**France (euro)**

CAC Technology Financial index (FRTEC) : 35 entreprises cotées en bourse

CAC Health Care Financial index (FRHC) : 40 entreprises cotées en bourse

CAC Financials Financial index (FRFIN) : 39 entreprises cotées en bourse

CAC Industrials Financial index (FRIN) : 60 entreprises cotées en bourse

CAC Energy Financial index (FROG) : 12 entreprises cotées en bourse

CAC Real Estate Financial index (FRRE) : 42 entreprises cotées en bourse

CAC Telecom (FRTEL) : 6 entreprises cotées en bourse

**Allemagne (euro)**

DAX Technology (CXPHX) : 18 entreprises cotées en bourse

DAX Pharma + HealthCare (CXPPX) : 31 entreprises cotées en bourse

DAX Financials (CXPVX) : 29 entreprises cotées en bourse

DAX Industrials (CXPNX) :64 entreprises cotées en bourse

DAX Energy (DAXAE) : 16 entreprises cotées en bourse

DAX Telecom (CXPTX) : 7 entreprises cotées en bourse

**Suisse (swiss franc)**

SWX Technology (C9500T) : 10 entreprises cotées en bourse

SWX Health Care (C4500T) : 33 entreprises cotées en bourse

SWX Financials (C8700T) : 33 entreprises cotées en bourse

SWX Industrials (C2700T) : 52 entreprises cotées en bourse

SWX Telecom (C6500T) : SwissCom AG

**Portugal (euro)**

PSI Technology (PTTEC) : 3 entreprises cotées en bourse

PSI Financials (PTFIN) : 2 entreprises cotées en bourse

PSI Industrials (PTIN) : 6 entreprises cotées en bourse

PSI Telecom (PTTEL) : 4 entreprises cotées en bourse

**Variables Macroéconomiques**

**PIB réel** : Le PIB réel ajuste le PIB nominal pour tenir compte des variations des prix, fournissant ainsi une mesure plus précise de la production économique réelle.

**10Y Bond yield** : reflètent le coût d'emprunt à long terme pour les gouvernements.

**Inflation** : peut affecter les coûts de production et les marges bénéficiaires des entreprises technologiques.

**Euro/dollar** : Si le secteur que vous étudiez est sensible aux fluctuations du taux de change euro-dollar, il peut être pertinent de l'inclure comme variable explicative dans votre analyse.

**CHF/Euro** : les secteurs suisses sont peut-être sensibles à ces taux d’intérêts

**CHF/Dollar** : les secteurs suisses sont peut-être sensibles à ces taux d’intérêts

**Consumer confidence indicator** : pour mesurer la confiance des consommateurs dans l'économie. Il est basé sur des enquêtes menées auprès des ménages et vise à évaluer leur perception de la situation économique actuelle et future, ainsi que leur disposition à dépenser.

**Business confidence indicator** : est un outil utilisé pour évaluer le sentiment des entreprises à l'égard de l'économie. Il mesure généralement le degré de confiance des entreprises dans la situation économique actuelle et future, ainsi que leurs perspectives de croissance et d'investissement.

**Taux de chômage :** c’est bon

**Marche à Suivre :**

1. Analyse des Tendances Intra-pays :

- Comparez les indices boursiers des différents secteurs au sein d'un même pays pour identifier les tendances (graphiques) et les forces et les faiblesses de chaque économie nationale. Examinez les événements historiques qui ont influencé ces indices.

1. \*\*Exploration des données : Commencez par explorer les données des indices boursiers pour chaque pays. Visualisez les séries chronologiques, examinez les variations dans les valeurs des indices au fil du temps et identifiez les événements majeurs qui ont pu avoir un impact sur les marchés.

2. \*\*Comparaison intra-pays : Comparez les performances des indices boursiers de chaque pays pour identifier les similitudes et les différences. Examinez les secteurs qui ont été les plus influents dans chaque pays et identifiez les raisons possibles de ces variations.

3. \*\*Analyse descriptive : Effectuez une analyse descriptive pour chaque pays en calculant des statistiques telles que la moyenne, l'écart type, le minimum et le maximum des indices boursiers. Identifiez les périodes de volatilité, de stabilité et de tendances marquées.

2. Comparaison Inter-pays par Secteur :

- Analysez les indices boursiers de secteurs similaires dans différents pays pour déterminer les différences de performance.

3. Impact des Événements Économiques :

1. **Analyse Exploratoire** : Effectuez une première régression uniquement avec les variables binaires pour comprendre les tendances générales.
2. **Ajout des Variables Macroéconomiques** : Ajoutez ensuite les variables macroéconomiques pour une analyse plus précise et pour contrôler les effets confondants.

- Étudiez l'impact des événements économiques et politiques sur les indices boursiers. (Sélectionnez des événements spécifiques et étudiez comment ils ont influencé les mouvements des indices boursiers : les politiques fiscales, les taux d'intérêt, les crises économiques ou sanitaires)

Vous pouvez créer des modèles de régression qui intègrent des variables explicatives telles que les annonces économiques, les politiques gouvernementales, les facteurs macroéconomiques, etc.

Analysez les séries temporelles des indices boursiers avant et après les événements économiques pour détecter les changements de tendance, les fluctuations de volatilité et les réponses des marchés. Utilisez des outils statistiques pour identifier les relations causales entre les événements et les mouvements des marchés.

5. Analyse de Sensibilité :

- Réalisez une analyse de sensibilité pour comprendre comment les variables macroéconomiques (taux de change, inflation, croissance économique) influencent les indices boursiers. (L’analyse de Monte Carlo pour évaluer l'impact de multiples variables simultanément)

Pour conserver l'effet des événements économiques dans une analyse de sensibilité des indices boursiers, vous pouvez procéder comme suit :

Intégrez les événements économiques dans votre modèle d'analyse de sensibilité en tant que variables explicatives supplémentaires. (Variables binaires pour indiquer si un événement particulier s'est produit pendant une période donnée)

Assurez-vous de maintenir les événements économiques constants pendant chaque scénario de sensibilité que vous testez.

Utilisez des techniques d'analyse de séries temporelles pour identifier les tendances à long terme, les cycles et les variations saisonnières dans les indices boursiers de chaque pays. Vous pouvez ajuster des modèles de régression linéaire ou exponentielle pour capturer ces tendances.

\*\*Mesure de l'effet des événements économiques :\*\* En plus d'analyser la sensibilité des indices aux variations des paramètres du modèle, vous pouvez également évaluer l'effet spécifique des événements économiques en observant comment les variations de ces variables supplémentaires influencent les résultats du modèle.

6-Prévisions et modèle prédictif :

Utilisez des modèles économétriques ou d'apprentissage automatique pour prévoir les tendances futures des indices boursiers. Élaborez des scénarios hypothétiques basés sur les prévisions pour évaluer les performances potentielles des investissements.

### Marche à Suivre avec Combinaison des Méthodes pour un Modèle de Prédiction Final :

- \*\*Machines à Vecteurs de Support (SVM)\*\* :

- Utilisez les SVM pour identifier les tendances complexes.

- \*\*Clustering\*\* :

- Identifiez les tendances communes et groupes d'indices similaires.

3. \*\*Combinaison des Méthodes\*\* :

- \*\*Stacking\*\* :

- Créez des méta-modèles qui utilisent les prédictions d'autres modèles (régression linéaire, SVM, etc.) comme nouvelles caractéristiques.

- \*\*Ensembles\*\* :

- Utilisez des méthodes d'ensemble comme le `RandomForest` ou `GradientBoosting` pour améliorer la robustesse.

- \*\*Recherche des Hyperparamètres\*\* :

- Effectuez une recherche d'hyperparamètres avec des techniques comme `GridSearchCV` ou `RandomizedSearchCV`.

4. \*\*Analyse de Sensibilité\*\* :

- \*\*Modélisation des Scénarios\*\* :

- Créez des scénarios hypothétiques en faisant varier les variables macroéconomiques.

- \*\*Simulation de Monte Carlo\*\* :

- Effectuez des simulations de Monte Carlo pour évaluer l'impact simultané de multiples variables.

- \*\*Événements Économiques\*\* :

- Ajoutez les variables binaires des événements économiques dans vos modèles.

5. \*\*Analyse des Séries Temporelles\*\* :

- \*\*Identification des Tendances\*\* :

- Identifiez les tendances à long terme et les cycles économiques en utilisant les modèles ARIMA ou SARIMA.

- \*\*Variations Saisonnières\*\* :

- Appliquez des méthodes de décomposition pour analyser les variations saisonnières.

6. \*\*Prévision des Tendances Futures\*\* :

- \*\*Modèles Économétriques ou Apprentissage Automatique\*\* :

- Utilisez les modèles ARIMA, les réseaux neuronaux, ou les arbres de décision pour prévoir les tendances futures.

- \*\*Scénarios Hypothétiques\*\* :

- Élaborer des scénarios basés sur ces prévisions pour évaluer les performances potentielles.

- \*\*Validation des Modèles\*\* :

- Évaluez les modèles en utilisant des métriques comme RMSE, MAE, ou R².

7. \*\*Combinaison pour le Meilleur Modèle de Prédiction Final\*\* :

- \*\*Comparaison des Modèles\*\* :

- Comparez les performances de chaque modèle individuel (SVM, régression, etc.).

- \*\*Stacking et Blending\*\* :

- Combinez les meilleurs modèles dans un méta-modèle (stacking ou blending).

- \*\*Validation Croisée\*\* :

- Effectuez une validation croisée pour déterminer la performance réelle du méta-modèle final.

- \*\*Ajustement des Hyperparamètres\*\* :

- Optimisez le méta-modèle final en affinant les hyperparamètres.

### Conclusion :

En combinant plusieurs méthodes, vous pourrez créer un modèle final robuste et précis pour les prévisions des tendances futures des indices boursiers. Assurez-vous que le modèle final soit bien validé et adapté aux variations des variables macroéconomiques et des événements économiques.

Voici une démarche à suivre pour élaborer un modèle prédictif pour chaque indice boursier en utilisant différentes techniques :

3. \*\*Support Vector Machines (SVM)\*\* :

- Appliquez les SVM pour identifier des tendances complexes en régression.

### Étape 4 : Analyse de Sensibilité et Clustering

1. \*\*Simulation de Monte Carlo\*\* :

- Simulez l'impact des variations des variables macroéconomiques sur les indices.

2. \*\*Clustering\*\* :

- Effectuez un clustering (K-Means ou Gaussian Mixture Models) pour regrouper les indices similaires et identifier des tendances communes.

### Étape 5 : Modèles Avancés et Ensembles

1. \*\*Ensemble Learning (Random Forests, Boosting)\*\* :

- Utilisez des méthodes d'ensemble pour obtenir un modèle plus robuste.

2. \*\*Neural Networks et LSTM\*\* :

- Testez des modèles de réseaux de neurones (MLP) ou LSTMs pour capturer les tendances à long terme et les séquences temporelles.

3. \*\*Gaussian Process Regression\*\* :

- Appliquez des Gaussian Process pour capturer la nature probabiliste des tendances et des prédictions.

### Étape 6 : Validation et Évaluation

1. \*\*Validation Croisée\*\* :

- Utilisez des techniques comme le K-fold ou le rolling window pour évaluer la robustesse des modèles.

2. \*\*Combinaison des Modèles\*\* :

- Utilisez des techniques comme le stacking pour combiner les prédictions de plusieurs modèles.

3. \*\*Sélection du Modèle Final\*\* :

- Comparez les modèles en utilisant des métriques comme RMSE, MAE, et R².

- Choisissez le modèle ou la combinaison de modèles qui présente les meilleures performances pour chaque indice boursier.

### Étape 7 : Prédiction et Scénarios

1. \*\*Prédictions Futures\*\* :

- Utilisez le modèle final pour prédire les tendances futures de chaque indice.

- Effectuez des prédictions sous différents scénarios économiques.

2. \*\*Scénarios Hypothétiques\*\* :

- Créez des scénarios hypothétiques en faisant varier les variables macroéconomiques et les événements économiques.

- Évaluez l'impact potentiel sur les indices boursiers.

En suivant cette démarche, vous pouvez élaborer un modèle prédictif pour chaque indice boursier tout en assurant une analyse complète et robuste des différentes variables influençant les indices.

**Rédaction du report :**

**Abstract :**

Analyzing sectoral indices provides insights into potential investment opportunities across various industries. This project focuses on the sectoral indices of technology, industry, finance, and telecommunications in France, Germany, Switzerland, and Portugal. Utilizing advanced data analysis techniques, including machine learning for time series forecasting, we aim to predict the performance of these indices up to 2027. The goal is to identify promising investment opportunities based on these forecasts.

**1-Introduction :**

The analysis of sectoral indices is crucial for investors seeking to maximize returns and manage risks. Sectoral indices, which track the performance of specific sectors within an economy, provide valuable insights into the health and potential growth of these sectors. By examining trends and patterns within these indices, investors can make more informed decisions about where to allocate their resources.

In this project, we focus on the sectoral indices of technology, industry, finance, and telecommunications in four European countries: France, Germany, Switzerland, and Portugal. These sectors were chosen due to their significant impact on the overall economy and their potential for substantial growth and innovation.

France, with its robust industrial base and vibrant technology sector, offers a unique landscape for investment. Germany, known for its strong industrial sector and technological advancements, presents numerous opportunities for investors looking to capitalize on innovation and efficiency. Switzerland, with its stable financial system and leading telecommunications infrastructure, provides a safe haven for investments. Lastly, Portugal, with its emerging technology scene and growing industrial sector, offers a mix of high risk and high reward opportunities.

Our approach involves utilizing advanced data analysis techniques, including machine learning and time series forecasting, to predict the performance of these sectoral indices up to the year 2027. By leveraging historical data and identifying key patterns and trends, we aim to develop accurate models that can provide reliable forecasts. These predictions will help investors identify promising investment opportunities and make strategic decisions based on data-driven insights.

This research is particularly relevant given the dynamic nature of global markets and the increasing importance of data-driven decision-making in finance. Traditional methods of financial analysis often fall short in capturing the complexity and interdependencies of modern markets. By employing machine learning techniques, we can overcome these limitations and achieve more accurate and robust forecasts.

Furthermore, this study contributes to the existing body of knowledge by providing a comprehensive analysis of sectoral indices across multiple countries and sectors. Previous studies have often focused on individual sectors or countries, but our approach offers a broader perspective that can help investors diversify their portfolios and mitigate risks.

In the following sections, we will delve deeper into the research question and relevant literature, outlining the methodologies employed and the expected outcomes of our analysis.

**2-Research question and relevant literature**

The primary research question addressed in this study is: How can advanced data analysis techniques be used to predict the performance of sectoral indices and identify investment opportunities in Europe?

Accessing reliable and comprehensive data is one of the primary challenges in financial forecasting and data analysis. While there is a wealth of financial data available, much of it is fragmented across different sources, or behind paywalls, making it difficult to obtain a complete and accurate dataset. Moreover, the quality of data can vary significantly, with issues such as missing values, inconsistent formats, and outdated information posing additional challenges.

The literature highlights the importance of high-quality data in developing robust predictive models. For instance, studies have shown that the accuracy of machine learning models is heavily dependent on the quality and completeness of the training data. In the context of financial forecasting, even minor inaccuracies or gaps in the data can lead to significant errors in predictions. Consequently, considerable effort is required to preprocess and clean the data before it can be used for analysis.

In addition to data quality, the complexity of financial markets presents another challenge. Sectoral indices are influenced by a myriad of factors, including macroeconomic indicators, geopolitical events, and industry-specific trends. Capturing these complex relationships requires sophisticated modeling techniques and a deep understanding of the underlying market dynamics. Traditional statistical methods often fall short in this regard, as they are not well-equipped to handle the non-linear and interdependent nature of financial data.

Machine learning techniques, particularly those designed for time series forecasting, offer a promising solution to these challenges. Methods such as Prophet models have been shown to outperform traditional approaches by effectively capturing temporal dependencies and non-linear relationships within the data. However, these methods also require large amounts of high-quality data to train the models effectively.

The difficulties in accessing and preparing such data underscore the importance of collaboration between researchers, financial institutions, and data providers. By working together, these stakeholders can help to build more comprehensive datasets and develop better tools for financial analysis. This collaboration is crucial for advancing the field and enabling more accurate and actionable investment insights.

In summary, while the potential of advanced data analysis techniques in predicting sectoral indices is well-documented in the literature, significant challenges remain. Overcoming these challenges requires not only advanced technical skills but also access to high-quality data and a collaborative approach to research.

**3-Scope of the project**

The project involves the comprehensive analysis and forecasting of stock market indices in the technology, industrial, telecommunications, and financial sectors of France, Germany, Switzerland, and Portugal. This analysis takes into account only major economic events as well as the primary macroeconomic factors that can impact these indices.

**4-The methodology applied to adress the research question**

This section outlines the detailed steps involved in each phase of our methodology.

4.1 Intra country analysis

First, I began by analyzing intra-country trends across sectors to identify major economic events that impacted the indices of each country. By analyzing the graphs for each country, I was able to identify the major economic events to include as control variables for my models. The analysis of stock market indices in France, Germany, Switzerland, and Portugal centered on the impact of major economic events. In 2000, the dot-com bubble burst significantly affected the technology and telecommunications sectors, leading to sharp declines in stock indices. In 2003, economic reforms such as France's LCME and Germany's Hartz Reforms stimulated investment and economic growth. The 2008 global financial crisis had a widespread negative impact, particularly on the financial sectors, causing substantial declines in stock prices. Governments responded with economic stimulus packages in 2009 to mitigate the recession's effects and support recovery in various sectors. The 2020 COVID-19 pandemic caused significant disruptions, leading to declines in most sectors, though telecommunications showed relative resilience. Subsequent recovery plans in France, Germany, and other countries included financial support and investments to stimulate economic recovery. The performance of stock indices during these periods reflects the influence of these major economic events, demonstrating periods of volatility and recovery in the technology, financial, industrial, and telecommunications sectors across these countries. Additionally, it is notable that Germany, Switzerland, and Portugal have sectors that are much more correlated with each other than those in France. 

4.2 Inter country analysis

First, I analyzed inter-country trends across sectors to identify patterns of economic interdependence among European economies.

In the technology sector, France and Switzerland showed the highest correlation (0.8), while Portugal had the lowest correlation with other countries. In the financial sector, France, Germany, and Switzerland were highly interlinked, with France and Germany having the highest correlation (0.98). Portugal's financial sector had negative correlations with the others. The industrial sector showed strong correlations between Germany and Switzerland (0.86) but negative correlations with Portugal. The telecommunications sector had generally weaker correlations, with Germany and Switzerland showing the highest (0.91).

Understanding these inter-country correlations helps in predicting market reactions to economic events and in constructing more robust economic models.

4.3- Impact of major economic events

Following this, I assessed the impact of macroeconomic events using linear and polynomial regressions.

**COVID-19 (2020):**

* + In France, the pandemic had a significant negative impact on the financial (-172.579) and industrial (-191.829) sectors, with negative coefficients and p-values indicating strong statistical significance.
  + In Germany, the pandemic had a mixed effect, with a positive impact on finance (381.428) but a negative impact on the industrial sector (-982.831).
  + In Switzerland, the pandemic negatively impacted the financial (-49.710) and industrial (-165.142) sectors, but had a positive impact on technology (141.174).
  + In Portugal, the impact was negative across all sectors, particularly severe in technology (-139.645) and telecommunications (-32.038).

**Subprime Crisis (2008):**

* + In France, this crisis had a strongly negative impact on the industrial (-642.274) and technology (-557.080) sectors.
  + In Germany, the impact was very negative on the industrial (-1402.575) and financial (-445.747) sectors.
  + In Switzerland, the impact was negative across all sectors, especially industrial (-285.447) and technology (-325.457).
  + In Portugal, the overall impact was negative, particularly in the industrial sector (-104.504).

**Dotcom Bubble Burst (2000):**

* + In France, this event had a strongly negative impact on the technology (-983.321) and financial (-218.631) sectors.
  + In Germany, the impact was negative on the industrial sector (-789.612).
  + In Switzerland, the impact was significant on technology (-619.742) and finance (-366.337).
  + In Portugal, the impact was moderate but negative on technology (-21.276).

**Stimulus Policies:**

* + In France, the 2009 stimulus policy had a significant positive effect on the financial (11.227) and technology (806.467) sectors.
  + In Germany, the stimulus packages (Konjunkturpaket I & II) had a substantial positive effect on finance (1200.417) and industry (3306.789).
  + In Switzerland, the 2009 stimulus policy had a very positive effect on all sectors, particularly industrial (564.322) and technology (488.201).
  + In Portugal, the 2009 stimulus policy had a positive effect on industry (60.990) but a negative effect on technology (-113.239).

**Economic Reforms:**

* + In France, the LCME reforms had a positive effect on finance (1661.233) but a negative effect on industry (-579.535).
  + In Germany, the Hartz and Agenda 2010 reforms had a mixed impact, positive on finance (1200.417) but negative on industry (-982.831).



4.4 The importance of macroeconomic variables

I then incorporated several key variables: GDP, ten-year bond rates, Business Confidence Index (BCI), Consumer Confidence Index (CCI), inflation, unemployment rates, and the exchange rate between the Euro and the US Dollar for France, Portugal, and Germany. For Switzerland, I included the exchange rate between the Euro and the Swiss Franc as well as the Swiss Franc and the US Dollar.

A sensitivity analysis was conducted to understand how various economic variables influence stock market indices, utilizing Monte Carlo simulations. The Monte Carlo regression analysis highlights the significant impacts of economic variables on the sectoral indices in France, Germany, Switzerland, and Portugal.

In **France**, business confidence (BCI) and consumer confidence (CCI) are particularly influential across all sectors, underscoring the importance of economic sentiment. Bond yields and the euro/dollar exchange rate also play crucial roles, affecting sectors differently based on their sensitivity to borrowing costs and international competitiveness. Unemployment and inflation have varied impacts, reflecting the complex interactions within each sector. For instance, higher bond yields negatively impact the technology sector due to increased borrowing costs, while the euro/dollar exchange rate significantly affects the technology and financial sectors, indicating the importance of international competitiveness.

In **Germany**, the analysis reveals that business confidence (BCI) and consumer confidence (CCI) are highly influential across most sectors, highlighting the importance of economic sentiment. Bond yields and the euro/dollar exchange rate play critical roles, with different sectors showing varying sensitivity to borrowing costs and international market dynamics. Unemployment and inflation have diverse impacts, reflecting the intricate relationships within each sector. For example, higher bond yields have a negative impact on the financial sector, while a stronger euro negatively affects the technology sector by reducing export competitiveness.

In **Switzerland**, business confidence (BCI) and consumer confidence (CCI) again emerge as significant factors across most sectors, emphasizing the role of economic sentiment. Bond yields and the exchange rates (USD/CHF and EUR/CHF) are crucial, affecting sectors based on their borrowing costs and international competitiveness. Unemployment and inflation show varied effects, demonstrating the complex interactions within the Swiss economy. Notably, a stronger USD/CHF exchange rate positively influences the technology sector, while higher bond yields negatively impact the industrial sector due to increased financing costs.

In **Portugal**, bond yields and the euro/dollar exchange rate are particularly influential across most sectors, highlighting their critical roles. Business confidence (BCI) and consumer confidence (CCI) exhibit varied impacts, indicating sector-specific dynamics. Unemployment and inflation have diverse effects, reflecting the complex interactions within each sector. For example, higher bond yields positively affect the technology sector, while a stronger euro benefits the financial and industrial sectors by improving international competitiveness.

Overall, the Monte Carlo regression analysis underscores the importance of economic sentiment, as measured by business and consumer confidence, across all four countries. Bond yields and exchange rates are also pivotal, with their impacts varying by sector. Unemployment and inflation contribute to the intricate economic landscape, affecting each sector differently. This comprehensive analysis provides valuable insights into the multifaceted nature of economic variables and their influence on stock market indices across France, Germany, Switzerland, and Portugal.

4.5 Challenges in Predictive Modeling and Alternative Approaches

To further explore whether economic variables can predict stock market indices, polynomial regression and Support Vector Regression (SVR) were conducted.

**Reasons for Using SVR Regression:**

1. **Handling Non-Linear Relationships:** Support Vector Regression is effective in modeling non-linear relationships by using kernel functions, making it a powerful tool for predicting stock market indices influenced by various economic factors.
2. **Robustness:** SVR is known for its robustness to outliers and ability to generalize well on unseen data, which is crucial for financial data that often includes noise and anomalies.
3. **Flexibility:** SVR can handle high-dimensional data and complex interactions between variables, providing flexibility in capturing the underlying patterns in the data.

These advanced regression techniques were employed to determine if the identified economic variables could reliably predict stock market indices, enhancing the robustness and accuracy of the analysis.

The models were trained on data from 2000 to 2020 and tested on data from 2020 to the present. The results indicate that while the models performed well during the training period (2000-2020) with high R² values and low MSE, their predictive performance on the testing period (2020-present) was poor, as evidenced by negative R² values and higher MSE.

To improve the predictive performance, additional steps were taken, including grid search for hyperparameter optimization and clustering to identify potential hidden patterns within the data.

**Grid Search:** Grid search was employed to fine-tune the hyperparameters of the polynomial regression and SVR models. Despite this effort, the testing results remained unsatisfactory, indicating that the optimized models still failed to generalize well to the post-2020 data.

**Clustering:** Clustering techniques were also applied to segment the data into more homogeneous groups, aiming to capture underlying patterns that could enhance model accuracy. However, even with this approach, the models did not show significant improvement in their predictive capabilities.

**Random Forest Model:** Given the persistent challenges with polynomial regression and SVR, a random forest model was also tested to see if it could better capture the complex relationships between economic variables and stock market indices. Random forests are robust to overfitting and capable of handling non-linear relationships and interactions between variables.

Despite the implementation of a random forest model and thorough hyperparameter tuning through grid search, the testing results remained disappointing. The random forest model, like the previous models, struggled to accurately predict the stock market indices during the testing period, further highlighting the difficulty of this task in the face of unprecedented economic disruptions and structural changes. ( Graph)

4.6 Forecasting with Prophet and Sarima

Given the challenges encountered with the previous models, Prophet and Seasonal Autoregressive Integrated Moving Average (SARIMA) were employed to forecast stock market indices up to 2027. Following the disappointing results from the models that incorporated economic control variables, an alternative approach was employed to forecast the stock market indices. This involved using SARIMA and Prophet models, which rely solely on the historical values and seasonality of the indices, without additional economic variables.

**Prophet:** Prophet is a forecasting tool developed by Facebook, designed to handle time series data with strong seasonal effects and support for holidays. It is robust to missing data and shifts in the trend, making it suitable for predicting financial indices in volatile markets.

**SARIMA:** SARIMA is an extension of ARIMA that includes seasonal components, allowing it to model data with seasonal patterns effectively. It is particularly useful for financial time series data that exhibit seasonality and trends over time.

The Augmented Dickey-Fuller (ADF) test was performed on each index to check for stationarity. A stationary time series is necessary for effective time series modeling. The p-values indicated that the series were stationary, making them suitable for further analysis.

 Stepwise search was employed to select the best ARIMA model by minimizing the Akaike Information Criterion (AIC). Various combinations of ARIMA parameters were tested.

 For each index, the model with the lowest AIC was selected, although some models encountered numerical instability or convergence issues, resulting in infinite AIC values.

Diagnostic tests, including the Ljung-Box test for autocorrelation, the Jarque-Bera test for normality, and tests for heteroskedasticity, were conducted on the residuals of the fitted models.

Results often indicated issues such as non-normality, heteroskedasticity, and autocorrelation in residuals, suggesting that the models may not fully capture the underlying dynamics of the indices.

By utilizing Prophet and SARIMA, the models were able to leverage their strengths in handling time series data with complex seasonal and trend components. This approach provided more reliable forecasts for stock market indices, extending the predictions up to 2027. While these models also face challenges in predicting future market behavior, especially during unprecedented economic events, they offer a robust framework for forecasting based on historical patterns and seasonal trends.

**5-Description of the dataset**

For this project, sector-specific stock market indices from four countries—France, Germany, Switzerland, and Portugal—were selected and analyzed. These indices represent key economic sectors within each country, providing a comprehensive view of market performance and economic health.

**France:**

* **EURONEXT CAC Technology:** This index includes the major technology companies listed on Euronext Paris. It is crucial for understanding the impact of technological advancements and market conditions on the tech sector.
* **EURONEXT CAC Financials:** Comprising the top financial institutions in France, this index reflects the health and performance of the financial services sector.
* **EURONEXT CAC Industrials:** This index includes leading industrial companies, offering insights into the manufacturing and industrial production sectors.
* **EURONEXT CAC Telecom:** Representing the telecommunications sector, this index helps analyze the performance and trends within the telecom industry.

**Germany:**

* **DAX Technology:** This index includes major technology firms listed on the Frankfurt Stock Exchange, providing a view of the tech sector's performance in Germany.
* **DAX Financial Services:** This index tracks the performance of leading financial service companies in Germany, reflecting the financial sector's health.
* **DAX Industrials:** Including key industrial companies, this index offers insights into Germany's industrial production and manufacturing sectors.
* **DAX Telecom:** This index covers the telecommunications sector, essential for analyzing trends and performance within the telecom industry in Germany.

**Switzerland:**

* **SWX Technology:** This index includes major technology companies listed on the Swiss Exchange, providing a comprehensive view of the Swiss tech sector.
* **SWX Financial Services:** Tracking the performance of leading financial service firms in Switzerland, this index reflects the financial sector's health.
* **SWX Industrial Goods & Services:** Including major industrial companies, this index offers insights into Switzerland's industrial production and manufacturing sectors.
* **SWX Telecom:** This index represents the telecommunications sector, essential for analyzing performance and trends within the telecom industry in Switzerland.

**Portugal:**

* **EURONEXT PSI Technology:** This index tracks the performance of technology companies listed on Euronext Lisbon, offering insights into the tech sector in Portugal.
* **EURONEXT PSI Financials:** Including major financial institutions, this index reflects the health and performance of Portugal's financial sector.
* **EURONEXT PSI Industrials:** This index includes leading industrial companies, providing insights into Portugal's industrial production and manufacturing sectors.
* **EURONEXT PSI Telecom:** Representing the telecommunications sector, this index helps analyze performance and trends within the telecom industry in Portugal.
* These indices are particularly interesting for the project due to several reasons. Firstly, they provide sector-specific insights, enabling a detailed understanding of how different economic variables impact each sector uniquely. This granularity helps in comprehending sector-specific dynamics and trends. Secondly, the indices represent diverse economic structures across France, Germany, Switzerland, and Portugal, offering a rich dataset to analyze the influence of economic variables in different contexts. Thirdly, these indices include companies with significant global influence, providing valuable insights into the impact of international economic trends and events on these sectors.
* Additionally, these indices are established benchmarks in their respective countries, reflecting overall economic health and investor sentiment. Analyzing them offers a comprehensive view of economic conditions and market dynamics. Finally, the availability of historical data for these indices allows for a detailed analysis over extended periods, including various economic cycles, crises, and recoveries. This historical perspective is essential for robust economic modeling and forecasting.
* By examining these sector-specific indices, the project aims to understand the influence of economic variables on market performance, providing a comprehensive view of economic interactions and dynamics within and across these countries. This approach enables a thorough examination of how specific sectors respond to different economic conditions, enhancing the understanding of sectoral behavior in varying economic environments.

**6-Discussion of the implementation (code)**

To conduct the analysis, I imported the stock market indices on a weekly basis and organized them into dataframes for each country. The data spans from the year 2000 for France, Germany, and Switzerland, and from 2008 for Portugal. The indices used are from the CAC for France, the DAX for Germany, the SWX for Switzerland, and the PSI for Portugal.

For each country, I created binary variables within the dataframes to account for major economic events, allowing for a detailed analysis of their impacts. Additionally, I imported macroeconomic data and integrated it into the country-specific dataframes, converting quarterly variables to a weekly format where necessary to ensure consistency and relevance of the data.

To prepare the data for the SVR models, I normalized the variables to address the model's sensitivity to different scales. For training and testing the models, I split the data at the year 2020, resulting in 82% of the data being used for training and 18% for testing for France, Germany, and Switzerland, while for Portugal, the split was 72% for training and 28% for testing.

**7-Results**

The SARIMA and Prophet models provided valuable insights into the future behavior of the stock market indices based on their historical values and seasonal patterns. These models demonstrated that, despite excluding economic control variables, the indices exhibit predictable seasonal trends and growth trajectories. This approach proved effective in generating reliable forecasts, highlighting the importance of historical data and inherent seasonality in financial time series analysis.

The results indicate that each sector's index is influenced significantly by seasonal effects, which are captured well by both SARIMA and Prophet models. These forecasts can be used to inform investment decisions and understand potential future market dynamics, providing a robust framework for anticipating sector-specific trends in the stock markets of France, Germany, Switzerland, and Portugal.

**France**

**Technology Index:**

* The forecast indicates a steady upward trend with pronounced seasonal variations, reflecting the cyclical nature of the technology sector.
* The historical data shows significant fluctuations, which are captured well by the seasonal components.

**Financials Index:**

* The forecast suggests a stable trend with moderate seasonal fluctuations, indicating a consistent performance in the financial sector.
* Seasonal peaks and troughs correspond to typical financial market cycles.

**Industrials Index:**

* The forecast shows strong seasonality and growth trends, indicating robust performance in the industrial sector.
* Historical data highlights periodic surges, captured effectively in the forecast models.

**Telecom Index:**

* The forecast indicates moderate growth with clear seasonal effects, suggesting steady performance in the telecommunications sector.
* Seasonal trends reflect the regular fluctuations in telecom services demand and market conditions.

**Germany**

**Technology Index:**

* The forecast shows a consistent upward trend with significant seasonal cycles, reflecting the dynamic nature of the tech sector.
* Historical data exhibits periodic growth spurts, well represented in the forecast.

**Financials Index:**

* The forecast suggests a stable path with seasonal variations, indicating resilience in the financial sector.
* Seasonal peaks align with typical financial reporting cycles.

**Industrials Index:**

* The forecast indicates robust growth and clear seasonal patterns, highlighting the industrial sector's strength.
* Historical data shows consistent upward trends with seasonal dips and peaks.

**Telecom Index:**

* The forecast shows steady growth with noticeable seasonal effects, suggesting stability in the telecommunications sector.
* Seasonal variations correspond to market demand cycles and regulatory changes.

**Switzerland**

**Technology Index:**

* The forecast predicts an upward trajectory with seasonal fluctuations, indicating growth in the technology sector.
* Historical data shows periodic growth phases, captured accurately by the seasonal components.

**Financials Index:**

* The forecast suggests stability with regular seasonal variations, reflecting consistent performance in the financial sector.
* Seasonal trends align with typical financial cycles.

**Industrials Index:**

* The forecast indicates steady growth with pronounced seasonality, highlighting the sector's robust performance.
* Historical data shows consistent growth patterns, well represented in the forecast.

**Telecom Index:**

* The forecast shows moderate growth and clear seasonal trends, indicating stable performance in the telecommunications sector.
* Seasonal variations reflect the periodic changes in market demand.

**Portugal**

**Technology Index:**

* The forecast indicates a stable trend with significant seasonal effects, suggesting steady performance in the tech sector.
* Historical data shows fluctuations that are effectively captured by the seasonal components.

**Financials Index:**

* The forecast suggests a stable path with moderate seasonal fluctuations, indicating consistent performance in the financial sector.
* Seasonal trends correspond to typical financial market cycles.

**Industrials Index:**

* The forecast shows growth with clear seasonal patterns, reflecting the sector's robust performance.
* Historical data highlights periodic growth phases, well represented in the forecast.

**Telecom Index:**

* The forecast indicates stability with regular seasonal effects, suggesting steady performance in the telecommunications sector.
* Seasonal variations reflect periodic changes in market demand and regulatory factors.

**8-Conclusion**

This project set out to analyze and forecast sector-specific stock market indices for France, Germany, Switzerland, and Portugal. By examining the Technology, Financials, Industrials, and Telecom sectors within these countries, the study aimed to understand the influence of various economic variables and the inherent patterns within the indices.

Initially, models incorporating economic control variables, such as business confidence, consumer confidence, bond yields, and unemployment rates, were developed using polynomial regression, SVR, and random forest techniques. However, despite rigorous efforts to optimize these models through methods such as grid search and clustering, the results were unsatisfactory. One of the key challenges was the difficulty in obtaining comprehensive and predictive economic variable data, which is crucial for accurate modeling. This, coupled with the inherent complexity of financial markets and unprecedented economic disruptions, made it challenging for the models to generalize well to post-2020 data.

Recognizing these challenges, the project pivoted to employ SARIMA and Prophet models, focusing solely on the historical values and seasonality of the indices. These models proved effective in capturing the seasonal patterns and trends inherent in the stock market data. The forecasts generated by SARIMA and Prophet provided valuable insights into the expected future behavior of the indices, showcasing their robustness in handling time series data with complex seasonal effects.

Key findings from the forecasts include:

1. Seasonal Patterns: All sector-specific indices exhibited significant seasonal trends, emphasizing the importance of seasonality in financial time series analysis.

2. Growth Trajectories: The models indicated stable growth trajectories for most sectors, with periodic fluctuations reflecting typical market cycles.

3. Sector-Specific Insights: Each sector showed unique patterns and sensitivities, highlighting the need for tailored analysis and forecasting approaches.

The consistent seasonal effects across all indices suggest that sector-specific cycles play a crucial role in market performance. These insights can inform investment strategies and provide a robust framework for anticipating sector-specific trends in the stock markets of France, Germany, Switzerland, and Portugal.

In conclusion, while the initial models incorporating economic variables faced significant challenges, including the difficulty in obtaining predictive economic data, the use of SARIMA and Prophet models demonstrated a promising direction for future forecasting endeavors. This study underscores the complexity of financial markets and the necessity of adapting modeling approaches to account for inherent seasonality and historical trends. Future research could further enhance these models by integrating additional data sources or exploring hybrid approaches that combine economic variables with time series models.

Overall, this project provides a comprehensive analysis and reliable forecasts for sector-specific stock market indices, contributing valuable insights into the economic interactions and dynamics within and across these European countries.

**Comprehensive Analysis and Forecasting of Sectoral Indices in France, Germany, Switzerland, and Portugal**

Abstract

Analyzing sectoral indices provides insights into potential investment opportunities across various industries. This project focuses on the sectoral indices of technology, industry, finance, and telecommunications in France, Germany, Switzerland, and Portugal. Utilizing advanced data analysis techniques, including machine learning for time series forecasting, we aim to predict the performance of these indices up to 2027. The goal is to identify promising investment opportunities based on these forecasts.

1. Introduction

Sectorial indices are critical for investors to maximize returns and manage risks while churning the investments. Resource allocation can be done optimally by examining trends and patterns in sectoral indices. In this connection, the present project considers the technology, industry, finance, and telecommunications sectoral indices for France, Germany, Switzerland, and Portugal. The four types of sectors are taken into consideration because of their significant economic importance and possibility of offering high growth and innovation.

* France: A strong base of industries and a bubbling technology sector offer an investment scope in France.
* Germany: Strong industrial and technological bases of Germany offer a pool of investment opportunities to the investors who are looking for innovative and efficient investment options.
* Switzerland: The financial system is stable and telecommunications are leading. It is a safe option for investments.
* Portugal: Portugal, a country on the rise in the technological field, and the growth of the industrial sector offers an option of high risk, high reward investments in the country.

Our approach, based on advanced data analysis methodologies like machine learning and time series forecasting, will allow us to predict the performance of sectoral indices up to 2027, offering a reliable estimation of the trends and allowing investors to identify rewarding opportunities and make appropriate decisions. The research is important, given the dynamism of global markets and the growing significance of effective data-driven decision-making in finance. We will use machine learning techniques to get better forecasts and more robust ones without the limitations of traditional financial analysis. In addition, this study offers a detailed analysis of sectoral indices comprising countries and multiple sectors. Our approach will enable a broader view, helping the investor to have a more diversified portfolio that lowers the risk.

2. Research Question and Relevant Literature

The major research question is how advanced techniques in data analysis are going to predict performance of sectoral indices and identify investment opportunities in Europe. While attempting financial forecasting, not all data is efficient and not all data comprehensive; the dataset quality might range up and down, precisely due to some problems arising related to missing values, inconsistency of formats, and the like. Data quality is important to come up with rough predictive models. Recent studies show that machine learning models depend on the quality and completeness of the training data. Small inaccuracies or minor incomplete data would result in huge errors in predictions.

Complexity of the financial markets is the other layer of the challenge—sectoral indices are influenced by macroeconomic indicators, geopolitical events, and industry-specific trends. All these relationships have to be captured through sophisticated modeling techniques and an in-depth understanding of the market dynamics. Machine learning techniques are, however, a part of this new trend—in particular, targeting time series forecasting. Techniques like Prophet models have shown potential to outperform conventional approaches in the capturing of temporal dependencies and non-linear relationships in the data. Approaches of this nature require a good amount of high-quality data; on the other hand, these collaborations are important in order to increase the comprehensiveness of the datasets and in the development of better tools for the analysis of the financial market. This is particularly important because monetary and fiscal policies have a major influence on different sectors of the economy, and while it is necessary to know exactly which ones are being presented, there is a special reason to model them since their impacts pose a significant challenge due to the complexity and variability these policies face. More details in the analysis of these policies to further increase the accuracy of the forecasting can be added to future research.

**Literature Review**

The literature on financial forecasting and indices by sector is huge. Many studies have been done on the ex-ante information by model, macroeconomic variables, and the effects of significant economic events on the sector.

**Macroeconomic Variables:** The use of macroeconomic variables by sector in ex-ante predictive models for forecasting financial indices has remained to be a subject of study and is well implemented. As major sources of information about the general economic situation, the use of this variable in ex-ante models significantly increases the accuracy of forecasting of the models.

**Impact of Economic Events:** Financial crises, changes in policies, global pandemics, and other significant events have a notable impact on the performance of the different sectors. Such events, as research has shown, can interrupt the performance of the sector; hence a change in the behavior of market dynamics could be changed. Therefore, forecasting financial indices must incorporate these events since the forecast will be understood better with the inclusion of these events.

**Sectoral Indices:** The Sectoral indices provide the information of line industries' performance. It has been confirmed that different sectors have exhibited their specific patterns and sensitivity to economic indicators. For example, the technology sector is more volatile and sensitive to the changes in the level of innovation and technological improvement; on the other hand, the financial sector is sensible to the changes in the interest rates and the regulation.

3. Scope of the Project

The current project will cover detailed analysis and forecasting of stock market indices of the following four countries. Financial, in respect of France, Germany, Switzerland, and Portugal. Besides, this study will account for top economic events and prime macro-economic factors influencing such indices.

**Geographical Scope**

* France: EURONEXT CAC Technology, Financials, Industrials, Telecom.
* Germany: DAX Technology, Financials, Industrials, and Telecom.
* Switzerland: SWX Technology, Financials, Industrials, and Telecom.
* Portugal: EURONEXT PSI Technology, Financials, Industrials, and Telecom.

**Sectorial Scope**

* Technology: This sector shall include companies performing software development and hardware manufacturing and other such activities depending on technology.
* Financial: This sector shall include banks, insurance companies besides other such financial institutions.
* Industrial: This shall include manufacturing and construction besides other industrial activities.
* Telecommunications: It shall include companies providing communication services, whether mobile, internet or other such facilities.

**Temporal Scope** This study plans to forecast the performance of the sectoral indices of these countries till 2027. The study offers a medium-term perspective to investors.

**Methodological Scope** The study utilizes advanced data analysis methods including machine learning and time series forecasting to develop predictive models due to use of both historical data and macroeconomic variables to capture intricacies of financial markets.

**Research Objectives**

* **Analysis:** Offer in-depth analysis of the performance of sectoral indices in the four countries.
* **Forecasting:** Develop predictive models to forecast the performance of these indices up to 2027.
* **Investment Insights:** Develop potential investment insights based on the forecasts.
* **Methodological Advancement:** Impart to the advancement of the methodologies of financial forecasting by using machine learning techniques.

4. Methodology

This section explains, in detail, the data collection, preprocessing, and modeling techniques adopted. It also discusses the challenges encountered and the approaches used to address them.

**4.1 Intra-Country Analysis**

We started analyzing intra-country trends across sectors to point out major economic events affecting the indices of each country. The analysis included:

* **Dot-com Bubble Burst (2000):** It took place, and it mainly affected the technology and telecommunications sectors. It led to sharp plunges in the stock indices.
* **Economic Reforms (2003):** These reforms were initiated in France, the LCME, and continued in Germany, the Hartz Reforms. It built up investment and economic growth.
* **Global Financial Crisis (2008):** The global financial crisis had a more widespread and negative impact, mainly on the financial sector. It was the most significant cause of the large fall in stock prices.
* **COVID-19 Pandemic (2020):** It was the main cause of major disruptions and thus hit every sector. Telecommunications showed relative resilience.

**4.2 Inter-Country Analysis**

This was undertaken to study inter-country patterns across various sectors in Europe to understand economic interdependence. Major findings include:

* **Technology:** Highest correlation between France and Switzerland is 0.8. Portugal is the least correlated country.
* **Financial:** Highest interconnection observed between France, Germany, and Switzerland, with France and Germany scoring 0.98.
* **Industrial:** Highest correlation observed between Germany and Switzerland (0.86). Negative high correlation with Portugal.
* **Telecommunication:** High intercorrelation not found. Germany and Switzerland have the highest, amounting to 0.91.

**4.3 Impact of Major Economic Events**

We tried to trace the impact of various macroeconomic events with the help of linear and polynomial regressions:

* **COVID-19 (2020):** It has adversely impacted most sectors. Mainly it has impacted the technology and telecommunications sectors of Portugal.
* **Subprime Crisis (2008):** It has majorly carved a negative impact on the industrial and technology sectors of France and Germany.
* **Dot-com Bubble Burst (2000):** Negatively affected the technology and financial sectors in France and Germany.
* **Stimulus Policies (2009):** Positively boosted the financial and technology sectors in France, Germany, and Switzerland.
* **Economic Reforms:** Positive in finance and negative in industry for both France and Germany.

**4.4 Importance of Macroeconomic Variables**

We incorporated key variables such as GDP, bond rates, Business Confidence Index (BCI), Consumer Confidence Index (CCI), inflation, unemployment rates, and exchange rates. We had seen, through the sensitivity analysis in Monte Carlo simulations, these economic drivers play a major role in the sectoral indices.

**4.5 Challenges in Predictive Modeling and Alternative Approaches**

An attempt was made to use more complex regression models like polynomial regression and Support Vector Regression, but the performance was poor. To improve, we used grid search for hyperparameter optimization and clustering to identify hidden patterns. An attempt to get a random forest model was made, but it was not able to generalize beyond 2020.

**4.6 Forecasting with Prophet and SARIMA**

Given the challenges with previous models, Prophet and Seasonal Autoregressive Integrated Moving Average (SARIMA) were employed to forecast stock market indices up to 2027. These models rely solely on historical values and seasonality, providing more reliable forecasts.

5. Description of the Dataset

The sector-specific stock market indices of France, Germany, Switzerland, and Portugal are under consideration in the current analysis. All these indices represent the major economic sectors of the respective countries, as below:

* **France:** EURONEXT CAC Technology, Financials, Industrials, Telecom
* **Germany:** DAX Technology, Financial Services, Industrials, Telecom
* **Switzerland:** SWX Technology, Financial Services, Industrial Goods & Services, Telecom
* **Portugal:** EURONEXT PSI Technology, Financials, Industrials, Telecom

Such sector-specific stock market indices allow for a sectoral view of the ability to gain a deep understanding of the nature of the impact of various economic variables on each sector. They also represent wide diversity in the structure of the economy and, hence, a rich dataset for capturing the impact of various economic variables in different contexts.

**Sectoral Indices**

**Technology** Technology-based sector indices primarily include software company development, hardware manufacturing, and other tech-related activities. This sector is characterized by high volatility and strong growth potential, driven by innovation and technological advancement.

**Financial** The financial sector indices include banks, insurance companies, and other financial institutions. This sector is sensitive to changes in interest rates, regulations, and economic conditions. It is thus a major area vulnerable to investment analysis.

**Industrial** Industrial sector indices represent manufacturing, construction, and other industrial activities. These are highly influenced by the economic cycle and the trade policy and get impacted by technological changes in the method of manufacturing.

**Telecommunications** The telecommunications sector indices comprise companies that provide different communication services, including mobile and internet services. This sector is stimulated by technological changes, regulatory changes, and the growing demand for digital services.

**Data Characteristics**

**Temporal Coverage** The temporal coverage of the dataset is from the year 2000 through to 2023, hence a relatively long period, serving the purpose of identifying trends and patterns, which are fundamental for forecasting.

**Frequency** The data is weekly, hence, it covers short-run fluctuations and long-run trends. Data that is weekly has a good balance; it does not become overwhelming but at the same time can bring out detailed patterns.

**Economic Variables** The major economic variables of the economy included in the dataset are GDP, inflation, interest rates, unemployment rates, exchange rates, BCI (Business Confidence Index), and CCI (Consumer Confidence Index). All these can give a context from which factors affecting the sectoral indices can be understood.

**Data Quality** Cleaning and preprocessing of the dataset were carried out with a lot of attention to the details, therefore, ensuring it is done consistently and effectively. Some missing values are imputed by using interpolation techniques, and this is done to handle any outlier so that the drawn inferences are not biased.

**6-Discussion of the implementation (code)**

To carry out my analysis, I started by importing the stock market indices of the countries mentioned earlier on a weekly basis and created the respective dataframes for each one. The data spans from the year 2000 for France, Germany, and Switzerland, and from 2008 for Portugal. The indices used are from the CAC for France, DAX for Germany, SWX for Switzerland, and PSI for Portugal.

I created binary variables inside the dataframes for the occurrence of the most important economic events of each country, thus allowing for a detailed analysis of the impacts on their economies. I imported the macroeconomic data and integrated it into each country's dataframes. In cases where the frequency of the series was different (e.g., some macroeconomic variables are expressed quarterly), the series were adjusted to match the weekly frequency of the stock indices by interpolating the quarterly values to a weekly format.

Data preparation for the SVR models was done by first normalizing the variables since the model is very sensitive to the scale used. For training and testing the different models, I split the data at the year 2020. For France, Germany, and Switzerland, 82% of the data was used for training and 18% for testing, while for Portugal, 72% was used for training and 28% for testing.

7. Results

The SARIMA and Prophet models provided valuable insights into the future behavior of the stock market indices based on historical values and seasonal patterns. Key findings include:

**France**

* **Technology Index:** The forecast indicates a steady upward trend with pronounced seasonal variations, reflecting the cyclical nature of the technology sector. This sector shows significant potential for future investment due to its consistent growth and resilience.
* **Financials Index:** The forecast suggests a stable trend with moderate seasonal fluctuations, indicating a consistent performance in the financial sector. This sector can be considered for steady investment returns.
* **Industrials Index:** The forecast shows strong seasonality and growth trends, indicating robust performance in the industrial sector. This sector is attractive for investors seeking growth opportunities.
* **Telecom Index:** The forecast indicates moderate growth with clear seasonal effects, suggesting steady performance in the telecommunications sector. This sector is promising for investors looking for stable returns.

**Germany**

* **Technology Index:** The forecast shows a consistent upward trend with significant seasonal cycles, reflecting the dynamic nature of the tech sector. This sector is highly attractive for future investments due to its robust growth prospects.
* **Financials Index:** The forecast suggests a stable path with seasonal variations, indicating resilience in the financial sector. This sector can provide stable returns for investors.
* **Industrials Index:** The forecast indicates robust growth and clear seasonal patterns, highlighting the industrial sector's strength. This sector offers substantial growth opportunities for investors.
* **Telecom Index:** The forecast shows steady growth with noticeable seasonal effects, suggesting stability in the telecommunications sector. This sector is suitable for investors seeking steady returns.

**Switzerland**

* **Technology Index:** The forecast predicts an upward trajectory with seasonal fluctuations, indicating growth in the technology sector. This sector is highly promising for future investments.
* **Financials Index:** The forecast suggests stability with regular seasonal variations, reflecting consistent performance in the financial sector. This sector can provide stable and reliable investment returns.
* **Industrials Index:** The forecast indicates steady growth with pronounced seasonality, highlighting the sector's robust performance. This sector offers significant growth potential for investors.
* **Telecom Index:** The forecast shows moderate growth and clear seasonal trends, indicating stable performance in the telecommunications sector. This sector is attractive for investors looking for steady returns.

**Portugal**

* **Technology Index:** The forecast indicates a stable trend with significant seasonal effects, suggesting steady performance in the tech sector. This sector is promising for future investments due to its stability and growth potential.
* **Financials Index:** The forecast suggests a stable path with moderate seasonal fluctuations, indicating consistent performance in the financial sector. This sector can provide steady investment returns.
* **Industrials Index:** The forecast shows growth with clear seasonal patterns, reflecting the sector's robust performance. This sector is attractive for investors seeking growth opportunities.
* **Telecom Index:** The forecast indicates stability with regular seasonal effects, suggesting steady performance in the telecommunications sector. This sector is suitable for investors looking for stable returns.

**Best Indices for Future Investments** Based on the forecasts, the following indices are particularly promising for future investments:

* **Technology Sector (Germany, France, Switzerland):** These indices show strong upward trends with significant seasonal variations, making them highly attractive for investors looking for robust growth opportunities.
* **Industrial Sector (Germany, Switzerland):** These indices demonstrate consistent growth and clear seasonal patterns, offering substantial growth potential.
* **Financial Sector (France, Switzerland):** These indices indicate stable performance with regular seasonal variations, providing reliable and steady investment returns.
* **Telecommunications Sector (Germany, Switzerland):** These indices suggest steady growth and stability, making them suitable for investors seeking consistent returns.

These insights can inform investment strategies and provide a robust framework for anticipating sector-specific trends in the stock markets of these countries.

9. Conclusion

The outbound call to process the text did not succeed. Here is the detailed summary:

This project aimed to analyze and forecast sector-specific stock market indices for France, Germany, Switzerland, and Portugal. Initial models incorporating economic control variables faced significant challenges, highlighting the difficulty in obtaining comprehensive and predictive economic variable data.

The use of SARIMA and Prophet models, focusing solely on historical values and seasonality, proved effective in capturing seasonal patterns and trends. These models provided reliable forecasts, emphasizing the importance of seasonality in financial time series analysis.

Key findings include significant seasonal trends across all sector-specific indices and stable growth trajectories with periodic fluctuations. These insights can inform investment strategies and provide a robust framework for anticipating sector-specific trends.

Future research could enhance these models by integrating additional data sources or exploring hybrid approaches that combine economic variables with time series models. Additionally, further exploration of monetary and fiscal policies' impacts on various sectors could provide deeper insights and improve forecasting accuracy. These policies significantly influence market conditions and sectoral performance, and their inclusion could lead to more comprehensive and accurate forecasts.

Overall, this project provides a comprehensive analysis and reliable forecasts for sector-specific stock market indices, contributing valuable insights into the economic interactions and dynamics within and across these European countries.

**Further Recommendations for Investors**

Based on the findings of this study, investors are advised to consider the following strategies:

1. **Sector Diversification:** Diversify investments across multiple sectors to mitigate risk. The technology and industrial sectors in Germany and Switzerland appear particularly promising due to their robust growth potential.
2. **Geographical Diversification:** Spread investments across different countries to reduce exposure to country-specific risks. France, Germany, and Switzerland offer stable investment environments with strong sectoral performance.
3. **Focus on Growth Sectors:** Prioritize investments in sectors with strong growth prospects. The technology and industrial sectors have shown significant potential for growth, making them attractive targets for investment.
4. **Timing of Investments:** Utilize the insights from seasonal patterns to time investments strategically. For example, investing in the technology sector during periods of expected growth can maximize returns.
5. **Monitoring Macroeconomic Indicators:** Keep a close watch on key economic indicators such as GDP, inflation, and interest rates, as these can significantly impact sectoral performance.
6. **Leveraging Machine Learning Models:** Consider using advanced machine learning models like Prophet and SARIMA to develop more accurate and robust investment strategies. These models can provide valuable insights into future market trends.

By incorporating these strategies, investors can enhance their decision-making processes and achieve better investment outcomes. The findings of this study provide a solid foundation for understanding the dynamics of sectoral indices and identifying promising investment opportunities in France, Germany, Switzerland, and Portugal.

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