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Article

Sector Dynamics: Equity and fixed-income performance across market cycles

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SUMMARY

Investment decisions require balancing risk and return, which is a core principle of Modern Portfolio Theory. Understanding how different asset classes interact is essential for building resilient portfolios, especially as equity and fixed-income markets respond differently to economic conditions. We delve into the performance of the Standard and Poor's (S&P) 500 Information Technology and Financials equity sectors compared to their corresponding U.S. investment-grade fixed-income returns. Correlations were evaluated between sector returns and critical metrics such as price-to-earnings ratio, credit spreads, and government debt yields. Using data from 1995 to 2025, we analyzed the role of diversification in portfolio construction through Modern Portfolio Theory. We hypothesized that there would be measurable and negative correlations between S&P 500 equity sector returns and their corresponding investment-grade fixed-income spreads, and that these relationships would vary in strength across recession and expansion periods. Our results revealed notable relationships between equity and fixed-income performance across various economic cycles, emphasizing the importance of sector-specific strategies in managing risk. This analysis questions traditional views on the stability of investment-grade bonds, shedding light on the evolving dynamics of financial markets. Our research deepens the field's understanding of how diversification can optimize risk-adjusted returns, offering tactical insights for advancing portfolio management strategies and guiding future investment research.

INTRODUCTION

When private clients approach financial advisors for recommendations about investing their wealth, Harry Markowitz and his pioneering research regarding Modern Portfolio Theory (MPT) are often at the heart of these conversations. In 1952, Markowitz wrote about the concept of portfolio selection, which emphasized diversification and its impact on risk and return, and won Markowitz the Nobel Prize in Economic Sciences in 1990 (1). This work led to the discovery of the efficient frontier, which helped financial advisors craft an optimal portfolio asset allocation for their clients (1). The "60-40" portfolio is now considered a hallmark investment strategy where 60% of assets are invested in equities, with the other 40% in fixed income (2). Although many factors are at play, the essential premise is that the portfolio's equity portion provides the client with the opportunity for capital appreciation with more volatility. In contrast, the fixed income side of the portfolio, particularly when using investment-grade bonds, offers a generally more predictable income stream with less systematic risk exposure, also known as beta, the measure of an asset's volatility relative to the S&P 500. A value above one indicates higher volatility than the market and vice versa. This asset allocation has long been an industry standard, particularly for risk-averse clients seeking steady income alongside capital growth (3). By diversifying a portfolio with a mix of fixed income and equity holdings, investors have a better chance of meeting their financial goals (4). This approach prioritizes maintaining consistent market exposure over long investment horizons rather than attempting to profit from short-term market fluctuations, while combining lower-volatility income assets with higher-growth equities to support long-term goals such as retirement planning and wealth transfer. Financial advisors often complement this structure by tailoring fixed-income allocations for near-term needs while using equities for long-term growth opportunities.

Building on this foundation, later contributions by Burton Malkiel and John Bogle reinforced the importance of diversification and index-based strategies in navigating unpredictable market movements (4). Recent work extends Modern Portfolio Theory to sector-specific analyses, demonstrating how diversification across industries such as Information Technology and Financials can mitigate sector downturns (5). Together, these insights highlight the enduring importance of diversification, which not only motivates our focus on equity and fixed-income interactions at the sector level but also explains why these theories have garnered widespread support among research scientists and financial advisory firms.

However, a clear gap exists in how sector-specific equity and fixed-income returns behave in relation to each other across economic cycles. Most literature focuses on broad asset classes rather than correlations between sectors. Our work addresses this gap in knowledge through comparison and analysis of performance patterns of the Information Technology and Financials sectors, both in equities and investment-grade bonds, to evaluate their diversification benefits. Additionally, the research will investigate the correlations among these sector returns and other factors, including price-to-earnings (P/E) ratios, credit spreads, and government debt yields. The P/E ratio measures the price investors are willing to pay for a unit of earnings and is commonly used as an indicator of growth expectations and valuation. Credit spreads refer to the difference in yield between corporate bonds and comparable maturity treasury bonds, and they are particularly relevant here because wider spreads commonly reflect greater perceived credit risk. Yield

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is the income return on an investment, typically expressed as an annual percentage based on the investment's cost or market value. Finally, we looked at the betas of these different asset classes to investigate the premise of Markowitz's theories on diversification and asset allocation and identify potential new research areas.

Our hypothesis posits that there will be measurable and generally negative correlations between Standard & Poor's (S&P) 500 equity sector returns and their corresponding investment-grade fixed-income spreads, and that these relationships will vary in strength across recessionary and expansionary periods. Moreover, we aim to document performance patterns in the Technology and Financial sectors relative to the S&P 500 and other essential factors. By examining these relationships, we will draw connections between diversification and portfolio construction to evaluate whether these relationships are consistent between the equity and fixed-income asset categories across the economic cycle.

RESULTS

In this study, we investigated the relationships between equity sector returns and their corresponding investment-grade (IG) fixed-income spreads, with a focus on the Technology and Financials sectors of the S&P 500. The Information Technology and Financial sectors within the S&P 500 were selected because they are essential factors for the broader market and economy. From an equity perspective, the Information Technology sector is considered to have a higher beta, while from an investment grade perspective, the Financials sector has a higher beta (6). We also reviewed investment-grade bonds from these sectors to assess their performance and diversification benefits relative to equities.

The analysis was based on data from 1995 to 2024 for the S&P 500 Technology and Financials equity sectors as well as the US IG bonds for these same sectors. We included the three-month U.S. Treasury Bill (T-bill) yield and gross domestic product (GDP) growth rates as barometers for short-term and long-term factors that influenced the economy, providing insights into the relationships between the equities and fixed income markets relative to macroeconomic factors.

S&P 500 annual stock performance, defined here as annual percentage change in index price level, and average IG spreads showed a negative correlation. With a calculated correlation coefficient of -0.58 between S&P 500 performance and Financials IG options-adjusted spread (OAS) **(Table 1)**. In addition, the Pearson correlation coefficient (arbitrary unit) between S&P 500 annual percentage change and average IG spreads was calculated to be -0.66 **(Figure 1)**. This suggested a relationship where, when the spreads widened, the S&P 500 was likely to decrease in value. Valuation and short-term rate measures for the Technology sector were also examined, including annual price-to-earnings ratios and end-of-year three-month Treasury bill yields, illustrating the co-movement of Technology sector price-to-earnings ratios and end-of-year three-month Treasury bill yields over the period **(Figure 2).**

Another relationship that warranted consideration was that S&P 500 Financials sector annual stock performance (%) had a -0.48 correlation with Financial IG OAS and a -0.58 correlation with average total market IG spreads. This indicates that when financial fixed-income spreads and average total market IG spreads (sector-agnostic) both widened, it was likely that the financial stocks in the S&P 500 decreased in value. Interestingly, the general market had more correlation than the specific sector itself. The stronger correlation with the general market relative to sector-specific spreads indicates the potential influence of broader macro factors, such as changes in Federal Reserve monetary policy, GDP growth, or employment levels **(Figure 3)**.

Other statistical measures had important implications regarding diversified portfolio construction. The calculated correlations were 0.90 between Information Technology IG OAS and Financials IG OAS, and 0.96 with the average total market IG spreads for the total market **(Figure 4)**. Finally, the -0.46 correlation between end-of-year (EOY) three-month T-bill yield and average GDP supported exploration **(Figure 4)**. This highlighted that short-term rates and expectations significantly impacted market confidence.

The relationships between various sectors and asset classes were shown in a correlation matrix that highlighted the strength and direction of these connections **(Table 2)**. This matrix helped to identify the strength and direction of relationships between different industries and asset classes, which provided insight into the diversification potential of combining these investments in a portfolio. The correlations emphasized the relationships between equity sectors and their corresponding investment-grade bonds. The negative correlations between the equity returns and average IG spreads suggested that as credit spreads widened, equity returns tended to decline. This reinforced the importance of fixed income as a hedge against equity volatility. Additionally, the relatively low correlations between sectors indicated the diversification benefits of combining different sectors within a portfolio.

DISCUSSION

This study identified several important relationships between equity returns, IG fixed income performance, and macroeconomic factors. Broadly, equity markets

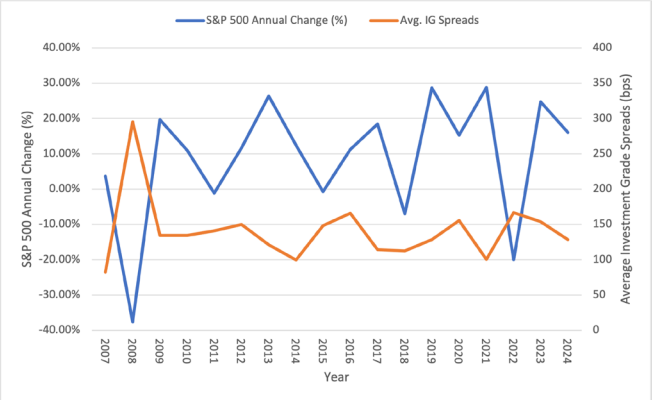

Figure 1: S&P 500 Annual Changes vs. Average IG Spreads (2007–2024). Line graph illustrates the annual percentage changes in the S&P 500 (left y-axis) and the average investment-grade (IG) spreads in basis points (bps) (right y-axis). Data represent observed trends across the 2007–2024 period, highlighting the inverse movement between S&P 500 performance and IG spreads.

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Metric	Recession Periods	Expansion Periods	Trend
S&P 500 Annual Change (%)	-28.77%	9.33%	↓ Lower in recessions
S&P 500 Technology Annual Change (%)	-36.07%	15.40%	↓ Lower in recessions
S&P 500 Financials Annual Change (%)	-34.65%	9.56%	↓ Lower in recessions
Info-Tech IG Annual Performance (%)	-9.00%	4.51%	↓ Lower in recessions
Financials IG Annual Performance (%)	-10.71%	3.98%	↓ Lower in recessions
Avg. IG Spreads	230.81	140.13	↑ Higher in recessions
EOY 3-month T Bill Yield (%)	1.64%	2.50%	↓ Lower in recessions
GDP Growth Rate (%)	1.04%	2.83%	↓ Lower in recessions

Table 1: Summary Statistics of Sector Performance During Recession and Expansion Periods. The table shows the performance of various financial metrics during recession and expansion periods. Metrics include the S&P 500 Annual Change (%), sector-specific performance (Technology and Financials), Investment-Grade (IG) annual performance, Average IG Spreads, EOY 3-month T-Bill Yield (%), and GDP Growth Rate (%). The data highlights contrasting trends, with significantly lower performance and wider spreads during recessions compared to expansions.

and IG spreads exhibited a negative correlation, with widening spreads often accompanying declines in stock performance. Sector-level analysis showed that Technology and Financials displayed distinct dynamics: Technology tended to be more volatile but less tied to its IG debt, while Financials demonstrated stronger equity–debt linkages. In addition, fixed income spreads were highly correlated across sectors, suggesting that shifts in monetary policy may have outweighed sector-specific effects. These findings provide context for how macroeconomic conditions, sector dynamics, and diversification interact in portfolio construction.

A recession is commonly defined by sustained declines in broad economic activity. During recessionary periods within our dataset, specifically years 2009 and 2020, IG spreads widened. When corporate spreads widen, the yield on a corporate bond increases further compared to a government bond of roughly the same duration. Given the perceived risk, an investor requires more compensation (in the form of yield) to purchase the corporate bond. Additionally, when credit spreads widen, this signals that the market views IG bonds as riskier, with a heightened probability of default. The correlation between the S&P 500 and corporate bond yields suggests that as corporate spreads widen (increase), the S&P 500 is more likely to decrease in value.

Conversely, as credit spreads narrow, the S&P 500 was likely to increase in value. When spreads widen, this is correlated with the stock market decreasing in value, which supports the negative correlation between these factors. The data show that higher S&P 500 Technology Annual P/E ratios contrasted with periods of increasing yield rates, which are typically linked with a tighter money supply by the Federal Reserve (3).

IG debt plays a central role in calculating corporate spreads, as these spreads measure the difference in yield between IG corporate bonds and comparable-maturity U.S. Treasury securities. Although IG debt is viewed as a source of diversification for equities, it is interesting to note that corporate spreads have a strong relationship with large-cap equities. The observed correlations between S&P 500 performance, corporate bond yields, and IG spreads require further exploration. These results suggest that fixed-income spreads are highly correlated across sectors, which could mean that average spreads across all industries relative to government risk-free rates are critically important and may outweigh sector-specific effects. Corporate spreads widened and narrowed in a correlated fashion based on these changes in government rates. Our results suggest that this relationship is significant and may point to predictive factors worth exploring further.

At the same time, sector performance under varying economic conditions highlighted how macroeconomic indicators influenced returns **(Table 1)**. Sector returns tended to fluctuate depending on the broader environment. For example, the Technology sector showed a notable increase in returns during recessionary periods, which may seem counterintuitive but could be linked to heightened demand for cost-reducing technologies and early-cycle investments. In contrast, the Financials sector performed better during expansionary periods, reflecting its sensitivity to economic growth.

Nonetheless, the S&P 500 has robust correlations of 0.87 with the S&P 500 Technology sector and 0.80 with the S&P 500 Financials sector but only a 0.46 correlation with the Information Technology IG annual performance and 0.50 with the Financials IG annual performance, so there are some diversifying benefits between equity and fixed income exposure. This finding is consistent with Markowitz's Modern Portfolio Theory, which emphasizes that combining assets with imperfect correlations can reduce overall portfolio risk and improve risk-adjusted returns. The relationship between the S&P 500 Technology Annual P/E ratio and the EOY three-month T-Bill yield demonstrated an intriguing, albeit counterintuitive, trend.

Another interesting finding is that the S&P 500 Technology annual performance sector was only 0.13 correlated with the S&P Technology P/E ratio, and 0.04 correlated with average

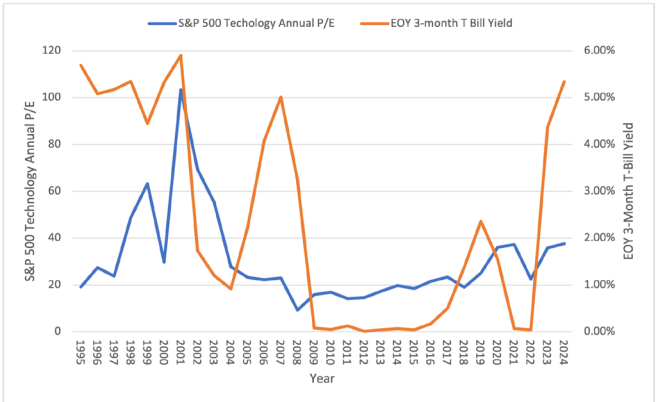

Figure 2: S&P 500 Technology Annual P/E Ratio vs. EOY 3-Month T-Bill Yield (1995–2024). Line graph showing the S&P 500 Technology Annual Price-to-Earnings (P/E) ratio (left y-axis) and the End-of-Year (EOY) 3-Month T-Bill yield (right y-axis) from 1995 to 2024. The data highlights an inverse relationship between growth expectations in the Technology sector (P/E ratios) and short-term interest rates (T-Bill yields), indicating the higher yields often coincide with lower growth valuations.

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Metric	S&P 500 (%)	Tech (%)	Tech P/E	Fin (%)	Fin P/E	Tech IG (%)	Tech IG OAS	Fin IG (%)	Fin IG OAS	Avg IG OAS	3M T-Bill	Average GDP	GDP Growth Rate
S&P 500 (%)	1.00												
Tech (%)	0.87	1.00											
Tech P/E	-0.08	0.04	1.00										
Fin (%)	0.80	0.48	-0.07	1.00									
Fin P/E	0.05	0.18	-0.14	-0.04	1.00								
Tech IG (%)	0.46	0.39	0.00	0.34	0.30	1.00							
Tech IG OAS	-0.61	-0.51	-0.23	-0.51	0.08	-0.30	1.00						
Fin IG (%)	0.50	0.50	0.25	0.49	0.36	0.82	-0.42	1.00					
Fin IG OAS	-0.58	-0.50	-0.35	-0.48	0.08	-0.24	0.90	-0.22	1.00				
Avg IG OAS	-0.66	-0.55	-0.34	-0.58	0.09	-0.23	0.96	-0.37	0.93	1.00			
3M T-Bill	0.09	0.13	0.39	0.10	-0.17	0.13	0.10	0.00	0.10	0.10	1.00		
Average GDP	-0.06	-0.01	-0.25	-0.20	-0.05	-0.33	0.02	-0.27	-0.14	-0.14	-0.46	1.00	
GDP (%)	0.28	0.14	0.09	0.42	-0.57	-0.29	-0.34	-0.25	-0.35	-0.38	0.24	-0.19	1.00

Table 2: Correlation Matrix of Sector Returns Between Equities and Bonds. Heatmap showing the pairwise Pearson correlation coefficients calculated between each pair of variables, including equity returns (S&P 500, Tech, Financials), valuation measures (P/E ratios), investment-grade bond performance (Tech IG, Fin IG), credit spreads (OAS), and macro indicators (3M T-Bill yield, GDP). Correlations were calculated using the Pearson method, dividing the covariance between each pair by the product of their standard deviations. Data highlight strong correlations within equity sectors and between bond sectors, with weaker or negative correlations between equities and Average IG Spreads, illustrating diversification benefits when combining less-correlated assets in a portfolio. Note: Positive correlations are represented in blue (darker blue means stronger positive correlation), while negative correlations are represented in red (darker red means stronger negative correlation), indicating the strength and direction of relationships across asset classes.

GDP growth. The S&P 500 Technology sector is often considered a source of growth in portfolios, particularly in the USA. These results suggest that simply looking for "cheap" Technology stocks (low P/E ratio) during times of economic strength does not lead to alpha generation in the sector (7). This strategy may seem appealing because strong economic conditions are often associated with rising corporate earnings, which can make undervalued stocks appear poised for growth. Our results align with Malkiel's argument that low valuations can coincide with the end of an earnings cycle, when performance is about to decline, while higher valuations may appear earlier in the cycle when growth prospects and returns are stronger (4).

The P/E ratios in our dataset were weakly correlated with Technology sector performance. When a company grows quickly and earnings rise rapidly, investors often "pay extra" for this growth, leading to elevated P/E ratios. However, when the company matures and growth slows, the P/E ratio will decrease, sometimes rapidly. Although the company will look reasonably valued, it will likely not have the earnings momentum that it had before to excite the market (8). It may even underperform the broader market despite now being reasonably priced. Another issue may be that many Technology companies are cyclical businesses that require capital investment and can see their earnings profile wiped out at the end of a market cycle during a contraction. This means when a product's stocks look cheap, they are at the end of a cycle and earnings are about to plummet (i.e., "cheap for a reason"). However, when this happens, some market pundits contend this is when a company's share price is more attractive due to valuation. Therefore, one could argue that when a cyclical business looks expensive on short-term earnings projections, this is when you want to buy the stock, and when it looks cheap (due to peak earnings), this is when you want to sell the stock.

These patterns emphasized the importance of adopting sector-specific strategies tailored to different economic climates across the business cycle **(Table 1)**. Additionally, the Technology sector tends to exhibit more seasonality than the Financials sector, partly due to the cyclical and volatile nature of semiconductor orders, Q4 budget flushes, and patterns in software and hardware spending that often peak around product launches and holiday periods (9). In future research, we would be interested in testing whether Technology stocks are leading indicators of market performance, and Financials stocks are lagging ones. Our findings provided important historical insights into how economic indicators may have influenced subsequent market performance. By quantifying market expectations based on historical data this could lead to more accurate predictions and generate strategies to anticipate market inflection points. While this seems to be the opposite of the Efficient Market Hypothesis, this pathway is certainly worth exploring (10).

Interestingly, the S&P 500 Information Technology returns beta was 1.59 compared to the S&P 500 Financials returns beta being 1.03, which aligned with our hypothesis (**Table 3**). Consistent with their growth-oriented portfolio, Information Technology stocks were anticipated to have more volatility relative to the Market. However, the Information Technology IG returns beta was 0.19, while the Financials IG returns beta was 0.29. This may be because, despite their earnings volatility, many information technology companies tend to have balance sheets that are flush with cash. Apple, for instance, currently has $134 billion in cash but only $92 billion in debt (11). Meanwhile, Nvidia has $53.7 billion in cash with only $8.5 billion in debt (12). Although these are just a few examples, Information Technology companies have conservative balance sheets despite being exposed to volatile earnings cycles. So, while the earnings streams are more volatile, which may contribute to a higher P/E that is relatively

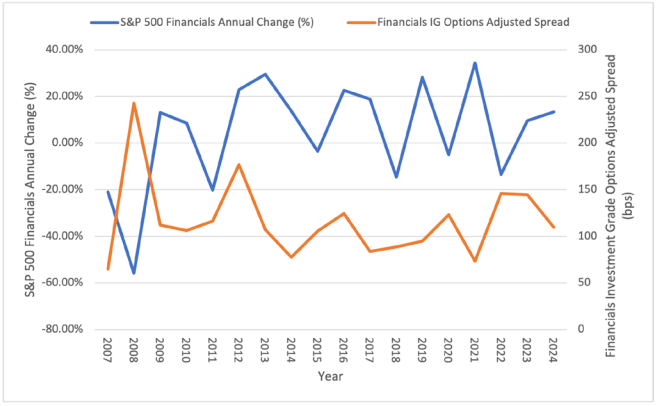

Figure 3: Financials Sector Performance vs. IG Spread Correlations (2007–2024). Line graph showing the annual percentage changes in the S&P 500 Financials sector (left y-axis) compared to Financials IG Options Adjusted Spreads in basis points (right y-axis) from 2007 to 2024. The data highlight an inverse relationship, suggesting that wider spreads are associated with weaker Financials sector performance.

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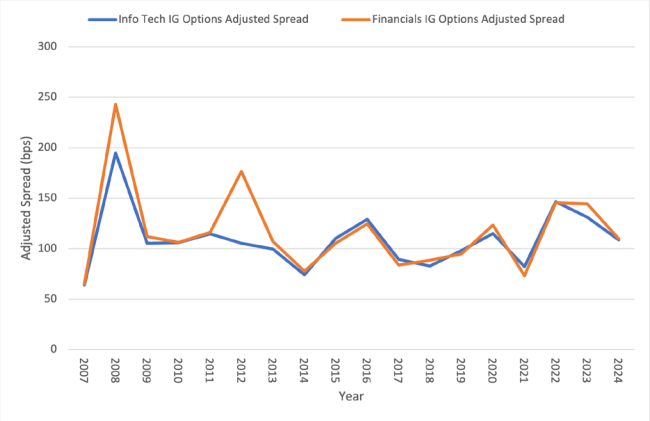

Figure 4: Info-Tech IG Options Adjusted Spread vs. Financials IG Options Adjusted Spread (2007–2024). Line graph showing the Info-Tech IG Options Adjusted Spread and Financials IG Options Adjusted Spread in basis points from 2007 to 2024. The data highlights the strong positive correlation between these two sectors' spreads, indicating that broad macroeconomic conditions, such as changes in interest rates and overall credit risk sentiment, tend to move investment-grade spreads for different sectors in tandem.

uncorrelated with sector-wide share price performance, Information Technology IG debt is viewed as a less volatile alternative to Financials IG Debt.

The correlation analysis supports MPT. We observe that despite the S&P 500 having a 0.80 correlation with S&P 500 Financial sector returns and a 0.87 correlation with S&P 500 Technology sector returns, those two sectors have only a 0.48 correlation with each other. This means that owning only stocks in the technology or financial sector(s) is riskier than holding the broader S&P 500, but combining both sectors reduces sector-specific risk and provides greater diversification, leading to better risk-adjusted returns over the long term. Although their correlations with the S&P 500 are moderate, they are not equal to one, so unique sector risks remain that diversification can help mitigate (13). This supports the premise of MPT on portfolio construction in that diversification is the gateway for improved risk-adjusted returns.

One data point that surprised us was the lack of correlation that average GDP had with equity returns and, in the case of Financials, even had a -0.20 correlation. Furthermore, average GDP was even less correlated with IG fixed income performance and OAS. Although this area requires more research, these findings may reflect limitations in the effectiveness of market timing strategies. Sometimes, you will read in the newspapers that economic data is good, and the article is written to imply that this is an excellent time to get into the Market. The average GDP may seem to be an uncorrelated variable or a lagging indicator. Therefore, buying stocks due to published positive GDP results appears unwise. Additional research on this topic may help reveal more about this issue. This observation is consistent with prior research showing that financial market development metrics, like liquidity and bank credit, predict economic performance more robustly than broad macro indicators alone (14). Nevertheless, these results indicate that reliance on lagging indicators such as average GDP growth may result in missed investment opportunities. In contrast, leading indicators may offer greater explanatory and predictive value in assessing market dynamics and warrant further investigation (15).

A primary limitation is data. Our data sources provided only annual data and, in a couple of cases, quarterly data. When we could not get quarterly data, we opted only to use yearly data rather than attempt to smooth the data to a quarterly format. However, we believe it would be more interesting to see the monthly and daily data trends. If we attempt to build a quantitative investment model, monthly or daily data may be required to help decipher more precise relationships.

Another consideration that could be of interest is how international developed markets and emerging markets trended with the United States and how much diversification they offer. It is possible that many large US companies are spread worldwide and, in themselves, international microcosms, in a way. We are moderately skeptical about how much diversification the international markets offer and if the diversification benefits vary among the different asset classes. However, it is interesting that the US stock market seems so growth-heavy while the European one seems so value-heavy (16). Our future research will aim to quantify whether this is the case and to further investigate the associated diversification opportunities. Beyond that, the European market appears to trade at lower valuations than the US market, reflected in its comparatively lower P/E ratios. This difference could be due to factors such as different growth prospects, the size of their Information Technology sectors, transparency, liquidity, tax policies, or a combination of some of these factors. Other topics we would like to investigate that are explicitly related to the work done here include understanding leading and lagging indicators and expanding this research to encompass other sectors and asset classes.

Although the principles of diversified portfolio theory are well established, the predictability of this relationship has been widely and justifiably questioned. However, this work suggested that future research is warranted, and potentially very insightful observations could be attained. This exploration of financial strategies examined various factors that influenced how diversified portfolios between fixed income and equity asset classes helped clients achieve their goals. This analysis underscores the importance of aligning

Sector	Covariance with S&P 500	S&P 500 Returns Variance	Beta
S&P 500 Information Technology	0.0465	0.0293	1.59
S&P 500 Financials	0.0303	0.0293	1.03
Info-Tech Investment Grade (IG)	0.0055	0.0293	0.19
Financials Investment Grade (IG)	0.0086	0.0293	0.29

Table 3: Calculations of Covariance, Variance, and Beta for Selected Sectors. Table showing covariance with S&P 500 returns, S&P 500 variance, and beta values for Information Technology, Financials, Info-Tech IG, and Financials IG. Higher beta values indicate greater sensitivity to market movements.

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debt levels, corporate strategy, and market conditions when considering idiosyncratic risk. While the aggressive use of balance sheet resources can lead to potentially ephemeral growth and profitability, companies must consider the robust risk management necessary to mitigate the adverse effects of economic drawdowns. Moreover, low-debt strategies offer a safer, more stable approach, particularly valuable during periods of market volatility and economic uncertainty that could be viewed as "growth-limiting" in robust times. A balance is needed, and diversification helps achieve that symmetry. Furthermore, a group of securities could be considered riskier than another in one asset class, but the comparison could change in a different asset class. This suggests a very efficient market with effective pricing mechanisms, transparency, and potential investment opportunities. We are very excited about our findings thus far but believe considerably more work needs to be done.

MATERIALS AND METHODS

Data Acquisition

Data was sourced from multiple reputable and publicly available platforms for this analysis. FRED (Federal Reserve Economic Data) provided GDP growth rates and Treasury Yields. Yahoo Finance Public Libraries was used for P/E ratios, equity returns, fixed income returns, and yield spreads. Regarding data collection, historical financial data, including equity and fixed income returns as well as P/E ratios and spreads, were sourced from Yahoo Finance and the FRED and publicly available data from Bloomberg. Data covered annual returns from 1995 to 2024 for the S&P 500 and corresponding IG bonds when available.

Data Aggregation

Data aggregation was performed using Python, with the pandas library serving as the primary tool for data ingestion cleaning, alignment, and transformation. Raw financial and macroeconomic data was obtained from publicly available sources, including the Federal Research Economic Data database and Yahoo Finance. These data sets included equity index levels, sector-specific returns, P/E ratios, investment-grade credit spreads, and government yield series.

Data was imported into pandas data frames and standardized into consistent formats. Data fields were parsed into datatime objects and set as the index to enable time-series operations. All series were aligned on a common time index, and data frequencies were harmonized by resampling where necessary. Monthly observations were carried forward to the most recent available value to fill gaps, and annual values were computed from monthly data using percentage-change and aggregation functions. Duplicate entries were removed, and missing values were addressed using interpolation or forward-filling as appropriate to preserve continuity.

This research required broad market data at the S&P 500 level and sector-specific data for the Information Technology and Financials sectors. The equity and fixed income returns by sector were aggregated to understand their potential impact on broader market performance and to draw conclusions about diversification. P/E ratios and spreads were also collected to observe their insights across different market cycles and understand their perceived risk levels.

The aggregation workflow relied on standard pandas operations such as set_index, resample, pct_change, and merge. Descriptive statistics, including means, standard deviations, and extrema, were computed directly from the aggregated return series. Time-series visualizations were generated using matplotlib to confirm data integrity prior to formal statistical analysis.

Data Analysis

The primary methods include correlation and estimation of betas using Excel and Python for data aggregation, computational efficiency, and accuracy. The correlation analysis was performed to quantify the strength of relationships between various financial variables such as equity returns, investment-grade fixed-income returns, P/E ratios, and credit spreads. A correlation matrix was then created using Excel to quantify these relationships; thereby, the most robust relationships could be delineated. This correlation matrix helps highlight diversification benefits or risks, which are critical in portfolio selection.

Statistical Methods

The calculations of covariance, variance, and beta are detailed to give a clearer understanding of the methodology behind the analysis. Variance was calculated using the standard formula (**Equation 1**),

$$S^2 = \frac{\sum(x_i - \bar{x})^2}{(n-1)}$$

Variance measures how far each number in the set is from the mean, indicating the spread of the data.

Covariance between two return series was computed as (**Equation 2**)

$$cov_{x,y} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{(n-1)}$$

Covariance measures how two random variables change together. Determining the degree to which two asset prices move together is crucial in the financial world. A positive covariance indicates that the security returns move in the same direction, while a negative covariance indicates that they move inversely. The covariance between annual returns of the S&P 500 and the Technology sector was calculated to assess how closely their performance aligned each year.

Correlation coefficients were then derived by dividing the covariance by the product of the standard deviation of each variable (**Equation 3**):

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

The correlation coefficient was computed for each pair of sectors to interpret whether their returns moved in the same direction and to what extent.

Beta is a measure of the volatility of an asset in the market and was calculated as (**Equation 4**)

$$\beta = \frac{Cov\,(r_i,\ r_m)}{Var(r_{m)}}$$

the ratio of the covariance of the asset's returns with the market returns to the variance of the market returns. It is an

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important concept in the Capital Asset Pricing Model, which is utilized to predict the expected return of assets based on their beta and market return. The beta analysis measured the Information Technology and Financial sectors compared to the overall performance of the other markets. Beta values were calculated to provide a methodology to assess the risk associated with specific sectors relative to the S&P 500 and the fixed-income markets, and what conclusions could be drawn from these.

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