Comparative Analysis of Manufacturing and Services Sectors Across Selected European Countries (2013-2020)

1. Introduction:

The project analyzes the performance of the manufacturing and service sectors across selected European countries between 2013 and 2020. The objective is to compare growth, average economic value and volatility across countries and sectors using structured data analysis and visualisation techniques.

Manufacturing and Services were chosen because they represent the two core pillars of any economy. Manufacturing supports exports, employment and industrial capacity while services drive digitalisation, financial activity and modern economic expansion.

A balanced economy requires a strong foundation in both sectors. Overdependency on only one can restrict long-term growth - an insight supported by global economic research, including Indian Economy analyses.

The aim of this project is to identify:

- Country-wise performance patterns
- Sector-wise differences in stability and growth
- Overall growth trajectories
- Economic maturity and volatility across regions.

This helps in understanding market strength, economic resilience and long-term competitiveness

2. Data Sources:

The datasets used in this project were extracted from Eurostat - structural business statistics, specifically:

1. Eurostat (Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) (2005-2020)
   Dataset ID: sbs_na_ind_r2
2. Annual detailed enterprise statistics for services(NACE Rev. 2, N-H) (2005-2020)
   Dataset ID: sbs_na_1a_se_r2.

- These data sets include financial and operational indicators over multiple years.

selected countries over multiple years from 2013 to 2020.
After cleaning and processing, the final combined dataset contains 37 Rows and 7 columns with the following key variables:

- Country
- Category Enterprise, Turnover, Production Value)
- Avg_growth_percent
- Avg_value
- Volatility_Range

- Overall_growth_Percent
- Sector (Manufacturing/Services)

☐ The Countries selected:
- Italy, Germany, Spain, Sweden, Netherlands, and France .

☐ These countries were included because:
1. The Eurostat dataset contained complete and consistent muti-year data only for these countries.
2. They represent major European economies with sufficient data for comparison
3. They provide a meaningful diversity of industrial and services structures.

3. Tools & Technologies used:
- SQL(SQLite) - Data querying, KPI, Calculations
- Python(Pandas, Numpy, Matplotlib, seaborn) - EDA and Visualisations
- Google Colab - Python execution environment
- Excel and Google sheets - Data cleaning and transformation
- Github - Version control and Project storage

This toolset was chosen to ensure end-to-end coverage of data cleaning, analysis, visualisation and reproducibility

4. Methodology:
4.1 Data Cleaning and Preparation:

After extracting the raw data:
1. Filtered the dataset to include only the six selected countries
2. Unpivoted all sheets(for both manufacturing and services) using google sheets functions: ARRAYFORMULA, FLATTEN and SPLIT.
3. Ensured that all six sheets (Enterprise, Turnover, Production value for both sectors) contained no duplicates, no missing values and no blanks.
4. Saved each cleaned sheet in CSV format.

4.2 SQL Analysis:

SQL was used because:
1. The project involved structured date
2. Required relationship-based calculations
3. Needed consistent, transparent KPI computation

- Key Performance Indicators(KPIs):

  For each sheet, following KPIs were computed:
  1. **Avg_growth(%)**
  2. **Avg_value**
  3. **Volatility_Range**
  4. **Overall_growth(%)**

☐ A total of 6 sheets x 4 KPIs = 24 SQL outputs were generated.

☐ In next steps:

1. All three manufacturing sheets were merged into Manufacturing_Master
2. All three services sheets were merged into Services_Master
3. Both Master sheets were stored as CSV for further analysis.

4.3 Python Analysis:

☐ Python was chosen for its:

- Simplicity in data manipulation
- Strong visualisation libraries
- Ease of Combining datasets

☐ Steps performed:

1. Imported both master CSV files.
2. Verified data quality(duplicates, missing values).
3. Added a sector column in each sheet
4. Combined both sheets into a final dataframe fianl_df
5. Exported the combined dataset for reporting
6. Created comparison charts for four KPIs
    - Overall Growth (%)
    - Average value
    - Volatility Range
    - Average Growth (%)

These charts provided clear cross-sector and cross-country comparisons.

4.4 Descriptive Statistics and Exploratory Data Analysis (EDA):

Using Python (Pandas, Matplotlib, Seaborn), the following analyses were conducted:

1. Summary Statistics
   Revealed variations, skewness and standard deviations across key metrics.
2. Distribution Analysis (Histogram)
   Displayed right-skewed turnover and production value distributions.
3. Outlier Detection (Boxplots)
   Identified economies with unusually high or volatile performance
4. Correlation Heatmap
   Displayed relationship between production, turnover, volatility and growth.
5. Country Rankings (Bar charts)
   Ranked countries by each KPI.

This stage provided foundational insights into structural economic differences.

5. Descriptive statistics and Exploratory Data analysis(EDA):

- In this stage, descriptive analytical techniques were applied to understand the structure and behaviour of the combined manufacturing and services data sets. Using Python(Pandas, Matplotlib, Seaborn), multiple statistical summaries and visualisations were generated.
- Revenue trends were analysed across years to observe country-wise growth patterns. Volatility patterns were examined using the volatility index derived from

SQL Calculations, helping identify countries with stable vs. fluctuating performance. Growth analysis visualised annual percentage growth for each country, highlighting positive and negative periods.

- A correlation Matrix was also generated to study the relationship between variables such as revenue, growth, enterprise count and production value. This provided insights into which metrics move together and which are independent.

☐ **Exploratory Data Analysis (EDA)**

The cleaned and integrated dataset was analyzed using python to understand data distribution, volatility, magnitude differences, and relative standing of countries across key indicators. The dataset included variables such as:

1. Average Growth(%)
2. Average Enterprise count
3. Average Turnover
4. Average Production Value
5. Volatility (Enterprise, Turnover and production value)
6. Overall Growth(%)

The following analyses were performed:

1. Summary Statistics:

   Descriptive statistics revealed:

   - Large variation between countries in turnover and production value
   - High standard deviation in turnover, indicating uneven economic concentration.
   - Growth percentages had a mix of positive and negative values, confirming fluctuating performance across countries and sectors.

This step gave a clear idea of which variables have the most spread, indicating potential volatility or market inequality.

2. Distribution Analysis(Histograms):

   Histograms showed:

- Turnover and Production value were right-skewed, that means a small number of high - performing countries dominate the sector.
- Growth rate distributions were concentrated around small positive or negative values. which indicates that large year-over-year changes are rare.
- Enterprise count distribution was moderately spread, with a few countries having significantly more enterprises than the rest.

This confirms that the performance is not evenly distributed across countries.

3. Outlier Detection(Boxplots)

   Boxplots revealed:

   - Both manufacturing and services turnover contain outliers - countries that dramatically outperform others.
   - Growth percentage had fewer outliers, meaning growth fluctuations are more consistent across countries.
   - Production value had the highest outlier concentration, confirming that a few economies dominate production output.

These outliers correspond to countries such as Germany, Italy and Netherlands as identified by SQL analysis.

4. Correlation Analysis(Heatmap)
   Correlation Heatmap findings are:

- Turnover and production value show strong positive correlation, meaning higher production generally reflects higher revenue.
- Growth percentage correlates weakly with enterprise count, meaning more enterprises do not guarantee higher growth.
- Volatility measures have moderate correlation with turnover - countries with high revenue often show higher fluctuations.

These patterns help identify stable vs unstable economies.

5. Cross-Country Ranking(Bar Charts)

Top performing countries differ by metric:

- Highest Turnover - Italy, Germany, Netherlands
- Highest Average Enterprise Count - Italy, Spain, Netherlands
- Highest Production Value - Italy, Germany, Netherlands
- Highest Overall Growth - Germany and Sweden(with mainly positive performance)

Lower-tier countries showed negative growth and lower enterprise counts.

Key Observations:

- A small cluster of countries dominate the agritech activity.
- Most countries show mixed or negative growth, confirming sector instability.
- Turnover and production output tend to rise together
- Enterprise base does not automatically translate into high revenue or strong growth.

Conclusion for EDA Analysis:

- EDA confirms the presence of strong economic concentration, mixed growth signals and structural differences between countries.

6. Interpretation and Insights:

- The combined analysis of manufacturing and services sectors produced several actionable insights based on enterprise count, turnover, production value, growth percentage and volatility. These insights capture both sector-level and country-level performance.

1. Sector-level Insights:

   1.1 Manufacturing sector

   - Shows strong concentration in a few European economies such as Italy, Germany and Netherlands.
   - Growth patterns are mixed, with many countries showing negative or inconsistent YOY growth.
   - Production value is extremely uneven, indicating unequal industrial capability across countries.
   - Turnover volatility is higher indicating the manufacturing sector is more sensitive to economic cycles.

1.2 Services sector:

- More Stable performance overall
- Lower volatility patterns compared to manufacturing
- Growth percentages are more evenly distributed
- Fewer extreme outliers, indicating the service sector is more balance across countries.

2. Country-level Insights:

2.1 Top performers:

a. Germany:

- Most consistent across turnover, growth and production metrics.
- Strong industrial base and stable performance.

b. Italy:

- Highest turnover and production value but more volatility
- High output but less stable

c. Netherlands:

- High Performance in enterprise count and turnover
- Strong services and manufacturing mix.

2.2 Mid-Performers (moderate performance with low volatility):

1. Sweden
2. Spain

2.3 Low-Negative Performers:

a. Countries around the EU periphery show more negative and lower turnover.

3. Cross-sector Comparison:

- Manufacturing has higher revenue concentration but lower stability
- Services (specifically ITC related) show better balance across countries and lower volatility.
- Countries strong in manufacturing tend to also lead in services turnover, indicating a connection between overall economic infrastructure and sector performance.

4. Growth Insights:

- Germany and Sweden show the most positive long-term growth trends.
- Many countries show negative growth values across both sectors, indicating market contraction or structural challenges.
- Service sector growth is more uniform with fewer extreme variations.

5. Volatility Insights:

- Italy and Netherlands show high turnover and Production volatility, meaning despite strong revenue, they face unpredictable cycles.
- Stable markets(Germany, Sweden) show lower volatility, indicating predictable performance.

This is valuable for economic planning and investment decisions as stability is as important as volume.

Summary of Interpretation:

- Manufacturing is a high-value, high-volatility sector dominated by a few strong countries.
- Services are more stable and balanced across Europe.
- Germany is the most consistent and resilient economy.
- Italy and the Netherlands are high-performing but highly volatile.
- Enterprise count alone does not drive growth as the revenue and production value matter more.
- Growth trends are Mixed, with several countries facing Contraction, especially in manufacturing.

7. Conclusion of Project:

- The combined analysis of manufacturing and services data reveals strong structural differences across European economies. Manufacturing shows higher revenue concentration but greater volatility, indicating that only a few economies like Germany, Italy and Netherlands have the industrial depth necessary to sustain consistently high production and turnover.
- In contrast, the services sector displays better balance and lower volatility, suggesting a wider distribution of services sector capabilities across countries.

☐ The summary statistics, distribution patterns, and correlation insights collectively show that countries with higher production capabilities tend to achieve higher revenue, but this does not directly indicate growth. Growth rates remain mixed, with several countries facing contractions. Stability or low volatility emerges as a key indicator of economic resilience, particularly in countries like Germany and Sweden.

☐ Overall, the analysis highlights the interdependency between enterprise activity, production output and economic stability, indicating that high economic value is not always aligned with growth. This multi-metric approach provides a clearer understanding of sectoral strengths and the competitive landscape across Europe.

8. Recommendations and Future scope of this Project:

☐ Recommendations Based on the findings:

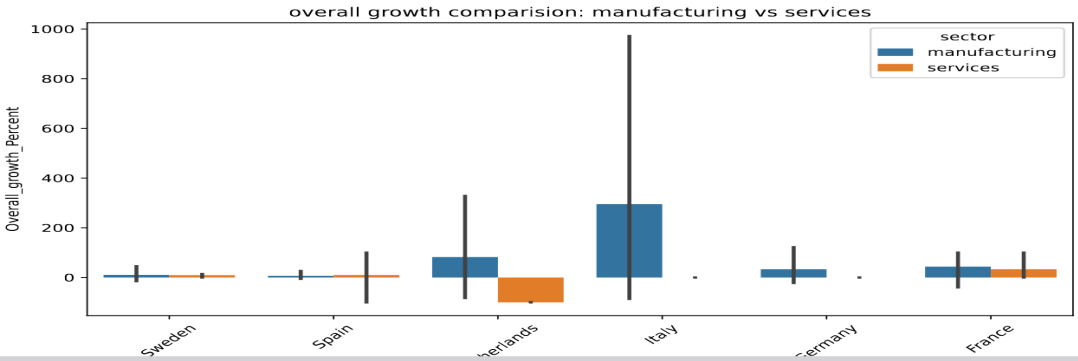
- Focus on High-stability Markets:
  Countries like Germany and Sweden demonstrate strong, consistent performance and low volatility.These markets are attractive for long-term investment and policy planning.
- Monitor High-value but volatile Markets
  Italy and the Netherlands generate strong revenue but show higher fluctuations. These countries require adaptive strategies and risk mitigation.
- Strengthen Underperforming Markets
  Countries with mixed or negative growth trends can be stabilized by enhancing digital infrastructure, enterprise support and innovation-driven policies.
- Encouraging cross-sector synergy
  Since services show more stability, integrating service-driven strategies into manufacturing can improve resilience.

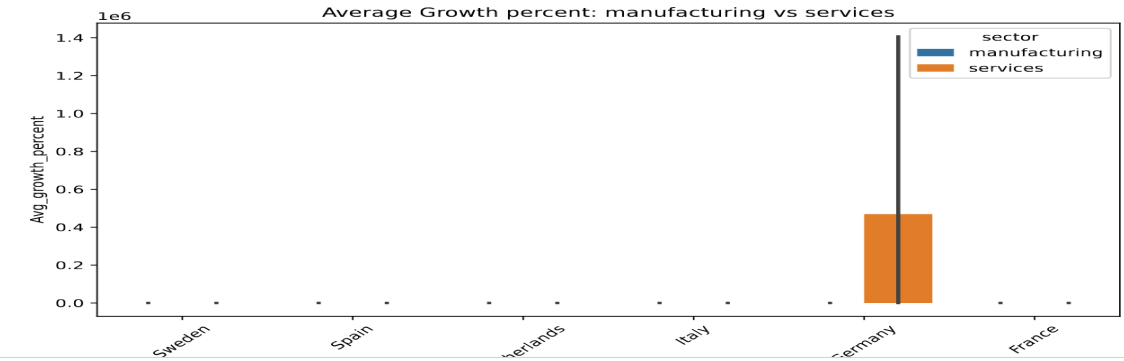
- [ ] Future Scope of the Project:

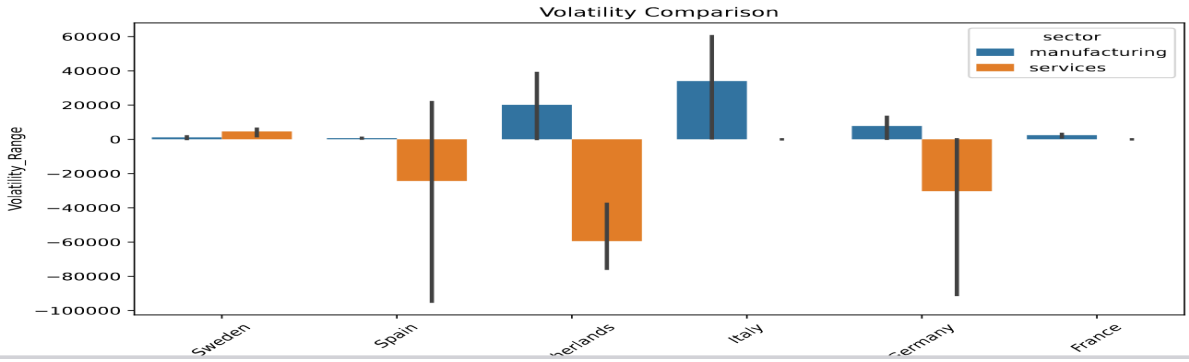
  If expanded further, this project can be enhanced in several ways like:

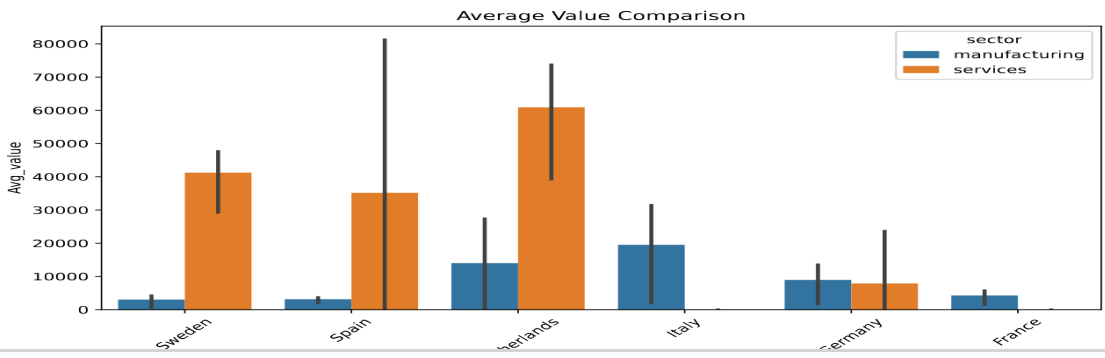
  1. Time-Series Forecasting:
     Build forecasting models to predict future growth and turnover trajacetroy (ARIMA/Prophet)
  2. Cluster Analysis:
     Group countries into clusters (high-stable, high-growth, volatile, emerging) to better understand strategic positioning.
  3. Machine Learning Classification:
     Train models to predict which countries are likely to exhibit high enterprise growth based on turnover, production and volatility metrics.
  4. Dashboarding and BI expansion:
     Create interactive dashboards in PowerBI or Tableau for policymakers or stakeholders.
  5. Sector-Specific Deep Dive:
     Spit manufacturing into sub-sectors like chemicals, automotive, machinery and analyze deeper patterns.

Appendix: Charts and Visualizations





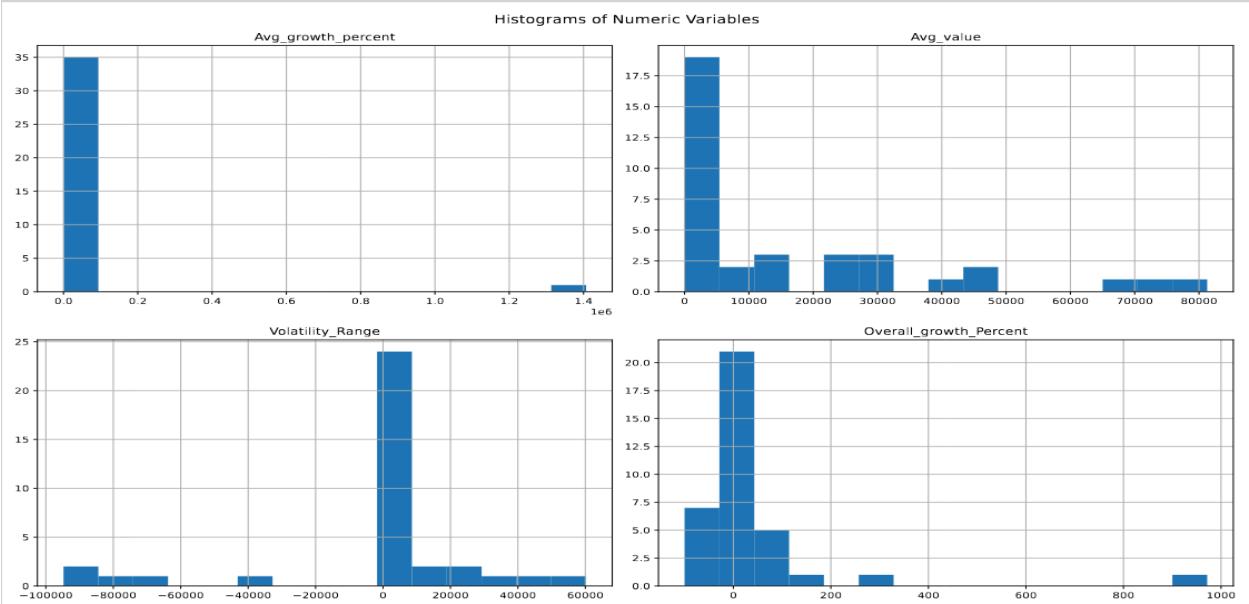


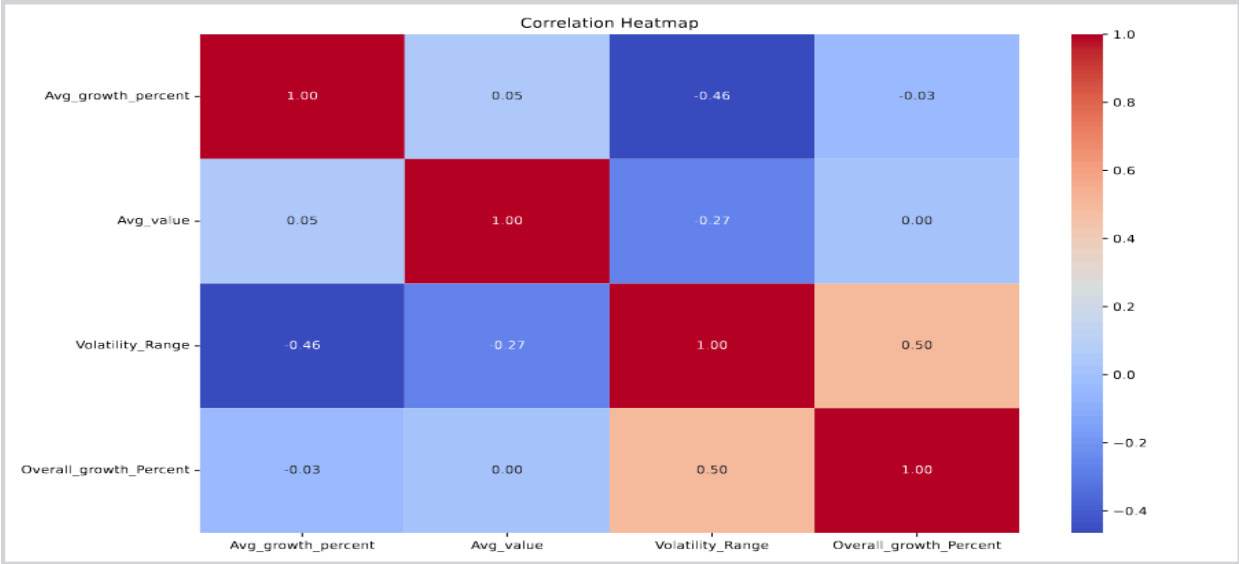


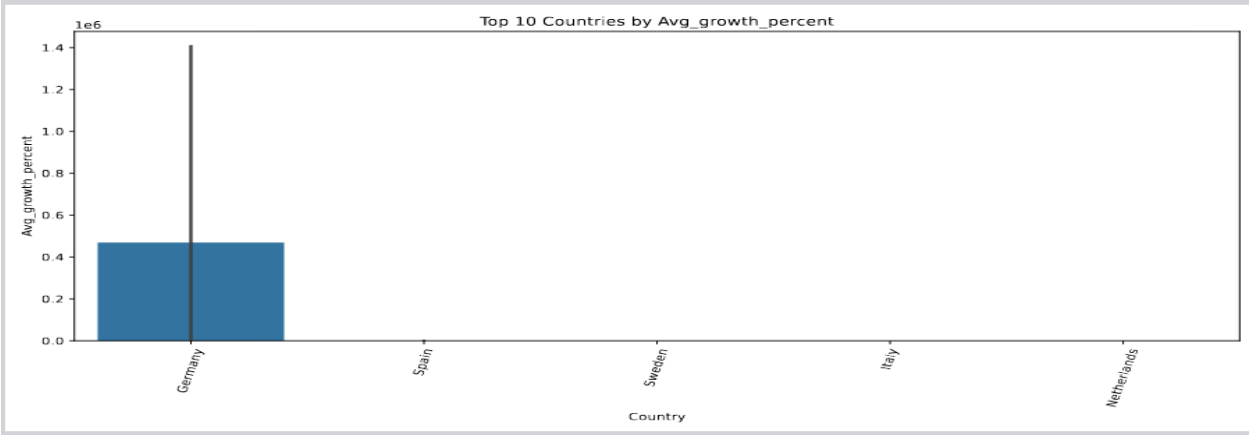
EDA Analysis:

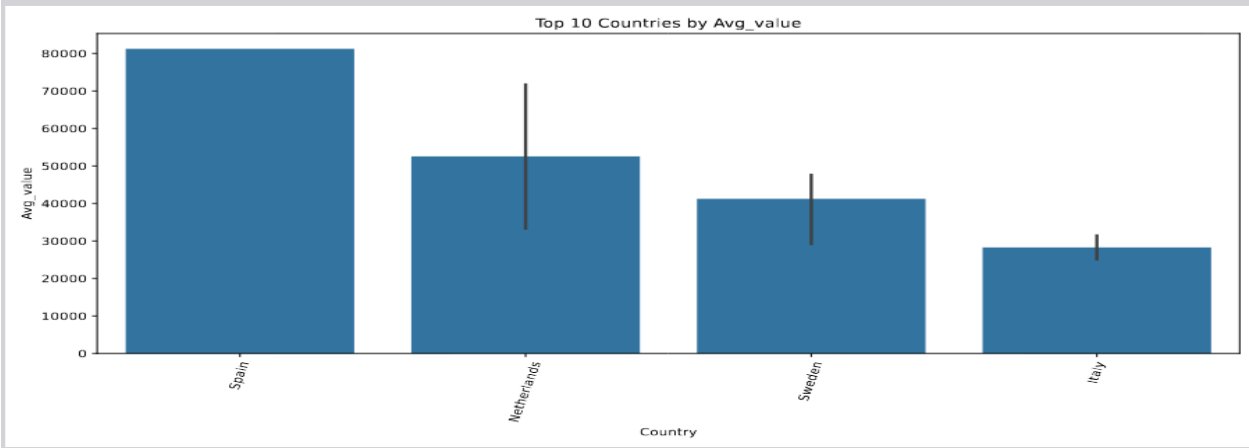
Summary Statistics

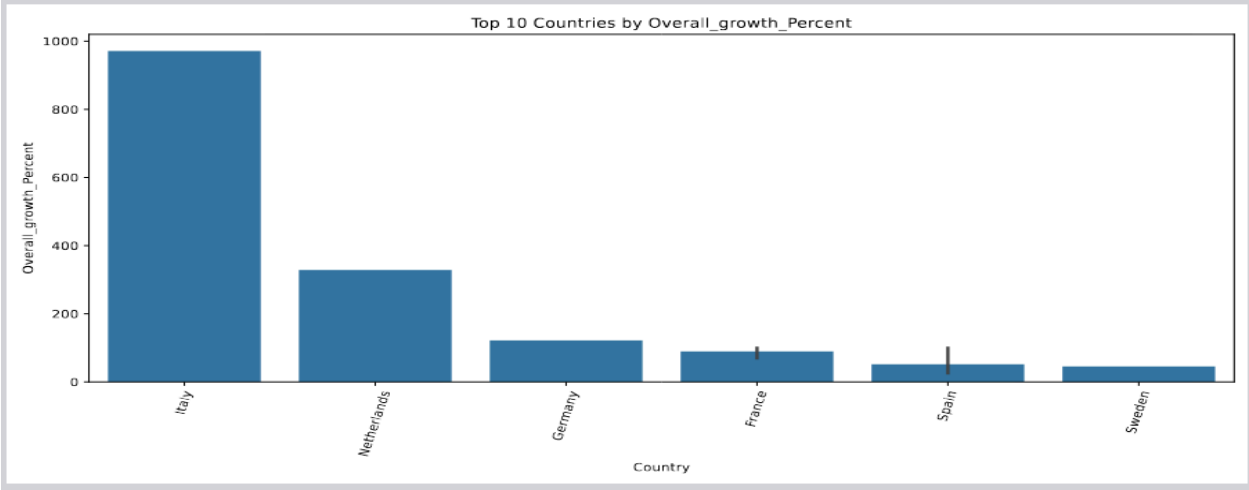
	Avg_growth_percent	Avg_value	Volatility_Range	Overall_growth_Percent
count	36.0	36.0	36.0	36.0
mean	39078.45444444445	16513.792499999996	-3584.675	35.28944444444445
std	234488.6650712425	22758.116734769144	32196.263226772797	178.65871055402084
min	-20.62	1.0	-94769.2	-100.0
25%	-2.4125	368.1575	0.0	-7.52
50%	0.0	4215.6849999999995	497.5	0.0
75%	0.0	25658.329999999998	3871.275	26.9125
max	1406929.0	81271.5	60239.8	971.64






Top 10 Countries by Avg_growth_percent
1e6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Avg_growth_percent
Germany
Spain
Sweden
Italy
Netherlands
Country


Top 10 Countries by Avg_value
80000
70000
60000
50000
40000
30000
20000
10000
0
Avg_value
Spain
Netherlands
Sweden
Italy
Country


Top 10 Countries by Overall_growth_Percent
1000
800
600
400
200
0
Overall_growth_Percent
Italy
Netherlands
Germany
France
Spain
Sweden
Country