Time-frequency nexus of geopolitical tension, economic uncertainty, and trade flows:

A wavelet coherence-based evidence from China and USA

[1][a] Sodiq Olaide, Bisiriyu & [b] Manzoor Hassan, Malik

[a] Ph.D. Research Student, Department of Economics,
Easwari School of Liberal Arts,
SRM University AP, Andhra Pradesh, India

[b] Assistant Professor, Department of Economics,
Easwari School of Liberal Arts,
SRM University AP, Andhra Pradesh, India

[1] Corresponding author: bisiriyusodiq_olaide@srmap.edu.in; bisiriyusodiqolaide@gmail.com

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Abstract

This article examines the time and frequency interdependence of geopolitical tension, economic uncertainty, and trade flows of the world's largest traders – China and the USA, using wavelet coherence analysis on monthly data from January 2006 to February 2024. The empirical investigation reveals novelty of beneficial geopolitical and economic uncertainty to the USA and China trade during the trade war and severe Covid pandemic eras respectively. Also, the findings largely suggest a bidirectional interdependence of geopolitical tension, economic uncertainty, and trade flows of China and the USA in the short run. The momentous policy recommendations of the findings were discussed.

Keywords: Geopolitical tension; economic policy uncertainty; import; export; wavelet coherence.

1. Introduction

Differences in nations resource endowment have made trade flows the largest contributor to the world's gross domestic product, thus becoming a growth mechanism that facilitates efficiency across the globe through economies of scale, technology transfer, and by strengthening specialization instituted on comparative advantage. However, the interconnectedness of the world countries brought by increased globalization has made prevailing events in countries, regions, and geopolitical zones often affect the flow of world trade through magnified trade costs, supply chain disruption, market volatility, increased trade sanctions and restrictions, and many others (Yu & Wang, 2023; Hou et al., 2024). Such an effect becomes severe when the event or tension emerges in resource-rich countries. The World Trade Organization (WTO) highlighted that the global trade flows have been impeded by global tensions, which could result in trade fragmentation across geopolitical lines (WTO Annual Report, 2024). In this regard, the consequential prevailing unpredictable nature of the global economy in recent years has attracted enormous literature to global uncertainty measures (see Figure 1). We thus in this article examine the time-frequency nexus of geopolitical tensions (GPR), economic uncertainty (EPU), and trade flows–import and export (IMP & EXP) of China and the United States (US). Generally, GPRs include crucial events relating to international political tensions such as wars, diplomatic disagreement, and terrorism (Kazakova & Kim, 2020), while EPU represents uncertainties in trade, monetary, fiscal, and other global policy-related occurrences.

Although a multitude of literatures have studied the impacts and effects of these uncertainties– GPR and EPU on different economic parameters such as stock markets (Das et al., 2019; Adebayo et al., 2022; Jia et al., 2023), exchange rates (Kisswani & Elian, 2021; Bilgili et al., 2022), tourism (Tiwari et al., 2019; Kazakova & Kim; 2021; Nguyen et al., 2022), financial markets (Chiang, 2021; Demir & Danisman, 2021; NguyenHuu et al., 2024), and capital flows

(Feng et al., 2019; Yu & Wang, 2023), with sparse evidence on the world trade flows (Gupta et al., 2019; Drobetz et al., 2020; Islam et al., 2022; Singh et al., 2023; Hou et al., 2024). Furthermore, existing trade-related studies to geopolitical tension and economic policy uncertainty (such as Gupta et al., 2019; Drobetz et al., 2020; Islam et al., 2022; Singh et al. 2023; Hou et al., 2024) had not considered world significant trade countries like China and the USA that contribute more than 20% of world trade (WTO, 2023). In this regard, it becomes pertinent to provide an answer to the question of how responsive are the trade flows of China and the USA to geopolitical tensions and economic policy uncertainty?

To answer this question, we analyze the time-frequency nexus of geopolitical tension, economic policy uncertainty, and trade flows (import and export) of China and the USA with the rest of the world. This study is motivated by the adverse effects of uncertainties on global trade flows and contributes to existing literature on GPR, EPU, and trade flows in two-folds. Firstly, this is the leading study that examines the nexus of GPR and EPU on the trade flows of the world's two leading trade giants. The results of the study thus provide a comprehensive understanding of China and the USA's responsiveness to the global persisting political and economic uncertainties for policy actions. Secondly, we contribute to the literature by focusing on both developed and developing countries. As noted by Tiwari et al. (2019) and Drobetz et al. (2020), the vulnerability of developing countries to political and economic-related uncertainties is higher than that of their developed counterparts due to weak institutions (Gray, 1997). Thus, our analysis in this study contributes to existing literature by confirming the sensitivity of the two largest developed and developing countries of the world to global uncertainties.

Our findings suggest that (i) trade flows of China and the USA are more sensitive to geopolitical tension in the short run and the severe Covid-19 periods; (ii) geopolitical tension has a short- and medium-term positive influence on trade flows of China, and a short-term positive

influence on USA trade; (iii) economic policy uncertainty exhibits an in-phase relationship with trade flows of China, while the USA shows a mixed in-and out phase for the short and medium term. The study results demonstrate that trade flows respond significantly to geopolitical tension and economic policy uncertainty in the short run. Finally, our rich empirical findings are discussed with policy implications and recommendations for policymaking. The remainder of this study is structured as follows: Section 2 briefs the review of empirical literature; Section 3 provides the data and estimation strategies; Section 4 presents the empirical results and discussion; and Section 5 concludes the study.

2. Literature

Existing empirical literature has demonstrated that the prevalence of GPR and EPU has a significant impact on trade–visible and invisible. Kozakova and Kim (2021) analyzed monthly data of tourist arrivals from China and Japan to South Korea using the wavelet analysis technique. Their results suggest that geopolitical risks and economic uncertainties adversely affect tourism. However, the study shows the resilience of the tourism industry to the shocks over time. A similar result was reported by Tiwari et al. (2019) on the influence of GPR and EPU on tourism trade in India. The robust evidence provided with wavelet analysis of 174 monthly observations shows that the implications of GPR on tourism demand prevail in the long run while EPU does not. The analysis further confirms a greater influence of GPR on tourism than EPU. In another study, Jia et al. (2023) investigated GPR and EPU impacts on China's metal futures price volatility. By employing the GARCH-MIDAS estimation strategy, their results show that metal futures prices are sensitive to political and economic uncertainties. Furthermore, the results corroborate previous submissions that trade is more influenced by GPR. Drobetz et al. (2021) examined GPR and EPU effects on shipping freight rates with the Bayesian VAR model focusing on China, Brazil, and the USA. The examination evident the adverse effects of GPR and EPU on freight rates. Interestingly, the results demonstrated that

global GPR are more consequential than country-specific GPR shocks. Supporting this is the finding of Hou et al. (2024) that GPR significantly impacts trade costs. Further, the reaction of 24 emerging markets stock trade to EPU, GPR, and financial stress was studied by Das et al. (2021). The study causality-in-quantile estimation reports show that the impact of EPU, GPR, and financial stress is heterogeneous across countries. However, the study presents a novel and contrasting result that EPU has greater and more significant influence than GPR and financial stress.

Gupta et al. (2019) used the fixed and random effects model to analyze the effects of GPR on trade flows of 164 developing countries within the classical gravity model framework. The study results informed significant negative effects of GPR on bilateral trade flows. Wang et al. (2024) also show in their GPR and China bilateral trade flow analysis that GPR impedes bilateral trade. Islam et al. (2023) made the estimation of the USA mineral imports response to GPR and EPU using a quantile-on-quantile regression approach. The results show a negative reaction of the USA mineral import demand to GPR in the long run. On the other hand, a positive impact of EPU on mineral import demand was established. This supports the study of Caldara and Iacoviello (2018) that demonstrated GPR as a persistent obstructive parameter to USA international trade. Singh et al. (2023) demonstrated GPR impacts on Latin America trade patterns, focusing on the seven largest economies. The findings validate the general adverse impact of GPR on trade with a heterogeneous negative effect on imports. Kim and Jin (2023) confirm the deteriorating impact of GPR on Korea international trade with a varying negative impact with trading partners. Choi (2024) investigated economic policy uncertainty and geopolitical risk impact the sectoral volatility within the USA stock market using the time-varying parameter vector autoregressive spillover technique on 500 S&P indices from January 2002 to December 2023. The study finding show that economic policy uncertainty has a greater

impact on sectoral volatility than geo-political risk while the latter's effect appear to be concentrated in the short term.

It is evident from the brief foregone review of empirical literature that studies have examined GPR and EPU impacts on trade. However, most of the studies failed to account for the EPU impact on trade flows–import and export. Whereas the study of Demir and Gozgor (2018) suggested evidence of EPU impact on trade as economic agents possess the natural risk-averting behaviours and tendencies. Also, none of the existing studies have focused on the analysis of the top two world trading countries–China and the USA in the analysis of GPR, EPU, and trade nexus. Hence, this study's investigation fills the gap and provides intriguing discussion for policy actions.

3. Data and estimation strategies

To answer the question raised, we use monthly time series data of the global GPR[2] and EPU[3] indexes and aggregate merchandize trade (import and export) for China and the USA with the rest of the world from 2006M1 to 2024M2, i.e., 218 monthly observations. Trade data was extracted from the WTO database, while GPR and EPU were sourced from the GPR database of Caldara and Iacoviello (2022) and the EPU database of Davis (2016), respectively. The GPR and EPU are constructed based on search algorithms of articles in prominent newspapers. The common word strings in newspapers that are captured to construct GPR are "terrorism", "nuclear", "war", "tensions", "military", "conflict", "sanction", and "geopolitics" while words

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[2] The global GPR is the risk and tensions arising between territories and countries that affect the normal international and peaceful diplomatic discourse across the world. The global index is created from a leading global newspaper dataset with specific keywords associated with geopolitical tensions. Notably, the index is constructed based on normalized frequencies of articles with geopolitical tension-related keywords with respect to the total number of published articles in the given period – month, quarter, and annual (see Caldara & Iacoviello 2019 https://matteoiacoviello.com/gpr.htm).

[3] The global EPU index reflects a wide range of economic policy discussions that quantifies the level of world uncertainties from global article selection that contained economic-related terms. It is also worth pointing out that the global EPU follows the same methodological approach of construction as the GPR (available at: https://www.policyuncertainty.com/).

such as "uncertain", uncertainty", "regulation", "monetary policy", "central bank", "economic", "economy", and "deficit" are used for EPU construction. The monthly time trend of the world political and economic uncertainties is visualized in Fig. 1, while Fig. 2 and 3 pictured the trend series of China and USA trade respectively with the descriptive properties of all data in Table 1[4].
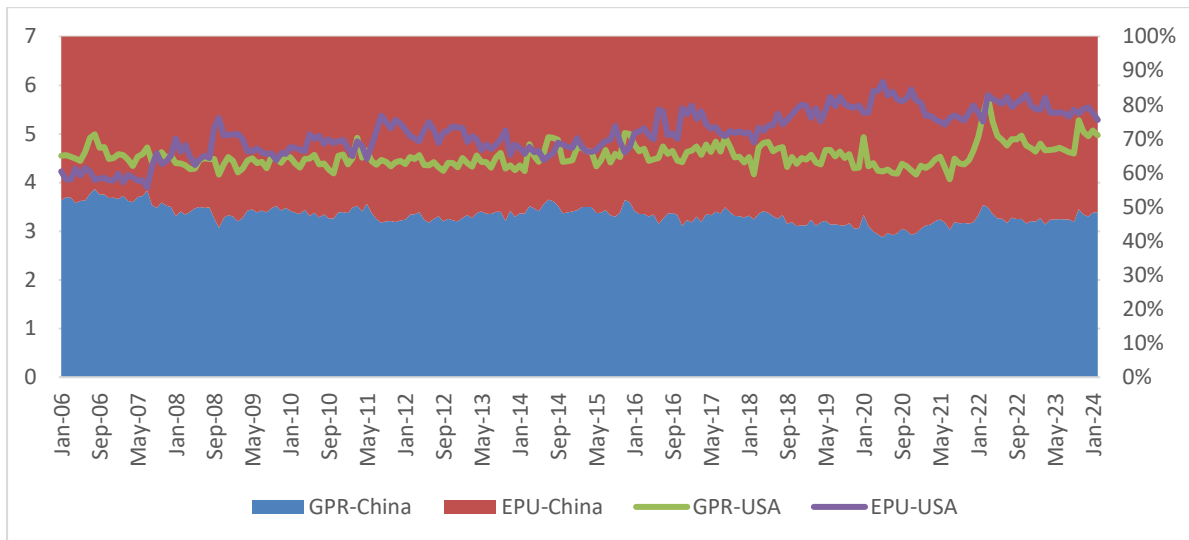

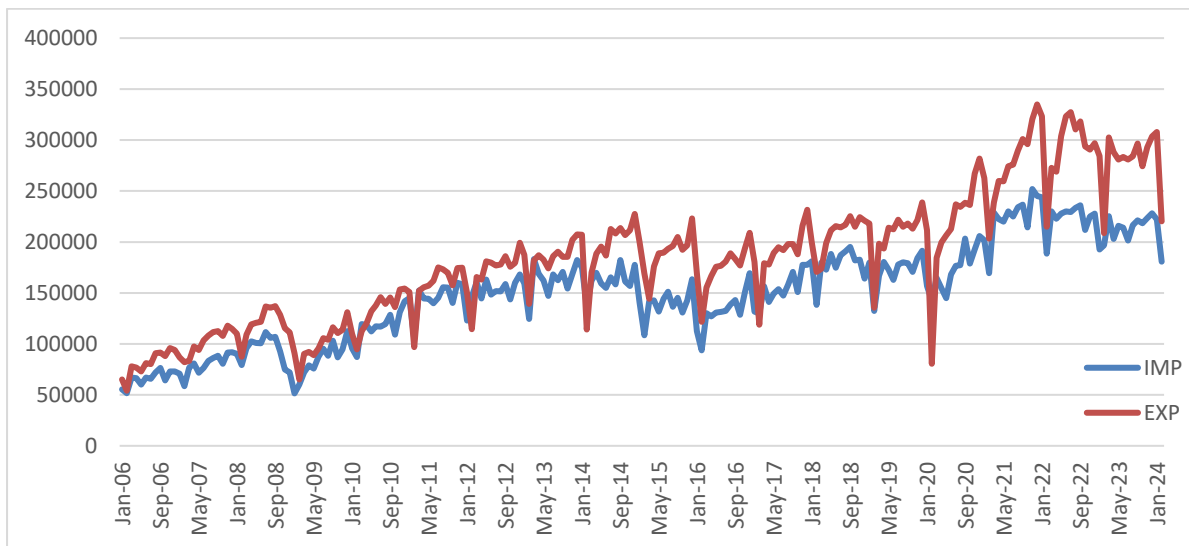**Figure 1:** Time series trend of geopolitical tension and economic policy uncertainty in China and the USA

Figure 2: Time series trend of China import and export

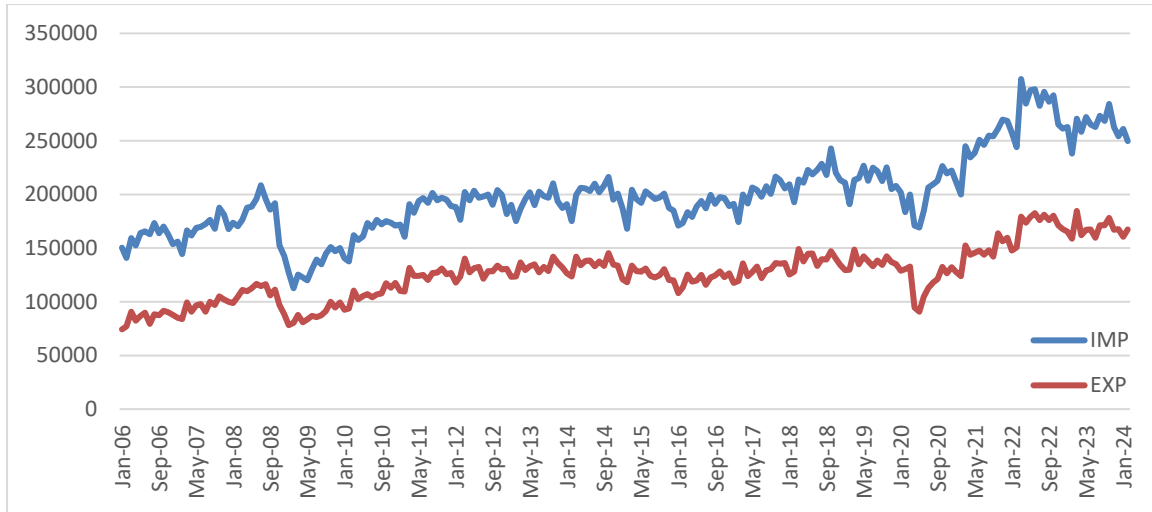[4] Used data is available upon reasonable request

Figure 3: Time series trend of USA import and export

The results in Table 1 show a positive mean, minimum, maximum, and standard deviation for all the variables. However, it presents differences in the maximum and minimum values of the variables to show variability of their series over time. This is also evident with the standard deviation values dispersion from their mean. Furthermore, all the variables are negatively skewed with mesokurtic distributions except GPR, which is positive and highly leptokurtic. Finally, the Jarque-Bera statistics and probabilities reveal non-normality of GPR, China's import and export, and the USA export series.

Table 1: Data descriptive properties

| | GPR | EPU | IMP | | EXP | |
			China	**USA**	**China**	**USA**
Mean	4.5463	5.0155	11.850	12.188	12.047	11.722
Minimum	4.0647	3.8963	10.847	11.631	10.898	11.216
Maximum	5.7650	6.0674	12.436	12.636	12.721	12.126
Std. Dev.	0.2345	0.4726	0.3681	0.1873	0.3872	0.2002
Skewness	1.3006	-0.1850	-0.7403	-0.0421	-0.5062	-0.3381
Kurtosis	6.4103	2.4040	2.8060	3.2742	2.6366	2.7407
Jarque-Bera	167.10***	4.4707	20.257***	0.7478	10.512***	4.7653*
Observations	218	218	218	218	218	218

*Note: *** & * denotes significant at 1% and 10%.*

We employed the innovative wavelet coherence technique for estimation strategies[5]. Our analysis follows two processes of estimating (i) the continuous power spectrum and (ii) the coherence spectrum. We used the continuous wavelet spectrum to generate cross-wavelet power for time and frequency domains, while wavelet coherence is used to observe the interdependence of the variables within time and frequency dimensions. The wavelet technique and approach surpass some barriers of the conventional econometric techniques, which include non-normality and allows time-frequency-based estimation. With the wavelet technique, the relationship among GPR, EPU, and trade is defined in a bivariate system of time and frequency domains. Thus, we examine the discrete impact of GPR and EPU on the trade of China and the USA. The wavelet coherence model is mathematically expressed as:

$$Z_{ab}^2(v,s) = \frac{|S(s^{-1}W_{ab}(v,s))|^2}{SS\,(|s^{-1}W_a(v,s)|)^2 S(|s^{-1}W_b(v,s)|)^2} \tag{1}$$

4. Results and discussion

We present and discuss the empirical results of our investigation in this section. Figures 4 and 5 show the wavelet coherence analysis for the time-frequency nexus between GPR, EPU, and trade in China and the USA, respectively. The horizontal axes indicate the timeline of the series (ranging from January 2006 to February 2024), while the vertical axes explain the frequency band, which is classified as short run (0–8), medium term (8–16), and long run (16–64). The colour spectrum of the figures explains the strength of the coherence between the series, with dark red indicating strong coherence, the cold blue showing low coherence, while the light blue and yellow depict weak coherence. Furthermore, the black-bound contours within the cone of

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[5] In-depth delineation of the wavelet coherence technique has proliferated the literature; to avoid redundancy, we thus request interested readers to see (Crowley, 2007; Guo et al., 2022; Raza et al., 2017; Badmus et al., 2023) for more details on the technique.

influence[6] represent a region of statistical significance in the movement of two time series at 5% using the Monte-Carlo simulation approach.

The result in Figure 4 shows short-run coherences among GPR, EPU, and China trade, while the medium and long terms show sparse strong coherence. Categorically, in the short term, the relationship between China's GPR and IMP shows a positive co-movement in 2011 and 2016 with IMP leading, a positive co-movement from December 2018 to December 2019 with GPR leading, and a negative correlation in the Covid-19 era of January 2020 to June 2021 with GPR leading. The medium-term relationship suggests relative low coherence except in 2007 and 2014, which could be the consequence of the global financial crisis or great recession and the Ukraine-Russia crisis. Similarly, the long-term periods show weak correlation between GPR and IMP, but the cluster around 2018 and 2022 depicts strong coherence with an out-phase difference that reveals negative co-movement with high influence from GPR between early 2020 towards the end of 2021. These results prove evidence of bidirectional causality between GPR and IMP in China, with the influence arising mostly from GPR. This finding is supported by existing results of Liu et al. (2022) and Zhang et al. (2022) of negative effects of GPR in the Covid pandemic era on import trade. In the case of GPR and EXP, the short run solely depicts the prevalence of a high correlation of the series with EXP leading between 2014 and mid-2016. Negative co-movement is also evident in late 2019 to early 2020. In addition, the medium- and long-run relationships are very low except in the medium term of 2008, 2012 towards 2013, and 2019 to mid-2020, where high correlation persists. These results evidently show a stronger causal relationship between GPR and EXP in the short run than in the medium and long terms, thus reinforcing the proof of Zhao et al. (2021).

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[6] The cone of influence is shown with a gray U-shaped line to reveal the significant wavelet power transform. Thus, wavelet transforms outside the cone are regarded as unreliable. In addition, the arrow pointers show the phase differences. Right left-up and right left-down (↗↘) pointing arrows imply an in-phase relationship with variables one and two leading, respectively. If otherwise (that is ↖↙) it indicates an out-phase relationship.

On the other hand, the periodicity and temporal variation between EPU and IMP show a continuous, inconsistent relationship of the series in the short, medium, and long terms. However, a significant positive co-movement is evident in the short term of recent years (2021–2023), with much influence from IMP. Also, a high consistent relationship is depicted in the medium term of 2009, while the long-run cluster in 2010 towards June 2011 shows strong correlation and reveals EPU significantly triggers IMP. The significant causality from EPU to IMP informs the sensitivity of the Chinese economy to expected raising costs attributed to policy uncertainties. The finding implies more imports are made during intense EPU periods to avert the high cost of importation in the long run. This result validates the submissions of Drobetz et al. (2021) and Hou et al. (2024) that EPU increases trade cost. The panel for EPU and EXP coherence shows high positive co-movement in the medium term of 2013 and long-run of June 2009 to 2010, with an in-phase difference that reveals EPU is a leading series granger causing EXP. The result of the panel also suggests a positive, strong correlation between EPU and EXP in the short run of 2012 and 2020 to 2023. These results indicate that uncertainties in the global economy brought by Covid-19 from early 2020 to late 2023 significantly increase the export of China. This finding is not far-fetched, as the Chinese Covid vaccines were reported to account for about 50% of the 7.3 billion global vaccines (Mallapaty, 2021).

Generally, the medium- and long-term inconsistencies of GPR and EPU on Chinese trade can be attributed to the country's complex trade structure, making her not be negatively affected except in the long period of Covid-19. Being the world's largest exporter, China has over the decade built a resilient global supply chain that suppresses the medium- and long-term negative effects of world prevailing tensions and uncertainties on her trade volume. Similarly, the country's economic policies, such as long-term trade agreements and shifting of production

strategies, have been significant in debarring the medium- and long-term adverse impact of tensions and uncertainties on aggregate merchandize import and export.

**Fig. 4:** Wavelet bi-variate coherencies of China GPR and EPU vs IMP and EXP
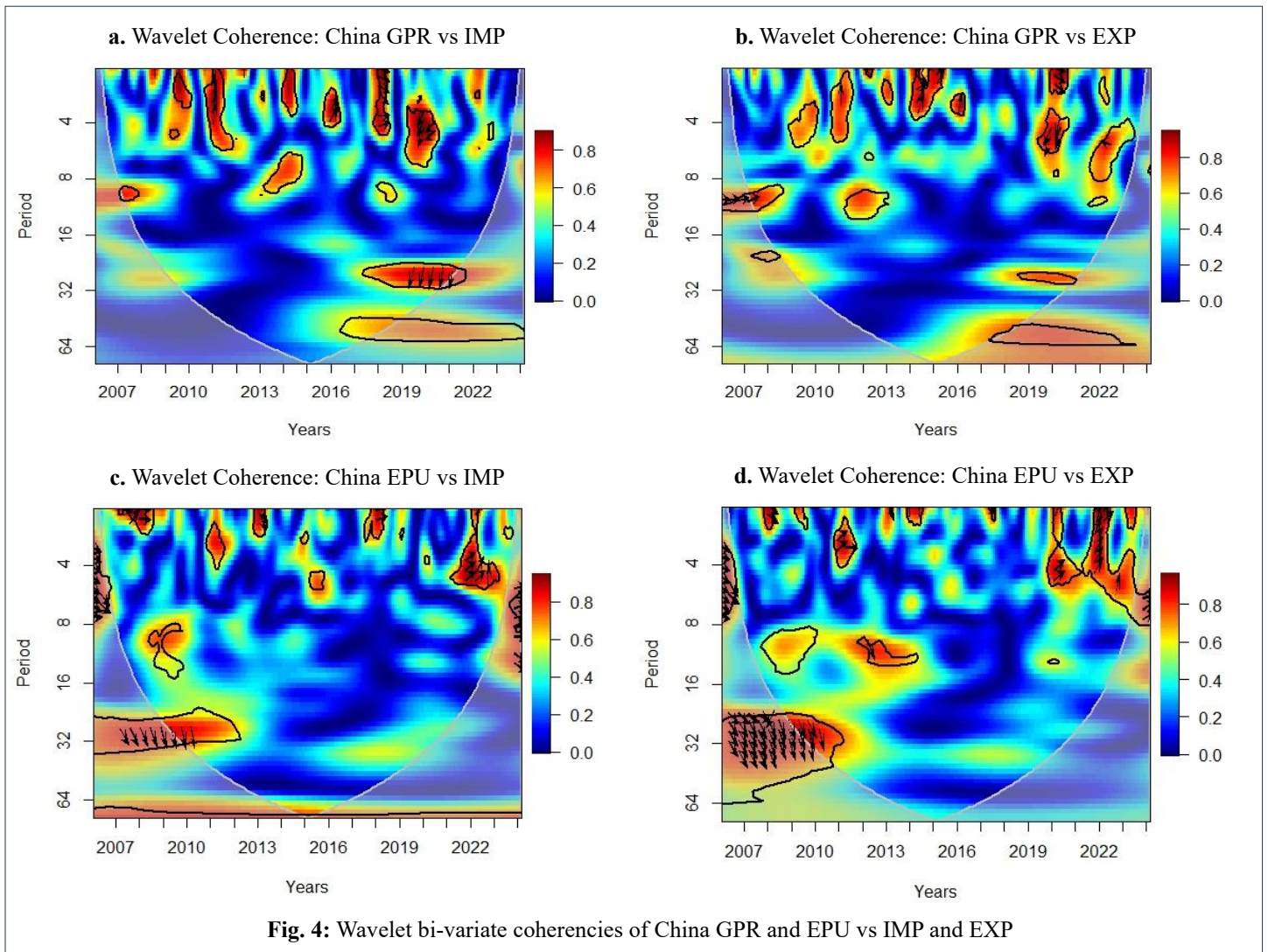
The panel display in Figure 5 exhibits the coherence between global geopolitical tension, economic policy uncertainty, and USA trade. The panel for GPR and IMP suggests a strong negative and positive co-movement, with GPR leading in 2008, 2017 and 2019, respectively, in the short run, while IMP leads in 2021 due to the need for Covid-19 shocks and instability recovery. The medium- and long-run results reveal low coherence over time except in the financial crisis years of 2007 and 2008 and between 2016 and 2021. These results imply the aggregate merchandize imports of the USA are not vulnerable to GPR, while the significant strong coherence of GPR and IMP in the long run pre-Covid era could be the effect of the

commencement of the USA-China trade war, which prompted the USA to impose additional tariffs on her largest supplier – China, with tightened trade restrictions (Kwan, 2020). This result validates the submission of Itakura (2020) that the trade war significantly hampers imports and outputs. The result of the GPR-EXP time and frequency nexus clearly suggests short-term coherence with positive co-movement (EXP leading) in 2011 and a very strong correlation in the late 2021 to 2022. Further, the medium- and long-term periods reveal a very weak relationship of the series except in the medium term of 2007 to 2008 with evidence of strong correlation and the long term of 2018 to 2019, where GPR significantly drives EXP. This suggests that global tensions of 2018 towards 2019 prompted countries to increase their exports from the USA as an anticipatory measure of the trade conflict retaliation in the form of an increased tariff, and Covid-19 triggers the USA total merchandize export. As a result, the USA aggregate merchandize exports increased by 7.6% in the year 2018 to surpass her previous 5-year average (US DoC, 2018).

Moving to the lower left panel in Figure 5, there are high coherence clusters in the very short run (0-4) period and out-phase negative co-movement of EPU with IMP in the Covid-19 period. This result reveals the negative effect of Covid-19 on imports due to the global lockdown measures. In addition, the medium-time relationship depicts a strong relationship between 2012 and 2013, while a relatively weak coherence is observed between 2010 and 2011. The panel of EPU and EXP presents evidence of positive co-movement with EPU leading in 2017, negative correlation with EXP leading in 2011 to 2012, and high coherence in 2021 to 2022 in the short run. The medium term reveals strong coherence from July 2008 to June 2010 and weak correlation between 2012 and 2013, while the long-run estimate shows positive in-phase co-movement with EPU leading from 2009 to 2010. These results demonstrate bidirectional causality evidence between the series and inform that the aftermath of the global financial crisis

of 2007-08 influences the USA's exports in the short, medium, and long run, while Covid-19 predominantly affects short- and medium-term exports.

Fig. 5: Wavelet bi-variate coherencies of USA GPR and EPU vs IMP and EXP
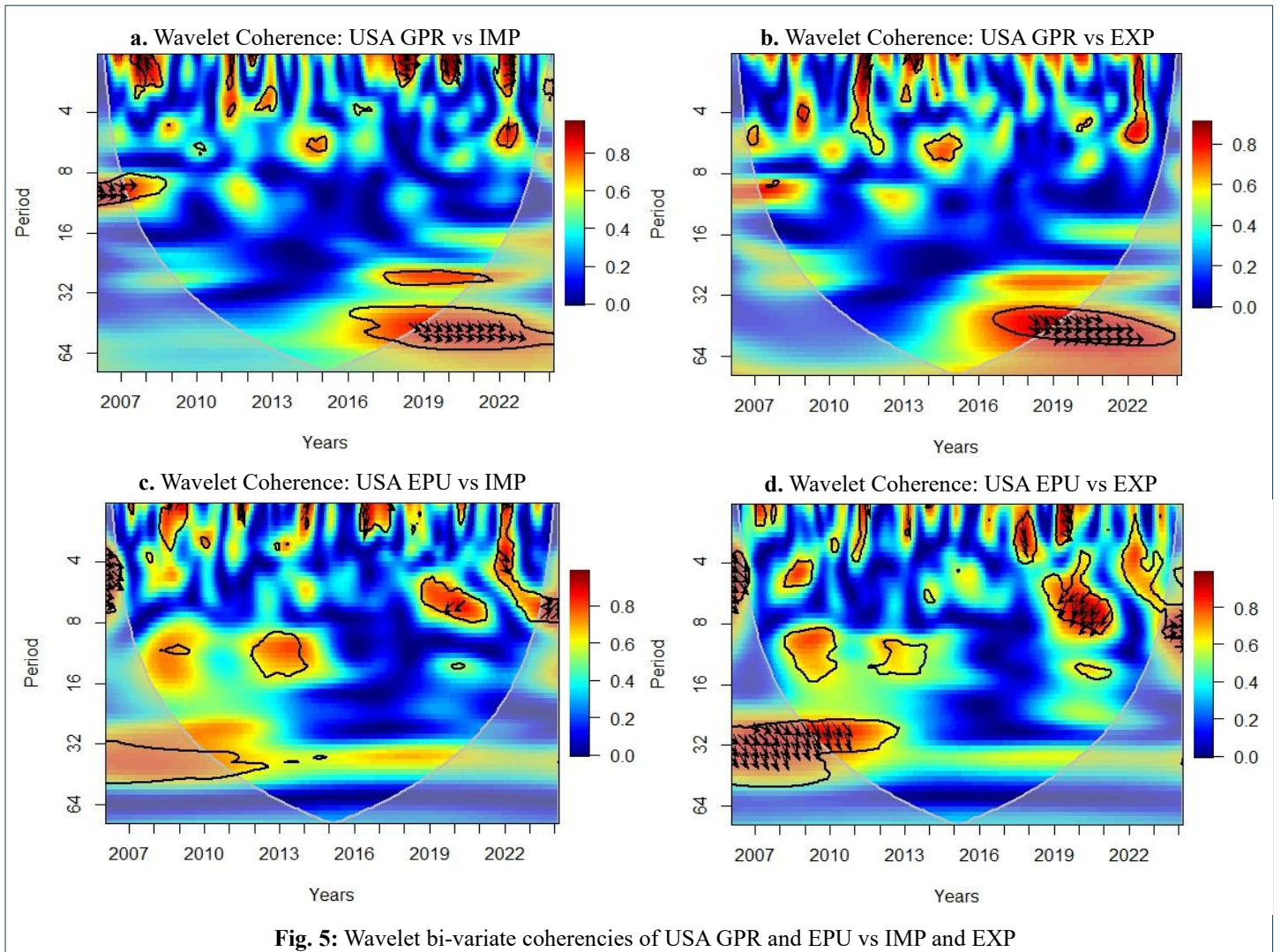
Comparatively, the findings for China and the USA reveal that the GPR and EPU are more correlated with IMP and EXP in the short run, except in the long run of the post-global financial crisis years of 2009-10 and the Covid pandemic era of late 2019 and 2020. This outcome aligns with the assertion of Kozakova and Kim (2021) that developed and strong economies automatically find resilience to GPR and EPU shocks over the medium and long time. In addition, this finding evident and proves the advanced characteristics of the Chinese economy, as trade is elastic to global shocks. The suspectable underlying reason for this is China's favourable and strong trade institutional arrangements, such as bi- and multilateral trade

agreements, support for export-led growth incentives, and pro-trade policy, which often promote international trade. Conclusively, the empirical investigation reveals novel findings of beneficial GPR and EPU to the USA and China trade during the trade war and severe Covid pandemic era, respectively.

5. Conclusion and policy implications

In this study, the global geopolitical risk index (GPR) and economic policy uncertainties (EPU) were employed to examine the period and time variation interdependence of geopolitical tension, economic uncertainty, and trade flows of China and the USA from 2006 M1 to 2024 M2 with wavelet coherence technique. Trade flow is observed as aggregate merchandized exports and imports, and the analysis presents three interesting results. Firstly, trade flows of China and the USA were more sensitive to geopolitical tensions in the short run periods and nearly all periods of the severe covid pandemic months. Secondly, geopolitical tension has an overall greater impact on China and the USA trade flows, with a short- and medium-term positive influence on China and a short-term positive influence on the USA. Lastly, economic uncertainty has a positive correlation with China's trade and a mixed (positive and negative) co-movement with the trade of the USA. Largely, our findings suggest a bidirectional interdependence of geopolitical tension, economic uncertainty, and trade flows of China and the USA in the short run.

In this regard, it is undeniable that the prevailing global geopolitical risks and economic uncertainty are affecting the two world's largest traders. Thus, for policy actions, this study recommends diversification and regional trade policies based on its findings. Market and supply chain diversification can reduce reliance on a single or a few countries; thereby, the worsening effects of global shocks can be minimized or averted in the long run. This is evident with China's trade co-movement with global geopolitical tension and economic policy uncertainty over the years. The country has largely been able to restrict the global shock effect

to short periods based on its solidified global market and supply chains. Similarly, as geopolitical tension and economic uncertainty disrupt trade flows through increased trade costs, it is recommended that regional trade policies and agreements are reviewed with sensitive frameworks that can reduce the vulnerabilities of countries, especially the developing countries with weak institutional arrangements, to the periodicity impact of global shocks. Such arrangements can guarantee reduced risks arising from global uncertainties through lower trade costs and strengthened domestic production capabilities.

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