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Statistical analysis of the impact of profitability in the manufacturing and service sectors on the UK Economy's Growth

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Abstract

The UK economy's performance is closely tied to the profitability of its Manufacturing Sector (MS) and Service Sector (SS). Understanding these sectors' dynamics is crucial for effective policymaking. Integrating sustainable practices in both sectors enhances profitability and operational efficiency while contributing to economic growth and reducing environmental impact. This study investigates the relationship between UK economic growth and profitability in the MS and SS from 1998 to 2022. The primary objective is to examine how profitability influences the UK's growth trajectory. Employing various statistical methods, including correlation, regression, cointegration, and variance decomposition analyses, the study aims to provide insights into the interplay between GDP and sector profitability. A quantitative approach using secondary data on GDP and profitability from reliable sources is adopted. Correlation analysis explores relationships between these variables, while regression analysis assesses the impact of MS and SS profitability on GDP. Cointegration tests identify long-term equilibrium relationships, and variance decomposition analysis reveals the variability of GDP and sector profitability over time. The correlation matrix indicates positive associations between GDP and both sectors, with the SS showing a stronger correlation. Regression analysis confirms significant effects of both sectors on GDP, with the SS exerting a positive influence and the MS a negative impact. Cointegration tests highlight long-term stability, and variance decomposition analysis emphasizes the dynamic nature of these relationships. This study elucidates the intricate link between UK economic growth and sector profitability, underscoring the SS's critical role in driving expansion while addressing challenges in the MS. Policy recommendations include enhancing productivity and innovation in both sectors, informed by evidence-based decision-making. Overall, the study contributes valuable insights into the UK economy's growth dynamics, guiding sustainable economic development strategies.

Keywords: Cointegration; Sector interplay; Sustainable economic development; Variance decomposition

1. Introduction

The United Kingdom boasts a robust, advanced, and globally engaged trade economy, with a rich industrial heritage dating back to the 19th century's Industrial Revolution. With a diverse economic landscape encompassing various sectors, the UK stands as one of the leading economies globally (Testik & Sarikulak, 2021). Historically, a key driver of UK economic prosperity has been its manufacturing sector (MS), which accounts for over 10% of the nation's total output and provides employment opportunities for more than 2.6 million individuals (Farid, 2021; Suhányi et al., 2023). Conversely, the Services Sector (SS) dominates the UK's economic landscape, contributing approximately 80% of the country's overall production and employing over 27 million people (Pat, 2020).

Manufacturing has been regarded as the high route to growth in earlier development economics literature, with industrialization considered a sign of economic success (Atiah, 2019). Recent studies indicate that over two-thirds of

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the GDP in advanced nations is generated by the services sector (Geeta & Sivanand, 2021; Phiri et al., 2022; Jovović & Cvetković, 2022). Manufacturing and services are the key industries that drive the rapid expansion and prosperity of many industrialized countries (Di Berardino & Onesti, 2018; AlKathiri, 2021). Growth laws, formulated based on Kaldor's (1966) theories, emphasize the manufacturing industry's substantial influence on GDP growth and its role in self-expansion. This influence is further supported by studies such as those by Olamade and Oni (2016), highlighting other industries' positive impact on manufacturing growth.

Industrialization has historically driven economic growth, aiding countries in transitioning to high-income economies (Sun & Liao, 2021; Yangailo, 2023). Studies highlight its pivotal role in income generation, job creation, and the provision of goods and services (Gryshova et al., 2020; Kumar & Pattanaik, 2020). Since the 1950s, research in development economics has highlighted the significant correlation between industrialization and economic development, emphasizing its critical importance (Savelyev et al., 2021; Klimiuk & Petryshyn, 2022; Min, 2023).

During the latter half of the 20th century, and particularly in the 21st century, the services sector experienced substantial growth, emerging as a dominant force in the economic framework of numerous nations in terms of both output and employment (Geeta & Sivanand, 2021; Sadiq et al., 2023). Concurrently, the manufacturing sector (MS) has witnessed a decline in its share of gross domestic product (GDP) in high-income countries, while the services sector has expanded significantly (Satdeve, 2020; Geeta & Sivanand, 2021). This shift has prompted discussions regarding the importance of prioritizing the development of the services sector in what is often referred to as the "postindustrial age." Scholars such as Haskel and Westlake (2017) argue that for economies aiming to enhance productivity and foster growth, increased focus on the services sector is essential. Notably, Michael Porter, a prominent advocate of the post-industrial society narrative, emphasized the growing significance of services, stating in an interview with Manufacturing and Technology News that services now hold substantial value in the contemporary economic landscape.

Advancements in information and communication technology (ICT) have facilitated scale economies in various services (Hallward-Driemeier & Nayyar, 2018). Specialized service providers often offer more profitable options than in-house production within manufacturing firms (Nayyar, 2013). Particularly in digitalized services, scale economies are prevalent, with some digital services nearing zero marginal cost per unit. Services have increasingly become hubs of innovation, challenging the notion that research and development (R&D) is exclusive to manufacturing. Global R&D expenditure in services has surged, indicating a shift in focus (Manyika et al., 2017).

The role of manufacturing in economic development remains paramount. Most countries transitioning to high-income status have done so through industrialization (World Bank, 2008). Studies confirm the positive correlation between GDP growth and the industry's share of GDP (Ocampo et al., 2009). Experts consistently emphasize the link between manufacturing expansion and long-term economic growth (Nayyar, 2013). Meckstroth's (2017) work illustrates how manufacturing supports ancillary service activities, demonstrating the vastness of the manufacturing value chain.

Despite the expansion of the services sector, the importance of manufacturing to a nation’s economic foundation should not be underestimated. The industrial sector often provides critical support for services, including logistics, maintenance, and infrastructure development, which are essential for overall economic stability. Therefore, the interaction between the manufacturing and services sectors is a crucial area of study, particularly in understanding how these sectors contribute to the overall economic growth of a country.

The MS and SS are key contributors to economic growth and development in every nation, developed or emerging. The study investigates how the UK's manufacturing and service sectors fare in terms of economic growth. The discourse on post-industrial society, primarily in high-income nations, highlights a decline in the MS's share of economies, termed premature de-industrialization by Palma (2005). This trend is partly driven by the decreasing relative prices of manufactured goods. Despite this shift, the IMF suggests that transitioning employment from manufacturing to services can still foster productivity growth and economic advancement (IMF, 2018).

The shift towards a predominant service sector in national economies, observed in both high- and low-income countries, has sparked discussions on the implications of a post-industrial society. This transition highlights the necessity for economic policies that equally prioritise the growth of the service sector alongside manufacturing. The research gap addressed by this study is a lack of comprehensive analysis on how the performance of the manufacturing sector (MS) and the services sector (SS) specifically correlates with the United Kingdom's economic growth. The aim of this study is to investigate the relationship between UK economic growth and the performance and profitability of the MS and SS. Specifically, the study aims to address the relationship and correlation between economic growth, measured by the total GDP of the United Kingdom, and the performance of its MS and SS. To achieve this objective, the study employs linear regression and correlation analysis as the most suitable methods.

The paper is divided into several sections: The introduction provides an overview of the UK trade economy and examines the roles of MS and SS, addressing a research gap on their impact on GDP. The methodology section covers research approaches, secondary data sources, and statistical analysis. The Results section presents findings, while the Discussion section analyzes the results. The Conclusion section summarises and discusses the implications of the study, aiming to offer a comprehensive understanding of the relationship between UK GDP and the performance of MS and SS.

2. Environmental Sustainability: A Path to Profitability and Economic Growth

The environmental sustainability of the manufacturing and service sectors is increasingly recognized as a pivotal factor influencing economic growth, particularly in the context of profitability and operational efficiency (Bour et al., 2019). In the UK, the relationship between environmental sustainability and economic growth, as seen through sectors like manufacturing and services, reveals intricate dynamics where sustainability efforts can align with profitability and long-term growth objectives (Filgueiras & De Melo, 2023).

Manufacturing, often associated with high carbon emissions, resource consumption, and waste generation, faces considerable pressure to adopt sustainable practices. The push toward cleaner production methods, such as the integration of renewable energy, waste reduction strategies, and circular economy models, can simultaneously reduce environmental impact and enhance profitability by improving operational efficiency (Santos et al., 2019). The UK's manufacturing sector is undergoing a transition where firms adopting sustainability practices are not only reducing their environmental footprint but also benefiting from cost savings, increased demand for eco-friendly products, and access to green investment (Abualfaraa et al., 2020).

In the service sector, the impact of environmental sustainability is more nuanced. While services typically generate fewer direct emissions compared to manufacturing, they still influence environmental sustainability through resource usage, energy consumption, and supply chain management (Evangelista et al., 2018). Advanced project and logistics management plays a crucial role in minimizing the environmental impact of the service sector. For instance, through sustainable logistics and supply chain optimization, companies can reduce fuel consumption, decrease transportation costs, and mitigate emissions (Kaur & Singh, 2016). This chain reaction effect highlights how adopting sustainability in one area of operations can lead to broader economic benefits.

Statistical analyses, such as examining the profitability impact of sustainable practices in both sectors, suggest a positive correlation between sustainability initiatives and economic growth. Firms prioritizing environmental sustainability often experience enhanced brand reputation, customer loyalty, and operational resilience, which, in turn, boosts profitability (Chang & Kuo, 2008). Moreover, economies like the UK, which incentivize sustainable practices through policy measures, see sectors contributing to growth in ways that align with national environmental goals.

Environmental sustainability in both the manufacturing and service sectors plays a crucial role in promoting long-term economic growth. By embracing sustainable practices, companies can drive profitability while contributing to the UK's broader objectives of economic resilience and environmental preservation (Alaloul et al., 2022). The adoption of advanced project management and sustainable logistics further amplifies this impact, ensuring that economic growth does not come at the expense of environmental health.

3. Methodology

Research approaches encompass various strategies and methodologies for formulating hypotheses, data collection, analysis, and interpretation. The selection process involves decisions guided by philosophical assumptions. Priya (2016) defines research approaches as broad strategies including theories and procedures. They align with the research problem. Decisions are influenced by research purpose, background, and audience. Two main approaches, qualitative and quantitative, cater to different research needs. Qualitative methods verify component presence, while quantitative methods measure presence levels using statistical approaches. In the context of studying UK economic expansion, a quantitative approach will examine profitability's impact on the industrial and service sector (SS), utilizing statistical analysis of secondary data from various sources.

3.1. Data Collection

The study involved gathering data on profitability within the MS and SS, alongside the growth of the UK economy, to evaluate a hypothesis. Utilizing statistical methods, the collected data will be analyzed to ascertain the presence of a positive correlation among these variables. Employing a deductive approach, the research aims to explore the association between profitability and economic growth. In this deductive framework, hypotheses or theories are

scrutinized through statistical analysis of available data. Deductive reasoning entails the logical process of drawing conclusions about specific instances based on known general premises or established truths (Naranjo Llupart, 2022). Researchers employing deductive methods move from broad statements to specific assertions, aligning with the principles of quantitative research and positivism, particularly focusing on hypothesis testing.

3.2. Sources of Data

The study will rely on secondary data sources to gather information. These sources will include government publications, academic journals, and news articles. Specifically, government publications such as those from the UK Office for National Statistics (ONS) and the Bank of England will be utilized. Additionally, academic journals like the Journal of Business Economics and the Journal of International Economics will be consulted. News articles from trusted sources such as the BBC, the Guardian, and the Financial Times will also be considered. The data sources may encompass various types of information, including financial reports of MS and SS companies, economic indicators like GDP, employment statistics, industry surveys, government reports, and scholarly research papers relevant to the study. It is ensured that the data is sourced from reputable sources, including national statistical agencies and industry associations.

3.3. Data Analysis

Data analysis encompasses the process of scrutinizing, refining, manipulating, and modeling data to extract pertinent information, facilitate inferences, and underpin decision-making processes (Meta, 2014). Widely employed across business, scientific, and social science domains, data analysis spans various dimensions and methodologies, incorporating numerous techniques under diverse titles. Its application contributes to enhanced scientific decision-making and streamlined research operations within today's commercial landscape.

Statistical techniques will be deployed to analyze the data. Descriptive statistics will offer a comprehensive overview and description of the collected data, while inferential statistics will be employed to test hypotheses and extrapolate conclusions about the population based on sample data. Statistical methodologies such as regression analysis, correlation analysis, and descriptive statistics will be utilized to interrogate the dataset. The principal objective is to evaluate the relationship between profitability metrics, such as net profit margin and return on investment, and economic growth metrics, such as the GDP growth rate.

3.4. Methodology Framework

3.4.1. Linear and Multiple Regression Analysis

The study utilizes linear regression analysis to investigate the relationship between the dependent variable (GDP at current basic prices) and the independent variables (fossil fuel electricity generation per capita and hydroelectricity generation per capita). The multiple regression model is expressed as follows:

$$Y_{i,j} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon_{i,j} \quad (1)$$

In matrix form, this can be represented as:

$$Y_{i,j} = F(X_{i,j}, \beta) + \varepsilon_{i,j} \quad (2)$$

Where: $Y_{i,j}$ is the GDP at current basic prices (kwh/capita), β_0 is the intercept, β_1 and β_2 are the linear parameters for X_1 and X_2 respectively, X_1 is the fossil fuel electricity generation per capita, X_2 is the hydroelectricity generation per capita, $\varepsilon_{i,j}$ is the error term.

3.4.2. Estimation of Model Parameters

The estimates of the β\betaβ coefficients are the values that minimize the error sum of squares for the sample. The formula for the estimates is:

$$\beta = (X'X)^{-1}X'Y = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \end{bmatrix} \quad (3)$$

The mean square error (MSE) is given by:

$$MSE = \frac{SSE}{n-(p+1)} \quad (4)$$

Where: n is the sample size, $p + 1$ is the number of β coefficients in the model, including the intercept, SSE is the sum of squared errors.

The sample standard deviation or regression/residual standard error is the square root of the MSE:

$$S\,S = \sqrt{MSE} \quad (5)$$

The primary goal of the analysis is to measure the marginal effect of the explanatory variables on the dependent variable.

3.4.3. Hypotheses

The study considers the following hypotheses:

- **Null Hypothesis (H0):** There is no significant relationship between the GDP and the performance of fossil fuel and hydroelectricity generation sectors in the UK.
- **Alternative Hypothesis (H1):** There is a significant relationship between the GDP and the performance of fossil fuel and hydroelectricity generation sectors in the UK.

The decision-making process for these hypotheses involves analyzing the p-values obtained from the regression analysis:

If the p-value is less than 0.05 (or any other chosen significance level), the null hypothesis is rejected, indicating a significant relationship. If the p-value is greater than or equal to 0.05, the null hypothesis is not rejected, indicating no significant relationship.

3.4.4. Statistical Tests

To ensure the robustness of the regression model, several statistical tests are conducted:

F-test: Used to determine if the overall regression model is a good fit for the data.

t-test: Used to determine the significance of individual regression coefficients.

The F-test statistic is calculated as:

$$F = \frac{MSR}{MSE} \quad (6)$$

Where: MSR is the mean square regression, MSE is the mean square error.

The t-test statistic for each coefficient β_i is calculated as:

$$t = \frac{\beta_i}{SE(\beta_i)} \quad (7)$$

Where: $SE(\beta_i)$ is the standard error of the coefficient β_i.

4. Results

4.1. Descriptive Analysis

Table 1 presents descriptive statistics for three variables: GDP, MS, and SS, each measured in billion pounds. The mean, representing the average value across 25 observations, is 1965.12 billion pounds for GDP, 24.29 billion pounds for MS,

and 77.15 billion pounds for SS. The median, which is the middle value when the data are ordered, is 2041.80 billion pounds for GDP, 23.07 billion pounds for MS, and 75.14 billion pounds for SS.

Table 1 Descriptive analysis

Statistic	GDP (Billion Pounds)	MS (Billion Pounds)	SS (Billion Pounds)
Mean	1965.12	24.29	77.15
Median	2041.80	23.07	75.14
Maximum	2803.59	33.09	119.36
Minimum	853.91	18.69	39.56
Std. Dev.	607.28	4.27	23.56
Skewness	-0.48	0.77	0.24
Kurtosis	2.18	2.33	2.03
Jarque-Bera	1.67	2.96	1.22
Probability	0.43	0.23	0.54
Observations	25	25	25

The maximum value, indicating the highest observed value, is 2803.59 billion pounds for GDP, 33.09 billion pounds for MS, and 119.36 billion pounds for SS. Conversely, the minimum value, indicating the lowest observed value, is 853.91 billion pounds for GDP, 18.69 billion pounds for MS, and 39.56 billion pounds for SS.

Standard deviation measures the dispersion or variability around the mean, with values of 607.28 billion pounds for GDP, 4.27 billion pounds for MS, and 23.56 billion pounds for SS. Higher standard deviation values indicate greater variability.

Skewness assesses the asymmetry of the data distribution, with GDP being negatively skewed (-0.48) and MS and SS being positively skewed (0.77 and 0.24, respectively).

Kurtosis measures the peakedness or flatness of the data distribution. Higher values indicate a more peaked distribution, with kurtosis values of 2.18 for GDP, 2.33 for MS, and 2.03 for SS.

The Jarque-Bera test evaluates the normality of the data distribution, with higher values suggesting a departure from normality. All variables exhibit normal distribution, as indicated by probability values greater than 0.05.

4.2. Time Plot for the Dependent and Independents Variables

In Figure 1, the GDP plot reveals an overall upward trend, indicating economic growth over the years. However, this growth appears to be irregular, with fluctuations that suggest periods of economic expansion and contraction.

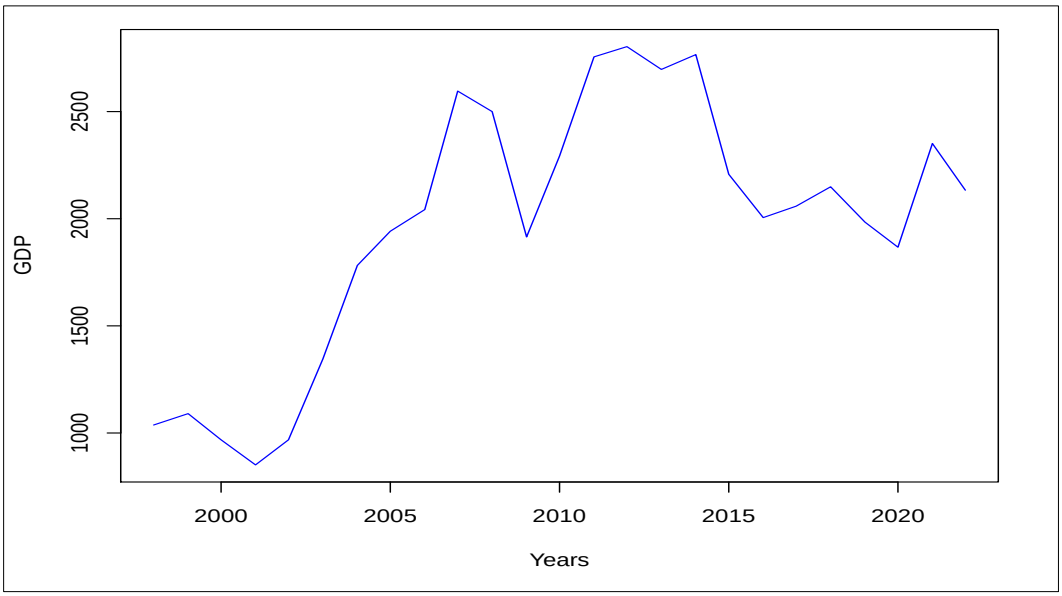

Figure 1 GDP time series of the study

Figure 2 shows the time plot for Money Supply (MS). Unlike GDP, the MS plot exhibits a consistent linear growth pattern. This steady increase implies a systematic expansion in the monetary base over time, potentially due to deliberate policy measures aimed at controlling liquidity and stimulating economic activity.

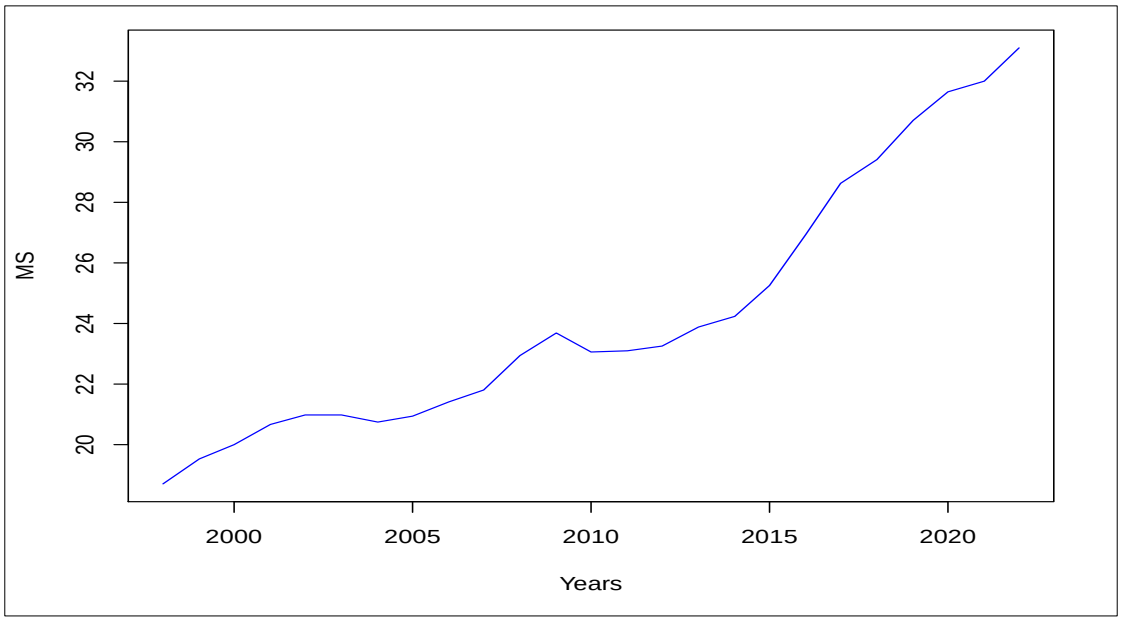

Figure 2 Time series of MS profitability

Similarly, Figure 3 presents the Stock Market Performance (SS) over the same period. The SS plot also follows a linear trajectory, indicating a continuous rise in stock market profitability. This consistent growth in the stock market might reflect increasing investor confidence, better corporate performance, and effective regulatory frameworks promoting market stability.

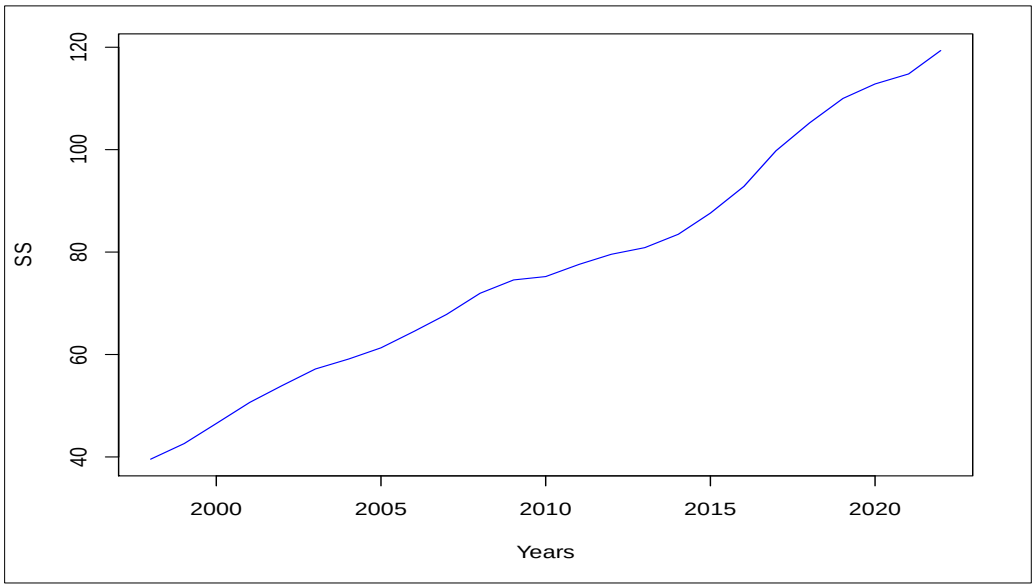

Figure 3 Time series for SS profitability

While GDP shows an overall rise with irregularities, the linear growth patterns of MS and SS suggest a more predictable and stable increase in these variables over the years.

4.3. Relationships Between the UK GDP, with MS and SS Profitability

Correlation matrix, elucidating the relationships among three variables: GDP, MS, and SS is shown in Figure 4. The values within the matrix represent correlation coefficients, indicating the strength and direction of these relationships. The analysis reveals a weak to moderate positive correlation of 0.39 between GDP and MS, a moderate positive correlation of 0.56 between GDP and SS, and a robust positive correlation of 0.98 between MS and SS.

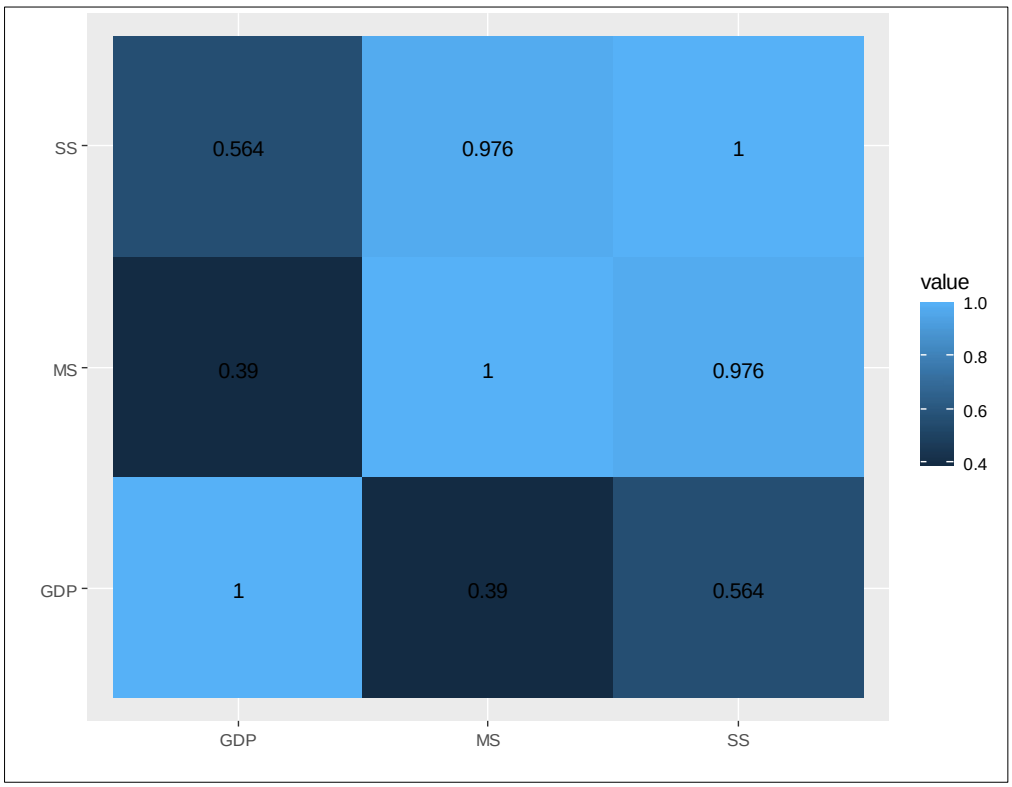

Figure 4 Correlation matrix for Variables Relationships

4.4. Impact of MS and SS Profitability on the Economic Growth of UK

From the regression results in Table 2, the coefficient estimate for the MS variable is -493.43. This is statistically significant with a t-value of -10.08 and a very low p-value (1.05×10^{-9}). This suggests that the MS has a significant and negative impact on the outcome variable (GDP). Specifically, for each unit increase in the MS, the estimated GDP decreases by 493.43 units, holding all other variables constant.

Table 2 Regression analysis

	Estimate	Std. Error	t value	Pr (>|t|)	R-squared
(Intercept)	6088.34	542.88	11.21	1.44×10^{-10}	0.8787
MS	-493.43	48.96	-10.08	1.05×10^{-9}	
SS	101.94	8.88	11.48	9.28×10^{-11}	

The coefficient estimate for the SS variable is 101.94. This is also statistically significant with a t-value of 11.48 and a very low p-value (9.28×10^{-11}). This indicates that the SS exerts a substantial and positive influence on GDP. Specifically, for each unit increase in the SS, the estimated GDP increases by 101.94 units, holding all other variables constant.

Additionally, the R-squared value of 0.8787 suggests that approximately 87.87% of the variability in GDP is explained by the MS and SS predictors. This indicates a strong fit of the model, with these predictors explaining a significant portion of the variation in GDP.

4.5. Model Prediction Equation

Table 3 and Figure 5 the actual values of our dependent variable (GDP) and the value predicted by the Linear Regression (LR) model. And from the chart, it can be seen that the predicted values of our model are close to the actual values, as they rise similarly over the years.

Table 3 Comparison of Actual and Predicted GDP Values for the Years 1998-2022

Years	Actual GDP	Predicted GDP
1998	1041.228	894.6322
1999	1090.41	795.5874
2000	968.3931	957.1606
2001	853.9119	1067.91
2002	969.8004	1236.973
2003	1346.67	1566.895
2004	1784.265	1878.022
2005	1940.352	2014.623
2006	2041.801	2110.282
2007	2593.747	2255.463
2008	2501.036	2107.158
2009	1915.051	2012.909
2010	2291.318	2368.55
2011	2756.666	2605.548
2012	2803.598	2728.949
2013	2696.921	2562.917
2014	2767.321	2646.276

2015	2207.379	2573.495
2016	2007.64	2266.333
2017	2057.712	2126.387
2018	2151.319	2304.283
2019	1986.68	2146.873
2020	1869.272	1977.082
2021	2352.477	1999.619
2022	2133.029	1924.073

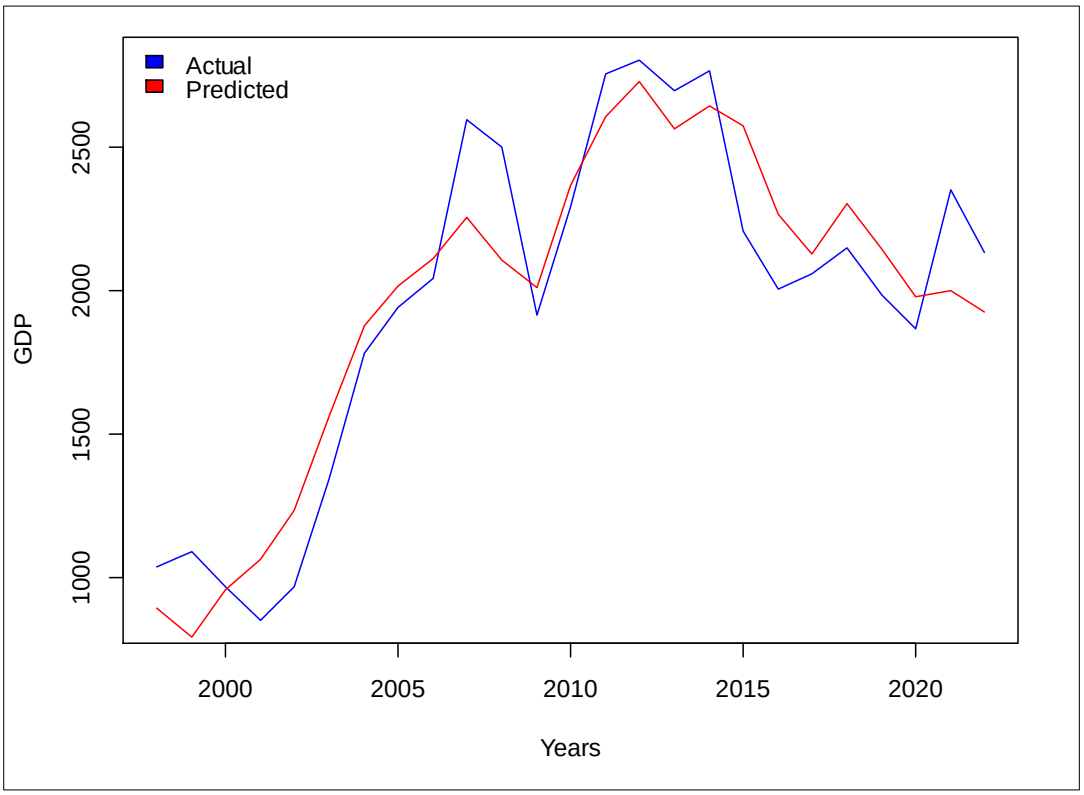

Figure 5 Model of GDP prediction against actual GDP

4.6. Vector Error Correction Model (VECM)

According to the ADF test results in Table 4, all variables are stationary but at different levels, which satisfies the use of vector autoregression (VAR) models. GDP is stationary at first difference I(1), while both MS and SS are stationary at second difference I(2), with none being stationary at level I(0).

Table 4 Augmented Dickey-Fuller Unit Root Test

Variables	At Level	At First Difference	At Second Difference	Order of Integration
	Prob	Lag	Prob	Lag
GDP	0.8344	0	0.0061	1
MS	0.8984	1	0.1215	0
SS	0.6218	1	0.1916	1

The Vector Autoregression (VAR) model presented here offers a comprehensive framework for analysing the dynamic interactions among GDP, MS, and SS variables. The provided equations and accompanying table provide valuable insights into how MS and SS profitability influence UK GDP.

The error correction coefficients indicate a long-term equilibrium relationship between the variables. For instance, the negative coefficient for D (GDP) (-1.077207) suggests that deviations from equilibrium in GDP are corrected over time. Similarly, the positive coefficient for D (MS) (0.001513) and the negative coefficient for D (SS) (-0.000114) indicate adjustment processes towards equilibrium for MS and SS, respectively.

The lagged differences elucidate short-term dynamics, revealing the impact of past changes in GDP, MS, and SS on current GDP. These coefficients, such as D (GDP (-1)), D(MS (-1)), and D(SS(-1)), capture the influence of lagged variables on the current period's GDP, shedding light on the system's dynamic behavior. By representing the first differences of the variables, D (GDP), D (MS), and D (SS) capture changes in these variables over time by representing the first differences. Lagged values of GDP, MS, and SS (e.g., GDP (-1), MS (-1), SS (-1)) are incorporated to account for temporal dependencies, reflecting the model's autoregressive nature.

Statistical measures such as R-squared and the F-statistic assess the model's overall fit and significance. High R-squared values for GDP (0.580565) and SS (0.650390) indicate a substantial portion of their variability is explained by MS and SS profitability, suggesting a meaningful relationship between these variables. The VAR model facilitates a nuanced analysis of the dynamic relationships among GDP, MS, and SS. By accounting for both short-term dynamics and long-term equilibrium, it offers valuable insights for policymakers and economists seeking to understand and predict economic phenomena.

4.7. Co-integration Test: Johansen Cointegration Test

The cointegration test is a statistical method used to evaluate the presence of a long-term relationship between two or more time series variables (Rezaee et al., 2020). It is particularly applicable when analyzing non-stationary variables that may share a common stochastic trend (Zhang et al., 2023).

Cointegration tests provide critical insights into long-term relationships among variables and have wide applications in macroeconomics, finance, and other fields where understanding equilibrium relationships is important.

Table 5 Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.674781	33.27503	29.79707	0.0191
At most 1	0.322426	8.563383	15.49471	0.4073
At most 2	8.68E-06	0.000191	3.841466	0.9907

The test results indicate that at the 5% significance level, the null hypothesis of "none" (i.e., no cointegrating equations) is rejected. This implies the presence of at least one long-term relationship among the variables.

The test also shows that the hypothesis of "at most 1" cointegrating equation cannot be rejected, as the test statistic is smaller than the critical value. Therefore, the data provides weak evidence for the presence of only one cointegrating equation.

However, the hypothesis of "at most 2" cointegrating equations is strongly rejected since the test statistic exceeds the critical value. Thus, the data suggest that the presence of more than two cointegrating equations is unlikely.

Unrestricted Cointegration Rank Test (Trace) results, as shown in Table 5, indicate at least one cointegrating equation among the variables. These findings confirm the existence of long-term relationships between MS profitability, SS profitability, and the UK's GDP.

4.8. Variance Decomposition

Variance decomposition analysis provides insights into variables' relative contributions to explaining their own variances within a system. When a variable explains all its own variance, it indicates that the variable's fluctuations or

changes are entirely driven by its own historical values, with no influence from other variables in the model (Koop, 2013).

From a theoretical perspective, variance decomposition in a VAR (Vector Autoregressive) model examines the relative contributions of individual variables in explaining variability or fluctuations within the system. It evaluates the extent to which each variable's past values, along with the values of other variables in the system, affect its own variance. This analysis provides insights into the intrinsic dynamics and interdependencies among variables within the model. It identifies key drivers of variability and helps understand the relative importance of endogenous variables in explaining their own fluctuations (Koop, 2013).

The theoretical interpretation of variance decomposition is rooted in the idea that variables in the system are influenced by their own lagged values and the lagged values of other variables. By decomposing the variances, researchers can quantitatively assess each variable's unique contribution and observe how their influence changes over time. Additionally, variance decomposition allows for the assessment of transmission channels and feedback mechanisms within the system, providing insights into dynamic interactions among variables and highlighting how shocks or changes in one variable propagate and affect the behaviour of other variables (Enders, 2014).

In the variance decomposition analysis of GDP, MS, and SS, the contributions of these variables to their variances vary over time. Initially, GDP explains all its own variance, while MS and SS have no input. However, as time progresses, MS and SS begin to explain portions of GDP's variance. Similarly, MS primarily explains its own variance, with a slight influence from GDP, while SS's variance is largely influenced by MS and GDP. This analysis underscores the interdependencies between variables, aiding in understanding their relative importance in explaining variances.

5. Discussion

The descriptive analysis reveals significant variability in GDP, MS, and SS over the observation period, highlighting the dynamic nature of these economic indicators. The positive trends observed in the time series plots for GDP, MS, and SS indicate overall economic growth, with MS and SS showing more consistent, linear increases compared to the more irregular pattern of GDP. This suggests that while GDP is influenced by a broader range of factors, MS and SS have been steadily rising, likely due to specific economic policies or market conditions (Ramallari & Merko, 2023).

The correlation analysis highlights the interrelationships among the variables. The moderate positive correlations between GDP and both MS and SS suggest that increases in money supply and social security expenditure are associated with higher GDP, supporting the idea that these factors play a role in driving economic growth. The strong correlation between MS and SS further indicates that these two variables are closely linked, potentially reflecting coordinated policy measures or economic conditions that simultaneously influence both.There exists a weak to moderate positive correlation (0.390) between GDP and MS profitability, suggesting that as GDP grows, there is a modest tendency for MS profitability to increase. This implies that economic growth may have a positive, albeit limited, influence on the performance of MS ventures (Priya & Aroulmoji, 2020; Gruhle & Harms, 2022). A moderate positive correlation (0.564) is observed between GDP and SS profitability, indicating that as GDP expands, there is a relatively stronger impact on the profitability of SS ventures. This underscores the significance of economic growth in bolstering the performance of SS enterprises (Sasaki, 2020).

The regression analysis has important policy implications. The negative impact of MS on GDP suggests that increases in money supply, beyond a certain point, may have detrimental effects on economic growth, possibly due to inflationary pressures or misallocation of resources. On the other hand, the positive impact of SS on GDP underscores the importance of social security expenditures in supporting economic growth (Lypnytskyi & Lypnytska, 2022; Kaplan et al., 2023). The strong fit of the regression model, as indicated by the high R-squared value, implies that MS and SS are significant determinants of GDP. This reinforces the need for policymakers to carefully consider the levels and changes in money supply and social security expenditures when devising economic strategies.

Most notably, a strong positive correlation (0.976) is identified between MS and SS profitability. This suggests that the two sectors are closely intertwined, with improvements in MS profitability typically associated with concurrent enhancements in SS profitability. The implications of this correlation are profound, highlighting the symbiotic relationship between these sectors within the economy (Chao et al., 2019; Tenucci & Supino, 2019).

The regression analysis further elucidates the relationship between these variables, revealing significant effects of both MS and SS profitability on GDP. Interestingly, the MS exerts a negative impact, while the SS exerts a positive one. This indicates that while the MS may hamper GDP growth, the SS plays a pivotal role in driving economic expansion. The

model exhibits high explanatory power, as evidenced by the elevated R-squared value, indicating that a substantial proportion of the variability in GDP is accounted for by the independent variables (MS and SS profitability). This underscores the robustness of the model in capturing the dynamics of the economic system. The presence of error correction coefficients suggests a long-term equilibrium relationship between GDP, MS profitability, and SS profitability. This implies that deviations from equilibrium are corrected over time, highlighting the stability of the economic system (Mundt et al., 2022).

The short-term dynamics, captured by lagged differences, illustrate the impact of past changes in GDP, MS profitability, and SS profitability on current GDP. The Unrestricted Cointegration Rank Test (Trace) results affirm the presence of at least one cointegrating equation among the variables, indicating long-term relationships between MS profitability, SS profitability, and GDP (De Robertis & Kondi, 2022). Moreover, the possibility of multiple cointegrating equations suggests intricate linkages between these variables, further emphasising their interconnectedness (Shah & Gizaw, 2023).

The VECM analysis provides deeper insights into the dynamic adjustments and long-term equilibrium relationships among GDP, MS, and SS. The error correction mechanism indicates that deviations from the long-term equilibrium are corrected over time, suggesting that the economy tends to revert to a stable state despite short-term fluctuations (Duguleana, 2021). The findings from the cointegration test confirm the existence of long-term relationships among GDP, MS, and SS. This implies that any long-term economic strategy must consider these interdependencies to achieve sustainable growth.

Variance decomposition analysis highlights the evolving contributions of MS and SS to GDP variability over time. Initially, GDP fluctuations are primarily self-driven, but as time progresses, MS and SS begin to play a more significant role. This dynamic interaction suggests that while short-term economic policies might focus on immediate GDP drivers, long-term strategies need to incorporate the influences of money supply and social security to manage economic variability effectively.

Understanding the interplay between the industrial and SSs and their influence on the UK's GDP is vital for economic analysis and policymaking (Trofimov, 2023). Consequently, numerous researchers have delved into this subject to shed light on the matter. According to Szirmai (2009), there are unique opportunities for capital accumulation in the manufacturing industry.

According to Atiah (2019), the SS accounts for more than two-thirds of GDP in developed countries, significantly contributing to economic growth. The empirical findings support the theory that the services sector is now the primary engine of growth. However, the percentage of manufacturing remains positively correlated with economic growth, particularly during periods of growth acceleration.

The UK is a key market for international investors, with a higher amount of foreign money invested in British assets and shares than in any other country outside of the US and Hong Kong. Approximately £600 billion worth of foreign investments were made in the country over the past ten years, which is equal to one-third of its GDP (Njoroge, 2021)

. According to statistics, capital inflows are crucial for British companies and the nation's economy as a whole. Nearly 95% of net inflows in 2015 came from the financial services sector in the United Kingdom.

6. Conclusion

This study examines the impact of MS and SS profitability on the UK's economic expansion, employing correlation, regression, cointegration, and variance decomposition analyses. Findings reveal positive correlations between GDP and both sectors, with the SS showing a stronger effect. Regression analysis indicates significant impacts of both sectors on GDP, with the SS positively influencing GDP while the MS has a negative impact. Long-term equilibrium relationships between GDP and sector profitability are established, supported by cointegration tests. Variance decomposition analysis elucidates the interactions between GDP and sector profitability variations.

The study underscores the importance of the SS for economic growth, recommending policies to enhance productivity and innovation in this sector. Additionally, it highlights the need for measures to mitigate the negative impact of the MS on GDP. These findings align with previous research emphasizing the critical role of both sectors in driving economic growth. Policymakers are urged to prioritize policies fostering productivity and growth in both MSs and SSs to sustain economic development.

Policies aimed at enhancing the UK's manufacturing sector should include long-term investments, improvements in product markets, and incentives such as R&D tax credits. Strengthening the SS sector is crucial for boosting GDP, and creating a business-friendly environment that attracts investments, supports infrastructure development, and stimulates economic expansion.

Continuous monitoring and support for innovation and productivity within both sectors are essential. Evidence-based decision-making is crucial for effectively implementing policies that promote sustainable economic development.

Future research could explore the specific mechanisms through which SS profitability influences GDP growth in different economic contexts. Additionally, investigating how policies targeting MS and SS sectors interact and impact overall economic resilience and stability would be valuable.

Further studies could delve deeper into the comparative advantages of different industries within the MS and SS sectors and analyze how these advantages contribute to economic growth. Exploring the role of technological advancements and international trade dynamics on sectoral profitability and economic performance would also enhance our understanding of these relationships.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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