Shock Resistors or Transmitters? Contagion across Industries and Countries during the COVID-19 Pandemic and the Global Financial Crisis

Hadi Harb , Mehmet Umutlu

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Highlights

- We study how shocks spread across sectors and countries over the last two global crises.
- We use residual-based and volatility-adjusted correlation as a measure of contagion.
- Some sectors and countries were shock-resistant while others were transmitters.
- The ability to spot immune markets has implications for portfolio diversification.

Shock Resistors or Transmitters? Contagion across Industries and Countries during the COVID-19 Pandemic and the Global Financial Crisis

Hadi Harb[1,2] and Mehmet Umutlu[3,*]

[1] *Graduate School, Yasar University, Bornova, 35100, Izmir, Turkiye*

[2] *Department of Accounting and Finance, University of Science and Arts in Lebanon, Beirut, Lebanon.*

[3] *Accounting and Finance Subject Group, The Business School, Edinburgh Napier University, Edinburgh, EH14 1DJ, United Kingdom.*

** Corresponding Author. Email address:m.umutlu@napier.ac.uk*

Abstract

We examine how global shocks from various sources propagate across industries and countries. Financial contagion is measured using residual-based and volatility-adjusted correlation. Specific industries and countries were resilient during both global crises, while others played a significant role in transmitting shocks.

Keywords: Contagion, COVID-19 pandemic, global financial crisis, correlation, international diversification

JEL Classification: E44; G15; H12; I18

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1. Introduction

The COVID-19 pandemic and the 2008 global financial crisis (GFC) indicate how global shocks can quickly spread across countries and industries, reducing the benefits of international diversification. Asness et al. (2011) argue that global diversification may provide modest investment protection during downturns. Therefore, there is rising interest in analysing international portfolio diversification efficiency to prepare for future global shocks. In contrast to

prior studies on whether cross-country or cross-industry diversification facilitates international diversification during crises (Umutlu and Yargi, 2022), this study takes a distinct approach. It investigates whether the same industries or countries spread shocks over the last two global crises and whether any of them remain resilient. These research questions have implications for enhancing the efficiency of international diversification, particularly during global downturns. In this regard, this paper assesses the claim that risk-reduction benefits of international diversification disappear during crises when they are most needed.

The financial crisis of 2008-2009 was the first genuinely global crisis since the Great Depression of 1929 (Bekaert, et al., 2014). This crisis originated in a small segment of the lending market in the United States. Subsequently, it spread swiftly across various economies and industries, irrespective of their market integration and development stages, resulting in a global phenomenon. In the same way, the COVID-19 pandemic started in China and progressed globally, hitting stock markets worldwide (Arteaga-Garavito et al., 2024). Resulting market volatility surpassed the historical levels observed during the global financial crisis in 2008 and black Monday in 1987 (Baker, et al., 2020). Motivated by the global impact of both crises and the expanding literature that compares them (Gunay & Can, 2022), this study investigates the distinct responses of industries and countries to global shocks during each crisis. The two global crises are compared in terms of shock transmission across industries and countries. This comparative analysis allows us to uncover lessons for future global crises. Overall, our objective is to identify asset allocation decisions that facilitate effective international diversification, even during global crisis periods.

Our study augments the current body of research in numerous respects. First, we examine whether there are any common shock propagation channels during the most recent two global crises. Second, we analyze not only country indices but also industry indices as two potential conduits through which shocks can spread. Third, we quantify the magnitude of shock transmission using Fry et al.'s (2010) volatility-adjusted residual correlation as a financial contagion indicator. This indicator accurately estimates financial contagion by measuring the correlation after accounting for variations in volatility. Fourth, correlations are calculated using residuals from the Fama and French (2015) five-factor model extended with Carhart's (1997)

momentum factor (FFC6 model), which is the most comprehensive model for computing residual correlations.

2. Data and Methodology

Our analysis encompasses a diverse sample of 59 countries, including a combination of developed and emergent markets, as well as 20 global industries. The industry categories are based on the industry classifications of Datastream. We obtained the daily total return index data for DS country and DS World industry indices from the Datastream between May 01, 2005 and May 31, 2023. To assess the transmission of shocks from the source market *i* to the recipient market *j*, we utilize the contagion measure of Fry et al. (2010), which is based on the difference in correlations between crisis and pre-crisis periods. This measure relies on the correlation of residuals from a factor model and is adjusted to account for volatility. The FFC6 model represented by Eq. (1) is used to obtain residuals.

$$R_{i,t} - r_f = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \beta_6 MOM_t + e_i \quad (1)$$

where $R_{i,t}$ represents the daily return on asset *i* on day *t* and r_f is the risk-free rate which is proxied by the one-month US T-bill rate. MKT_t, SMB_t, HML_t, RMW_t, CMA_t, and MOM_t represent the daily international market, size, value, profitability, investment, and momentum factors, respectively. These international factors are sourced from Kenneth French's online data library, which also provides the factor construction details.[1] Eq. (1) is estimated for each month using daily data within a month and daily residuals are estimated.

To reach the residual-based contagion measure in Eq. (2), first the correlation between the source market and the recipient market in a tranquil non-crisis period, ρ_x, is calculated. Then ρ_x is compared to the correlation observed during the turbulent crisis period, $V_{y|x}$, which is adjusted for the typically high volatility during such times.

[1] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

$$CR_{i\to j} = \left(\frac{V_{y|x} - \rho_x}{\sqrt{Var(V_{y|x} - \rho_x)}} \right)^2 \quad (2)$$

Here, *CR* is the contagion between the source market *i* and the recipient market *j*. The pre-crisis period correlation, ρ_x, is the standard correlation measure while the volatility-adjusted correlation in the crisis period, $V_{y|x}$, is defined by Eq. (3).

$$V_{y|x} = \frac{\rho_y}{\sqrt{1+\delta(1-\rho_y^2)}} \quad (3)$$

where δ, which is equal to $(s_{y,i}^2 - s_{x,i}^2)/s_{x,i}^2$, shows the proportionate change in the volatility of residuals in the source market *i*. $s_{x,i}^2$ and $s_{y,i}^2$ are the sample variances of residuals in *i* during pre-crisis and crisis periods, respectively. ρ_y represents the unadjusted correlation between *i* and *j* during the crisis period. Fry et al. (2010) show that the denominator of Eq. (2) can be expressed in terms of previously defined variables ρ_x, ρ_y, δ as well as T_x and T_y, which are defined as the length of sample periods for pre-crisis and crisis periods, respectively.[2] They also show that *CR* follows a Chi-square distribution with a degree of freedom of one under the null hypothesis of no contagion.

$$H_0: V_{y|x} = \rho_x$$

$$H_1: V_{y|x} \neq \rho_x$$

3. Results and Discussion

According to Hong et al. (2023), the pandemic is set to commence in February 2020. In April 2023, the World Health Organisation declared the end of the pandemic. We follow Fry et al. (2014) to define the GFC period as September 2007 to December 2009. Selecting an equal length period as the crisis periods before the start of each crisis gives the pre-crisis periods. Thus, the pandemic's pre-crisis period is July 2016–January 2020, while that of GFC is May 2005–August 2007.

[2] See the appendix in their study for details.

Figures 1 and 2 show the time-series behavior of industry and country returns, respectively. These figures indicate that crisis periods (around 2008 and 2020) are typically characterized by high volatility whereas pre-crisis periods are comparatively calm. This observation lends credence to the utilization of a volatility-adjusted contagion measure.

[Insert Figure 1]

[Insert Figure 2]

Table 1 shows the contagion test results for industries during both crises. For GFC, the US is the source market of shock. During the pandemic, shocks originating from China are examined. At 5% or lower significance, 12 of 20 industries reject the null of no contagion during GFC. Likewise, 13 industries exhibit contagion during the pandemic. Moreover, nine of the contagion-prone industries were common in both crises, indicating a clear pattern of shock propagation within specific industries. Some industries transmit shocks for one crisis. During the pandemic, Travel and Leisure's *CR* value of 31.27 rejects the no-contagion hypothesis at 1% significance. This is consistent with stringent global mobility restrictions imposed to control the spread of the coronavirus.

Besides, the GFC strengthened the correlation of the Financial Services industry (*CR* = 7.56) with the US market (shock source) at a 1% significance level. This is also not surprising as GFC started in the financial sector. Apart from these crisis-specific channels, most shocks are transmitted through nine industries, which can be perceived as systematic channels of shock transmission. Global investors seek shock-resistant industries for efficient international diversification. Such industries that do not show contagious effects during both crises are Personal Care Drugs and Groceries, Health Care, Technology, and Consumer Products and Services. These industries may possess the potential to be resilient to shocks, making them attractive to global investors, particularly during turbulent times.

The no-contagion hypothesis cannot be rejected for both crises for 14 countries as shown in Table 2, suggesting they are immune to shocks. Many of these countries are emerging or frontier markets, not fully integrated into global capital markets. That may explain why segmented countries receive shocks differently. Obviously, these countries provide international investors

with diversification opportunities. Overall, investing in immune industries of immune countries can help stabilize global portfolios for the next shock.

3.1 Further Tests

We conduct two robustness tests. First, we employ alternative time windows for the crisis periods. Following Mollah (2014), we use the September 2008 - December 2009 period as the GFC period. For the COVID-19 pandemic, the September 2020 - April 2023 period serves as an alternative crisis period. Second, we employ CAPM as an alternative to the FFC6 model to obtain residual-based correlations. The results from both tests echo our original results. (Please see Tables A1-A4 in the Online Appendix).

Finally, we employ a different contagion component to determine the correlation between expected, i.e. systematic, returns from the FFC6 model. Hence, the new contagion measure complements residual-based correlation by addressing systematic correlation. In Tables A5 and A6, almost all industries and most countries exhibit an increase in systematic correlation during both crises as global crises typically deteriorate economic fundamentals (like interest rates, inflation, etc.) worldwide. This reveals residual-based contagion's ability to capture industries and countries with excess correlation beyond the correlation driven by economic fundamentals.

4. Conclusion

Global crises cause widespread impacts and reduce the benefits of international diversification. We examine shock transmissions across countries and industries during the GFC and COVID-19 pandemic to identify resilient markets that can help international investors diversify efficiently during global crises. We show that certain industries and countries proved shock-resistant, whereas others were shock-transmitters during both crises. Adding resilient industries from resilient countries to a portfolio and eliminating contagion-prone ones can remarkably boost portfolio immunity. The ability to identify resilient industries and countries gives investors a critical edge to proactively rebalance their portfolios for risk mitigation.

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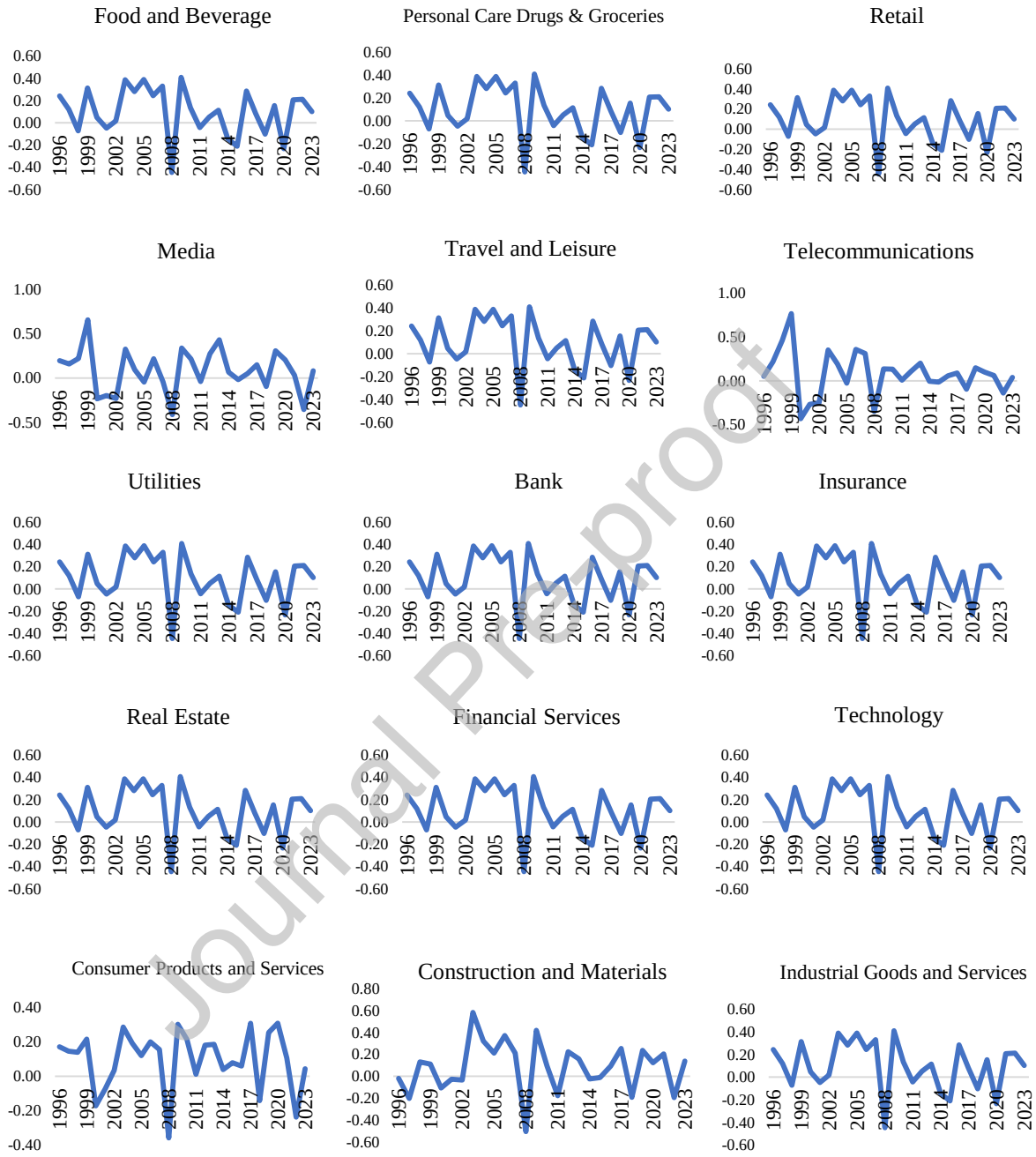
Figure 1: $ Denominated Annual Industry Returns (%)



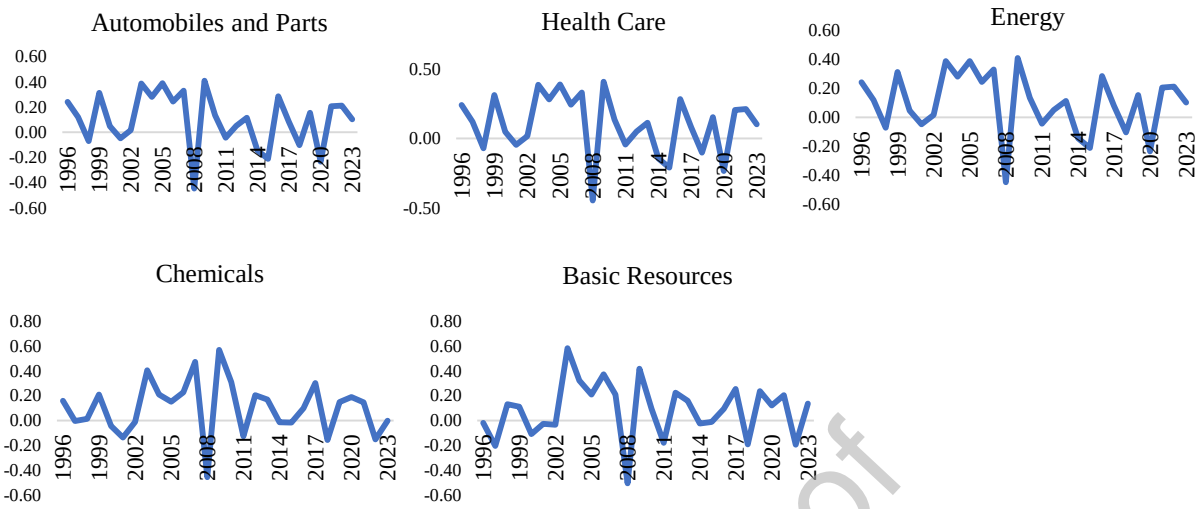
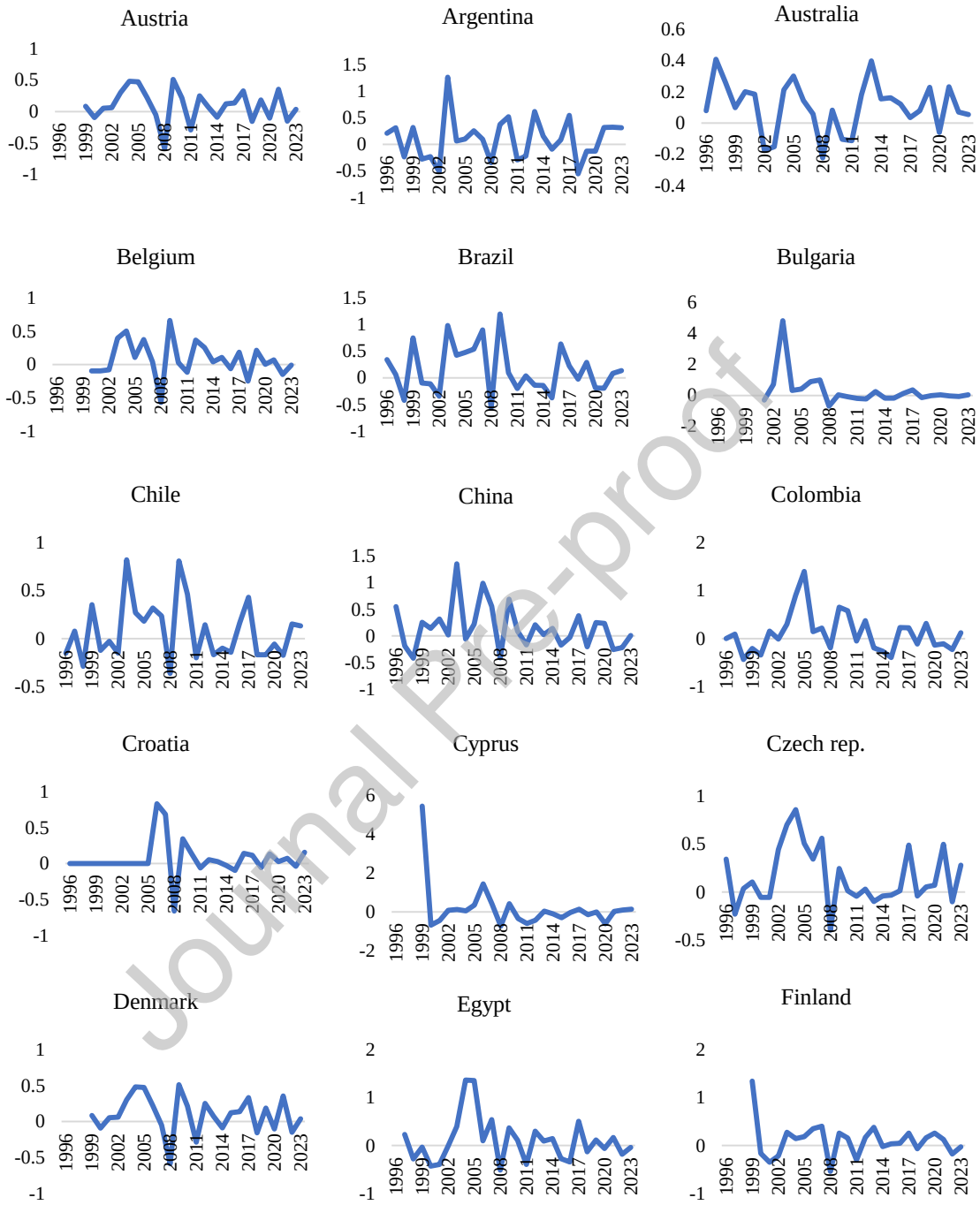
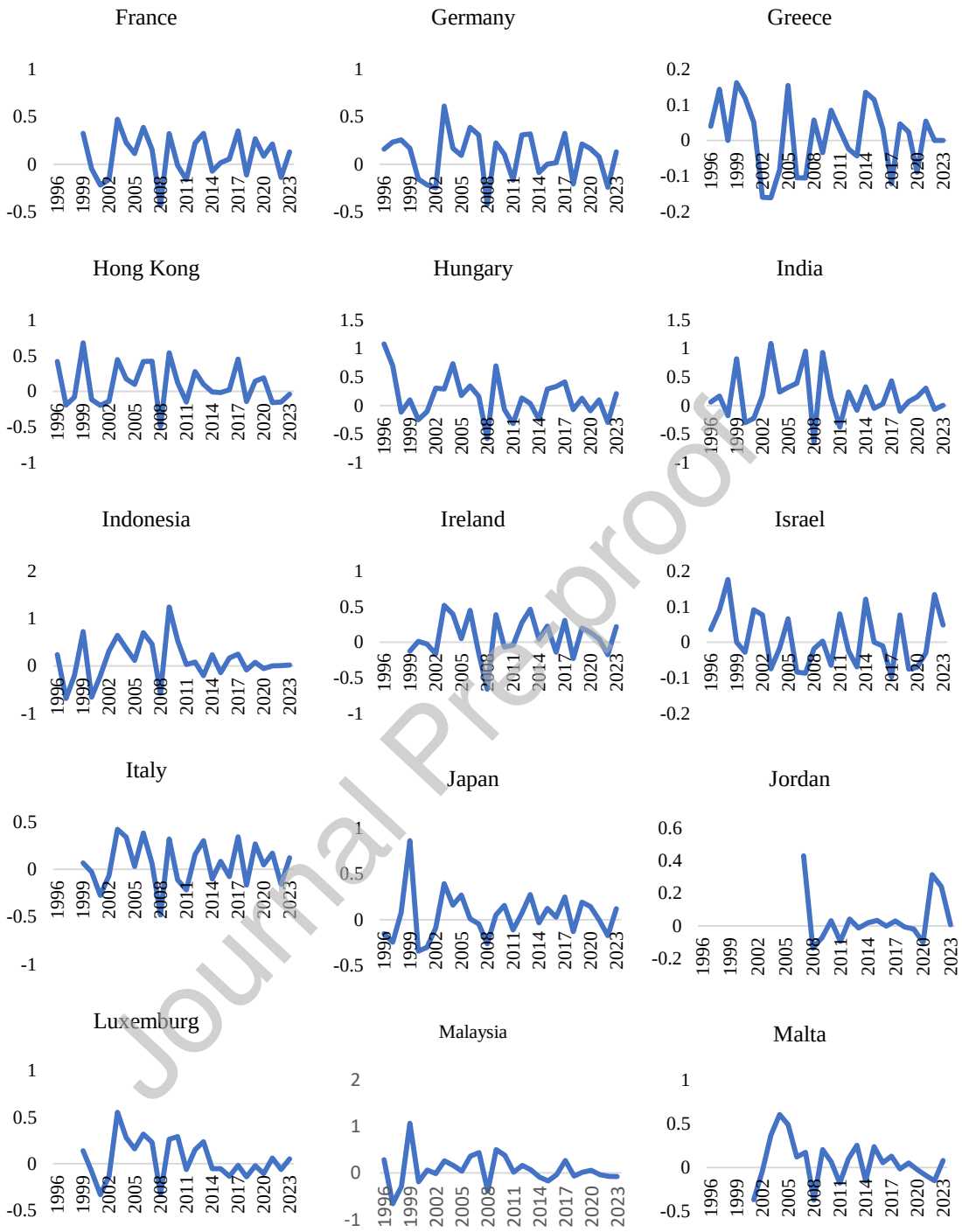
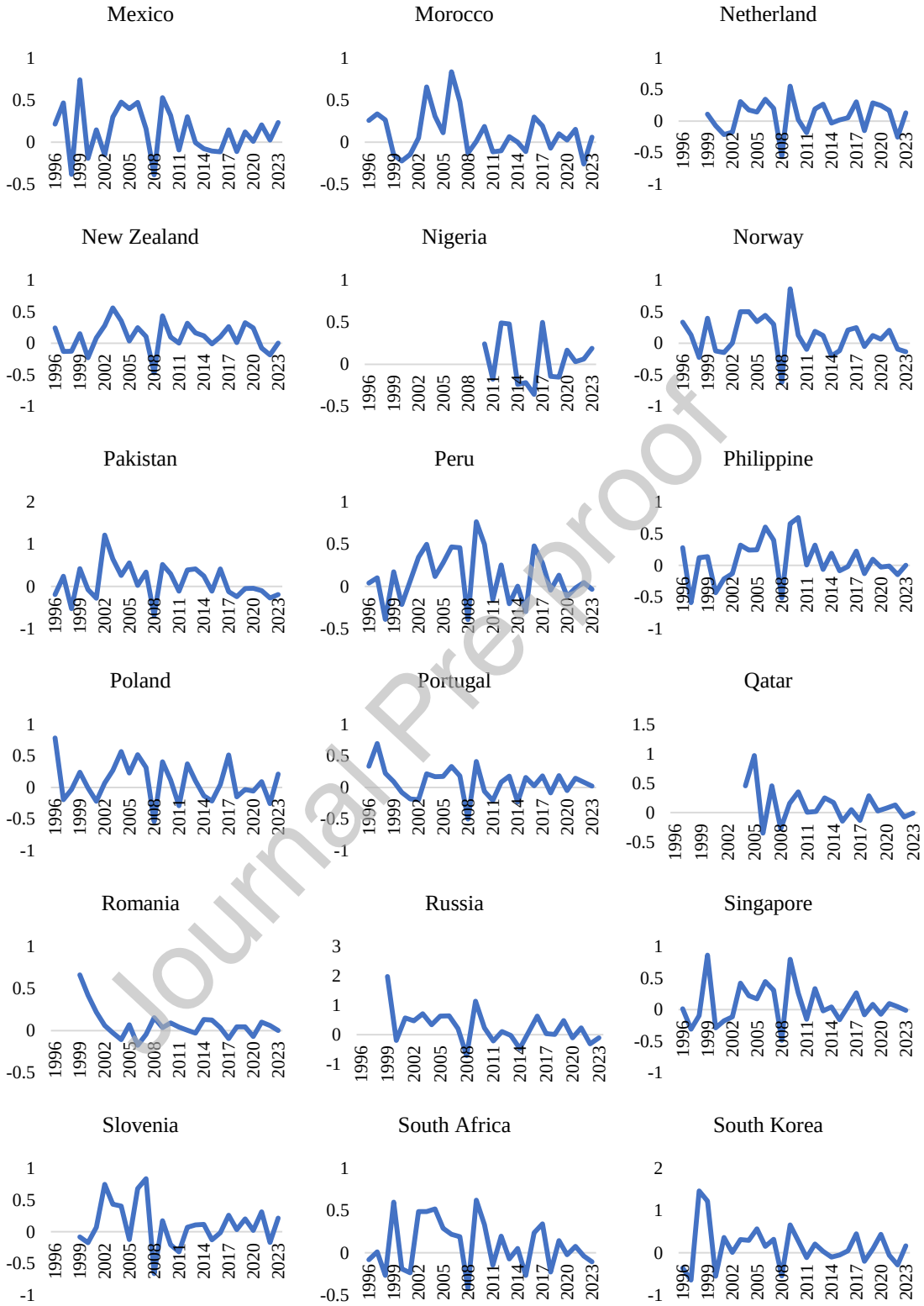


Figure 2: $ Denominated Annual Country Returns (%)







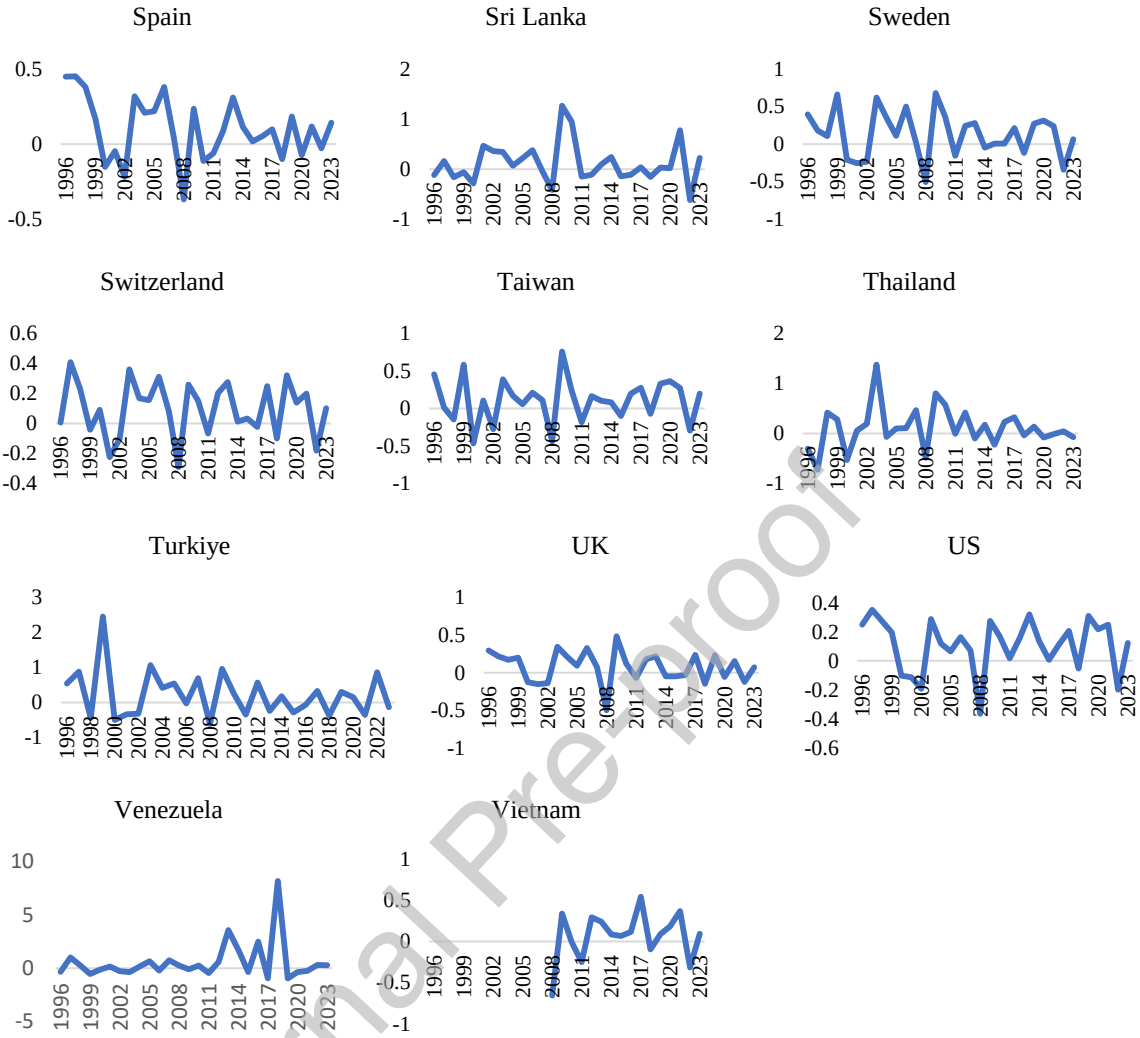


Table 1. Contagion from the source country of shock (*i*) to the recipient industries (*j*)

Industry	CR_{GFC}	$CR_{Pandemic}$
Energy	47.94**	2.23
Chemicals	3.59	6.12*
Basic Resources	0.32	6.99**
Construction and materials	21.96**	32.71**
Industrial goods and services	7.01**	24.26**
Automobiles and parts	78.42**	16.82**
Food and beverage	10.44**	4.51*
Personal Care Drugs and Groceries	2.82	2.71
Health Care	0.39	0.16
Retail	16.02**	2.21
Media	11.61**	8.73**
Travel and leisure	1.53	31.27**
Telecommunications	20.16**	6.31*
Utilities	0.01	9.27**
Banks	72.68**	70.18**
Insurance	62.4**	13.85**
Real Estate	27.81**	32.47**
Financial Services	7.56**	2.73
Technology	0.01	2.78
Consumer Products and Services	0.03	2.22

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

Table 2. Contagion from the source country of shock (*i*) to the recipient countries (*j*)

Countries	CR_{GFC}	$CR_{Pandemic}$	Countries	CR_{GFC}	$CR_{Pandemic}$	Countries	CR_{GFC}	$CR_{Pandemic}$
Argentina	17.99**	3.59	Indonesia	6.83**	32.6**	Romania	0.06	0.26
Australia	11.84**	14.78**	Ireland	134.14**	0.46	Russia	0.10	12.5**
Austria	22.11**	1.22	Israel	0.45	0.65	Singapore	28.16**	26.46**
Belgium	198.38**	0.17	Italy	35.65**	3.56	Slovenia	0.04	5.17*
Brazil	13.67**	0.66	Japan	9.16**	5.95*	S. Africa	9.19**	4.41*
Bulgaria	2.48	0.27	Jordan	-	0.77	S. Korea	40.26**	29.85**
Chile	0.17	4.45*	Luxemburg	0.25	0.98	Spain	23.46**	0.99
China	6.75*	-	Malaysia	6.61*	9.32**	Sri Lanka	0.39	1.56
Colombia	10.67**	0.82	Malta	0.70	0.29	Sweden	71.8**	9.66**
Croatia	-	0.08	Mexico	7.77**	2.94	Switzerland	57.11**	16.69**
Cyprus	3.52	0.18	Morocco	0.27	0.65	Taiwan	11.47**	40.72**
Czech Rep.	2.33	5.03*	Netherland	101.08**	0.12	Thailand	4.22*	9.23**
Denmark	9.33**	2.98	N. Zealand	0.00	5.39*	Turkiye	2.09	0.87
Egypt	7.64**	0.59	Nigeria	-	0.11	UK	31.35**	11.28**
Finland	33.49**	2.64	Norway	0.13	0.92	US	-	10.75**
France	67.97**	5.02*	Pakistan	0.61	0.35	Venezuela	1.44	1.82
Germany	28.88**	3.99*	Peru	4.22*	4.33*	Vietnam	-	1.11
Greece	20.18**	8.80**	Philippine	0.07	9.02**			
Hong Kong	33.27**	47.48**	Poland	3.34	19.88**			
Hungary	4.81*	7.10**	Portugal	3.33	0.32			
India	21.31**	4.84*	Qatar	0.80	0.29			

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