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Article

Evaluating the relationship between United States housing prices and United States markets

Abraham Anantha[1], Om Patel[1], Naqeeb Punjani[2]
[1] Elkins High School, Missouri City, Texas
[2] Encore Capital, Sugar Land, Texas

SUMMARY

Policymakers often design policies based on forecasts for specific markets, but these forecasts don't always match the broad trends across sector-wide movements. As a result, the policies can misallocate resources or even worsen economic outcomes when applied in contexts that require a larger lens. We aimed to find a correlation between the various U.S. markets and the housing market to create more accurate predictions. We selected to compare the stock, commodity, and consumer markets because they represent the major pillars of economic activity. Data was collected from publicly available sources including government sites. After formatting the datasets, we performed Pearson correlation analyses with different offset periods to determine how changes in one market preceded or followed another. With our base comparator being the housing market, we hypothesized that the housing market would be positively correlated with all U.S. markets. Our results supported our hypothesis, showing that each of the specified sectors — the stock, commodity, and consumer markets — had a correlation coefficient >0.80 when compared to the housing market. Interestingly, we also found that the housing market led the S&P 500 by 16 months. This would suggest that the housing market can be used to predict the stock market: specifically, when the housing market peaks, the S&P 500 should peak 16 months later. Our findings suggest that correlations and lag patterns between the US housing market and other economic sectors could be leveraged to improve forecasts, providing economic policymakers with more reliable guidance.

INTRODUCTION

The United States (U.S.) housing market is inextricably linked with its economy's overall performance, and a change in housing prices often signals broader economic trends. A few economic theories, such as the Efficient Market Hypothesis, can explain the link between the markets that constitute the economy (1). Despite this, prior research has not fully explored the time-lagged interactions among these markets, particularly in the context of predictive modeling. Our study addresses this gap by systematically analyzing the correlations and lag structures between U.S. housing prices and other key economic indicators — specifically the S&P 500, Gold, and Consumer Price Index.

To capture key dimensions of the U.S. economy, we focus on four major indicators. The Housing Price Index (HPI) is published by the Federal Housing Finance Agency (FHFA) and measures the movement of single-family home prices using a repeat-sales methodology (2). This methodology tracks price changes for the same property over time to avoid skews from new construction or differing house qualities (2). The S&P 500 Index represents the weighted performance of 500 of the largest U.S. publicly traded companies (3). The version we use is nominal, meaning it is not adjusted for inflation or dividends, and is commonly viewed as a proxy for overall stock market performance (3). The Consumer Price Index (CPI) is a key measure of inflation published by the Bureau of Labor Statistics (4). It is calculated based on the weighted average of a fixed basket of goods and services, including food, housing, transportation, and medical care (4). Finally, gold prices serve as our indicator for the commodity market (5). We selected gold due to its strong historical correlations with other commodities and its consistent role as a store of value and hedge against inflation, especially during periods of market uncertainty (5).

We analyzed these indicators not just for their correlation with the housing market, but also for the lagging time between their movements, revealing which markets might lead or follow changes in housing. As policymakers and investors increasingly rely on quantitative indicators to anticipate economic conditions, our research provides a timely exploration into how inter-market relationships can inform forward-looking strategies. Our study covering the years from 1991–2023 is relevant given the current environment of market volatility, inflation concerns, and housing affordability challenges (6).

There currently exist differences in the perception of market relations and trends. For example, according to Robert Shiller in his book entitled 'The Subprime Solution,' the dramatic and unsustainable rise in housing prices prior to 2008 played a vital role in triggering economic instability (7). He hypothesized that the inflated prices of houses contributed to the sharp fall in the S&P 500 and contraction of the U.S. Gross Domestic Product (GDP), thus underlying tectonic movements of housing markets as the early warning system of such economic recessions or growth phases with periods of inflation (7). This is considered an odd viewpoint when compared to previous standards due to the common consensus that there was a strictly positive correlation between the markets (8). However, the 2008 economic crash proved otherwise. Understanding why this crash happened and its abnormality can help us recognize the deeper relationships between the markets. Furthermore, these events have shown the importance of following the trends in the housing market as barometers that can predict broader economic change in other economic sectors within three years.

As house prices change, they directly affect the primary

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determinants of economic activities: household wealth, consumption, and borrowing (9). Increasing house prices boost household wealth, and as house prices increase, the associated rise in household wealth increases consumer spending (10). On the other hand, decreasing house prices erode household wealth and consumer confidence, decrease spending, and lead to an economic slowdown (11). Similarly, housing market trends are usually coupled with stock market performance; hence, changes in housing prices may serve as a valuable predictor of broader trends in financial markets (12). The following question then comes to mind: How can we use the trend in the housing market to predict other key economic indicators such as GDP growth, inflation, or even stock market performance? More clarity on the nature of these links may support decision-making by key stakeholders, such as policy makers and investors.

We hypothesized the housing market has a high positive correlation with other major U.S. markets. In other words, if the housing market is in an uptrend, then the other U.S. markets should follow in an uptrend. We tested this through various data analyses like correlation, cross-correlation, spectral, and identification of various trends. Our results showed that all markets evaluated are positively correlated with the housing market at varying strengths and have varying lag times depending on the rate of market change. Investors and policymakers can use this information to more accurately predict and resist economic depression and lower troughs while allowing for policies that accelerate market self-correction faster.

RESULTS

We compared HPI with CPI, gold and the S&P 500 using correlational, cross-correlation, and trend analyses. We chose these analyses to determine which market serves as the driving factor, how long it takes for the other market to reflect changes in the driving market, how strongly one market reflects the other, and to identify any peculiar behaviors between the two markets. Our initial analysis containing the relationship between each of the indices and HPI used data from the beginning of 1991 to the end of 2023

First, we compared HPI to the S&P 500 in order to determine their relationship. In our comparison, we noticed that HPI heavily correlates with other indicators, proving that other markets reflect the housing market. HPI had a high correlation with the S&P 500 (Pearson's correlation, $R = 0.94$, $p < 0.001$). This indicates that the S&P 500 closely follows HPI trends. We also discovered that HPI leads the S&P 500 by 16 months since that is when the correlation between the datasets is the highest (**Figure 1**). This suggests that the S&P 500 index takes 16 months to more accurately reflect changes in the housing market.

HPI is also strongly correlated to CPI (Pearson's correlation, $R = 0.94$, $p < 0.001$), which is similar to HPI and S&P 500. CPI has its strongest correlation with HPI when it leads by 32 months (Pearson's correlation, $R = 0.96$, $p < 0.001$) (**Figure 2**). This suggests that changes in inflation take 32 months to reflect in the housing market.

HPI had the weakest correlation with gold prices (Pearson's correlation, $R = 0.81$, $p < 0.001$). Similar to CPI and HPI, gold leads HPI with their strongest correlation being at 48 months offset (**Figure 3**). This suggests that changes in the commodity market, as represented by gold, take approximately 48 months to influence the housing market.

In order to more clearly understand data trends, we next divided the timeframe into pre-2008 and post-2008 financial crisis periods. The analysis was done using a split data set, where we cut the data set in half (first half 1991-2007; second half 2008-2023). We then ran the same tests as before, using the divided dataset. Note that correlation coefficients will have a significant shift compared to previous findings as the data sets were split in half for before and after the crises to run the analysis. HPI and CPI were tightly linked before and after the 2008 crisis (Pearson's correlation, $R = 0.97$, $p < 0.001$). HPI and the S&P 500 had a weaker correlation (Pearson's correlation, $R = 0.75$, $p < 0.001$). After the crisis, however, the correlation between the S&P 500 and HPI dramatically increased (Pearson's correlation, $R = 0.95$, $p < 0.001$). This suggests that housing and the stock market have become more tightly linked (**Figure 4**). HPI and gold weren't heavily linked (Pearson's correlation, $R = 0.66$, $p < 0.001$). The correlation after the crises saw a small increase in correlation (Pearson's correlation, $R = 0.66$, $p < 0.001$).

We also included the HPI dataset for each census division to capture the nuances and variations across different geographical regions. We used the FHFA data for the census divisions to compare it to the other indices and utilized the same time frame as the initial analysis (1991-2023). All regions showed strong positive correlations with the CPI, S&P 500, and gold prices. Notably, the West South-Central Division exhibited the strongest overall correlation with both CPI (Pearson's correlation, $R = 0.96$, $p < 0.001$) and the S&P 500 (Pearson's correlation, $R = 0.96$, $p < 0.001$), followed

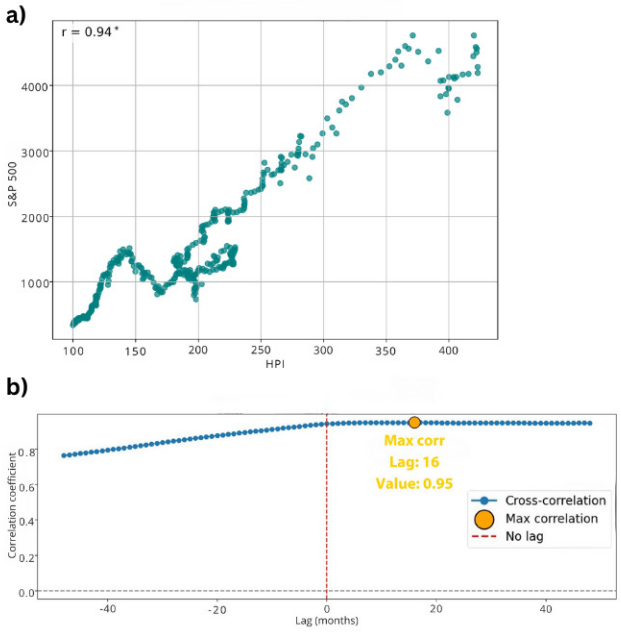

Figure 1: HPI and S&P 500 correlation. A) HPI points with their associated S&P 500 values without time lag. HPI and S&P 500 values are highly correlated (Pearson's Correlation, $R = 0.94$, $p < 0.001$*). B) Correlation between S&P 500 and HPI for different offset periods.

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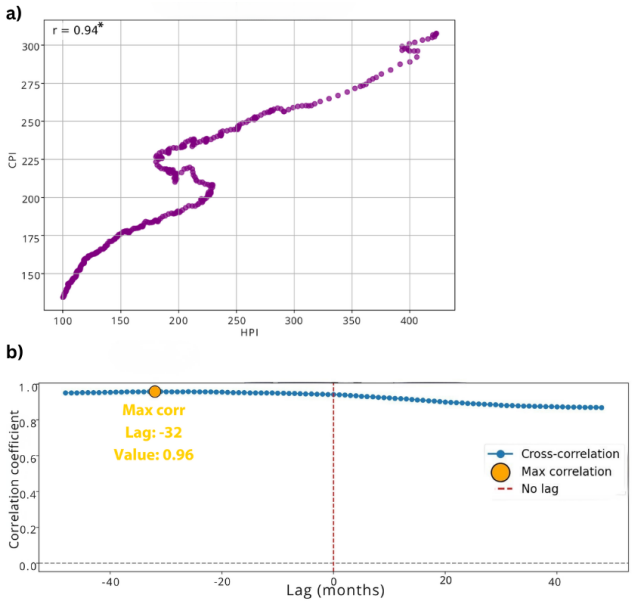

Figure 2: HPI and CPI correlation. A) HPI points with their associated CPI values without time lag. HPI and CPI values are highly correlated (Pearson's Correlation, R = 0.94, p < 0.001*). B) Correlation between HPI and CPI for different offset periods.

closely by the West North-Central Division (CPI: (Pearson's correlation, R = 0.96, p < 0.001), S&P 500: (Pearson's correlation, R = 0.95, p < 0.001)). These results suggest that housing prices in central and southern regions are more tightly coupled with national inflation and stock market trends. Meanwhile, coastal regions such as the New England and Pacific Divisions showed slightly lower correlations with the S&P 500 ((Pearson's correlation, R = 0.89, p < 0.001) and (Pearson's correlation, R = 0.92, p < 0.001), respectively) and gold ((Pearson's correlation, R = 0.80, p < 0.001) and (Pearson's correlation, R = 0.77, p < 0.001)), indicating potential regional distinctions in market behavior or exposure to broader economic forces. Interestingly, there were also differences in the region during the 2008 crisis. All the regional housing markets dropped, but the Mountain division dropped by the largest magnitude, and it also increased by the largest magnitude comparatively after the crisis ended. Additionally, the West and East South-Central divisions weren't as affected by the 2008 crash in comparison to the other divisions as they dropped the least in magnitude. These variations reinforce the importance of considering regional housing dynamics when interpreting national housing trends (**Figure 5**).

DISCUSSION

We hypothesized that the housing market would be positively correlated with all U.S. markets. Our results show that each correlation coefficient between the selected markets and housing markets is ≥0.85. This means that HPI strongly correlates with all the selected markets in this analysis (13). These strong relationships have several implications. For economists, this underscores the interdependency between asset classes and suggests a need for housing market data to be integrated into broader macroeconomic forecasting models. For investors, the high correlation and identifiable lag structures offer potential opportunities for market timing, portfolio rebalancing, and hedging strategies based on housing market trends.

The finding that CPI drives HPI through the lag time correlation coefficient test shows the long-standing idea that inflation can drive housing prices (14). This means that bills passed and money injected into the economy can be reflected in housing prices by the sudden increase or decrease of the housing market. However, housing prices show greater extremes (-10% to +10.8 growth) when compared to CPI (-2.1% to +5.6%), suggesting that inflation rates are steadier than the housing market. We have also seen that the housing market grows much faster than general consumer prices, suggesting that although both are influenced by inflation, other factors, like demographics, may variably affect these indicators (15). This insight is particularly valuable for policymakers seeking to evaluate the immediate effects of monetary interventions or stimulus policies.

Gold and housing prices having a correlation coefficient of 0.81 does not imply shared driving factors. This can be proven by the fact that gold prices continued to rise during the 2008 economic crises while house prices plummeted. This also reflects that gold might not have been a good indicator of the commodity market due to many commodity prices plummeting during the period (16). Even though gold and house prices have a correlation coefficient of 0.81, and gold precedes the housing market in uptrends, gold is not a reliable indicator of the commodity market as previously thought. It may not reflect the correlation and interplay between the general commodity market and housing prices. Therefore, investors should exercise caution when interpreting correlations in volatile periods.

HPI and the S&P 500 had the highest correlation. Investors

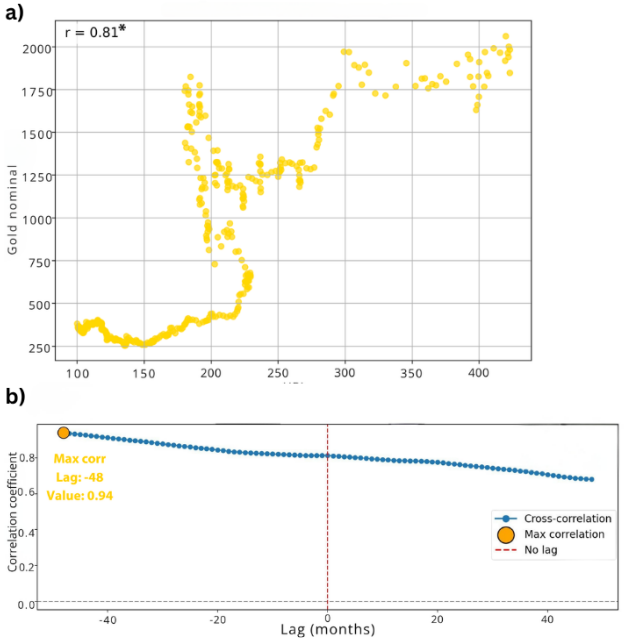

Figure 3: HPI and Gold correlation. A) HPI points with their associated Gold values without time lag. HPI and Gold values are highly correlated (Pearson's Correlation, R = 0.81, p < 0.001*). B) Correlation between HPI and Gold for different offset periods.

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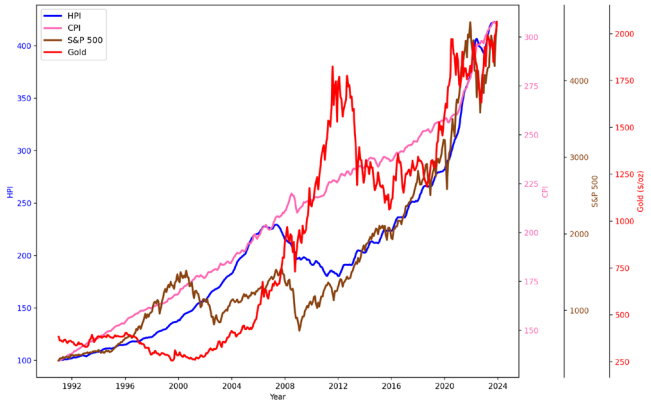

Figure 4: Overlay of economic indices. Line graph illustrating the values of each economic index at different times, with a scaled y-axis so that correlation is easier to see. Data values associated with different times were plotted on a line graph, and y-axis was created based on each index range.

may find long-term co-investment strategies between equities and real estate beneficial, as they tend to move in tandem over multiple years. However, the differing return profiles (340% for the S&P vs. 47% for HPI from 1990 to 2001) and volatility levels imply different risk-reward balances. Notably, HPI leads the S&P 500 by 16 months and offers a promising early indicator, though annual analysis shows divergence and highlights the limitations of short-term forecasting.

Robert Schiller, a prominent economist who accurately predicted both the dotcom and housing market crashes, has hypothesized that changes in the housing market led to the 2008 market crash, and this appears to be supported by our findings (17). We have demonstrated that there is a strong correlation between markets, which would suggests that the housing crash would lead to a crash in the general economy. If the S&P 500 and other indicators can be used to predict the housing market, how did it crash when the other indicators were going up? The specific reason for the 2008 crash lies in large amounts of subprime lending (18). The market was "rising" because houses were bought through bank speculation of rapid asset appreciation. This caused a bubble where houses were being bought, but money wasn't moving because mortgages were not being paid back. This is what led to the crash because the market had to self-correct, and people who didn't pay their loans were forced to give up their houses (18). This demonstrates that there can be external factors/influences which can change normally observed trends, emphasizing the importance of complementing quantitative indicators with policy and market structure analysis when using them for forecasting or intervention strategies.

The findings from the pre- and post-2008 analysis reveal that while the correlation between HPI and CPI remained consistently high across both periods, the relationship between HPI and the S&P 500 substantially strengthened after the 2008 financial crisis—from 0.75 before the crisis to 0.95 afterward. This suggests that the stock market has become more sensitive to housing market fluctuations in the post-crisis economy, possibly due to increased investor involvement in real estate, greater financialization of housing assets, or macroeconomic policies that simultaneously influence both sectors. The relatively stable yet weaker correlation between HPI and gold indicates that while housing and commodities may share some inflation-related dynamics, they respond differently to economic shocks. Overall, these results underscore the evolving nature of inter-market relationships, and they emphasize the need for investors and policymakers to consider how systemic events like financial crises can alter the predictive value of traditional indicators. Future research should continue to track these relationships over time, especially during periods of heightened volatility.

To further explore localized economic dynamics, we analyzed how each U.S. Census Division's Housing Price Index (HPI) correlates with national economic indicators. The results show that all regions exhibit strong positive correlations with CPI, S&P 500, and gold prices, though the strength of these relationships varies. Central and southern regions—particularly the West South Central and West North Central Divisions—show the strongest correlations with both CPI (Pearson's correlation, $R = 0.96$, $p < 0.001$) and the S&P 500 ((Pearson's correlation, $R = 0.96$, $p < 0.001$) and (Pearson's correlation, $R = 0.95$, $p < 0.001$), respectively), indicating that these housing markets are highly responsive to national inflation and equity trends. In contrast, coastal regions such as New England and the Pacific Division demonstrate slightly lower correlations, suggesting regional economic or demographic factors may dilute national trends (19). Correlations between gold and the regional housing markets were generally weaker across all regions, though still moderate, with the Middle Atlantic and West South-Central Divisions showing the strongest links. These findings highlight the value of regional analysis: while national indicators provide a reliable general picture, housing markets in certain areas may be sensitive to macroeconomic forces. This has implications for localized policy interventions, investment strategies, and forecasting accuracy at the regional level.

The housing market seems to be highly connected with the other markets evaluated. The positive correlation between all the markets and housing prices means that over long periods, they do reflect each other and can be used as valid indicators for predictions of trends in the market (13). However, this does not mean that one market directly drives changes in another.

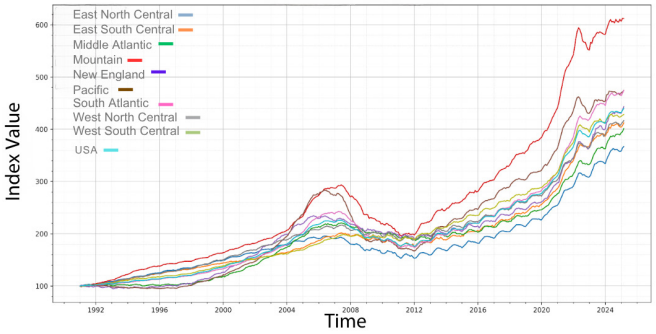

Figure 5: Housing Price Index (HPI) by region. Line graph illustrating the values of each HPI index for a specific census division at a certain time. Data values associated with different times were plotted on a line graph.

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It merely means that one market only reflects the changes shown in another. In short-term predictions, predicting other markets using HPI or housing prices using other markets is unreliable. We know this because, between the S&P 500 and HPI analysis, we observed that the correlation analysis done for each year led to correlation coefficients that weren't high enough to make assumptions based on just one of the indicators reliably, as the correlation coefficient wasn't >0.9 (20).

Finally, our study opens multiple avenues for further research. First, investigating the role of co-factors such as household income, debt-to-income ratios, or savings rates may yield more nuanced insights. Second, examining other economies could help determine whether these correlations and lags are globally applicable or specific to the U.S. market, whose housing and financial markets are heavily influenced by consumer credit, federal monetary policy, and large institutional investors. Third, applying machine learning models like neural networks or random forests could capture non-linear relationships and improve prediction accuracy. Fourth, comparing condominiums and multi-family houses with the other markets could reveal how different housing types respond to broader economic trends. Apartments, condominiums, and multi-family homes have been excluded from our research because of considerable differences in ownership type, financial schemes, and valuation patterns. The inclusion of these forms of property would add more variance caused by the forces of the rental market, density in these urban areas, and investor behavior, potentially hiding the correlations between macro-economic indicators and the conventional trends in the housing market. Exclusive comparison of these varying factors with other markets can provide more straightforward results than mixing it in with single-family housing.

In summary, while high correlation values validate the use of HPI as a broad economic indicator, they must be interpreted with caution, especially for short-term forecasting. Policymakers and investors alike should consider these relationships as part of a larger, multifactor framework for economic planning and financial decision-making.

MATERIALS AND METHODS

Data processing

HPI data was obtained from the Federal Housing Finance Agency (2). Data for the S&P 500 Index was collected from S&P500 100 Year Historical Chart (21). Data for CPI was collected from Bureau of Labor Statistics (4). Data for gold was collected from the Gold Prices 100 Year Historical Chart (22) The value time distribution used for all data was 1 month. Data for HPI, gold, S&P 500 Index, and CPI were compiled into a single CSV file for ease if analysis.

To compile the master spreadsheet, data points were obtained from each of the sources and matched up by year and month. The analyses described below were then run using the aligned data values. The full data table can be found in the appendix.

Collection of monthly data

For each of the indices, analyses were conducted using monthly values. To get the monthly values, we took the value of that index on the first day of that month. We then calculated the following analyses using those values.

The correlation between HPI and the other indices (S&P 500, Gold, CPI)

The equation for Pearson's correlation coefficient was used to calculate the correlation coefficient. The equation is as follows:

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

A Pearson correlation coefficient was generated for HPI against all the other data sets using Pandas (23), NumPy (24), and SciPy (25) Python libraries.

Cross-correlation analysis: Assessing for time-lag correlations

We shifted one time series relative to the other by a range of lag periods which allowed us to evaluate correlations at different time offsets. In our analysis, we employed a lag time restriction of up to four years (48 months), calculating the correlation at each month, to capture the dynamic relationship between the housing market and other U.S. markets as a methodological choice rather than a reflection of established empirical findings. For each lag point, we calculated the correlation between the variables. The correlation calculation that we used for this step involves the previous processes used in the correlation analysis section.

Trend analysis

Using historically known data, like the timings of recessions and bull markets, we found commonalities in how an indicator changed during those periods (i.e., gold doesn't fall during recessions). We then calculated the statistical significance of these observations. using Pearson's test because it is an industry standard in financial econometrics.

Pre- and post 2008 correlations

The entire data set was split into two different data sets with September 1, 2008, being the break point. We then used the same methods to run the analysis that was used previously.

Graphing

Graphing was done using Python version 3.11.6 (26), with libraries such as Plotly (27), Seaborn (28), and Matplotlib python libraries (29).

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Appendix:

Spreadsheet with data values for each index and the corresponding month:

https://docs.google.com/spreadsheets/d/1nZBKhqhzG1f1IXmCWx15_uJy-DDTXNaacuFEBIB3gAY/edit?usp=sharing