

# **Decoding Sector Valuation Dynamics: Exploring the Nexus of Company Fundamentals, Economic Indicators, and Equity Valuations via Predictive Analytics**

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## Précis

This study examines the key drivers of equity valuation across various sectors and industries. Equity valuation is a critical metric that captures a company's perceived worth and influences investment decisions, mergers and acquisitions, and risk management strategies. Understanding the primary factors impacting valuation is essential for market participants to make informed choices.

The research seeks to unveil determinants of equity valuation that may have been obscured by traditional linear regression techniques. With modern ensemble machine learning methods, particularly gradient-boosted decision trees, the study aims to leverage non-linear relationships among a diverse set of variables and fluctuations in stock prices, which serves as a proxy for shifts in company valuations.

The analysis employed both linear regression and gradient-boosted decision tree models to explain the variance in monthly stock returns across various sectors within the Global Industry Classification Standard (GICS). The results uncover substantial variations in the factors influencing equity valuation between sectors. Various commodities, economic factors, and company fundamentals emerged as the primary determinants, with their relative importance contingent upon the sector context. Particularly noteworthy is the consistent superiority of gradient-boosted decision tree models over linear regression methods, underscoring the significance of capturing intricate non-linear patterns in financial data analysis.

The identified drivers provide crucial insights that can enhance investors' decision-making, improve valuation modeling practices, and strengthen risk management strategies. By uncovering these pivotal factors, the study aims to guide market participants in navigating the complexities of financial markets with greater foresight.

Future research could explore the incorporation of additional data sources, such as forward guidance from companies, analyst forecasts, news events, and social media sentiment, to further enhance the predictive power of the models. Additionally, investigating industry-specific, sub-industry-specific, and global market dynamics could

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furnish valuable insights into the determinants of equity valuation transcending the context of the United States and broad sector approach.

Overall, this study contributes to a more comprehensive understanding of the dynamic forces shaping equity valuations, empowering investors, analysts, and industry stakeholders to make more informed decisions and refine their valuation methodologies.

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# **Decoding Sector Valuation Dynamics: Exploring the Nexus of Company Fundamentals, Economic Indicators, and Equity Valuations via Predictive Analytics**

The valuation of a company represents a pivotal endeavor in the dynamic landscape of financial markets, serving as a guiding compass for investors and shaping capital allocation decisions. This metric encapsulates a company's perceived worth, reflecting its financial health, growth prospects, and market standing. Understanding the primary drivers of equity valuation is critical for investors to make informed choices regarding stock selection, portfolio management, and risk mitigation strategies. Moreover, in mergers and acquisitions, precise and nuanced company valuations influence negotiations and strategic decisions that can restructure entire industries. As articulated by Koller, Goedhart, Wessels, et al. (2010, p. 3), "value is the defining dimension of measurement in a market economy."

Expanding upon the foundational work laid by Ely et al. (2007), Liu, Nissim, and Thomas (2002), Khan (2016), and Deng, Easton, and Yeo (2012), this study aims to delve into the determinants of equity valuations across diverse sectors and industries. While these prior studies have shed light on the varying influences of certain variables on company valuation within specific industry and sector contexts, their reliance on conventional linear regression methods may have overlooked the potential impacts of nuanced non-linear relationships and more intricate patterns on valuation dynamics.

Similarly, this research encompasses a broad spectrum of metrics, including commodities, economic indicators, and diverse company fundamentals, seeking to uncover the primary drivers of equity valuation within the Global Industry Classification Standard (GICS) sectors. Employing modern ensemble machine learning techniques, such as gradient-boosted decision trees, harnesses relationships that may have eluded previous linear regression analyses. Thus, this study aims to offer a more comprehensive and holistic understanding of the key factors driving fluctuations in valuation.

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Acknowledging the unique characteristics and complexities inherent in various sectors, as emphasized by Li (2021), this research endeavors to offer empirical insights that equip market participants with a deeper comprehension of the factors impacting sector-specific valuations with enhanced accuracy and foresight. By decoding these pivotal drivers, this study also aims to steer risk management and speculative strategies, facilitating the anticipation of potential valuation reactions to shifts in the identified determinants.

Moreover, valuation methodologies like Discounted Cash Flow (DCF) analysis and comparable company analysis heavily hinge on underlying assumptions, profoundly influencing the resulting valuation estimates. Through the identification and prioritization of key drivers that may have been previously overlooked or undervalued, there lies the opportunity to refine and optimize due diligence resource allocation in valuation modeling endeavors.

## Methodology

### Data Collection

To construct the dataset, historical daily stock prices, quarterly financial statements (10-Q Filings), and earnings call dates were collected for companies contained within the S&P 500, 400, and 600 indices. Stock data and 10-Q financials were sourced from Yahoo Finance, while the respective earnings call dates and times were collected through the Stocktwits API. Various commodity prices, economic indicators, and other market factors were retrieved from Yahoo Finance and the Federal Reserve Economic Data (FRED) database.

The dependent variable is the percentage change in a stock's adjusted closing price from the previous period, representing the change in a company's valuation. Independent variables include the percent change for a diverse set of company fundamentals (e.g. revenue, profitability ratios, cash flows), commodity prices, economic indicators, and other market factors potentially influencing equity valuations, refer to Table A1 in the appendix for a comprehensive list of variables.

A monthly time frame was analyzed, spanning from January 25, 2014, to February

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17, 2024, encompassing 525 weeks (approximately 10 years). Percent changes in company fundamentals and select economic indicators reported quarterly were calculated based on their last release.

### Data Preprocessing

The raw data underwent several preprocessing and analysis steps to handle outliers and missing values.

For the dependent variable, monthly stock returns, the top and bottom 15 values for each sector were explored to identify potential extreme outliers. Observations due to extraordinary events were removed (e.g. GameStop's short squeeze in 2021, failed acquisitions, bankruptcy) as well as improper historical data for IPOs. Further outlier treatment involved Winsorizing returns to within 4-6 interquartile ranges (IQRs) from the median on a per-sector basis.

To address potential autocorrelation stemming from seasonality, new features were incorporated with lagged values spanning 3, 6, or 12 months. The selection of specific lags for each GICS sector was guided by autocorrelation function plots depicting the median percentage change of each company fundamental. This approach mitigates the effects of seasonal patterns in an overall sector's financial metrics on the model.

Missing values for independent variables were imputed with 0, representing no change, when there was no economic data release or earnings call that particular month. The independent variables were then standardized. Potential outliers for the independent variables were identified and removed using the DBSCAN clustering algorithm for each GICS sector (Ester, Kriegel, Sander, Xu, et al., 1996).

### Model Development

Both a multivariate linear regression model from the Python library cuML and a gradient-boosted decision tree regression model (LightGBM) were trained for selected<sup>1</sup> GICS sectors/industries to explain the variance in the percentage change in stock prices based on the percentage change in the independent variables (Raschka, Patterson, & Nolet, 2020; Zhang, Si, & Hsieh, 2017).

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<sup>1</sup> Refer to Table A2 in the appendix for selected sectors/industries.

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A 5-fold cross-validation technique was employed to assess the models during both variable selection and hyperparameter tuning stages, aiming to mitigate potential overfitting of the models and to maximize the generalizability of the findings. These folds were stratified to ensure an equal representation of earnings releases within each fold.

A backward stepwise regression approach was used to address multicollinearity and retain the most important independent variables for each model. Highly correlated variables were identified using correlation matrices, scatter plots, and Variance Inflation Factor (VIF) analysis. The groups of correlated variables identified across the full dataset were:

**Table 1**

*Correlated Variable Groups*

Net Income	Debt Ratio	Total Revenue	EBIT	Current Ratio	Cash Flow Margin	Tangible BV per Share	Gold	Copper	Wheat
ROA	Debt to Equity	Operating Revenue	Interest Coverage	Quick Ratio	CROA	BV per Share	Silver	Aluminum	Corn
Basic EPS	Assets to Equity				Cash Flow to Debt		Platinum		Soybean
ROE									
Net Profit Margin									

Subsequently, each variable within its group of correlates underwent thorough testing in each model. The individual variable that contributed to the highest average cross-validated  $R^2$  value among its correlates was retained. After mitigating multicollinearity, variables were systematically eliminated from the model to maximize the average cross-validated  $R^2$ , thereby removing variables that did not enhance nor contribute to the predictive capability of the models.

Finally, cross-validated hyperparameter tuning was conducted on the linear regression model (Elastic Net) and the gradient-boosted decision tree model (LightGBM) in an effort to optimize model performance and stabilize the remaining variables through regularization.

## Model Rationale

The methodology employed in this study leverages regression techniques to uncover the drivers influencing equity valuations by explaining the variance in stock returns. The percentage change in stock prices as the dependent variable provides a

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direct window into how various financial metrics and economic factors impact a firm's market value. Regression analysis allows for quantifying the relationships between these independent variables and shifts in company valuation. By using gradient-boosted decision trees (LightGBM), analysis can flexibly capture complex, non-linear patterns that meaningfully contribute to movement in valuations obscured by traditional linear approaches. The variable selection process retains the most influential drivers while mitigating multicollinearity concerns. Ultimately, uncovering these determinants by explaining stock return variance elucidates the factors driving changes in valuations within each sector's context. This crucial insight allows market participants to refine valuation modeling due diligence practices and inform speculative strategies by anticipating potential reactions to changes in identified drivers. Furthermore, it contributes to strengthening risk management protocols through proactive measures that mitigate potential risks associated with fluctuations in the identified determinants.

## Analysis and Results

Linear regression models can be interpreted using the coefficients of the standardized independent variables, while gradient-boosted decision tree models can be interpreted using SHAP (SHapley Additive exPlanations) values. SHAP values offer a unified interpretation of models by quantifying the impact of each independent variable on the model's output (Lundberg & Lee, 2017; Mitchell, Frank, & Holmes, 2022). Interpretation is based on the median LightGBM model (model with the median  $R^2$  across 5-fold cross-validation). Utilizing the median model provides a balanced perspective on model performance and explanatory power, alleviating potential overfitting concerns.

Considering the monthly time frame used in the regression analysis, commodities and most economic indicators are expected to carry high importance to the models. This is due to the month-to-month variation observed in these variables, which consequently impacts valuations more frequently within the chosen time frame. Company fundamentals and certain economic variables are typically reported on a quarterly basis, potentially diminishing their importance because of their lesser

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frequency. Therefore, it's essential to keep reporting frequencies in mind while interpreting each primary driver's importance ranking. Variables with less frequent reporting should be weighed accordingly, independent of those exhibiting month-to-month volatility. Refer to Table A1 for a comprehensive list of variables, noting non-monthly reporting frequencies.

Additionally, some economic indicators are not reported in real-time, lagging current economic conditions. As such, these variables should be interpreted as the market's reaction to these economic data releases and its subsequent anticipation of future economic conditions/trends.

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## Summary Table

**Table 2**

*Summary Table: Identified Drivers by Sector*

Variable	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Sector	Health Care	Financial Services	Information Technology	Communication Services	Utilities	Real Estate	Total Count
<u>Commodities</u>													
Oil	I	I		I	I	I	I	I	I	I	I	I	9
Gold													0
Silver												I	2
Copper			I			I							2
Aluminum								I	I				3
Platinum					I	I		I	I				3
Palladium	I	I				I					I		4
Natural Gas	I		I			I							2
Wheat						I	I				I		3
Corn													0
Soybean		I											1
Coffee			I			I							2
Sugar							I						1
Cotton	I	I	I	I			I	I		I			6
<u>Economic</u>													
Federal Funds Rate		I	I	I	I	I		I		I	I	I	8
3 Month Treasury Yield	I										I		2
10 Year - 2 Year Treasury Yield Spread	I	I	I		I		I						4
BAA - AAA Corporate Bond Yield Spread						I		I					2
VIX	I	I	I	I	I	I	I			I	I	I	9
30 Year - 15 Year Mortgage Rate Spread										I			1
CPI	I	I		I			I			I	I	I	6
Unemployment Rate												I	1
Federal Budget Surplus or Deficit					I								1
Housing Starts			I		I		I	I	I	I			6
Real GDP											I		1
Average Home Price			I										1
<u>Company Fundamentals</u>													
Total Revenue	I						I	I				I	2
Operating Revenue		I		I									3
Net Income													0
Basic EPS						I							1
EBITDA		I			I							I	3
EBIT										I			1
Current Ratio											I		1
Quick Ratio													0
Gross Profit Margin	I	I	I	I	I			I				I	7
Net Profit Margin			I							I			1
Cash Flow Margin			I										1
Operating Margin			I	I	I	I	I	I	I	I	I	I	8
ROA	I					I							2
CROA						I							1
ROE					I				I				2
Efficiency Ratio	I									I	I		3
Inventory Turnover													0
Debt to Equity													0
Debt Ratio		I											2
Interest Coverage					I								1
Cash Flow to Debt	I	I											2
Assets to Equity													0
R&D to Revenue										I			1
Investment CF to OCF						I							1
Financing CF to OCF			I								I		2
Free Cash Flow	I	I	I	I	I		I	I	I	I	I		9
Capex								I				I	2
BV per Share													0
Tangible BV per Share												I	0

I: Identified as a top driver for the sector.

Financial Services: Industry Group

Oil and cotton emerged as primary drivers for 9/11 and 6/11 sectors, respectively, highlighting their important impact on equity valuations and the economy at large. Oil's importance is unsurprising given its pervasive role in the economy, influencing production costs, transportation, and consumer spending. Cotton's prominence is likely

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more indirect, rising as an important indicator of overall consumer demand and economic activity. Gold was never identified as a top driver, however, it is highly correlated with silver (2/11) and platinum (3/12). These other metals tended to explain shifts in valuations more effectively than gold. Among the soybean (1/11), wheat (3/11), and corn (0/11) group of correlates, a preference was given to wheat.

The fear index, VIX, was a top driver in 9/11 sectors, underscoring its critical role in reflecting market sentiment and risk perceptions. The federal funds rate was a top driver in 8/11 sectors as an important economic variable with influence on borrowing costs, consumer spending, and investment decisions. Inflation and housing starts were also common drivers, both identified in 6/11 sectors, drawing attention to their broad impacts on the economy.

Free cash flow was the most commonly identified company fundamental, emerging as a top driver in 9/11 sectors. Profitability margins (e.g. gross profit margin, operating margin) were also prevalent as measures of financial health and operational efficiency.

A variable from the net income, ROA, EPS, ROE, and net profit margin group of correlates was identified in 6/11 sectors. However, which variable emerged varied among sectors; notably, net income never emerged as a primary driver, and the others surfaced in only 1 or 2 sectors each. This underscores the nuanced interplay between these metrics and equity valuations within the unique context of each sector.

### **Energy Sector**

The Energy Sector model was the best-perfomring, exhibiting a median adjusted  $R^2$  of 50.74% on the LightGBM model (Table 14). Top drivers of positive stock returns in the Energy Sector:

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**Table 3**

*Energy Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
1	Oil ↑	2	VIX ↓	18	ROA ↑
3	Cotton ↑	8	3 Month Treasury Yield ↑	19	Operating Revenue ↑
7	Natural Gas ↑	11	10 Year - 2 Year Treasury Yield Spread ↓	22	Cash Flow to Debt ↑
9	Palladium ↓	12	CPI ↓	23	Efficiency Ratio ↓
				24	Free Cash Flow ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure B3 for the model’s SHAP plot.

Unsurprisingly, commodities take center stage, with oil as the most important driver and natural gas in the top 10. Given the energy sector’s heavy reliance on oil/gas production and exploration, fluctuations in oil/gas prices directly impact the profitability and valuations of energy companies. Other commodities such as cotton and palladium also play a role, reflecting broader economic conditions and industrial demand. Likely due to its usage in vehicle manufacturing and petroleum refining, the sector is sensitive to palladium prices. Increases in palladium prices may impact costs for energy companies and their bottom line.

Key indicators such as market volatility (VIX), interest rates (Treasury yields), and broader macroeconomic metrics like the Consumer Price Index (CPI) are influential. Market volatility can signal economic uncertainty, impacting investor sentiment and consequently, valuations. The sector appears to do well in periods of higher short-term interest rates and low inflation.

Return on assets (ROA) measures how efficiently a company is utilizing its assets to generate profits. In the energy industry, which requires large investments in exploration, drilling, refineries, and infrastructure, efficient usage of assets is crucial for long-term sustainability and attracting investor capital.

Operating revenue directly reflects the top-line performance of a company, which is heavily influenced by commodity prices and demand for energy products.

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

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Consistently growing operating revenue is a positive signal for valuations.

The cash flow to debt ratio is vital as energy projects often require significant debt financing. A higher cash flow to debt ratio indicates a company's ability to service its debt obligations and maintain financial flexibility. This is especially important during periods of economic uncertainty and low energy price environments.

Efficiency ratio measures how well a company is managing its costs and operating expenses. Energy companies with lower efficiency ratios are better positioned to weather periods of low commodity prices and maintain profitability.

Free cash flow is the cash remaining after a company has paid for its operating expenses and capital expenditures. In the energy sector, where capital expenditures are high, robust free cash flow generation is essential for funding new projects, paying down debt, and driving long-term value.

Overall, the sector values more efficient asset utilization and debt management as well as increasing operating revenue with free cash flow growth.

## Materials Sector

The Materials Sector exhibited a median adjusted  $R^2$  of 35.97% on the LightGBM model (Table 15). Top drivers of positive stock returns in the Materials Sector:

**Table 4**

*Materials Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Oil ↑	1	VIX ↓	7	Gross Profit Margin ↑
3	Soybean ↑	10	Federal Funds Rate ↓	11	Debt Ratio ↓
4	Cotton ↑	15	10 Year - 2 Year Treasury Yield Spread ↓	17	Cash Flow to Debt ↑
5	Palladium ↑	16	CPI ↓	18 & 22	EBITDA ↑
				28	Free Cash Flow ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. "higher is better"), ↓ denotes that lower variable values are associated with positive returns (i.e. "lower is better").

Drivers based on the median LightGBM model's<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure C3 for the model's SHAP plot.

Commodities take center stage as key drivers for the sector, with oil as the most

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

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influential commodity much like the energy sector. Oil plays a pivotal role as a material input and energy source across various industries within the materials sector. Many commodities move in tandem with oil prices, reflecting broader economic conditions and industrial demand. High soybean and cotton prices are also reflective of high demand for raw materials.

Turning to economic factors, market volatility (VIX) stands out as an important driver. Heightened market volatility often signals economic uncertainty, which can impact demand for materials and disrupt supply chains, ultimately affecting the sector's performance.

The federal funds rate and the 10-year to 2-year Treasury yield spread also emerged as influential factors. Changes in interest rates can impact borrowing costs for materials companies, particularly those with substantial debt financing for capital-intensive projects or operations. Decreasing short-term interest rates has a positive impact on the sector, reducing borrowing costs.

The Consumer Price Index (CPI) can impact input costs for materials companies, potentially squeezing profit margins and affecting profitability.

Regarding company fundamentals, the gross profit margin stands out. It is ranked in the top 10 of importance despite its quarterly reporting frequency. Gross profit margin is a key metric that reflects a company's ability to generate profits after accounting for production costs. In the Materials Sector, where capital expenditures can be significant, maintaining healthy gross profit margins is crucial for profitability and long-term sustainability.

Lower debt (debt ratio) and the cash flow to debt ratio are vital metrics, as materials companies often rely on debt financing for capital-intensive projects and operations. A higher cash flow to debt ratio indicates a company's ability to service its debt obligations and maintain financial flexibility, which is essential during economic downturns or periods of low demand.

EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) is a widely used measure of a company's operating profitability, providing insights into its

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core business performance without the impact of financing and accounting decisions. In the materials sector, EBITDA is a valuable metric for assessing a company's earnings power.

In capital-intensive sectors like materials, robust free cash flow generation is essential for funding growth opportunities, paying down debt, and driving long-term value. Overall, the sector values higher profit margins and more efficient debt management with EBITDA and free cash flow growth.

### Industrials Sector

The Industrials Sector exhibited a median adjusted  $R^2$  of 38.10% on the LightGBM model (Table 16). Top drivers of positive stock returns in the Industrials Sector:

**Table 5**

*Industrials Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Copper ↑	1	VIX ↓	11	Operating Revenue ↑
5	Cotton ↑	4	Federal Funds Rate ↓	17	Gross Profit Margin ↑
12	Natural Gas ↑	7	10 Year - 2 Year Treasury Yield Spread ↓	19	Operating Margin ↑
15	Coffee ↑	13	Average Home Price ↓	20	Free Cash Flow ↑
		18	Housing Starts ↑	21	Financing CF to OCF ↓
				22	Cash Flow Margin ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure D3 for the model’s SHAP plot.

Commodities greatly impact the sector, with copper, cotton, natural gas, and coffee playing key roles. Copper is essential in construction, manufacturing, and infrastructure projects, serving as an indicator of economic activity and industrial demand. Cotton is a key agricultural output, with higher prices signaling increased demand for textiles and in turn, industrial and farming equipment. Coffee is a consumer staple with global demand, reflecting broader economic conditions and industrial activity.

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

Market volatility (VIX) remains a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic uncertainty, impacting investor sentiment and industrial demand.

Interest rates, as measured by the 10-year to 2-year Treasury yield spread and federal funds rate, are highlighted as influential factors. Higher interest rates can impact borrowing costs for industrial companies, particularly those with significant debt financing for capital projects and operations.

Real estate metrics such as average home prices and housing starts are primary drivers. Increases in home construction are a boon for the sector, signaling economic growth and demand for construction materials and equipment. Declining home prices are potentially the result of additional home supply, signaling the high demand for new projects. These metrics provide insights into housing market conditions, construction activity, and infrastructure development, which can impact industrial companies' performance.

Key company fundamentals include operating revenue, gross profit margin, and operating margin. These serve as vital indicators of a company's performance and profitability. Maintaining healthy revenue growth and profit margins is essential for industrial companies to drive shareholder value and sustain long-term growth.

Additionally, metrics like free cash flow, cash flow margin, and the financing cash flow to operating cash flow ratio deserve attention. Free cash flow offers insights into a company's financial robustness and capacity to fuel growth endeavors. The cash flow margin delineates the percentage of revenue converted into cash flow, while the financing cash flow to operating cash flow ratio assesses a company's reliance on external financing for its operations, with a diminishing ratio indicating greater self-sufficiency in funding operations. These metrics play a crucial role in evaluating a company's liquidity, financial flexibility, and ability to sustainably generate future cash flows.

Overall, the sector values operating revenue growth, higher profit margins, and more efficient financing operations with free cash flow growth.

## Consumer Discretionary Sector

The Consumer Discretionary Sector exhibited a median adjusted  $R^2$  of 38.42% on the LightGBM model (Table 17). Top drivers of positive stock returns in the Consumer Discretionary Sector:

**Table 6***Consumer Discretionary Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Oil ↑	1	VIX ↓	16	Operating Margin ↑
3	Platinum ↑	5	Federal Funds Rate ↓	18	Debt Ratio ↓
9	Cotton ↑	6	Housing Starts ↑	19	Gross Profit Margin ↑
		10	CPI ↓	20	EBITDA ↑
		12	Federal Budget Surplus or Deficit ↓	23	Free Cash Flow ↑
				24	ROE ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure E3 for the model’s SHAP plot.

Commodities such as oil, platinum, and cotton are important drivers in the Consumer Discretionary Sector. Oil, platinum, and cotton are essential inputs for various consumer goods and services such as apparel, electronics, and automobiles. Higher prices of these commodities may reflect increasing consumer demand.

Market volatility (VIX) remains a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic uncertainty, impacting consumer sentiment and discretionary spending.

The sector is sensitive to interest rates, as indicated by the federal funds rate. Lower short-term interest rates can stimulate consumer spending by reducing borrowing costs, benefiting firms in the sector.

Housing starts stand out as a key driver with a ranking in the top 5 despite its less frequent reporting frequency. New home builds can indicate consumer confidence and economic growth. Additionally, new homes can boost demand for home-related

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

consumer goods and services such as furniture, appliances, and home improvement products which are included in the sector.

Lower inflation is a positive driver for the sector, as measured by the Consumer Price Index (CPI). Low inflation can boost consumer purchasing power and confidence, leading to increased spending on discretionary items. Higher government spending (a declining federal budget surplus), also appears to be a positive driver for the sector as this can stimulate economic growth and consumer spending.

Key company fundamentals such as operating margin, debt ratio, gross profit margin, EBITDA, free cash flow, and return on equity (ROE) are essential indicators of a company's financial health and profitability. Maintaining healthy profit margins, low debt relative to assets, strong returns on equity, EBITDA growth, and robust free cash flow generation are crucial for consumer discretionary companies to drive shareholder value and sustain future growth. Overall, the sector values higher profitability margins, lower debt, and higher returns on equity with EBITDA and free cash flow growth.

### **Consumer Staples Sector**

The performance of both models was relatively weak, yet still statistically significant as measured by F-stat, in the Consumer Staples Sector, with a median adjusted  $R^2$  value of 19.13% for the LightGBM model (Table 22). Poor performance in the sector may be attributed to the wide array of goods and services included in the sector, which includes the production, distribution, and retail of various consumer goods. Top drivers of positive stock returns in the Consumer Staples Sector:

## DECODING SECTOR VALUATION DYNAMICS

**Table 7**

*Consumer Staples Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Platinum ↑	1	VIX ↓	5	Gross Profit Margin ↑
4	Oil ↑	7	10 Year - 2 Year Treasury Yield Spread ↓	10	Free Cash Flow ↑
6	Coffee ↓	9	Housing Starts ↑	17	Investment CF to OCF ↓
8	Palladium ↓	14	Federal Funds Rate ↓	24	CROA ↑
12	Wheat ↑			25	Basic EPS ↑
				26	Operating Margin ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure F3 for the model’s SHAP plot.

Many commodities are essential inputs for various consumer goods, including food, beverages, and household products. Changes in commodity prices can be suggestive of demand and impact production costs as well as profit margins for consumer staples companies.

Market volatility (VIX) remains a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic uncertainty and tempered expectations of economic growth. Declining short-term interest rates (federal funds rate) can stimulate consumer borrowing and spending, benefiting the sector.

Increased housing starts can boost demand for consumer staples products. Housing starts is also an indicator of economic growth and consumer confidence, which can drive demand for consumer staples.

Higher profit margins, as indicated by gross profit margin and operating margin, are drivers of higher valuations in the sector. Companies with higher profit margins can generate more revenue from each dollar of sales, leading to expectations of higher profitability in the future. Cash flow growth as measured by free cash flow, efficient usage of cash in financing operations (financing cash flow to operating cash flow ratio), and a more efficient cash return on assets (CROA) are primary drivers. EPS growth is

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

another key metric for the sector.

### Health Care Sector

Much like the Consumer Staples Sector, the Health Care Sector had relatively weak performance, however, the model was statistically significant as measured by the F-statistic. The residual plots (Figure G1) and RMSE reveal even worse performance in the sector compared to consumer staples despite similar  $R^2$  values.

The LightGBM model had a median adjusted  $R^2$  of 19.38% on the LightGBM model (Table 19). The sector includes a wide range of companies, from pharmaceutical/biotech firms to medical device manufacturers and healthcare providers, which may be contributing to the difficulty in predicting returns. Much of the sector is potentially driven by regulatory changes, drug approvals, and healthcare policies that are not captured in the dataset. Top drivers of positive stock returns in the Health Care Sector:

**Table 8**

*Health Care Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Copper ↑	1	VIX ↓	11	Operating Margin ↑
4	Oil ↑	6	Federal Funds Rate ↓	12	Total Revenue ↑
7	Sugar ↓	13	BAA - AAA Corporate Bond Yield Spread ↓	15	Gross Profit Margin ↑
9	Wheat ↑			19	Debt Ratio ↓
				23	ROA ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure G3 for the model’s SHAP plot.

Commodities such as copper, oil, sugar, and wheat are drivers in the sector with copper and oil used in medical devices and equipment.

Market volatility (VIX) remains a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic uncertainty and impact investor sentiment. Lower short-term interest rates and a

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

stronger corporate environment as indicated by the declining BAA to AAA corporate bond yield spread, appear to benefit the sector.

Higher profit margins, revenue growth, lower debt, and higher returns on assets are key drivers for the sector.

### Financial Services Industry Group

Banking and insurance industry groups were omitted from the analysis of the Financials Sector due to a lack of data. The LightGBM model had a median adjusted  $R^2$  of 41.21% (Table 20). Top drivers of positive stock returns in the Financial Services Industry Group:

**Table 9**

*Financial Services Industry Group: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2	Oil ↑	1	VIX ↓	16	Free Cash Flow ↑
3	Aluminum ↑	5	CPI ↓	17	Operating Margin ↑
4	Cotton ↑	14	Housing Starts ↑	22	Capex ↑
				23	Operating Revenue ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model's<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure H3 for the model's SHAP plot.

Commodities such as oil, aluminum, and cotton are important drivers in the Financial Services Industry Group. Increases in commodity prices can indicate economic growth, resulting in higher demand for financial services.

Market volatility (VIX) remains a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic uncertainty, impacting investor sentiment and financial markets. Lower inflation, as measured by the Consumer Price Index (CPI), can boost purchasing power, leading to increased spending and investment in financial services. Housing starts can indicate

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

economic growth and consumer confidence, which can drive demand for financial services.

Free cash flow growth, higher profit margins, investments in projects (capital expenditures), and operating revenue are key drivers in the sector. Free cash flow growth is essential for financial services companies to fund operations, invest in growth opportunities, and return capital to shareholders. Higher profit margins and operating revenue indicate strong financial performance and inform anticipation of future growth. Capital expenditures reflect investments within the company, signaling potential growth, expansion, and innovation.

### Information Technology Sector

For the Information Technology sector, the median adjusted  $R^2$  was 33.67% on the LightGBM model (Table 21). Top drivers of positive stock returns in the Information Technology Sector:

**Table 10**

*Information Technology Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
1	Oil ↑	6	BAA - AAA Corporate Bond Yield Spread ↑	13	Free Cash Flow ↑
2	Platinum ↑	12	Housing Starts ↑	18	ROE ↑
9	Aluminum ↑	22	Federal Funds Rate ↓	19	R&D to Revenue ↓
				20	Operating Margin ↑
				21	Gross Profit Margin ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure I3 for the model’s SHAP plot.

Commodities such as oil, platinum, and aluminum are drivers of the Information Technology sector. Rising commodity prices can indicate economic growth resulting in increased demand for technology products and services.

Intriguingly, overall market volatility (VIX) was not identified as an important driver by the LightGBM model. The sector is sensitive to interest rate changes, as

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

indicated by the BAA to AAA corporate bond yield spread and federal funds rate.

Increased housing starts can also boost demand for technology products and services as an indicator of economic growth and consumer confidence.

Key metrics encompass growth in free cash flow, return on equity (ROE), and profit margins. Notably, a reduction in research and development expenditure relative to revenue (R&D to revenue) serves as a detrimental factor for the sector. This decline could dampen prospects for innovation and product development, critical components for technology companies to sustain a competitive advantage and growth.

### Communication Services Sector

The Communications Services Sector had somewhat weak performance with an adjusted  $R^2$  of 25.15%, however, with statistical significance as measured by the F-statistic (Table 22). The relatively poor performance in the sector may be attributed to the diverse range of companies within the sector, including telecommunications, advertising, broadcast, cable, and entertainment. Top drivers of positive stock returns in the Communication Services Sector:

**Table 11**

*Communication Services Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
1	Oil ↑	3	30 Year - 15 Year Mortgage Rate Spread ↑	12	Free Cash Flow ↑
2	Silver ↑	4	CPI ↓	17	Efficiency Ratio ↓
7	Cotton ↑	9	Housing Starts ↑	18	Operating Margin ↑
8	Aluminum ↑			21	EBIT ↑
				22	Net Profit Margin ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure J3 for the model’s SHAP plot.

Commodities such as oil, silver, cotton, and aluminum are drivers in the sector.

Rising commodity prices can indicate economic growth, resulting in increased demand for communication services.

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

Interest rate changes, as indicated by the 30-year to 15-year mortgage rate spread, are drivers in the Communication Services sector. Increased housing starts can boost demand for communication services as an indicator of economic growth and consumer confidence.

Free cash flow, efficiency ratio, profit margins, and EBIT were identified as primary drivers of valuations within the sector. Free cash flow growth, more efficient operations, and higher profitability ratios with EBIT growth are expected to drive up valuations.

## Utilities Sector

The Utilities Sector model was one of the best-performing, with a median adjusted  $R^2$  of 44.84% on the LightGBM model (Table 23). Top drivers of positive stock returns in the Utilities Sector:

**Table 12**

*Utilities Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
11	Wheat ↑	1	VIX ↓	21	Free Cash Flow ↑
18	Palladium ↓	3	3 Month Treasury Yield ↓	22 & 29	Efficiency Ratio ↓
		9	Real GDP ↑	24	Financing CF to OCF ↓
		10	Federal Funds Rate ↓	25	Current Ratio ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure K3 for the model’s SHAP plot.

Commodities such as wheat and palladium are drivers in the Utilities sector. Rising wheat prices can indicate economic growth and increased demand for utility services. Palladium is an important input for emissions control systems, higher prices could potentially lead to higher costs for utility companies.

Market volatility (VIX) is a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

uncertainty and impact investor sentiment. The sector is sensitive to interest rate changes, as indicated by the 3-month Treasury yield and the federal funds rate. Lower interest rates can reduce borrowing costs, leading to higher valuations.

Key metrics include free cash flow, efficiency ratio, financing cash flow to operating cash flow, and current ratio. A declining financing cash flow to operating cash flow ratio can indicate further self-sufficiency in financing operations and growth. Overall, the sector is driven by more efficient operations, self-sufficiency in financing, and strong liquidity positions with free cash flow growth.

### Real Estate Sector

The Real Estate Sector had one of the best-performing models, with a median adjusted  $R^2$  of 49.26% on the LightGBM model (Table 24). Top drivers of positive stock returns in the Real Estate Sector:

**Table 13**

*Real Estate Sector: Top Drivers*

Commodities		Economic		Company Fundamentals	
Importance Rank	Commodity	Importance Rank	Factor	Importance Rank	Metric
2 10	Silver ↑	1	VIX ↓	16	Operating Margin ↑
	Oil ↑	3	Unemployment Rate ↓	17	Capex ↓
		4	Federal Funds Rate ↓	18	Total Revenue ↑
		6	CPI ↓	20 & 29	Gross Profit Margin ↑
				22	EBITDA ↑

Note: ↑ denotes that higher variable values are associated with positive returns (i.e. “higher is better”), ↓ denotes that lower variable values are associated with positive returns (i.e. “lower is better”).

Drivers based on the median LightGBM model’s<sup>2</sup> SHAP values. Ambiguous relationships were omitted, see Figure L3 for the model’s SHAP plot.

Commodities such as silver and oil are drivers in the sector. Rising commodity prices can indicate economic growth resulting in increased confidence and demand for real estate properties, driving up prices.

Market volatility (VIX) is a crucial driver, with lower volatility typically associated with positive stock returns. Heightened market volatility can signal economic

<sup>2</sup> Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

uncertainty and impact investor sentiment in real estate. The sector is sensitive to interest rate changes, as indicated by the federal funds rate. Lower short-term interest rates can reduce borrowing costs for real estate companies, leading to higher valuations. Low inflation and a declining unemployment rate are positive drivers for the sector, as they indicate a healthy economic environment with increased consumer purchasing power and confidence.

Key financial metrics include profitability ratios, capital expenditures, revenue, and EBITDA. Capital expenditures are indicative of investments in growth opportunities and expansion. Overall, the sector values higher profitability margins, revenue growth, investments in projects, and EBITDA growth.

## Robustness

The LightGBM model outperformed a linear model in all sectors on an adjusted  $R^2$  basis, averaging a difference of 12.27%. The LightGBM model's ability to capture non-linear relationships through gradient-boosted decision trees was more effective in elucidating the variance in stock returns overall compared to a linear approach. Additionally, the LightGBM model consistently outperformed the linear model across all sectors in MSE and MAE, revealing better predictive accuracy and lower error rates. The F-statistic demonstrated higher values for the LightGBM model across 9 out of 11 sectors. Furthermore, all models exhibited statistical significance, as evidenced by F-stat p-values nearing 0 in all cases. However, it should be noted that both models regularly suffered from heteroscedasticity and non-normality of residuals (see the Limitations section).

## DECODING SECTOR VALUATION DYNAMICS

**Table 14**

*Energy Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	40.05%	37.95%	4.09%	29.93%	40.88%	38.88%
Adjusted $R^2$	39.81%	37.70%	4.11%	29.65%	40.65%	38.68%
MSE	1.56%	1.55%	0.13%	1.37%	1.74%	1.53%
RMSE	12.50%	12.45%	0.51%	11.72%	13.18%	12.39%
MAE	8.92%	8.90%	0.21%	8.60%	9.24%	8.86%
F-stat	151.04	157.21	19.20	136.26	190.99	196.92
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	51.01%	50.20%	2.68%	45.01%	52.41%	55.70%
Adjusted $R^2$	50.74%	49.93%	2.69%	44.71%	52.14%	55.50%
MSE	1.23%	1.24%	0.08%	1.13%	1.34%	1.11%
RMSE	11.08%	11.15%	0.35%	10.62%	11.59%	10.55%
MAE	7.84%	7.82%	0.16%	7.55%	8.04%	7.37%
F-stat	161.79	164.64	12.54	149.71	187.10	234.70
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix B for additional model figures and tables.

The LightGBM model outperformed the linear model by 10.93% in the Energy Sector, with median adjusted  $R^2$  values of 50.74% and 39.81%, respectively. Additionally, the LightGBM model surpassed the linear regression model across the other metrics including MSE, RMSE, MAE, and F-stat.

## DECODING SECTOR VALUATION DYNAMICS

**Table 15**

*Materials Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	27.62%	27.42%	0.53%	26.51%	28.09%	27.81%
Adjusted $R^2$	27.39%	27.18%	0.53%	26.27%	27.86%	27.62%
MSE	0.83%	0.84%	0.06%	0.74%	0.94%	0.83%
RMSE	9.09%	9.14%	0.35%	8.62%	9.72%	9.12%
MAE	6.58%	6.60%	0.20%	6.27%	6.87%	6.58%
F-stat	117.95	118.28	9.03	108.10	131.85	147.62
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	36.35%	36.77%	1.12%	35.60%	38.86%	53.80%
Adjusted $R^2$	35.97%	36.39%	1.13%	35.22%	38.50%	53.58%
MSE	0.73%	0.73%	0.06%	0.63%	0.83%	0.53%
RMSE	8.52%	8.53%	0.37%	7.95%	9.09%	7.30%
MAE	6.12%	6.10%	0.21%	5.74%	6.36%	5.15%
F-stat	97.11	96.36	7.73	86.60	109.59	180.76
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix C for additional model figures and tables.

The LightGBM model outperformed the linear model by 8.58% in the Materials Sector, with median adjusted  $R^2$  values of 35.97% and 27.39%, respectively. It also outperformed across all other metrics except F-stat.

## DECODING SECTOR VALUATION DYNAMICS

**Table 16**

*Industrials Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	26.96%	25.89%	1.63%	23.30%	27.49%	26.25%
Adjusted $R^2$	26.86%	25.78%	1.63%	23.19%	27.39%	26.17%
MSE	0.72%	0.73%	0.02%	0.71%	0.76%	0.73%
RMSE	8.50%	8.55%	0.11%	8.43%	8.72%	8.53%
MAE	6.11%	6.14%	0.07%	6.07%	6.23%	6.13%
F-stat	247.12	250.87	6.54	244.06	261.42	314.24
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	38.22%	37.86%	1.43%	35.54%	39.69%	48.91%
Adjusted $R^2$	38.10%	37.74%	1.43%	35.41%	39.57%	48.83%
MSE	0.61%	0.61%	0.02%	0.60%	0.63%	0.50%
RMSE	7.79%	7.83%	0.10%	7.73%	7.95%	7.10%
MAE	5.43%	5.48%	0.08%	5.41%	5.62%	5.04%
F-stat	293.52	292.22	4.79	285.07	298.84	462.92
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix D for additional model figures and tables.

The LightGBM model outperformed the linear model by 11.24% in the Industrials Sector, with median adjusted  $R^2$  values of 38.10% and 26.86%, respectively, outperforming across all other metrics as well.

# DECODING SECTOR VALUATION DYNAMICS

**Table 17**

*Consumer Discretionary Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	25.46%	24.53%	1.17%	22.91%	25.50%	24.80%
Adjusted $R^2$	25.34%	24.41%	1.17%	22.79%	25.39%	24.71%
MSE	1.01%	1.02%	0.02%	1.00%	1.06%	1.02%
RMSE	10.06%	10.12%	0.10%	10.02%	10.27%	10.10%
MAE	7.44%	7.47%	0.06%	7.39%	7.58%	7.45%
F-stat	209.13	210.96	6.21	204.74	222.92	264.32
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	38.55%	38.16%	1.12%	36.20%	39.20%	49.63%
Adjusted $R^2$	38.42%	38.04%	1.12%	36.07%	39.08%	49.55%
MSE	0.83%	0.84%	0.02%	0.83%	0.88%	0.68%
RMSE	9.10%	9.16%	0.11%	9.08%	9.37%	8.27%
MAE	6.65%	6.67%	0.10%	6.57%	6.85%	6.08%
F-stat	291.83	293.51	3.29	291.25	300.00	473.23
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix E for additional model figures and tables.

The LightGBM model for the Consumer Discretionary Sector outperformed the linear model across all metrics. Outperforming on an adjusted  $R^2$  basis by 13.08%, with median adjusted  $R^2$  values of 38.42% and 25.34%, respectively.

## DECODING SECTOR VALUATION DYNAMICS

**Table 18**

*Consumer Staples Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	11.40%	11.19%	2.27%	8.87%	15.15%	11.93%
Adjusted $R^2$	11.11%	10.89%	2.28%	8.56%	14.87%	11.70%
MSE	0.67%	0.66%	0.03%	0.61%	0.71%	0.66%
RMSE	8.19%	8.15%	0.20%	7.82%	8.41%	8.12%
MAE	5.90%	5.87%	0.10%	5.71%	5.98%	5.85%
F-stat	39.91	39.96	2.10	37.42	43.73	49.52
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	19.55%	18.67%	2.14%	15.81%	21.29%	28.10%
Adjusted $R^2$	19.13%	18.24%	2.15%	15.37%	20.87%	27.80%
MSE	0.61%	0.61%	0.03%	0.57%	0.65%	0.54%
RMSE	7.83%	7.80%	0.18%	7.53%	8.09%	7.34%
MAE	5.61%	5.59%	0.07%	5.50%	5.69%	5.28%
F-stat	45.72	45.00	3.71	39.32	49.96	64.92
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix F for additional model figures and tables.

The LightGBM model outperformed the linear model by 8.24% in the Consumer Staples Sector, with median adjusted  $R^2$  values of 19.13% and 10.89%, respectively.

## DECODING SECTOR VALUATION DYNAMICS

**Table 19**

*Health Care Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	11.24%	10.51%	1.21%	9.00%	11.91%	10.85%
Adjusted $R^2$	11.09%	10.35%	1.22%	8.85%	11.76%	10.73%
MSE	1.13%	1.13%	0.03%	1.09%	1.17%	1.12%
RMSE	10.62%	10.62%	0.14%	10.44%	10.83%	10.61%
MAE	7.49%	7.51%	0.09%	7.38%	7.65%	7.49%
F-stat	72.00	70.33	3.89	64.09	74.19	87.08
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	19.59%	19.95%	1.34%	17.92%	21.95%	23.37%
Adjusted $R^2$	19.38%	19.74%	1.34%	17.71%	21.75%	23.22%
MSE	1.00%	1.01%	0.04%	0.96%	1.07%	0.97%
RMSE	9.98%	10.05%	0.19%	9.79%	10.35%	9.83%
MAE	6.98%	7.03%	0.11%	6.93%	7.23%	6.88%
F-stat	82.73	81.19	3.70	75.31	85.42	107.22
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix G for additional model figures and tables.

The LightGBM model outperformed the linear model by 8.02% in the Health Care Sector, with median adjusted  $R^2$  values of 19.13% and 11.11%, respectively.

## DECODING SECTOR VALUATION DYNAMICS

**Table 20**

*Financial Services Industry Group: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	27.92%	28.13%	1.49%	25.72%	29.89%	28.79%
Adjusted $R^2$	27.61%	27.83%	1.49%	25.41%	29.60%	28.55%
MSE	0.63%	0.63%	0.05%	0.56%	0.70%	0.63%
RMSE	7.93%	7.95%	0.31%	7.51%	8.36%	7.93%
MAE	5.86%	5.87%	0.17%	5.63%	6.12%	5.85%
F-stat	97.43	96.08	6.86	87.80	106.23	120.01
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
R2	41.50%	41.62%	2.03%	38.55%	44.95%	46.26%
Adjusted R2	41.21%	41.33%	2.04%	38.25%	44.69%	46.05%
MSE	0.52%	0.51%	0.04%	0.46%	0.57%	0.47%
RMSE	7.21%	7.17%	0.25%	6.76%	7.52%	6.89%
MAE	5.17%	5.17%	0.16%	4.90%	5.40%	4.97%
F-stat	141.34	139.60	10.25	121.89	152.28	190.31
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix H for additional model figures and tables.

The LightGBM model outperformed the linear model by 13.60% in the Financial Services Industry Group, with median adjusted  $R^2$  values of 41.21% and 27.61%, respectively.

## DECODING SECTOR VALUATION DYNAMICS

**Table 21**

*Information Technology Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	20.52%	20.35%	1.32%	18.45%	22.37%	20.61%
Adjusted $R^2$	20.36%	20.19%	1.32%	18.28%	22.22%	20.48%
MSE	0.94%	0.94%	0.04%	0.87%	0.97%	0.93%
RMSE	9.72%	9.67%	0.19%	9.34%	9.87%	9.66%
MAE	7.11%	7.10%	0.14%	6.87%	7.28%	7.09%
F-stat	127.46	127.94	3.61	123.28	133.19	159.73
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	33.87%	34.14%	1.11%	32.62%	36.00%	39.49%
Adjusted $R^2$	33.67%	33.95%	1.11%	32.43%	35.82%	39.35%
MSE	0.79%	0.77%	0.03%	0.72%	0.80%	0.71%
RMSE	8.89%	8.80%	0.17%	8.48%	8.95%	8.43%
MAE	6.40%	6.32%	0.12%	6.12%	6.42%	6.09%
F-stat	154.21	152.42	6.91	139.35	160.01	210.29
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix I for additional model figures and tables.

The LightGBM model outperformed the linear model by 13.31% in the Information Technology Sector, with median adjusted  $R^2$  values of 33.67% and 20.36%, respectively.

## DECODING SECTOR VALUATION DYNAMICS

**Table 22**

*Communication Services Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	19.77%	18.96%	2.19%	14.65%	20.77%	19.85%
Adjusted $R^2$	19.20%	18.39%	2.21%	14.05%	20.21%	19.40%
MSE	0.89%	0.89%	0.02%	0.87%	0.92%	0.88%
RMSE	9.42%	9.45%	0.08%	9.34%	9.59%	9.40%
MAE	6.78%	6.76%	0.06%	6.66%	6.82%	6.73%
F-stat	33.49	34.05	1.31	32.54	35.69	42.62
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	25.84%	23.80%	3.48%	17.24%	26.49%	36.65%
Adjusted $R^2$	25.15%	23.09%	3.52%	16.46%	25.80%	36.17%
MSE	0.82%	0.84%	0.02%	0.82%	0.88%	0.70%
RMSE	9.08%	9.16%	0.14%	9.03%	9.37%	8.36%
MAE	6.49%	6.49%	0.08%	6.40%	6.60%	5.97%
F-stat	30.52	30.61	1.25	28.76	32.64	49.11
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix J for additional model figures and tables.

The LightGBM model outperformed the linear model on all metrics besides F-stat in the Communication Services Sector. Outperforming on an adjusted  $R^2$  basis by 5.95%, with median adjusted  $R^2$  values of 25.15% and 19.20%, respectively. The poor performance and relatively small gap between the two models are likely due to the diverse range of companies/industries within the sector.

# DECODING SECTOR VALUATION DYNAMICS

**Table 23**

*Utilities Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	23.17%	22.38%	2.84%	19.11%	26.66%	23.40%
Adjusted $R^2$	22.77%	21.98%	2.85%	18.69%	26.27%	23.08%
MSE	0.29%	0.30%	0.02%	0.27%	0.32%	0.29%
RMSE	5.37%	5.43%	0.17%	5.24%	5.64%	5.40%
MAE	4.05%	4.10%	0.09%	4.00%	4.25%	4.08%
F-stat	57.47	57.40	4.86	51.27	65.06	71.39
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	45.36%	45.25%	3.39%	39.63%	49.11%	51.91%
Adjusted $R^2$	44.84%	44.74%	3.42%	39.06%	48.63%	51.55%
MSE	0.20%	0.21%	0.02%	0.19%	0.24%	0.18%
RMSE	4.51%	4.56%	0.24%	4.31%	4.87%	4.28%
MAE	3.11%	3.20%	0.12%	3.10%	3.39%	2.98%
F-stat	86.99	83.76	7.39	72.94	91.00	122.36
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Refer to Appendix K for additional model figures and tables.

The LightGBM model outperformed the linear model by 22.07% in the Utilities Sector, with median adjusted  $R^2$  values of 44.84% and 22.77%, respectively. This is the largest gap between the two models across all sectors, leveraging non-linear patterns in the Utilities Sector is particularly important.

**Table 24***Real Estate Sector: Model Statistics*

(a) Linear: Cross-Validated					(b) Linear: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	29.45%	30.48%	2.14%	27.71%	33.58%	$R^2$
Adjusted $R^2$	29.28%	30.32%	2.14%	27.54%	33.42%	Adjusted $R^2$
MSE	0.49%	0.49%	0.02%	0.46%	0.51%	MSE
RMSE	7.03%	7.01%	0.11%	6.81%	7.12%	RMSE
MAE	5.09%	5.14%	0.10%	5.02%	5.33%	MAE
F-stat	192.05	191.69	6.07	181.57	198.80	F-stat
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	P>F
(c) LGBM: Cross-Validated					(d) LGBM: Full Dataset	
	Median	Mean	STD	Min	Max	Score
$R^2$	49.49%	49.48%	2.19%	46.01%	52.29%	$R^2$
Adjusted $R^2$	49.26%	49.25%	2.20%	45.77%	52.08%	Adjusted $R^2$
MSE	0.36%	0.36%	0.01%	0.34%	0.37%	MSE
RMSE	6.02%	5.97%	0.09%	5.82%	6.07%	RMSE
MAE	4.18%	4.21%	0.07%	4.12%	4.32%	MAE
F-stat	217.23	217.65	3.91	211.74	223.79	F-stat
P>F	0.0000	0.0000	0.0000	0.0000	0.0000	P>F

Refer to Appendix L for additional model figures and tables.

The LightGBM model outperformed the linear model by 19.98% in the Real Estate Sector, with median adjusted  $R^2$  values of 49.26% and 29.28%, respectively. Much like the Utilities Sector, the Real Estate Sector demonstrated a noteworthy gap between the two models, indicating the importance of leveraging non-linear patterns in the sector.

## Limitations

While this study contributes valuable insights into the drivers of equity valuations, its limitations should be acknowledged. The study's findings are based on historical data and may not fully capture the dynamic nature of financial markets over time. What has driven valuations in the past may not necessarily hold in the future, as market conditions and investor sentiment are subject to change.

The study's focus on the S&P 500, 400, and 600 indices may limit the generalizability of the findings to markets outside of the United States. Future research

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could explore the drivers of equity valuations in global markets to provide a more comprehensive understanding of the factors influencing valuations within specific regions. Additionally, certain industry groups, industries, and sub-industries were underrepresented in the dataset due to the holdings of the S&P indices and availability of data. Future research could provide a more granular analysis, providing insights into the drivers of equity valuations within specific industries and sub-industries.

The models do not account for news events outside of the dataset, such as geopolitical events, regulatory changes, and technological advancements, which can significantly impact equity valuations. Analyst forecasts and price targets as well as forward guidance from companies were also not included in the analysis. These could provide additional insights into market expectations and their impact on equity valuations.

Both regression models commonly suffered from heteroscedasticity for returns exceeding approximately  $\pm 20\%$  and a skewed distribution of residuals beyond  $\pm 2$  standard deviations (see Residuals Plots in the Appendix, pp. 52–90). The models were less robust in predicting extreme returns, however, this is to be expected given the absence of news events and potential earnings surprises in the dataset that may cause large price movements. Future research could explore alternative techniques and additional data sources to improve model robustness.

## Conclusion

In essence, this research has delved into the fundamental determinants of equity valuation spanning the GICS sectors. Gradient-boosted decision tree models consistently outperformed linear regression approaches, demonstrating the importance of leveraging flexible, non-linear patterns in financial regression analysis. Notably, the analysis revealed that the drivers of equity valuations varied across sectors, emphasizing the need for a tailored, sector-specific approach to valuation. Intriguingly, net income did not emerge as a primary driver across sectors, and EPS featured in a single sector. Rather, free cash flow emerged as a pivotal driver in 9 out of 11 sectors, underscoring its profound significance as a fundamental metric in equity valuation. While expected due

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to its utilization in Discounted Cash Flow (DCF) models, this finding accentuates the criticality of cash flow generation and precise forecasting in ascertaining a company's worth. A profitability ratio also emerged as a key metric in 9 out of 11 sectors, highlighting its relevance in assessing future growth prospects and financial health.

The identified drivers provide crucial insights that can enhance investors' decision-making processes, improve valuation modeling practices, and strengthen risk management strategies. Armed with a deeper understanding of the pivotal factors influencing sector-specific valuations, market participants can make more informed choices regarding stock selection, portfolio management, and strategic positioning in mergers and acquisitions. Furthermore, the insights gleaned from this study can serve as a compass for researchers and practitioners, aiding them in refining valuation methodologies such as DCF and comparable company analyses. This refinement may entail scrutinizing underlying assumptions through strategically prioritizing the most influential variables. Overall, this research contributes to a more comprehensive understanding of the dynamics influencing equity valuations, providing investors, analysts, and industry stakeholders with enhanced tools to navigate the intricate terrain of financial markets with heightened foresight and confidence.

## Future Research

As noted in the Limitations section, model performance may be further enhanced by incorporating additional data sources such as forward guidance from companies, analyst forecasts, recommendations, and price targets to provide a more comprehensive view of market expectations and their impact on equity valuations. Additional sources could include social media sentiment analysis and natural language processing to capture market sentiment, news events, and investor behavior. Incorporating these factors should enhance the predictive power of the models and provide a more nuanced understanding of the drivers of equity valuations as events are “priced in.”

Given the broad scope of the study, future research could explore industry-specific and sub-industry-specific drivers to provide more granular insights into the factors influencing valuations. This could assist investors in tailoring their investment strategies

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within specific industries and sub-industries.

Additionally, there may be differing findings in markets outside of the United States, warranting further research into the drivers of equity valuations in international markets. This could provide valuable insights for investors with international portfolios through the identification of regional factors influencing valuations.

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## Appendix A

**Table A1***Independent Variables*

Company Fundamentals QoQ %Δ	Economic Indicators %Δ	Commodities %Δ
Total Revenue	Federal Funds Rate	Oil
Operating Revenue	3 Month Treasury Yield	Gold
Net Income	10 Year - 2 Year Treasury Yield Spread	Silver
Basic EPS	BAA - AAA Corporate Bond Yield Spread	Copper
EBITDA	In(Volatility Index) <sup>a</sup>	Aluminum
EBIT	30 Year - 15 Year Mortgage Rate Spread	Platinum
Current Ratio	CPI (Consumer Price Index for All Urban Consumers: All Items in U.S. City Average)	Palladium
Quick Ratio	Unemployment Rate	Natural Gas
Gross Profit Margin	Federal Budget Surplus or Deficit	Wheat
Net Profit Margin	Housing Starts (New Privately-Owned Housing Units Started: Total Units)	Corn
Cash Flow Margin	Real GDP <sup>b</sup>	Soybean
Operating Margin	Average Home Price (Average Sales Price of Houses Sold for the United States) <sup>b</sup>	Coffee
ROA		Sugar
CROA		Cotton
ROE		
Efficiency Ratio		
Inventory Turnover		
Debt to Equity		
Debt Ratio		
Interest Coverage		
Cash Flow to Debt		
Assets to Equity		
R&D to Revenue		
Investment CF to OCF		
Financing CF to OCF		
Free Cash Flow		
Capex		
BV per Share		
Tangible BV per Share		

<sup>a</sup> Note: Natural Log %Δ<sup>b</sup> QoQ %Δ**Table A2***Selected Sectors: Global Industry Classification Standard (GICS)*

Energy Sector	(p. 17)
Materials Sector	(p. 19)
Industrials Sector	(p. 21)
Consumer Discretionary Sector	(p. 23)
Consumer Staples Sector	(p. 24)
Health Care Sector	(p. 26)
Financial Services Industry Group <sup>3</sup>	(p. 27)
Information Technology Sector	(p. 28)
Communication Services Sector	(p. 29)
Utilities Sector	(p. 30)
Real Estate Sector	(p. 31)

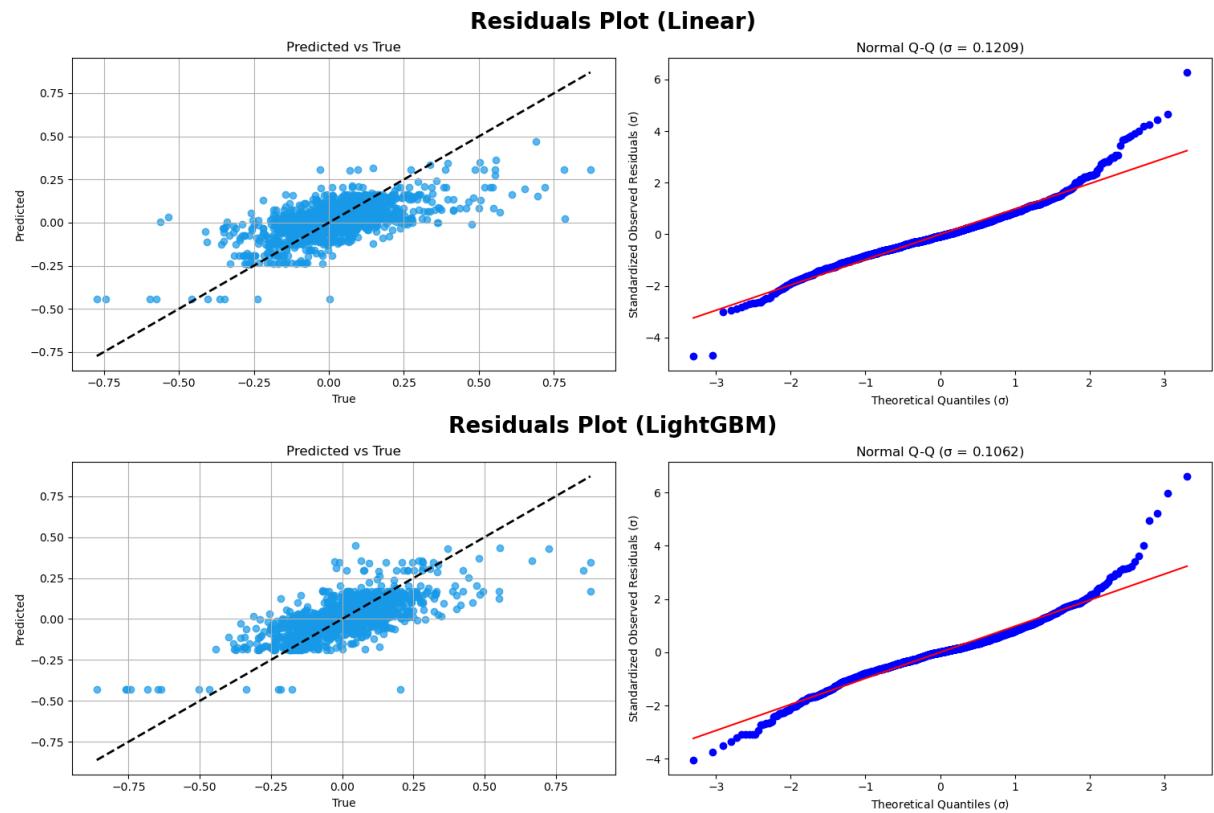
<sup>3</sup> Bank and Insurance Industry Groups omitted due to lack of data.

## Appendix B

### Energy Sector

**Figure B1**

*Energy Sector: Residuals Plots (Median Model)*

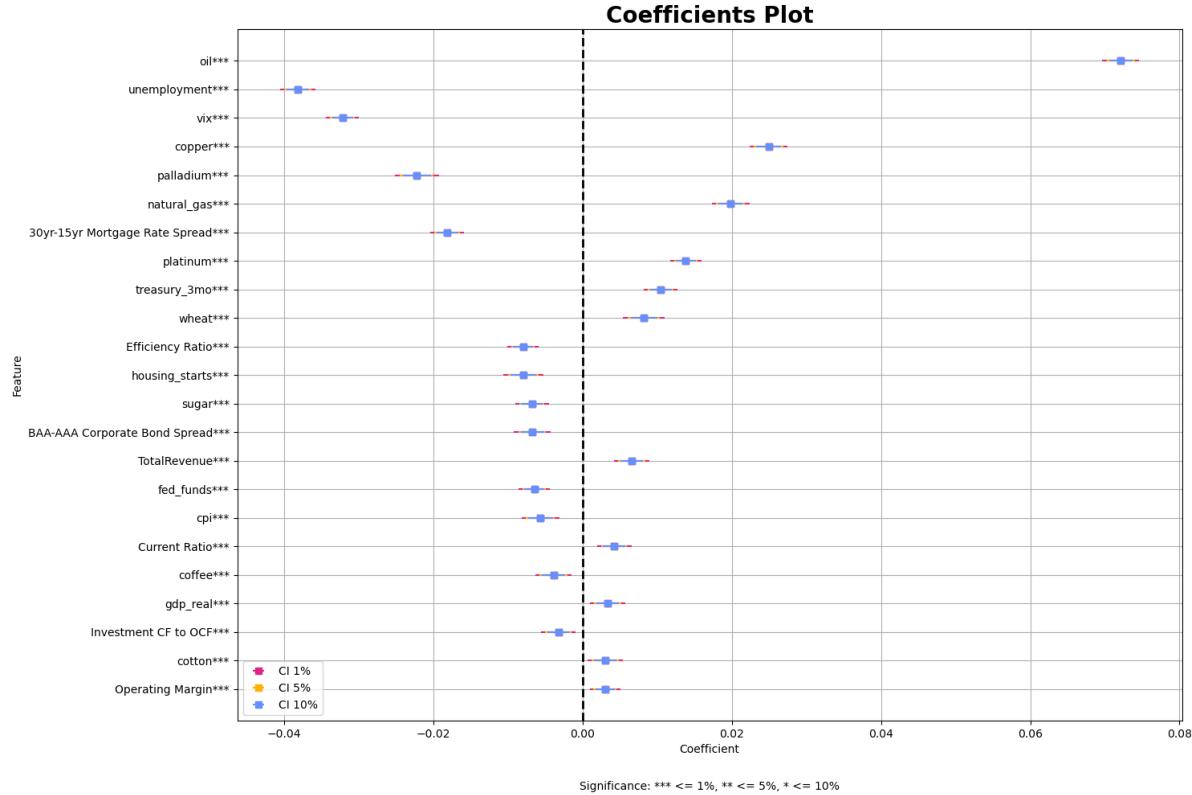


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure B2**

*Energy Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table B1 for coefficient statistics.

**Table B1**

*Energy Sector: Linear Regression Coefficient Statistics (Median Model)*

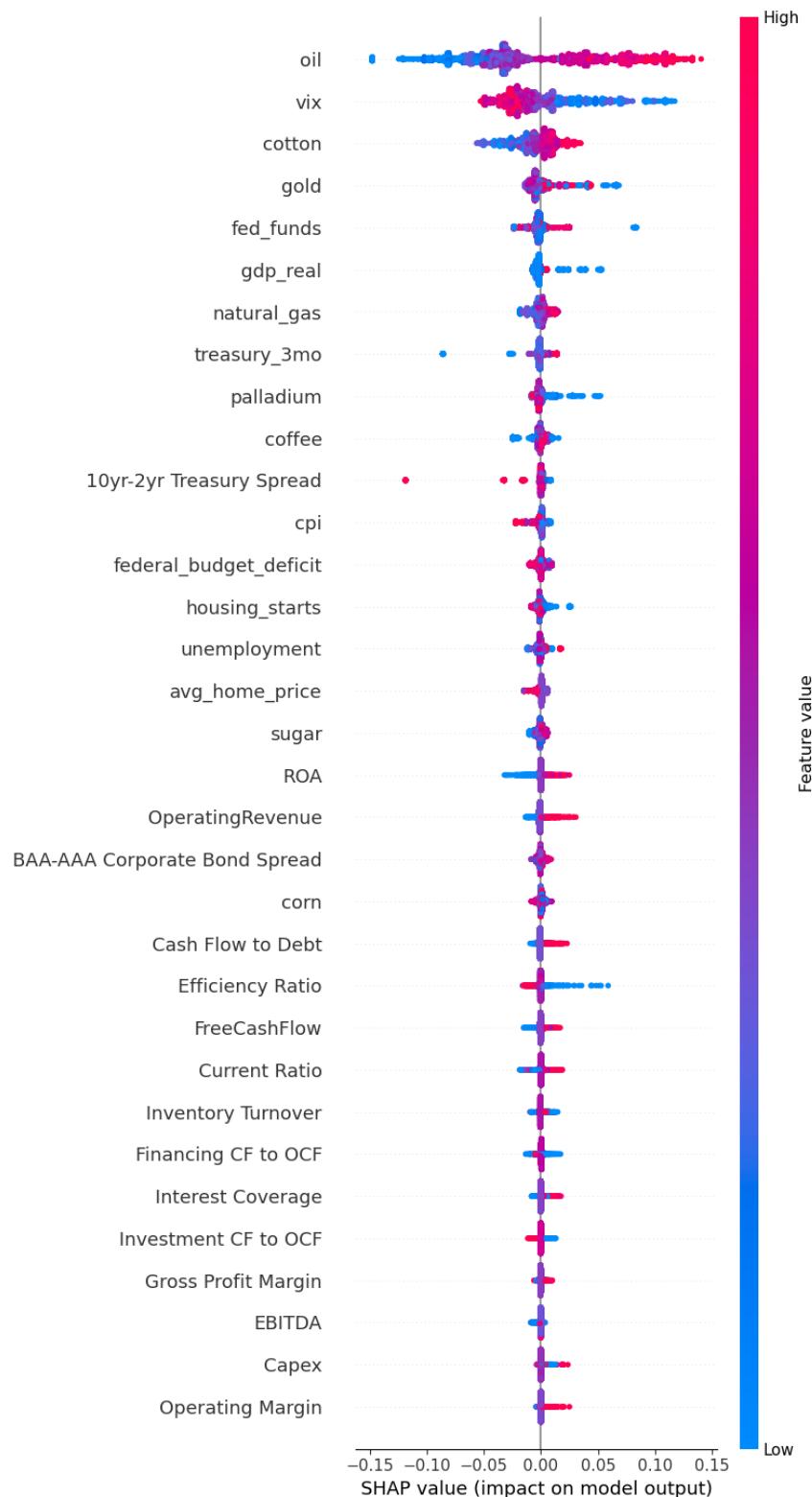
	Coef	Std Err	t	P >  t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
oil	0.072119	0.000959	75.208093	0.000000e+00	1.645118	0.001578	1.960375	0.001880	2.576681	0.002471
unemployment	-0.038168	0.000917	41.626649	0.000000e+00	1.645118	0.001508	1.960375	0.001798	2.576681	0.002363
vix	-0.032191	0.000848	37.942988	0.000000e+00	1.645118	0.001396	1.960375	0.001663	2.576681	0.002186
copper	0.024927	0.000993	25.098230	0.000000e+00	1.645118	0.001634	1.960375	0.001947	2.576681	0.002559
palladium	-0.022238	0.001153	19.290435	0.000000e+00	1.645118	0.001897	1.960375	0.002260	2.576681	0.002970
natural_gas	0.019830	0.000987	20.097302	0.000000e+00	1.645118	0.001623	1.960375	0.001934	2.576681	0.002542
30yr-15yr Mortgage Rate Spread	-0.018138	0.000871	20.832268	0.000000e+00	1.645118	0.001432	1.960375	0.001707	2.576681	0.002243
platinum	0.013830	0.000801	17.274325	0.000000e+00	1.645118	0.001317	1.960375	0.001570	2.576681	0.002063
treasury_3mo	0.010473	0.000869	12.051312	0.000000e+00	1.645118	0.001430	1.960375	0.001704	2.576681	0.002239
wheat	0.008210	0.001091	7.527143	5.995204e-14	1.645118	0.001794	1.960375	0.002138	2.576681	0.002811
Efficiency Ratio	-0.008001	0.000815	9.814769	0.000000e+00	1.645118	0.001341	1.960375	0.001598	2.576681	0.002100
housing_starts	-0.007948	0.001028	7.733571	1.221245e-14	1.645118	0.001691	1.960375	0.002015	2.576681	0.002648
sugar	-0.006813	0.000875	7.786004	8.215650e-15	1.645118	0.001440	1.960375	0.001715	2.576681	0.002255
BAA-AAA Corporate Bond Spread	-0.006754	0.000951	7.104753	1.350919e-12	1.645118	0.001564	1.960375	0.001864	2.576681	0.002449
TotalRevenue	0.006591	0.000926	7.119706	1.213252e-12	1.645118	0.001523	1.960375	0.001815	2.576681	0.002385
fed_funds	-0.006479	0.000801	8.083756	8.881784e-16	1.645118	0.001318	1.960375	0.001571	2.576681	0.002065
cpi	-0.005645	0.000991	5.698187	1.270725e-08	1.645118	0.001630	1.960375	0.001942	2.576681	0.002553
Current Ratio	0.004219	0.000896	4.708409	2.554940e-06	1.645118	0.001474	1.960375	0.001757	2.576681	0.002309
coffee	-0.003903	0.000948	4.116240	3.904693e-05	1.645118	0.001560	1.960375	0.001859	2.576681	0.002443
gdp_real	0.003357	0.000928	3.618484	2.988685e-04	1.645118	0.001526	1.960375	0.001819	2.576681	0.002390
Investment CF to OCF	-0.003262	0.000905	3.603657	3.164137e-04	1.645118	0.001489	1.960375	0.001775	2.576681	0.002333
cotton	0.003010	0.000920	3.271215	1.077149e-03	1.645118	0.001514	1.960375	0.001804	2.576681	0.002371
Operating Margin	0.003001	0.000795	3.773926	1.623090e-04	1.645118	0.001308	1.960375	0.001559	2.576681	0.002049

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure B3**

*Energy Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



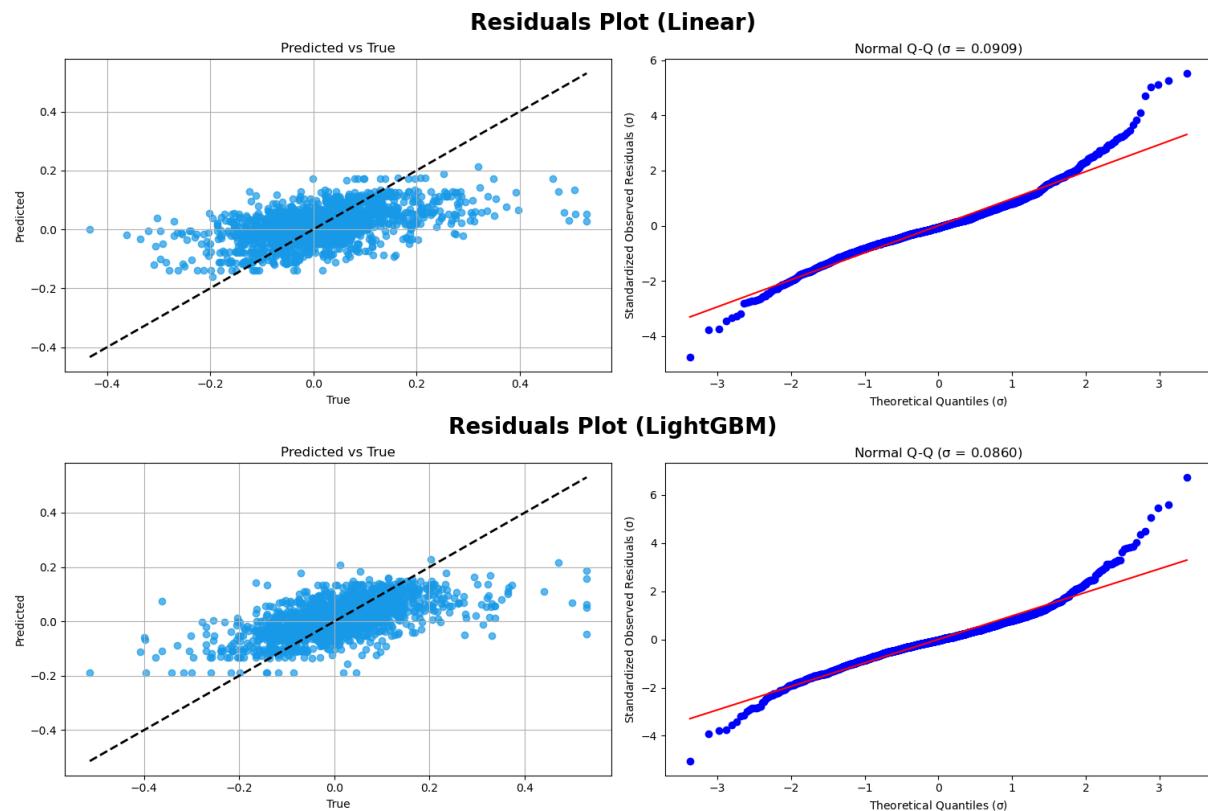
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix C

### Materials Sector

**Figure C1**

*Materials Sector: Residuals Plots (Median Model)*

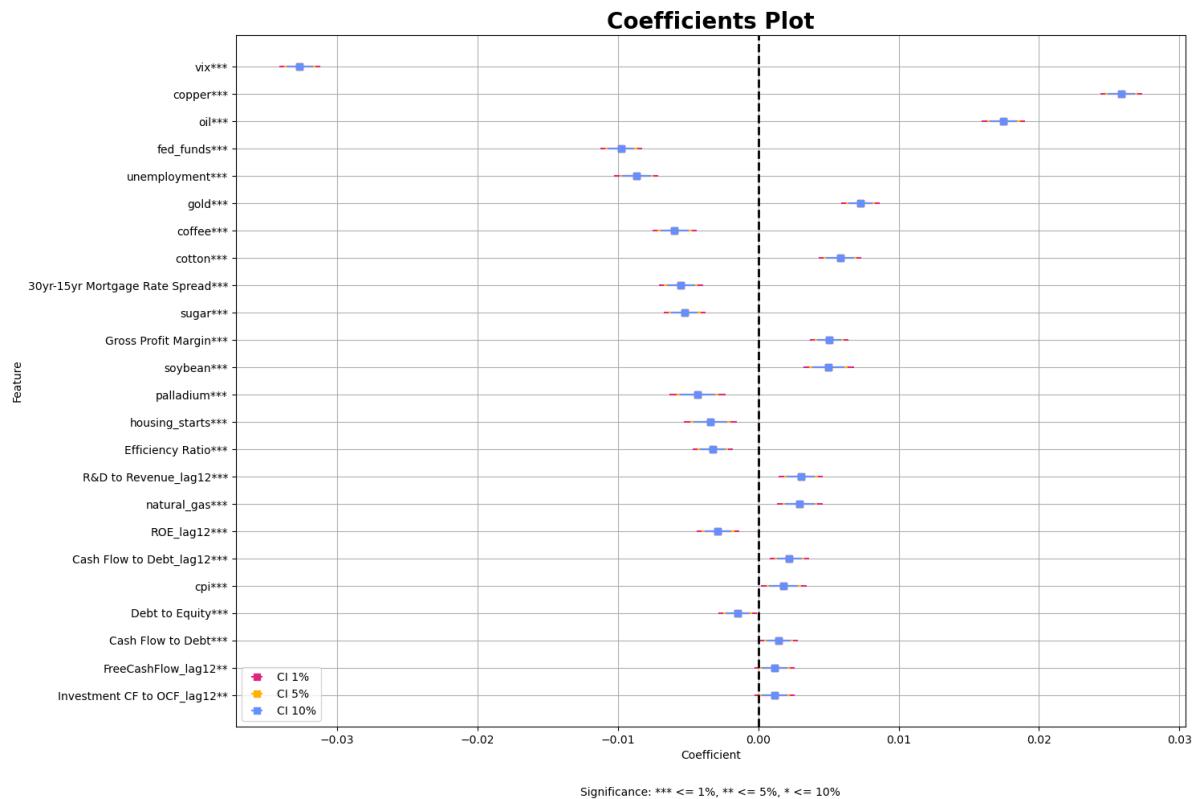


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure C2**

*Materials Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table C1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table C1**

*Materials Sector: Linear Regression Coefficient Statistics (Median Model)*

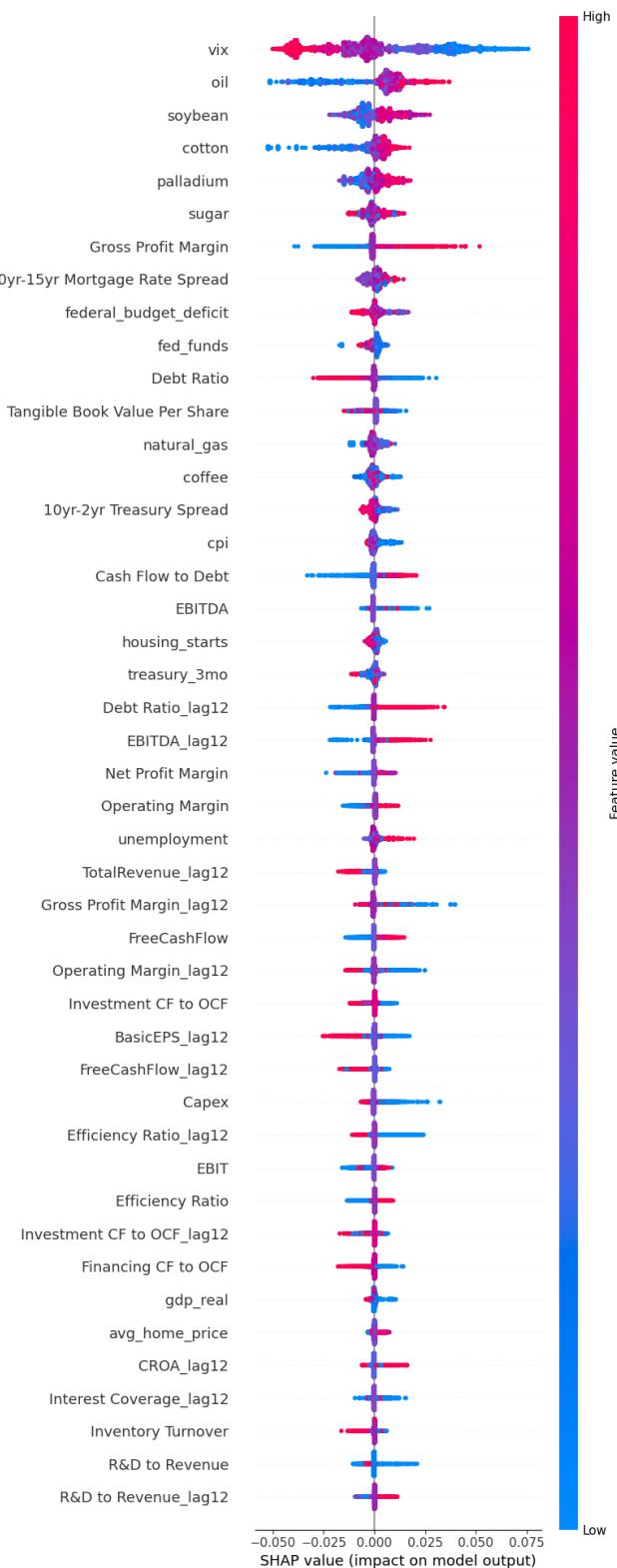
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.032670	0.000573	56.996400	0.000000e+00	1.645059	0.000943	1.960284	0.001124	2.576493	0.001477
copper	0.025858	0.000585	44.215908	0.000000e+00	1.645059	0.000962	1.960284	0.001146	2.576493	0.001507
oil	0.017464	0.000598	29.209475	0.000000e+00	1.645059	0.000984	1.960284	0.001172	2.576493	0.001540
fed_funds	-0.009781	0.000579	16.883030	0.000000e+00	1.645059	0.000953	1.960284	0.001136	2.576493	0.001493
unemployment	-0.008679	0.000610	14.216847	0.000000e+00	1.645059	0.001004	1.960284	0.001197	2.576493	0.001573
gold	0.007280	0.000531	13.711729	0.000000e+00	1.645059	0.000873	1.960284	0.001041	2.576493	0.001368
coffee	-0.005962	0.000615	9.701652	0.000000e+00	1.645059	0.001011	1.960284	0.001205	2.576493	0.001583
cotton	0.005821	0.000597	9.753867	0.000000e+00	1.645059	0.000982	1.960284	0.001170	2.576493	0.001538
30yr-15yr Mortgage Rate Spread	-0.005526	0.000610	9.058539	0.000000e+00	1.645059	0.001004	1.960284	0.001196	2.576493	0.001572
sugar	-0.005263	0.000581	9.057284	0.000000e+00	1.645059	0.000956	1.960284	0.001139	2.576493	0.001497
Gross Profit Margin	0.005062	0.000528	9.584668	0.000000e+00	1.645059	0.000869	1.960284	0.001035	2.576493	0.001361
soybean	0.005005	0.000703	7.120071	1.179945e-12	1.645059	0.001156	1.960284	0.001378	2.576493	0.001811
palladium	-0.004328	0.000770	5.618760	1.993136e-08	1.645059	0.001267	1.960284	0.001510	2.576493	0.001984
housing_starts	-0.003411	0.000731	4.665576	3.131570e-06	1.645059	0.001203	1.960284	0.001433	2.576493	0.001884
Efficiency Ratio	-0.003247	0.000555	5.852369	5.052831e-09	1.645059	0.000913	1.960284	0.001088	2.576493	0.001430
R&D to Revenue_lag12	0.003039	0.000611	4.972157	6.770024e-07	1.645059	0.001005	1.960284	0.001198	2.576493	0.001575
natural_gas	0.002953	0.000632	4.674761	2.995025e-06	1.645059	0.001039	1.960284	0.001238	2.576493	0.001628
ROE_lag12	-0.002872	0.000585	4.908044	9.395480e-07	1.645059	0.000963	1.960284	0.001147	2.576493	0.001508
Cash Flow to Debt_lag12	0.002202	0.000540	4.076020	4.629209e-05	1.645059	0.000889	1.960284	0.001059	2.576493	0.001392
cpi	0.001802	0.000630	2.861777	4.224539e-03	1.645059	0.001036	1.960284	0.001235	2.576493	0.001623
Debt to Equity	-0.001483	0.000531	2.795954	5.188001e-03	1.645059	0.000873	1.960284	0.001040	2.576493	0.001367
Cash Flow to Debt	0.001444	0.000533	2.711264	6.718174e-03	1.645059	0.000876	1.960284	0.001044	2.576493	0.001372
FreeCashFlow_lag12	0.001177	0.000559	2.107441	3.511292e-02	1.645059	0.000919	1.960284	0.001095	2.576493	0.001439
Investment CF to OCF_lag12	0.001176	0.000552	2.130153	3.319185e-02	1.645059	0.000908	1.960284	0.001082	2.576493	0.001422

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure C3**

*Materials Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



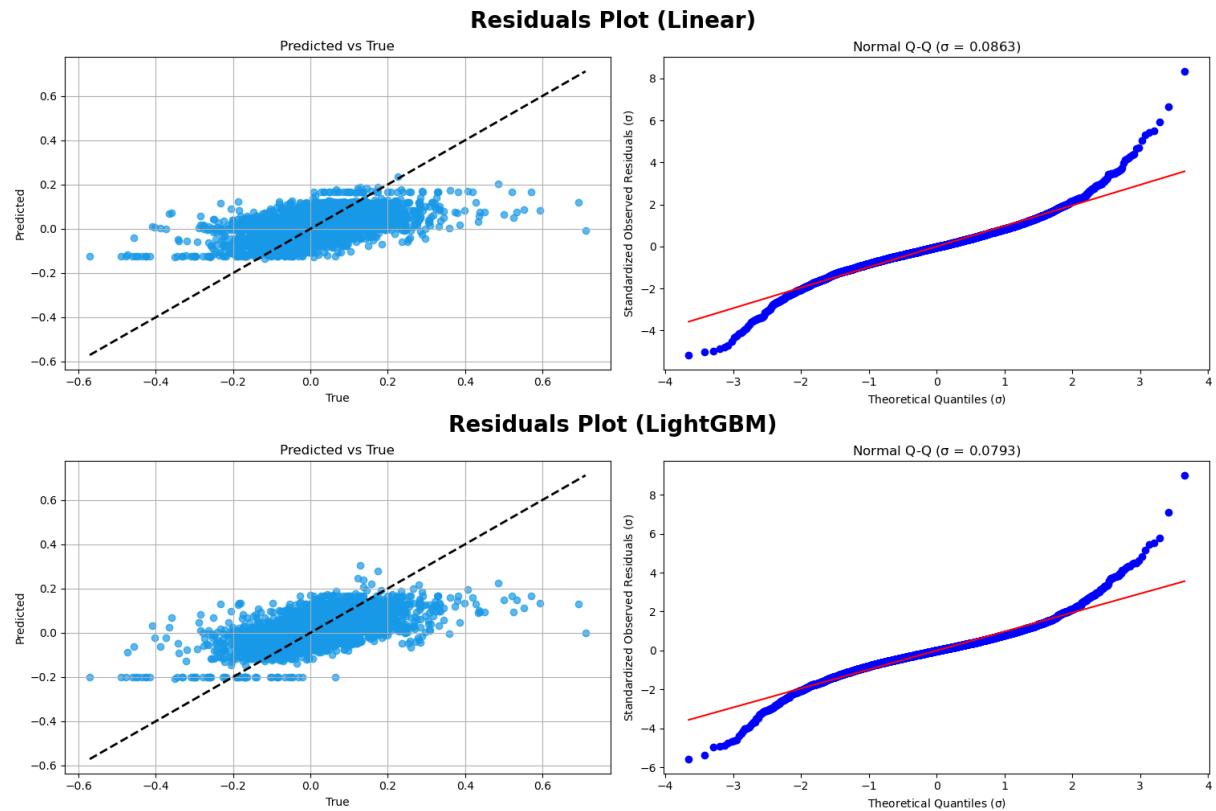
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix D

### Industrials Sector

**Figure D1**

*Industrials Sector: Residuals Plots (Median Model)*

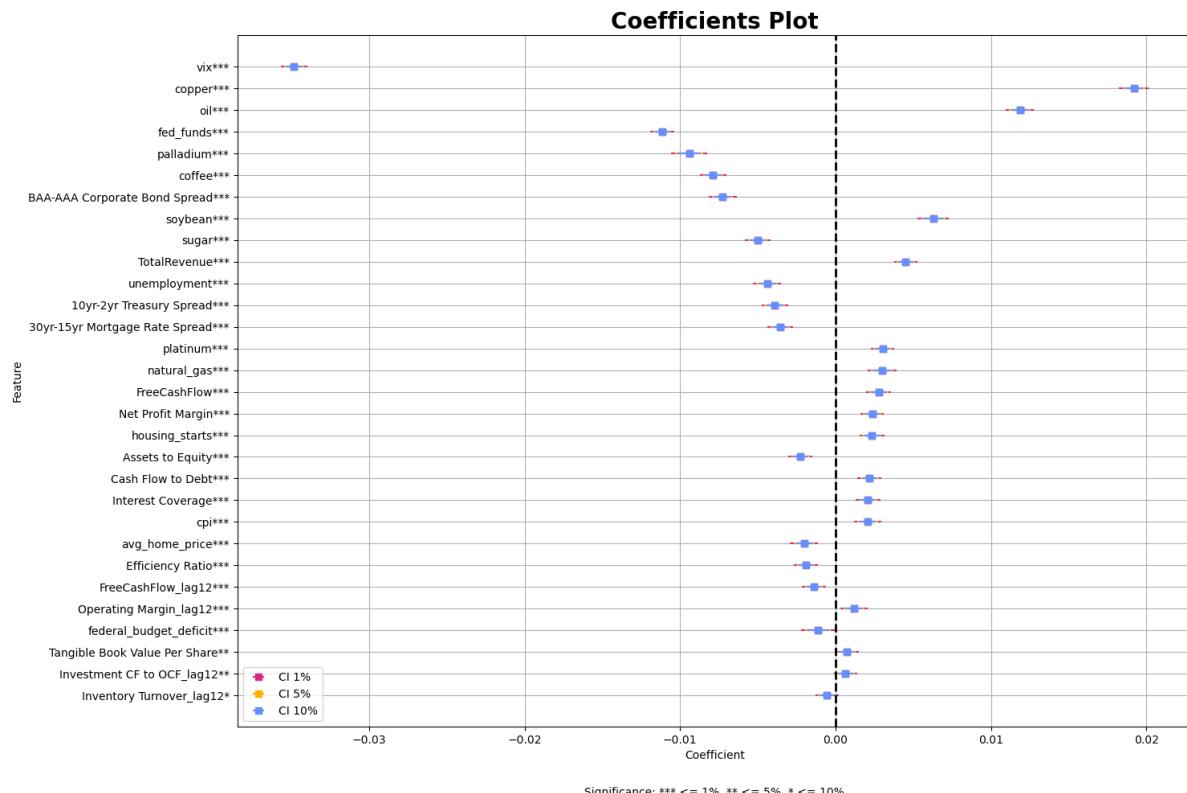


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure D2**

*Industrials Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table D1 for coefficient statistics.

## DECODING SECTOR VALUATION DYNAMICS

**Table D1**

*Industrials Sector: Linear Regression Coefficient Statistics (Median Model)*

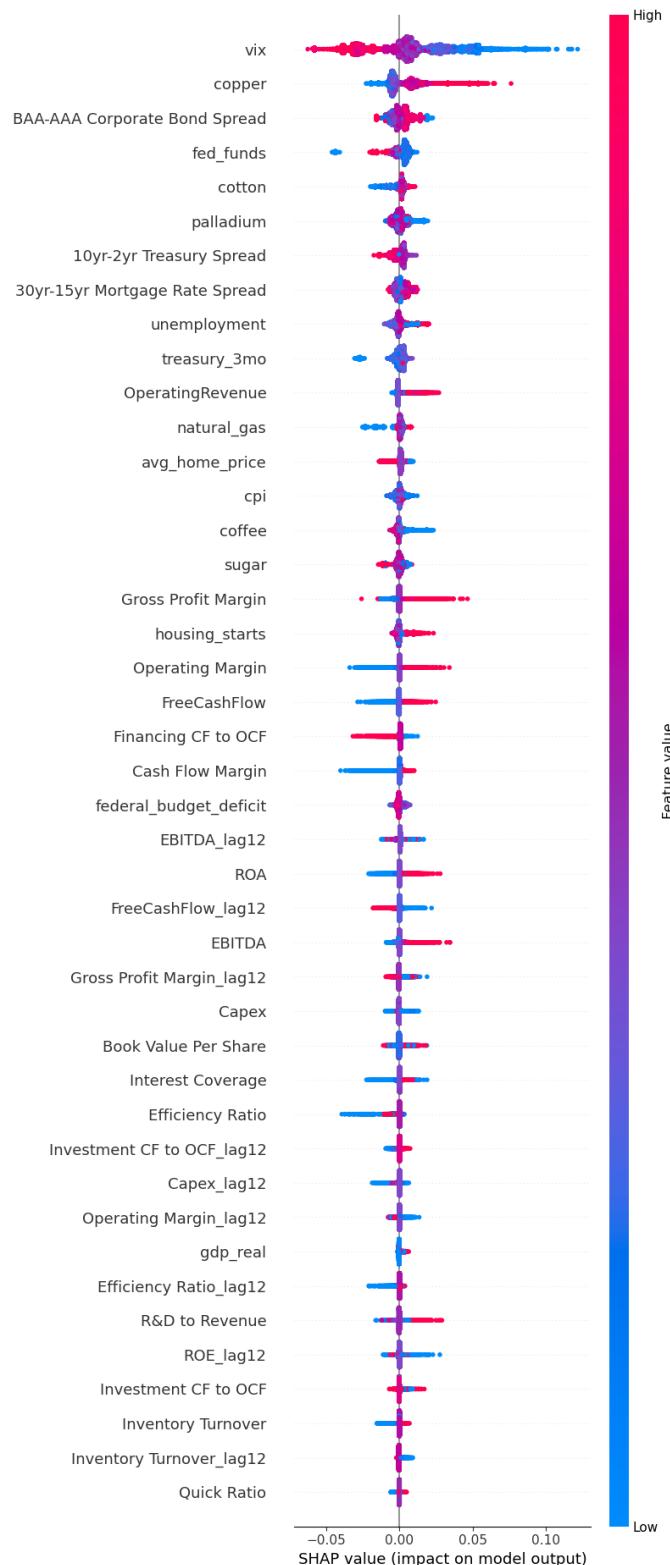
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.034846	0.000329	106.018560	0.000000e+00	1.644925	0.000541	1.960075	0.000644	2.57606	0.000847
copper	0.019193	0.000369	52.046263	0.000000e+00	1.644925	0.000607	1.960075	0.000723	2.57606	0.000950
oil	0.011864	0.000348	34.066534	0.000000e+00	1.644925	0.000573	1.960075	0.000683	2.57606	0.000897
fed_funds	-0.011140	0.000297	37.461731	0.000000e+00	1.644925	0.000489	1.960075	0.000583	2.57606	0.000766
palladium	-0.009409	0.000457	20.568201	0.000000e+00	1.644925	0.000753	1.960075	0.000897	2.57606	0.001178
coffee	-0.007888	0.000331	23.803426	0.000000e+00	1.644925	0.000545	1.960075	0.000649	2.57606	0.000854
BAA-AAA Corporate Bond Spread	-0.007262	0.000349	20.835321	0.000000e+00	1.644925	0.000573	1.960075	0.000683	2.57606	0.000898
soybean	0.006290	0.000391	16.091937	0.000000e+00	1.644925	0.000643	1.960075	0.000766	2.57606	0.001007
sugar	-0.004996	0.000324	15.440495	0.000000e+00	1.644925	0.000532	1.960075	0.000634	2.57606	0.000833
TotalRevenue	0.004519	0.000297	15.226676	0.000000e+00	1.644925	0.000488	1.960075	0.000582	2.57606	0.000765
unemployment	-0.004401	0.000347	12.694730	0.000000e+00	1.644925	0.000570	1.960075	0.000680	2.57606	0.000893
10yr-2yr Treasury Spread	-0.003907	0.000335	11.664282	0.000000e+00	1.644925	0.000551	1.960075	0.000657	2.57606	0.000863
30yr-15yr Mortgage Rate Spread	-0.003557	0.000311	11.424984	0.000000e+00	1.644925	0.000512	1.960075	0.000610	2.57606	0.000802
platinum	0.003034	0.000296	10.258112	0.000000e+00	1.644925	0.000487	1.960075	0.000580	2.57606	0.000762
natural_gas	0.003008	0.000366	8.207762	2.220446e-16	1.644925	0.000603	1.960075	0.000718	2.57606	0.000944
FreeCashFlow	0.002785	0.000310	8.998133	0.000000e+00	1.644925	0.000509	1.960075	0.000607	2.57606	0.000797
Net Profit Margin	0.002364	0.000296	7.986280	1.332268e-15	1.644925	0.000487	1.960075	0.000580	2.57606	0.000763
housing_starts	0.002353	0.000316	7.434627	1.088019e-13	1.644925	0.000521	1.960075	0.000620	2.57606	0.000815
Assets to Equity	-0.002263	0.000304	7.441755	1.032507e-13	1.644925	0.000500	1.960075	0.000596	2.57606	0.000783
Cash Flow to Debt	0.002186	0.000301	7.260160	3.999023e-13	1.644925	0.000495	1.960075	0.000590	2.57606	0.000776
Interest Coverage	0.002087	0.000308	6.765546	1.362443e-11	1.644925	0.000507	1.960075	0.000605	2.57606	0.000794
cpi	0.002055	0.000338	6.078365	1.234732e-09	1.644925	0.000556	1.960075	0.000663	2.57606	0.000871
avg_home_price	-0.002009	0.000351	5.724932	1.048624e-08	1.644925	0.000577	1.960075	0.000688	2.57606	0.000904
Efficiency Ratio	-0.001906	0.000295	6.455851	1.099263e-10	1.644925	0.000486	1.960075	0.000579	2.57606	0.000761
FreeCashFlow_lag12	-0.001386	0.000296	4.685847	2.805226e-06	1.644925	0.000487	1.960075	0.000580	2.57606	0.000762
Operating Margin_lag12	0.001204	0.000345	3.488170	4.873168e-04	1.644925	0.000568	1.960075	0.000676	2.57606	0.000889
federal_budget_deficit	-0.001121	0.000421	2.661149	7.793264e-03	1.644925	0.000693	1.960075	0.000826	2.57606	0.001085
Tangible Book Value Per Share	0.000727	0.000297	2.444289	1.452182e-02	1.644925	0.000489	1.960075	0.000583	2.57606	0.000766
Investment CF to OCF_lag12	0.000645	0.000296	2.181907	2.912728e-02	1.644925	0.000486	1.960075	0.000579	2.57606	0.000761
Inventory Turnover_lag12	-0.000537	0.000296	1.817309	6.918377e-02	1.644925	0.000486	1.960075	0.000579	2.57606	0.000761

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure D3**

*Industrials Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



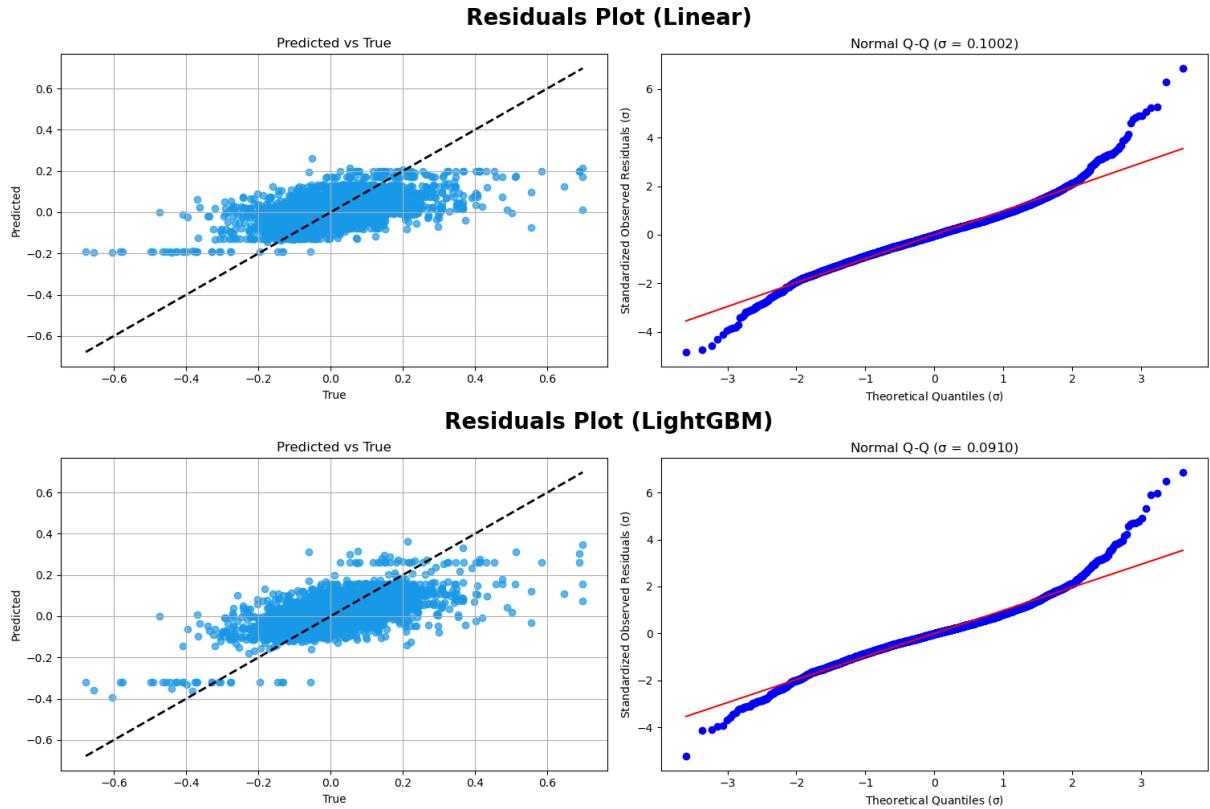
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix E

### Consumer Discretionary Sector

**Figure E1**

*Consumer Discretionary Sector: Residuals Plots (Median Model)*

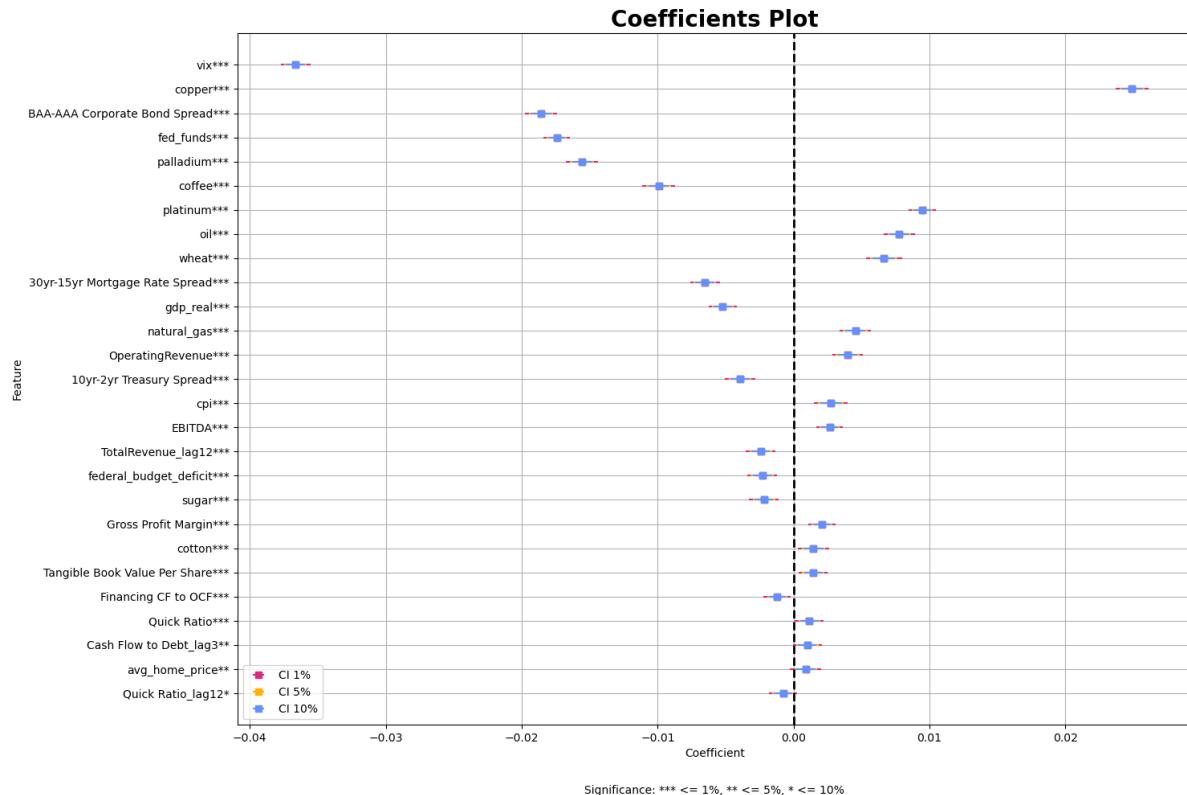


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure E2**

*Consumer Discretionary Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table E1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table E1**

*Consumer Discretionary Sector: Linear Regression Coefficient Statistics (Median Model)*

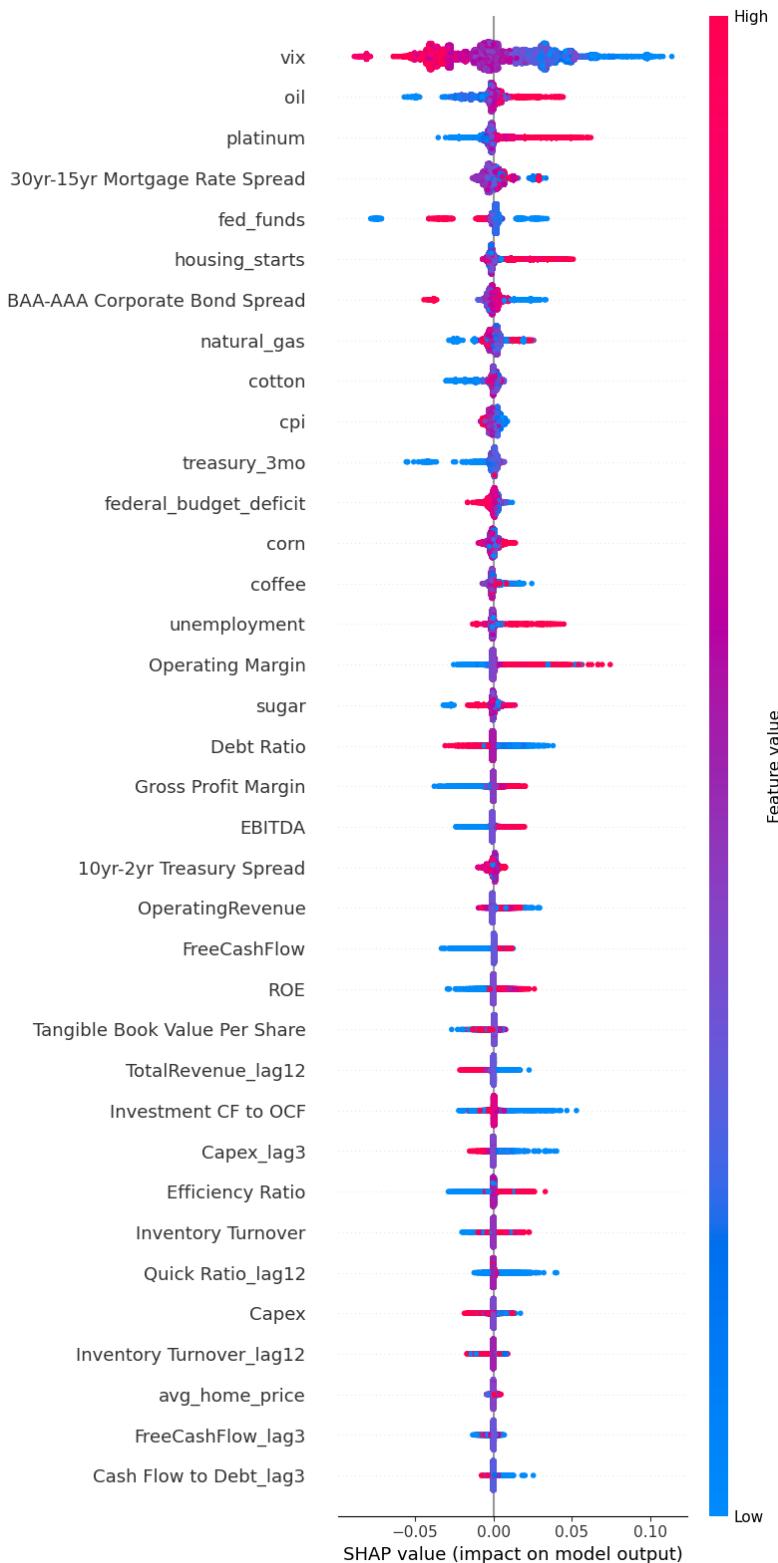
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.036635	0.000424	86.440573	0.000000e+00	1.644941	0.000697	1.9601	0.000831	2.576111	0.001092
copper	0.024899	0.000470	52.938871	0.000000e+00	1.644941	0.000774	1.9601	0.000922	2.576111	0.001212
BAA-AAA Corporate Bond Spread	-0.018579	0.000460	40.385533	0.000000e+00	1.644941	0.000757	1.9601	0.000902	2.576111	0.001185
fed_funds	-0.017417	0.000380	45.854122	0.000000e+00	1.644941	0.000625	1.9601	0.000745	2.576111	0.000978
palladium	-0.015554	0.000457	34.044705	0.000000e+00	1.644941	0.000752	1.9601	0.000896	2.576111	0.001177
coffee	-0.009929	0.000463	21.429828	0.000000e+00	1.644941	0.000762	1.9601	0.000908	2.576111	0.001194
platinum	0.009462	0.000380	24.921168	0.000000e+00	1.644941	0.000625	1.9601	0.000744	2.576111	0.000978
oil	0.007781	0.000450	17.307491	0.000000e+00	1.644941	0.000739	1.9601	0.000881	2.576111	0.001158
wheat	0.006644	0.000511	13.001764	0.000000e+00	1.644941	0.000841	1.9601	0.001002	2.576111	0.001316
30yr-15yr Mortgage Rate Spread	-0.006523	0.000427	15.270926	0.000000e+00	1.644941	0.000703	1.9601	0.000837	2.576111	0.001100
gdp_real	-0.005216	0.000408	12.788159	0.000000e+00	1.644941	0.000671	1.9601	0.000800	2.576111	0.001051
natural_gas	0.004537	0.000455	9.973165	0.000000e+00	1.644941	0.000748	1.9601	0.000892	2.576111	0.001172
OperatingRevenue	0.003975	0.000441	9.016396	0.000000e+00	1.644941	0.000725	1.9601	0.000864	2.576111	0.001136
10yr-2yr Treasury Spread	-0.003938	0.000435	9.054217	0.000000e+00	1.644941	0.000715	1.9601	0.000852	2.576111	0.001120
cpi	0.002755	0.000482	5.710593	1.144138e-08	1.644941	0.000793	1.9601	0.000945	2.576111	0.001243
EBITDA	0.002656	0.000379	7.005869	2.543965e-12	1.644941	0.000624	1.9601	0.000743	2.576111	0.000977
TotalRevenue_lag12	-0.002418	0.000420	5.763009	8.402000e-09	1.644941	0.000690	1.9601	0.000822	2.576111	0.001081
federal_budget_deficit	-0.002303	0.000428	5.374393	7.782676e-08	1.644941	0.000705	1.9601	0.000840	2.576111	0.001104
sugar	-0.002189	0.000419	5.227128	1.741459e-07	1.644941	0.000689	1.9601	0.000821	2.576111	0.001079
Gross Profit Margin	0.002064	0.000389	5.302414	1.156726e-07	1.644941	0.000640	1.9601	0.000763	2.576111	0.001003
cotton	0.001460	0.000441	3.306838	9.454603e-04	1.644941	0.000726	1.9601	0.000865	2.576111	0.001137
Tangible Book Value Per Share	0.001438	0.000412	3.488258	4.873751e-04	1.644941	0.000678	1.9601	0.000808	2.576111	0.001062
Financing CF to OCF	-0.001200	0.000388	3.096405	1.961931e-03	1.644941	0.000638	1.9601	0.000760	2.576111	0.000998
Quick Ratio	0.001161	0.000411	2.825982	4.718944e-03	1.644941	0.000676	1.9601	0.000805	2.576111	0.001058
Cash Flow to Debt_lag3	0.001013	0.000412	2.462366	1.381196e-02	1.644941	0.000677	1.9601	0.000807	2.576111	0.001060
avg_home_price	0.000883	0.000440	2.008264	4.463060e-02	1.644941	0.000723	1.9601	0.000862	2.576111	0.001133
Quick Ratio_lag12	-0.000775	0.000399	1.943996	5.191197e-02	1.644941	0.000656	1.9601	0.000782	2.576111	0.001028

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure E3**

*Consumer Discretionary Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



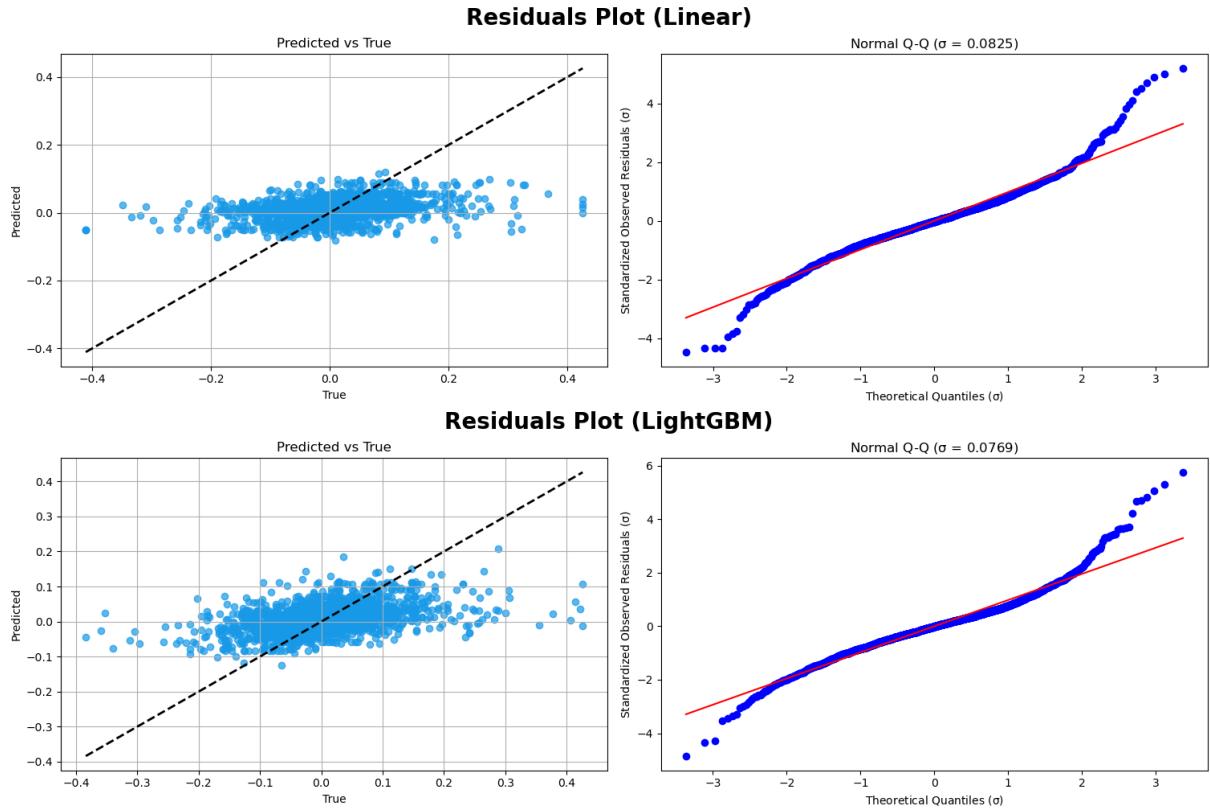
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix F

### Consumer Staples Sector

**Figure F1**

*Consumer Staples Sector: Residuals Plots (Median Model)*

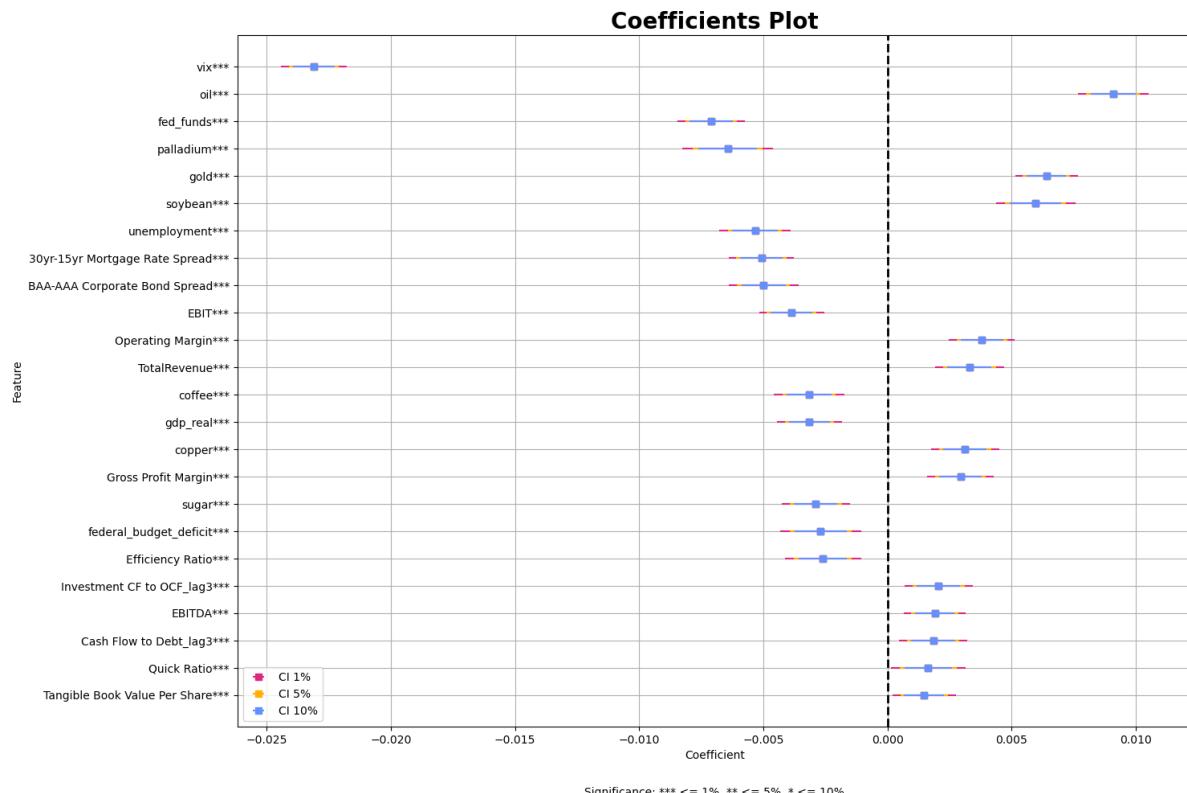


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure F2**

*Consumer Staples Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table F1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table F1**

*Consumer Staples Sector: Linear Regression Coefficient Statistics (Median Model)*

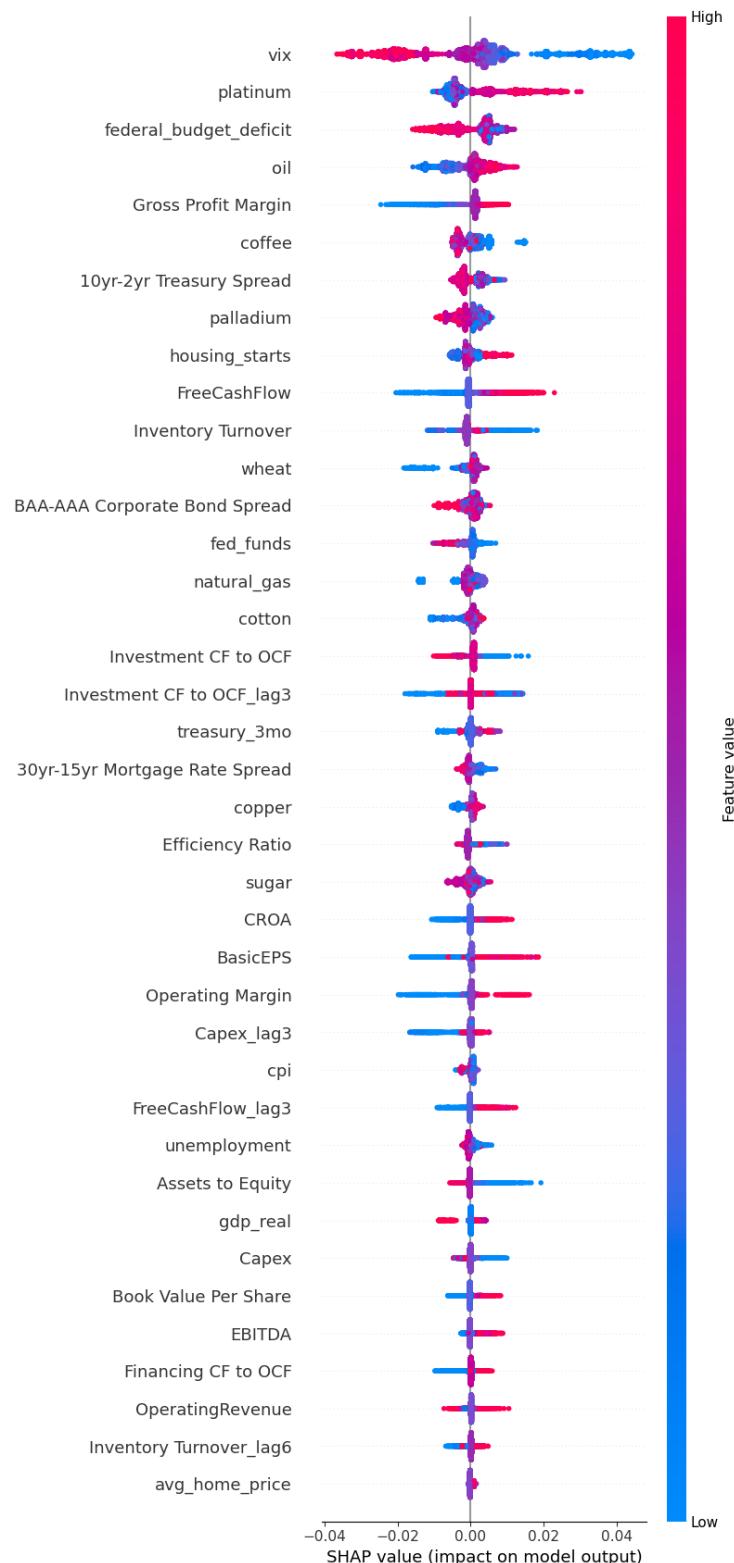
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.023115	0.000513	45.017084	0.000000e+00	1.645064	0.000845	1.960292	0.001007	2.576508	0.001323
oil	0.009093	0.000553	16.445982	0.000000e+00	1.645064	0.000910	1.960292	0.001084	2.576508	0.001425
fed_funds	-0.007107	0.000526	13.514298	0.000000e+00	1.645064	0.000865	1.960292	0.001031	2.576508	0.001355
palladium	-0.006433	0.000712	9.035043	0.000000e+00	1.645064	0.001171	1.960292	0.001396	2.576508	0.001834
gold	0.006400	0.000489	13.081798	0.000000e+00	1.645064	0.000805	1.960292	0.000959	2.576508	0.001261
soybean	0.005965	0.000623	9.578772	0.000000e+00	1.645064	0.001024	1.960292	0.001221	2.576508	0.001605
unemployment	-0.005335	0.000558	9.557536	0.000000e+00	1.645064	0.000918	1.960292	0.001094	2.576508	0.001438
30yr-15yr Mortgage Rate Spread	-0.005077	0.000513	9.897096	0.000000e+00	1.645064	0.000844	1.960292	0.001006	2.576508	0.001322
BAA-AAA Corporate Bond Spread	-0.004984	0.000545	9.150436	0.000000e+00	1.645064	0.000896	1.960292	0.001068	2.576508	0.001403
EBIT	-0.003857	0.000512	7.539640	5.284662e-14	1.645064	0.000841	1.960292	0.001003	2.576508	0.001318
Operating Margin	0.003808	0.000514	7.409519	1.409983e-13	1.645064	0.000845	1.960292	0.001007	2.576508	0.001324
TotalRevenue	0.003308	0.000540	6.122992	9.663046e-10	1.645064	0.000889	1.960292	0.001059	2.576508	0.001392
coffee	-0.003154	0.000550	5.733069	1.025948e-08	1.645064	0.000905	1.960292	0.001079	2.576508	0.001418
gdp_real	-0.003142	0.000503	6.246555	4.433407e-10	1.645064	0.000827	1.960292	0.000986	2.576508	0.001296
copper	0.003124	0.000533	5.864485	4.703459e-09	1.645064	0.000876	1.960292	0.001044	2.576508	0.001373
Gross Profit Margin	0.002945	0.000518	5.689538	1.323531e-08	1.645064	0.000852	1.960292	0.001015	2.576508	0.001334
sugar	-0.002887	0.000533	5.414068	6.358496e-08	1.645064	0.000877	1.960292	0.001045	2.576508	0.001374
federal_budget_deficit	-0.002688	0.000631	4.260280	2.067562e-05	1.645064	0.001038	1.960292	0.001237	2.576508	0.001626
Efficiency Ratio	-0.002601	0.000595	4.374488	1.234235e-05	1.645064	0.000978	1.960292	0.001166	2.576508	0.001532
Investment CF to OCF_lag3	0.002058	0.000533	3.858674	1.149939e-04	1.645064	0.000877	1.960292	0.001046	2.576508	0.001374
EBITDA	0.001909	0.000485	3.935978	8.363445e-05	1.645064	0.000798	1.960292	0.000951	2.576508	0.001249
Cash Flow to Debt_lag3	0.001844	0.000538	3.431040	6.046300e-04	1.645064	0.000884	1.960292	0.001054	2.576508	0.001385
Quick Ratio	0.001645	0.000586	2.806297	5.024824e-03	1.645064	0.000964	1.960292	0.001149	2.576508	0.001510
Tangible Book Value Per Share	0.001480	0.000491	3.012346	2.601329e-03	1.645064	0.000808	1.960292	0.000963	2.576508	0.001266

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure F3**

*Consumer Staples Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



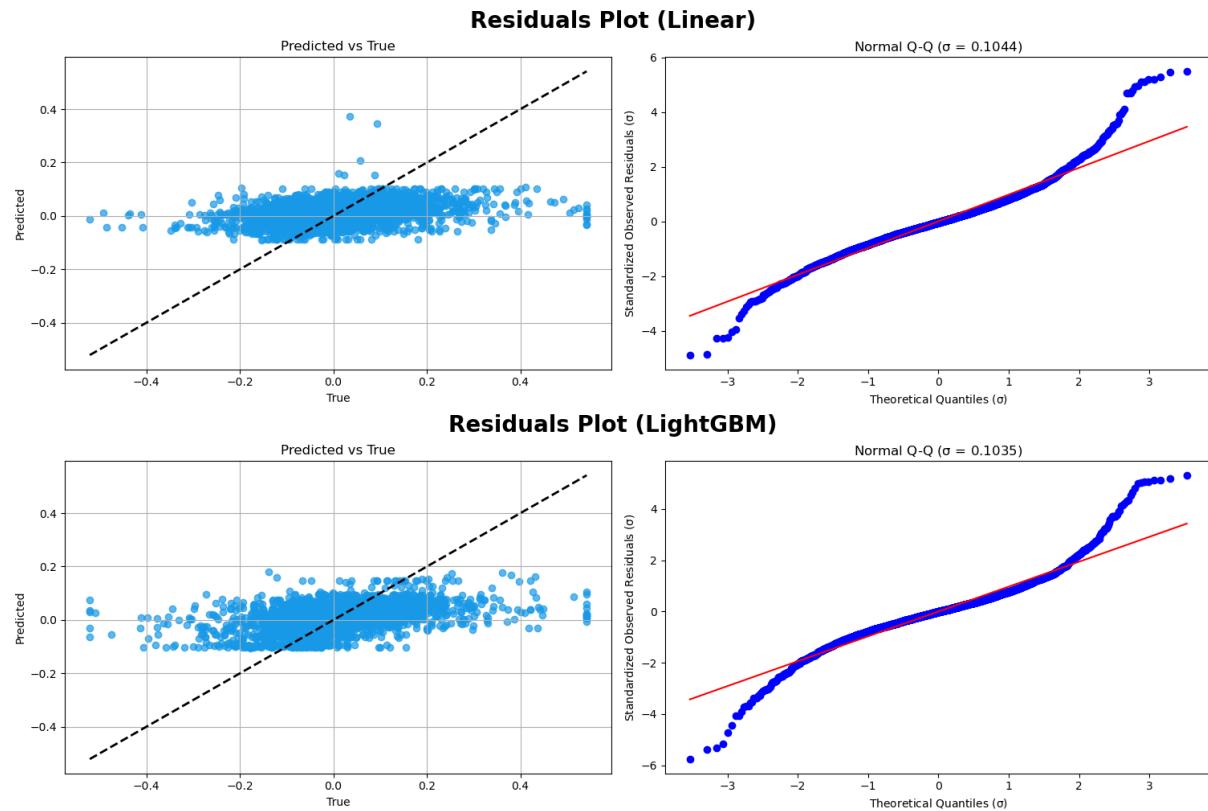
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix G

### Health Care Sector

**Figure G1**

*Health Care Sector: Residuals Plots (Median Model)*

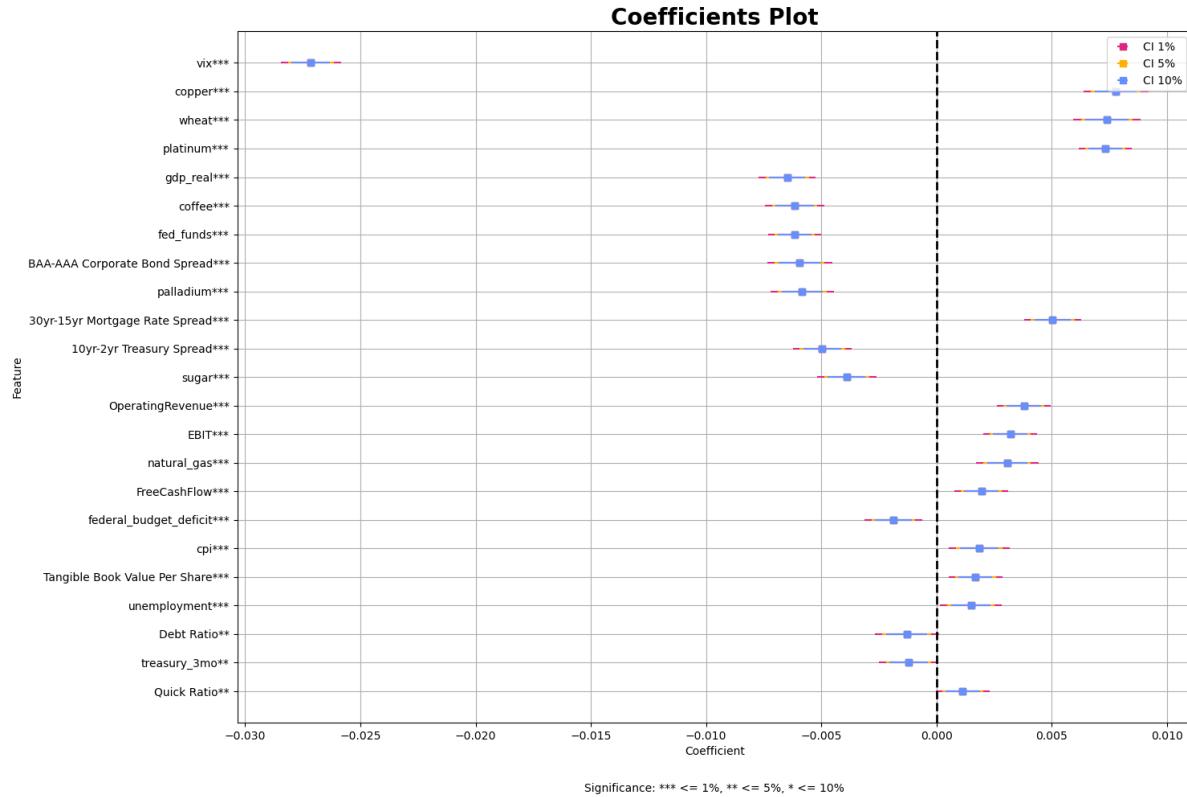


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure G2**

*Health Care Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table G1 for coefficient statistics.

**Table G1**

*Health Care Sector: Linear Regression Coefficient Statistics (Median Model)*

	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.027151	0.000507	53.533995	0.000000e+00	1.644966	0.000834	1.96014	0.000994	2.576193	0.001307
copper	0.007791	0.000550	14.167818	0.000000e+00	1.644966	0.000905	1.96014	0.001078	2.576193	0.001417
wheat	0.007393	0.000571	12.945928	0.000000e+00	1.644966	0.000939	1.96014	0.001119	2.576193	0.001471
platinum	0.007327	0.000452	16.210130	0.000000e+00	1.644966	0.000744	1.96014	0.000886	2.576193	0.001164
gdp_real	-0.006476	0.000482	13.432324	0.000000e+00	1.644966	0.000793	1.96014	0.000945	2.576193	0.001242
coffee	-0.006157	0.000503	12.231627	0.000000e+00	1.644966	0.000828	1.96014	0.000987	2.576193	0.001297
fed_funds	-0.006153	0.000450	13.665211	0.000000e+00	1.644966	0.000741	1.96014	0.000883	2.576193	0.001160
BAA-AAA Corporate Bond Spread	-0.005935	0.000550	10.783855	0.000000e+00	1.644966	0.000905	1.96014	0.001079	2.576193	0.001418
palladium	-0.005828	0.000537	10.858062	0.000000e+00	1.644966	0.000883	1.96014	0.001052	2.576193	0.001383
30yr-15yr Mortgage Rate Spread	0.005047	0.000482	10.470082	0.000000e+00	1.644966	0.000793	1.96014	0.000945	2.576193	0.001242
10yr-2yr Treasury Spread	-0.004953	0.000499	9.920136	0.000000e+00	1.644966	0.000821	1.96014	0.000979	2.576193	0.001286
sugar	-0.003892	0.000497	7.827187	5.329071e-15	1.644966	0.000818	1.96014	0.000975	2.576193	0.001281
OperatingRevenue	0.003801	0.000451	8.431924	0.000000e+00	1.644966	0.000741	1.96014	0.000884	2.576193	0.001161
EBIT	0.003210	0.000453	7.083093	1.479483e-12	1.644966	0.000745	1.96014	0.000888	2.576193	0.001167
natural_gas	0.003074	0.000526	5.847129	5.116860e-09	1.644966	0.000865	1.96014	0.001031	2.576193	0.001354
FreeCashFlow	0.001950	0.000449	4.341565	1.425015e-05	1.644966	0.000739	1.96014	0.000881	2.576193	0.001157
federal_budget_deficit	-0.001868	0.000482	3.876103	1.066445e-04	1.644966	0.000793	1.96014	0.000945	2.576193	0.001242
cpi	0.001853	0.000513	3.612629	3.042077e-04	1.644966	0.000844	1.96014	0.001005	2.576193	0.001321
Tangible Book Value Per Share	0.001691	0.000452	3.740541	1.843841e-04	1.644966	0.000743	1.96014	0.000886	2.576193	0.001164
unemployment	0.001505	0.000521	2.885837	3.909928e-03	1.644966	0.000858	1.96014	0.001022	2.576193	0.001343
Debt Ratio	-0.001284	0.000539	2.383092	1.718163e-02	1.644966	0.000887	1.96014	0.001057	2.576193	0.001389
treasury_3mo	-0.001204	0.000503	2.393118	1.671942e-02	1.644966	0.000828	1.96014	0.000987	2.576193	0.001297
Quick Ratio	0.001144	0.000453	2.523703	1.162396e-02	1.644966	0.000746	1.96014	0.000889	2.576193	0.001168

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure G3**

*Health Care Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



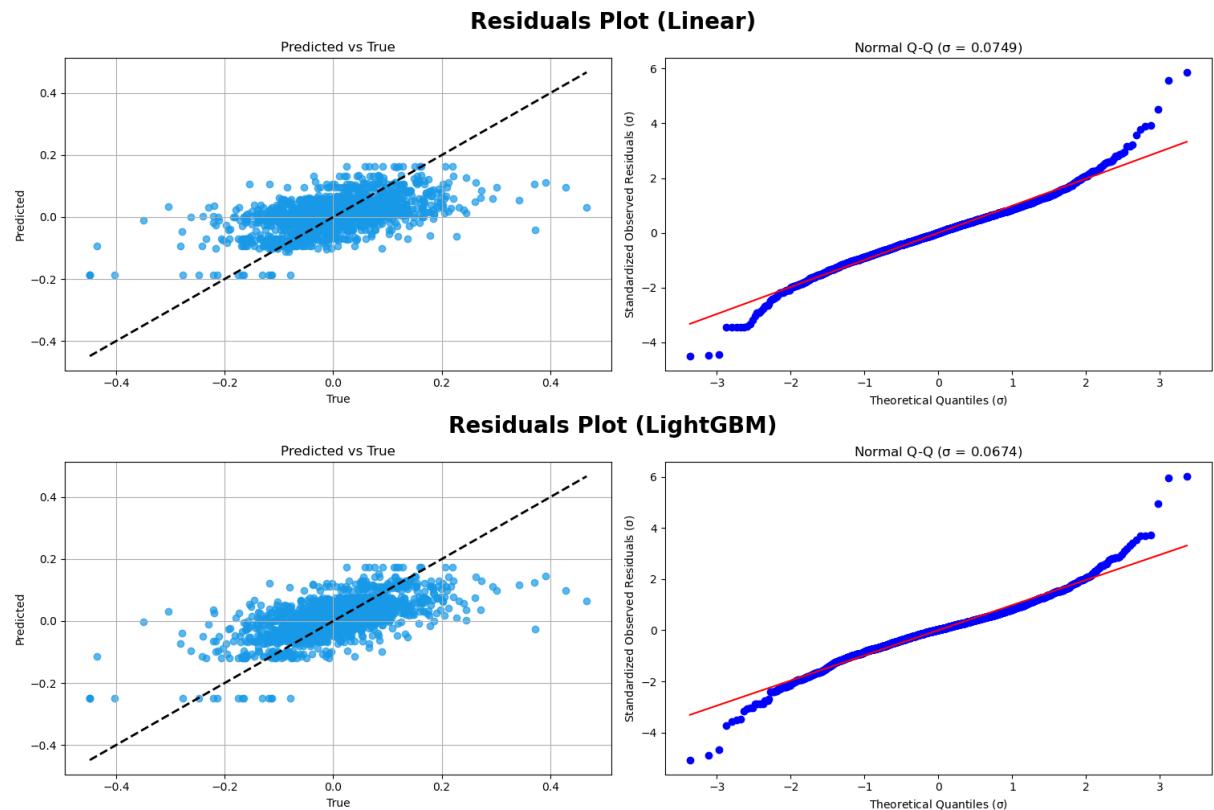
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix H

### Financial Services Industry Group

**Figure H1**

*Financial Services Industry Group: Residuals Plots (Median Model)*

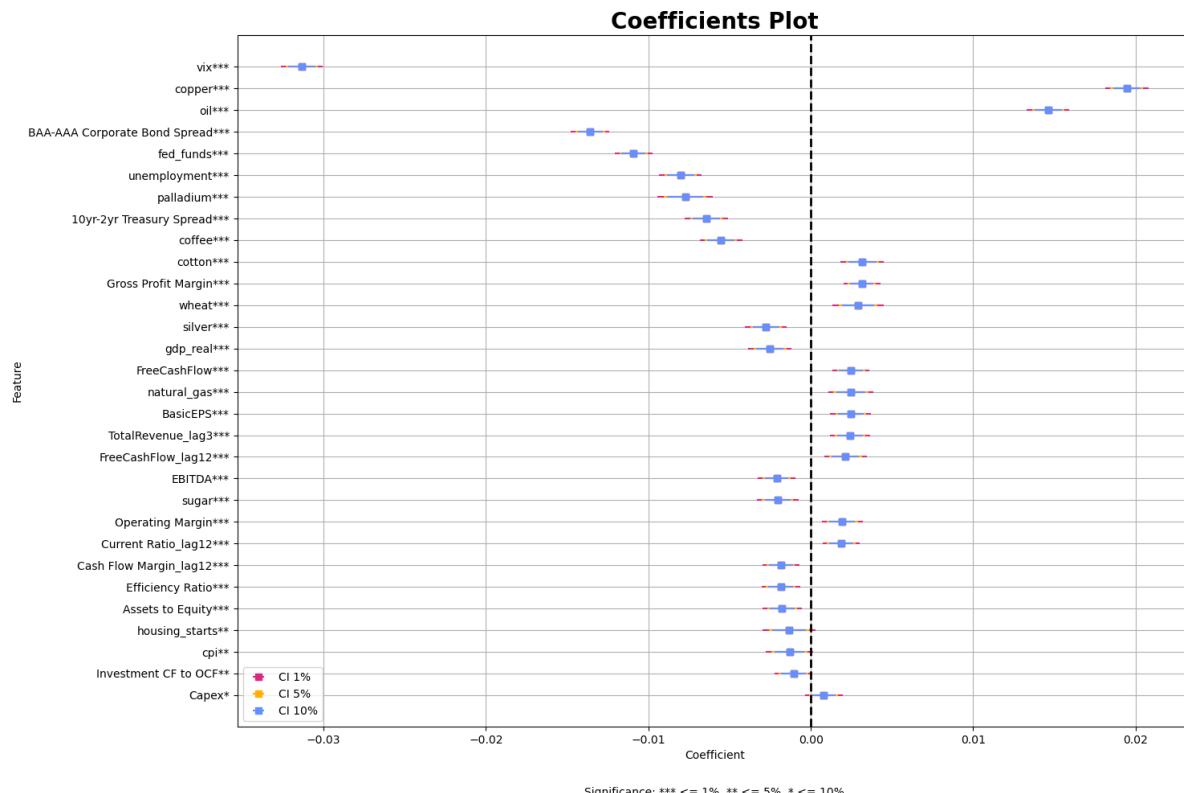


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure H2**

*Financial Services Industry Group: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table H1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table H1**

*Financial Services Industry Group: Linear Regression Coefficient Statistics (Median Model)*

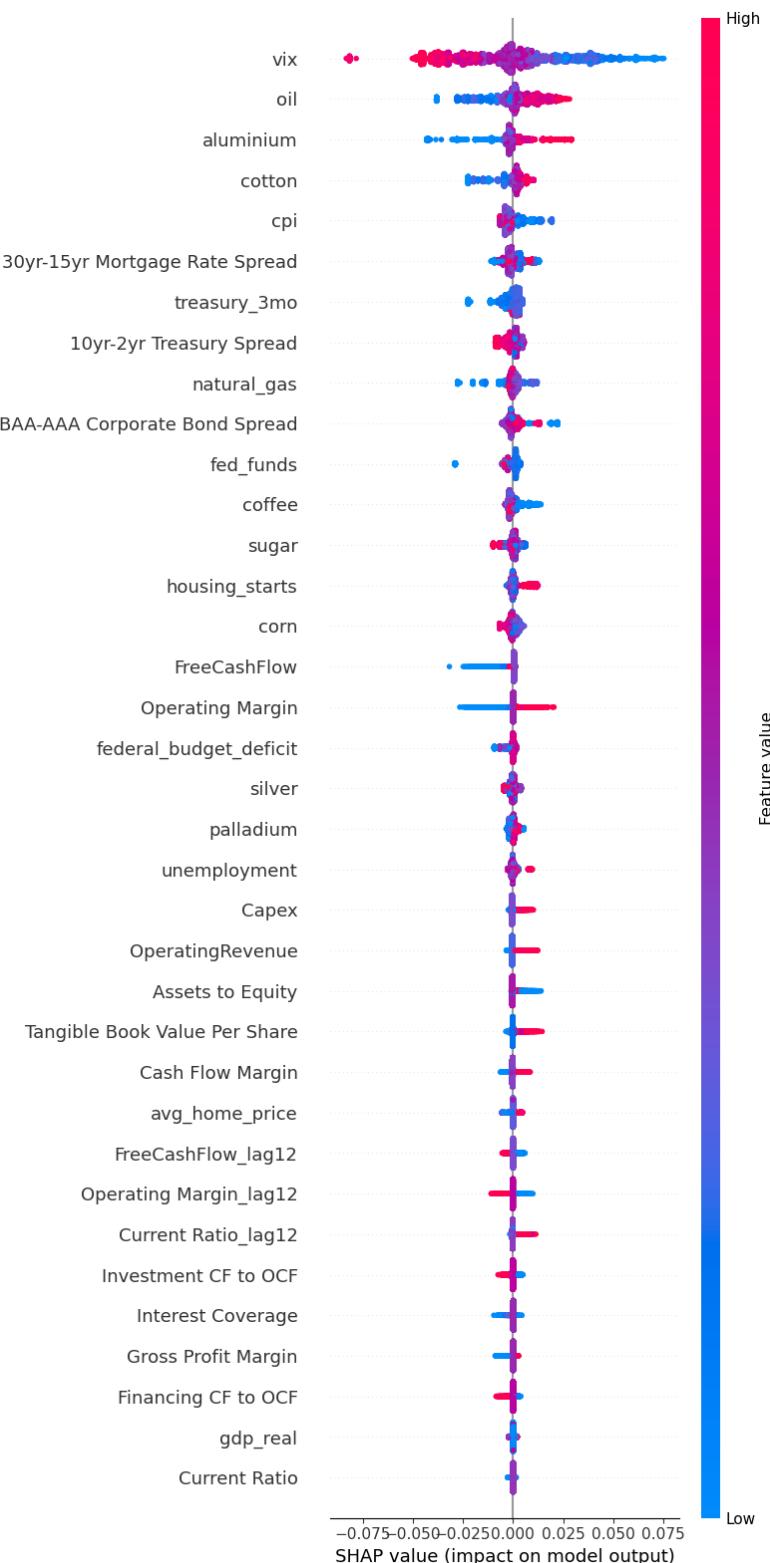
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.031343	0.000504	62.185638	0.000000e+00	1.645066	0.000829	1.960295	0.000988	2.576515	0.001299
copper	0.019458	0.000520	37.439433	0.000000e+00	1.645066	0.000855	1.960295	0.001019	2.576515	0.001339
oil	0.014617	0.000510	28.674433	0.000000e+00	1.645066	0.000839	1.960295	0.000999	2.576515	0.001313
BAA-AAA Corporate Bond Spread	-0.013591	0.000464	29.304031	0.000000e+00	1.645066	0.000763	1.960295	0.000909	2.576515	0.001195
fed_funds	-0.010910	0.000448	24.359437	0.000000e+00	1.645066	0.000737	1.960295	0.000878	2.576515	0.001154
unemployment	-0.008026	0.000507	15.841387	0.000000e+00	1.645066	0.000834	1.960295	0.000993	2.576515	0.001305
palladium	-0.007736	0.000666	11.610142	0.000000e+00	1.645066	0.001096	1.960295	0.001306	2.576515	0.001717
10yr-2yr Treasury Spread	-0.006435	0.000511	12.600030	0.000000e+00	1.645066	0.000840	1.960295	0.001001	2.576515	0.001316
coffee	-0.005530	0.000510	10.842056	0.000000e+00	1.645066	0.000839	1.960295	0.001000	2.576515	0.001314
cotton	0.003173	0.000515	6.156642	7.830778e-10	1.645066	0.000848	1.960295	0.001010	2.576515	0.001328
Gross Profit Margin	0.003143	0.000443	7.094863	1.418643e-12	1.645066	0.000729	1.960295	0.000868	2.576515	0.001141
wheat	0.002904	0.000607	4.784202	1.750976e-06	1.645066	0.000999	1.960295	0.001190	2.576515	0.001564
silver	-0.002758	0.000498	5.539282	3.144755e-08	1.645066	0.000819	1.960295	0.000976	2.576515	0.001283
gdp_real	-0.002524	0.000519	4.866904	1.157808e-06	1.645066	0.000853	1.960295	0.001016	2.576515	0.001336
FreeCashFlow	0.002474	0.000444	5.567412	2.678954e-08	1.645066	0.000731	1.960295	0.000871	2.576515	0.001145
natural_gas	0.002465	0.000544	4.528330	6.041212e-06	1.645066	0.000895	1.960295	0.001067	2.576515	0.001402
BasicEPS	0.002451	0.000485	5.057535	4.352422e-07	1.645066	0.000797	1.960295	0.000950	2.576515	0.001249
TotalRevenue_lag3	0.002408	0.000484	4.976034	6.641083e-07	1.645066	0.000796	1.960295	0.000949	2.576515	0.001247
FreeCashFlow_lag12	0.002141	0.000510	4.200322	2.697623e-05	1.645066	0.000839	1.960295	0.000999	2.576515	0.001313
EBITDA	-0.002106	0.000446	4.720292	2.399726e-06	1.645066	0.000734	1.960295	0.000875	2.576515	0.001150
sugar	-0.002037	0.000491	4.146316	3.417593e-05	1.645066	0.000808	1.960295	0.000963	2.576515	0.001266
Operating Margin	0.001941	0.000482	4.025912	5.733945e-05	1.645066	0.000793	1.960295	0.000945	2.576515	0.001242
Current Ratio_lag12	0.001881	0.000446	4.214626	2.532609e-05	1.645066	0.000734	1.960295	0.000875	2.576515	0.001150
Cash Flow Margin_lag12	-0.001847	0.000446	4.141938	3.483357e-05	1.645066	0.000734	1.960295	0.000874	2.576515	0.001149
Efficiency Ratio	-0.001844	0.000467	3.951351	7.845646e-05	1.645066	0.000768	1.960295	0.000915	2.576515	0.001202
Assets to Equity	-0.001771	0.000469	3.776696	1.602071e-04	1.645066	0.000771	1.960295	0.000919	2.576515	0.001208
housing_starts	-0.001331	0.000631	2.109679	3.492054e-02	1.645066	0.001038	1.960295	0.001237	2.576515	0.001626
cpi	-0.001316	0.000562	2.340544	1.928294e-02	1.645066	0.000925	1.960295	0.001103	2.576515	0.001449
Investment CF to OCF	-0.001064	0.000458	2.325950	2.004893e-02	1.645066	0.000753	1.960295	0.000897	2.576515	0.001179
Capex	0.000794	0.000454	1.747355	8.061852e-02	1.645066	0.000747	1.960295	0.000890	2.576515	0.001170

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure H3**

*Financial Services Industry Group: LightGBM SHAP Beeswarm Plot (Median Model)*



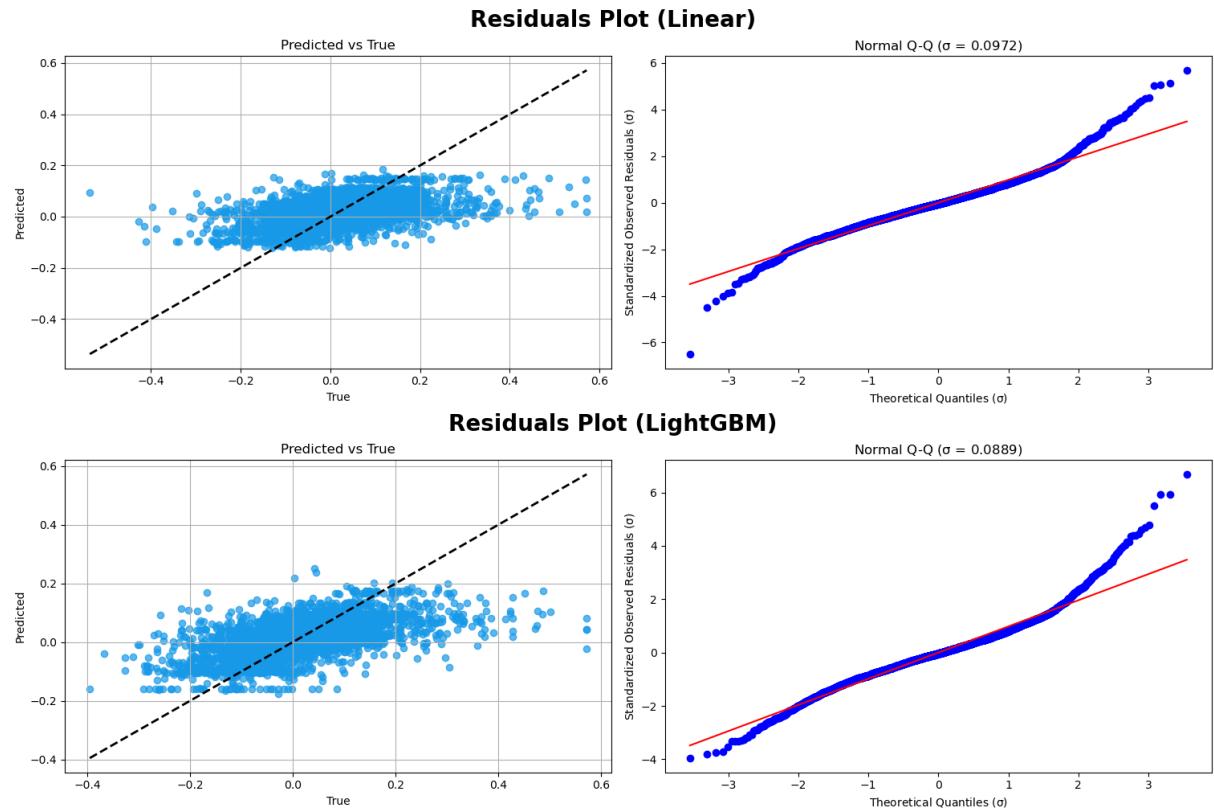
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# Appendix I

## Information Technology Sector

**Figure I1**

*Information Technology Sector: Residuals Plots (Median Model)*

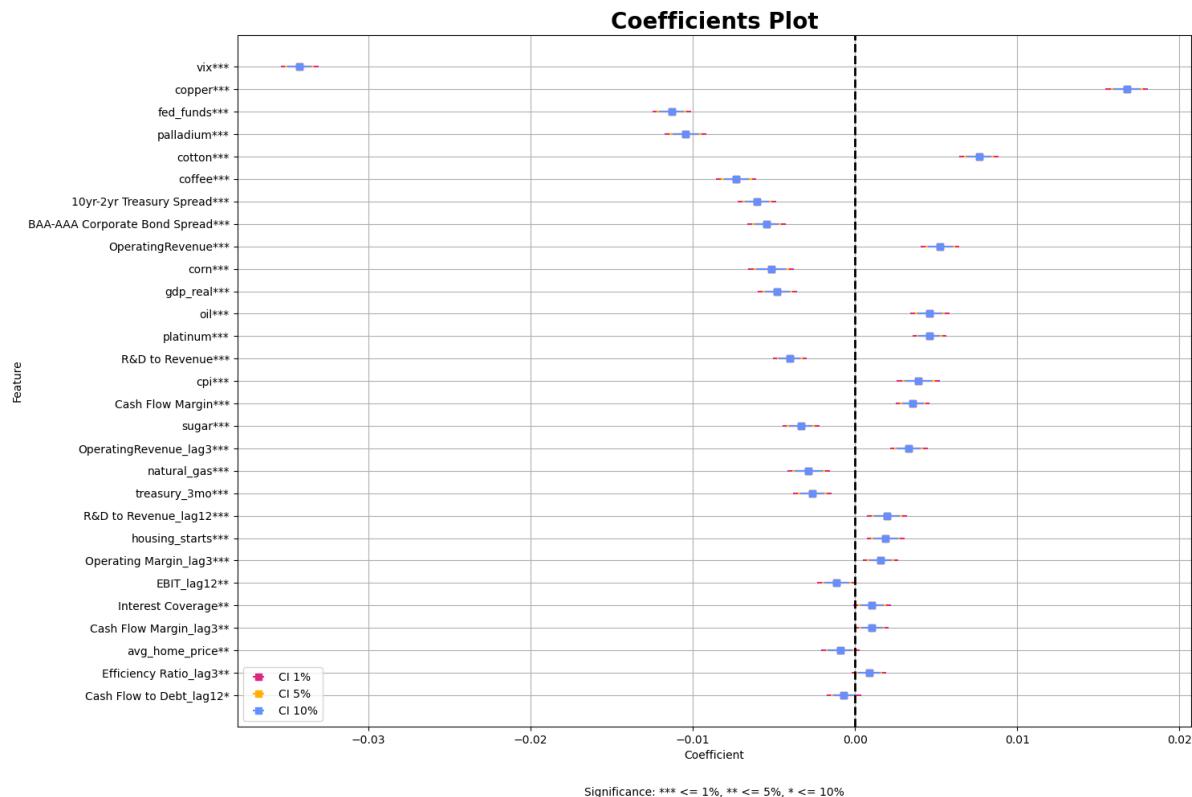


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure I2**

*Information Technology Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table I1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table I1**

*Information Technology Sector: Linear Regression Coefficient Statistics (Median Model)*

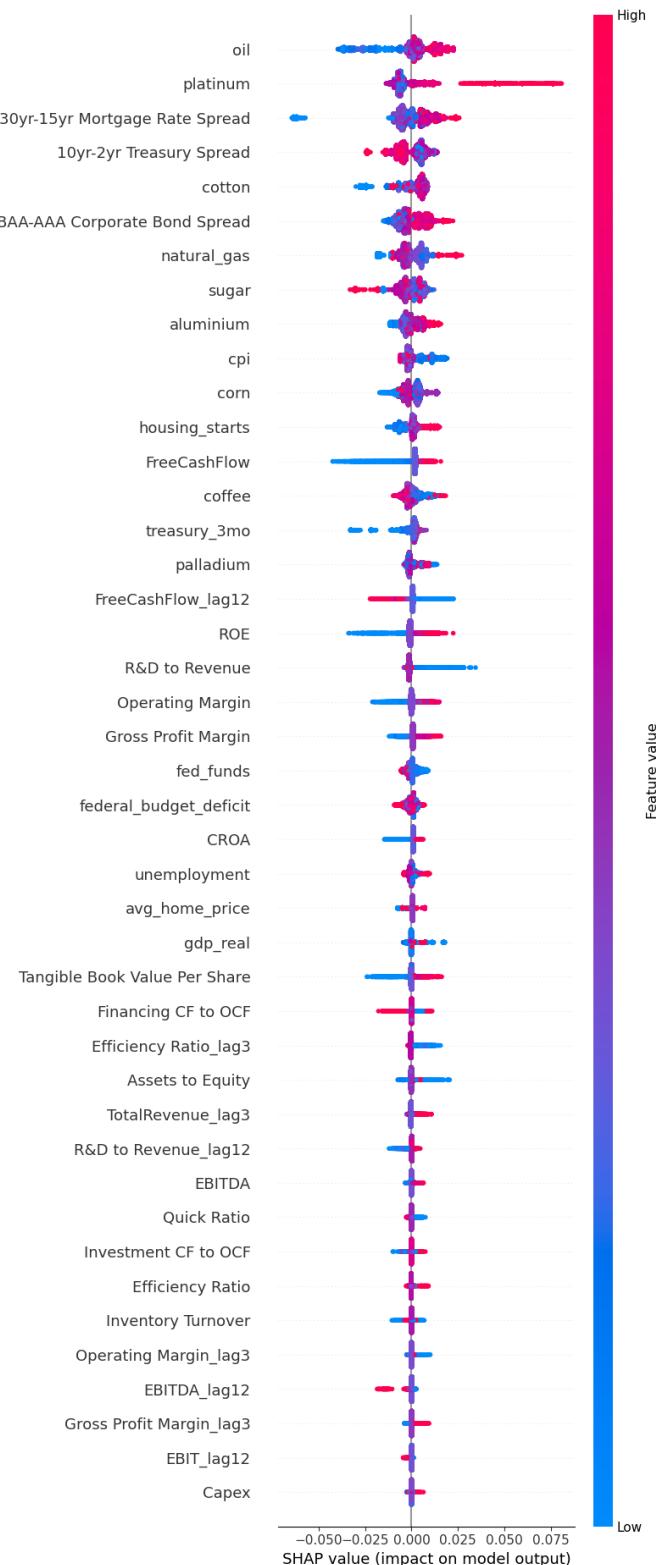
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.034253	0.000452	75.717710	0.000000e+00	1.64496	0.000744	1.960129	0.000887	2.576171	0.001165
copper	0.016759	0.000509	32.907494	0.000000e+00	1.64496	0.000838	1.960129	0.000998	2.576171	0.001312
fed_funds	-0.011316	0.000462	24.475140	0.000000e+00	1.64496	0.000761	1.960129	0.000906	2.576171	0.001191
palladium	-0.010444	0.000500	20.890312	0.000000e+00	1.64496	0.000822	1.960129	0.000980	2.576171	0.001288
cotton	0.007659	0.000469	16.336329	0.000000e+00	1.64496	0.000771	1.960129	0.000919	2.576171	0.001208
coffee	-0.007310	0.000481	15.207499	0.000000e+00	1.64496	0.000791	1.960129	0.000942	2.576171	0.001238
10yr-2yr Treasury Spread	-0.006047	0.000457	13.234850	0.000000e+00	1.64496	0.000752	1.960129	0.000896	2.576171	0.001177
BAA-AAA Corporate Bond Spread	-0.005453	0.000458	11.895580	0.000000e+00	1.64496	0.000754	1.960129	0.000898	2.576171	0.001181
OperatingRevenue	0.005248	0.000465	11.281356	0.000000e+00	1.64496	0.000765	1.960129	0.000912	2.576171	0.001198
corn	-0.005168	0.000550	9.388277	0.000000e+00	1.64496	0.000905	1.960129	0.001079	2.576171	0.001418
gdp_real	-0.004798	0.000472	10.161374	0.000000e+00	1.64496	0.000777	1.960129	0.000926	2.576171	0.001216
oil	0.004621	0.000474	9.756957	0.000000e+00	1.64496	0.000779	1.960129	0.000928	2.576171	0.001220
platinum	0.004591	0.000406	11.298270	0.000000e+00	1.64496	0.000668	1.960129	0.000796	2.576171	0.001047
R&D to Revenue	-0.004023	0.000405	9.931424	0.000000e+00	1.64496	0.000666	1.960129	0.000794	2.576171	0.001044
cpi	0.003911	0.000518	7.543852	4.840572e-14	1.64496	0.000853	1.960129	0.001016	2.576171	0.001336
Cash Flow Margin	0.003564	0.000406	8.770319	0.000000e+00	1.64496	0.000669	1.960129	0.000797	2.576171	0.001047
sugar	-0.003340	0.000441	7.580465	3.641532e-14	1.64496	0.000725	1.960129	0.000864	2.576171	0.001135
OperatingRevenue_lag3	0.003311	0.000452	7.321115	2.589040e-13	1.64496	0.000744	1.960129	0.000886	2.576171	0.001165
natural_gas	-0.002859	0.000516	5.539188	3.092084e-08	1.64496	0.000849	1.960129	0.001012	2.576171	0.001330
treasury_3mo	-0.002622	0.000460	5.700590	1.217374e-08	1.64496	0.000757	1.960129	0.000902	2.576171	0.001185
R&D to Revenue_lag12	0.001983	0.000482	4.112559	3.934718e-05	1.64496	0.000793	1.960129	0.000945	2.576171	0.001242
housing_starts	0.001896	0.000454	4.177916	2.959294e-05	1.64496	0.000747	1.960129	0.000890	2.576171	0.001169
Operating Margin_lag3	0.001587	0.000427	3.712937	2.056412e-04	1.64496	0.000703	1.960129	0.000838	2.576171	0.001101
EBIT_lag12	-0.001144	0.000467	2.446628	1.443184e-02	1.64496	0.000769	1.960129	0.000916	2.576171	0.001204
Interest Coverage	0.001053	0.000448	2.346870	1.894532e-02	1.64496	0.000738	1.960129	0.000879	2.576171	0.001155
Cash Flow Margin_lag3	0.001040	0.000409	2.544642	1.094935e-02	1.64496	0.000672	1.960129	0.000801	2.576171	0.001053
avg_home_price	-0.000910	0.000461	1.972152	4.861136e-02	1.64496	0.000759	1.960129	0.000904	2.576171	0.001189
Efficiency Ratio_lag3	0.000877	0.000414	2.115560	3.439936e-02	1.64496	0.000682	1.960129	0.000812	2.576171	0.001068

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure I3**

*Information Technology Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



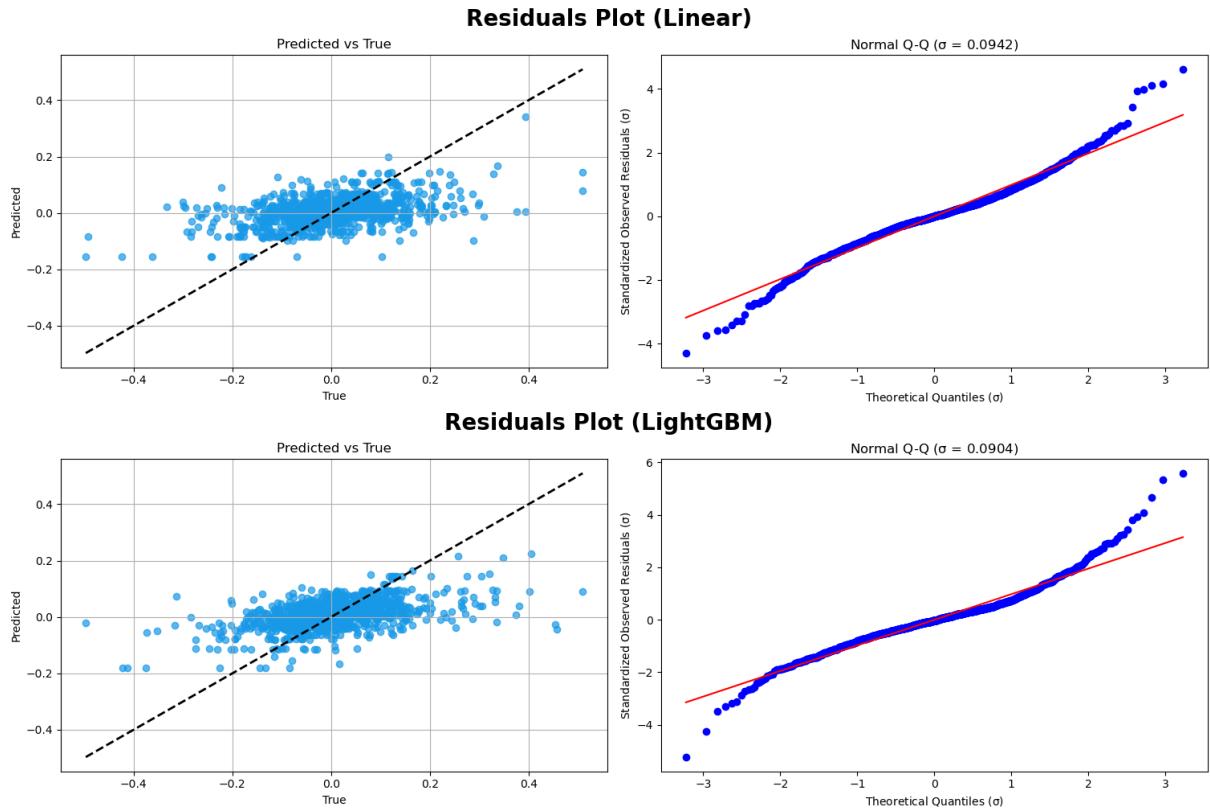
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix J

### Communication Services Sector

**Figure J1**

*Communication Services Sector: Residuals Plots (Median Model)*

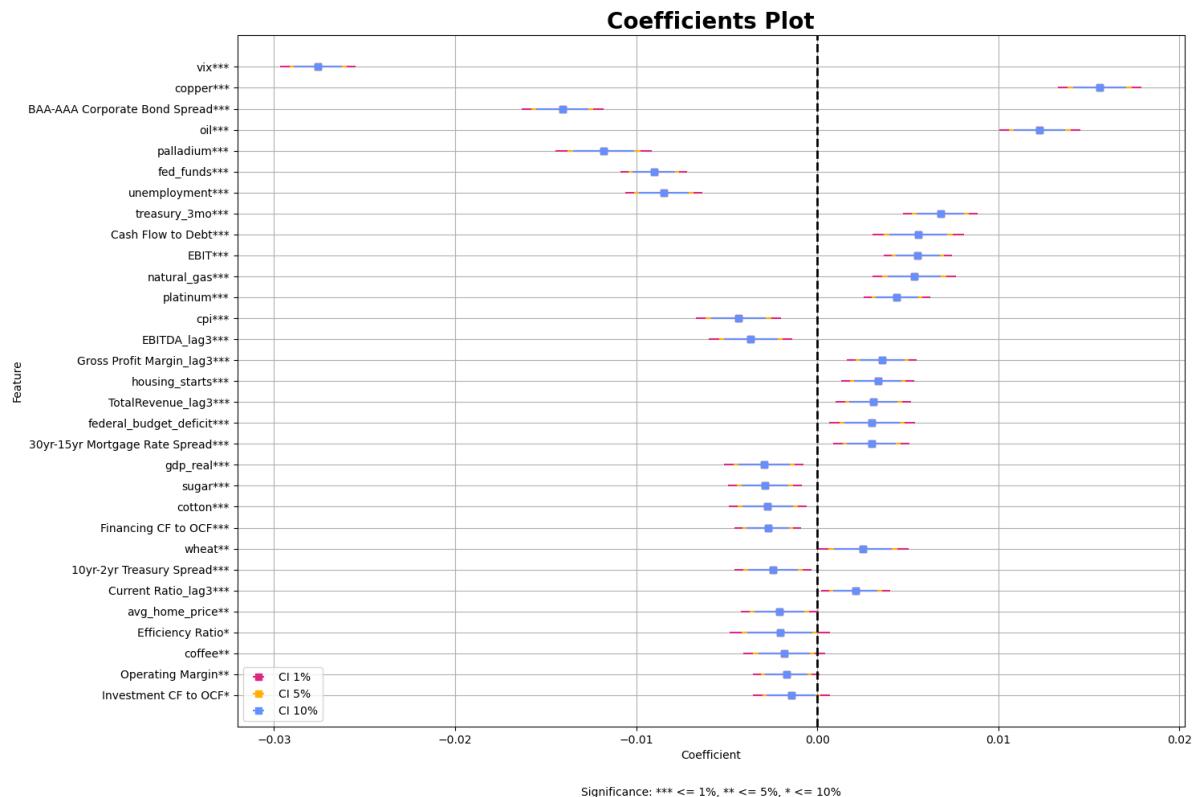


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure J2**

*Communication Services Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table J1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table J1**

*Communication Services Sector: Linear Regression Coefficient Statistics (Median Model)*

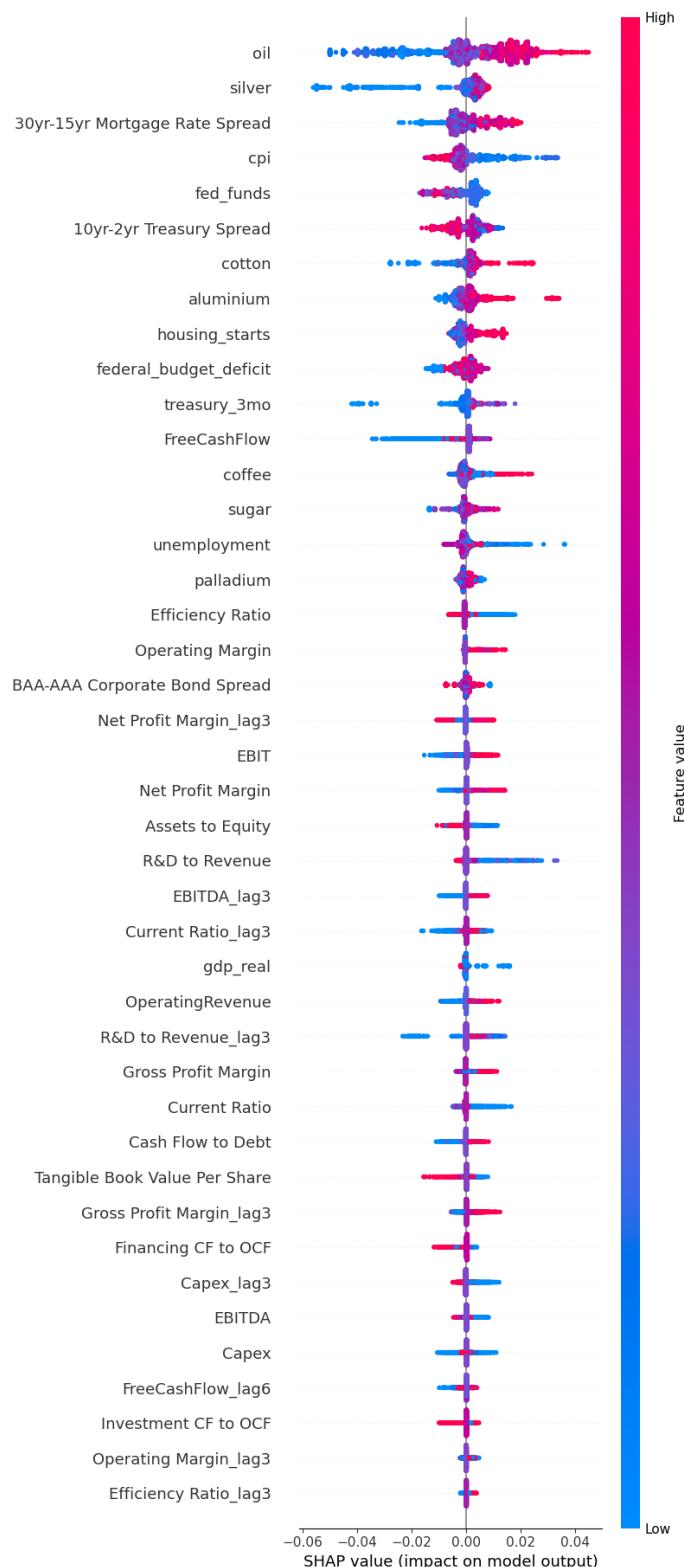
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.027567	0.000810	34.052027	0.000000e+00	1.645202	0.001332	1.960507	0.001587	2.576955	0.002086
copper	0.015589	0.000899	17.342420	0.000000e+00	1.645202	0.001479	1.960507	0.001762	2.576955	0.002316
BAA-AAA Corporate Bond Spread	-0.014071	0.000874	16.094728	0.000000e+00	1.645202	0.001438	1.960507	0.001714	2.576955	0.002253
oil	0.012286	0.000863	14.241930	0.000000e+00	1.645202	0.001419	1.960507	0.001691	2.576955	0.002223
palladium	-0.011791	0.001029	11.461653	0.000000e+00	1.645202	0.001692	1.960507	0.002017	2.576955	0.002651
fed_funds	-0.009022	0.000714	12.634803	0.000000e+00	1.645202	0.001175	1.960507	0.001400	2.576955	0.001840
unemployment	-0.008481	0.000831	10.207494	0.000000e+00	1.645202	0.001367	1.960507	0.001629	2.576955	0.002141
treasury_3mo	0.006799	0.000804	8.458643	0.000000e+00	1.645202	0.001322	1.960507	0.001576	2.576955	0.002071
Cash Flow to Debt	0.005575	0.000978	5.701626	1.264887e-08	1.645202	0.001609	1.960507	0.001917	2.576955	0.002520
EBIT	0.005551	0.000733	7.573000	4.418688e-14	1.645202	0.001206	1.960507	0.001437	2.576955	0.001889
natural_gas	0.005355	0.000897	5.968919	2.577463e-09	1.645202	0.001476	1.960507	0.001759	2.576955	0.002312
platinum	0.004390	0.000715	6.141115	8.922569e-10	1.645202	0.001176	1.960507	0.001402	2.576955	0.001842
cpi	-0.004355	0.000919	4.738794	2.218219e-06	1.645202	0.001512	1.960507	0.001802	2.576955	0.002368
EBITDA_lag3	-0.003678	0.000898	4.095690	4.285285e-05	1.645202	0.001477	1.960507	0.001760	2.576955	0.002314
Gross Profit Margin_lag3	0.003574	0.000751	4.760714	1.991472e-06	1.645202	0.001235	1.960507	0.001472	2.576955	0.001935
housing_starts	0.003337	0.000783	4.263052	2.059073e-05	1.645202	0.001288	1.960507	0.001535	2.576955	0.002017
TotalRevenue_lag3	0.003098	0.000803	3.855605	1.171031e-04	1.645202	0.001322	1.960507	0.001575	2.576955	0.002070
federal_budget_deficit	0.003022	0.000923	3.274215	1.067810e-03	1.645202	0.001519	1.960507	0.001810	2.576955	0.002379
30yr-15yr Mortgage Rate Spread	0.002983	0.000814	3.662821	2.524067e-04	1.645202	0.001340	1.960507	0.001597	2.576955	0.002099
gdp_real	-0.002941	0.000853	3.447024	5.721427e-04	1.645202	0.001404	1.960507	0.001673	2.576955	0.002198
sugar	-0.002896	0.000788	3.673396	2.422134e-04	1.645202	0.001297	1.960507	0.001545	2.576955	0.002031
cotton	-0.002739	0.000839	3.262575	1.112532e-03	1.645202	0.001381	1.960507	0.001646	2.576955	0.002163
Financing CF to OCF	-0.002725	0.000714	3.818428	1.361656e-04	1.645202	0.001174	1.960507	0.001399	2.576955	0.001839
wheat	0.002517	0.000979	2.570571	1.018592e-02	1.645202	0.001611	1.960507	0.001920	2.576955	0.002523
10yr-2yr Treasury Spread	-0.002444	0.000833	2.936001	3.342068e-03	1.645202	0.001370	1.960507	0.001632	2.576955	0.002145
Current Ratio_lag3	0.002112	0.000740	2.855928	4.311367e-03	1.645202	0.001217	1.960507	0.001450	2.576955	0.001906
avg_home_price	-0.002075	0.000836	2.483545	1.304540e-02	1.645202	0.001375	1.960507	0.001638	2.576955	0.002153
Efficiency Ratio*	-0.002070	0.001081	1.914998	5.555795e-02	1.645202	0.001778	1.960507	0.002119	2.576955	0.002785
coffee	-0.001832	0.000872	2.100911	3.570595e-02	1.645202	0.001435	1.960507	0.001710	2.576955	0.002247
Operating Margin	-0.001707	0.000712	2.397284	1.655883e-02	1.645202	0.001172	1.960507	0.001396	2.576955	0.001835
Investment CF to OCF	-0.001435	0.000820	1.750650	8.007640e-02	1.645202	0.001348	1.960507	0.001607	2.576955	0.002112

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure J3**

*Communication Services Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



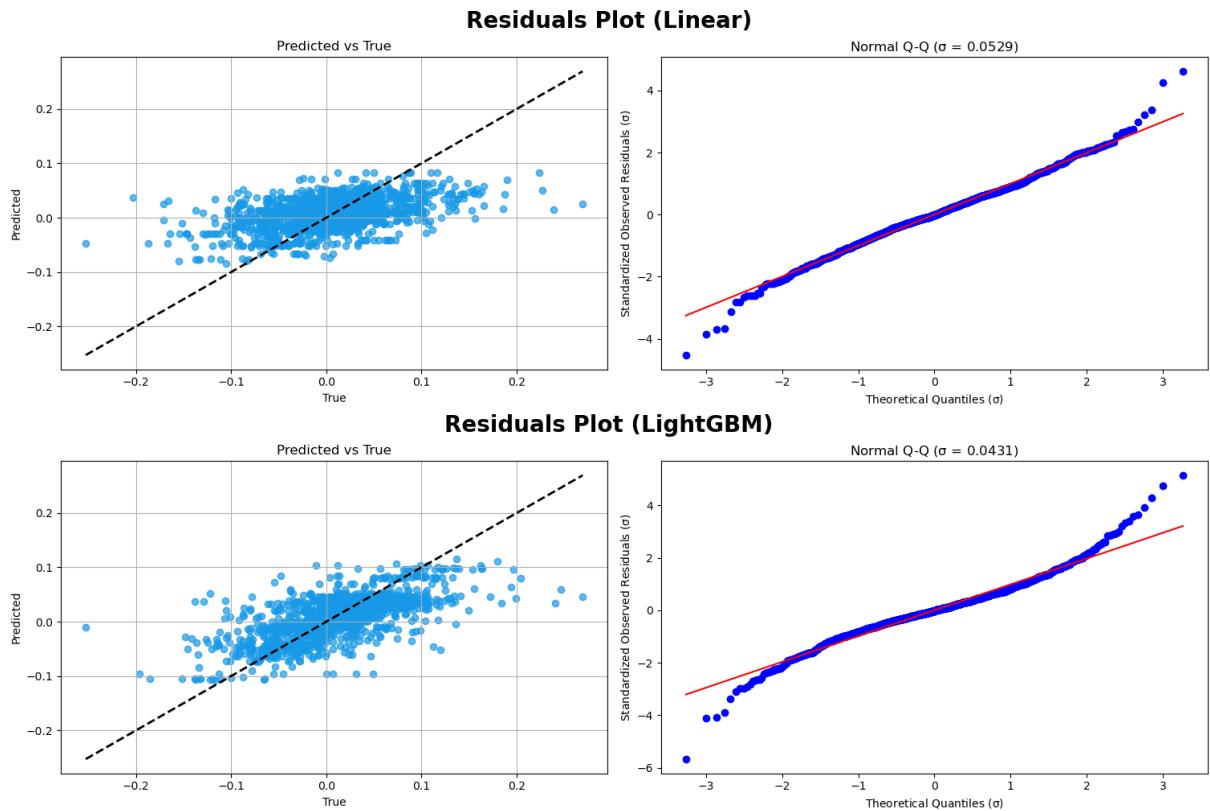
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix K

### Utilities Sector

**Figure K1**

*Utilities Sector: Residuals Plots (Median Model)*

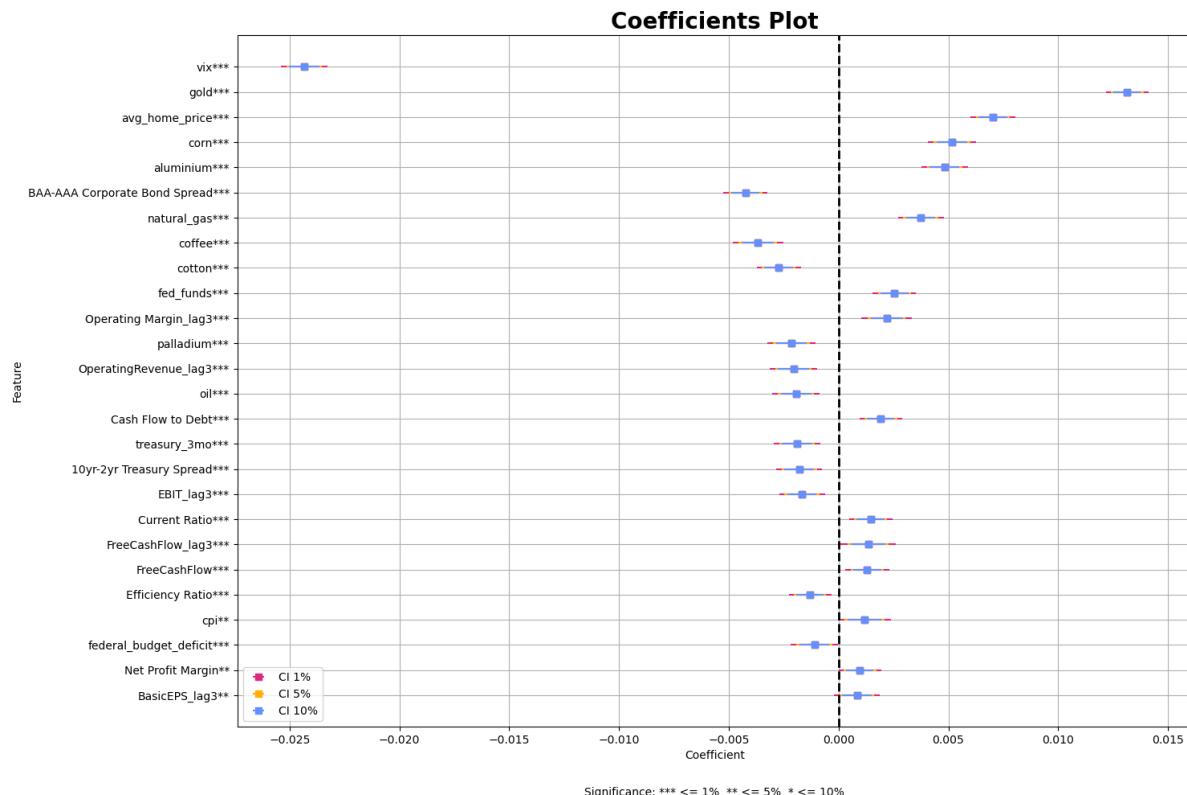


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## DECODING SECTOR VALUATION DYNAMICS

**Figure K2**

*Utilities Sector: Linear Regression Coefficient Plot (Median Model)*



Significance: \*\*\* <= 1%, \*\* <= 5%, \* <= 10%

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table K1 for coefficient statistics.

# DECODING SECTOR VALUATION DYNAMICS

**Table K1**

*Utilities Sector: Linear Regression Coefficient Statistics (Median Model)*

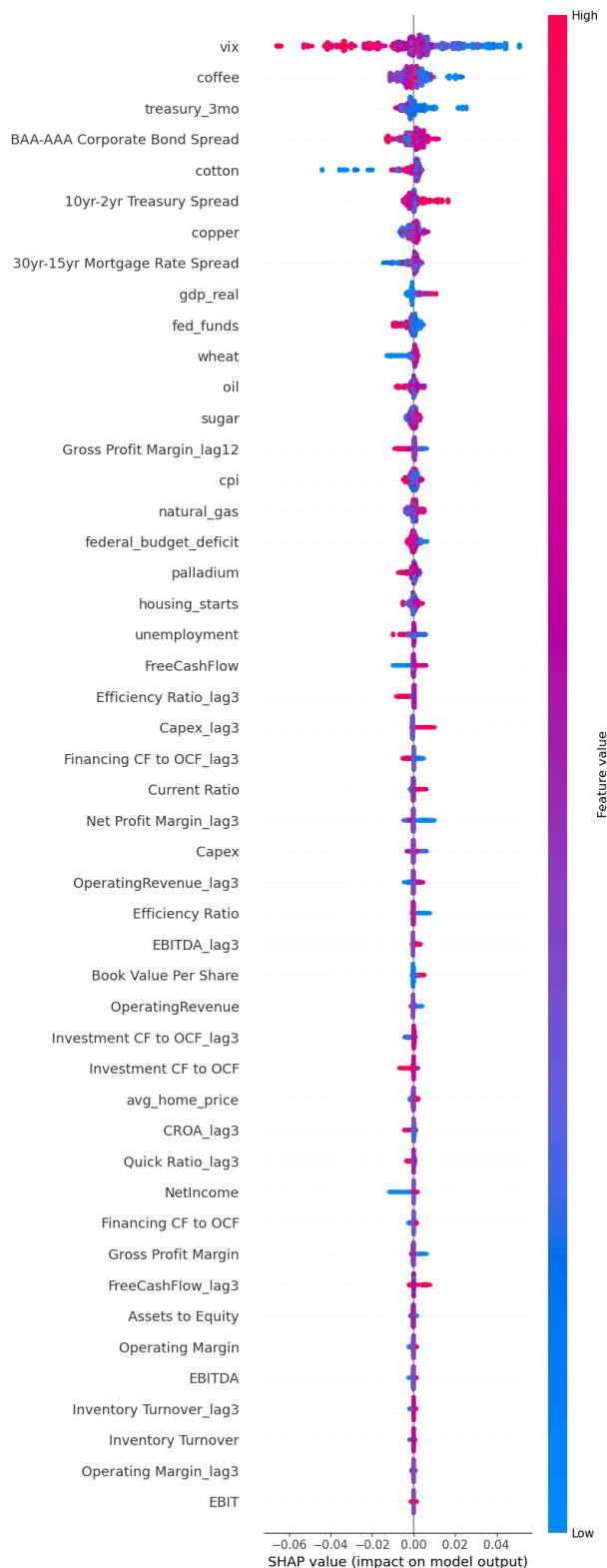
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.024343	0.000414	58.769465	0.000000e+00	1.645158	0.000681	1.960437	0.000812	2.576811	0.001067
gold	0.013144	0.000377	34.830485	0.000000e+00	1.645158	0.000621	1.960437	0.000740	2.576811	0.000972
avg.home_price	0.007028	0.000398	17.659898	0.000000e+00	1.645158	0.000655	1.960437	0.000780	2.576811	0.001026
corn	0.005156	0.000426	12.104872	0.000000e+00	1.645158	0.000701	1.960437	0.000835	2.576811	0.001098
aluminium	0.004828	0.000413	11.697316	0.000000e+00	1.645158	0.000679	1.960437	0.000809	2.576811	0.001064
BAA-AAA Corporate Bond Spread	-0.004243	0.000392	10.815376	0.000000e+00	1.645158	0.000645	1.960437	0.000769	2.576811	0.001011
natural_gas	0.003740	0.000404	9.249836	0.000000e+00	1.645158	0.000665	1.960437	0.000793	2.576811	0.001042
coffee	-0.003674	0.000447	8.227388	2.220446e-16	1.645158	0.000735	1.960437	0.000875	2.576811	0.001151
cotton	-0.002731	0.000391	6.988364	3.145040e-12	1.645158	0.000643	1.960437	0.000766	2.576811	0.001007
fed_funds	0.002547	0.000383	6.644220	3.372191e-11	1.645158	0.000631	1.960437	0.000751	2.576811	0.000988
Operating Margin_lag3	0.002187	0.000443	4.935853	8.238772e-07	1.645158	0.000729	1.960437	0.000869	2.576811	0.001142
palladium	-0.002150	0.000428	5.023974	5.237102e-07	1.645158	0.000704	1.960437	0.000839	2.576811	0.001103
OperatingRevenue_lag3	-0.002057	0.000424	4.852759	1.254486e-06	1.645158	0.000697	1.960437	0.000831	2.576811	0.001092
oil	-0.001942	0.000419	4.630235	3.744816e-06	1.645158	0.000690	1.960437	0.000822	2.576811	0.001081
Cash Flow to Debt	0.001919	0.000378	5.072649	4.064674e-07	1.645158	0.000622	1.960437	0.000742	2.576811	0.000975
treasury_3mo	-0.001898	0.000415	4.574431	4.890306e-06	1.645158	0.000683	1.960437	0.000813	2.576811	0.001069
10yr-2yr Treasury Spread	-0.001797	0.000408	4.404003	1.084844e-05	1.645158	0.000671	1.960437	0.000800	2.576811	0.001052
EBIT_lag3	-0.001668	0.000405	4.113097	3.966407e-05	1.645158	0.000667	1.960437	0.000795	2.576811	0.001045
Current Ratio	0.001459	0.000385	3.793755	1.501349e-04	1.645158	0.000633	1.960437	0.000754	2.576811	0.000991
FreeCashFlow_lag3	0.001342	0.000484	2.775828	5.526564e-03	1.645158	0.000795	1.960437	0.000948	2.576811	0.001246
FreeCashFlow	0.001303	0.000387	3.369357	7.591269e-04	1.645158	0.000636	1.960437	0.000758	2.576811	0.000997
Efficiency Ratio	-0.001300	0.000374	3.480253	5.052090e-04	1.645158	0.000614	1.960437	0.000732	2.576811	0.000962
cpi	0.001187	0.000463	2.563738	1.038407e-02	1.645158	0.000762	1.960437	0.000908	2.576811	0.001194
federal_budget_deficit	-0.001106	0.000417	2.654978	7.956448e-03	1.645158	0.000686	1.960437	0.000817	2.576811	0.001074
Net Profit Margin	0.000972	0.000378	2.572334	1.013007e-02	1.645158	0.000621	1.960437	0.000740	2.576811	0.000973
BasicEPS_lag3	0.000832	0.000406	2.048424	4.057042e-02	1.645158	0.000668	1.960437	0.000796	2.576811	0.001047

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure K3**

*Utilities Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



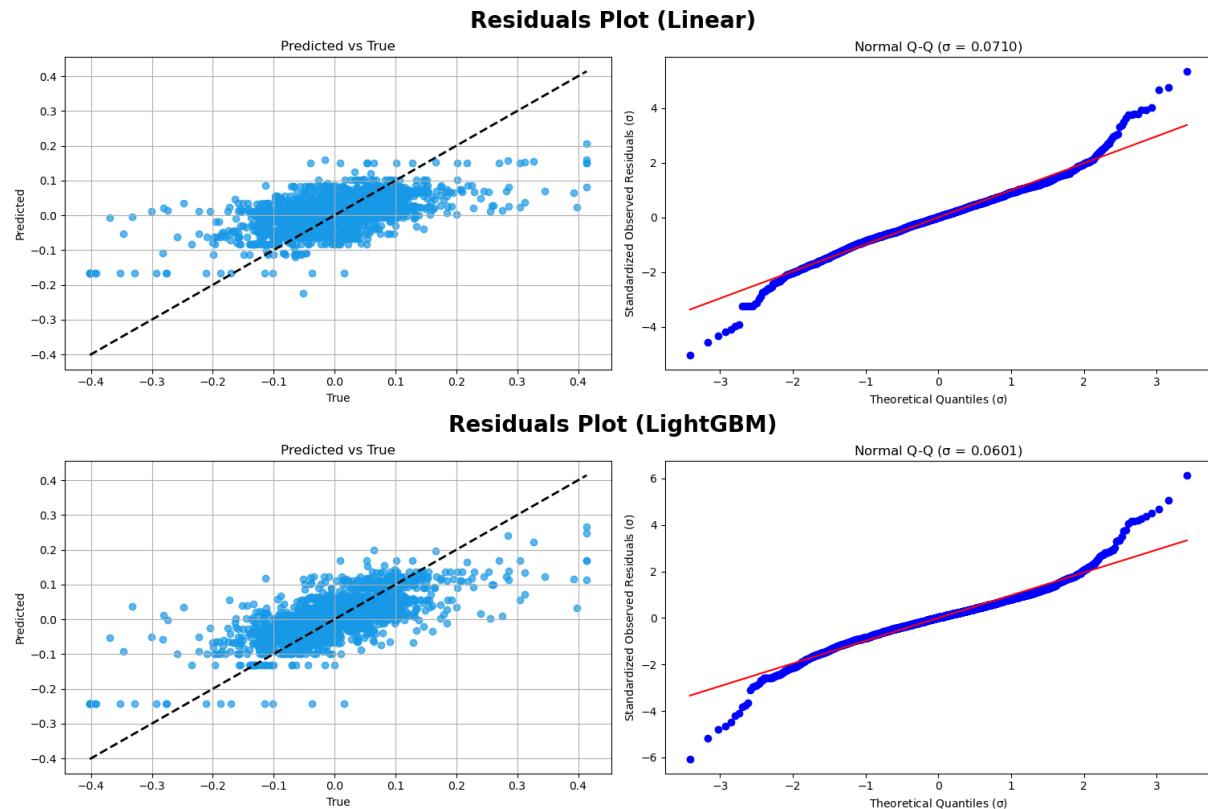
Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

## Appendix L

### Real Estate Sector

**Figure L1**

*Real Estate Sector: Residuals Plots (Median Model)*

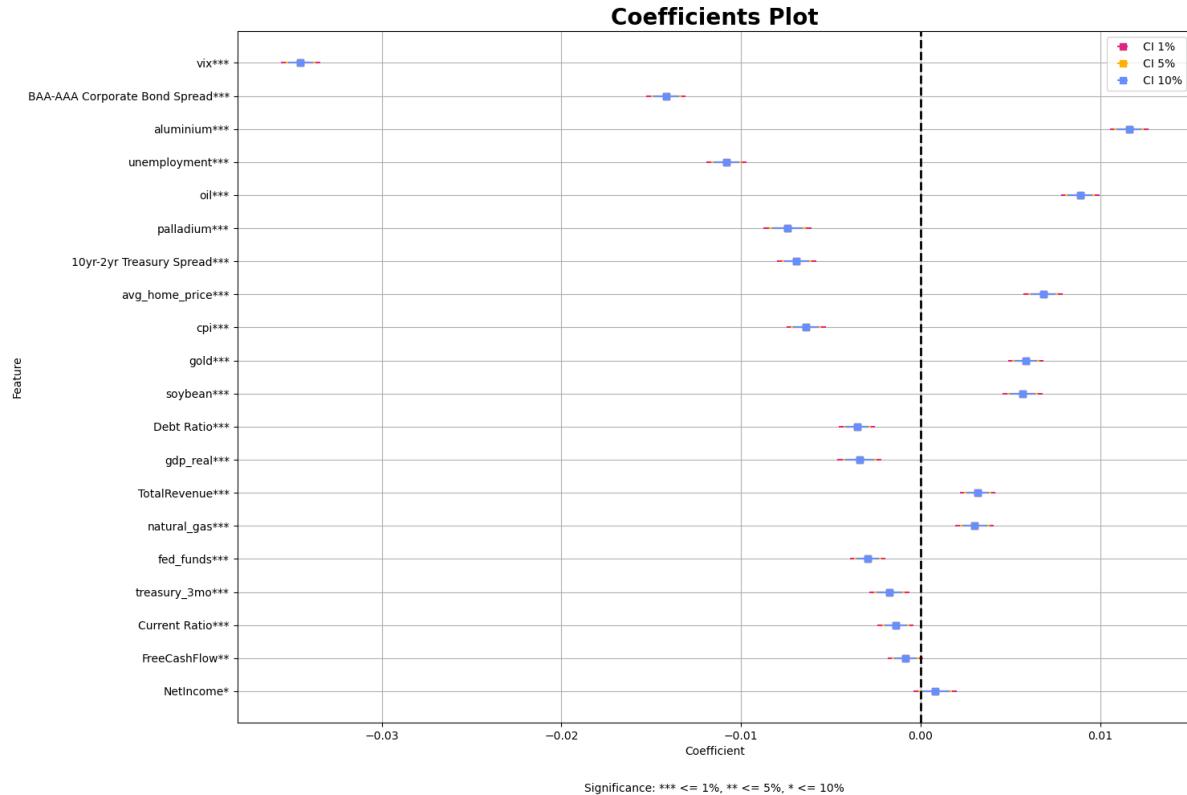


Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure L2**

*Real Estate Sector: Linear Regression Coefficient Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

See Table L1 for coefficient statistics.

**Table L1**

*Real Estate Sector: Linear Regression Coefficient Statistics (Median Model)*

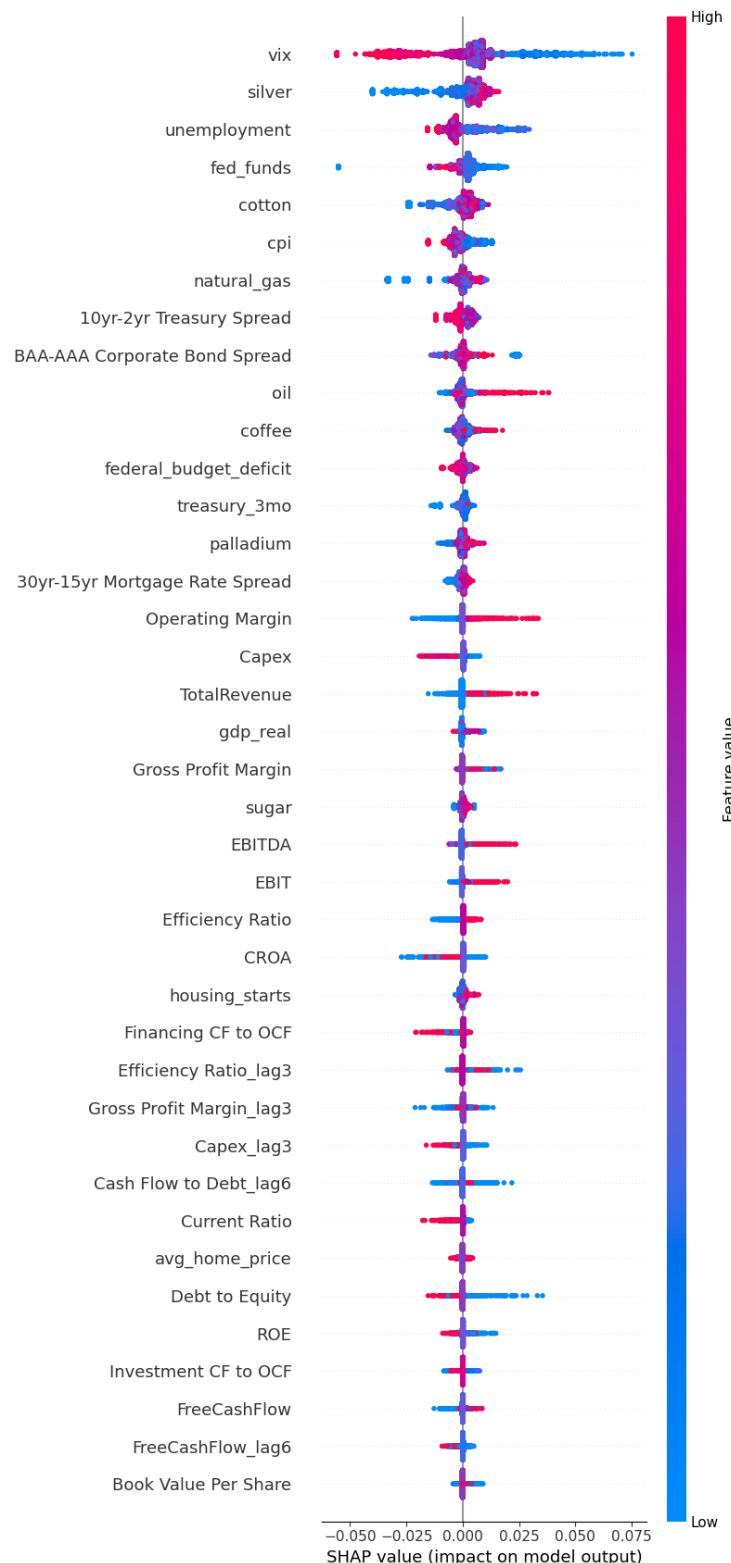
	Coef	Std Err	t	P> t	t* (10%)	CI (10%)	t* (5%)	CI (5%)	t* (1%)	CI (1%)
vix	-0.034532	0.000427	80.928407	0.000000e+00	1.645031	0.000702	1.96024	0.000836	2.576401	0.001099
BAA-AAA Corporate Bond Spread	-0.014171	0.000426	33.283127	0.000000e+00	1.645031	0.000700	1.96024	0.000835	2.576401	0.001097
aluminium	0.011610	0.000420	27.659970	0.000000e+00	1.645031	0.000691	1.96024	0.000823	2.576401	0.001081
unemployment	-0.010829	0.000432	25.091283	0.000000e+00	1.645031	0.000710	1.96024	0.000846	2.576401	0.001112
oil	0.008890	0.000421	21.102733	0.000000e+00	1.645031	0.000693	1.96024	0.000826	2.576401	0.001085
palladium	-0.007423	0.000522	14.219400	0.000000e+00	1.645031	0.000859	1.96024	0.001023	2.576401	0.001345
10yr-2yr Treasury Spread	-0.006910	0.000429	16.108630	0.000000e+00	1.645031	0.000706	1.96024	0.000841	2.576401	0.001105
avg.home.price	0.006825	0.000422	16.190385	0.000000e+00	1.645031	0.000693	1.96024	0.000826	2.576401	0.001086
cpi	-0.006385	0.000425	15.031439	0.000000e+00	1.645031	0.000699	1.96024	0.000833	2.576401	0.001094
gold	0.005864	0.000386	15.210977	0.000000e+00	1.645031	0.000634	1.96024	0.000756	2.576401	0.000993
soybean	0.005672	0.000430	13.178291	0.000000e+00	1.645031	0.000708	1.96024	0.000844	2.576401	0.001109
Debt Ratio	-0.003546	0.000386	9.191051	0.000000e+00	1.645031	0.000635	1.96024	0.000756	2.576401	0.000994
gdp_real	-0.003396	0.000477	7.118287	1.180611e-12	1.645031	0.000785	1.96024	0.000935	2.576401	0.001229
TotalRevenue	0.003179	0.000388	8.203830	2.220446e-16	1.645031	0.000638	1.96024	0.000760	2.576401	0.000998
natural_gas	0.002998	0.000421	7.116107	1.199263e-12	1.645031	0.000693	1.96024	0.000826	2.576401	0.001085
fed_funds	-0.002948	0.000385	7.654381	2.153833e-14	1.645031	0.000634	1.96024	0.000755	2.576401	0.000992
treasury_3mo	-0.001752	0.000430	4.076393	4.615135e-05	1.645031	0.000707	1.96024	0.000842	2.576401	0.001107
Current Ratio	-0.001388	0.000389	3.571926	3.563021e-04	1.645031	0.000639	1.96024	0.000762	2.576401	0.001001
FreeCashFlow	-0.000849	0.000384	2.213978	2.685640e-02	1.645031	0.000631	1.96024	0.000752	2.576401	0.000988
NetIncome	0.000813	0.000473	1.718837	8.567995e-02	1.645031	0.000778	1.96024	0.000927	2.576401	0.001218

Median Model: Model with the median  $R^2$  across 5-fold cross-validation.

# DECODING SECTOR VALUATION DYNAMICS

**Figure L3**

*Real Estate Sector: LightGBM SHAP Beeswarm Plot (Median Model)*



Median Model: Model with the median  $R^2$  across 5-fold cross-validation.