

Analyzing the Impact of Macroeconomic Factors on Renewable and Non-Renewable Energy Markets in COVID-19 and Ukraine-Russia Shocks

PRESENTED BY:

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PRESENTATION OVERVIEW

- AIM: Analyzing **Impact of Gold and Oil Markets** on **Macro National Energy (RE and NRE)** Markets.
- MOTIVATION: Extracting key economic policies for **RE Market Stabilization after dual-shocks**.
- FIELD: **Financial Economics**
- METHOD: **Time-Frequency domain analysis with Wavelet Transforms**
- FOCUS REGIONS: **USA, EU, Japan, China, India**
- TEMPORAL BOUNDARY: **Jan 1, 2020 to March 31, 2023**

STUDY AREAS

Population:

47%

GDP:

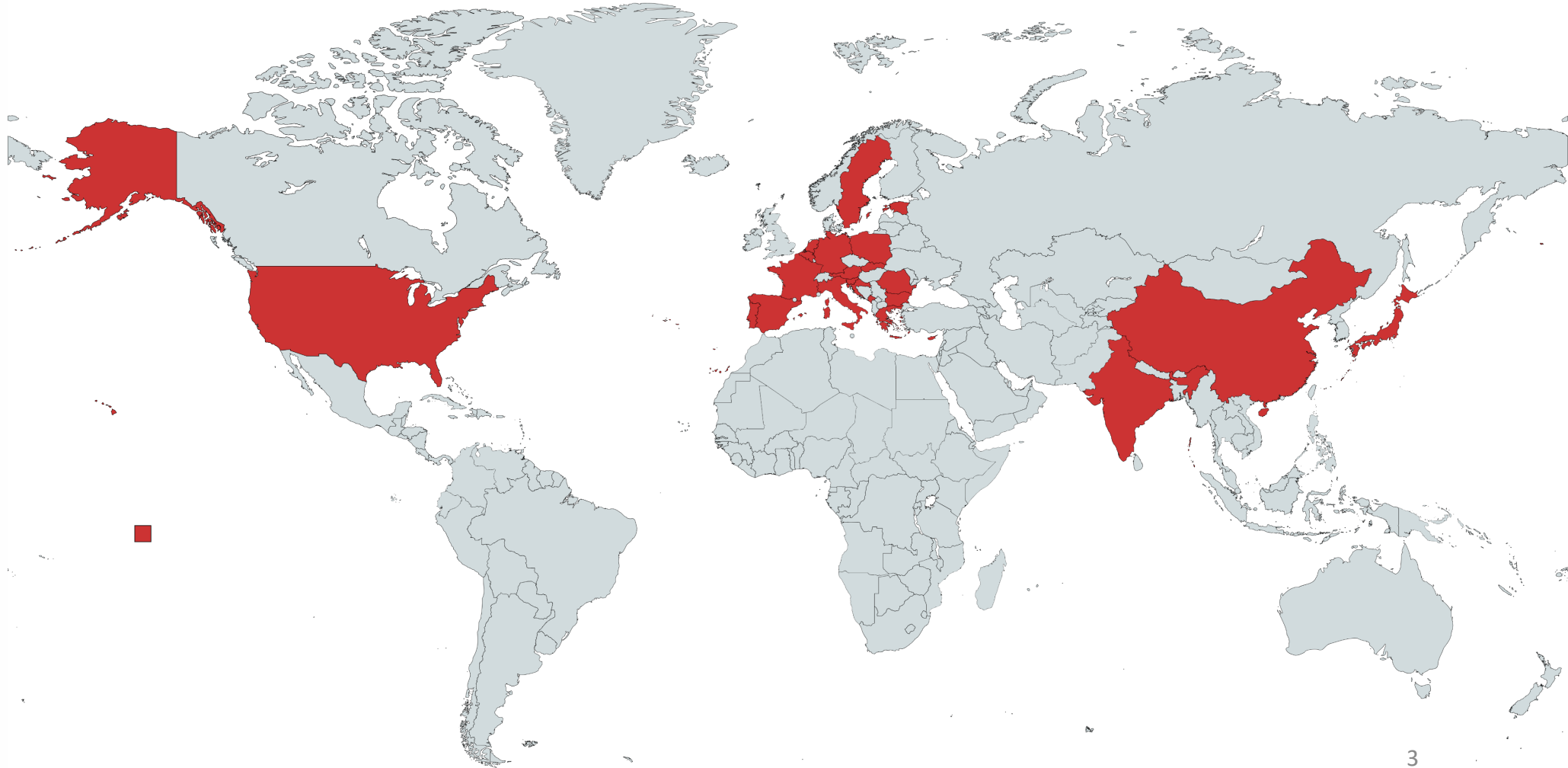
57%

Energy-use:

65%

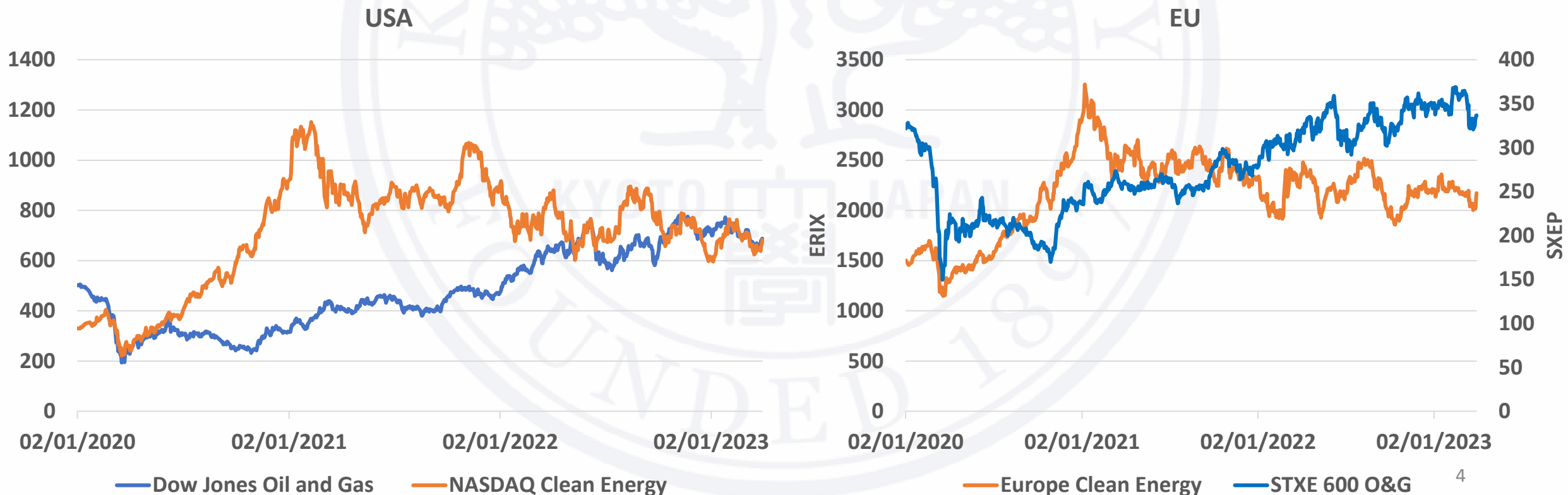
Emissions:

60%



BACKGROUND – Why RE-NRE separated?

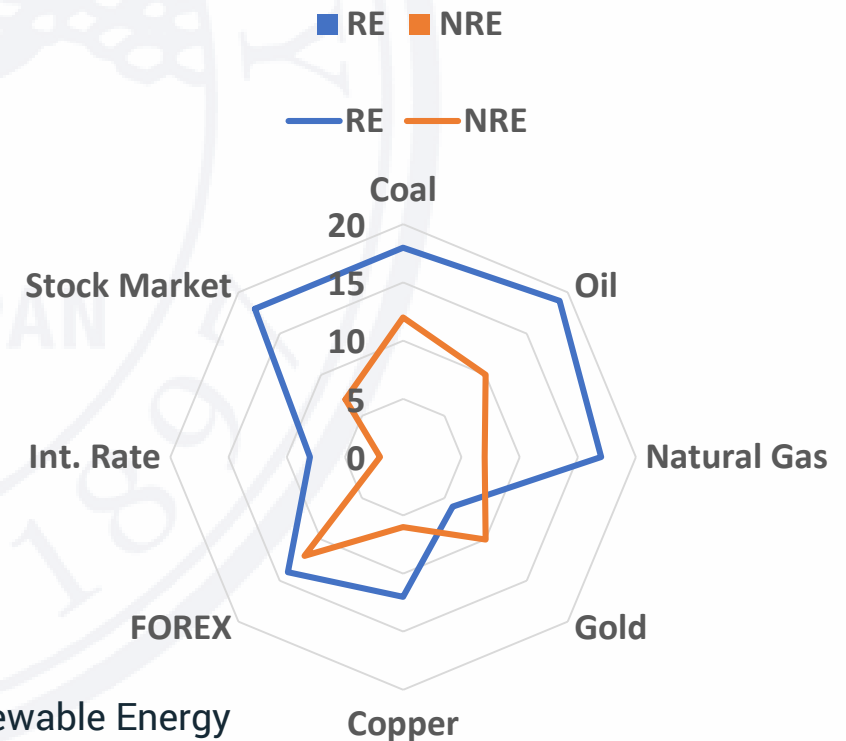
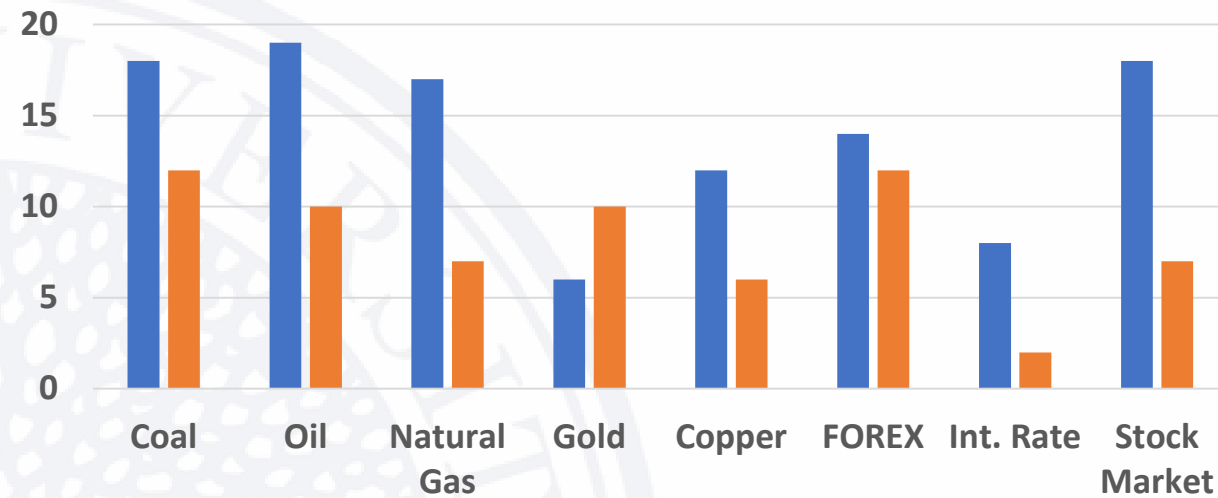
- **RE**: mainly solar, wind and bio; **NRE**: mainly fossil fuels
- Completely **differing stochastic patterns** for RE and NRE.
- **Economic policies** are driven towards RE or NRE differently in nations.



BACKGROUND – Why only Oil and Gold?

- Study by author on **India RE-NRE markets** using **Short-time Fourier**.
- **Higher** frequency interaction -> **unstable**
- **Lower** frequency interaction -> **stable**
- Oil – **highest frequency** interaction with RE.
- Gold – **only factor** with **lower frequency of interaction** with RE than NRE.
- Key outcome: RE investments should be diversified with Gold for post-COVID stabilization in India.

Frequency Peaks After COVID



BACKGROUND – Literature Review

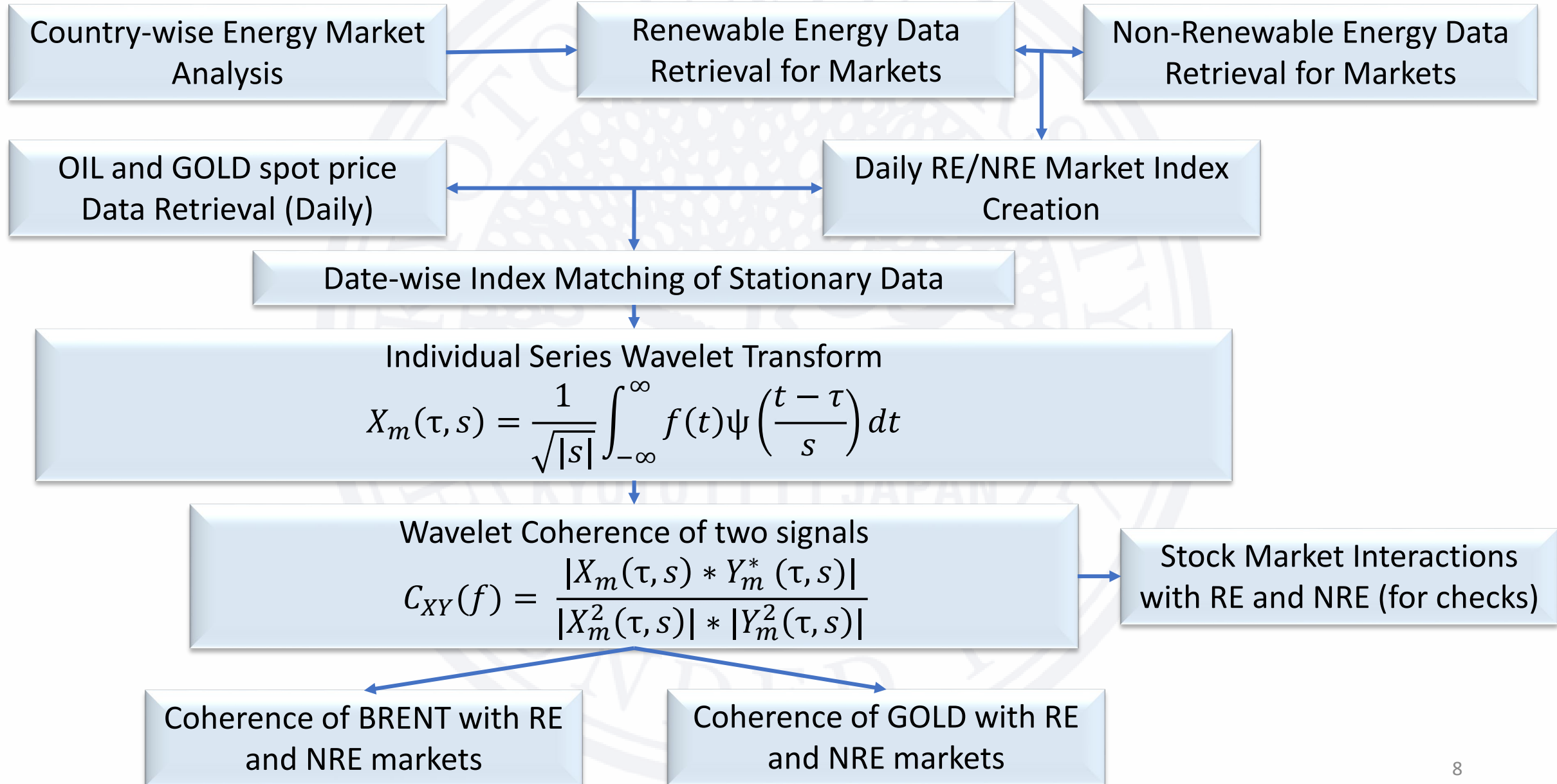
- Very few studies conducted in the **Time-Frequency domain for post-COVID energy market recovery**.
- **GAP 1** – Effect of Oil and Gold differentially on RE and NRE.
- **GAP 2** – Comparing COVID and Ukraine-Russia shocks on RE and NRE.
- **GAP 3** – RE market development policy comparison among top emitters during dual shocks.

NAME	REGION	FACTORS	MAIN CONCLUSION
Mahi et al. (2021)	Global Indices	NRE and RE (NASDAQ), Economic Activity	Econ. act. strongly co-move with NRE, but not strong with RE. Returns are stable for NRE.
Hung (2021)	USA	WTI Oil Index, Agriculture Commodity	Agro and Oil spillover is more during COVID than before. Agro comm comove with WTI.
Chien et al (2021)	USA	Gold, NYSE index, Elec Index WTI Index, COVID infection rate	Oil, GDP, stock, elec decrease with increase in COVID index, Oil market low co-movement with stock, Elec, gold
Mensi et al. (2023)	Japan, Canada, USA, BRICS	Country Stocks, Oil Index, Gold Index, VIX Index	Co-movement intense during COVID and 2008. All markets comove at med-low frequency.
Hanif et al. (2023)	Global Indices	Six RE indices, Rare Earth Index	Six RE markets connected, up during COVID. Rare earth/RE hedging lose efficiency at COVID.

DATA – How were RE-NRE indices represented?

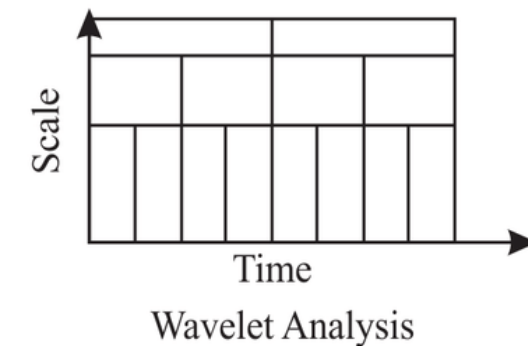
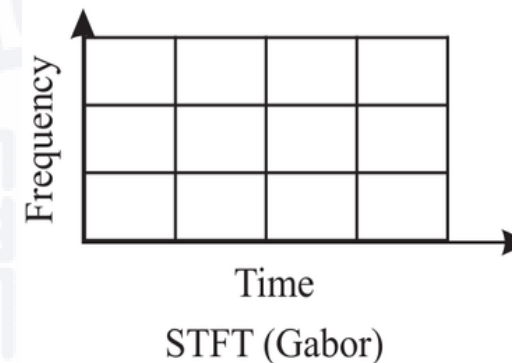
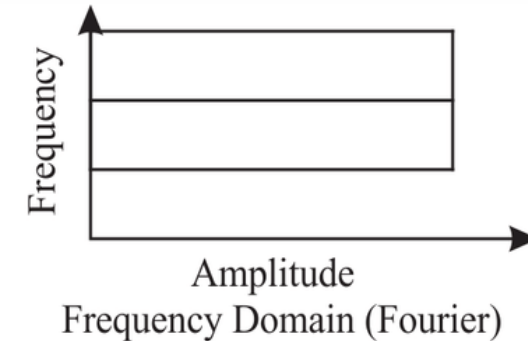
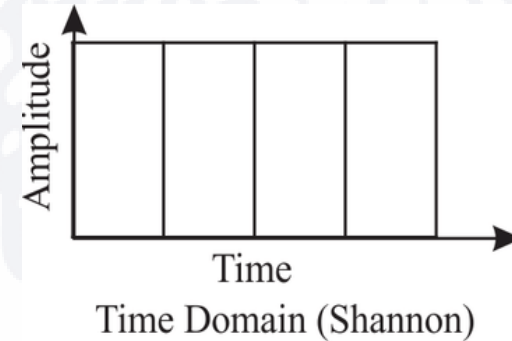
INDICES	INDIA	CHINA	JAPAN	EU	USA
RENEWABLE ENERGY INDEX (RE)	Jindal Clean Ene.	KGRN CE Capital	Japan Clean Energy Index	European Renewable Energy Index (ERIX)	NASDAQ Clean Energy Index
	Suzlon Solar	Xinyi Energies			
	Tata Power CE	Shenhua Corp			
	WEBSOL Solar	FTSE ER			
	Borosil Renew	FTSE EP	Tokyo Stock Exchange Returns (TOPIX)		
	Solar India				
	Inox Wind				
	Adani Green				
NON-RENEWABLE ENERGY INDEX (RE)	Bombay Stock Exchange Oil & Gas Index	FTSE China A 600 Oil & Gas	Osaka Gas	STOXX EU 600 Oil and Gas	Dow and Jones Oil and Gas Index
			Tokyo Gas		
			JPEC		
			TOPIX		

METHODOLOGY



METHODOLOGY – Why Wavelet Analysis?

- Economic Shock analysis requires **high frequency data** (daily).
- **Stationary** data needed for modelling. Daily data **noisy**.
- Frequency domain – **meaningful low frequency** (longer delay) interactions. **Higher frequency noise** ignored.
- Wavelet – **resolution** in **both time** and **frequency** directions.



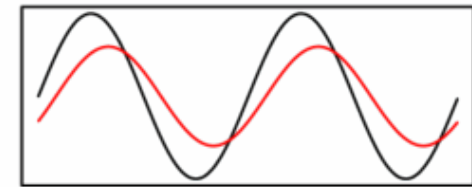
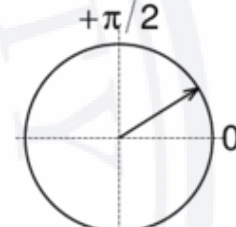
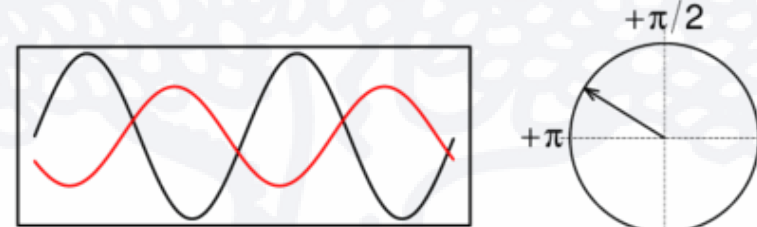
FREQUENCY AND PHASE INTERPRETATIONS

- Frequency Bands:
- **High**: 1 to 8 days
- **Mid**: 8 to 64 days
- **Low**: 64 to 256 days

X: RE/NRE; Y: Macroeconomic factor (Stock, Oil, Gold)

x, y out of phase

x, y in phase

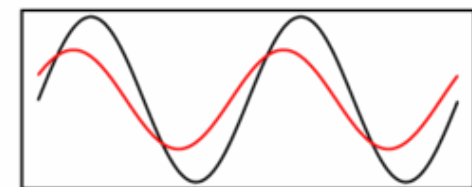
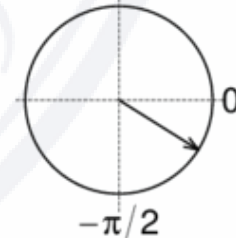
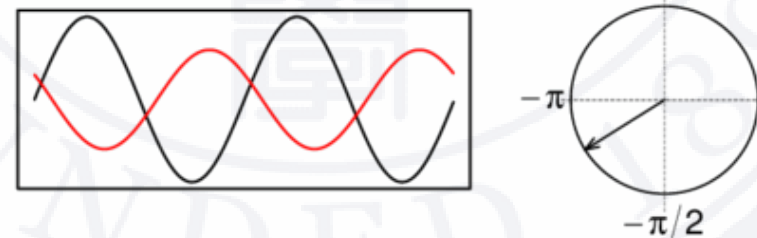


leading: *y* (—), lagging: *x* (—)

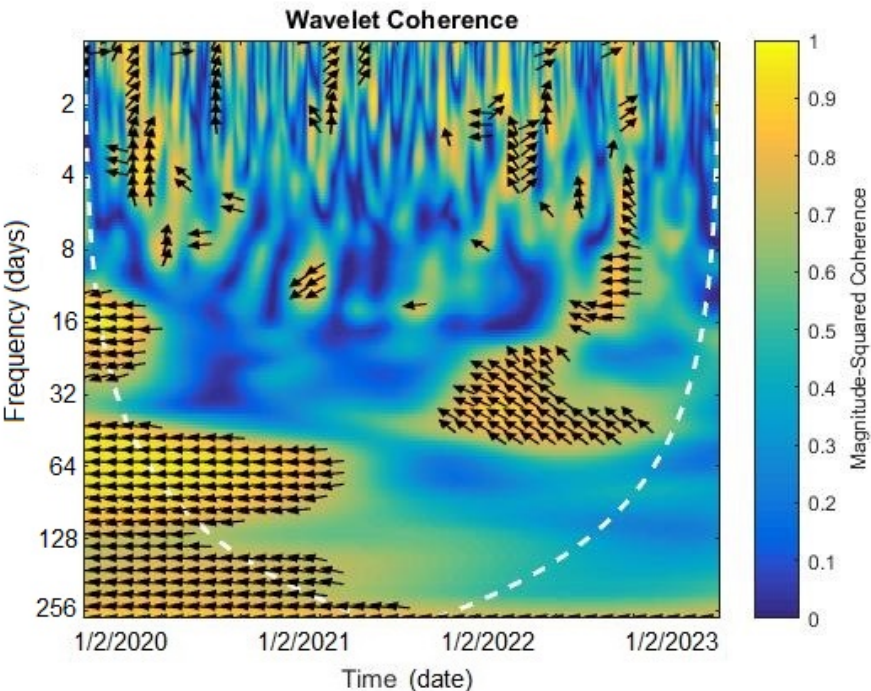
leading: *x* (—), lagging: *y* (—)

leading: *x* (—), lagging: *y* (—)

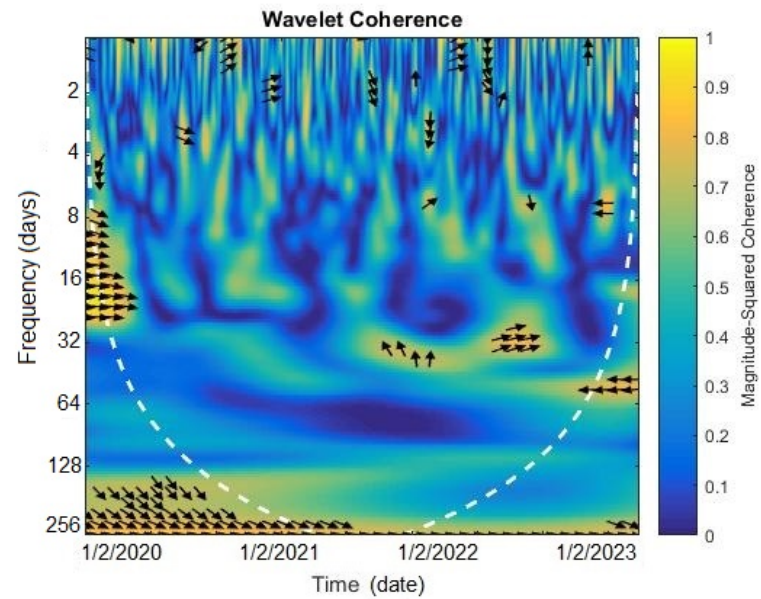
leading: *y* (—), lagging: *x* (—)



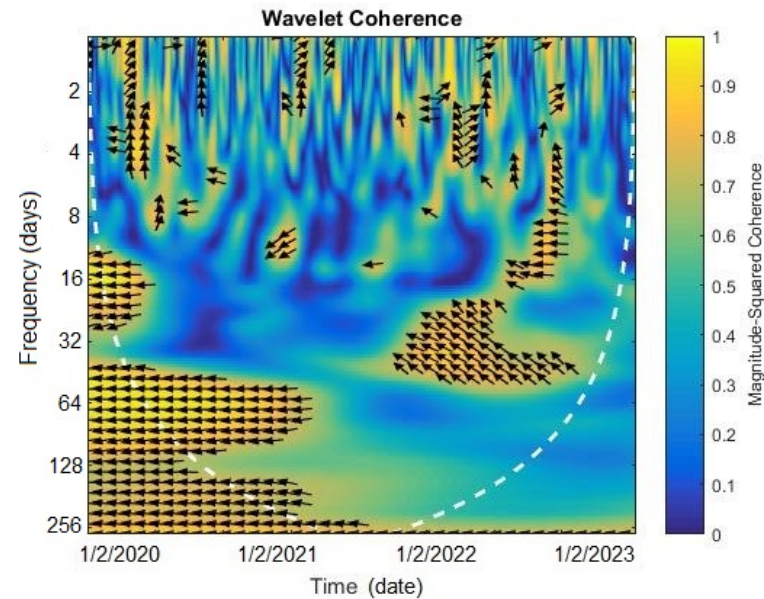
In-Phase: Good; **Anti-Phase**: Not so good



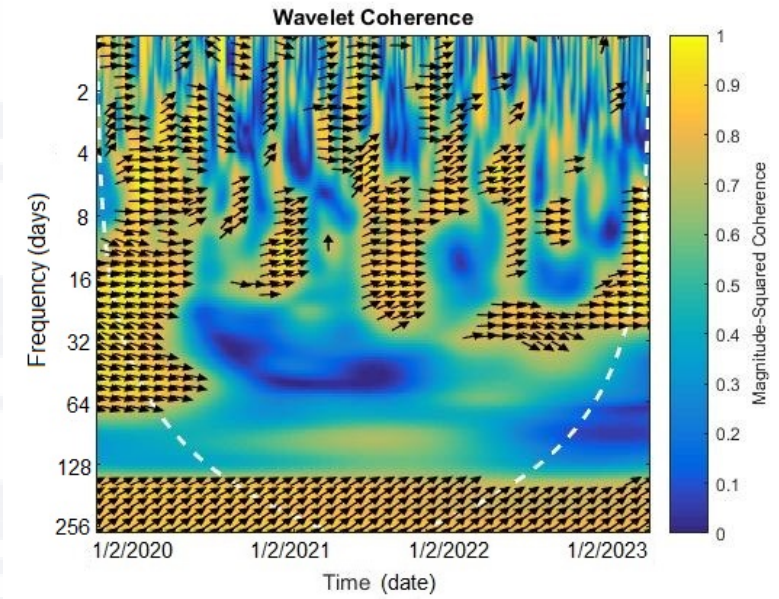
RESULTS (RE and Stock Market)



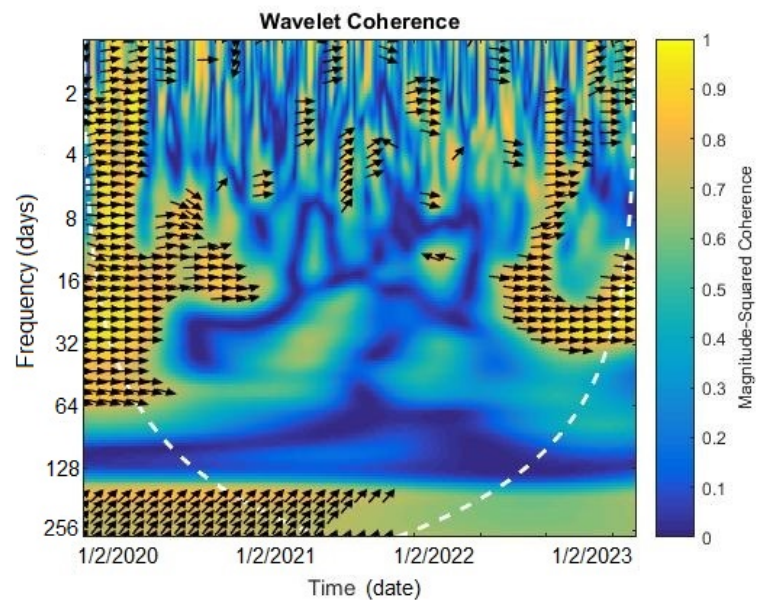
CHINA



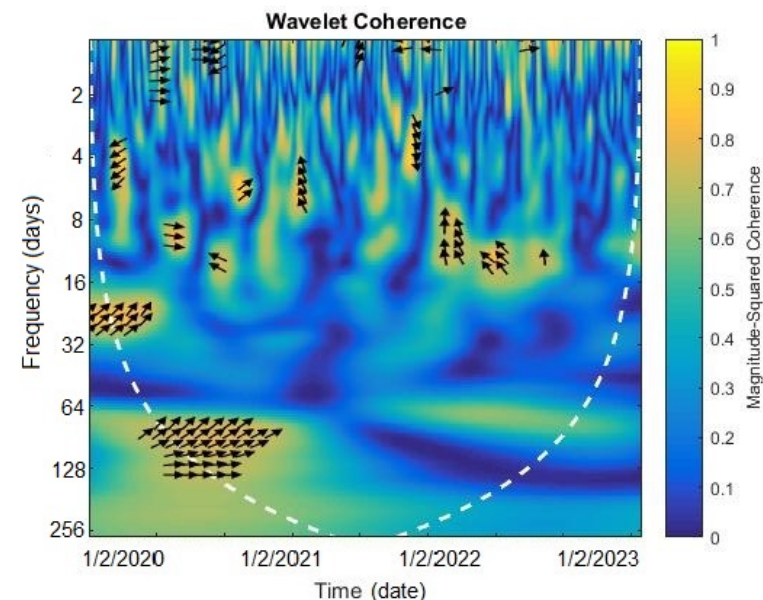
INDIA



JAPAN

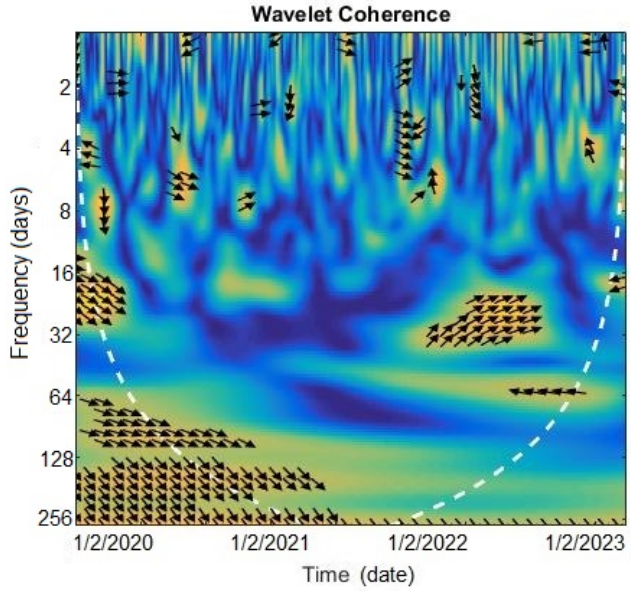


EU

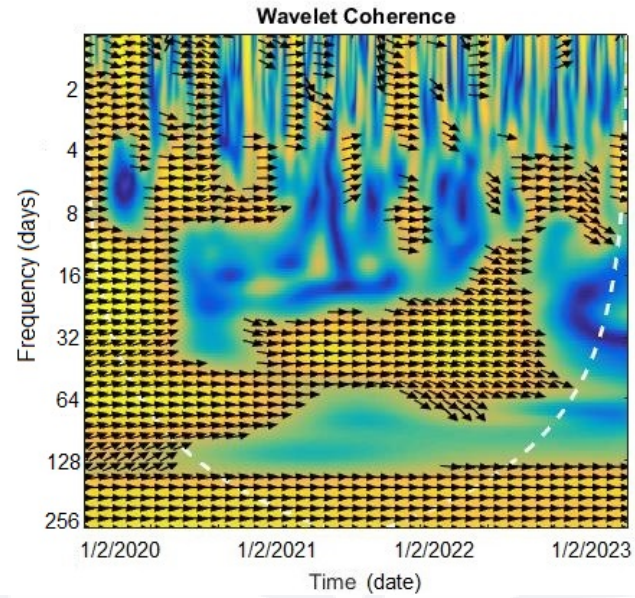


USA

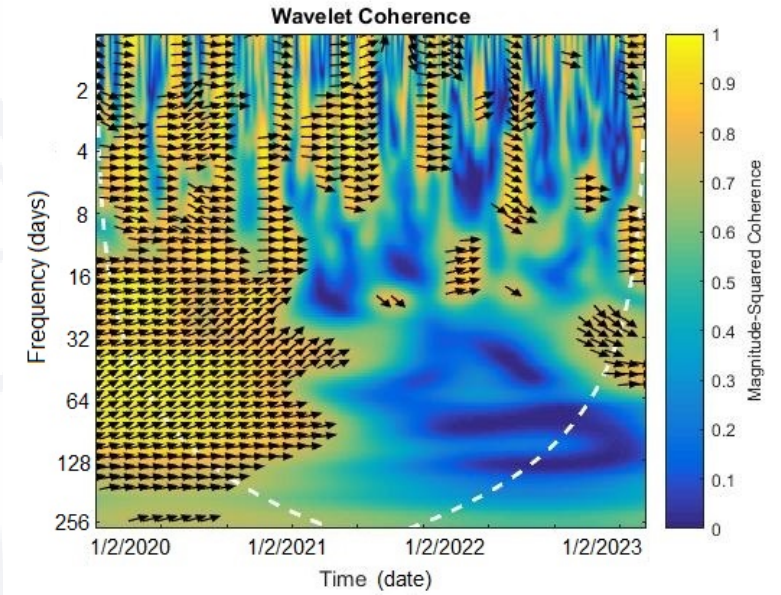
RESULTS (NRE and Stock Market)



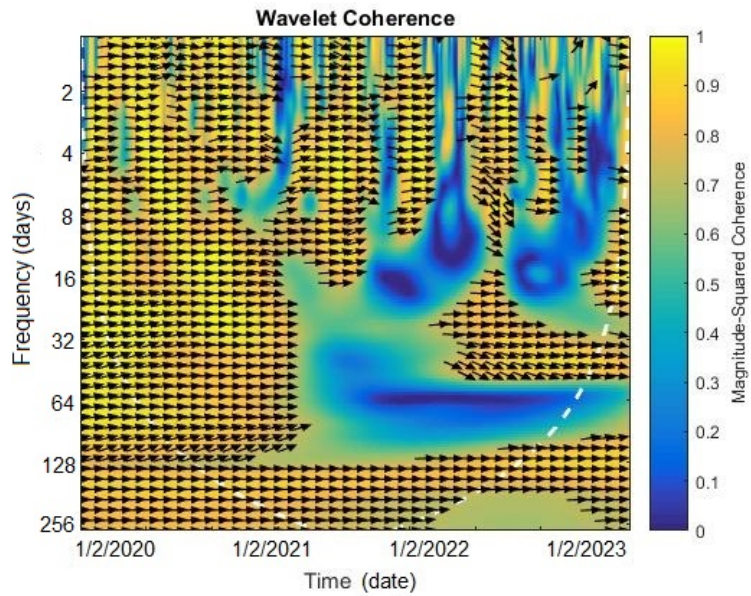
CHINA



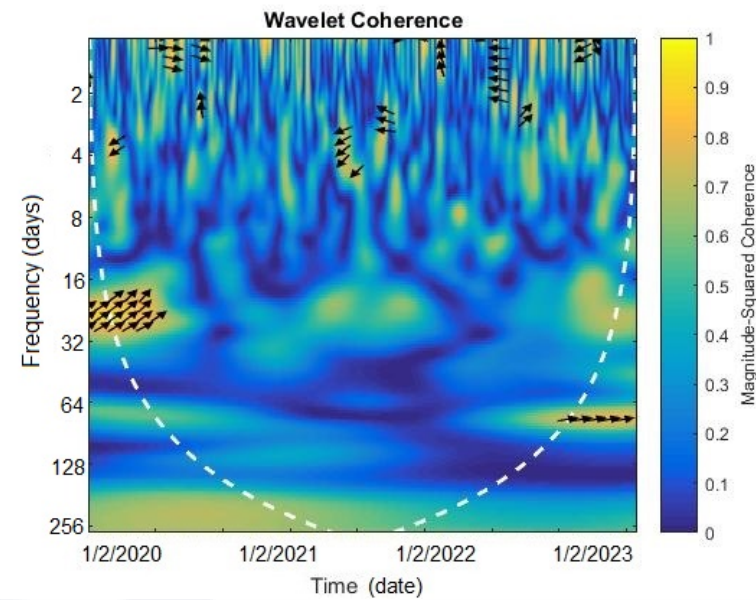
INDIA



JAPAN



EU

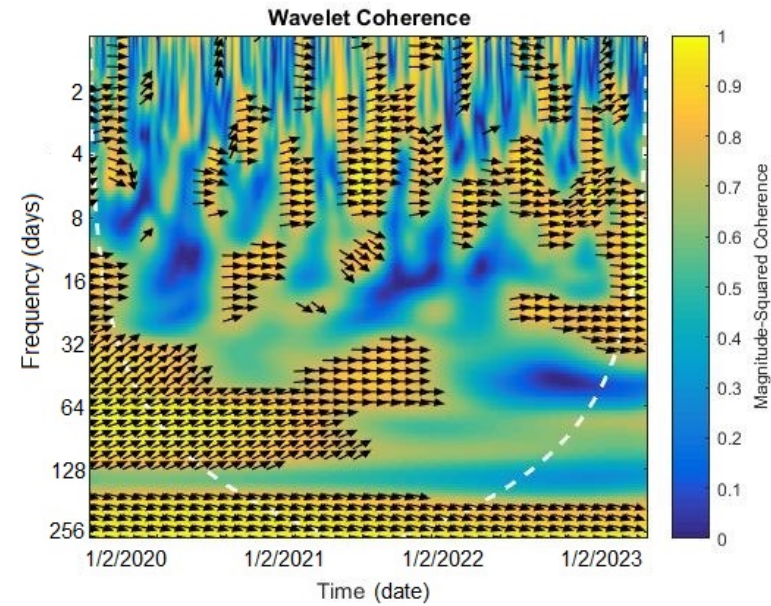
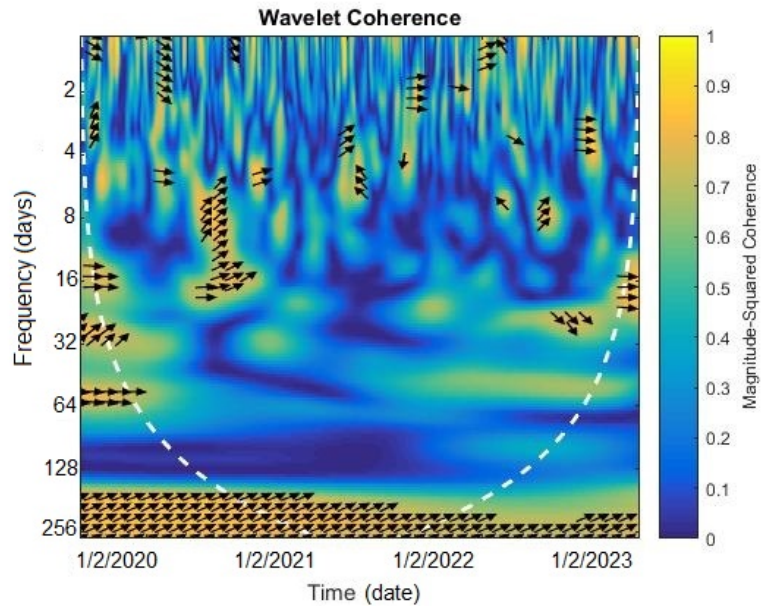
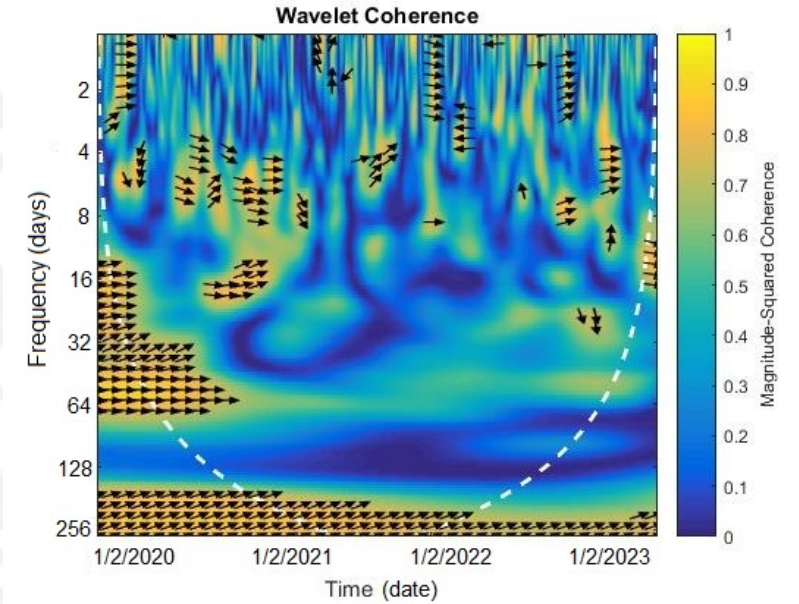
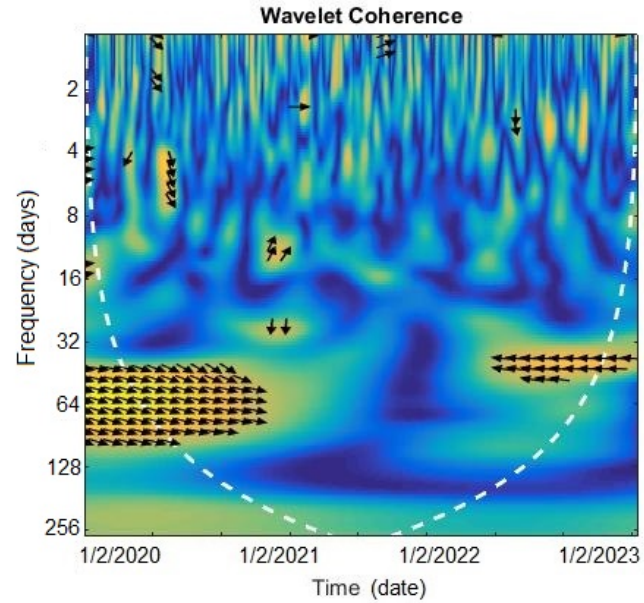
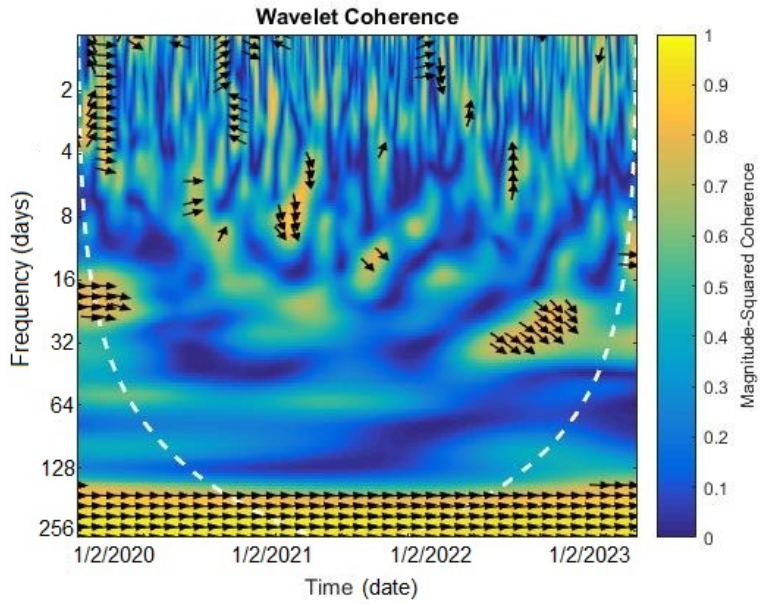


USA

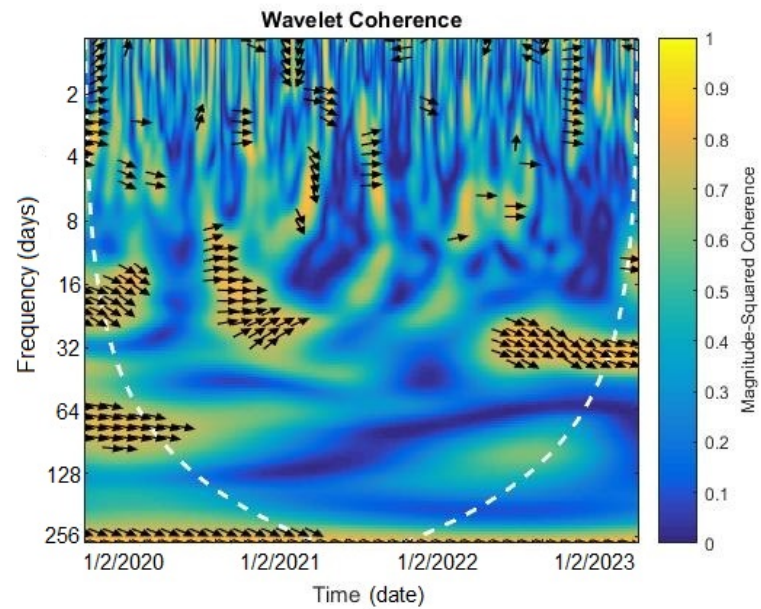
DISCUSSIONS (RE and NRE as part of Stock Market)

- USA and China – **net exporters** (China imports crude, exports refined). Investors keep energy markets **decoupled** from Stock market.
- EU and Japan during COVID-19 – NRE market treated equal to Stocks. Indian investors continued NRE investments in shocks.
- EU and India post Ukraine-Russia oil crisis – **RE and Stocks aligned**. India RE investment **not synchronous**; should mimic EU.
- Japan **decoupled NRE** from stock markets at onset of Ukraine-Russia and **coupled RE** market.

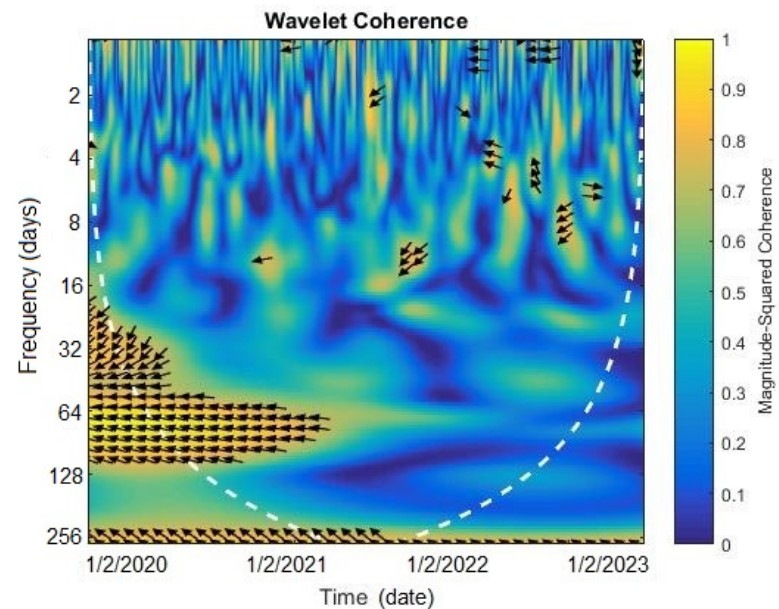
RESULTS (RE and BRENT)



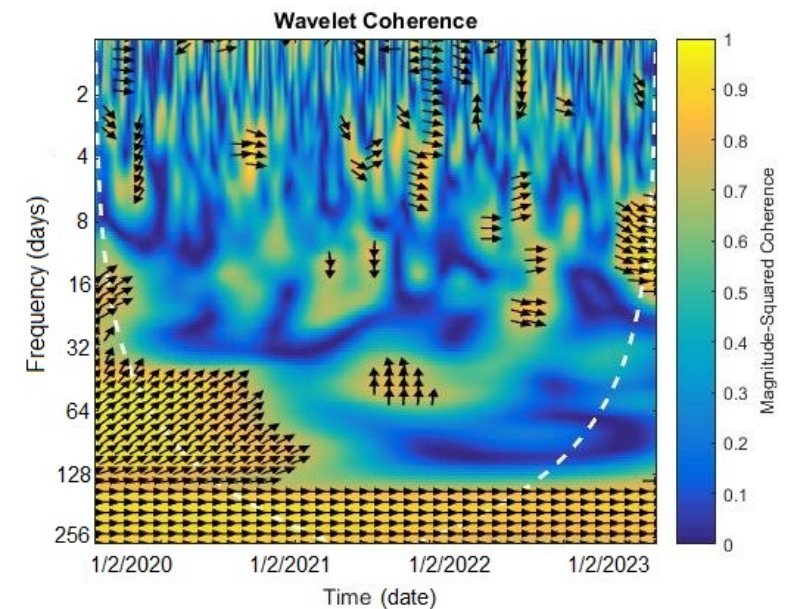
RESULTS (NRE and BRENT)



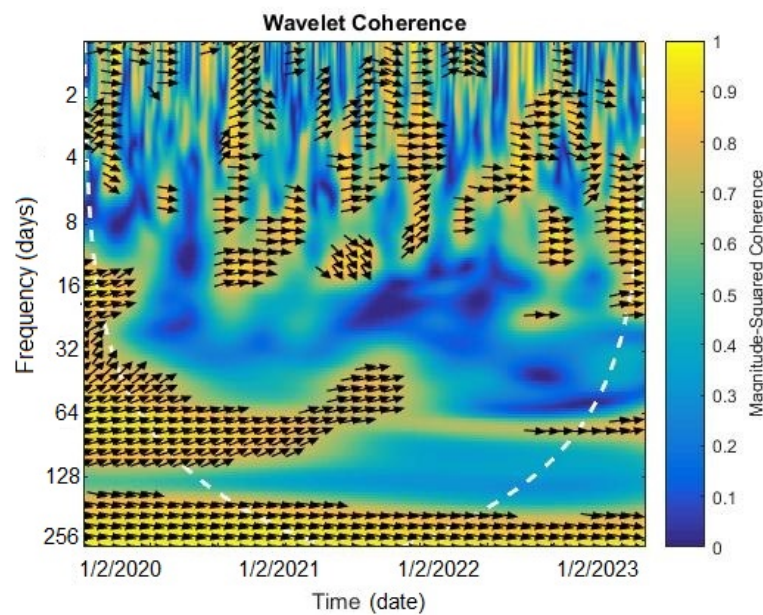
CHINA



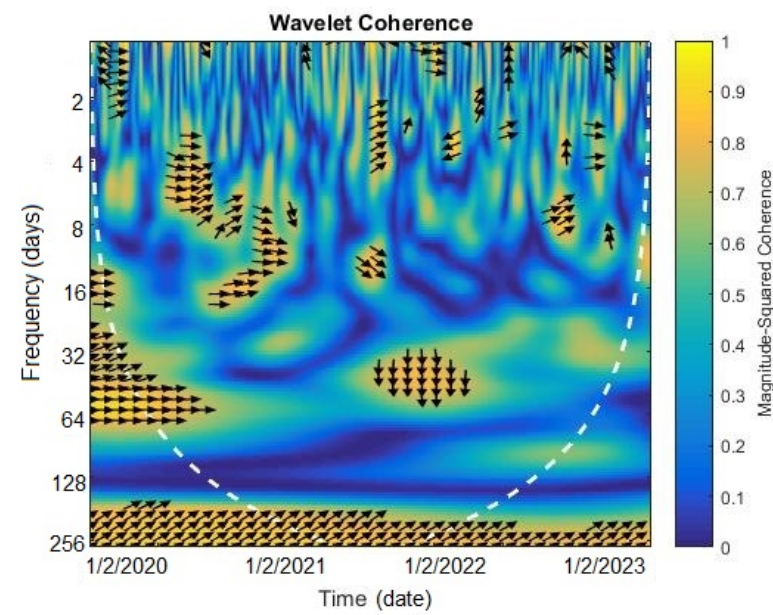
INDIA



JAPAN

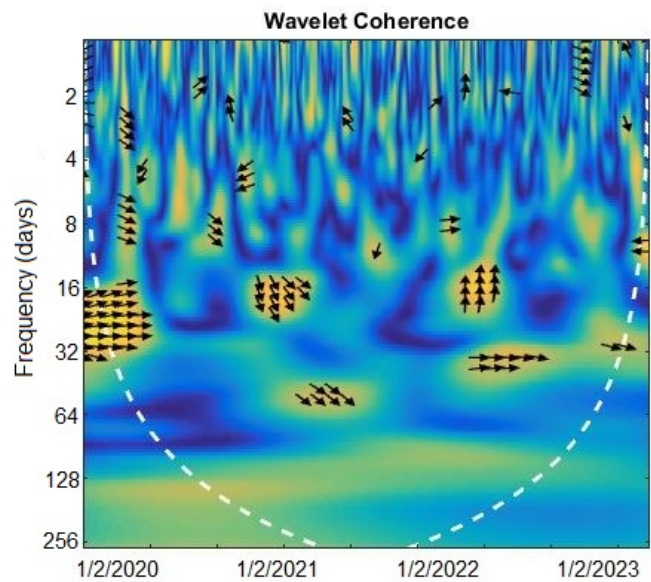


EU

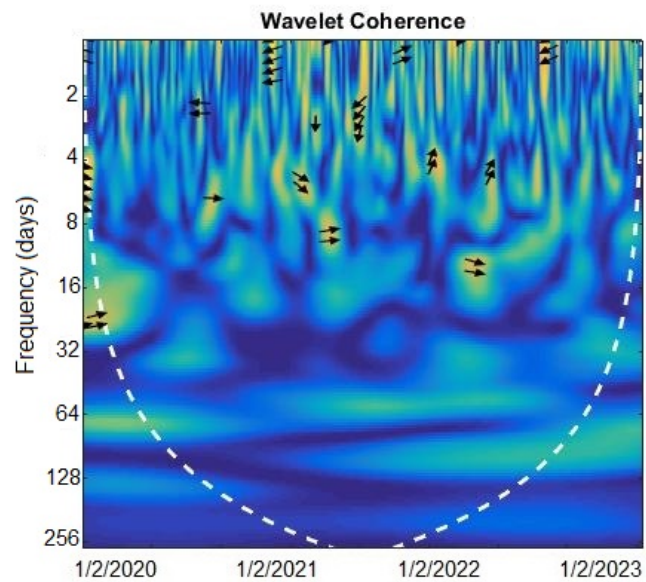


USA

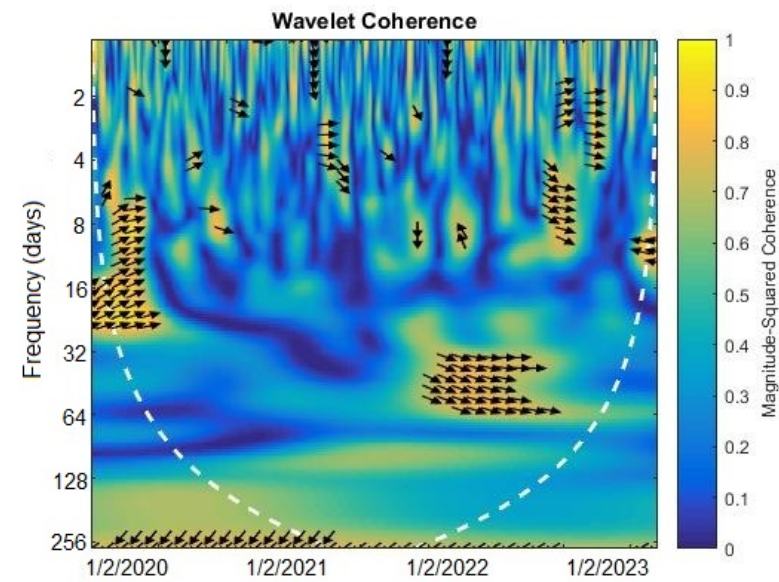
RESULTS (RE and GOLD)



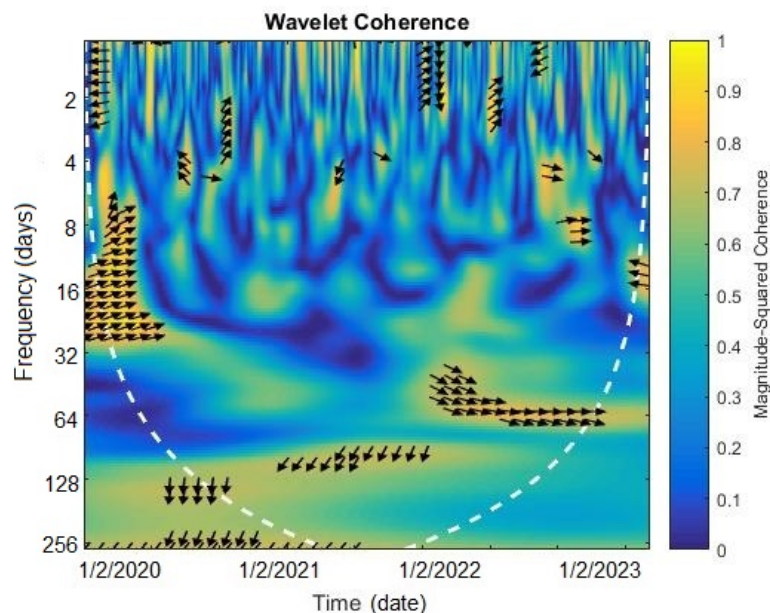
CHINA



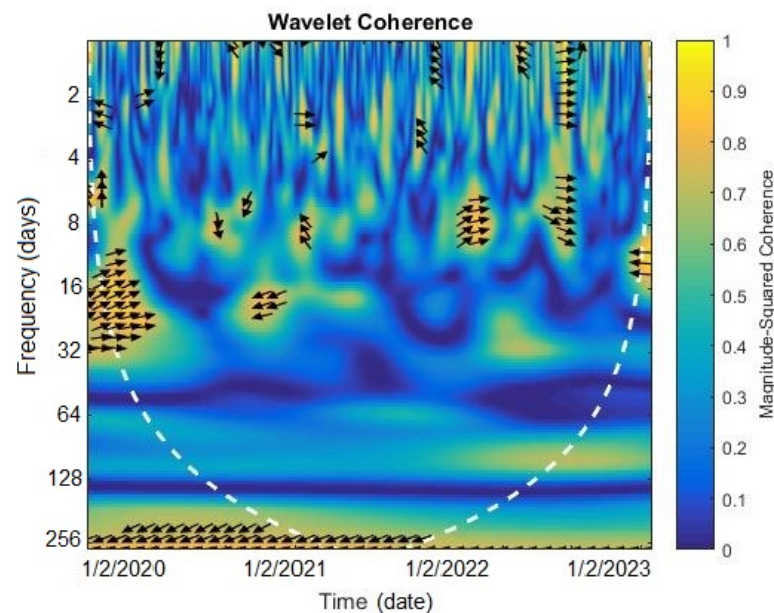
INDIA



JAPAN

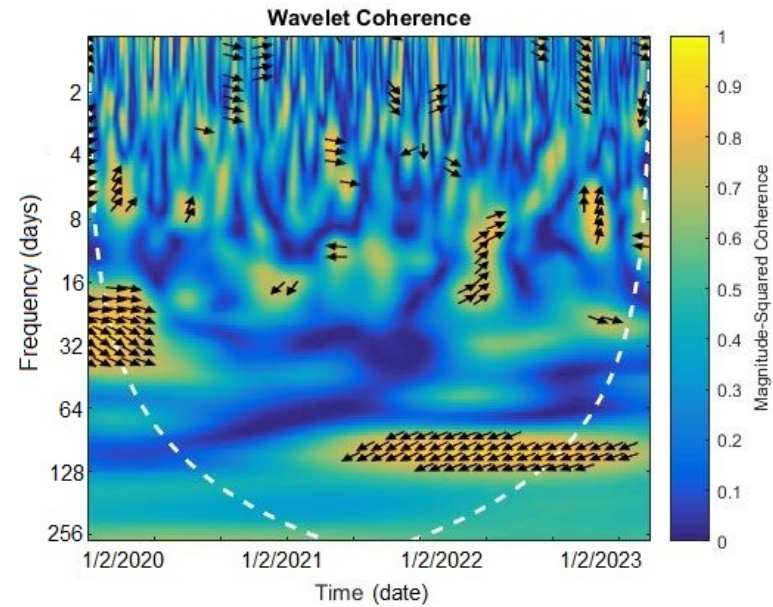


EU

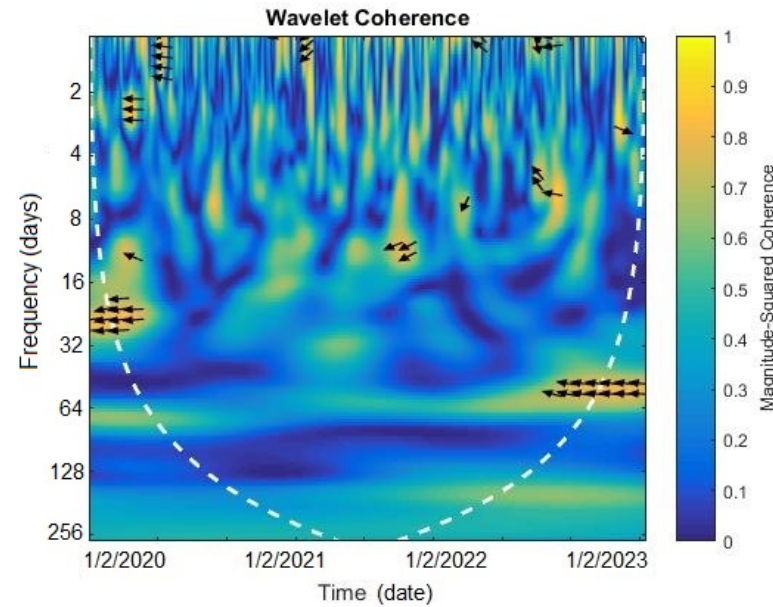


USA

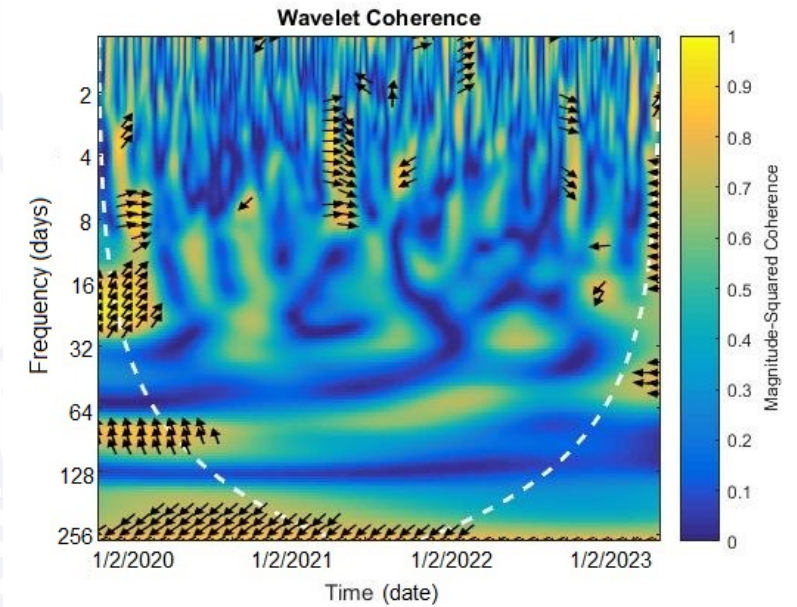
RESULTS (NRE and GOLD)



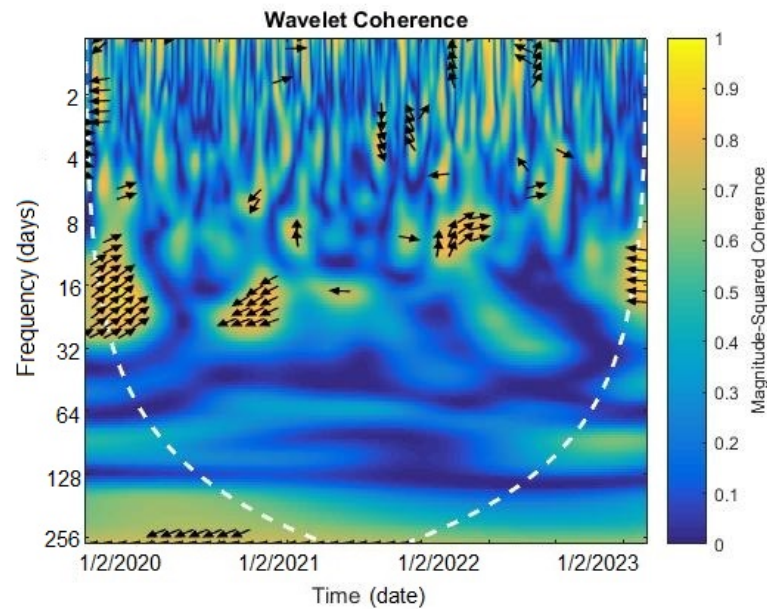
CHINA



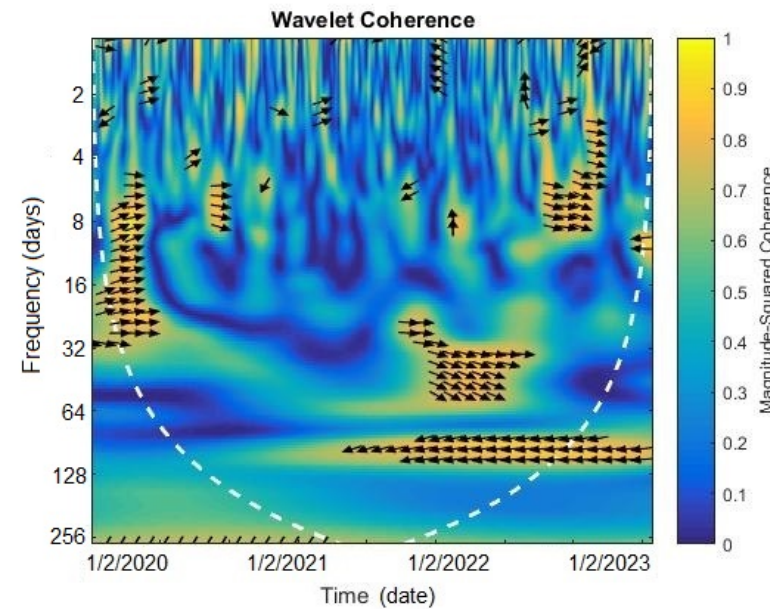
INDIA



JAPAN



EU



USA

DISCUSSION – Comparison of Shocks

- COVID-19 – **economic** shock; Ukraine-Russia – **Oil** Shock
- Oil Shock **decouples long-term RE investment** cycling with Oil markets, creating RE market instability. Demand shock – no effect.
- **Oil producing USA remains in-phase** with short- and long-term **RE-Oil cycling**. Leading with Oil, tends to stabilize domestic NRE markets.
- **Non-oil producing nations** (Japan and EU) stabilize with **in-phase mid-term cycling** of domestic **NRE** and **International Oil** market.
- Demand shock **discourages long-term RE and Gold markets cycling**. Oil shock **encourages** in **developed PV producing nations**.
- Demand shock **decouples domestic NRE and Intl. Gold markets**. Oil shock **brings in mid-long term NRE-Gold cycling** in **developed nations with EV**.

DISCUSSION – Comparison of Nation Economies for Oil and Energy Markets

- EU and USA: EU **maintains long-term NRE-Oil** cycling, USA **maintains RE-Oil** cycling.
- Japan and USA: Developed economies **opposing Russia**, **stabilizes** domestic **NRE** market during Oil shock briefly. USA leads with Oil market.
- EU and India: Developing economies **decouple RE-Oil during Oil shock**.
- Developed nations maintain long-term in-phase **RE-Oil through shocks**.
- India: Only country with **out-of-phase NRE-Oil cycling** in normal time.
- EU and Japan: Demand shock **no effect** on NRE-Oil cycling. Oil shock forces **short-term cycling in NRE-Oil**.

DISCUSSION – Comparison of Nation Economies for Gold and Energy Markets

- **Developed nations**: RE-Gold **mid-term cycling** in normal time. NRE markets stabilized after Oil shock with **limited time long-term cycling NRE-Gold** (out-of-phase)
- **Developed nations with EV**: During Oil shock, **immediate RE-Gold long-term cycling**. Gold is invested first. (Oil producing USA did not do this)
- **Developing nations**: RE-Gold **not cycled**. Investment policy required. Follows developed nations to stabilize NRE markets with Gold after Oil shock.
- Pre-COVID **NRE-Gold investments decoupled** with dual shocks for **all nations**.

CONCLUSIONS – Policy Implications

- **Oil shock** to be followed with **EV production**. Investors diversify RE and Gold, rendering RE market stability.
- **EU** should **adopt Oil purchasing diversity**. RE-Oil markets can be linked.
- **Developing economy** investors should **align NRE and Oil markets** to in-phase, for RE-Gold promotion.
- **Short-term RE-Gold cycling** with Gold leading to be practiced in **developing economies**, after Oil shock
- **Post Oil-shock, developing nations** should **subsidize PV production**, to stabilize RE markets with Gold market diversification.

FUTURE RESEARCH

- Gross Generalization:
Look into states of USA and individual nations of EU (collaboration)
- Real Impact of EV:
Looking into battery markets (REE, Copper markets)
- Segregating RE:
Differing RE technologies having varying properties