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EU External Trade Patterns and Financial Indicators Across Key Global Regions

MSc Research Project
MSc in Data Analytics

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EU External Trade Patterns and Financial Indicators Across Key Global Regions: An Empirical Assessment (2008–2024)

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Abstract

This research paper discusses the development of the external trade between the European Union and the four principal world regions of China, North America, South Asia, and Middle East Turkey between the years 2008 and 2024 and on the idea of using the regional stock market indices as the leading indicator of the subsequent trade flows. The approach is led by disruptions of the world, such as the COVID-19 pandemic, oil-price shocks, the realignment of geopolitical partnerships, and supply chains, and constant conflicts in Eastern Europe. This research also incorporates various heterogeneous data in a harmonised analysis tool. The analysis is supported by detailed trade records announced by UN Comtrade and Eurostat along with the financial market data, obtained with the help of Yahoo finance. It uses a time-series graphical presentation, comparative trade-structure analysis, correlation and Granger causality analysis to determine structural trends and predictive association. Results indicate that there are increasing trade deficits between the EU and China, continuing surpluses between the EU and North America, increasing but off-balanced trading between the EU and South Asia and fluctuating yet, strategically significant trading between the EU and Middle Eastern economies. At product level, machinery, transport equipments, chemicals and intermediate goods overwhelm the product in all regions. The results of Granger causality tests indicate that a number of regional stock indices, the Abu Dhabi DAX index (ADX) being the most predictive among them, the Hang Seng Index, and North American market indicators have statistically significant predictive capabilities of future trade flows at a given lag. The findings improve the knowledge base on how financial markets and real economic activity interact across time, providing valuable information with connotations amongst policy makers, investors and international trade strategists.

1 Introduction

The international trade scene and the nature of intertwined relations throughout the world has undergone massive transformation in recent twenty years, the process of which has been predetermined by the changing geopolitical relations and the accelerated change of technologies, restructuring global value chains, and unprecedented disruptions of the economies. The growth and disaggregation of global value chains have installed countries in elaborate transnational production networks to change the geography and structure of

trade flows Gereffi (2018). In the case of the European Union (EU), one of the largest trading blocks in the world, it has been accompanied by an exposure to systemic shocks, such as the global financial crisis of 2008-2009, the Eurozone sovereign debt crisis, the COVID-19 pandemic and the recovery thereof, and supplies-chain bottlenecks and energy price spikes due to geopolitical tensions, including the Russia-Ukraine conflict Kilian (2009). In this dynamic environment, EU has complicated trade relations with developed, developing and energy producing countries. Its trade relations with China, North America, South Asia, and the Middle East and Turkey are quite prominent, and they all support the involvement of Europe in the global manufacturing networks, energy markets, and strategic supply chains (Head and Mayer (2014),Kathuria (2018) and Akan and Balin (2016)).

This study is inspired by a series of events across the world that have defied historic trends of economic interdependence and indicated the necessity to gain a deeper insight into how trade reacts to financial, geopolitical and macroeconomic shocks. Rapid industrialization and exports of China has changed its position in the world and European production networks, strengthening Europe's reliance on Chinese intermediate and final goods Rodrik (2006). The bilateral relations between the two regions in terms of high-value manufacturing and services, especially in high-value production, can be mentioned as one of the most stable and deeply integrated transatlantic trade Fontagné and Santoni (2022). Slowly obtaining the diversification of its exports as well as basing its industries, South Asia, led by India, still has structural and infrastructural limitations Bahmani-Oskooee and Bolhasani (2008). Middle East and Turkey are in a separate category of key energy providers, and in the example of Turkey, as an increasingly significant manufacturing partner Fattouh (2021). Concurrently and simultaneously, financial markets have become more interconnected and are frequently viewed as foreshadowing of actual real-world activity, stock returns being demonstrated to feature information on forthcoming production, consumption, and investment processes. Empirical literature on the financial status, capital flows, and the emerging markets indicates that variations in the financial variables may have a significant effect on the level of trade, especially during the time of stress or a change in policies.

Although such a rich body of research exists, less has been done to study EU external trade vis-a-vis several key regions of partners concomitantly with specific references to regional stock market indices as the possible key predictors of trade flows in the future. A considerable body of literature concentrates on either the bilateral relations between two economic entities, including EU and China or EU and the United States as a trading partner. Not many studies coordinate multi-regional EU trade information and regional equity index over a long period and use time-series methods like the Granger causality to assess predictive relations of multiple partner regions at once. This paper fills that gap by examining EU trade between 2008 and 2024 with China, North America, South Asia and the Middle East and Turky and combines in-detailed statistics of EU trade with UN Comtrade and other sources of available data with regional stock indexes available on Yahoo Finance. The research applies visual analytics, correlation and Granger causality tests based on a harmonised quarterly panel to (i) record the development of EU external trade on the four regions, (ii) test the structural and sectoral variations in the composition of trade and the role of partners, and (iii) assess whether regional stock indexes hold statistically significant predictive data of future EU trade flows. The rest of the paper will be organized in the following way. Section 2 covers the available literature on the subject of international trade, global value chains, and financial-real linkages. The

research methodology is introduced in the section 3. Section 4 covers the analytical architecture and design specification. Section 5 contains the implementation. The findings of the empirical assessment are presented in Section 6, which covers regional case analysis and causality findings. Section 7 summarizes and covers future work opportunities.

2 Related Work

2.1 International Trade Dynamics, Global Value Chains and EU External Trade

The trend, in the way trade takes place in the world has changed dramatically in the last 20 years due to the growth of global value chains (GVCs), technological modernization, and emergent economies. Gereffi (2018) holds that the cross-border fragmentation of production can be seen as the 'second unbundling', which has saturated trade relations by placing countries in the middle of the complicated production networks of other countries. His analysis provides a background explanation of how the European Union (EU) relates with the large manufacturing centers like China, and **?** through the centrality of GVC governance defines the specialization of countries at various production levels. The framework developed by Gerraffi can be of such use when interpreting sectoral asymmetries defining EU-China trade.

The literature covering the rise in industrial development in China is well stated. Rodrik (2006) proves the fact that China is showing productivity and export performance outliers which are quite uncharacteristic of the common trends in the developing economies. More recently, Kee and Tang (2015) demonstrate that the intensification and diversification of exports in China was accelerated after joining WTO and, thus, trade flows with Europe changed. **?** also underscores the fact that the production networks in the world operated through China made Europe vulnerable to major threats during the COVID-19 outbreak, thus bringing further support to the structural dependence observed in the EU-China trade figures.

The transatlantic relationship has been historically described as being stable and heavily integrated. Fontagné and Santoni (2022) discover that the EU trade with the US is based on high value manufacturing and services supported by the long-term institutional and regulatory relationships. Head and Mayer (2014) in their argument using gravity modeling state that the transatlantic corridor is one of predictable bilateral relations in the world economy. These results are similar to empirical findings that show that EU-North American trade is balanced and resilient even to global shocks.

Trade has taken a different trend with South Asia. It is supported in a study by Bahmani-Oskooee and Bolhasani (2008), which confirms the extent to which South Asian economies are increasingly diversifying their export base even though they have been overly reliant on intermediate goods and textiles in exportation. In his review of the integration of India into the global markets, Kathuria (2018) proposes that the process of upgrading Indian exports is disproportionate, and it is not achieved due to the lack of infrastructure. All these studies put these moderate yet stable growth of EU-South Asia trade flows into perspective.

Middle East and Turkey belong to the very specific group of the EU trade partners, whose interaction is mostly caused by the energy flows and relations geopolitical connections. As Fattouh (2021) demonstrate, the volatility of oil exports in the economies of

the oil producers is associated with the global commodity cycles that directly affect the trade relations these economies have with Europe. In the case of Turkey, in particular, Akan and Balin (2016) report on how the continued participation of customs-union in relation to the EU has increased bilateral trade in manufactured goods, which builds upon industrial complementarities other than those brought about by the Gulf economies.

The policies of the EU trade are also enhanced by the theory of living institutions. **?** reveals the flaws in world supply chains, whereas Juan et al. (2022) gives detailed descriptions of the role of Europe in the production networks across the borders. According to the Kumar and Singh (2025), the interdependency of the EU in trade with Asia has been on the rise, specifically in electronics, machinery, and intermediate goods. When united, these contributions prove that EU trade dynamics differ significantly in various regions of partners and are conditioned by structural factors, i.e. by their industrial capabilities, endowments, and the integration into the global systems of production.

2.2 Financial Markets, Stock Indices and Trade Linkages

The financial markets have traditionally been viewed as being futuristic of the macro economical trends. Fama (1990) shows that stock-return series contain predictive information of the upcoming real economic activity, which includes industrial production and consumption. In the same manner, Schwert (1990) affirms that the fluctuations in the equity markets predict greater economic fluctuation and, thus, it offers a theoretical basis in connecting stock indices with trade flows.

The nexus of the financial conditions and the international trade have been studied to considerable depth. Chor and Manova (2012) confirm that a tightening of financial condition has a strong negative effect on export performance especially in industries with a weak financial position thus highlighting the possibility of financial markets being used as indicators of trade performance. Moreover, Forbes and Warnock (2012) record the spread of capital-flow shocks worldwide and state that trade-finance environments, along with real sector success, can be affected by financial strain in the dominant economies.

Studies of financial integration in the world provide a further background. Bekaert et al. (2014) note that the integration of equity-market is further centralized in times of crisis, which enhances the cross-border dissemination of shocks. Miranda-Agrippino and Rey (2020) say that the global financial cycles which have been caused by the monetary policy and the equity-market dynamics of U.S evoke a greater impact on the real economic activity in the global market. These findings justify the applicability of the connection between EU trade and the financial factors in different regions (including North America).

There is a significant difference between the financial-real interaction in the emerging markets. bbb(()) discover that the financial liberalization is a facilitator of the trade performance in the emerging economies and, at the same time, ventures into sensitizing the external financial cycles. Sarathkumara and Samarakoon (2024) show that the South Asian equity markets are increasingly integrated with the international markets where the transmission of the real-sector repercussions is limited. This finding is consistent with the weakened Granger-causality relationship observed between the South Asian indices and the trade flows between the EU and South Asia.

The commodity-based economies are characterized by another dynamic. Kilian (2009) presents evidence that oil-price shocks have a strong impact on macro-economy and trade flows in the economy that imports its energy like the EU. Basher et al. (2012) indicate that in emerging Gulf economies, oil and stock markets do move considerably hence indicating

sensitivity of financial markets to the phenomenon of commodity cycles. These results support the high degree of predictive relationship presented between the ADX (Abu Dhabi) and the EU-Middle East trade flows.

Professional reports are supplementary to scholarly studies. Forbes and Warnock (2012) highlights the importance of financial conditions in the world trade recovery after the COVID-19 pandemic, and the **?** records the growing impact of equity markets on the performance of the European external sector.

Taken together, these studies help to develop a solid theoretical framework as well as empirical base to research whether stock indices reflect forward-looking information, which is competent to explore the relationship between stock indices and EU bilateral trade flows.

2.3 Synthesis and Identified Research Gap

The literature review shows that there is a significant difference in the dynamics of international trade across regions, which depends on the involvement in the global value chain, industrial powers, and structural reliance. At the same time, financial markets may be described as predictive models of the actual economy and stock indices, as summing up of the expectations concerning demand and production and overall economic situations. However, despite the strong evidence of a relationship between financial situations and macroeconomic performance, very few studies combine regional stock indices with EU bilateral trade flows and even fewer studies analyze relationship prediction among multiple partner regions.

The existing empirical evidence is often focused on either dynamics in trade (i.e., the emergence of Chinese exports, stability of transatlantic trade, Asia rising, the Middle East being dependent on oil, etc.) or linkages in financial markets (equity market integration, financial cycles, transmission of commodity markets), but rarely on the interaction of the two. None of the studies have so far engaged in systematic harmonization of EU trade information going to China, North Africa, South Asia and the Middle East as well as Turkey over a multi-decade period whilst also determining causality by region upon region in terms of financial indices.

To fill this gap, the given work will combine multi-regional EU trade dynamics with predictive indicators that will be determined by global and regional stock market. This combination of visual analytics, sectoral awareness, and Granger-causal testing of four key economic areas is a new addition to the body of literature and provides grounds on which, more solid frameworks of trade forecasting can be built.

3 Methodology

This paper uses a structured methodology framework to combine data entry, pre-processing, heterogeneous data union, time conversion, visual analytics and econometric analysis. The methodology design will be scientifically rigorous, reproducible and analytically rich enough to examine seventeen years of trade as well as financial relationships between the European Union and four key regions of the world: China, North America, South Asia, and the Middle East and Turykiye. The method is an amalgamation of known empirical data methods of international economics with the use of time-series processing and statistical inference used in the financial analysis.

3.1 Data Acquisition & Initial Processing

The research process will start by getting the raw trade data of the two different sources. The first data is EU trade with countries of the Middle East and Turkey from 2009-2024. These were retrieved based on publicly available UN-Comtrade data files of trade and first presented in a semi-structured format with column headers that were misaligned, duplicate metadata fields, and irregular text formatting. As a solution to these problems, there was a column-shifting plan whereby the headers were re-aligned and some unnecessary fields such as unused "typeCode" records were eliminated. A continuous dataset was then created by merging the two time periods (2009-2019 and 2020-2024). All the trade values in numbers were standardized, converted into billions (USD), and filtered to select only the countries forming the Middle East of Turkey cluster according to the universal international classification. The resultant data set is clean and constantly formatted, with the names of partners, years, trade flows and value of the trade.

3.2 Secondary Dataset Preparation

The second dataset continues information about EU trade with China, North America, and South Asia from 2008-2022. As opposed to the MET dataset, in this data, the data was provided as structured Excel files each file had the import or export flows of one region. The files were organized in visual form with the columns being grouped by the years. Melt operation was used to produce a standardized time series data, where 'Year' was the independent variable, and a long format was created which was previously a wide structure. Trade values were first corresponded into thousands of USD then it had to convert into millions and then billions so that they can be compared. String normalization was applied to get rid of inconsistencies in names of groups of products. It was categorized using a region extraction function that placed each record under China, North America or South Asia by the name of the source file. The result of this was a harmonized multi-region trade dataset of fifteen years, with product group, partner and trade flow classifications.

3.3 Dataset Consolidation and Integrity Checks

The two trade data were then consolidated. The MET dataset does not provide data on product groups, so the unified table will contain a reminder to indicate that this is missing rather than turning the structural consistency upside down. A consolidated data set was formed which included all four regions and any year between 2008-2024 as well as both import and export flows. The data set was checked in terms of integrity by verifying the temporal coverage, identifying the missing values, range checking and verification of the agglomeration. These steps were to guarantee the validity and standardization of the ultimate analytical basis.

3.4 Stock Market Data Extraction and Time Alignment

The data of the stock markets were also included to see the possible relationship of prediction between regional financial markets and EU trade flow. Regional benchmarks were taken in the index data on a daily basis using the Python library yfinance: STOX50E, STOX600 and DEX in Europe; S&P500, NASDAQ and TSX in the North America area; NIFTY 50 and MumbaiSE in the South Asian region; and ADX and QSI in the Middle

East region. Some of the indices (especially those in the GCC markets) were not available or structurally incompatible, and therefore had to be excluded. The value series of 'Adj Close' or 'Close' price was kept to each of the actionable indices. The datasets were reorganized around a shared panel taking the form of date-time indices and then more recently resampled to average monthly and quarterly time-frames. The frequency of quarterly was selected as the desired format of econometric analysis, as it is less costly than the volatility of financial markets as well as less fast-paced like international trade.

In order to equate trade and financial data over time, annual values of trade were turned into quarterly step functions by allocating annual value to all four quarter-end times of that identical year. Synchronous comparison and econometric testing was possible with the combined quarterly data. This method restricts the variability within a year, but it would be suitable in studying medium term relationships, and comparable with the general rule in macro-financial research.

3.5 Analytical Workflow: Visual, Comparative, Correlation, and Causality Analysis

There are four components of the analytical methodology. The former is the first part called visual analytics, which includes time-series plots of imports and exports, of both regions, trade balances, analysis of partners composition, and analysis of products breakdown. These visualizations offer background information on the patterns of the structure, establishing trend in the fact that EU–China trade deficit was growing, EU-NA flows are stable, and EU-MET trade is volatile because of energy-price cycles. The second element is comparative regional assessment through the combined plot of illustrations of disparities in the trade magnitude, growth rates and market share of the four regions.

The third one is statistical correlation analysis where Pearson correlation coefficient was calculated between quarterly values of trade and quarterly levels of stock indexes. In this analysis, the level of contemporary relationship between financial and trade indicators was assessed. Findings indicated weakly evident correlations, implying that there is no evidence that stock markets and trade flows are managed in tandem but there are longer term dynamics that may exist.

The last and complex ingredient is Granger causality testing. based on the quarterly differenced series, Granger causality was measured between the individual regional stock indices and the individual corresponding EU trade values up to eight lags. This method affirms the presence of the applicability of past financial market results in the forecasting of future trade flows. Results obtained in the tests indicated that, the ADX index forecasts EU-MET trade at a number of lags, and the Hang Seng Index predicts EU-China trade at lags six and seven. The predictive effects of lag three and later on North American indices show a lot of correlation. These findings provide new information on the time and directional relations between trade and financial markets.

To conclude, a strict set of data alignments, time-based normalization, visual analysis and econometric analysis forms the basis of the research methodology. It makes sure that the analyses made in the further sections are based on the analyses which have been repeatedly validated with the help of well-developed analytical methods and are, therefore, in compliance with the accepted international trade and financial economics scientific standards.

4 Design Specification

This research design identifies analytical architecture, conceptual framework, functional constituents which enable the integration, transformation and assessment of multi-regional trade and financial data. Since the study is based on heterogeneous data sources that are different in terms of the structure, frequency, and the level of granularity, the design anticipates modularity, scalability and consistency of the methodology. This framework forms the basis of the further implementation, as well as the systematic creation of visual, statistical and econometric information.

4.1 Architecture Layers and Conceptual Workflow

The analytical design has four relational layers which include the Data Acquisition Layer, the Data Processing and Harmonization Layer, the Analytical Layer, and Output and Evaluation Layer. These layers, combined with one another, create the logical architecture that processes the raw data to the interpretable results. Figure 1 shows the Architecture Diagram, illustrating how each of these layers interact within the overall workflow.

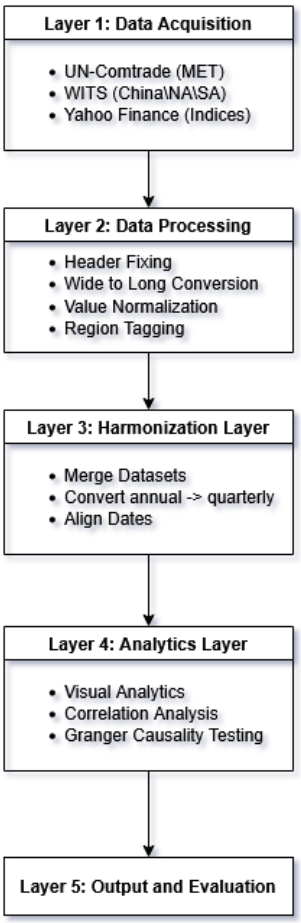

Figure 1: Architectural Diagram

4.2 Design Specification

The first one is Data Acquisition and it is associated with accessing raw data which are gathered by various sources. The EU trade statistics with the Middle East and Turkey are captured by UN-Comtrade exports whereas EU trade with China, North America and South Asia is captured by structured Excel files of 2008-2022 from WITS (World Integrated Trade Solution). Yahoo Finance will be accessed through automated API-like calls where it extracts the stock index data programmatically. In this design, repeatable and clear data retrieval process is ensured, although there are some indices to be dealt with in terms of missing or de-listed entries such as GCC markets indices. All datasets are processed into one central repository, handled in the Python environment.

4.3 Data Processing Layer

Data Processing and Harmonization is the second layer, which is the center of transformation in the system. It is aimed at transforming different data into one logical analysis system. In the case of the MET dataset, column-shifting and repairing of headers along with elimination of unnecessary metadata are necessary because of structural misalignment happening in the raw data files. In the case of China/NA/SA datasets, the temporal structure is standardized with a wide-to-long transformation that is based on melt operations. Both databases also undergo numeric standardization, tagging partners/region and product-group cleansing as well as monetary values change to billions of USD. A single schema is then enforced over sets of data, allowing the formation of the consolidated table represented by the data-frame name "all_trade".

4.4 Harmonization and Temporal Alignment Layer

The financial datasets executions proceed through a parallel processing pipeline that is similar to the previous one. The re-sampling of stock-index values is done between daily, monthly and quarterly. Multi-index column designs are flattened, non-available indices are filtered and quarterly timestamps are synchronized with trade data. Since the data of the trade are annual frequency, the design has a step-wise quarterly expansion process which identifies the annual value as being allocated to the respective quarter-end datings. This method maintains both zero and finite comparability in time of real economy and financial variables.

4.5 Analytical Framework Layer

The third layer is the Analytical Framework, which determines the methods that are used to reveal relationships and come up with insights. This system will also include a visual analytics component that will generate time-series of plot, trade-balance curve, partner-distribution curve, product-level comparisons, rolling-volatility curve and index-trade overlay. Such visualizations can expose variation in structure between regions, identify anomalies, and create an intuitive base of next generation econometric explanations. There is a statistical segment that calculates the correlations and Granger causality tests and determines the existence and direction of predictive relationships between trade flows and stock indices. Up to eight quarters of lag structure is supported, in consideration of the design need to be flexible in delivering the requirements of capturing variable trade-cycle periods.

4.6 Output and Evaluation Layer

The last layer, which is the Output and Evaluation, controls the display of results. The architecture generates processed datasets, graphs, statistical tables and econometric summaries, and all these are an input to the analysis and discussion of the research results. The system will be in a way that it will have a modular experimentation whereby case studies of each region can be implemented in an independent fashion whilst maintaining methodological consistency.

4.7 Design Considerations

The design focuses on accuracy, reproducibility, and comparability concerning geography and time. It should have the capability to meet the anomalies in raw trade data, time-series transformation, and missing financial information, and maintain fidelity over time. The architecture is modular and hence it guarantees flexibility to other regions, variables, or forecasting mechanisms during future work.

Comprehensively, the EU design specification offers a logical and scalable framework on the analysis of the EU external trade and its correlation with the financial market indicators. The framework will ensure that further implementation procedures are followed on a solid and rationally sound basis, thus allowing the overall assessment, as introduced in the report.

5 Implementation

The implementation of the research project transformed the theoretical and methodological framework into an operationalized analytical system that is able to work with heterogeneous data, produce visual representations and conduct econometric analysis. They were implemented in a Jupyter Notebook with Python, chosen due to its large range of data processing, visualization and statistical libraries.

Figure 2 shows the Implementation Diagram, illustrating how the steps cascade together to the final output.

5.1 Environment Configuration and Library Setup

The processing environment setup has started by installing and importing the necessary Python libraries. Pandas and NumPy were the two basic data manipulation tools, which allowed addressing large tabular data effectively and performing overlapping work, reshaping, and number manipulation. The visualisations using Matplotlib and Seaborn were of high quality, whereas the econometric tools necessary to conduct the correlation test, stationarity, and Granger causality tests were offered by Statsmodels. The yfinance library was used to access stock index data in a programmed way. The choice of these libraries is based on well-known best practice in empirical economics and data science, thus making the approaches replicable and reliable.

5.2 Trade Data Processing Pipeline

The data-processing pipeline was executed in functions that were called out in a modular fashion in accordance to the structure that was outlined in the methodology. Raw trade

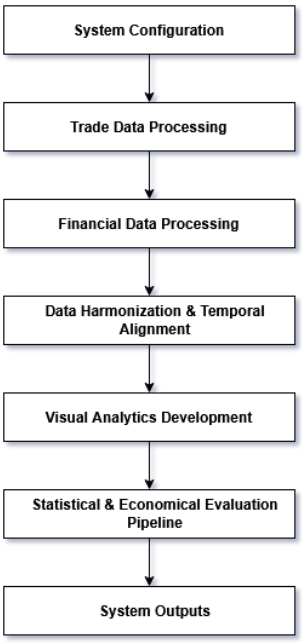

Figure 2: Implementation Structure

files available at UN-Comtrade had been read and cleansed using header re-alignment, type conversion, and row filtering. The second group of functions processed the conversion of tables in wide format into long format series to enable the analysis of regions using standard format. Auto-extractions were made of region identifiers extracted out of filenames, and numeric fields were cleaned and transformed into billions of USD. The two bodies of trade through which the data had been collected were then combined into one structure with the same field definitions and time synchrony. During this procedure, validation checks were made so that the year ranges are not lost or misplaced, missing values are handled well, and assigning trade flows was done correctly.

5.3 Financial Data Acquisition and Processing

The retrieval of stock market data was in the form of automated API-like calls with the support of yfinance. The system tried to download daily values of 'Adj Close' or 'Close' data that was in 2008-2024 period according to the targeted index. Instead of allowing a system crash because of missing data, conditional dealing was added to take care of the indices not available in Yahoo Finance like some of the benchmarks in the Gulf market. Stored retrieved information was organized in a dictionary format and then combined into a multi-column data-frame. That was followed by a data implementation of daily data and resampling it to monthly and quarterly frequencies through Pandas resampling functions. The choice of quarterly statistics was based on a further analysis and harmonization of data by flattening columns to remove multi-index structures.

5.4 Data Harmonization and Temporal Alignment

The most important aspect of the implementation was the annual trade data and quarterly stock index values matching function. It was done by a step-function expansion whereby all annual trade value was interpolated to quarter-end timestamps. The quarterly trade

and index series were combined with the help of a quarterly unified dataset created through the joining of both series based on the alignment of the data through date. This data was used to conduct statistical analysis and overlays.

5.5 Visual Analytics Development

The implementation of visual analytics had a number of custom plotting functions. These functions produced time-series plots of imports, exports and trade balances, region-to-region comparisons, partner contribution charts, product level analysis as well as stock index trends. All the plots were provided with titles, labels, legends, and aesthetic settings, which are appropriate to represent in an academic manner. The visual results were presented with the intuitive explanations of main structural trends in the EU trade which constituted a fundamental part of the assessment.

5.6 Statistical & Econometric Evaluation Pipeline

The pipeline comprised a descriptive and a statistical output on evaluation. The correlation matrices were calculated through the Statsmodels and were then plotted on a heatmap to indicate trends of trade flow indices. A set of granger causality tests in Statsmodels were performed at lag structures as far as eight quarters. Those were summarized into a tabular form to make sense of the findings. These econometric results were discussed in the evaluation section.

5.7 Final Deliverables and System Outputs

The implementation generated a number of the final deliverables: a consolidated and completely cleaned trade dataset; a quarterly consolidated dataset that included trade and financial data; a set of visualization representing structural, comparative, and product-level insights; and econometric outputs that determined causality between stock markets and trade. All of these deliverables give strength to the analytical findings of the study and offer a repeatable basis of future research.

6 Evaluation

6.1 EU–China Trade Evaluation

The trade strength between EU and China has been featured with structural imbalance and significant growth of import and export both between the years 2008 and 2024 Figure 3. The number shows that Chinese imports to the EU have grown at a consistently higher rate than the opposite exports have. The trade deficit is becoming deeper after 2016, which was an era when China was experiencing more rapid transition to high-technology manufacturing and Europe was even more reliant on Chinese electronics and intermediate products.

There are three major inflection points which can be noticed closely. The former is realized around 2010-2012, when the wake-up response of the crisis led to the European demand in low-price intermediate products. The second one is in 2016-2018 when it was coinciding with the process of industrial upgrading in China and US-China trade tension that redirected Chinese excess exports to Europe. The third inflection can be observed in

2020-2021 when following world shakeups due to COVID-19, imports of Chinese products in the EU skyrocketed, which is consistent with findings of Arriola et al. (2020), who stated that China is the only large economy that remained active in export momentum in the pandemic because of its early factory re-activation and domination in medical and technological equipment.

The concentration of EU exports to China to Figure 4, at the product level indicates that there is much concentration in machinery, transport equipment, chemicals and high-value intermediary goods. Such categories represent the traditional export strengths of Europe and indicate the complementarities between EU specialization in the industry and the domestic needs of advanced components of China.

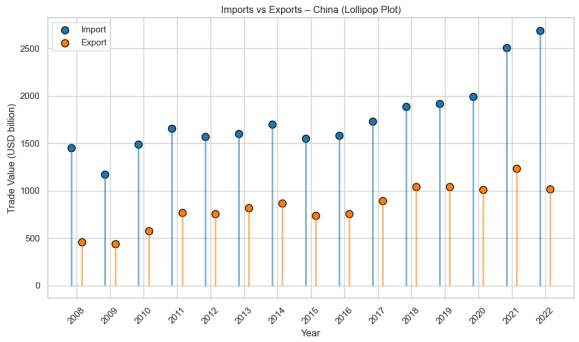

Figure 3: EU-China Imports & Exports

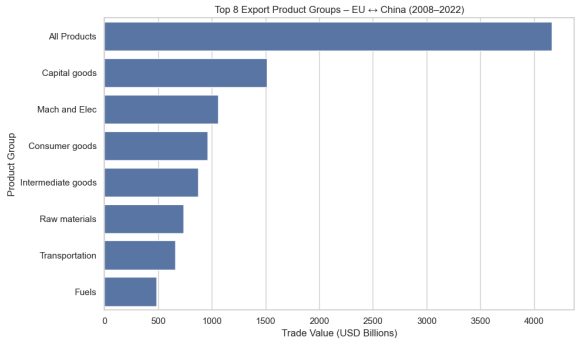

Figure 4: EU-China Product Groups

Deeper layers of analysis are financial linkages. Figure 5 overlays EU–China trade with the Hang Seng Index (HSI), revealing limited contemporaneous co-movement but suggesting lagged relationships. Nevertheless, the results of Granger-causality reveal statistically significant predictive causality between the HSI and EU-China trade at lags six and seven with a p-value of 0.33 and 0.24 respectively, which means that the financial anticipations in the general China-Hong Kong financial ecosystem predict future changes in trade flows almost 18-24 months prior. This fact is in line with empirical studies that have shown that East Asian financial markets incorporate forward-looking signals associated with the production and export activity.

Going by the empirical trends as discussed above, the time series analysis of EU-China trade balance can also be seen in Figure 6 that captures the widening of the deficit in an isolated cumulative fashion. As indicated in the image, the trade balance of the EU with China began to deteriorate on a sustained basis since 2008, with accelerations in the deficit since 2015, coinciding with the pace of continuous increase in the penetration of the Chinese exports to the European market. The fact that the negative slope is very

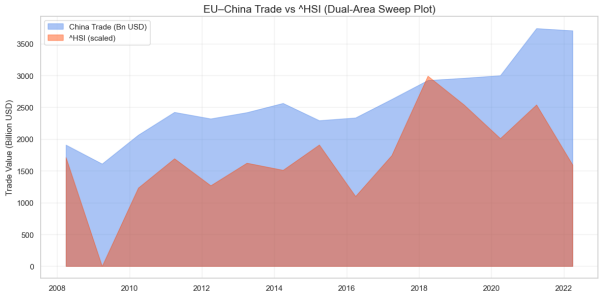

Figure 5: EU-China Trade with HSI Index

strong in the year of the pandemic indicates that Europe is very dependent on Chinese medical, electronic, and intermediate goods in times of disruption of the global supply-chain. These observations support the previous arguments that structural asymmetry, as opposed to short term volatility is the main cause of the continuous deficit status of EU. Further, the comparative analysis of Shanghai Composite Index (000001.SS), as

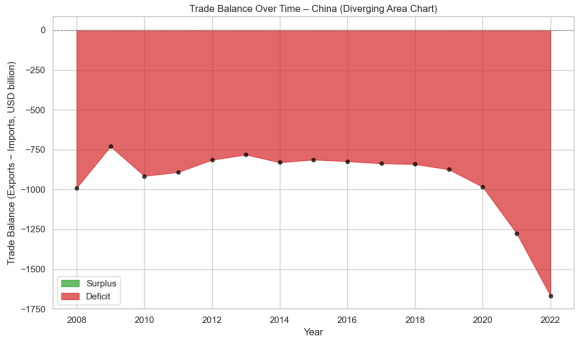

Figure 6: EU-China Trade Balance

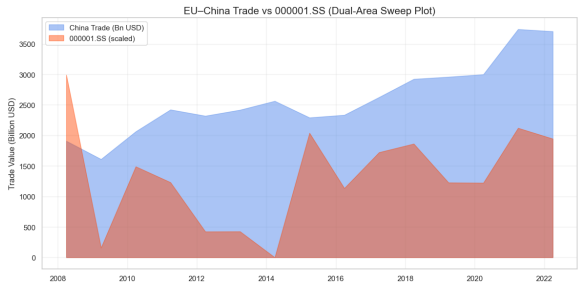

Figure 7: EU-China Trade over Shanghai Composite Index

Figure 7, provides a broader view of financial-trade relationship as compared to Hang Seng Index. The representation indicates that the major market cycles in mainland China are associated with the change of directions of EU trade flows with China, especially at the times of domestic economic tightening in 2015 and pandemic-driven volatility in 2020. Even though the contemporaneous relation is also limited, these results give credence to the thesis statement that investor sentiment and macroeconomic expectations embedded in Chinese financial markets, have embedded implicit indication of future export behavior, even where the causal pathways occur at the long lags.

Lastly, Figure 8, sums up the trends of a series of standards or market indicators in China giving a larger scale to the derivation of the financial relationship behind the Chinese performance in the external trade. A combination of the up and down movement presented in this visualization represents periods of liquidity growth and narrowing cycles and changing investment sentiment, which negatively impact the production capacity, as well as the export volumes, indirectly.

The case study of EU and China in general demonstrates asymmetries in the shape of a trade relationship primarily based on manufacturing flows and marked by sluggish but deep-rooted financial-trade causal processes. This overall financial view is consistent with the findings of Granger causality, and thus it supports the fact that China creates a long term but lagged effect on trade patterns in terms of finance.

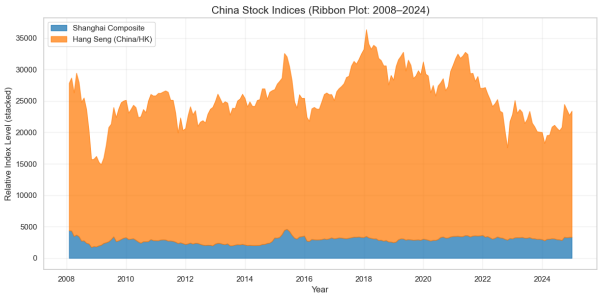

Figure 8: China Stock Indices

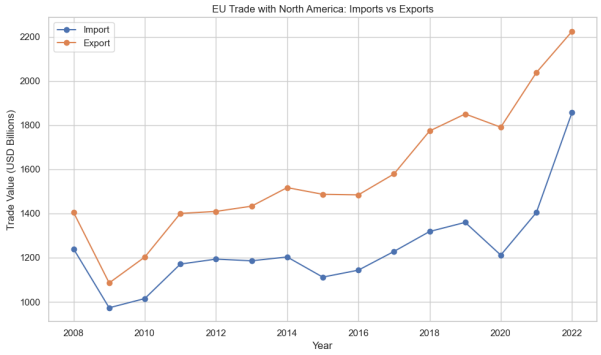

Figure 9: EU-North America Imports & Exports

6.2 EU–North America Trade Evaluation

The EU-North America trade follows a vastly different pattern compared to EU-China flows, which is characterized by long-termed balance, industrial complementarity between each other, and shock resistance. Figure 9 illustrates that the growth in imports and exports is consistent and nearly parallel over the whole period of 17 years. As compared to the growing deficit in the case of China, EU records a steady trade surplus with North America which indicates the high-value nature of its exports including pharmaceuticals, automobiles, aerospace parts and high-tech machinery. The trend is also strong at the time of international economic pressure. As an example, the crisis of 2008-09 only causes a short-term narrowing process in both directions but after that, expansion is quick. Likewise, the 2020 disruptions brought about by the pandemic do not cause a change in the structural course, but only a slight temporary reduction. These results are consistent with Felbermayr et al. (2018), who state that transatlantic trade was one of the most consistent bilateral relations in the world economy. Fig. 9 discloses the sectoral characteristics of the EU exports to North America. The machinery and transport equipment are dominant reflecting similar trends in trade with China with more representation of high-end manufactured goods. This is in line with Anderson and Steinberg (2025), who observes that the EU-US trade is influenced by a high tech, pharmaceutical, and aeronautic character of a premium manufacturing partnership.

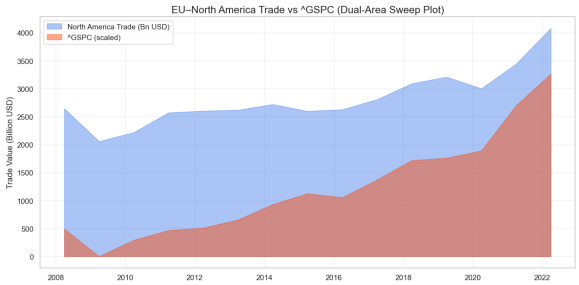

Figure 10: EU-NA VS S&P 500

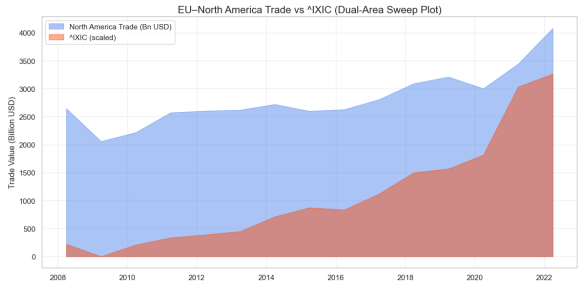

Figure 11: EU-NA VS NASDAQ

Figure 10 and Figure 11 describe the stock market trends that the trends of the stock markets of North America like the S&P 500 and NASDAQ are strongly positive long-term returns, far superior to the European and Asian indices. The US and Canadian financial markets are also crisis related as these indices bounce back at a quicker rate. When overlaid with EU–North America trade, the short-term correspondence appears

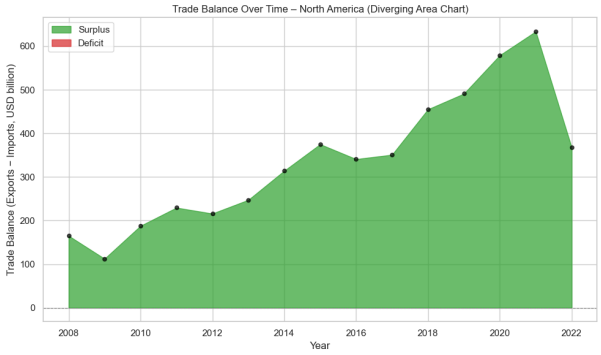

Figure 12: EU-North America Imports & Exports

limited, consistent with the general findings of Bekaert et al. (2011) on financial–real economy disconnects in the short run. Nevertheless, according to the results of Granger causality tests, North American indices have significant predictive power starting at lag three and continuing at higher lags. This implies that the EU-North America trade is propelled by the financial market situation in the US and Canada by about 9-12 months. These findings confirm the hypothesis that the financial markets reflect the expectation of investment cycles, consumer demand, and production capacity all of which work into a trade flow with lagging time. The long-term development of the EU/North America

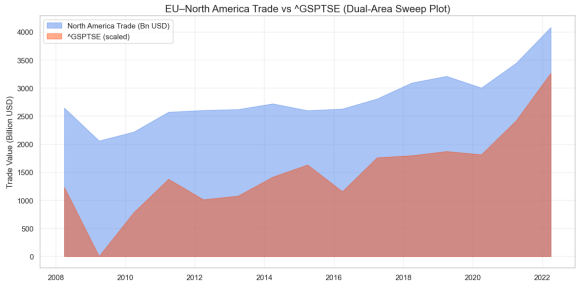

Figure 13: EU-NA Trade over Canadian Composite Index

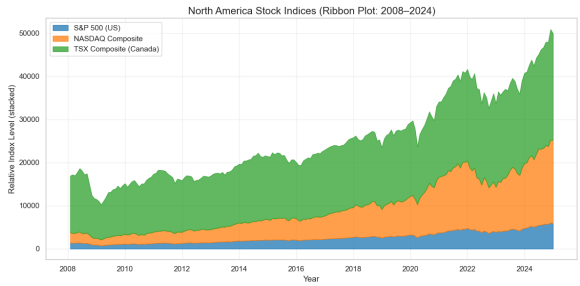

Figure 14: North American Stock Indices

trade balance can be seen in a more explicit way in Figure 12. This illustrates that although the trends of 2009, 2016, and 2020 have fluctuated a bit, on a bigger scale, the structure of the trade surplus of the EU with the region has not changed. Unlike the growing deficit in bilateral trade with China, the EU-North America balance shows a mature mutually beneficial relationship that is supported by diversification of industrial relationships.

Further enlightenment is given by Figure 13 whereby the volumes of trade between EU and North America is overlaid on the Canadian TSX Composite Index. This is as compared to a relatively small current or near-term effect of Canadian capital markets when in comparison to the dominant US indices. However, the observed economic negative returns to the TSX in the 2008-09 and 2020 crises are similar to the decline of EU-North America trade volumes, which shows that the effects of external shocks on the markets of the North American region are transmitted into the operations of the trade, albeit with weaker causational force than that of the United States.

North America economic climate is condensed in Figure 14, which gives the key indices (S&P 500, NASDAQ and TSX) in a single comparative perspective. This visualization

indicates that, empirically, the US markets have steadily displayed an upward trend compared to Canada, thus justifying the Granger-causality tests that indicated that the S&P 500 and the NASDAQ were major predictors. The swarm behaviour being seen in this visualization supports the idea that North American financial markets act as predictive adherents to the economic activity, with the trade flows relying on multi-quarter delays.

The Europe North America case study therefore depicts a stable trade relationship where it is balanced with high value sectors and predictable monetary-trade relations.

6.3 EU–South Asia Trade Evaluation

EU- South Asia trade, although less in size, has been showing a steady long term growth and rising in strategic importance. The visualizations indicates that the imports and exports take an upward trend throughout the period with the export increasing more rapidly in earlier years and the import in the later period. The outcome is a fairly balanced trade relationship as opposed to that of EU -China which is asymmetrical and volatile like EU-MET flows. This pattern is consistent with other reports about the growing industrial foundation and diversification of exports in South Asia by Kumar and Singh (2025). The leading export products of EU to South Asia include machinery, intermediate goods, chemicals, and transport equipment. These classifications reveal that South Asia is slowly becoming a part of the world value chains especially in the manufacturing and pharmaceutical sector. South Asian stock indices such as NIFTY50, Sensex show robust growth and periodical corrections Figure 15 and Figure 16. Such trends indicate that the Indian financial markets are increasingly becoming mature and open to international integration Pandey et al. (2020). The results of the granger causality indicate that the lags are weak, though, at times, significant, indicating that South Asian stock markets do not predict EU-South Asia trade significantly. This can be explained by the structural variations in composition of trade, textile dominance in imports and failure to have full financial integration in the region.

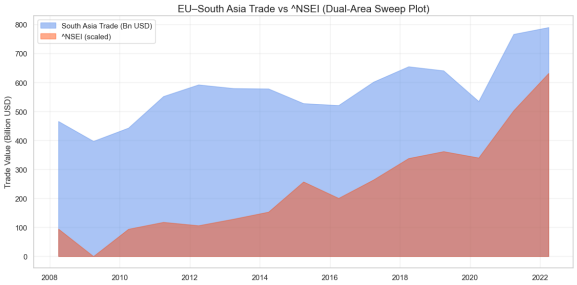

Figure 15: EU-SA VS NIFTY50

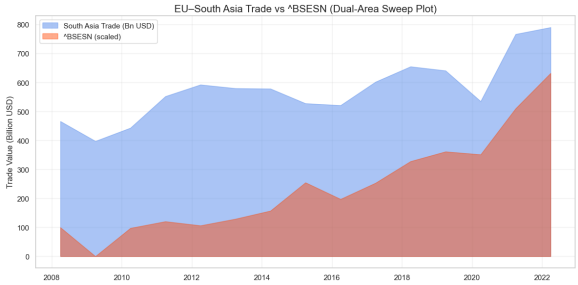

Figure 16: EU-SA VS SENSEX

To a smaller-focused view on sectoral composition is provided in Figure 17, which highlights the domineering effect of machinery, chemicals, pharmaceuticals, and intermediate goods in EU exports to South Asia. The visualization shows well how the region is getting increasingly integrated into global value chains or the processing of chemicals and assembling electronics and equipment and medical goods. The results are consistent with the previous argument regarding the industrial upgrading of South Asia, although in an uneven way, which creates enhanced complementarities in production systems of Europe.

The bilateral trade balances trends are illustrated in Figure 18 that shows the relatively slight but consistent surplus that is held by the EU. Compared to the strong asymmetries of the China or the volatility of the flows in Malaysia, Thailand, and Indonesia (MET), the EU balance in South Asia is still relatively stable denoting a more modest but structurally stable trade relationship. This confirms the conclusion that the EU-South Asia trade is not characterized by a great cyclical fluctuation but rather slow and steady growth. Regional financial market behavior has been summarized in the Fig-

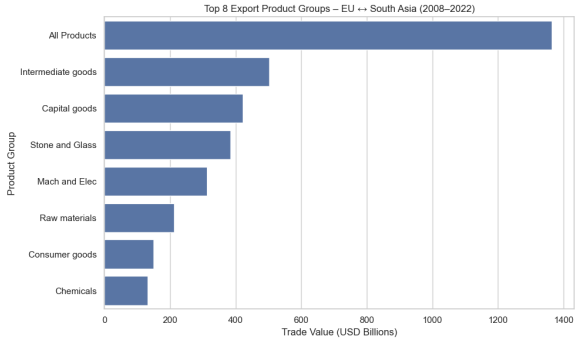

Figure 17: Top Export Products - South Asia

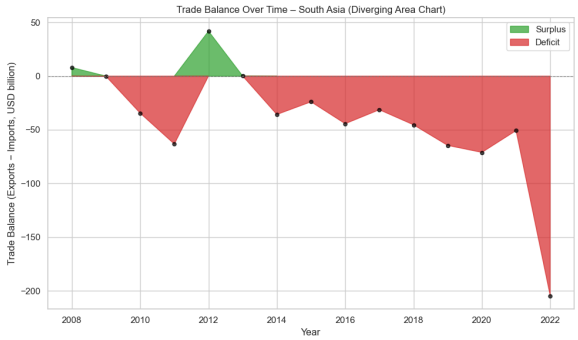

Figure 18: EU-South Asia Trade Balance

ure 19 that shows parallel trends of NIFTY50 and SENSEX among other South Asian indices. The relatively milder and less turbulent curves here can strengthen the statistical results that the financial-trade connection in this region is minor as compared to China or North America. These visual patterns further assist in the achievement of empirical responses to the limited Granger significance established and why South Asian financial markets do not always factor in the trade fluctuations.

In general, the EU- South Asia case study demonstrates a weak partnership that is gradually gaining strength with increasing industrial complementarities, and weak financial-trade linkages relative to other regions.

6.4 EU–Middle East & Turkey Trade Evaluation

EU-Middle East and Turkey (MET) trade is volatile in nature based on energy markets and geopolitics. Figure 20 emphasizes the drastic changes in imports related to the changes in oil prices globally, including the oil price crash in 2014, the shock of the pandemic in 2020, and the energy crisis immediately after the invasion in 2022. Export, on the other hand, is showing a more consistent pattern, fueled by machinery, manufactured

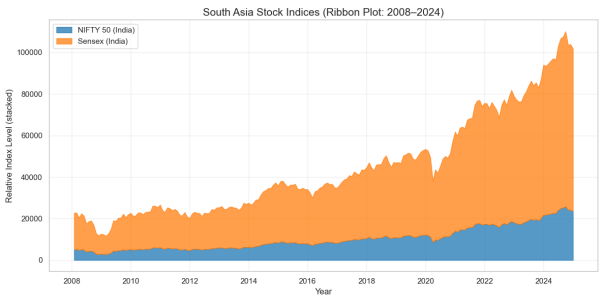

Figure 19: South Asian Stock Indices

goods and industrial supplies. A major discovery in Figure 21 is that Turkey is the largest partner of the EU in MET trade. Its diversified manufacturing economy contrasts to the Gulf economies which are energy-export reliant. This mirrors the twin rhythm of EU-MET trade, that is, industrial integration with Turkey and energy-based flows with the Gulf states.

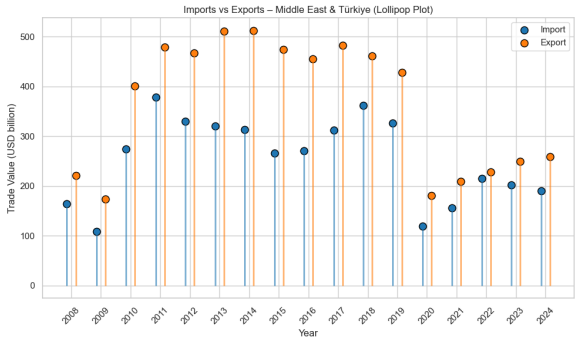

Figure 20: EU-MET Imports & Exports

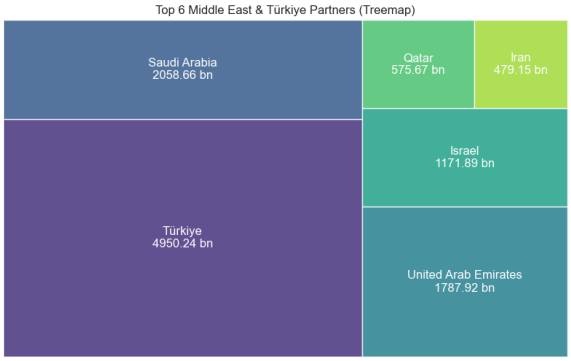

Figure 21: Top 5 Middle-East Partners of EU

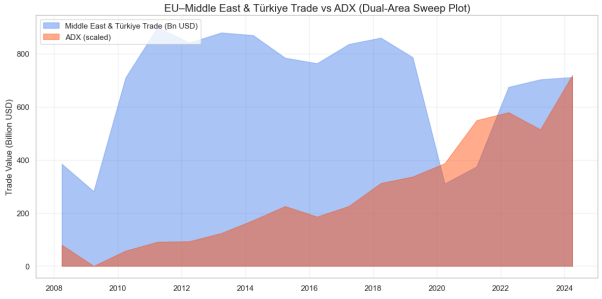

Figure 22: EU-MET vs ADX

The stock market indexes in the area (e.g. ADX) have a strong response to the global oil cycles Figure 22. Granger causality results indicate statistically significant predictive variables of ADX on EUMET trade over various lags (3-8). This means that the financial market in the Middle East, which is largely pegged on oil prices, includes information about the levels of future EU energy imports.

The larger trends of the trade balance between the EU and MET economies are well illustrated in Figure 23. This figure draws attention of high volatility in EU imports due to the oil price cycles, political instability and energy crises. Peaks in the deficit coincide exactly with energy shocks in the world of 2014 (the collapse of the oil prices), 2020 (demand contraction due to the pandemic), and 2022 in the context of a new geopolitical conflict (due to the energy crisis). This description supports the argument that trade conduct of the MET region is innately linked to world trends in commodities.

Lastly, Figure 24 makes a translation of the trends of the key financial indices in the Middle East, such as ADX and QSI. This visualization displays sharp changes associated with the instability of the oil markets to which one can relate the context of why ADX had the greatest Granger-causal significance of all the indices used in the study. These monetary tendencies are usually followed by respective shifts in the trade, which confirms

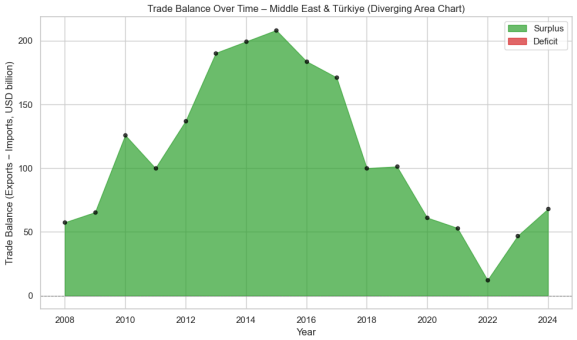

Figure 23: EU-MET Trade Balance

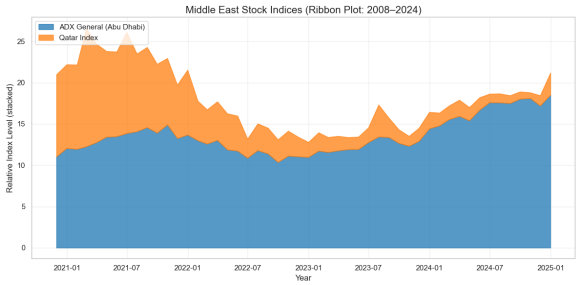

Figure 24: Middle-Eastern Stock Indices

the interpretation that MET market sentiment is closely linked with the export ability founded on energy.

The case study EU-MET thus shows a correlation with the cycles of energy, geopolitical uncertainties and a good financial-trade nexus mediated by the behaviour of oil-based indexes.

6.5 Discussion

The four case studies in total show various structural, temporal, and financial specifics of EU external trade. The EU-China trade is the most structurally asymmetrical due to the manufacturing asymmetry and the integration of supply chains. The EU-North America trade is defined by stability, complementary and resilience. The EU-South Asia trade is experiencing a gradual growth but has emerging industrial relationships but poor financial connections. The trade between EU and MET is volatile and financially causal, energy-driven. On a methodological level, the visual analytics reveal reasonably well the dissimilarities in the intensity, volatility, and product structure of trade per area. The econometric tests also support this point further by showing that the stock markets are predictive of trade activity in some areas- with huge lags. The development of the EU

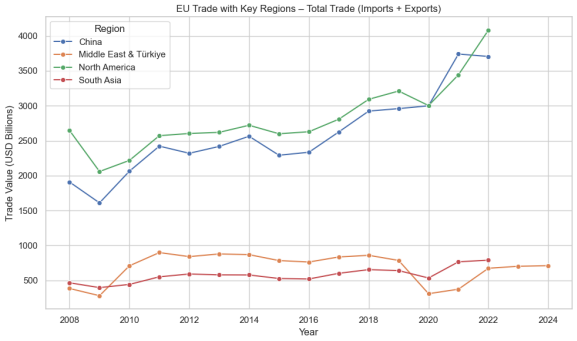

Figure 25: EU Trade with Key regions

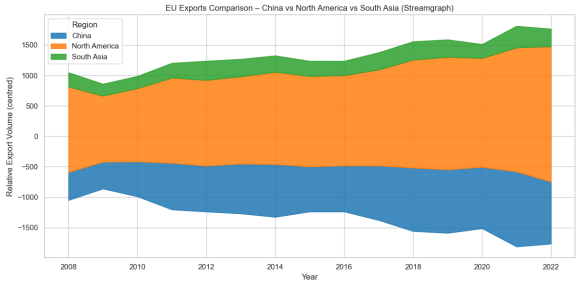

Figure 26: Export Comparison of Key Regions

trade ties with main external regions is graphically demonstrated in Figure 25, which provides a macro-view of the comparative size and development patterns of China, North America, South Asia and MET. This number highlights the fact that China is the leading trade partner to the EU, that North America is continuing to grow steadily, that there is a gradual development of South Asia, as well as the fact that MET economies are

highly volatile. This aesthetic pooling, therefore, supports the argument on structural inequalities of every regional alliance.

By the same margin, the chart Figure 26 shows the comparative volumes of exports made by the EU to three major regions with North America and the growing importance of South Asia taking center stage. This description supplements the previous story by showing the trend in diversification among the export activities of the regions with different economic features. The data contained in Figure 27 summarizes the trade-balance

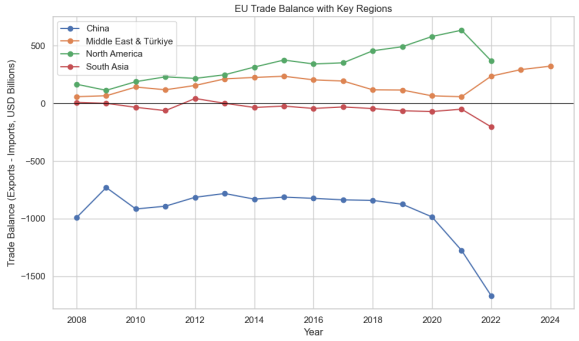

Figure 27: EU Trade Balance with Key regions

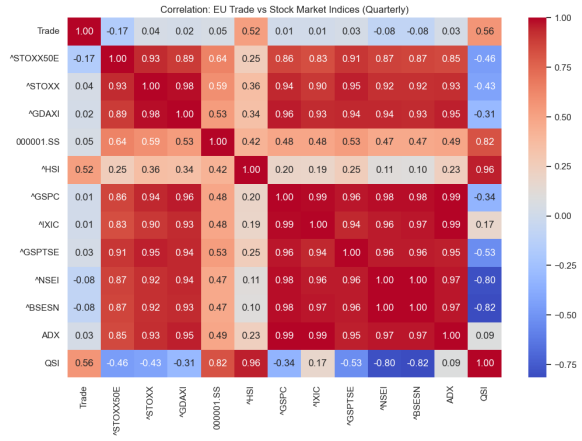

Figure 28: EU Trade vs Stock Market Indices Heat-Map

patterns in each of the four sectors of interest and shows how the deficit with China has been broadening, the surplus with North America remains steady, the balance with South Asia is relatively stable, and with MET is most volatile. It is this cross -regional comparison that brings to the fore the asymmetries already investigated in isolated case studies, thus highlighting the structural nature of EU trade imbalances.

The graphic representation of Figure 28 shows the relationship between the global financial situation and the EU trade by comparing aggregated stock-market indices and EU trade volumes. Although the representation is not causal, it nonetheless defines several concomitant turning points thereby supporting the theoretical construct of financial real economy links as expounded in the literature.

Figure 29 provides an international view of the financial behavior and shows that there is a varied performance of the financial behavior within Europe, North America, Asia and Middle East. This contextualizes the regional financial-trade causalities provided by the Granger tests in terms of the overall global financial ecosystem, and indicates the relative position of each market.

Lastly, the four Granger-Summary figures from Figure 30 to Figure 33 show the phenomenon of predictive financial behavior being specific regions. The Granger causality test shows that there are strong regional differences in predictive relationship between the indices in the European equities market and the trade flows in the European Union.

The most noticeable and intractable causality is in the case of North America: all three leading indices S&P 500, NASDAQ and TSX have statistically significant predictive power over a multiplicity of lags, primarily at short lags (1-3), and once again at longer lags. This trend indicates that financial market conditions can be predicated reliably in the next quarters of trade paths between the EU and North American markets in line with the highly interconnected and prospective character of the U.S. and Canadian

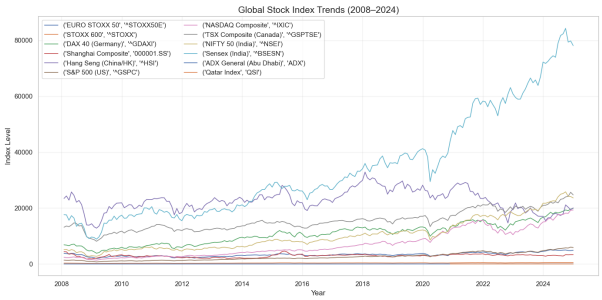

Figure 29: Global Stock Market Indices

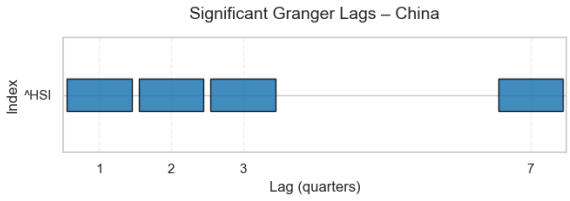

Figure 30: Significant Granger Lags - China

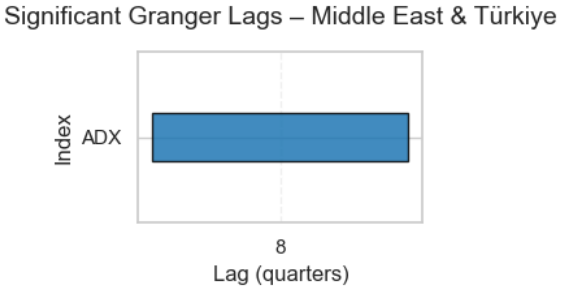

Figure 31: Significant Granger Lags - Middle East

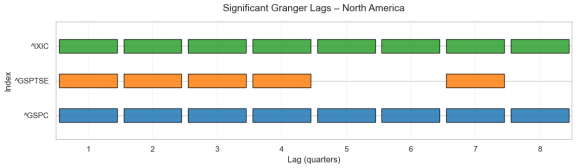

Figure 32: Significant Granger Lags - North America

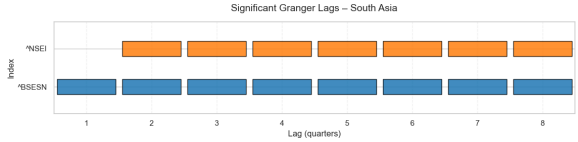

Figure 33: Significant Granger Lags - South Asia

capital markets.

However, this does not hold true in China. The Hang Seng Index is significant at a number of early lags (1-3) and at lag 7 again with episodic predictive power which is probably due to financial changes brought about by export oriented production. In contrast to it, the Shanghai Composite (000001.SS) does not exhibit any material causality at any lag, which highlights that the mainland financial markets and the external trade dynamics are structurally distinct.

The Middle East and Turkiye show a different trend: the ADX index shows no predictive value at both short and medium lags but has an effect only at lag 8 which suggests that the relationship between energy and price developments is long-lagged and the responses to macroeconomic developments slow down.

In general, these findings demonstrate that causality is strongest in well-developed financial systems like those of North America, partially present in globally connected financial hubs like those of Hong, and enforced or far behind in commodity-based markets like the MET region.

More importantly, this research confirms most of the patterns reported in the literature and adds to them in significant aspects. This is in contrast to other regional-based studies done before because it compares more regions within a single framework where financial indices have been incorporated as predictive variables. The findings confirm the futuristic character of the stock markets in the North American, Chinese/Hong Kong, and Middle Eastern environment in line with the research conducted by Fama (1990) and Yousuf and Zhai (2022). Nevertheless, they also suggest feeble financial-trade integration in South Asia, which confirms the findings of Pandey et al. (2020). These are limited by the fact that annual trade data has been stretched to quarterly as well as not covering all of the MET countries financially and exchange-rate variables are not available. Subsequent research may enhance temporal granularity, the use of multivariate models and analysis of other macro-financial variables.

7 Conclusion and Future Work

This study aimed to analyse the structural trends, industry structure, volatility trends and financial interconnectedness of the European Union in trade with four major regions in the world namely China, North America, South Asia and Middle East and Turkey. The main research question was whether financial market indices of the region have predictive power concerning trade flows within the EU and the ways in which the predictive powers vary across regions. Based on this question, the research aimed to (1) create a harmonized long-term dataset consisting of UN-Comtrade trade statistics and global stock index data (2) use a common structure of visual, statistical, and econometric analysis and (3) examine the structural character of each trade relationship based on comparative case studies. The paper was able to combine seventeen years of trade data (2008-2024) with the related financial market data, which has resulted in a complete quarterly dataset that can be subjected to econometric testing. The methodological framework, which included pre-processing of data, visual analytics, correlation analysis, and Granger causality, was helpful in offering a solid understanding of intricate interactions between trade and financial markets. The results across the regions show that there are powerful structural forces of EU trade which are closely related to economical geography and specialization. The degree to which changes in the trade are foreseen by the stock markets is however different

to a large extent. The analysis shows that EU-China trade has a high level of structural asymmetry and tardy yet meaningful financial-trade associations. The HSI index of Hong Kong has predictive power at longer lags, which suggests that the financial market of the East Asian countries captures expectations of international supply chain movement long before the European trade is adjusted. EU- North America trade has been observed to be stable, complementary, and have great econometric evidence that US and Canadian stock markets give forward-looking signal concerning performance in the field of trade with lags of three quarters or above. However, the EU South Asia trade shows much more limited financial connectivity though it shows a positive growth pattern indicating the emerging-market nature of the region and incomplete financial integration. Lastly EU Middle East and Turkey trade indicates that energy price cycles and financial indices driven by the same are important factors; they generate the greatest causality effects in the whole analysis. Collectively, these results can add a multi-regional comparative perspective that the previous literature lacks to a significant extent. Although past literature will tend to look at EU trading in bilateral or sector based perspectives in the present case, the integration approach here will highlight systematic variations and similarities in the key partner regions. It further gives empirical support that the predictive value of financial markets to the global trade cycles is region-specific. The study is, however, limited. The annual frequency of trade data evolved to quarterly frequency brings about the effects of smoothing which can cause short run changes to be blurred. The Yahoo Finance was unable to provide the data on several stock indices in the Gulf region, which restricted the granularity of the MET financial analysis. Moreover, the research is limited in scope, as it does not include factors that may be useful in determining trade values and stock indexes which include exchange rate, the interest rate, industrial production, or the geopolitical risk index. Although these limitations do not in any way undermine the main findings, they point to areas where the analysis can be improved through deeper analysis. Three major extensions should thus be the future work. To start with, the researchers can utilize a larger and more frequent trade information in terms of monthly or even weekly trade data released by the customs authorities or satellite-based estimates of the trade flows. It would help to have more refined analyses of short-term volatility and enhance econometric accuracy. Second, the correlation between trade, financial market, exchange rate and the prices of commodities could be modeled with the help of multivariate models (e.g., Vector Auto Regression (VAR), Vector Error Correction Models (VECM), or machine learning (e.g., LSTM neural networks)). This would enable predictive modelling and scenario simulation that could not be done using simple Granger causality. Third, it is essential that a sub-regional granularity be implemented in future research, especially when speaking of the Middle East and South Asia, with individual national economies varying immensely in terms of their industrial composition and reliance on trade. Lastly, it has high potential of applied and policy-relevant applications. Enriched forecasting models may aid policymakers to predict the tendency towards import dependency, supply chain risks and impacts of global financial shocks on European trade. The companies that might be involved in strategic sourcing or export planning may adopt financial-trade indicators in their risk mitigation strategy. In terms of research the integrative data and research framework designed here, offer a platform on which more complex models of global trade dynamics can be built. Overall, the study manages to answer its key questions and provides fresh ideas about interactions between financial markets and trade flows existing in the regions of great strategic value to the European Union. The study provides the basis of the further study of the international trade and its analysis through

the use of both further academic research and practical prediction in terms of the structural features of a certain trade partnership by revealing differentiated financial-trade dynamics and identifying the structure of a trade partnership.

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