.63	395.7290	10.17	566.9467	10.91	1979Q2	
2 *	228.4506	8.78					1985Q2	
3 *	241.5132	7.85					1987Q4	
4 *	204.2970	7.21					1990Q2	
5 *	301.5504	6.69					1992Q4	
6 *	360.8499	6.23					2000Q4	
7 *	226.9561	5.86					2005Q3	
8 *	292.9438	5.51					2008Q3	GFC
9 *	306.1394	5.20					2013Q2	
10 *	271.0591	9.10					2016Q4	Global Climate March
India – 1990Q2 – 2020Q2								
1 *	280.7046	9.63	1368.374	10.17	2248.711	10.91	1992Q1	
2 *	561.7784	8.78					2003Q4	SARS
3 *	917.8196	7.85					2005Q2	
4 *	1122.618	7.21					2006Q4	
5 *	1048.325	6.69					2008Q2	GFC
6 *	1111.750	6.23					2009Q4	i. GFC ii. Swine Flu- H1N1 virus/pigs
7 *	1368.374	5.86					2012Q4	
8 *	1199.290	5.51					2014Q2	
9 *	1137.739	5.20					2017Q1	i. Farmer protests ii. Reservations protests
10 *	1000.700	9.10					2018Q3	i. School strike for the climate ii. SC/ST Act protests

* Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Notes: supF statistics estimated using Bai and Perron (1998, 2003) methods. Critical values from the table, Bai and Perron (1998). In choosing the number of breaks, column 8 establishes the existence of at least twelve breaks.

In the case of India, we rejected the null hypothesis of no structural breaks with the associated break points with the maximised F-stat in 1992Q1, 2003Q4, 2005Q2, 2006Q4, 2008Q2, 2009Q4, 2012Q4, 2014Q2, 2017Q1 and 2018Q3. The supF(m + 1|m) is significant statistically at m = 10 and more than the critical value where the supF(m|1) = 280.7046 and supF(m|10) = 1000.700. In addition, the UDmax test and WDmax test corroborate the results with both rejecting the null hypothesis of no structural breaks and the alternative hypothesis of between one and ten breaks. Rationales for structural breaks in stock market in India seem to arise from the 2003 SARS in 2003Q4, the H1N1 virus/pigs Swine Flu in 2009Q4 and the GFC in 2008 and 2009. Moreover, structural breaks in 2017 quarter one were as a result of two protests, i.e. the April 2017 Farmer protests[3] and the August 2017 Reservations protests[4]; while the April 2018 SC/ST Act protests organised by the Members of the lower castes, Dalits appear to cause structural breaks in the third quarter of 2018.

In Asian countries, our results show that all the countries have up to ten break points in the period covered. As with other economies in other regions, most of the structural shifts happened between early 2000s through to late 2010s. However, there exists evidence of structural changes being caused as a result of the Asian Financial Crises (AFC) in the summer of 1997, especially in China. The most prominent source of structural breaks in the Asian markets appears to be from the 2008-2009 GFC. We also find evidence of break emanating from the 2003 SARS and the global climate march. In addition, as explained above, events have the tendency of unfolding over time; hence matching *exact* breaks in stock market data to *precise* events is very unlikely. For instance, the July 112010 Xinfaaluminium plant protest in China was culpable of the change in stock market series in the following year. We also find evidence of spill over of events within a region and across regions.

4.1.4 Other countries

Panel D in Table 5 presents the structural break results for other few selected economies. Firstly, when the stock market in Mexico is considered, we find 5% level of significance for the value of supF(m|1) test for all m. However, the successive supF(m + 1|m) up to m = 12 are significant statistically. Specifically, with the presence of a break at supF(10|1) = 643.5814 indicates the existence of additional breaks. Up to the twelfth test, the supF(12|12) = 1710.291, is above the critical value. A further analysis beyond twelve break points does not reveal any significant variation in the results. This implies the presence of only twelve major break dates. Periods where the F-stat are maximised include 1997Q1, 1999Q4, 2004Q1, 2005Q3, 2006Q4, 2008Q2, 2009Q3, 2010Q4, 2012Q1, 2014Q3, 2017Q1 and 2018Q4. This is validated by both the

[3]Organised by Farmers' organizations.
[4]Organised by Members of the Maratha community, young people, senior citizens.

UDmax and WDmax statistics that rejected the null hypothesis of no breaks and accepted the alternative of between one and twelve structural breaks. Root causes of structural breaks appear to emanate from the GFC in 2008 – 2009 in 2008Q2 and 2009Q3, and the School strike for the climate protest in December 2018. In terms of pandemics, structural breaks were caused by the 2009-2010 H1N1 virus/pigs Swine Flu in quarter three and four respectively in 2009 and 2010.

For Egypt, we find 5% level significance of the supF(m + 1|m) for only up to m = 10, with the F-stat of the first break point at 244.9534 and the tenth break point at 435.3630, both being above the critical values. The resultant break points for m = 10 are 2004Q1, 2005Q1, 2006Q3, 2007Q3, 2008Q3, 2011Q1, 2013Q4, 2016Q4, 2017Q4 and 2018Q4. Again, the UDmaxand Wdmax tests are consistent with the results by rejecting the null hypothesis of no breaks and accepting the alternative hypothesis of more than one break, however, not more than ten breaks. The only major cause of structural breaks in the Egyptian stock market is from the GFC in 2008Q3.

Similar to Mexico, structural breaks in stock market in South Africa, the supF(m + 1|m) is significant statistically at m = 12, i.e. twelve break dates, where the supF(12|1) = 347.1060 and supF(12|10) = 2510.596 are both above the critical values. The investigated break points for m = 12 include 1999Q4, 2004Q3, 2005Q4, 2007Q1, 2008Q3, 2009Q4, 2011Q1, 2012Q3, 2013Q4, 2015Q1, 2017Q3 and 2018Q4, and further confirmed by the UDmax and WDmax statistics where the null hypothesis of no structural breaks is rejected in support of the alternative hypothesis of the existence of structural breaks between one and twelve breaks. Likewise, to Egypt, the plausible rationale for a structural break is caused by the 2008 – 2009 GFC in the period 2008Q3 and 2009Q4. Further, MERS and Anti-Zuma Protest appear to cause structural breaks in 2015 quarter one and 2017 quarter three respectively.

Table 5. Bai and Perron Summary of Outcome for countries in other regions

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
Mexico – 1994Q1 – 2020Q2								
1 *	643.5814	9.63	1710.291	10.17	2651.712	10.91	1997Q1	Other factors
2 *	1007.983	8.78					1999Q4	
3 *	967.4337	7.85					2004Q1	
4 *	975.8745	7.21					2005Q3	
5 *	804.6608	6.69					2006Q4	
6 *	1361.299	6.23					2008Q2	GFC
7 *	1236.921	5.86					2009Q3	i. GFC ii. Swine Flu-H1N1 virus/pigs
8 *	1517.231	5.51					2010Q4	Swine Flu- H1N1 virus/pigs
9 *	1402.148	5.20					2012Q1	Other factors
10 *	1343.432	9.10					2014Q3	People's Climate March
11 *	1440.766	7.92					2017Q1	
12 *	1710.291	6.84					2018Q4	School strike for the climate
Egypt – 1998Q1 – 2020Q2								
1 *	244.9534	9.63	501.7961	10.17	703.0759	10.91	2004Q1	Other factors
2 *	501.7961	8.78					2005Q1	
3 *	459.7245	7.85					2006Q3	
4 *	283.9575	7.21					2007Q3	
5 *	337.4995	6.69					2008Q3	GFC
6 *	322.0410	6.23					2011Q1	Other factors
7 *	427.8323	5.86					2013Q4	
8 *	388.9078	5.51					2016Q4	Global Climate March
9 *	342.4591	5.20					2017Q4	Other factorsweqrswsÛA
W356tgfcxs ÛZ[;	435.3630	9.10					2018Q4	
South Africa – 1995Q2 – 2020Q2								
1 *	347.1060	9.63	2510.596	10.17	3534.655	10.91	1999Q4	
2 *	1271.716	8.78					2004Q3	
3 *	1035.043	7.85					2005Q4	
4 *	898.3294	7.21					2007Q1	
5 *	920.2119	6.69					2008Q3	GFC
6 *	969.2114	6.23					2009Q4	GFC
7 *	1861.129	5.86					2011Q1	
8 *	1207.951	5.51					2012Q3	
9 *	1385.717	5.20					2013Q4	
10 *	1683.702	9.10					2015Q1	MERS
11 *	1730.089	7.92					2017Q3	Anti-Zuma protest
12 *	2510.596	6.84					2018Q4	
Brazil – 1991Q1 – 2020Q2								
1 *	303.5569	9.63	884.8522	10.17	1245.779	10.91	1997Q1	
2 *	262.3923	8.78					2003Q4	SARS
3 *	320.2377	7.85					2005Q3	
4 *	356.1777	7.21					2007Q2	
5 *	433.3371	6.69					2008Q3	GFC
6 *	404.1004	6.23					2009Q4	i. GFC ii. Swine Flu-H1N1 virus/pigs
7 *	539.3448	5.86					2011Q3	
8 *	499.9342	5.51					2016Q3	
9 *	487.4786	5.20					2017Q4	
10 *	459.7922	9.10					2019Q2	i.Second Global

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 12: Model of Estimated Break Dates	Rationale
								Climate Strike ii.Youth Climate Strike iii.Strike for the climate iv. Education cuts protests
Nigeria – 1998Q1 – 2020Q2								
1 *	222.2424	9.63	318.7615	10.17	448.7827	10.91	2001Q2	
2 *	72.71625	8.78					2003Q4	SARS
3 *	175.7856	7.85					2006Q2	
4 *	146.6273	7.21					2007Q2	
5 *	148.0008	6.69					2008Q4	GFC
6 *	280.7952	6.23					2013Q1	
7 *	256.8169	5.86					2015Q1	EBOLA MERS
8 *	249.6091	5.51					2017Q3	
9 *	232.7784	5.20					2018Q3	
10 *	298.4081	9.10					2019Q3	i-School strike for the climate ii-Strike for the climate iii-Youth Climate Strike
* Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Notes: supF statistics estimated using Bai and Perron (1998, 2003) methods. Critical values from the table, Bai and Perron (1998). In choosing the number of breaks, column 8 establishes the existence of at least twelve breaks.								

For structural breaks in stock market in Brazil, we observed at least ten break dates during the period under investigation. At m = 10, we observed 5% statistical significance of the supF(m + 1|m) , where the supF(10|1) and the supF(10|10) are above the critical values. The m = 10 break points observed are 1997Q1, 2003Q4, 2005Q3, 2007Q2, 2008Q3, 2009Q4, 2011Q3, 2016Q3, 2017Q4 and 2019Q2. For the UDmax and WDmax tests, we rejected the null hypothesis of no structural breaks and accepted the alternative hypothesis of structural breaks, ranging between one and ten breaks. We also observed that possible causes of structural breaks on stock market in Brazil are likely to arise from the GFC in 2008-2009 in 2008Q3 and 2009Q4, and in 2019, three protests are suspects for the break in 2019Q2, these include, Second Global Climate Strike, Youth Climate Strike and Strike for the climate protests and Education cuts protests. In terms of pandemics, structural change in 2003 quarter four were possibly as a result of the 2002-2003 SARS outbreak; while in addition to GFC, the H1N1 virus/pigs Swine Flu also caused structural shift in 2009 quarter four.

Lastly, turning to Nigeria, we observed significant statistics of the supF(m + 1|m) of up to m = 10. As indicated in Table 5, from the first break of supF(10|1) to the tenth break of supF(10|10), we find statistics of 222.2424 value and 298.4081 value higher than the critical values. These results are in agreement with the UDmax (318.7615) and WDmax (448.7827) test statistics, which rejected the null of zero structural breaks in support of the alternative of between one and ten structural breaks. To appreciate the likely causes of the breaks, we compared them with protests and other events and discovered that the only culprit to stock market is the 2008-2009 GFC and the break occurred in the fourth quarter of 2008 in Nigeria. Considering disease outbreaks, our results confirmed that the 2002-2003 SARS caused structural breaks in the fourth quarter of 2003, while the combined effects of EBOLA and MERS caused breaks in the Nigerian stock market in the first quarter of 2015.

In this last group of countries, we observed that Mexico and South Africa have twelve break points each, while Egypt, Brazil and Nigeria have ten break dates under the period covered. The major cause of breaks in stock markets in this group appears to be from the 2008-2009 GFC and few causes from climate change protests. A plausible reason for the insignificant effects of protests to these economies could be because of lack of protests by citizens. We also find evidence of events contagion on some of the countries, for example, in Mexico, the September 21 2014People's Climate March in the US in North America seems to take its toll on the Mexican stock market, with a break point in the third quarter of 2014. In addition, the stock market in Brazil was negatively affected by three protests (Second Global Climate Strike, Youth Climate Strike &Strike for the climate) in 2019Q2. Further, apart from national specific protests affecting individual countries, for example, Anti-Zuma protest in South Africa and Education cuts protests in Brazil, we found evidence of certain global/pandemics causing structural breaks in the stock market (these pandemics include Swine Flu- H1N1 virus/pigs pandemic, SARS, MERS and EBOLA.

4.2. Supplementary Results (pre – COVID-19 sub-sample)

As explained above, we further provide supplementary results for the entire blocs of countries – Europe, North America & Australia, Asia and others. The pre – COVID-19 period ends in the second quarter of 2019. The start dates of our sample were determined by the handiness of data for each country investigated. We defined the termination period (2019Q2) in this fashion because it marks the period before the deadly Coronavirus was discovered in Wuhan, China.

Therefore, our sampled markets and periods include Europe – UK (1983Q3 – 2019Q2); Russia (1997Q3 – 2019Q2); Italy (1997Q4 – 2019Q2); Portugal (1992Q3 – 2019Q2); and Germany (1959Q3 – 2019Q2). North America & Australia – US (1966Q3 – 2019Q2); Canada (1919Q1 –

2019Q2); Australia (1992Q2 – 2019Q2). Asia – China (1990Q3 – 2019Q2); Japan (1969Q4 – 2019Q2); India (1990Q2 – 2019Q2). Others – Mexico (1994Q1 – 2019Q2); Egypt (1998Q1 – 2019Q2); South Africa (1995Q2 – 2019Q2); Brazil (1991Q1 – 2019Q2); and Nigeria (1998Q1 – 2019Q2). After detailed analysis of the structural break tests, our results for the pre – COVID-19 period are qualitatively similar when compared with the results for the full-sample period. These are displayed in Table 6.

Table 6 Bai and Perron Summary of Outcome for all countries – pre – COVID-19 period

Number of Breaks	F-stat.	Critical Value @ 0.05	*UDMax*	Critical Value @ 0.05	*WDMax*	Critical Value @ 0.05	m = 15: Model of Estimated Break Dates	Rationale
				Panel A – Europe				
UK – 1983Q3 – 2019Q2								
1 *	298.1240	9.63	789.4465	10.17	1288.530	10.91	1985Q4	
2 *	437.0760	8.78					1988Q4	
3 *	561.9786	7.85					1991Q1	
4 *	642.1294	7.21					1992Q4	
5 *	719.6093	6.69					1995Q3	
6 *	656.6744	6.23					1997Q2	
7 *	518.0411	5.86					1999Q1	
8 *	506.8703	5.51					2000Q4	
9 *	460.6055	5.20					2002Q3	SARS
10 *	430.2593	9.10					2004Q2	
11 *	493.9929	7.92					2006Q1	Camp for Climate Action
12 *	789.4465	6.84					2008Q3	i. Kingsnorth Power Station ii. GFC
13 *	729.0219	6.03					2010Q3	i. Royal Bank of Scotland ii. Swine Flu
14 *	686.8421	5.37					2013Q1	
15 *	642.2582	4.80					2016Q3	
Russia – 1997Q3 – 2019Q2								
1 *	99.54431	9.63	649.3396	10.17	1067.089	10.91	2000Q1	
2 *	116.2802	8.78					2002Q1	SARS
3 *	185.7745	7.85					2003Q2	SARS
4 *	160.6770	7.21					2004Q3	
5 *	328.4495	6.69					2005Q3	
6 *	629.0734	6.23					2006Q4	
7 *	649.3396	5.86					2008Q3	GFC
8 *	544.8247	5.51					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
9 *	563.3314	5.20					2010Q3	Swine Flu- H1N1 virus/pigs
10 *	563.9221	9.10					2011Q3	
11 *	521.5101	7.92					2015Q1	i. MERS ii. Global Climate March
12 *	514.9602	6.84					2016Q1	Global Climate March
13 *	430.7475	6.03					2017Q3	
14 *	430.7054	5.37					2018Q3	
Italy – 1997Q4 – 2019Q2								
1 *	201.3559	9.63	214.6287	10.17	430.5988	10.91	1998Q4	
2 *	120.8688	8.78					1999Q4	
3 *	114.4775	7.85					2001Q3	
4 *	114.5838	7.21					2002Q3	SARS
5 *	158.0857	6.69					2003Q4	SARS

6 *	176.9404	6.23					2004Q4	
7 *	153.7494	5.86					2005Q4	
8 *	140.1879	5.51					2006Q4	
9 *	174.9353	5.20					2007Q4	
10 *	116.3861	9.10					2008Q4	GFC
11 *	154.8574	7.92					2009Q4	GFC Swine Flu- H1N1 virus/pigs
12 *	156.1767	6.84					2011Q3	
13 *	158.4617	6.03					2013Q4	
14 *	148.0929	5.37					2016Q1	
15 *	214.6287	4.80					2017Q1	
Portugal – 1992Q3 – 2019Q2								
1 *	162.5891	9.63	165.6282	10.17	272.1841	10.91	1993Q4	
2 *	139.4888	8.78					1996Q2	
3 *	127.3944	7.85					1997Q3	
4 *	100.3583	7.21					1999Q4	
5 *	119.3930	6.69					2001Q2	
6 *	136.3278	6.23					2002Q3	SARS
7 *	165.6282	5.86					2003Q4	SARS
8 *	110.1041	5.51					2005Q4	
9 *	135.7249	5.20					2007Q1	
10 *	132.3753	9.10					2008Q2	GFC
11 *	121.7952	7.92					2011Q3	
12 *	124.0077	6.84					2013Q3	
13 *	118.6514	6.03					2014Q4	
14 *	117.3667	5.37					2016Q1	i. Global Climate March ii. MERS
15 *	112.4924	4.80					2017Q2	
Germany – 1959Q3 – 2019Q2								
1 *	1109.847	9.63	2900.523	10.17	5421.256	10.91	1962Q3	
2 *	2041.720	8.78					1967Q3	
3 *	2753.069	7.85					1973Q1	
4 *	2900.523	7.21					1975Q4	
5 *	2347.721	6.69					1982Q4	Anti-WAAhnsinnsFestivals
6 *	2414.034	6.23					1985Q3	Anti-WAAhnsinns Festivals
7 *	2072.576	5.86					1989Q1	Anti-WAAhnsinns Festivals
8 *	2243.177	5.51					1993Q3	
9 *	2011.388	5.20					1997Q1	
10 *	1820.108	9.10					1999Q4	
11 *	1718.869	7.92					2002Q3	SARS
12 *	2184.337	6.84					2005Q2	
13 *	2050.358	6.03					2010Q4	Swine Flu- H1N1 virus/pigs
14 *	2756.934	5.37					2013Q3	
15 *	2702.184	4.80					2016Q4	Global Climate March
Panel B – US, Canada & Australia								
US – 1966Q3 – 2019Q2								
1 *	910.8642	9.63	2062.568	10.17	3469.675	10.91	1971Q1	Cleveland State University Students Protests
2 *	1536.412	8.78					1973Q4	
3 *	1521.524	7.85					1976Q2	
4 *	1856.380	7.21					1980Q2	
5 *	2062.568	6.69					1983Q1	
6 *	2013.319	6.23					1985Q4	
7 *	2042.870	5.86					1989Q2	
8 *	1945.999	5.51					1991Q4	
9 *	1873.553	5.20					1995Q1	
10 *	1736.408	9.10					1997Q3	
11 *	1673.483	7.92					2006Q1	

12 *	1655.933	6.84					2008Q3	GFC
13 *	1581.107	6.03					2011Q1	
14 *	1580.374	5.37					2013Q3	People's Climate March
15 *	1526.544	4.80					2017Q1	i. People's Climate March ii. Immigration ban protests
Canada – 1919Q1 – 2019Q2								
1 *	1132.189	9.63	5612.128	10.17	11017.66	10.91	1926Q3	
2 *	2121.965	8.78					1931Q3	
3 *	2390.541	7.85					1936Q3	
4 *	2535.489	7.21					1945Q2	
5 *	5516.458	6.69					1950Q2	
6 *	2944.677	6.23					1955Q2	
7 *	3195.607	5.86					1961Q2	
8 *	3388.442	5.51					1966Q2	
9 *	5449.144	5.20					1972Q1	May Day 1971
10 *	5002.834	9.10					1979Q2	
11 *	4959.105	7.92					1985Q3	
12 *	4591.402	6.84					1991Q4	
13 *	5612.128	6.03					1996Q4	
14 *	5216.926	5.37					2005Q3	
15 *	5491.671	4.80					2014Q1	i. Ebola ii. People's Climate March
Australia – 1992Q2 – 2019Q2								
1 *	262.2572	9.63	668.4785	10.17	1237.971	10.91	1993Q3	
2 *	403.6589	8.78					1995Q3	
3 *	431.3896	7.85					1997Q2	
4 *	453.7993	7.21					1999Q4	
5 *	355.4684	6.69					2002Q3	SARS
6 *	552.4375	6.23					2004Q2	
7 *	494.4643	5.86					2005Q3	
8 *	542.4722	5.51					2006Q4	
9 *	668.4785	5.20					2008Q3	Kooragang Island GFC
10 *	623.3033	9.10					2009Q4	GFC
11 *	599.2291	7.92					2011Q3	
12 *	524.5563	6.84					2012Q4	
13 *	494.5295	6.03					2014Q1	Ebola
14 *	534.7334	5.37					2016Q4	Global Climate March
15 *	499.3499	4.80					2018Q2	School strike for the climate
Panel C – Asian Countries								
China – 1990Q3 – 2019Q2								
1 *	62.90128	9.63	228.0524	10.17	352.5112	10.91	1992Q1	
2 *	135.4445	8.78					1994Q1	
3 *	179.2666	7.85					1996Q3	
4 *	145.2230	7.21					1997Q4	AFC
5 *	150.2876	6.69					1999Q2	
6 *	228.0524	6.23					2000Q3	
7 *	198.6225	5.86					2001Q4	
8 *	146.6326	5.51					2004Q2	
9 *	131.2823	5.20					2006Q4	
10 *	133.1683	9.10					2008Q2	GFC
11 *	111.5900	7.92					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
12 *	116.6526	6.84					2011Q3	2010 Xinfaaluminum plant protest
13 *	110.0107	6.03					2014Q4	Ebola
14 *	129.6023	5.37					2016Q1	Global Climate March

15 *	147.6859	4.80					2018Q2	
Japan – 1969Q4 – 2019Q2								
1 *	338.9762	9.63	573.0599	10.17	1037.594	10.91	1972Q1	
2 *	573.0599	8.78					1976Q1	
3 *	245.2590	7.85					1978Q2	
4 *	525.9461	7.21					1980Q3	
5 *	491.4251	6.69					1983Q2	
6 *	465.6339	6.23					1985Q4	
7 *	526.3099	5.86					1988Q1	
8 *	453.4841	5.51					1990Q2	
9 *	407.7785	5.20					1992Q3	
10 *	394.4231	9.10					1997Q4	i. AFC ii. American Consulate Protest
11 *	416.3139	7.92					2001Q3	
12 *	449.7242	6.84					2005Q3	
13 *	426.9574	6.03					2008Q3	GFC
14 *	436.6562	5.37					2013Q2	
15 *	517.1806	4.80					2016Q4	Global Climate March
India – 1990Q2 – 2019Q2								
1 *	509.1892	9.63	955.8801	10.17	1746.302	10.91	1992Q1	
2 *	528.7310	8.78					1993Q4	
3 *	692.8581	7.85					1995Q1	
4 *	736.4718	7.21					1997Q2	AFC
5 *	658.7275	6.69					1999Q3	
6 *	672.7802	6.23					2001Q1	
7 *	774.9738	5.86					2003Q3	SARS
8 *	713.6543	5.51					2004Q4	
9 *	898.9928	5.20					2006Q1	
10 *	955.8801	9.10					2007Q2	
11 *	847.8896	7.92					2008Q3	GFC
12 *	881.9794	6.84					2009Q4	i. GFC ii. Swine Flu- H1N1 virus/pigs
13 *	879.9123	6.03					2012Q3	
14 *	823.4023	5.37					2014Q2	Ebola
15 *	870.4308	4.80					2017Q2	i. Farmer protests ii. Reservations protests
Panel D – Other countries								
Mexico – 1994Q1 – 2019Q2								
1 *	509.7057	9.63	1011.712	10.17	1806.171	10.91	1995Q4	
2 *	540.9597	8.78					1997Q2	
3 *	673.9843	7.85					1999Q2	
4 *	803.9603	7.21					2000Q4	
5 *	885.0349	6.69					2002Q1	SARS
6 *	924.1131	6.23					2003Q4	SARS
7 *	1011.712	5.86					2005Q3	
8 *	1008.962	5.51					2006Q4	
9 *	975.2950	5.20					2008Q2	GFC
10 *	914.9027	9.10					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
11 *	836.6900	7.92					2010Q4	Swine Flu- H1N1 virus/pigs
12 *	771.1924	6.84					2012Q1	
13 *	715.1012	6.03					2014Q3	i. Ebola ii. People's Climate March
14 *	662.3256	5.37					2016Q3	
15 *	616.6706	4.80					2018Q1	School strike for the climate
Egypt – 1998Q1 – 2019Q2								
1 *	538.6944	9.63	838.9186	10.17	1131.423	10.91	2000Q3	
2 *	519.3034	8.78					2001Q4	

3 *	473.7586	7.85					2003Q2	SARS
4 *	812.6265	7.21					2004Q3	
5 *	645.1836	6.69					2005Q3	
6 *	540.4993	6.23					2006Q3	
7 *	486.1585	5.86					2007Q3	
8 *	425.7222	5.51					2008Q3	GFC
9 *	376.9640	5.20					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
10 *	838.9186	9.10					2011Q3	
11 *	789.4020	7.92					2012Q3	
12 *	721.8021	6.84					2013Q4	
13 *	661.0177	6.03					2015Q3	MERS
14 *	602.0041	5.37					2016Q4	Global Climate March
South Africa – 1995Q2 – 2019Q2								
1 *	529.6804	9.63	1277.899	10.17	2286.385	10.91	1996Q2	
2 *	612.9073	8.78					1998Q3	
3 *	1277.899	7.85					1999Q4	
4 *	1088.170	7.21					2001Q4	
5 *	1101.909	6.69					2002Q4	SARS
6 *	985.8162	6.23					2003Q4	SARS
7 *	1246.241	5.86					2004Q4	
8 *	1229.984	5.51					2005Q4	
9 *	1036.008	5.20					2006Q4	
10 *	983.1020	9.10					2008Q3	GFC
11 *	929.8617	7.92					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
12 *	1073.882	6.84					2010Q4	Swine Flu- H1N1 virus/pigs
13 *	874.0629	6.03					2012Q4	
14 *	1044.574	5.37					2013Q4	
15 *	1139.631	4.80					2017Q3	Anti-Zuma protest
Brazil – 1991Q1 – 2019Q2								
1	9.2519	9.63	245.0580	10.17	491.6475	10.91	1992Q2	
2 *	9.2659	8.78					1993Q3	
3 *	31.5607	7.85					1994Q4	
4 *	43.0228	7.21					1996Q1	
5 *	60.1671	6.69					1997Q2	
6 *	65.3095	6.23					1998Q3	
7 *	68.3406	5.86					1999Q4	
8 *	87.8712	5.51					2001Q3	
9 *	87.0263	5.20					2003Q4	SARS
10 *	93.5931	9.10					2005Q3	
11 *	198.3741	7.92					2006Q4	
12 *	206.2150	6.84					2009Q3	i. GFC ii. Swine Flu- H1N1 virus/pigs
13 *	209.2060	6.03					2011Q3	
14 *	236.7394	5.37					2017Q1	
15 *	245.0580	4.80					2018Q2	
Nigeria – 1998Q1 – 2019Q2								
1 *	194.7093	9.63	441.8529	10.17	818.8421	10.91	1999Q1	
2 *	441.8529	8.78					2000Q2	
3 *	322.5033	7.85					2001Q2	
4 *	357.4513	7.21					2002Q4	SARS
5 *	303.3854	6.69					2003Q4	SARS
6 *	363.3974	6.23					2006Q1	
7 *	343.9566	5.86					2007Q1	
8 *	297.4251	5.51					2008Q4	GFC
9 *	261.6200	5.20					2011Q3	
10 *	372.5223	9.10					2012Q3	
11 *	378.2768	7.92					2013Q3	
12 *	360.2592	6.84					2014Q4	Ebola
13 *	367.9197	6.03					2015Q4	MERS

								Ebola
14 *	326.2511	5.37					2017Q2	
15 *	408.1456	4.80					2018Q3	

* Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Notes: supF statistics estimated using Bai and Perron (1998, 2003) methods. Critical values from the table, Bai and Perron (1998). In choosing the number of breaks, column 8 establishes the existence of at least fifteen breaks.

4.3. Robustness Checks

4.3.1 Lee-Strazicich (2003) structural break approach

For the purposes of robustness checks, we also provide additional results by analysing Lee and Strazicich structural breaks method. Following the shortcomings related to the Zivot-Andrews (1992) and Perron (1989) structural break techniques, Lee and Strazicich (2003) developed an endogenous structural break test based on the Langrange Multiplier (LM) framework (F. Adedoyin, et al, 2020). We begin by stating the data generating process (DCP) in this fashion:

$$y_t = \varphi' B_t + \xi_t, \qquad \xi_t = \delta \xi_{t-1} + \mu_t \tag{1a}$$

In Eqn. 1a, B_t represents vector of independent indicators and $\xi_t \approx IID\ N(0,\ \sigma^2)$. We considered two structural breaks as follows: Model A contains shifts in two level and denoted by $A_t = [1, t, D_{1t}, D_{2t}]'$, given that $D_{nt} = 1 \text{for} t \geq T_{Bn} + 1,\ n = 1, 2,$ and otherwise 0. The time period required for a break to ensue is denoted as T_{Bn}. Next, Model C is made up of two level and trend changes, which is explained by $A_t = [1, t, D_{1t}, D_{12}, DT_{1t}, DT_{2t}]'$, given $DT_{nt} = t - T_{Bn}$ for $t \geq T_{Bn} + 1, n = 1, 2,$ and otherwise 0.

Recall that the null hypothesis requires $(b = 1)$, while the alternative hypothesis requires $(b < 1)$ whereby the DGP constantly comprises breaks. For instance, conditional on the value of b, Model A has the following:

$$z_t = \vartheta_0 + d_1 B_{1t} + d_2 B_{2t} + z_{t-1} + \zeta_{1t} \tag{2a}$$
$$z_t = \vartheta_1 + \upsilon_t + d_1 D_{1t} + d_2 D_{2t} + \zeta_{2t} \tag{3a}$$

Eqn. (2a) represents the null hypothesis, while Eqn.(3a) represents the alternative hypothesis. The stationary disturbance terms are denoted by ζ_{1t} and ζ_{2t}; $B_{nt} = 1$ for $t = T_{Bn} + 1, n = 1, 2,$ and otherwise 0; $d = (d_1, d_2)$ and the trend parameter denoted by υ_t. However, for Model C, we respectively add the D_{nt} and DT_{nt} terms to Eqns.(2a) and (3a). It should be noted that dummy variables are included in the hull hypothesis (Eqn.2a), denoted as B_{nt}. To guarantee that the asymptotic distribution of the test statistics is uniform to the magnitude of (d) breaks given the null, it is crucial to include B_{nt} (see Perron, 1989, p.1393). See F. Adedoyin, et al. (2020) for details on the unit root test for break LM module.

We present the empirical results for Lee and Strazicich unit root test results for unknown structural breaks in Table 7.[5] As indicated in section 4.1 above, the results are assembled into five groups – Europe; America, Canada & Australia; Asia and other countries. In the case of Europe, the endogenous break tests reject the presence of a unit root (the null) in support of the alternative for the existence of break stationarity for UK, Russia, Italy and Germany, whereas the null cannot be rejected in the case of Portugal. That is, the LM test of Lee-Strazicich show a rejection of the unit root in support of the stationarity with structural breaks at 10% for UK and Russia; 5% for Italy and 1% for Germany. Further, considering the group in Panel B, the results show that the break test rejects the unit root in favour of the break stationary alternative only in the case of the US, at 1% level of significance, while unit root was found in the cases of Canada and Australia respectively. In the case of the Asian group, our results further indicate that we fail to reject the null of unit root break test for China and India, whereas the break test rejects the unit root in favour of the break stationary alternative in the case of Japan at the 1% level of significance. In Panel D, results for other countries are displayed. It can be seen that the break test rejects the null of a unit root in favour of the alternative of break stationarity for Mexico and Brazil at the 1% level, South Africa and Nigeria at the 5% level of significance, respectively.[6] Overall, with respect to break dates and the rationales, the results obtained from Lee and Strazicich unit root tests have qualitative similarities with those from Bai-Perron endogenous structural break test as displayed Tables 2 – 5.

[5] Critical values for Lee-Strazicich structural break test are displayed in Table 8.

[6] It should be noted that after differencing the series investigated, the endogenous break tests reject the presence of a unit root (the null) in support of the alternative for the existence of break stationarity for all countries. These results can be provided upon request.

Table 8 Lee – Strazicich Unit Root Test Results

S/N	Country	Coefficient {1}	T-stat.	Break Dates	Inference	Rationale
Panel A – Europe						
1.	UK	-0.4058*	-5.4575	1987Q1, 1990Q3, 1994Q1, 1997Q3, 2001Q1, 2004Q3, 2008Q1, 2011Q3, 2015Q1, 2018Q3,	Break stationary	i. Kingsnorth Power Station ii. GFC
2.	Russia	-0.6507*	-5.4238	1999Q3, 2001Q3, 2003Q3, 2005Q3, 2007Q3, 2009Q3, 2011Q3, 2013Q3, 2015Q3, 2017Q3	Break stationary	i. SARS, ii. GFC iii. Swine Flu-H1N1 virus/pigs iv. MERS v. Global Climate March
3.	Italy	-0.6851**	-5.5910	1999Q4, 2001Q4, 2003Q4, 2005Q4, 2007Q4, 2009Q4, 2011Q4, 2013Q4, 2015Q4, 2017Q4	Break stationary	i. SARS ii. GFC iii. Swine Flu-H1N1 virus/pigs
4.	Portugal	-0.5207	-5.3395	1995Q1, 1997Q3, 2000Q1, 2002Q3, 2005Q1, 2007Q3, 2010Q1, 2012Q3, 2015Q1, 2017Q3	Unit Root	SARS
5.	Germany	-0.3325***	-6.5012	1965Q3, 1971Q2, 1977Q1, 1982Q4, 1988Q3, 1994Q2, 2000Q1, 2005Q4, 2011Q3, 2017Q2	Break stationary	Anti-WAAhnsinns Festivals
Panel B – US, Canada & Australia						
1.	US	-0.3496***	-6.2602	1971Q4, 1977Q1, 1982Q2, 1987Q3, 1992Q4, 1998Q1, 2003Q2, 2008Q3, 2013Q4, 2019Q1	Break stationary	i. Cleveland State University Students Protests ii. GFC
2.	Canada	-0.0980	-4.3967	1929Q1, 1939Q1, 1949Q1, 1959Q1, 1969Q1, 1979Q1, 1989Q1, 1999Q1, 2009Q1, 2019Q1	Unit Root	i. May Day 1971 ii. GFC
3.	Australia	-0.4898	-5.1568	1994Q4, 1997Q2, 1999Q4, 2002Q2, 2004Q4, 2007Q2, 2009Q4, 2012Q2, 2014Q4, 2017Q2	Unit Root	i. SARS ii. GFC iii. Ebola
Panel C – Asian Countries						
1.	China	-0.3558	-4.3636	1993Q3, 1996Q2, 1999Q1, 2001Q4, 2004Q3, 2007Q2, 2010Q1, 2012Q4,	Unit Root	i. AFC ii. 2010 Xinfaaluminum plant protest

				2015Q3, 2018Q2		
2.	Japan	-0.4383***	-6.9481	1974Q3, 1979Q2, 1984Q1, 1988Q4 1993Q3, 1998Q2, 2003Q1, 2007Q4, 2012Q3, 2017Q2	Break stationary	i. AFC ii. American Consulate Protest iii. SARS
3.	India	-0.3774	-4.5756	1993Q1, 1995Q4, 1998Q3, 2001Q2, 2004Q1, 2006Q4, 2009Q3, 2012Q2, 2015Q1, 2017Q4	Unit Root	i. AFC ii. GFC iii. Swine Flu-H1N1 virus/pigs iv. Ebola v. Farmer protests vi. Reservations protests
			Panel D – Other countries			
1.	Mexico	-0.6685***	-6.1361	1996Q3, 1999Q1, 2001Q3, 2004Q1, 2006Q3, 2009Q1, 2011Q3, 2014Q1, 2016Q3, 2019Q1	Break stationary	i. GFC ii. Swine Flu-H1N1 virus/pigs iii. Ebola iv. People's Climate March
2.	Egypt	-0.5977	-5.0146	2000Q1, 2002Q1, 2004Q1, 2006Q1, 2008Q1, 2010Q1, 2012Q1, 2014Q1, 2016Q1, 2018Q1	Unit Root	i. GFC ii. Ebola iii. MERS iv. Global Climate March
3.	South Africa	-0.6149**	-5.5746	1997Q3, 1999Q4, 2002Q1, 2004Q2, 2006Q3, 2008Q4, 2011Q1, 2013Q2, 2015Q3, 2017Q4	Break stationary	GFC Anti-Zuma protest
4..	Brazil	-1.0950***	-10.2599	1993Q4, 1996Q3, 1999Q2, 2002Q1, 2004Q4, 2007Q3, 2010Q2, 2013Q1, 2015Q4, 2018Q3	Break stationary	
5.	Nigeria	-0.7059**	-5.6732	2000Q1, 2002Q1, 2004Q1, 2006Q1, 2008Q1, 2010Q1, 2012Q1, 2014Q1, 2016Q1, 2018Q1	Break stationary	i. GFC ii. Ebola iii. MERS

***, ** and * denote statistical significance at 1%, 5% and 10% respectively.

Table 8 Lee-Strazicich critical values for endogenous break test

Break points	Critical values		
$=(T_{B1}/T, T_{Bn}/T)$	1%	5%	10%
= (0.2 , 0.4)	-6.16	-5.59	-5.27
= (0.2 , 0.6)	-6.41	-5.74	-5.32
= (0.2 , 0.8)	-6.33	-5.71	-5.33
= (0.4 , 0.6)	-6.45	-5.67	-5.31
= (0.4 , 0.8)	-6.42	-5.65	-5.32
= (0.6 , 0.8)	-6.32	-5.73	-5.32

Source: Lee-Strazicich (2003)

5. Conclusion

The outbreak of the novel coronavirus has created a need for research into its impact on several aspects of human endeavours. Thus, this study adopts the Bai and Perron (2003a, 2003b, 1998) multiple regime shift technique to highlight exact number and dates of breakpoints in stock market data for 16 major markets across several regions of the world.

This study found different number of break dates across several regions. For instance, while selected sample countries in Europe have at least ten break dates under the period of investigation, we observe for US, Canada and Australia, only twelve break dates. Asia and the other bloc of countries report ten and twelve break dates respectively. Notably, one most prominent causes of structural changes in stock markets (with the exclusion of Germany) appears to be from the GFC, which had inverse effects on major market around the world. The most prominent source of structural breaks in the Asian markets appears to be from the 2008-2009 GFC. In addition, we found evidence of structural breaks in several stock markets in the world, resulting from the 2009-2010 Global Pandemic, that is, the H1N1 virus/pigs Swine Flu; 2003 SARS; MERS; and EBOLA. However, as explained above, events have the tendency of unfolding over time; hence matching exact breaks in stock market data to precise events is very unlikely.

One limitation of the current study is the inability to secure broader dataset to help test daily and monthly response of the stock market to the novel coronavirus. However, there is a huge benefit still from the current study as it serves as a blueprint for assessing the role of pandemics, crisis events or other factors in the stock market. Thus, future studies may also attempt to consider structural break dates in estimating stock market data for economic or financial modelling efforts.

6. Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Appendix

Table A.1. Global Pandemics Tracker

Name	Period	Location	Type	Death Toll
Antonine Plague	165-180		Smallpox or measles	5 million
Japanese Smallpox	735-737	Japan	Variola major virus	1 million
Plague of Justinian	541-542		Yersinia Pestis bacteria/rats, fleas	30-50 million
Black Death	1347-1451		Yersinia Pestis bacteria/rats, fleas	200 million
New World Smallpox outbreak	1520	Worldwide	Variola major virus	56 million
Great Plague of London	1665	United Kingdom	Yersinia Pestis bacteria/rats, fleas	100,000
Italian Plague	1629-1631	Italy	Yersinia Pestis bacteria/rats, fleas	1 million
Cholera Pandemics	1817-1923		V. Cholerae Bacteria	1 million above
Third Plague	1885	China and India	Yersinia Pestis bacteria/rats, fleas	12 million
Yellow Fever	Late 1800s	U.S	Virus/Mosquitoes	100000-150000
Russian Flu	1889-1890	Russia	H2N2	1 million
Spanish Flu	1918-1919	Spain	H1N1 virus/ Pigs	40-50 million
Asian Flu	1957-1958		H2N2 virus	1.1 million
Hong Kong Flu	1968-1970	Hong-Kong China	H3N2 virus	1 million
HIV/AIDS	1981-Present	World-Wide	Virus/Chimpazee	25-35 million
Swine Flu	2009-2010		H1N1 virus/ Pigs	200000

Name	Period	Location	Type	Death Toll
SARS	2002-2003		Coronavirus/ Bats, Civets	770
Ebola	2014-2016		Ebola virus/wild animals	11000
MERS	2015-Present		Coronavirus/ Bats, Camels	850
COVID-19	2019-Present	Worldwide	Coronavirus	8 million as August 2020

Note: www.weforum.org/agenda/2020/03/a-visual-history-of-pandemics

Table A.2. Event and protest tracker

Country	Protest Name	Start Date	Organizers
Albania	Local elections protests	Feb-19	Opposition parties.
Algeria	Protests against "Le Pouvoir"	Feb-19	Opposition parties; a wide range of everyday citizens, such as bankers, truck drivers, teachers, students.
Argentina	Austerity protests	Sep-18	Teachers, social organizations, leftist groups.
Argentina	Violence against women protests	Apr-20	Women.
Armenia	RejectSerzh" protests	Apr-18	Students, opposition leaders.
Australia	Wildfire protests	Jan-20	Students, activists.
Australia	Racial equality protests	Jun-20	General public.
Azerbaijan	Political prisoner protest	Jan-19	Umbrella group of opposition parties.
Bangladesh	Road safety protests	Jul-18	Middle school, high school, university students.

Country	Protest Name	Start Date	Organizers
Belarus	"Parasite" tax protests	Feb-17	General public.
Belarus	"Slipper uprising"	Jun-20	General public.
Benin	Election protests	Mar-19	Political supporters of former president Thomas Yayi.
Bolivia	Wildfire protests	Oct-19	General public.
Bolivia	2019 election protests	Oct-19	Opposition parties, labor groups, middle-class citizens, some indigenous groups, and (later) Morales's supporters.
Bosnia and Herzegovina	"Justice for David" protests	Mar-18	Bosnian Serbs.
Brazil	Education cuts protests	May-19	Students, teachers, teachers' unions.
Brazil	Coronavirus protests	Mar-20	General public.
Bulgaria	Corruption protests	Jul-20	General public.
Chile	Subway fare protests	Oct-19	Students, young people, professionals, civil society groups.
Colombia	National strikes	Nov-19	Students, unions, leftist groups, and indigenous groups.
Colombia	Coronavirus protests	Mar-20	General public.
Colombia	Prison protest	Mar-20	Prisoners.
Costa Rica	Tax reform protests	Sep-18	Trade unions, public sector workers.
Croatia	Teachers' strike	Nov-19	Members of teachers' unions, teachers, children.
Czech Republic	"Million Moments for Democracy" protests	Apr-19	General public.
Democratic	Election delay protests	Dec-17	Religious leaders, civil society organizations.

Country	Protest Name	Start Date	Organizers
Republic of the Congo			
Democratic Republic of the Congo	Judiciary reform protests	Jun-20	Supporters of President Felix Tshisekedi and his party, the Union for Democracy and Social Progress (UDPS).
Dominican Republic	Corruption protests	Jul-17	Young people.
Ecuador	Fuel subsidy protests	Oct-19	Indigenous groups, transportation unions, student groups, labor unions.
Ecuador	Coronavirus protests	May-20	Trade unions, social welfare organizations.
Egypt	Corruption protests	Sep-19	Young people.
Ethiopia	Political prisoner protests	Feb-18	Oromo and Amhara ethnic groups.
France	Labor reform protests	Sep-17	Trade unions, general public.
France	Rail unions' protests	Mar-18	Public sector workers, trade unions, students.
France	"Yellow Vest" protests	Nov-18	Initially mostly rural citizens, then later some urban working- and middle-class participants; some support from and participation by controversial far-right political groups.
France	Pension reform protests	Dec-19	Unions, public sector employees, Yellow Vest protesters, students, lawyers, rail workers.
France	Black Lives Matter protests	Jun-20	General public.
Gambia	"Three Years Is Enough"	Dec-19	General public.

Country	Protest Name	Start Date	Organizers
	protests		
Gaza Strip	"Great March of Return" protests	Mar-18	Palestinians.
Georgia	Russian interference protests	Jun-19	General public.
Georgia	Electoral reform protests	Oct-19	General public.
Germany	Far-right pact protests	Feb-20	Unions, antifascist groups, young people.
Germany	Coronavirus lockdown protests	Apr-20	Right- and left-wing extremists, conspiracy theorists, antivaccine groups.
Germany	Police brutality protests	Jun-20	General public.
Greece	Pension reform strike	Feb-20	Public sector trade unions.
Guinea	Term limit protests	Oct-19	Coalition of politicians, activists.
Haiti	PetroCaribe protests	Jul-18	Political opposition, young people, union workers, university professors, business associations, middle-class participants.
Honduras	2017 election protests	Dec-17	Political opposition, religious institutions.
Honduras	Privatization reform protests	Apr-19	Teachers, medical professionals, unions, trade groups, farmers, taxi and truck drivers, police officers.
Hong Kong	Sentencing protest	Aug-17	General public.
Hong Kong	Extradition bill protests	Apr-19	General public, especially younger citizens and students.
Hungary	"Slave law" protests	Dec-18	Trade unions, civil society groups, opposition parties.
India	Farmer protests	Apr-17	Farmers' organizations.
India	Reservations protests	Aug-17	Members of the Maratha community, young people, senior citizens.
India	SC/ST Act protests	Apr-18	Members of the lower castes, Dalits.

Country	Protest Name	Start Date	Organizers
India	Citizenship law protests	Dec-19	Students, young people (protesting discrimination against Muslims), citizens in northeastern India (protesting migration).
India	24-hour strike	Jan-20	Trade unions, students.
India	Migrant worker protest	Apr-20	Migrant workers.
Indonesia	West Papua protests	Aug-19	Papuan citizens.
Indonesia	Criminal code protests	Sep-19	University students.
Iran	Budget protests	Dec-17	Younger, working-class citizens, some of whom are from towns and rural cities.
Iran	Fuel hike protests	Nov-19	Low-income and working-class families.
Iran	Downed plane protests	Jan-20	University students.
Iraq	Iraq protests	Oct-19	Young people (especially young men), university students.
Israel	Recommendations bill protests	Dec-17	General public.
Israel	Nation-state law protests	Aug-18	Jews, Palestinians.
Israel	Israel coronavirus protests	Mar-20	General public.
Italy	Union-led economic protests	Feb-19	Trade unions.
Italy	Prison protest	Mar-20	Prisoners.
Japan	Police brutality protests	June-20	General public.
Jordan	Tax law protests	May-18	Youth movement, civil society groups, professional associations, labor unions.
Kazakhstan	Election protests	Jun-19	General public.

Country	Protest Name	Start Date	Organizers
Lebanon	WhatsApp tax protests	Oct-19	Different religious sects.
Lebanon	Prison protest	Mar-20	Prisoners.
Liberia	Economic protests	Jun-19	Opposition parties, civil society activists.
Madagascar	Electoral law protests	Apr-18	Opposition candidates.
Malawi	Election fraud protests	May-19	Opposition party leaders and their supporters.
Maldives	Maldives protests	Feb-18	General public.
Mali	Ethnic violence protest	Apr-19	Muslim religious leaders, representatives of the Fulani herding community, opposition parties, civil society groups.
Mali	Movement of June 5	Jun-20	General public.
Malta	"Mafia state" protests	Nov-19	Civil society.
Mexico	Femicide protests	Mar-20	Women, feminist organizations.
Moldova	Corruption protests	Jun-18	Opposition parties and their supporters.
Mongolia	Corruption protests	Dec-18	General public.
Montenegro	Corruption protests	Mar-19	Civic activists, students, academics, journalists.
Montenegro	"Religion law" protests	Dec-19	Serbian Orthodox Church clergy and their supporters, pro-Russian and pro-Serbian political movements.
Morocco	Teacher protests	Feb-19	Teachers, teachers' unions.
Nepal	"Guthi bill" protests	Jun-19	Trustees, cultural experts, activists, civil society, members of the Newar community.
New Zealand	Racial equality protests	Jun-20	General public.

Country	Protest Name	Start Date	Organizers
Nicaragua	Social security reform protests	Apr-18	University students, business sector, general public.
Pakistan	Islamabad sit-in protests	Oct-19	Conservative Islamist party, teachers and students from religious schools.
Peru	Fujimori pardon protests	Dec-17	General public.
Poland	Judicial reform protests	Jul-18	General public.
Poland	"Muzzle law" protests	Dec-19	Polish judges and lawyers, judges from across Europe.
Portugal	Police brutality protest	Jun-20	General public.
Romania	Corruption protests	Jan-17	Key participants varied by protest, from urban young people to Romanian diaspora, magistrates.
Russia	Corruption protest	Mar-17	Opposition leaders, activists.
Russia	Moscow election protests	Jul-19	Opposition groups with various political affiliations, young people.
Russia	Constitutional changes protests	Feb-20	Political opposition.
Russia	Coronavirus restrictions protests	Apr-20	General public.
Russia	Khabarovsk protests	Jul-20	General public.
Serbia	"1 Out of 5 Million" protests	Dec-18	Opposition parties.
Serbia	Coronavirus protests	Jul-20	General public.
Slovakia	"For a Decent Slovakia" protests	Mar-18	Young people.
South Africa	Anti-Zuma protest	Apr-17	General public.
South Africa	Violence against women protests	Sep-19	Gender rights activist organizations.
South Korea	Candlelight demonstrations	Oct-16	Trade unions, students, feminist groups, families, representatives from parties on the political right and left.

Country	Protest Name	Start Date	Organizers
South Korea	Justice minister protests	Oct-19	Anti-Cho protesters: evangelical Christian activists, conservatives, older citizens; pro-Cho protestors: younger, urban, white-collar workers.
Spain	Catalan independence protests	Oct-19	Pro-independence groups and their supporters.
Spain	Coronavirus protests	May-20	Supporters of the far-right Vox party.
Sri Lanka	Constitutional crisis protests	Oct-18	Supporters of the former prime minister.
Sudan	Sudanese revolution	Dec-18	General public, trade union of professionals, women.
Sudan	"Million-man March"	Jun-20	General public, professional organizations, resistance committees; Islamic groups and supporters of Bashir.
Taiwan	Pension reform protest	Jan-17	Public employees such as military personnel, teachers, police, civil servants.
Taiwan	Taiwan "Yellow Vest" protests	Dec-18	Activist groups, general public.
Thailand	Antigovernment protests	Jul-20	Youth groups, general public.
Togo	Term limit protests	Sep-17	Coalition of opposition parties, protestors from varying age groups, social classes, ethnicities.
Tunisia	Unemployment protests	Jun-20	General public.
Turkey	"March for Justice" protest	Jul-17	Turkey's largest pposition party.
Turkey	Economic protest	Dec-18	Public service workers' unions.
Ukraine	Peace plan protests	Oct-19	War veterans, moderate critics of Zelensky, nationalist and far-right activists.
United	People's Vote protests	Jun-18	People's Vote campaign, pro-EU groups, general public.

Country	Protest Name	Start Date	Organizers
Kingdom			
United Kingdom	Black Lives Matter protests	Jun-20	General public.
United States	Immigration ban protests	Jan-17	General public.
United States	"Keep Families Together" protest	Jun-18	General public.
United States	"Lights for Liberty" protest	Jul-19	General public (including protests in all fifty states, with a significant number occurring in regions that had voted for Trump in 2016).
United States	"Telegramgate" protests	Jul-19	Puerto Ricans.
United States	Coronavirus lockdown protests	Apr-20	Conservative organizers, grassroots groups.
United States	Prison protest	Apr-20	Immigration activists.
United States	Police brutality protests	May-20	General public.
Uruguay	Farmer protest	Jan-18	Farmers' organizations.
Venezuela	"Mother of All Marches" protests	Apr-17	Political opposition.
Venezuela	January 2019 protests	Jan-19	Working-class citizens who once represented one of the regime's bastions of support.
Vietnam	Cybersecurity/special economic zone protests	Jun-18	General public.
Zimbabwe	Mugabe protest	Nov-17	General public, including war veterans.

Source: https://carnegieendowment.org