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SPAIN'S INTERNATIONAL TRADE. ANALYSIS AND FORECASTING

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SPAIN'S INTERNATIONAL TRADE ANALYSIS AND FORECASTING

by

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0. Abstract

Spain's international trade is a key driver of its economic growth, contributing significantly to its GDP. Analyzing exports and imports reveals the economic structure and performance of various sectors, guiding policymakers in identifying growth areas and sectors requiring support.

Understanding the competitiveness of Spanish products and services in the global market is vital. It helps in developing strategies to enhance their presence and performance abroad, fostering innovation and quality. Diversifying markets by reducing dependence on a few trading partners and exploring opportunities in emerging markets mitigates the risks associated with over-reliance on traditional markets.

Despite the importance of these studies, there are significant limitations in consuming and analyzing information on Spain's international trade from existing sources and the internet. The data is often highly technical and complex, necessitating a strong grasp of economic terminology and concepts, which can be a barrier for those without a background in economics. Even individuals with a technical background require easy interpretation and flexible insights.

Information is typically dispersed across multiple sources, complicating the task of obtaining a comprehensive view. Users often need to navigate different reports, databases, and websites to piece together a full picture. Additionally, the lack of real-time data updates can lead to delays in understanding current trends and making timely decisions. Language barriers also pose challenges, as detailed reports are often published in Spanish, limiting accessibility for non-Spanish speakers. Furthermore, the absence of visual representations and user-friendly interfaces hinders quick and effective data interpretation.

Enhancing the perception of Spanish products abroad strengthens the national brand, benefiting exporters and tourism. Predictive analytics in international trade enables stakeholders to anticipate trends, adjust strategies proactively, and make informed

decisions, ensuring Spain's adaptability to global changes in politics, economics, and technology.

This academic work proposes an advanced solution using the Power BI tool to address these limitations. By providing a personalized, visual, and user-friendly interface with predictive capabilities, Power BI will enable diverse users to better understand Spain's international trade, facilitating informed decision-making and strategic planning.

Keywords: Spain Trade**,** International Trade, Exports, Imports. Economic Analysis, Market Diversification, Competitiveness, International Direct Investment (FDI), Predictive Analytics, Power BI

1. Introduction

The history of international trade analysis and reporting in Spain has undergone significant evolution, reflecting the country's economic development and increasing integration into the global market. In the early stages, the collection of trade data was rudimentary, focused primarily on basic import and export statistics. These figures were gathered manually and reported on an annual or semi-annual basis by government agencies. The main objective then was to track the balance of trade to ensure that exports were robust enough to support the national economy. This basic approach provided limited insights and lacked the detail needed for comprehensive economic analysis.

As Spain's economy began to expand and integrate more with global markets, particularly after the mid-20th century, the need for more detailed and timely data became apparent. The establishment of the Instituto Nacional de Estadística (INE) in 1945 marked a significant advancement. INE was tasked with systematically collecting, analyzing, and publishing economic data, including international trade statistics. This development was a crucial step towards more structured and formalized trade analysis. Despite the formation of INE, the data remained relatively static and was not easily accessible to the broader public.

The turning point came in 1986 when Spain joined the European Economic Community (EEC), now known as the European Union (EU). This integration required Spain to adopt more sophisticated data collection and analysis methods to manage the increased complexity and volume of trade. In response, the Spanish government established the Instituto de Comercio Exterior (ICEX) in 1982. ICEX was dedicated to promoting Spanish exports and providing detailed trade reports and market studies, thereby assisting businesses in navigating the complexities of international markets. Despite these advancements, the reports produced by ICEX were often exhaustive but static, making it difficult for users to derive actionable insights quickly.

With the advent of digital technology in the late 20th and early 21st centuries, data collection and analysis became more advanced. Online databases and digital reporting

tools allowed for real-time data updates and more accessible reports. Institutions like ICEX and INE started publishing detailed monthly and quarterly reports on international trade, covering various sectors and markets. These reports included comprehensive metrics such as trade in services, international direct investment (FDI), and regional trade patterns. Despite these advancements, the reports often remained dense, technical, and challenging to interpret. The static nature of these reports meant that they lacked interactive elements that could help users visualize trends and make informed decisions.

Today, while Spain's trade analysis includes a broad range of metrics, the data is often still presented in a static and complex format. This presentation style poses significant interpretation challenges for both general and specialized users. General users, without a background in economics, find it hard to navigate the detailed and jargon-heavy reports. Even specialized users, who are more familiar with economic data, struggle with the lack of dynamic and user-friendly presentations. The current solutions provided by the government, institutions, and the press, although exhaustive, are not easily interpreted by the public due to their static nature and complexity.

There is a clear need for more accessible and interactive data solutions. Modernizing the presentation of trade data with interactive dashboards, visualizations, and real-time updates could greatly enhance usability. Simplifying the language used in reports and providing summary insights could help bridge the gap, making the information more user-friendly for a broader audience. Additionally, integrating real-time data updates and interactive elements would allow users to more easily visualize trends and make timely decisions.

In conclusion, while Spain has made significant advancements in the collection and reporting of trade data, the current static and complex nature of these reports hinders easy interpretation and utilization. There is a pressing need for improvements in data presentation and accessibility to fully meet the needs of all users. Adopting modern tools like Power BI can address these challenges, ensuring Spain's trade analysis keeps pace with global trends and technological advancements.

1.1 Project Objectives

1. Centralize Data Access

Objective**:** Develop a user-friendly interface to provide seamless access to all relevant trade data.

Benefit**:** Simplifies information retrieval by reducing the need to navigate multiple sources.

2. Advanced Data Visualization

Objective**:** Implement dynamic charts, graphs, and interactive dashboards.

Benefit**:** Enables users to quickly understand complex trade trends and patterns.

3. Real-Time Data Integration

Objective**:** Ensure continuous data updates by integrating sources with real-time capabilities.

Benefit**:** Provides the most current information for timely and informed decision-making.

4. Customizable Reporting

Objective**:** Provide tools for creating and saving personalized reports.

Benefit**:** Allows users to tailor reports to their specific needs, enhancing relevance and usability.

5. Implement Predictive Analytics

Objective**:** Use machine learning and statistical models to forecast trade volumes and assess risks.

Benefit**:** Helps businesses and policymakers in strategic planning and risk management.

6. Enhance Interactive Features

Objective**:** Incorporate features like drilldowns, filters, and tooltips for deeper data exploration.

Benefit**:** Enables users to uncover insights that static reports might miss.

7. Integrate Diverse Data Sources

Objective**:** Combine data from multiple sources such as INE, ICEX, customs data, and international trade databases.

Benefit**:** Provides a comprehensive view of Spain's trade landscape.

8. Simplify Data Interpretation

Objective**:** Use plain language summaries and explanatory notes.

Benefit**:** Makes data interpretation easier for non-specialized users, ensuring broader accessibility.

9. Historical Data Analysis Tools

Objective**:** Provide tools for analyzing historical trade data to understand long-term trends.

Benefit**:** Offers crucial context for current data analysis and comparison.

10. User Training and Support

Objective**:** Develop training programs and resources, including tutorials and user guides.

Benefit**:** Ensures users can fully utilize the Power BI model effectively.

2. Theoretical framework

Examining the existing solutions to solve the demand for information on international trade in Spain, the current possibilities on the web have been analyzed. We can differentiate between two main groups: solutions provided by public organizations and those by private institutions.

This differentiation is relevant due to the distinct characteristics and purposes of each type of source, which impact their usability and accessibility. Public sources, such as government agencies, provide official, and often free data essential for policy-making and academic research. However, they tend to present data in a static and complex manner, making it less accessible for non-specialized users. On the other hand, private sources offer specialized, detailed, and often more user-friendly data, but usually at a cost, making them less accessible for smaller businesses or individual users. Below, we summarize these main solutions, indicating their public or private nature.

2.1 Public Sources:

Instituto Nacional de Estadística (INE): The INE, as Spain's official statistics agency, offers extensive trade data through detailed monthly and annual reports, including imports, exports, and trade balances. These reports are freely accessible on the INE website, providing a comprehensive and authoritative source of data.

However, the data presentation is often complex and not user-friendly. The static nature of the reports limits interactive analysis, making it difficult for users without a strong background in statistics or economics to interpret the data effectively.

Additionally, while INE provides a vast amount of historical and current data, the lack of real-time updates and interactive features makes it challenging for users to quickly derive actionable insights.

Instituto de Comercio Exterior (ICEX): ICEX focuses on promoting Spanish exports and international investments, offering in-depth market studies and trade statistics through monthly and quarterly reports accessible on the ICEX website.

While ICEX provides detailed sector-specific insights, the reports are often exhaustive but static, which can be overwhelming and hard to quickly interpret. Some services require registration or a fee, which can be a barrier for users seeking free access to comprehensive data.

Moreover, the emphasis on promoting Spanish businesses might lead to a bias in the data presentation, focusing more on positive aspects while potentially underreporting challenges or risks.

DataComex: Managed by the Spanish Secretary of State for Trade, DataComex offers detailed trade statistics, including imports, exports, and trade balances, with tools for custom queries. Available for free on the DataComex website, it provides comprehensive data.

However, the platform's interface can be challenging for non-technical users, and the static nature of the reports limits interactive analysis. The customization options, while useful, are not always intuitive, requiring users to have a certain level of expertise to fully utilize the tools. Additionally, like other public sources, DataComex data may not be updated in real-time, potentially leading to delays in accessing the most current information.

Banco de España (Bank of Spain): The central bank provides economic and financial data, including trade-related statistics such as balance of payments and international investments, accessible on the Banco de España website.

While it is an authoritative source, the focus is primarily on financial data rather than detailed trade data. This can make it less useful for users specifically looking for comprehensive trade statistics. Furthermore, the analytical reports are high-quality but can be complex and not easily digestible for general users. The limited interactive features and the static nature of the reports add to the difficulty of quickly interpreting and acting on the data.

2.2 Private Sources:

TradeMap by ITC: Developed by the International Trade Centre, TradeMap offers a global trade statistics database with detailed data for Spain, including trade flows, market access conditions, and tariffs. Basic access is free, but full access requires registration on the TradeMap website.

Although it provides comprehensive trade data, the platform can be complex for novice users, requiring a steep learning curve to fully utilize the tools. Additionally, the need for registration to access full features can be a barrier, especially for casual users or small businesses with limited resources.

Euromonitor International: This market research company provides detailed reports on trade activities, market trends, and forecasts for various sectors, accessible through subscription on the Euromonitor website.

While Euromonitor offers high-quality, detailed market reports and customizable research options, the subscription fees can be expensive, making it less accessible for smaller businesses or individual users. The data is often very detailed, which, while useful for in-depth analysis, can be overwhelming and too complex for casual users or those seeking quick insights.

Statista: Statista offers a wide range of data across numerous sectors, including trade volumes and economic impact, with visual tools like charts and infographics for easier interpretation. Some data is freely accessible, but full access requires a subscription on the Statista website.

Although Statista is user-friendly and provides a wide range of data, it may not offer the depth needed for specialized trade analysis compared to more focused trade databases. Additionally, the subscription cost can be a barrier for users seeking comprehensive access.

Fitch Solutions: Part of the Fitch Group, Fitch Solutions provides country risk and industry research, including trade data, through subscription on the Fitch Solutions website. Known for high-quality risk analysis and economic forecasts,

it primarily focuses on financial data, which may not fully address the needs of users looking for detailed trade statistics. The reports can be expensive, making it less accessible for smaller businesses or individual users. The emphasis on risk and financial data might also limit the breadth of trade-specific insights available.

This table summarizes the essential aspects of each solution, making it easier to compare and evaluate them:

Solution	Website	Description	Strengths	Weaknesses
Instituto Nacional de Estadística (INE)	https://www.ine.es/	Spain's official statistics agency, offering comprehensive trade data through monthly and annual reports.	Authoritative, comprehensive, free access.	Complex data presentation, static reports.
Instituto de Comercio Exterior (ICEX)	https://www.icex.es/	Promotes Spanish exports and international investments, providing detailed market studies and trade statistics.	Sector-specific insights, comprehensive.	Some services require fees, static reports.
DataComex	https://www.comercio.gob.es/comercio-exterior/datacomex	Managed by the Spanish Secretary of State for Trade, offering detailed international trade statistics and tools.	Detailed and customizable data.	Challenging interface, static data.
Banco de España	https://www.bde.es/	The central bank of Spain, providing economic and financial data, including trade-related statistics.	Authoritative, high-quality analyses.	Primarily financial data, limited interactivity.
TradeMap by ITC	https://www.trademap.org/	Developed by the International Trade Centre, offering a global trade statistics	Comprehensive global trade data, interactive tools.	Complex for beginners, registration

		database with detailed data.		needed for full access.
Euromonitor International	https://www.euromonitor.com/	Provides detailed reports on trade activities, market trends, and forecasts for various sectors.	High-quality reports, customizable research.	Expensive subscription, very detailed data.
Statista	https://www.statista.com/	Offers comprehensive data across numerous sectors, with visual tools for easier interpretation.	User-friendly interface, wide range of data.	Subscription required for full access, limited depth.
Fitch Solutions	https://www.fitchsolutions.com/	Provides country risk and industry research, including trade data, through subscription-based services.	High-quality risk analysis, detailed industry reports.	Expensive, primarily focused on financial data.

As these sources provide extensive and detailed data, their static nature and complexity often make it challenging for users to interact with and personalize the data.

Developing a dynamic and interactive tool in Power BI could enhance usability by enabling the generation of personalized reports, trend visualization, and informed decision-making with real-time data updates. This approach would address the limitations of existing solutions, improving the accessibility and interpretability of international trade data for both general and specialized users.

3. Methodology

When addressing the methodology used to carry out this academic work. It is important to divide it into several phases that range from the selection and extraction of data at its source, through intermediate transformation processes to modeling and loading the model into Power BI.

3.1 Phase 1 - Data Sources Selection

The Spanish Ministry of Finance's internation trade data is a critical resource for understanding and analyzing Spain's trade dynamics, despite some inherent challenges. This comprehensive database, managed by a reputable national authority, offers detailed and reliable statistics essential for robust analytical work. The Ministry ensures that the data is meticulously collected, regularly updated, and freely accessible, which is invaluable for researchers, businesses, and policymakers.

The data's granularity is one of its primary strengths, encompassing detailed statistics on imports, exports, trade volumes, and values. This includes specific insights into the types of goods traded, their origins and destinations, and corresponding trade volumes. Such detailed information allows for nuanced analysis, helping uncover trends and patterns not visible in aggregated datasets. However, the data is often stored in plain text formats, heavily segregated to reduce storage space, which complicates immediate analysis. This storage method prioritizes minimizing data size, which necessitates significant transformation work to make the data suitable for analysis tools.

Regular updates to the database ensure users have access to the most current information. The Ministry's commitment to updating the data periodically means users can rely on it for timely and informed decision-making. Additionally, the availability of extensive historical data allows for comprehensive trend analysis over extended

periods, providing crucial context for understanding long-term market dynamics and informing strategic decisions.

One of the key advantages of the Ministry of Finance's data is its compliance with national legal and regulatory standards. For companies operating within Spain or those engaged in international trade with Spanish entities, this ensures adherence to local laws and reporting requirements, mitigating potential legal issues. Furthermore, the data is free and openly accessible through the Ministry's website, removing financial barriers and democratizing access to critical economic information. This open access policy fosters a more informed and inclusive economic environment, benefiting a broad range of users.

However, the data's format presents significant challenges. Despite its comprehensive nature, the data is not initially structured for easy analysis in modern analytical tools. The focus on reducing data weight leads to highly segmented and compressed datasets, which require extensive transformation and cleaning before they can be effectively used in tools like Power BI. Users must undertake a substantial amount of preprocessing, including parsing plain text files, merging segregated datasets, and converting them into structured formats suitable for analysis. This preprocessing step is crucial but labor-intensive, highlighting the importance of having skilled data professionals to manage the transformation process.

The structured yet raw nature of this data includes comprehensive metadata and standardized codes, but the initial effort required to prepare it for analysis can be considerable. Despite these challenges, the data's richness and depth justify its use. The ability to perform detailed market analyses, identify emerging trends, and gain insights into potential disruptions in trade environments makes this data invaluable. By leveraging this meticulously maintained dataset, businesses and policymakers can make well-informed economic and strategic decisions, optimize supply chains, and identify new market opportunities.

In conclusion, the Spanish Ministry of Finance's international trade data is a vital resource for any data-driven project aiming to transform, model, and analyze trade data. While the data requires significant preprocessing due to its highly segmented

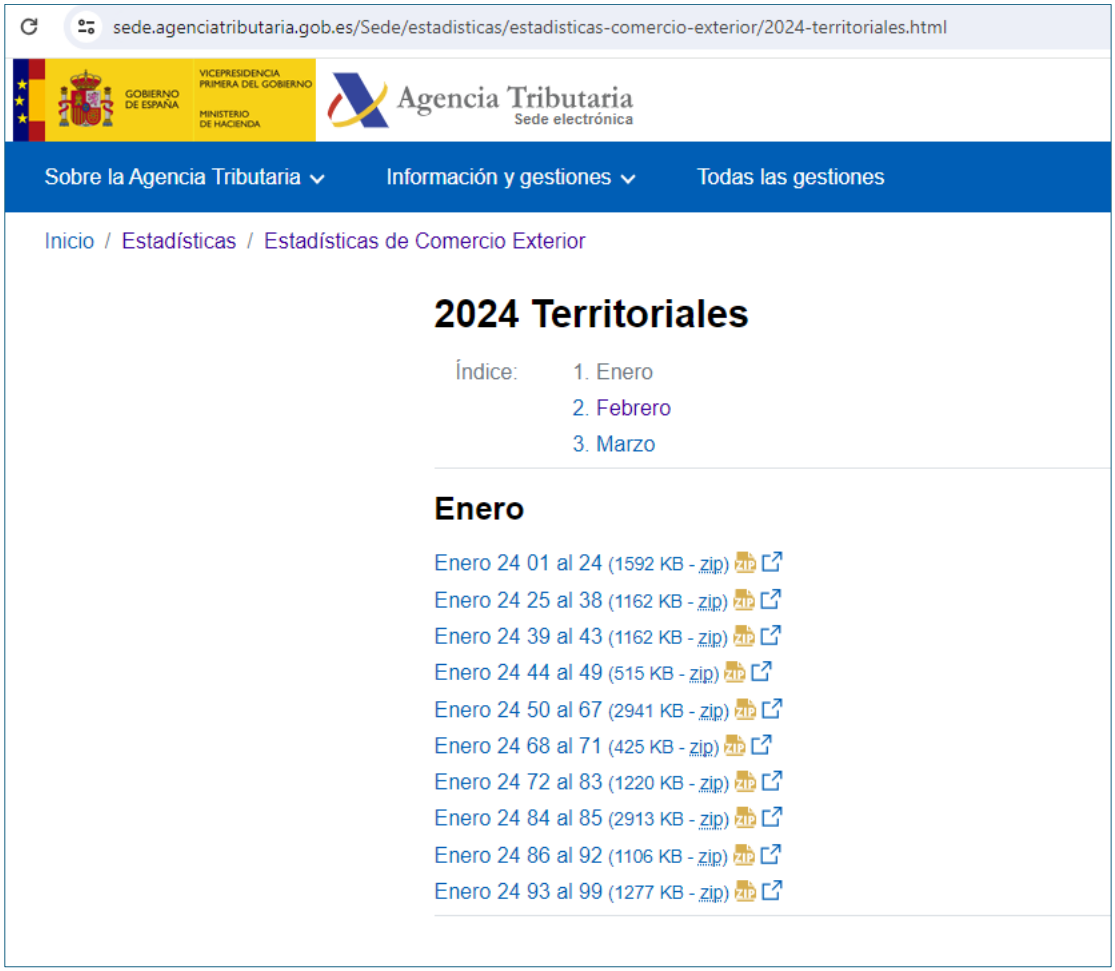
and storage-efficient format, its comprehensive detail, regular updates, and free access provide a solid foundation for insightful analysis. The benefits of utilizing such a rich dataset far outweigh the initial challenges, making it an indispensable tool for driving informed decision-making and fostering economic development.

3.1.1 Territorial series of monthly international trade statistics

Firstly, we will analyze the time series corresponding to territorial series international trade statistics for download and use in the report. Which, as we can see, contains data from January 2016 to date.
The data for each month is segregated into ten text files for reasons of efficiency and not to incur too much weight, as we mentioned before.

We find them on the official website of Spanish Ministry of Finance's.[1]

[1] *** All hyperlinks in this document refer to the relevant sections in the annex for detailed information**



Each of these flat files have an approximate average weight of between 6 and 7 Mb once decompressed.

To consume this data, we will download and decompress each of the files, hosting them on a local disk.

For the correct interpretation of the data, the Ministry makes available a PDF file as a guide to interpret the order in which the fields of the text file are structured.[2]

[2] *** All hyperlinks in this document refer to the relevant sections in the annex for detailed information**

3.1.2 Static dimensional data tables for mapping

To map and interpret the codes that are reflected in the territorial segregated files, it is necessary, on the one hand, to closely follow the combined nomenclature files[3] that the Treasury makes available

On the other hand, it is also necessary to investigate and create another series of mapping tables that will be used to interpret and give meaning to the nomenclatures and codes that make up the text files that we are going to use.
As a summary, since they will be analyzed in greater depth in the following stages of the development of this academic work, the mapping tables will be the following:

1 - Countries and Territories Mapping Table

2 - Customs Codes Mapping Table

3 - Transport Modes Mapping Table

4 - Spanish Provinces Mapping Table.

3.2 Phase 2 - Data Extraction and Preload

Efficient data ingestion and transformation are critical for analyzing international trade data. Power Query, used within the Microsoft Power BI suite, facilitates these processes through robust connectivity and efficient data handling capabilities.

This tool efficiently ingests data from a wide variety of sources thanks to an extensive array of data connectors. These connectors enable seamless integration of data from numerous platforms, including databases, cloud services, and on-premises data. For instance, it supports importing data from databases like SQL Server, Oracle, MySQL,

[3] *** All hyperlinks in this document refer to the relevant sections in the annex for detailed information**

and PostgreSQL; cloud services such as Azure SQL Database, Google BigQuery, and Amazon Redshift; and file formats like Excel, CSV, XML, and JSON. It also connects to online services like SharePoint, Microsoft Exchange, and Salesforce. This broad connectivity reduces the time and effort required to gather and integrate data from multiple platforms.

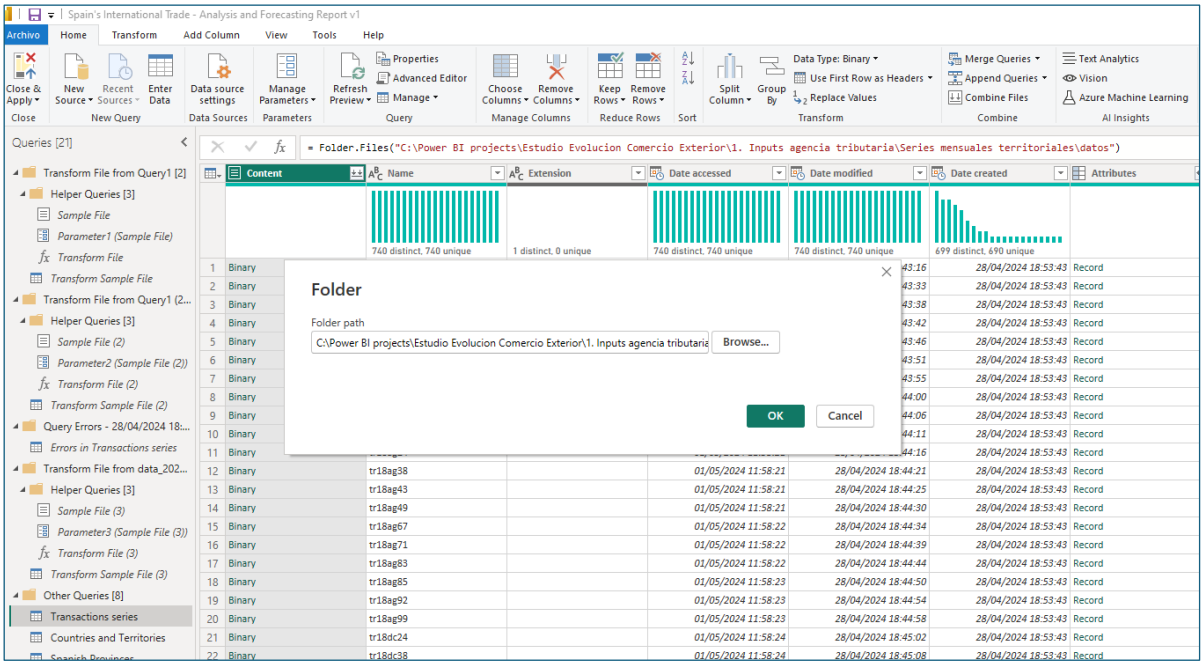
The architecture of the tool is designed for data handling efficiency, optimizing performance by processing data in a way that minimizes resource consumption and maximizes speed. It manages large datasets effectively by employing query folding, which pushes data transformations back to the source database whenever possible. This approach reduces the amount of data that needs to be transferred and processed locally, resulting in faster query performance and more efficient use of system resources.

Its user-friendly interface is designed to be intuitive, allowing users of all skill levels to connect to data sources and perform initial data ingestion tasks with minimal training. Step-by-step wizards guide users through the connection process, making it accessible for both novice and experienced data professionals.

In our case, the tool is particularly advantageous for ingesting and consolidating more than 1000 plain text files due to its robust data connectors and efficient handling of local file paths. It can automatically detect and import all text files from a specified folder, streamlining the ingestion process by reducing manual effort and ensuring consistency in data handling.

Additionally, the tool integrates with mapping tables, which will be utilized as dimension tables in subsequent Power BI modeling. These connectors facilitate efficient updating and refreshing of data from local sources, ensuring that both the raw data and the dimensional tables are always current and accurately reflect any changes.

Using these connectors and without needing to write code in the tool's scripting language, we can load all the international trade transaction files that we have previously downloaded from the ministry's website in just a few steps. In this specific case, we use the folder connector for local disk:



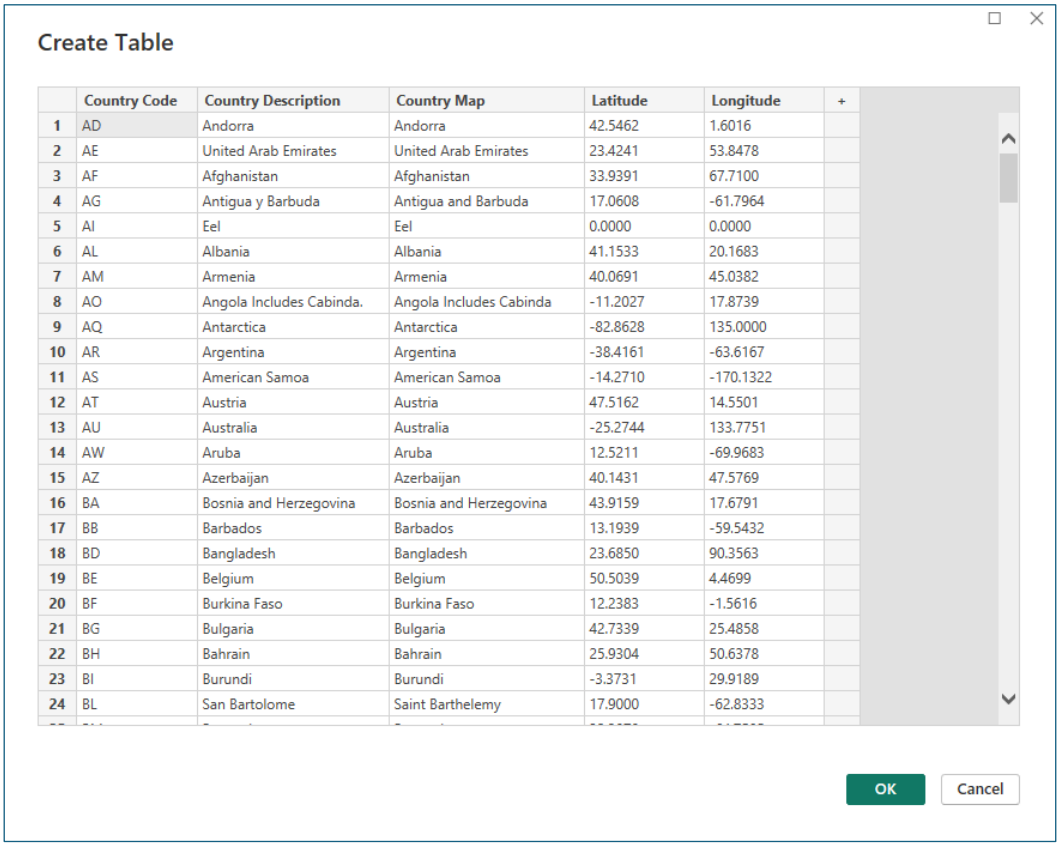
In the same way, we will proceed to load the Static dimensional data tables for fact table mapping.

Loading static tables directly within a data transformation tool provides several significant advantages overloading them from a local disk. One key benefit is centralized data management, which ensures that updates and changes are made in a specific location, maintaining consistency across all users and reports.

Additionally, removing the dependency on local file paths simplifies the setup, as it eliminates the need to configure paths for each user or system. This makes the data more accessible and reduces potential issues related to incorrect file path configurations. Data security is also enhanced, as static tables stored within a data tool can leverage its built-in security features, providing better protection and access control compared to files stored locally.

By using a centralized data tool, consistent data transformations can be applied across different datasets, ensuring uniformity in data cleaning and preparation processes. This leads to more reliable analysis and reduces the likelihood of manual errors that can occur with file management, such as accidental deletions or incorrect file versions.

Integrating static tables with other data sources becomes seamless, allowing for comprehensive analysis within a single environment. This approach also scales more effectively as data needs grow, handling larger datasets and more complex queries without the limitations imposed by local storage capacity.



	Country Code	Country Description	Country Map	Latitude	Longitude	+
1	AD	Andorra	Andorra	42.5462	1.6016	
2	AE	United Arab Emirates	United Arab Emirates	23.4241	53.8478	
3	AF	Afghanistan	Afghanistan	33.9391	67.7100	
4	AG	Antigua y Barbuda	Antigua and Barbuda	17.0608	-61.7964	
5	AI	Eel	Eel	0.0000	0.0000	
6	AL	Albania	Albania	41.1533	20.1683	
7	AM	Armenia	Armenia	40.0691	45.0382	
8	AO	Angola Includes Cabinda.	Angola Includes Cabinda	-11.2027	17.8739	
9	AQ	Antarctica	Antarctica	-82.8628	135.0000	
10	AR	Argentina	Argentina	-38.4161	-63.6167	
11	AS	American Samoa	American Samoa	-14.2710	-170.1322	
12	AT	Austria	Austria	47.5162	14.5501	
13	AU	Australia	Australia	-25.2744	133.7751	
14	AW	Aruba	Aruba	12.5211	-69.9683	
15	AZ	Azerbaijan	Azerbaijan	40.1431	47.5769	
16	BA	Bosnia and Herzegovina	Bosnia and Herzegovina	43.9159	17.6791	
17	BB	Barbados	Barbados	13.1939	-59.5432	
18	BD	Bangladesh	Bangladesh	23.6850	90.3563	
19	BE	Belgium	Belgium	50.5039	4.4699	
20	BF	Burkina Faso	Burkina Faso	12.2383	-1.5616	
21	BG	Bulgaria	Bulgaria	42.7339	25.4858	
22	BH	Bahrain	Bahrain	25.9304	50.6378	
23	BI	Burundi	Burundi	-3.3731	29.9189	
24	BL	San Bartolome	Saint Barthelemy	17.9000	-62.8333	

Finally, once these tables are loaded, we see that they are already in the Power Query interface. Along with other auxiliary queries created semi-automatically by the software to carry out these information loads.

3.3 Phase 3 - Data Transformation

Apart from the ingestion processes and connectors, Power Query offers intuitive data transformations through an accessible interface, eliminating the need for

programming. This makes it accessible to users with different levels of technical expertise, enabling them to clean, reshape, and prepare data using simple, menu-driven commands. Common tasks such as filtering rows, splitting columns, changing data types, and merging datasets can be done with just a few clicks. The interface visually represents the transformation steps, making it easier to understand and adjust the data processing workflow as needed.

In addition to the ingestion data previously discussed in this document, we proceed to perform the transformation steps of the main transaction data set to prepare them for loading into the relational model.

Detailed List of Actions

1. **Load Files from a Folder**
   Action: All files from a specific folder on your computer are collected.
   Why: This allows all the data needed for analysis to be gathered in one place.

2. **Filter Out Hidden Files**
   Action: Hidden files are excluded from the data collection.
   Why: This ensures that only relevant, visible files are included in the analysis.

3. **Apply a Custom Function to Each File**
   Action: A special function is used to process the content of each file.
   Why: This prepares the data from each file so it can be used in the analysis.

4. **Rename Columns to Track File Origin**
   Action: The column named "Name" is changed to "Source.Name".
   Why: This helps identify which file each piece of data came from, making it easier to trace the origin of the data.

5. **Keep Only Important Columns and Expand Data**
   Action: Only the important columns are kept, and the data from each file is expanded into a table format.

Why: This focuses on the essential data and converts it into a format that is easier to work with.

6. **Set Data Types Correctly**
   Action: Each column is set to the appropriate data type, like text or numbers.
   Why: This ensures that the data is treated correctly during analysis, preventing errors.

7. **Rename Columns for Clarity**
   Action: Columns are renamed to more meaningful names.
   Why: This makes the data easier to understand, by using intuitive names for each column.

8. **Replace Specific Values for Better Understanding**
   - Action: Certain values in the columns are replaced with clearer terms. For example, "E" is changed to "Export," "I" is changed to "Import," and blank spaces or null values are replaced with "Unknown."
   - Why: This makes the data more user-friendly and easier to interpret.

All this data transformation process results in the data table version that we will use in the next modeling stage. Transformation processes for static dimension tables are omitted because they are simpler transformation processes than just replacing some type of data or some column values.

3.4 Phase 4 - Building the Relational Data Model

Relational models are fundamental frameworks in database management that organize data into tables (or relations) consisting of rows and columns. Each table represents an entity, with columns defining attributes and rows representing records.

However, relational models for SQL databases differ significantly from those used in business analytics tools. In business analytics, the emphasis is on simplifying the structure to enhance data retrieval, visualization, and analysis, rather than on maintaining extensive normalization for data integrity and security.

In business analytics, relational models are often streamlined into star or snowflake schemas. These schemas are designed to facilitate efficient querying and reporting, supporting the creation of dynamic, interactive dashboards. A key component of these models is the use of fact tables and dimension tables.

Fact tables are central to business analytics models. They contain quantitative data, such as sales numbers, transaction amounts, or performance metrics, and are typically very large. Each row in a fact table is a record of a measurable event, and the table often includes international keys that link to dimension tables. These links are crucial for analyzing the facts in different contexts.

Dimension tables provide descriptive attributes related to the facts. They contain data about dimensions such as time, geography, products, or customers. These tables are usually smaller and more stable than fact tables and are optimized for readability and fast retrieval. Dimension tables add context to the facts, enabling users to perform detailed analysis and drill down into specific data points.

The star schema is the simplest form of a relational model in business analytics. It consists of a central fact table surrounded by dimension tables. Each dimension table is directly linked to the fact table, forming a star-like structure. This design is easy to understand and use, and it performs well for straightforward queries and reporting.

The snowflake schema is a more complex variant of the star schema. In this design, dimension tables are normalized into multiple related tables, leading to a more intricate structure resembling a snowflake. While this can lead to reduced data redundancy and improved data integrity, it may also complicate the querying process and require more complex joins.

Relational models in business analytics tools are designed to optimize the balance between simplicity and performance. By using fact and dimension tables within star or

snowflake schemas, these models facilitate efficient data analysis and visualization, making them indispensable for modern business intelligence applications.

In our current academic work, we will employ a star schema model. The central fact table will contain the series of transactions from international trade in Spain. Surrounding this fact table, we will have several static auxiliary mapping tables as dimensions. This model will enable us to effectively analyze trade data and gain valuable insights, supporting our data-driven decision-making processes.

3.4.1 Calendar Table Creation

One of the main attributes of our data set, especially when it comes to time series data, is the time dimension. Although the Power BI environment allows us to use the time dimension, or time column that is present in the fact table, it is a good and recommended practice to create a calendar table. With its presence, it is possible to have more capacity to generate advanced metrics and measures, in addition to giving the relational model consistency in time intelligence, improving its performance, and providing greater flexibility and customization to time attributes.

Creating a calendar table in Power BI can be accomplished through various methods, each with its own set of advantages. One common approach is to import a pre-existing calendar table from an external source, such as an Excel spreadsheet or a SQL database. This method is straightforward and allows for the use of a standardized calendar with pre-defined attributes. However, it may lack flexibility in customization to fit specific business needs.

Another alternative is to use Power Query to generate the calendar table. By using M code in Power Query, we can create a custom calendar table tailored to the specific requirements of your analysis, such as defining custom fiscal periods or excluding non-working days. This approach offers high customization and automation but can be complex for users unfamiliar with the M language.

A third method, and the one we will employ, is to create the calendar table using DAX (Data Analysis Expressions), the language of the Power BI frontend. DAX is designed specifically for data modeling and analysis, making it a natural choice for generating dynamic and flexible calendar tables directly within Power BI. Using DAX, we can create a highly customized calendar table that automatically updates based on the data in our model, ensuring that all date-related calculations and analyses are accurate and up to date. This approach leverages the full power of DAX functions and provides seamless integration with other elements of our Power BI reports.

In conclusion, while there are multiple ways to create a calendar table in Power BI, including importing from external sources or using Power Query, we will use DAX to build our calendar table. This method offers the best balance of flexibility, integration, and dynamic capabilities, ensuring that our date-based analyses are robust and tailored to our specific needs.

The code we have used for this table is below and has been commented for a better understanding of the different steps.

This calendar table will be incorporated into the relational model as we will see in the subsequent steps.

3.4.2 Connections Between Data Tables

In Power BI Modelling Page, we connect different tables in a star schema. The central fact table, "Transactions series," contains all transactional data related to international trade in Spain. This table is connected to several dimension tables that provide additional context and descriptive information.

Our dimension tables are as follows:

1. **Countries and Territories Mapping Table**

2. **Customs Codes Mapping Table**

3. **Transport Modes Mapping Table**

4. **Spanish Provinces Mapping Table**

5. **Calendar Table**

For the **Countries and Territories Mapping Table**, the connection is made using the "Country Code" column in both tables. This relationship is unidirectional, from the dimension table to the fact table, with a one-to-many cardinality.

The **Customs Codes Mapping Table** connects to the fact table via the "Customs Code" column. This relationship is bidirectional with a one-to-many cardinality.

For the **Transport Modes Mapping Table**, the connection is established using the "Transportation Code" column, with a unidirectional relationship from the dimension table to the fact table, and a one-to-many cardinality.

The **Spanish Provinces Mapping Table** connects to the fact table through the "Province Code" column. This relationship is unidirectional, from the dimension table to the fact table, with a one-to-many cardinality.

Lastly, the **Calendar Table** connects to the fact table using the "Date" column in the calendar table and the "Transaction Date" column in the fact table. This relationship is unidirectional, from the calendar table to the fact table, with a one-to-many cardinality.

Below is a visual representation of our model connections:

Fact Table	Dimension Table	Key Column	Relationship Type	Direction	Cardinality
Transactions series	Countries and Territories Mapping Table	Country Code	Unidirectional	Dimension to Fact	One-to-Many
Transactions series	Customs Codes Mapping Table	Customs Code	Bidirectional	Both Directions	One-to-Many
Transactions series	Transport Modes Mapping Table	Transportation Code	Unidirectional	Dimension to Fact	One-to-Many
Transactions series	Spanish Provinces Mapping Table	Province Code	Unidirectional	Dimension to Fact	One-to-Many
Transactions series	Calendar Table	Date (Calendar)	Unidirectional	Dimension to Fact	One-to-Many

This setup allows us to view each transaction through various dimensions: by country, customs code, transportation mode, province, and time period, providing a comprehensive analytical framework.

3.4.3 Creation of the Measures Table

A measures table in Power BI is a dedicated table that stores calculated metrics and key performance indicators (KPIs). These measures are created using DAX (Data Analysis Expressions) and provide dynamic calculations based on the underlying data model.

The advantages of using a measures table include:

Organization: Centralizing all measures in a single table helps keep the data model clean and organized. It makes it easier to find and manage calculations without searching through various tables.

Reusability: Measures can be reused across different reports and visualizations, ensuring consistency in calculations, and reducing the risk of errors.

Performance: Measures are optimized for performance, as they are calculated on-the-fly based on user interactions with the report. This allows for efficient handling of large datasets.

Flexibility: Measures can be updated or modified without altering the underlying data, providing flexibility to adapt calculations as business requirements change.

There are different alternatives for creating measures in Power BI. One common approach is to create them directly within the Power BI Desktop interface using DAX. This is a straightforward method for defining and managing calculations. Another method involves using Power Query, where transformations and calculations are applied during the data loading process. This allows for complex data shaping before the data is loaded into the data model. Advanced users may also utilize tools like DAX Studio to create and manage measures, offering more detailed control over the DAX code and performance tuning.

For this academic work, we have chosen to create measures through Power Query. This approach enables us to perform necessary data transformations and calculations before loading the data into the model. By doing so, we ensure that the data is pre-

processed and ready for analysis, which can simplify the DAX formulas and improve overall model performance.

The measures created in our academic work are tabled below. These measures will be used in other measures, filters and visuals and calculations throughout the report.

Measure Name
Exports
Imports
Transactions
Transactions (+0)
% Exports Freight vs Total
% Imports Freight vs Total
% Num. of Exports versus Total
% Num. of Imports versus Total
% Num. of Transactions versus Total
% Transaction Freight vs Total
% Transactions Value vs Total
% Value of Exports vs Total
% Value of Imports vs Total
Avg Transaction Freight (Kg)
Avg Transaction Value (€)
Card_Evo_ExpVsImp_MoM/YoY/QoQ
Card_Evo_ExpVsImp_SPLY
Card_Evo_Freight_MoM/YoY/QoQ
Card_Evo_Freight_SPLY
Card_Evo_Label_MoM/YoY/QoQ
Card_Evo_Label_SPLY
Card_Evo_Transactions_MoM/YoY/QoQ
Card_Evo_Transactions_SPLY
Card_Evo_Value_MoM/YoY/QoQ
Card_Evo_Values_SPLY
Exported vs Imported Value (%)
Exports Freight (Kg)
Exports Value (€)
Forecast Label
Forecast Metric
Imports Freight (Kg)
Imports Value (€)
Transactions Freight (Kg)
Transactions Value (€)

Some of the measures listed above, due to their innovation or importance, will be explained in the annex of this academic work.

4. Results

Upon completion of the data loading and construction of the relational model for analyzing Spain's international market, we present comprehensive insights derived from meticulous analysis. Our approach, anchored in a well-defined star schema, organizes the data into a central fact table supplemented by dimension tables, enriching our capacity to delve into transactional details.

4.1 Analysis Overview

Our analysis encompasses a diverse range of metrics and key performance indicators (KPIs), offering nuanced perspectives on both export and import activities. These metrics facilitate the evaluation of performance trends across time periods, the comparison of transportation modes, the assessment of trade distribution among provinces, and the exploration of the influence of customs codes on trade volumes.

4.2 Insights and Decision Support

The data-driven insights serve as a valuable resource for stakeholders, empowering them to make informed decisions and uncover opportunities for enhancing trade efficiency. Through detailed analysis, we aim to equip decision-makers with actionable insights that contribute to strategic planning and resource allocation.

4.3 Interactive Visualization

Our report incorporates dynamic visualizations and interactive elements, providing users with a seamless and intuitive means to explore the data. With features such as filtering, slicing, and drill-down capabilities, users can delve into specific dimensions such as time periods, geographical regions, and product categories. This interactive

approach ensures flexibility and adaptability to diverse business requirements and scenarios.

4.4 Communication of Results

While presenting results in a static document format may constrain the full potential of dynamic visualization tools, we endeavor to convey a comparable user experience. Our aim is to illustrate the depth and flexibility of insights derived, despite the limitations of a static medium.

In summary, the results of our analysis provide a robust foundation for understanding Spain's international trade dynamics. Through detailed metrics and interactive visualizations, stakeholders will gain valuable insights that can drive strategic decisions and foster a deeper understanding of market trends. Additionally, users will not only gain better access to information about Spain's international market but will also be able to make future predictions based on past data. These predictions will be flexible and customized to the users' needs, enhancing their ability to plan and strategize effectively.

4.5 International Trade Analysis

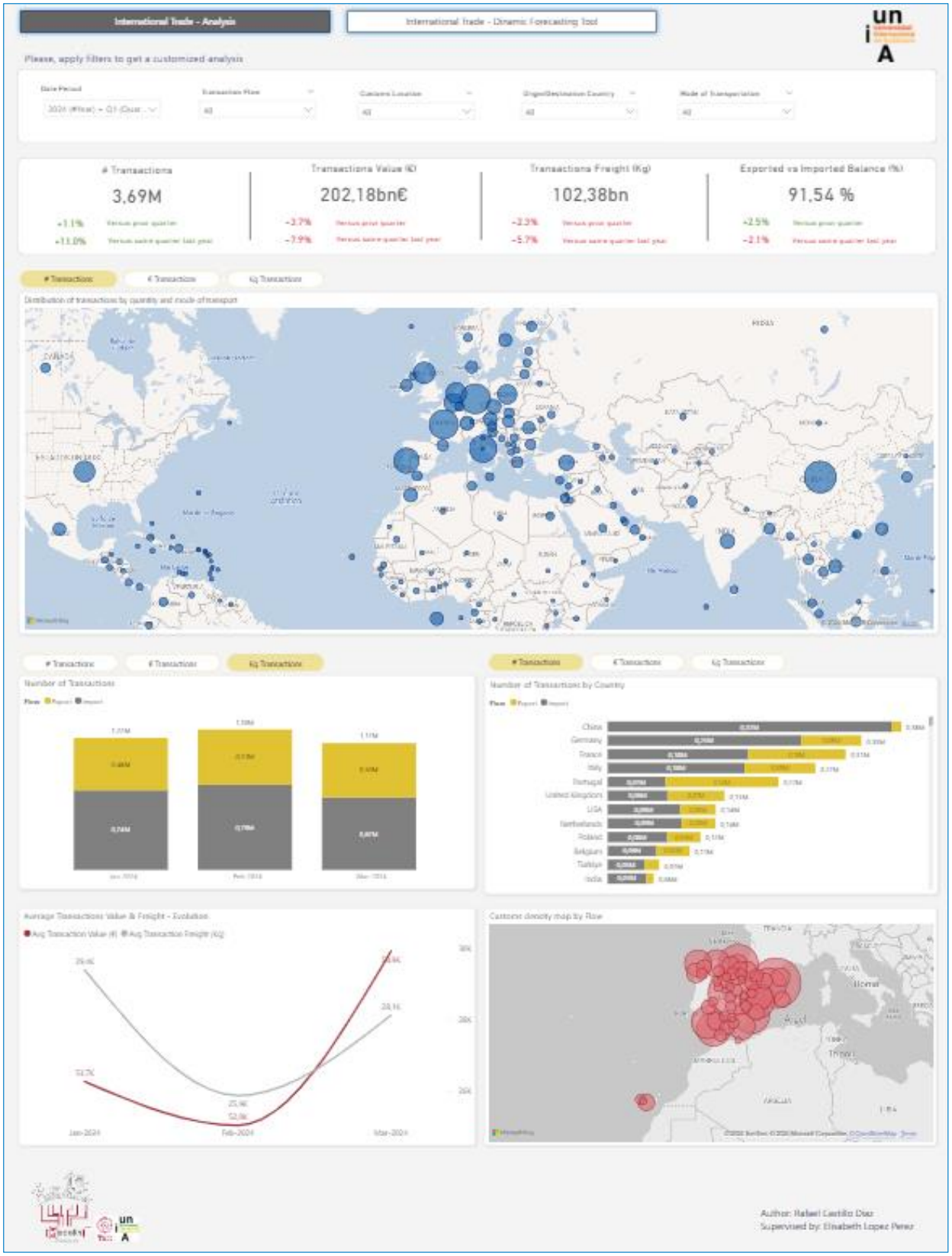
4.5.1 General Display – Landing Page

The main page of this report is titled **"International Trade - Analysis."** This landing page serves as the entry point for users to explore detailed insights into Spain's international trade activities. Although the full page will be shown below and may appear pixelated due to formatting constraints, it provides a comprehensive overview that sets the stage for the detailed analysis to follow.

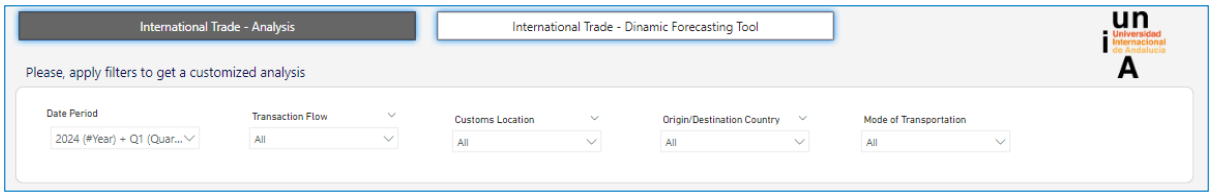
The subsequent sections of this document will explain each part of this landing page, detailing the functionalities, insights, and user experience. We will cover each section from top to bottom, ensuring that users understand how to interact with and benefit from the various elements of the report.

This approach will help users navigate through the report efficiently, making the most of the interactive and dynamic features designed to provide valuable trade insights and predictive capabilities tailored to their needs.

The next page shows a complete image of what the entire report page looks like.


International Trade - Analysis
International Trade - Dinamic Forecasting Tool
Please, apply filters to get a customized analysis
Transactions
3,69M
Transactions Value (€)
202,18bn€
Transactions Freight (Kg)
102,38bn
Exported vs Imported Balance (%)
91,54 %
Number of Transactions
Number of Transactions by Country
Average Transactions Value & Freight - Evolution
Customs density map by flow
Author: Rafael Castillo Diaz
Supervised by: Elisabeth Lopez Perez

4.5.2 Pages Navigator and General Slicers



The initial part of this page of the report includes the **Pages Navigator and General Slicers**. These elements are designed to enhance user interaction and streamline the navigation and filtering processes.

The Pages Navigator allows users to switch between different pages of the report with a single click. This feature ensures that users can easily access various sections of the report, each dedicated to specific aspects of international trade analysis, without getting lost or overwhelmed by the data.

The set of slicers provides powerful filtering options to refine the data displayed in the report. The available slicers, presented in the following order, allow users to focus on specific aspects of the trade data:

Date Period: Users can select the entire period, full years, quarters, or months, enabling them to analyze trends over different timeframes.

Transaction Flows: This slicer allows the user to choose between Export, Import, or Both, providing a clear view of the trade flow direction.

Customs Location: This filter helps in identifying whether the goods are being received or dispatched from the selected customs locations.

Origin / Destination Country: Users can select individual countries or groups of countries that engage in trade with Spain, allowing for detailed country-specific analysis.

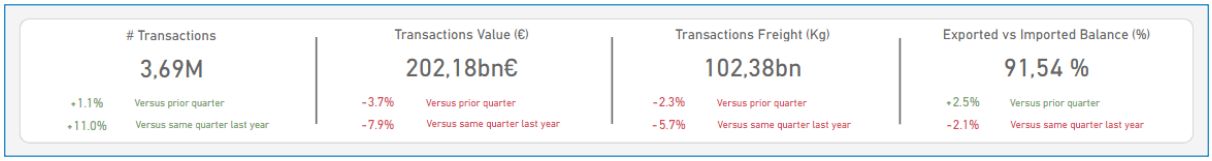
Mode of Transportation: This slicer offers options to filter the data based on different transportation methods used for the trade.

All slicers are dropdown menus that can be activated simultaneously, instantly updating all report data. They support multiple selections, have a "select all" option,

and include a text search feature to enhance the user experience by making it easier to find and apply specific filters.

By utilizing the Pages Navigator and the set of General Slicers, users can efficiently navigate through the report and customize the data views to meet their specific analytical needs, ensuring a seamless and insightful user experience.

4.5.3 KPIs Data Cards



The next section we will present consists of the **KPIs Data Cards**. These cards are incredibly useful from a user experience perspective as they allow users to quickly visualize key total numbers immediately.

The metrics displayed on these cards are crucial Key Performance Indicators (KPIs) due to their relevance and impact on understanding the overall performance of international trade transactions. The metrics include:

 # Transactions: This metric shows the total number of international trade transactions conducted. It is treated as a KPI because it provides a direct measure of trade activity, allowing stakeholders to gauge the volume of transactions over a given period.

Transactions Value (€): This metric represents the total monetary value of the transactions. It is essential as it gives insight into the economic scale of the trade activities, helping to understand the financial impact and revenue generated from these transactions.

Transactions Freight (Kg): This metric measures the total weight of goods involved in the transactions, expressed in kilograms. It is a critical KPI because it helps assess the logistics and transportation efficiency, as well as the physical volume of trade goods.

Exported vs Imported Balance (%): This metric shows the balance between exports and imports, expressed as a percentage. It is a vital indicator of trade balance, helping to understand whether the country is exporting more than it imports or vice versa. This balance is crucial for evaluating economic health and trade policies.

These metrics are dynamically updated based on the filtering context applied by the user at any given time, ensuring that the displayed data is always relevant to the specific period, countries, transportation modes, and other selected criteria.

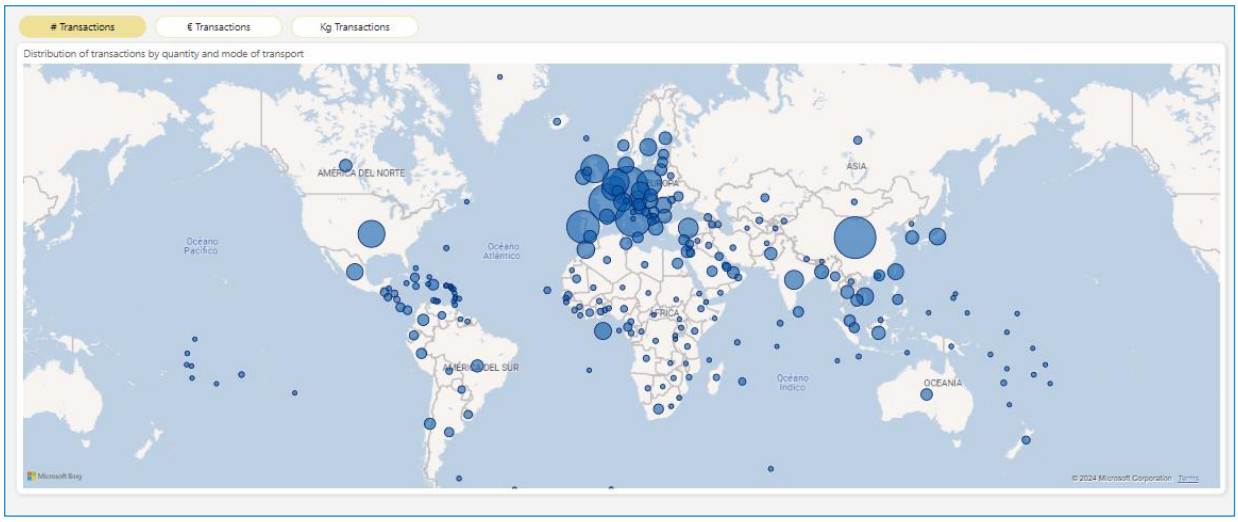
At the bottom of each card, there are two labels indicating the percentage change of the specific measure compared to the previous month or the same period in the previous year. This functionality has been custom developed in the backend of our academic work, as it is not a default feature provided by Microsoft.

These below labels provide a valuable perspective on how the KPIs are trending, offering immediate insights into month-over-month or year-over-year performance. This feature is adaptable based on the user's selected time frame, whether it is a month, a quarter, or a full year. If the selected date range does not support a meaningful calculation, the additional labels remain invisible to avoid confusion.

Furthermore, the text of these labels change color to indicate growth or decline: green for positive growth and red for a decrease. This visual cue enhances the user experience by providing quick, at-a-glance insights into the data trends, making it easier for users to understand performance changes instantly.

This innovative feature is a game-changer that elevates the user experience to the highest level, ensuring that users have access to not only static KPIs but also dynamic insights into how these metrics are evolving over time.

4.5.4 Global Distribution Maps



The next section features the **Global Distribution Maps**. These maps provide a global view of international trade activities, dynamically displaying data based on the selected filters and metrics.

The maps show worldwide distribution using country coordinates, with variable-sized bubbles representing the selected metric. Above the map, a button navigator allows users to switch between three metrics, customizing the map accordingly:

Transactions: Displays the number of transactions.

€ Transactions: Shows the transactions' value in Euros.

Kg Transactions: Represents the transactions' freight weight in kilograms.

This feature is crucial as it enables users to see the distribution of trade activities immediately, tailored to the filters they have selected. Users can quickly switch between different views to understand the trade landscape from multiple perspectives.

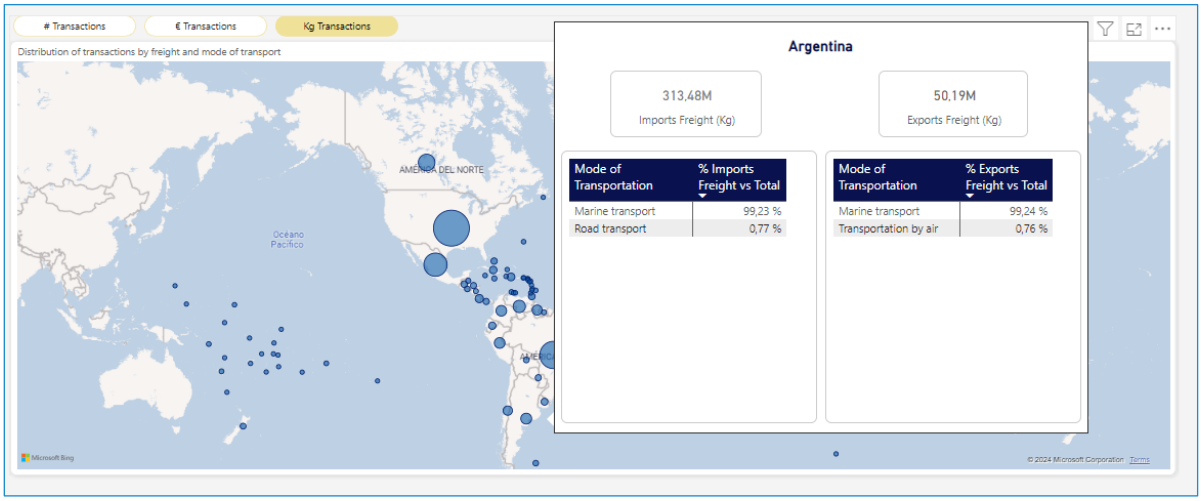
Despite there being three maps, only one is visible at a time, depending on the selected metric. Each map includes customized tooltips that enhance user interaction and provide detailed insights. When hovering over a bubble, the tooltip displays a panel with specific information for the country, divided into two sections:

Left Side: Shows the total number or value of the selected metric for imports, and below, a table indicating the percentage of the total metric by each mode of transportation used.

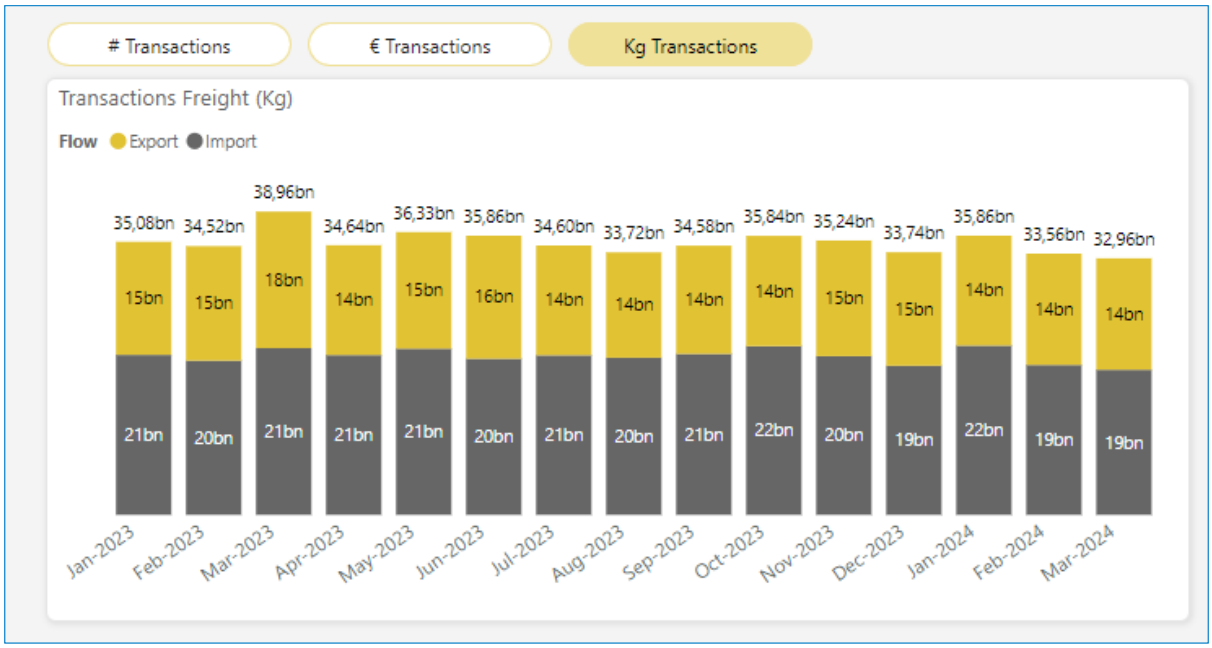
Right Side: Mirrors the left side, but for exports, providing a comprehensive view of both import and export activities for the selected country.

This dynamic and visual representation allows users to quickly grasp the distribution of trade activities. The interactive nature of the maps, combined with the detailed tooltips, provides an intuitive way to understand complex data. Users can easily identify key trends and patterns, making it a powerful tool for gaining insights into the international trade market.

Below is a screenshot to illustrate how this functionality works.



4.5.5 Time Series Analysis



This section of the report features a visual representation that allows users to analyze **the evolution of key trade metrics over time**. The visual includes a navigator with three buttons, enabling users to switch between the following metrics:

Number of Transactions

Value of Transactions (€)

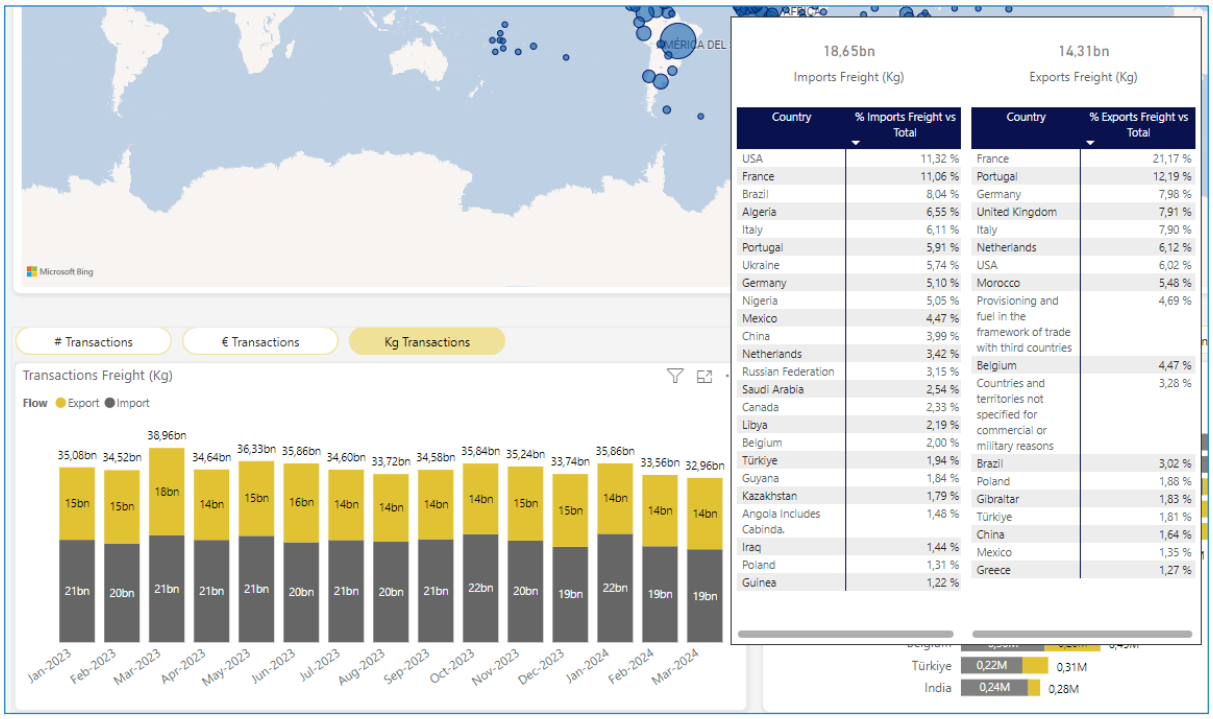
Weight of Transactions (Kg)

This visual presents the selected metric as a time series in a bar chart format, segregated by the flow of imports and exports. The data displayed in the chart dynamically updates based on the selected date filters and other contextual filters applied by the user, providing a clear view of how each metric evolves over time.

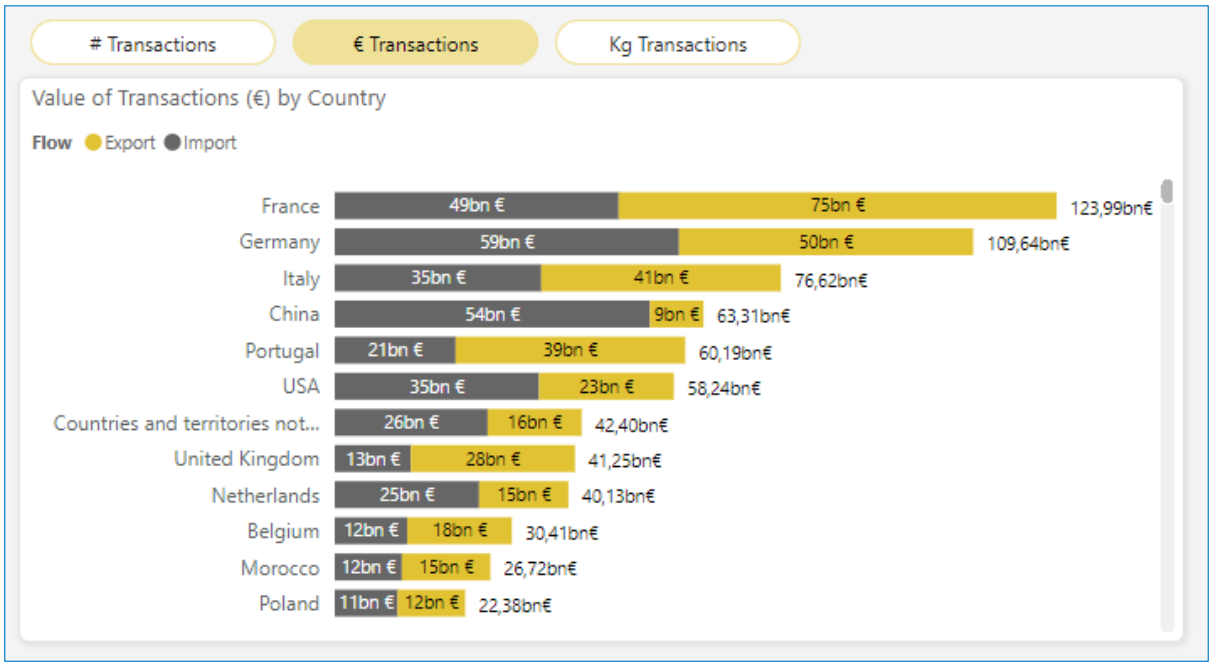
A customized tooltip enhances the interactivity of this visual. When users hover over a specific month in the chart, the tooltip displays a detailed breakdown of the metric (number, value, or weight) for that month. It shows the percentage distribution of exports and imports to each country, allowing users to quickly understand the contributions of different countries to the overall metric for that period.

This feature enables users to gain a comprehensive understanding of trade patterns and trends, segmented by imports and exports, and broken down by country. It offers a clear, detailed view of the dynamics of international trade, making it easier to identify significant changes and emerging trends.

Below is a screenshot to illustrate how the tooltip appears when the user hovers on a particular month.



4.5.6 Country Transactions Stacked Bar Chart



This section of the report features a stacked bar chart visual that displays the number of transactions for each country, although like other sections, this visual can be switched to show either € Transactions or Kg Transactions, providing flexibility in how the data is analyzed.

Each bar in the chart represents a country and aggregates the values of imports and exports. The bars are sorted from top to bottom in descending order based on the total number of transactions, making it easy to identify the countries with the highest trade volumes immediately.

The stacked bar chart not only allows users to see the total transactions per country but also differentiates between imports and exports within each bar. This clear visual distinction quickly helps users understand the composition of trade activities for each country.

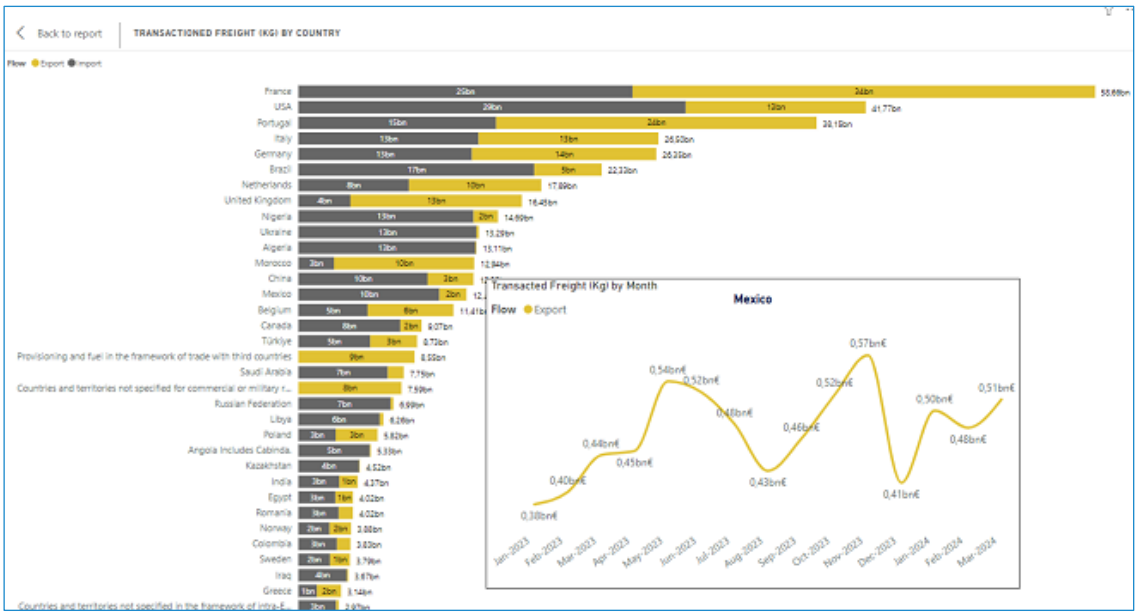
A key feature of this visual is the dynamic tooltip. When users hover over a segment of a bar, the tooltip provides a detailed temporal evolution of the selected metric

(number of transactions, value in euros, or weight in kilograms) for that specific country. The tooltip also indicates whether the hovered segment represents exports or imports.

The convenience and dynamism of this tooltip, combined with the stacked bar chart, greatly enhances the user experience. Not only does it allow users to see global numbers that capture a snapshot of the selected reporting period, but it also links these numbers to their temporal evolution. This capability allows users to delve deeper into the trends and patterns over time, offering a richer and more comprehensive understanding of the trade dynamics for each country.

This interactive feature ensures that users can quickly and easily transition from a high-level overview to a detailed temporal analysis, providing valuable insights at both macro and micro levels.

Below is a screenshot to illustrate how the tooltip appears when hovering over a specific segment of the stacked bar chart, showcasing the detailed temporal evolution of the selected metric.



4.5.7 Evolution of Key Trade Indicators

This special section of the report is dedicated to showcasing the evolution of two critical metrics that provide significant insights into the behavior of Spain's international trade over time. These metrics are:

Average Transaction Value in Euros (€)

Average Transaction Freight (Kg)

Both metrics are displayed together on a single line chart, with each series plotted on a separate Y-axis. This dual-axis approach is employed to facilitate the clear visualization of both series simultaneously, allowing users to better understand their individual and combined trends.

The use of two Y-axes is particularly beneficial in this context. The Average Transaction Value in Euros and the Average Transaction Freight are inherently different in scale and units. Plotting them on the same axis would make it difficult to discern meaningful patterns and relationships due to the disparity in their magnitudes. By using separate Y-axes, we ensure that both series are presented in a way that highlights their respective trends without one overshadowing the other. This method provides a balanced view, enabling users to accurately compare and analyze the evolution of these key indicators over time.

The importance of these indicators in our report cannot be overstated. The Average Transaction Value in Euros is a crucial metric that reflects the economic significance of individual transactions. It helps in understanding the financial impact of trade activities and detecting any changes in the value of traded goods.

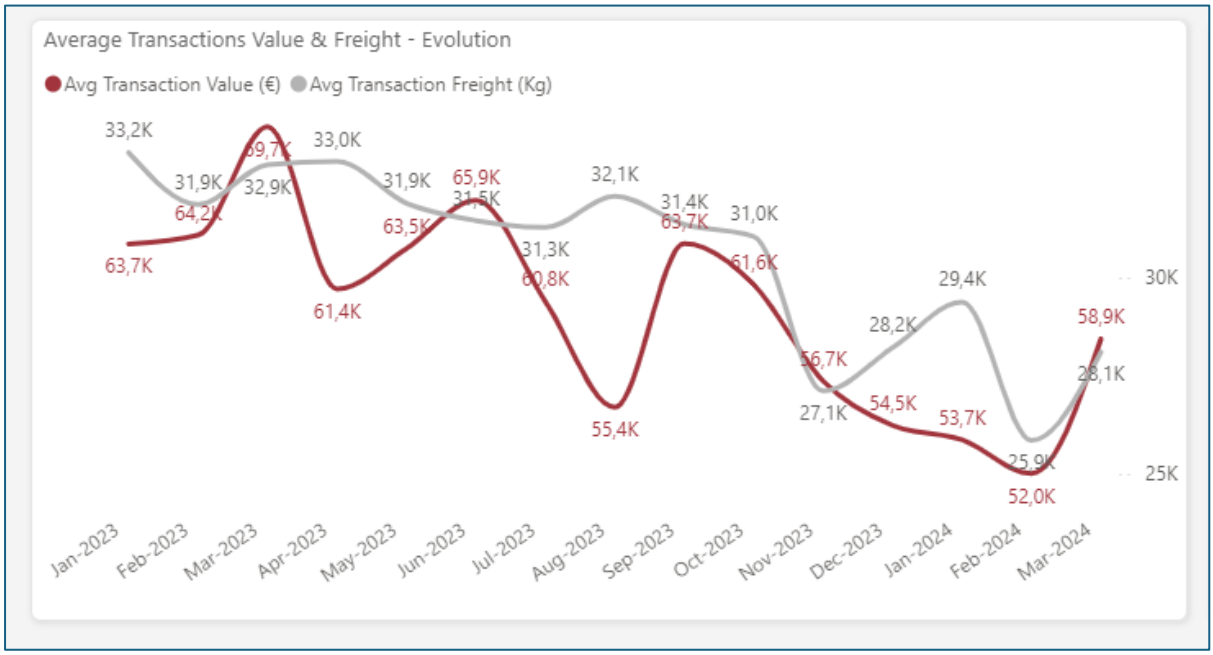
However, the Average Transaction Freight provides insights into trade's logistical aspects. It indicates the average weight of goods involved in transactions, which can be a proxy for understanding the volume and nature of the commodities being traded.

Together, these metrics offer a comprehensive picture of both the economic and physical dimensions of Spain's international trade.

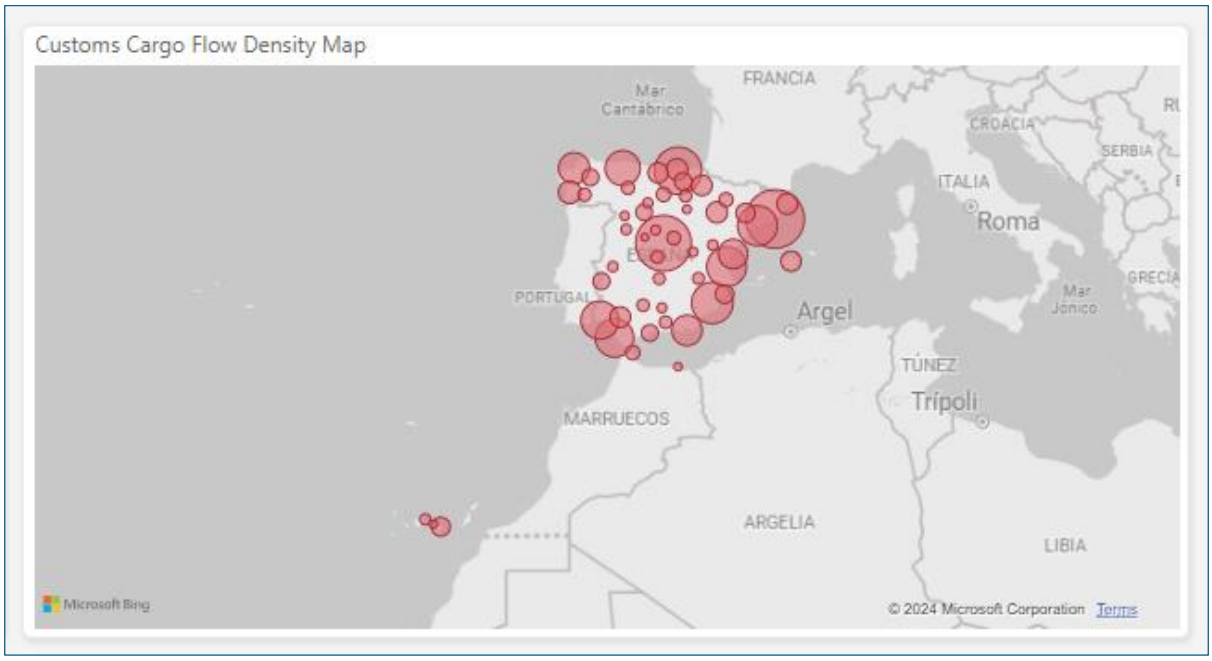
For illustrative purposes, we will show the evolution of these indicators from January 2023 to March 2024, the most recent data available at the time of writing. This period captures significant trends and variations, providing valuable insights into recent trade behaviors.

The combination of these two metrics on a single, dual-axis line chart allows for an intuitive and detailed analysis. Users can easily observe how the average transaction values and weights have evolved over time, identify seasonal patterns, detect anomalies, and make informed predictions about future trends.

Below is a screenshot to demonstrate the evolution of these metrics from January 2023 to March 2024, providing a visual example of how these key indicators are presented in the report.



4.5.8 Customs Cargo Flow Density Map



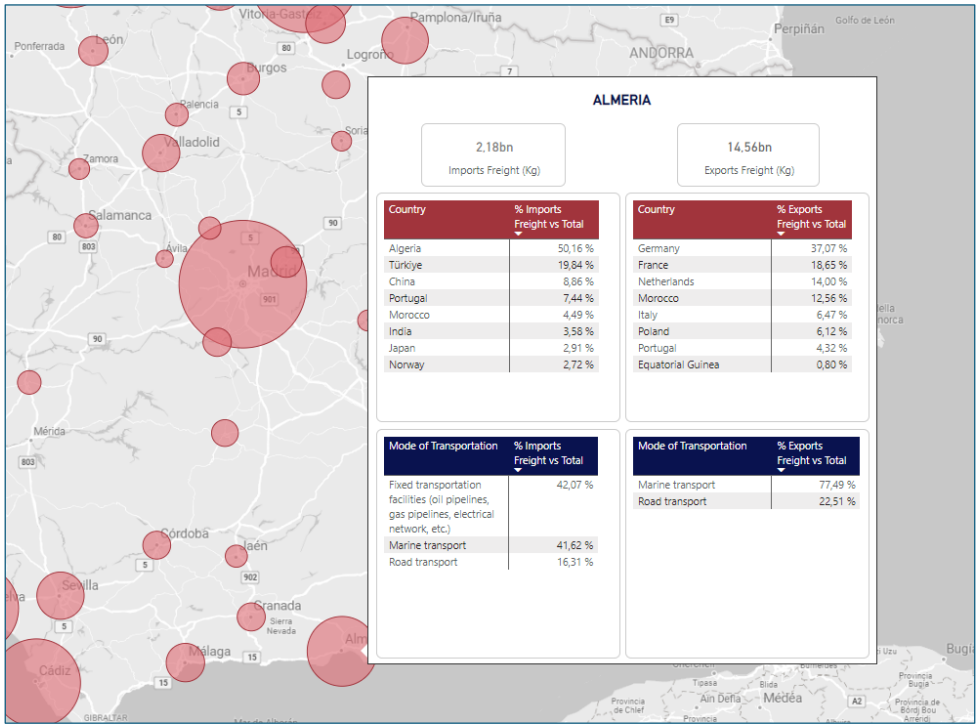
This final section of the first page of the report features flow density maps for import and export cargo at Spanish customs. This visual leverages Microsoft Bing Maps to plot the coordinates of Spanish customs locations, represented by variable-sized bubbles. The size of each bubble correlates with the volume of cargo handled, with larger bubbles indicating higher cargo flow.

Perhaps the most compelling aspect of this visual is the customized tooltip we've developed. When a user hovers over any of the bubbles, the tooltip provides detailed insights into the cargo flow through that specific customs location. The tooltip is divided into two main parts, offering a comprehensive overview of both imports and exports.

When the user hovers over a bubble, the tooltip opens to display the province where the customs location is situated. On the left side, it shows the total weight of imported cargo in kilograms, followed by two detailed tables. The first table lists the top countries ranked by the percentage of imported cargo they represent at this specific customs location. The second table provides a percentage breakdown of the imported cargo by transportation mode (e.g., air, sea, road). On the right side, the tooltip mirrors this structure for exports, displaying the total weight of exported cargo, the top countries by export value, and the percentage distribution by transportation mode.

This dynamic bubble map, coupled with the rich information provided by the tooltip, offers several powerful insights and possibilities. Users can quickly identify which customs locations handle the most cargo, both for imports and exports, by simply glancing at the map. The tooltip provides a detailed breakdown of cargo flow, helping users understand the distribution and composition of trade activities at each customs location. By showing the top countries contributing to cargo flow and the modes of transportation used, the tooltip allows for a nuanced analysis of trade routes and logistics. The interactive nature of the map means that as users change filters and parameters in the report, the map and tooltips update accordingly, providing real-time insights based on the selected context.

Overall, this visual not only enhances the understanding of cargo distribution across Spanish customs locations but also enables users to delve deeper into the specifics of trade logistics and country contributions, making it an invaluable tool for comprehensive trade analysis.



4.6 International Trade – Dynamic Forecasting Tool

The second page of our report, titled "International Trade – Dynamic Forecasting Tool," provides a robust and customizable tool for viewing and predicting time series data for various key metrics relevant to international trade. This tool allows users to select from a range of "Forecast Metrics," including:

Number of Transactions: Provides insight into the volume of trade activities, helping users understand the frequency and intensity of trade exchanges.

Value of Transactions (€): Measures the financial magnitude of trade, indicating economic value and revenue generated through international transactions.

Transactions Freight (Kg): Reflects the physical volume of goods traded, offering a perspective on the logistics and transportation aspects of international trade.

Average Transaction Value (€): Gives an average economic value per transaction, helping in understanding the value efficiency of each trade activity.

Average Transaction Freight (Kg): Provides the average weight per transaction, aiding in the analysis of trade logistics and shipment sizes.

% of Transactions vs Total: Shows the proportion of specific transactions relative to the total, useful for identifying significant trends and contributions within the dataset.

Users can select the desired metric and apply additional filters such as Transaction Flow, Customs Location, Origin/Destination Country, and Mode of Transportation. This allows for viewing the time series from January 2016 to the present date for the chosen indicator. The line chart then calculates the trend line and provides a 12-month forecast for that metric.

Power BI uses advanced mathematical models to perform these predictions through its "Analytics" functionality. The primary method employed is the exponential smoothing (ETS) model, popularly known as the Holt-Winters algorithm. This method is well-suited for handling trends and seasonality in time series data.

Regarding the forecasting details, we have set these attributes:

Forecast Length: We set the forecast length to 12 months, providing a forward-looking view of the selected metric for the next year.

Seasonality: Seasonality is corrected using a 12-point period, which adjusts for recurring patterns within the data. This means the model accounts for and adjusts to seasonal effects that repeat every 12 months, such as quarterly or annual cycles.

Confidence Interval: The forecast includes a confidence interval, typically set to 95%, indicating the range within which we can expect the actual values to fall with a high degree of certainty. This interval provides a measure of the reliability and precision of the forecast.

The **ETS model, particularly the Holt-Winters algorithm**, combines components of error, trend, and seasonality to generate accurate forecasts. Power BI utilizes two main variations, ETS AAA (Additive Error, Additive Trend, Additive Seasonality), suitable for data with regular seasonal patterns and constant trends and ETS AAN (Additive Error, Additive Trend, Multiplicative Seasonality), used for data with varying seasonal patterns and constant trends.

The Holt-Winters algorithm applies a weighted average of historical observations, giving more weight to recent observations. This allows the model to respond quickly to recent changes in the data. It Key equations are the following:

1. Level(L):

$$Lt = \alpha(Yt - St - m) + (1 - \alpha)(Lt - 1 + Tt - 1)$$

Where α is the smoothing parameter for the level, Yt is the observed value, $St-m$ is the seasonal component at period $t-m$, $Lt-1$ is the level at the previous period, and $Tt-1$ is the trend at the previous period.

2. Trend (T):

$$Tt = \beta(Lt - Lt - 1) + (1 - \beta)Tt - 1 \quad Tt = \beta(Lt - Lt - 1) + (1 - \beta)Tt - 1$$

Where $\beta\beta$ is the smoothing parameter for the trend.

3. Seasonality (S):

$St=\gamma(Yt-Lt)+(1-\gamma)St-m$St =γ(Yt −Lt)+(1−γ)St−m

Where γ is the smoothing parameter for the seasonality.

4. Forecast (F):

$Ft+h=Lt+hTt+St+h-m(k+1)$Ft+h =Lt +hTt +St+h−m(k+1)

Where h is the number of periods into the future to forecast and m is the number of periods in a seasonal cycle.

In our implementation, the ETS model helps in understanding and predicting the trends and seasonal patterns inherent in trade data. It provides a robust framework for making reliable forecasts by considering both past values and stochastic elements that could influence future values.

The use of the Holt-Winters algorithm in Power BI allows automatic adjustment of parameters to optimize forecast accuracy, facilitating informed and strategic decision-making based on the predicted data.

Regarding the usefulness of this tool, the dynamic selector developed allows users to choose the metric they wish to forecast, integrating seamlessly with the filters. This innovation overcomes the limitation of having to use multiple separate charts for each metric's forecast, which is a constraint in default Power BI functionality. Our solution enables the creation of a single, versatile line chart that adapts dynamically based on user selection, simplifying the interface and enhancing the user experience by providing a streamlined and interactive forecasting tool.

The value of this tool is further amplified by its ability to let users customize their predictions using the filter context. By adjusting filters such as Transaction Flow, Customs Location, Origin/Destination Country, and Mode of Transportation, users can tailor the forecast to specific scenarios, gaining insights directly relevant to their

needs. This level of customization empowers users to explore various aspects of trade data, uncovering trends and patterns that might otherwise go unnoticed.

Additionally, at the bottom of the report, we have incorporated an automatically generated text box that highlights the most relevant findings from the generated chart. This feature ensures that users not only see the visual data but also receive a concise summary of the key insights, enhancing their understanding and facilitating data-driven decision-making.

This sophisticated forecasting tool, with its dynamic metrics and customizable filters, provides a comprehensive and flexible approach to analyzing and predicting trade trends. It ensures users have the insights needed to make informed decisions and strategize effectively for future trade activities.

The following page shows the complete page of the report that contains this tool.

4.7 Analysis of Key Trade Issues

In this section, we will examine significant economic impacts using our comprehensive report. This analysis will utilize both historical data and predictive analytics to provide a detailed understanding of the trends and future directions of Spain's international trade. By presenting the results provided by the report and comparing them with existing literature and data available on the web, we aim to validate our findings and offer new insights. The three cases we will analyze are:

Evolution of Trade Relations with Russia since the Ukraine War.

Evolution of Transaction Flows at Huelva Customs Post-Political Events with Algeria.

4.7.1 Evolution of Trade Relations with Russia since the Ukraine War

Since the onset of the Ukraine war, trade relations between Spain and Russia have undergone significant changes. Using our report, we will analyze the historical data and predict future trends based on the current scenario.

The war in Ukraine has had far-reaching economic consequences, affecting trade relations worldwide. Spain's trade relationship with Russia, in particular, has seen substantial changes due to sanctions, shifts in global alliances, and changes in supply chain dynamics. Understanding these changes is crucial for Spanish businesses and policymakers to navigate the new trade landscape efficiently.

The disruption caused by the conflict has led to significant shifts in global trade patterns. Sanctions imposed on Russia by the European Union, including Spain, have resulted in a decrease in bilateral trade. Additionally, supply chain disruptions and increased geopolitical risks have compelled countries to seek alternative trading partners and routes. This case study will focus on how these broader geopolitical shifts have impacted Spain's trade with Russia.

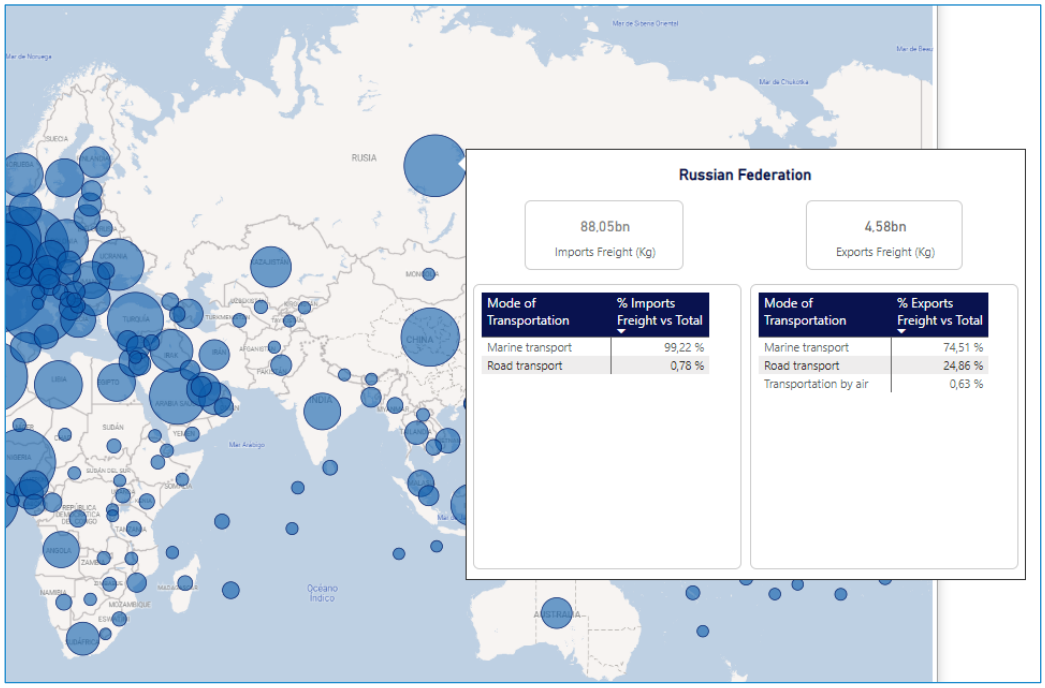
We will use our report to explore the evolution of trade metrics such as the number of transactions, transaction values, and freight volumes between Spain and Russia. By examining the data before and after the onset of the conflict, we can identify significant shifts or trends that correlate with key events in the Ukraine war. This analysis helps understand how the conflict has impacted trade relations and what the future might hold.

Current literature highlights several key impacts of the Ukraine war on international trade. Studies have shown that sanctions on Russia have led to significant reductions in trade volumes with European countries, including Spain. Research by the European Council on International Relations (ECFR) and other economic research institutions indicates a reorientation of trade routes and the search for alternative markets. Additionally, literature points out the increased volatility and uncertainty in trade relations, emphasizing the need for adaptive strategies.

For instance, a study by the European Council on International Relations discusses how European countries have had to navigate the complex landscape of sanctions and countersanctions, leading to a reconfiguration of supply chains and trade routes. Similarly, reports from the International Trade Centre (ITC) highlight the impact of these sanctions on trade volumes and the resultant search for new markets.

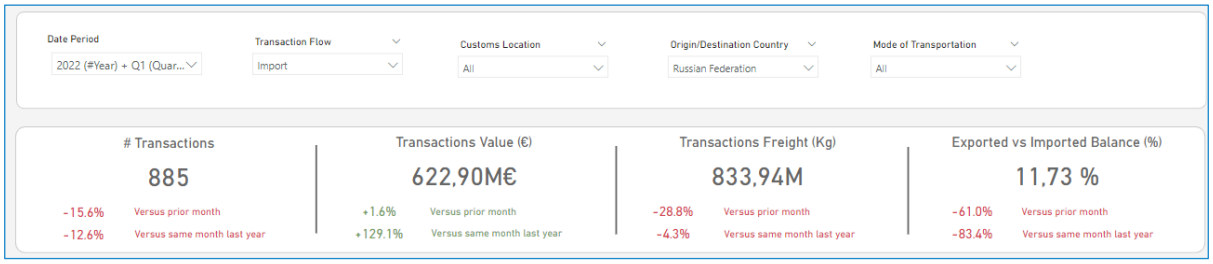
By comparing these findings with the data from our report, we can validate the observed trends and provide a more comprehensive understanding of how the conflict has reshaped trade dynamics between Spain and Russia. This comparison will also help identify any gaps in the literature and areas where our analysis can contribute new insights.

Firstly, we can see from the report that the Russian Federation represents the 11th country with the most transactions in transacted cargo with which Spain has relations. Especially relevant for its imports, since it is the seventh in order of importance since the beginning of our data set in January 2016



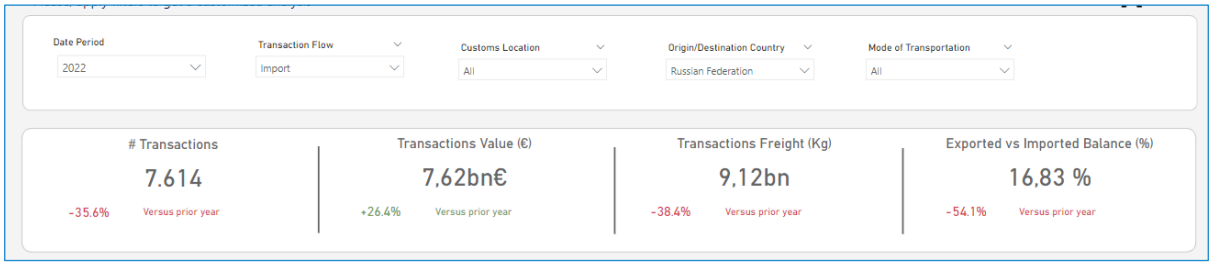
However, since the war began in February 2022, Russia has fallen to 12th place in terms of cargo imported into Spain, and to 18th in total cargo transacted taking into account both flows.

If we focus on the numbers we obtain when evaluating the impact in the month after the conflict began regarding the imports, the data are as follows.

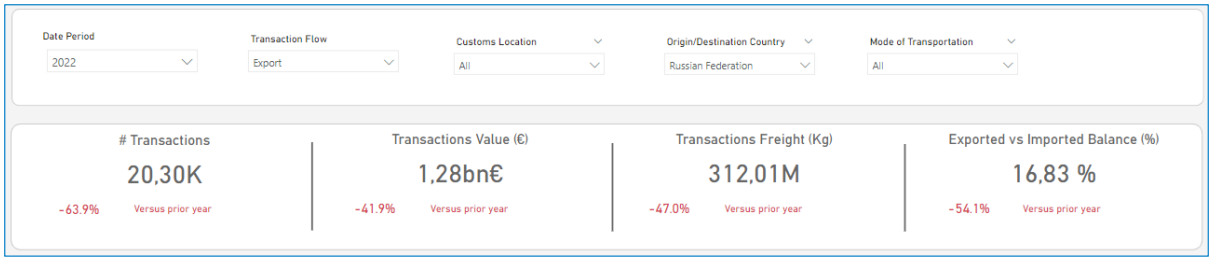


We observed a sharp decrease in all metrics: Number of transactions, transaction load and in the balance between the exported and imported value.
However, it is also found that the declared value of transactions increases significantly.
A possible explanation is that trade in luxury or high-value products has continued its natural flow despite the conflict.

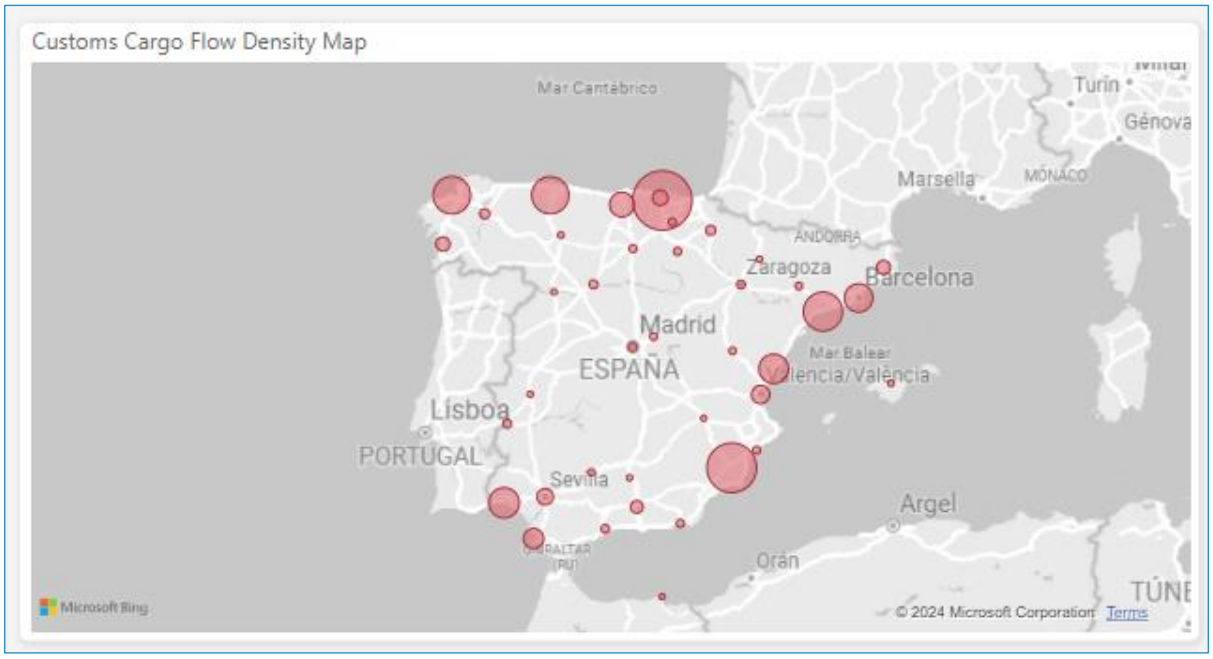
If we extrapolate these calculations to the full year 2022, we observe confirmation of this line of evolution that we already observed in March.



Regarding exports, if we look at the global numbers of shipments to Russia after the first year of armed conflict, we observe a, if possible, more pronounced decline in this flow.

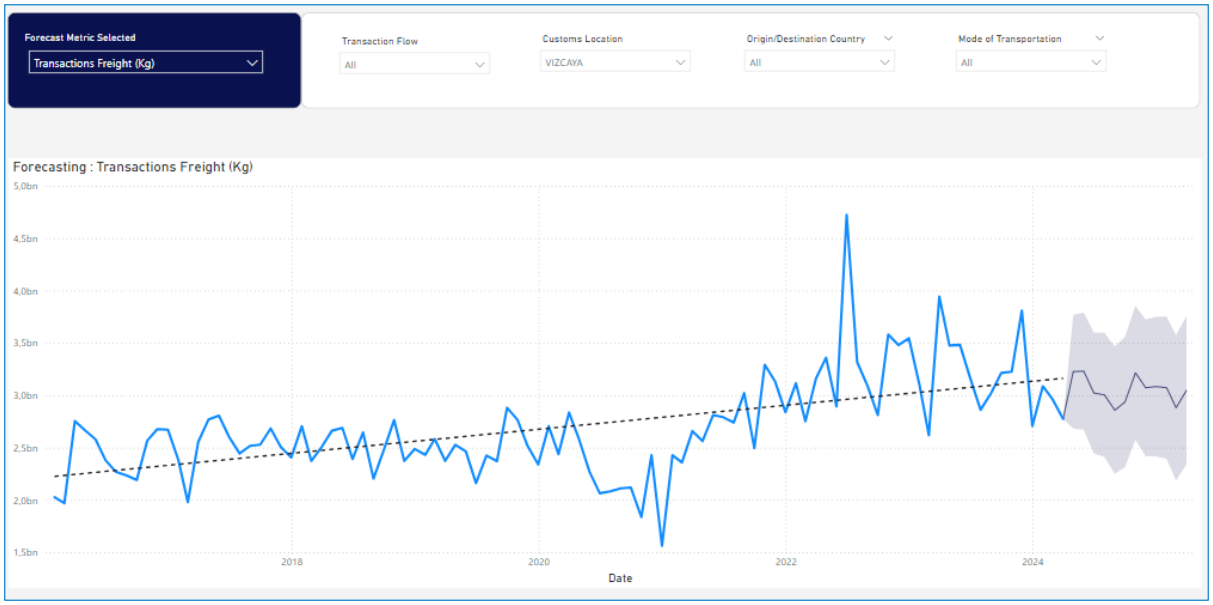


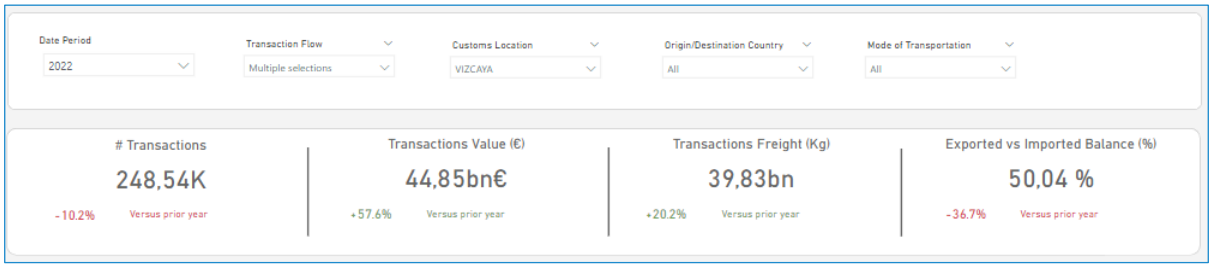
Consequently, this decline in the exchange of goods between both countries has had to substantially affect the normal flow of Spanish customs.
In the following image, we see the customs distribution map of cargo transacted to or from Russia in 2021 before the conflict.



As we can deduce, the customs of Vizcaya are the ones with the greatest flow with Russia. Below, we will examine his evolution to see how this international circumstance has affected it.

Below is the time series of total weight transactions at Vizcaya customs. And below are the indicators of this customs in 2022:

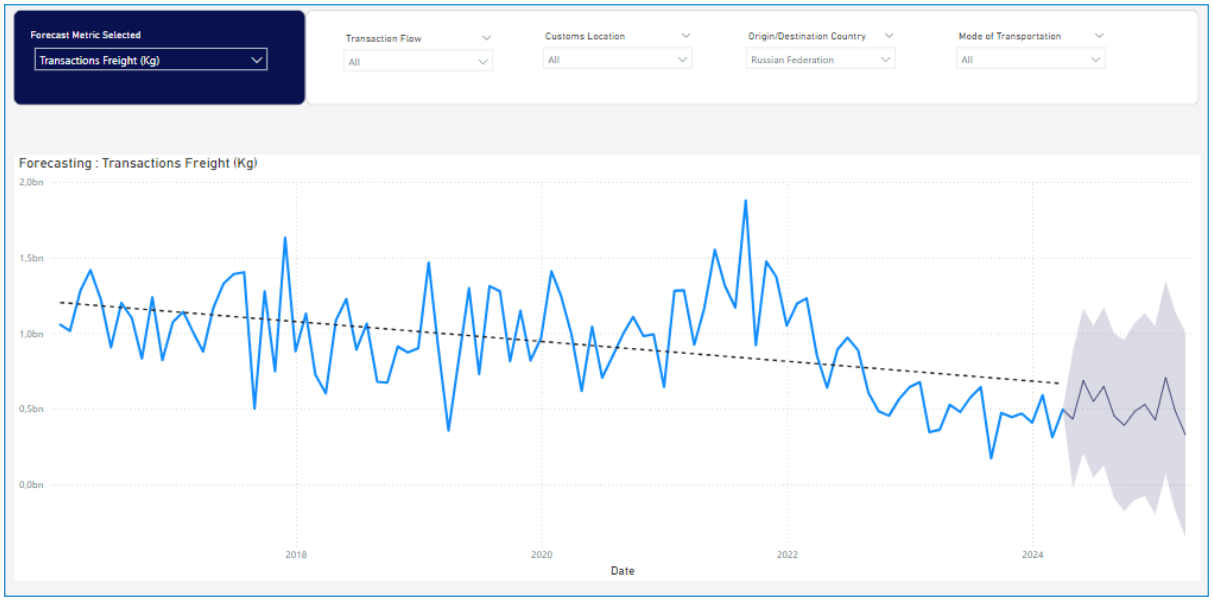




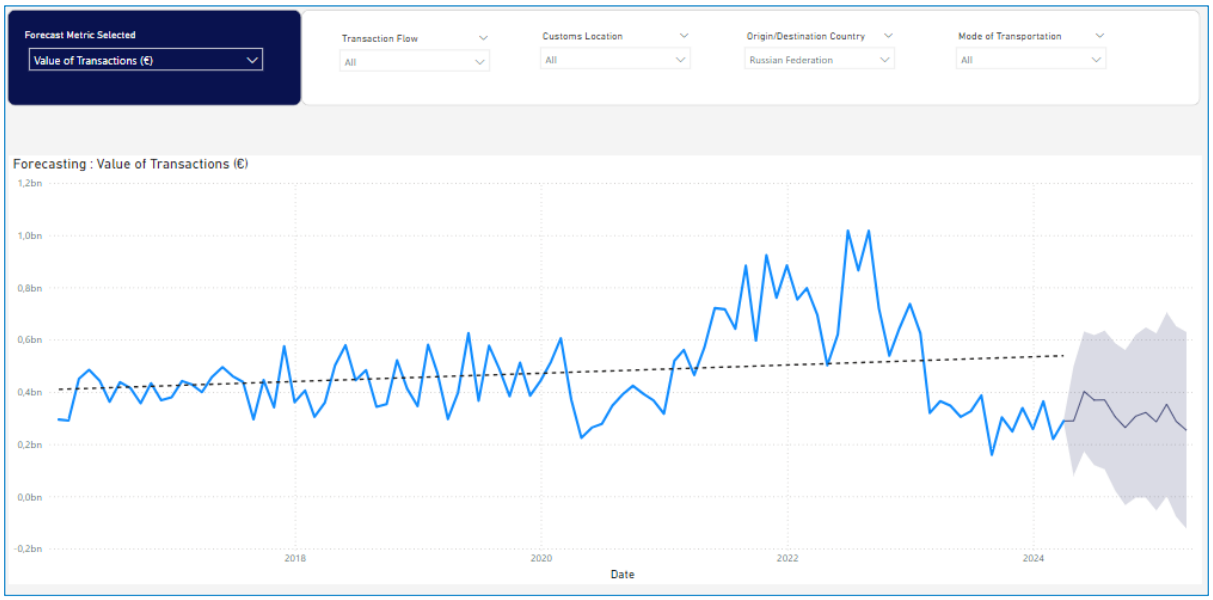
Interesting how despite the great impact that the start of the war in Ukraine had on the series of cargo transacted at the Vizcaya customs, the series is evolving so that the global results of the customs at the end of 2022, not only are not affected, but rather represented an increase in most of the metrics measured. An upward trend that continued well into 2023. Our prediction foresees stability in these customs for the next 12 months, following the trend of recent times.

Regarding the series for our country under study, the Russian Federation, we can extract the following from the prediction tool in our report.

In this order, the time series of the cargo transacted between Russia and Spain will be shown below. Secondly, the number of transactions, and lastly the series of value transacted in Euros:


Forecast Metric Selected
Transactions Freight (Kg)
Transaction Flow
All
Customs Location
All
Origin/Destination Country
Russian Federation
Mode of Transportation
All
Forecasting : Transactions Freight (Kg)
2,0bn
1,5bn
1,0bn
0,5bn
0,0bn
2018
2020
2022
2024
Date


Forecast Metric Selected
Number of Transactions
Transaction Flow
All
Customs Location
All
Origin/Destination Country
Russian Federation
Mode of Transportation
All
Forecasting : Number of Transactions
7K
6K
5K
4K
3K
2K
1K
0K
2018
2020
2022
2024
Date


Forecast Metric Selected
Value of Transactions (€)
Transaction Flow
All
Customs Location
All
Origin/Destination Country
Russian Federation
Mode of Transportation
All
Forecasting : Value of Transactions (€)
1,2bn
1,0bn
0,8bn
0,6bn
0,4bn
0,2bn
0,0bn
-0,2bn
2018
2020
2022
2024
Date

Interesting to observe how the transactional model between Spain and Russia has changed after the war.

Although the value of transactions increased in post-war periods, it seems that since 2023 it has decreased considerably, offering a forecast of stability between 0.3bn Euros in the next twelve months

As for the number of transactions, there has been a very abrupt decrease, although the trend in the cargo transacted has had a gentler decline. It can be assumed that larger cargo groupings are made derived from a difficulty of free transactions. Finally, the model predicts stability in terms of trade flow in the next twelve months, yes, at such low standards that Russia - Spain bilateral trade has never known in this century.

4.7.2 Evolution of Transactions at Huelva Customs Post-Algeria Events

The political events with Algeria have had a notable impact on trade through the Huelva customs. This section will analyze the flow of transactions, particularly focusing on imports via gas pipelines from Algeria, and compare the overall transaction evolution with neighboring provinces.

Introduction: The political tensions between Spain and Algeria have significantly impacted trade, especially in the energy sector. Huelva, being a key entry point for Algerian gas, has seen changes in transaction flows that reflect the broader political and economic shifts. Analyzing these changes can provide insights into the resilience and adaptability of Spain's energy supply chain and broader trade relationships with North Africa.

The breakdown in diplomatic relations between Spain and Algeria has led to disruptions in the energy supply chain, particularly affecting the import of natural gas through the pipelines. This case study will focus on the flow of transactions at the Huelva customs, examining how the import volumes and values have been affected and comparing these changes with those in neighboring customs regions.

We will utilize our report to examine the data on transactions at Huelva customs, looking at the volume and value of imports and exports. By focusing on the periods surrounding the political tensions with Algeria, we can identify trends and patterns, especially any changes in the flow of gas imports from Algeria. This analysis will be further enriched by comparing the evolution of transactions in neighboring customs regions to provide a broader context.

Comparison with Literature: Existing literature on Spain-Algeria trade relations, such as reports from the International Energy Agency (IEA) and economic studies from Spanish think tanks, highlight the critical role of Algerian gas in Spain's energy mix. These sources also discuss the potential vulnerabilities and strategic importance of diversifying energy imports. Recent political analyses emphasize the impact of diplomatic tensions on trade and the necessity for Spain to seek alternative energy sources and routes.

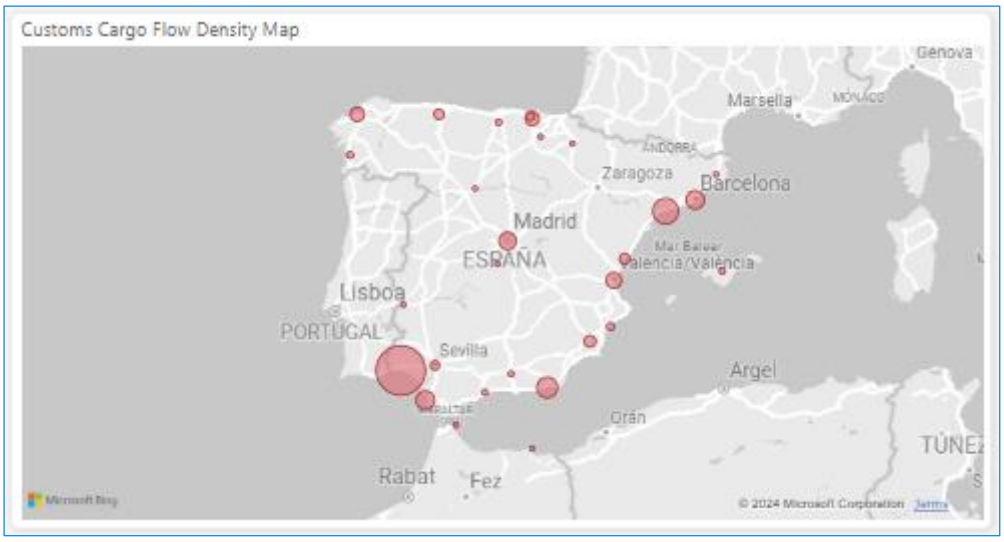
For instance, the International Energy Agency's reports on energy security discuss the strategic importance of Algerian gas and the potential risks associated with political instability. Economic studies from Spanish think tanks, such as the Real Instituto Elcano, provide detailed analyses of the economic implications of these political tensions, including the need for Spain to diversify its energy sources and reduce dependence on Algerian gas.

By comparing our findings with these studies, we can assess the extent to which the political events have disrupted trade flows and how Huelva's customs activities have adjusted. This will help contextualize our data within the broader narrative of Spain's energy security and trade strategy.

Investigating in our report, if we visualize the general numbers of Algeria in its commercial relationship with Spain, we can see that historically, Algeria is the eighth country in transacted cargo, eighteenth in transacted value.
But if we limit this data only to imports, Algeria is the seventeenth in terms of transaction value and the third largest historical supplier of Spanish external trade in terms of imported cargo, only behind France and the United States.

A country that reached with Spain in 2023 transactions totaling 6.42 billion Euros and almost 10.29 billion Kg.

Regarding the distribution of these imports in Spanish customs, we can see below the distribution map for the entire series since January 2016



The map places the Huelva customs office as the most important actor in terms of receiving goods from Algeria. Specifically, Huelva customs represent 54.5% of all cargo imported into Spain originating from this African country. 92.2% of them received through fixed transportation facilities such as gas pipelines.

As a consequence of the political and diplomatic situations experienced in recent years with respect to this country, there is legitimate interest in studying the evolution of imports at a general level of this important supplier, and the consequent impact that it has had in the flow of goods in Huelva customs.

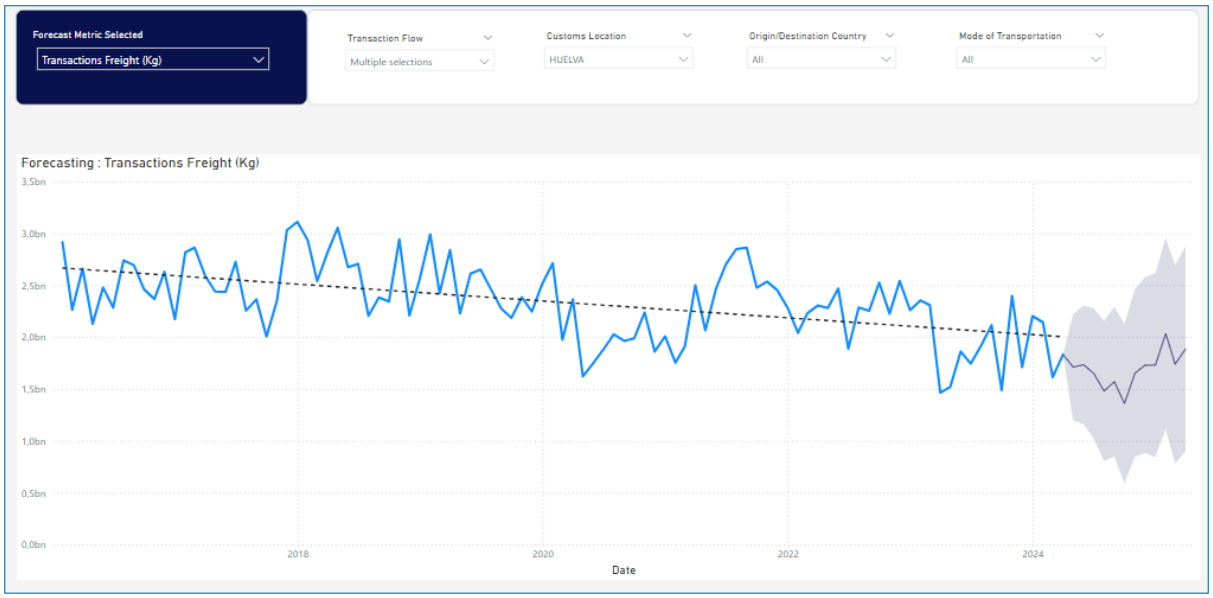
Below is the time series since 2016 of imported cargo from Algeria in Spain

It is not necessary to do many calculations to observe the negative trend of these imports, although just to show some numbers we will say that from the beginning of the series, January 2016 to the latest data as of March 2024, the decrease has been 50.97%.

Of special mention is the drop since March 2022, where the tensions of the Russia - Ukraine conflict, and Algeria's breach of the Treaty of Friendship with Spain a few months later, have caused a decrease of 8.37% in a short period of time. This evolution, however, seems to be slowing down, leading to a forecast of growth in the next twelve months.

This decrease registered in the previous series clashes with the information that is considered in international trade sources such as, for example, the latest report from the Forum of Gas Exporting Countries (FPEG), which ensures that Algeria was the second gas exporting country in 2023. natural gas through gas pipelines to the European Union (EU), with 19% of the total, and registered a significant increase in its exports of liquefied natural gas (LNG), becoming the leader on the African continent.

Regarding the evolution of imports at Huelva customs, we show the following graphs, firstly, the total transactions in Huelva, both imports and exports. And secondly, the series of imports into this customs office of cargo from Algeria:



It would not be too far-fetched to conclude, in the light of these data, that Algeria continues to bolster its gas supply to Europe, while the gradual decline in gas entry through southern Spain penalizes these customs points. Algeria's gas export strategy is expanding, yet the customs in southern Spain are experiencing deteriorating results.

Political tensions and strategic decisions between Spain and Algeria have significantly impacted the flow of gas through southern Spain. Algeria's strategy to reduce pipeline

gas supplies to Spain serves as leverage in diplomatic negotiations and shifts more exports to LNG, which bypasses Spanish entry points.

The reduction in pipeline gas supplies has led to a notable decline in the volume of gas entering through southern Spain's customs, particularly affecting ports like Huelva.

This decrease in gas imports impacts the economic performance of these customs points, leading to lower transaction volumes and reduced revenue.

Operational Challenges: Customs in southern Spain must adapt to these changes, potentially seeking to diversify the types of goods they handle to mitigate the impact of reduced gas imports.

In summary, Algeria's political and strategic decisions are leading to increased gas exports to Europe overall, while simultaneously causing a decline in gas imports through southern Spain, adversely affecting these customs points.

5. Conclusions and Recommendations

In this section, we summarize our main findings and suggest areas for future research to improve and deepen the analysis of Spain's international trade. Additionally, we highlight the value of using a Business Intelligence (BI) tool for this analysis, emphasizing its flexibility, customization, rapid response, and accessibility to the public, in contrast to existing products.

5.1 Conclusions

1. Evolution of Trade Relations with Russia since the Ukraine War:

The Ukraine war has caused significant changes in trade relations between Spain and Russia. Sanctions imposed by the European Union and other Western allies have led to a sharp reduction in trade volumes between the two countries. Our analysis shows a notable decline in the number of transactions and the value of imports and exports since the conflict began.

Spanish companies that depended on the Russian market have had to seek alternatives, diversifying their export markets to mitigate the negative impacts. However, this reorientation has not been sufficient to fully compensate for the loss of the Russian market, affecting the competitiveness and commercial strategies of various industries.

2. Evolution of Transaction Flows at Huelva Customs Post-Political Events with Algeria:

Political tensions between Spain and Algeria have directly impacted the flow of natural gas imports through the Huelva customs. The data show a significant drop in gas imports via pipelines, negatively affecting the operational results of this customs point.

The decrease in gas supply has led to the search for alternative energy sources, increasing imports of liquefied natural gas (LNG) from other suppliers. However, this has raised import costs and created uncertainty in energy supply, affecting key industries dependent on natural gas.

3. Value of Using a Business Intelligence Tool:

Conducting this analysis using a Business Intelligence (BI) tool like Power BI has provided significant advantages:

Flexibility: The ability to easily adjust and refine the analysis based on various parameters and filters allows for a more nuanced understanding of the data.

Customization: Users can tailor the analysis to their specific needs, focusing on the metrics and dimensions most relevant to their interests.

Rapid Response: Real-time data integration and the capability to quickly generate insights ensure timely and informed decision-making.

Accessibility: By making the analysis available through an interactive and user-friendly interface, we can democratize access to valuable trade insights, making them available to a broader audience beyond just specialists and policymakers.

In contrast to existing products, which often present data in a static and less accessible format, our BI-driven approach allows users to interact with the data dynamically. This interactivity enhances the user's ability to uncover insights and respond to emerging trends quickly, providing a significant competitive advantage.

5.2 Recommendations

1. Future Research:

Building upon the insights from our analysis, we propose several avenues for future research to deepen our understanding of Spain's international trade dynamics. These may include [specific recommendations here, e.g., exploring the impact of geopolitical factors on trade patterns, conducting in-depth sectoral analyses to identify growth opportunities, or examining the efficacy of trade policies in driving economic growth.

2. Expansion of the Predictive Model:

Incorporating more variables into the predictive model, such as global and regional macroeconomic data, will improve the accuracy of predictions and allow for better adaptation to changing economic conditions. This will include long-term trend analysis and the identification of seasonal patterns.

3.Strengthening Diversified Trade Relationships:

Spain should continue to diversify its export and import markets to reduce dependence on a few trading partners. This will mitigate the risks associated with political and economic tensions and ensure a steady supply of essential goods and services.

4. Improvement in Data Infrastructure:

Developing a more robust data infrastructure that allows real-time data integration will enhance responsiveness to rapid changes in international trade. This will include the implementation of advanced data collection and processing technologies.

5. Detailed Sectoral Analysis:

Conducting detailed sectoral studies to identify specific opportunities and challenges for each industry will help formulate more effective and targeted policies that promote growth and competitiveness in key sectors of international trade.

6. Education and Training:

Developing training programs for users to help them interpret and use data effectively. This can include tutorials, user guides, and ongoing support, ensuring that users make the most of the available analytical tools.

7. Sustainable Trade Policies:

Promoting policies that encourage sustainable and responsible trade practices. Adapting to the growing demands for sustainability in global trade will help maintain competitiveness and attract responsible investments.

8. International Collaboration:

Strengthening collaboration with international organizations and other countries to share best practices and data. This will improve the quality and effectiveness of trade analysis and facilitate access to international markets.

9. Technology and Innovation - Value of Business Intelligence (BI) Tools:

Adopting new technologies and analytical methodologies to continuously improve data collection, processing, and analysis. Keeping Spain at the forefront of international trade analysis will ensure the country is well-prepared to face future challenges.

In conclusion, our findings highlight the importance of detailed and adaptive analysis of Spain's international trade. The presented recommendations aim to enhance the understanding and management of trade dynamics, ensuring sustainable and balanced economic development. Leveraging a BI tool's capabilities, we can offer a more flexible, customizable, and accessible platform for analyzing and interpreting trade data, thereby supporting better decision-making and strategic planning.

6. Bibliography

1. Instituto Nacional de Estadística (INE). Spain's official statistics agency offering comprehensive trade data through monthly and annual reports.[4]

2. Instituto de Comercio Exterior (ICEX). Promotes Spanish exports and international investments providing detailed market studies and trade statistics.[5]

3. DataComex. Managed by the Spanish Secretary of State for Trade offering detailed international trade statistics and tools.[6]

4. Banco de España. The central bank of Spain providing economic and financial data including trade-related statistics.[7]

5. TradeMap by ITC. Developed by the International Trade Centre offering a global trade statistics database with detailed data.[8]

6. Euromonitor International. Provides detailed reports on trade activities market trends and forecasts for various sectors.[9]

7. Statista. Offers comprehensive data across numerous sectors with visual tools for easier interpretation.[10]

8. Fitch Solutions. Provides country risk and industry research including trade data through subscription-based services.[11]

9. Ministerio de Hacienda, España. Territorial series of monthly international trade statistics.[12]

[4] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[5] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[6] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[7] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[8] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[9] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[10] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[11] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.
[12] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

10. **Ministerio de Hacienda, España.** Combined nomenclature files.

11. **Microsoft Power BI Documentation**. Comprehensive guides and tutorials for using Power BI.[13]

12. **Microsoft Power Query Documentation**. Detailed information on using Power Query for data connection and transformation.[14]

13. **Microsoft DAX Reference**. Documentation and reference for Data Analysis Expressions (DAX) used in Power BI.[15]

14. **Microsoft M Language Reference.** Comprehensive guide to M language used in Power Query for data transformation.[16]

15. **Power View forecasting models.** Describing the forecasting models in Power View.[17]

[13] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

[14] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

[15] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

[16] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

[17] * All hyperlinks in this document refer to the relevant sections in the annex for detailed information.

7. Annex

7.1 Code Repository

Script for the transaction series transformation process in M:

```
let
// Step 1: Calling data with folder connector and invoking a custom function to access its content.
Source = Folder.Files("C:\Power BI projects\Estudio Evolucion Comercio Exterior\1. Inputs agencia tributaria\Series mensuales territoriales\datos"),
#"Filtered Hidden Files1" = Table.SelectRows(Source, each [Attributes]?[Hidden]? <> true),
#"Invoke Custom Function1" = Table.AddColumn(#"Filtered Hidden Files1", "Transform File (2)", each #"Transform File (2)"([Content])),
// Step 2: Automatic generated step to rename the column "Name" to "Source.Name" to show for each row the origin of itself. Very useful to create in DAX the Date Column
#"Renamed Columns1" = Table.RenameColumns(#"Invoke Custom Function1", {"Name", "Source.Name"})
// Step 3: Expanding the called data to display it as a data table
#"Removed Other Columns1" = Table.SelectColumns(#"Renamed Columns1", {"Source.Name", "Transform File (2)"}),
#"Expanded Table Column1" = Table.ExpandTableColumn(#"Removed Other Columns1", "Transform File (2)", Table.ColumnNames(#"Transform File (2)"(#"Sample File (2)"))),
// Step 4: Switching each column attribute to its correct type
 #"Changed Type" = Table.TransformColumnTypes(#"Expanded Table Column1",{{"Source.Name", type text}, {"AA ", type text}, {"F ", type text}, {"AD ", type text}, {"PR ", type text}, {"PA ", type text}, {"POSICION ", type text}, {"T", type text}, {" PESO (KG.) ", Int64.Type}, {"  UNIDADES    ", Int64.Type}, {"V.ESTADISTI  ", Int64.Type}, {"DF", type text}}),
// Step 5: Renaming Fields from its original name in the text files to intuitive and meaningful names
#"Renamed Columns" = Table.RenameColumns(#"Changed Type",{{"AA ", "Year"}, {"F ", "Flow"}, {"AD ", "Custom code"}, {"PR ", "Province code"}, {"PA ", "Country code"}, {"POSICION ", "Position"}, {"T", "Transportation code"}, {"  PESO (KG.) ", "Carried Weight (Kg)"}, {"  UNIDADES    ", "# Items"}, {"V.ESTADISTI  ", "Carried Value (€ Cents)"}, {"DF", "Tax Residence"}}),
 // Step 6: Next command lines are dedicated to replacing values from different columns to be clearer and more intuitive, or to change null values to unknown ones to also take them into account in the report
#"Replaced Value" = Table.ReplaceValue(#"Renamed Columns","E","Export",Replacer.ReplaceText,{"Flow"}),
#"Replaced Value1" = Table.ReplaceValue(#"Replaced Value","I","Import",Replacer.ReplaceText,{"Flow"}),
#"Replaced Value2" = Table.ReplaceValue(#"Replaced Value1",null,"Unknown",Replacer.ReplaceValue, {"Transportation code"}),
#"Replaced Value3" = Table.ReplaceValue(#"Replaced Value2","   ","Unknown",Replacer.ReplaceText,{"Custom code"}),
#"Replaced Value4" = Table.ReplaceValue(#"Replaced Value3","   ","Unknown",Replacer.ReplaceText,{"Province code"})
in
   #"Replaced Value4"
```

Script for the calendar table created in DAX:

```
Calendar Table =

// We use the DAX Addcolumns function together with the CALENDAR function to which we pass the beginning and end attributes of the date range.
ADDCOLUMNS (
CALENDAR ( DATE( YEAR ( MIN ( 'Transactions series'[Transaction date])), 01, 01), MAX( 'Transactions series'[Transaction date])),

// From here, using DAX functions, we create other columns whose values will be evaluated row by row for the specific value of the [Date] variable.
"DateSK", FORMAT ( [Date], "YYYYMMDD" ),
"#Year", YEAR ( [Date] ),
"#Quarter", QUARTER ( [Date] ),
"#Month", MONTH ( [Date] ),
"#Day", DAY ( [Date] ),
"Quarter", "Q" & FORMAT ( [Date], "Q" ),
"Month", FORMAT ( [Date], "MMMM" ),
"MonthShort", FORMAT ( [Date], "MMM" ),
"#WeekDay", WEEKDAY ( [Date],2 ),
"#YearWeek", WEEKNUM ( [Date],2 ),
"EndOfWeekDay", ( [Date] + 7 - WEEKDAY( [Date],2 ) ),
"Day", FORMAT ( [Date], "DDDD" ),
"DayShort", FORMAT ( [Date], "DDD" ),
"YearQuarter", FORMAT ( [Date], "YYYY" ) & "/T" & FORMAT ( [Date], "Q" ),
"Year#Month", FORMAT ( [Date], "YYYY/MM" ),
"YearMonthShort", FORMAT ( [Date], "mmm-YYYY" ),

// The following three columns are important for subsequent time analysis, since they will allow us to intuitively navigate between similar periods from previous years/months
"YearOffSet", (YEAR([Date]) - YEAR(TODAY())),
"MonthOffSet", (YEAR([Date]) - YEAR(TODAY()) ) * 12 + (MONTH([Date]) - MONTH(TODAY() )),
"QuarterOffSet", (YEAR([Date]) - YEAR(TODAY()) ) * 4 + (QUARTER([Date]) - QUARTER(TODAY() )))
```

Scripts for creating relevant measures used in the report in DAX:

```
# Transactions =


// Number of transactions
// This is a standard and initial calculation which will be used in different calculated measures.
// It only counts rows of the transaction series data table


COUNTROWS('Transactions series')
```

```
% Exports Freight vs Total =


// In this measure we calculate the percentage of the weight of exports under a filtering or selection context that will be determined by the user of the report, with respect to the total weight of exports.


// Internal variables are defined in the measure to improve performance and ease of code.


var ExportsFreightCountry = [Exports Freight (Kg)]
var TotalExports = CALCULATE([Exports Freight (Kg)], ALLSELECTED('Transactions series'))


RETURN
ExportsFreightCountry / TotalExports
```

```
Card_Evo_ExpVsImp_MoM/YoY/QoQ =


// This is an advanced measure that will give us functionality that is not included in the default functionalities that power bi has.
// We are going to calculate a measure that tells us, depending on the selected date filter context, which can be year, month or quarter, the variation of the specified variable with respect to the same previous time period.
//In this case, the variable that will be included in the dynamic calculation is the relationship between the value of exports and imports in a given period.




// First, we define the variables that store the value when the user performs a time filter
```

```
var selected_month_offset = SELECTEDVALUE('5 - Calendar Table'[MonthOffset])
var selected_year_offset = SELECTEDVALUE('5 - Calendar Table'[YearOffset])
var selected_qr_offset = SELECTEDVALUE('5 - Calendar Table'[QuarterOffSet])
var selected_months = COUNTROWS(VALUES('5 - Calendar Table'[MonthOffset]))

// Next, we define other local variables to store the value of our general variable in the
different time options before the selected date, and for the selected date as well
var previous_month = CALCULATE([Exported vs Imported Value (%)], FILTER(ALL('5 - Calendar
Table'), '5 - Calendar Table'[MonthOffset] = selected_month_offset - 1))
var previous_year = CALCULATE([Exported vs Imported Value (%)], FILTER(ALL('5 - Calendar
Table'), '5 - Calendar Table'[YearOffset] = selected_year_offset - 1))
var previous_qr = CALCULATE([Exported vs Imported Value (%)], FILTER(ALL('5 - Calendar
Table'), '5 - Calendar Table'[QuarterOffSet] = selected_qr_offset - 1))
var current_= [Exported vs Imported Value (%)]

// We calculate the evolution with the previously calculated variables
var evolution_MoM = (current_ - previous_month) / previous_month
var evolution_YoY =  (current_ - previous_year) / previous_year
var evolution_QoQ =  (current_ - previous_qr) / previous_qr

// We define the different possible scenarios through variables to be chosen in the return
later

var return_MoM = if(selected_month_offset,
    if(evolution_MoM>0, "+" & FORMAT(evolution_MoM, "0.0%"),
        if(evolution_MoM<0, FORMAT(evolution_MoM, "0.0%"))))

var return_YoY = if(selected_year_offset,
    if(evolution_YoY>0, "+" & FORMAT(evolution_YoY, "0.0%"),
        if(evolution_YoY<0, FORMAT(evolution_YoY, "0.0%"))))

var return_QoQ = if(selected_qr_offset,
    if(evolution_QoQ>0, "+" & FORMAT(evolution_QoQ, "0.0%"),
        if(evolution_QoQ<0, FORMAT(evolution_QoQ, "0.0%"))))

RETURN

// This conditional will return one of the previously calculated values based on what the
user and the context of the report have in selection at the given time.
```

```
if(HASONEVALUE('5 - Calendar Table'[MonthOffset]), return_MoM,
    if(HASONEVALUE('5 - Calendar Table'[YearOffset]) && selected_months = 12, return_YoY,
        if(HASONEVALUE('5 - Calendar Table'[QuarterOffSet]) && selected_months = 3,
return_QoQ,"")))
```

```
Card_Evo_Transactions_SPLY =

// This is an advanced measure that will give us functionality that is not included in the
default functionalities that power bi has.

// We are going to calculate a measure that tells us, depending on the selected date filter
context, which can be month or quarter, the variation of the specified variable with
respect to the same previous time period.

//In this case, the variable that will be included in the dynamic calculation is the
relationship between the number of transactions in a given period.

// First, we define the variables that store the value when the user performs a time
filter:
var selected_month_offset = SELECTEDVALUE('5 - Calendar Table'[MonthOffset])
var selected_qr_offset = SELECTEDVALUE('5 - Calendar Table'[QuarterOffSet])

// Next, we define other local variables to store the value of our general variable in the
different time options before the selected date, and for the selected date as well
var previous_year_month = CALCULATE([# Transactions], FILTER(ALL('5 - Calendar Table'),
'5 - Calendar Table'[MonthOffset] = selected_month_offset - 12))
var previous_year_qr = CALCULATE([# Transactions], FILTER(ALL('5 - Calendar Table'), '5 -
Calendar Table'[QuarterOffSet] = selected_qr_offset - 4))
var current_ = [# Transactions]

// Next local variable will help us to know if the date period selected is a whole month
of three months. The returned value of the measure will depend on this one.
var selected_months = COUNTROWS(VALUES('5 - Calendar Table'[MonthOffset]))

// We calculate the evolution with the previously calculated variables
var evolution_SMLY = (current_ - previous_year_month) / previous_year_month
var evolution_SQLY = (current_ - previous_year_qr) / previous_year_qr
```

```
// We define the different possible scenarios through variables to be chosen in the return
later
var return_SMLY = if(selected_month_offset,
    if(evolution_SMLY>0, "+" & FORMAT(evolution_SMLY, "0.0%"),
        if(evolution_SMLY<0, FORMAT(evolution_SMLY, "0.0%"))), "")

var return_SQLY = if(selected_qr_offset,
    if(evolution_SQLY>0, "+" & FORMAT(evolution_SQLY, "0.0%"),
        if(evolution_SQLY<0, FORMAT(evolution_SQLY, "0.0%"))), "")

RETURN
// This conditional will return one of the previously calculated values based on what the
user and the context of the report have in selection at the given time.
if(selected_month_offset, return_SMLY,
    if(selected_qr_offset && selected_months = 3, return_SQLY, ""))
```

```
Forecast Metric =

// This calculated measurement is also relevant for one of the functionalities that have
been developed in this academic work.
// Through a dynamic measurement, we are going to return a calculation made that is linked
to a selection that the user has made in a slicer.
// It will be explained in future sections, but it will provide the user with a time series
and prediction of the variable they select.

var number_of_trans = [# Transactions]
var value_of_trans = [Transactions Value (€)]
var transactions_freight = [Transactions Freight (Kg)]
var avg_transaction_value = [Avg Transaction Value (€)]
var avg_transaction_freight = [Avg Transaction Freight (Kg)]
var pge_transaction_vs_total = [% Num. of Transactions versus Total]

var metric_selected = SELECTEDVALUE('Forecast Metrics'[Forecast Metric])

RETURN

if (metric_selected = "Number of Transactions", number_of_trans,
    if (metric_selected = "Value of Transactions (€)", value_of_trans,
        if (metric_selected = "Transactions Freight (Kg)", transactions_freight,
```

```
            if (metric_selected = "Average Transaction Value (€)", avg_transaction_value,
                if (metric_selected = "Average Transaction Freight (Kg)",
avg_transaction_freight,
                    if (metric_selected = "% of Transactions vs Total",
pge_transaction_vs_total
                    ))))))
```

7.2 Links and cited sources

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3. Combined Nomenclature Files - Spanish Treasury: https://sede.agenciatributaria.gob.es/Sede/en_gb/estadisticas/estadisticas-comercio-exterior/nomenclatura-combinada.html
4. Instituto Nacional de Estadística (INE) - Spain's official statistics agency offering comprehensive trade data through monthly and annual reports: https://www.ine.es/
5. Instituto de Comercio Exterior (ICEX) - Promotes Spanish exports and international investments providing detailed market studies and trade statistics: https://www.icex.es/
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16. Microsoft DAX Reference - Documentation and reference for Data Analysis Expressions (DAX) used in Power BI: https://docs.microsoft.com/en-us/dax/
17. Microsoft M Language Reference - Comprehensive guide to M language used in Power Query for data transformation: https://docs.microsoft.com/en-us/powerquery-m/
18. Power View Forecasting Models - Describing the forecasting models in Power View: https://powerbi.microsoft.com/en-us/blog/describing-the-forecasting-models-in-power-view/