UNEXPECTED INFLATION AND THE STOCK MARKET

A REVISIT OF A LONG-FORGOTTEN ENIGMA

ANDREAS DANIELSSON

JIAYU LI

Master Thesis

Stockholm School of Economics

2022

Unexpected Inflation and the Stock Market: A revisit of a long-forgotten enigma

Abstract

As inflation has reached 40-year highs in the U.S., there is a new opportunity to revisit the relationship between the stock market and inflation. We first develop a theoretical valuation model based on a typical S&P 500 stock to benchmark the intrinsic value change one can expect when inflation increases by one percentage point. After establishing the benchmark impact, we measure unexpected inflation based on economists' forecasts and observe the one-day stock market response on the days when the U.S. Bureau of Labor Statistics releases its monthly CPI reports. We find no significant relationship between stock market returns and unexpected inflation for 2002-2022. However, we notice a shift in the unexpected inflation measure from 2021 onwards and find that, when observing post-2021 data only, the stock market responds negatively to unexpected inflation across different sectors. The S&P 500 responds by -6.1% for every percentage point of unexpected inflation. Contrary to common belief, real estate seems to be a poor inflation hedge as the Dow Jones Real Estate Index responds by -7.1%. The negative responses vary across the other sectors, with Consumer Discretionary responding most negatively by -8.3%, while Consumer Staples responds least negatively by -2.5%. Our results suggest that the market has not viewed new information about inflation as material for updating its long-term inflation expectations during 2002-2020, but only after 2021 when inflation started accelerating. While some sectors react less negatively to unexpected inflation, the results indicate that common stocks are unsatisfactory inflation hedges.

Keywords:

Inflation, Unexpected inflation, Inflation hedge, Stock market, Valuation

Authors:

Andreas Danielsson (24046)
Jiayu Li (41781)

Tutor:

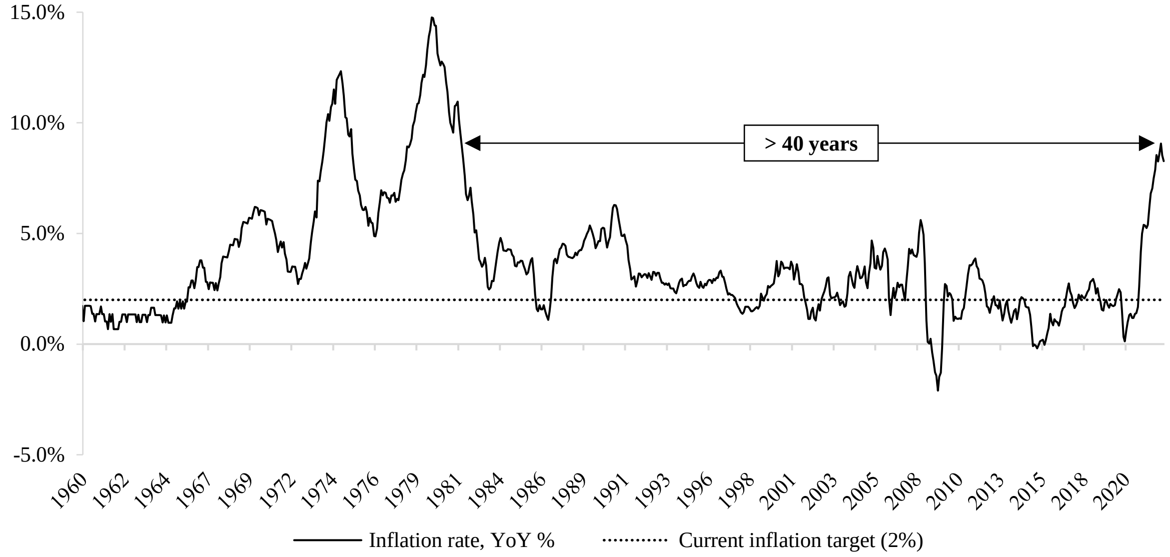
Henrik Andersson, Assistant Professor, Department of Accounting

Master Thesis
Master Program in Accounting, Valuation and Financial Management
Stockholm School of Economics

Contents

1. Introduction

Chart 1. Consumer Price Index in the United States, 1960-2022



As inflation recently reached 40-year highs, and stock markets are reacting to changing expectations about future macroeconomic conditions, there is a new opportunity to revisit the inflation and stock market question. How does the stock market react to new information about inflation? Do common stocks hedge unexpected inflation? Which sectors are more resilient to unexpected inflation? We give answers to these questions by observing the immediate stock market reaction across sectors when the U.S. Bureau of Labor Statistics releases its monthly Consumer Price Index ("CPI") reports. By comparing actual inflation figures with economists' forecasts, we develop a measure of unexpected inflation and find no significant market reaction to unexpected inflation in the period 2002-2022. However, we notice a shift in the unexpected inflation data in 2021 and investigate the pre- and post-2021 periods separately. Observing post-2021 data only, we find that the S&P 500 Index responds negatively by -6.1% for every percentage point of unexpected inflation. Similarly, the Dow Jones U.S. Real Estate Index responds negatively by -7.1%. The Consumer Discretionary index responds most negatively by -8.3%, while the Consumer Staples index responds least negatively by -2.5%.

During the last high inflationary period in the 1980s, researching inflation was popular, and many studies came to different conclusions on how stock prices respond to inflation. In the 1960s, there existed a general belief among academics and non-academics that the Fisher Equation also applies to the stock market, suggesting that equity investors are fully compensated for erosions in purchasing power due to inflation (Nelson, 1976). On the other hand, studies from the inflationary period of the 1970s and the 1980s often came to the unsatisfying conclusion that stocks are negatively related to inflation, making equity investors worse off during high inflation periods (Nelson, 1976; Bodie, 1976; Fama, 1981).

Later studies have also confirmed the negative relationship (Amihud, 1996; Wei, 2009). However, the case was never closed as many theories emerged around why the negative relationship existed. On the contrary, some researchers also found evidence of a positive relationship between stocks and inflation (Jaffe & Mandelker, 1976; Choudhry, 2001; Geetha et al., 2011; Kwofie & Ansah, 2018). Given this ambiguity, a revisit of the field can help clarify the relationship between inflation and stocks in developed economies, as there is a new opportunity to investigate the phenomenon.

Understanding the effects of unexpected inflation became critical with the realization that investors looking to hedge themselves fully against inflation need to consider both the expected and the unexpected parts of inflation. Fisher's (1930) famous "Fisher Equation" showed that investors are fully compensated for expected inflation in fixed-rate debt instruments like treasury bonds. However, when the expected inflation increases, the yield adjusts accordingly, and the bond price falls. Hence, investors looking to protect themselves from unexpected changes in inflation need to look further. Real assets, like real estate, have traditionally been seen as the optimal hedge against both expected and unexpected inflation. This narrative is a long-held belief widely found in financial newspapers, asset managers' comments, and the research literature. Most famously, Fama and Schwert (1977) claimed that private residential real estate is a complete hedge against both expected and unexpected inflation in their paper "Asset returns and inflation," which has been cited over 3,800 times.

We make three main contributions to the prior literature. First, since there is a gap in the literature regarding what benchmark effect one can expect when inflation increases, we model the intrinsic valuation change for a typical S&P 500 company when inflation increases by one percentage point in all future periods. Second, we contribute to clarifying the relationship between unexpected inflation and common stocks by using recent data and a new measure of expected inflation which does not require assuming a constant real interest rate. The second contribution may be the most important one, as most previous studies rely on the constant real interest rate assumption, at least to some extent. Simultaneously, plenty of evidence exists that the real interest rate and the inflation rate are negatively related, which complicates using a constant real interest rate assumption when studying inflation. Third, we provide new evidence of the impact of unexpected inflation on several stock market indexes across sectors, with further insights on real estate assets as hedges against unexpected inflation.

This paper follows the subsequent structure. First, we provide a brief historical overview in the "Historical background" section and outline the importance of understanding inflation for investors. Second, we discuss and relate our study to the prior literature in the "Literature review" section. Third, in the section "Research design and data," we explain our benchmark model and then describe our method for observing stock market responses to unexpected inflation. Fourth, in the "Results" section, we first present our benchmark model's outcome and discuss which variables influence the outcome. After discussing the benchmark model, we present our regression analysis, comment briefly on the findings, and perform additional tests with slight adjustments. Lastly, we discuss our results in the "Discussion" section, outline the limitations of our study in the "Limitations" section and summarize our findings in the "Conclusion" section while making suggestions for future research contributions.

2. Historical background

> "Inflation is as violent as a mugger, as frightening as an armed robber and as deadly as a hit man." – Ronald Reagan, 1978

In 1978, the United States presidential candidate, Ronald Reagan, declared inflation as violent as a mugger. At the time, inflation had spiraled to a 9 percent annual clip which outstretched to a historical high of 15 percent only two years later. The 1970s and 80s high inflation period came to be known as "the Great Inflation."

Inflation, sometimes described as "too much money spent chasing too few goods," occurs when the money supply growth in the economy exceeds the growth rate of goods and services, resulting in purchasing power erosion. Based on the driver, economists categorize inflation into Demand-Pull Inflation and Cost-Push Inflation. Demand-Pull inflation occurs when the aggregated demand for goods rapidly exceeds production capacity, while Cost-Push Inflation occurs when the supply of goods is in shortage or when production input costs increase (Totonchi, 2011).

The years 2021 and 2022 have seen sharp increases in inflation rates in the aftermath of several universal events. Following the COVID-19 breakout in 2020, the global economy was put on hold as governments introduced various measures to fight the pandemic. Consequently, labor markets and international travel were severely disrupted, which caused increases in input costs for producers across all industries (Santacreu & LaBelle, 2022). The current inflation has partially been caused by this supply chain shortage triggered in 2020. Hence, the nature of today's inflation is partly cost-push. However, as demand for unavailable services during the COVID-19 imposed restrictions was pent-up, the current inflation also partially stems from a demand-pull effect as the pent-up demand suddenly rebounded when everyday life returned to normal (Bernstein & Tedeschi, 2021). When inflation started increasing in early 2021, the Federal Reserve proclaimed that the inflation was "transitory" and caused by temporary circumstances. The claim was based on the argument that inflation was higher due to a few goods, and not widely spread in the economy (Tretina, 2022).

However, shortly after, in 2022, the war in Ukraine broke out and fractured the European energy supply, causing energy prices in Europe to rise. The U.S. has also been affected, where energy prices were up 14.3% in August 2022 compared to the same period the year before (U.S. Energy Information Administration, 2022). As the production of goods needs energy, such as electricity or gas, the increasing energy prices have further driven up the cost of production, in addition to the already existing supply-chain disruptions. The Ukraine war additionally caused food prices to increase, after several countries introduced sanctions on Russia (Tretina, 2022).

In the sections below, we discuss the significance of understanding inflation for different stakeholders across society because of its potential impact on their purchasing power and real wealth.

2.1. The social impact of inflation

The CPI measured by the Bureau of Labor Statistics ("BLS") represents all goods and services consumers purchase and are categorized into more than 200 categories. Every month, the BLS records the prices of over 80,000 items. Hence, inflation measured by the CPI is not an increase in a few prices but in many prices at once, broadly impacting society. For example, according to data from the BLS, in October 2022, the real average hourly earnings for all employees in the U.S. decreased by 2.8 percent, implying that all employees now afford fewer goods and services.

These lower real wages demonstrate that inflation can directly impact laborers' purchasing power, at least in the short run. Moreover, there may be economic, political, and ethical implications for society if inflation contributes to a redistribution of income among citizens and alters the standard of living for laborers when their real wage drops.

Since high unexpected inflation can cause sudden purchasing power losses, it may harm the broader trust in the economic system. In an article in the Financial Times in July 2022, Gary Stevenson explains how the perpetually low purchasing power today compared with the 1980s has affected his trust in the economic system and how, according to him, risky investments have become more appealing for regular people:

> "My dad never went to university. He worked at the post office for 35 years and could raise three kids and pay off [a mortgage] . . . he has a comfortable retirement.". "That is off the table for most young people now. It's created a bit of a panic." "If you can't do what your dad or grandad did . . . you have to come up with a better plan. At some point, risky bets start to look like the rational choice: "One way, you see a zero per cent chance of success. But if you take on insane risk. . . at least you have a chance." (Gary Stevenson, 2022)

While it is unknown if an increasing portion of the population shares Gary Stevenson's despair, the current inflation does not help as real wages continue to decrease. Additionally, high inflation may coincide with higher unemployment rates. Rising input costs due to inflation may motivate managerial decisions in companies, such as layoffs. One current example of inflation playing a role in the mass employee termination is Facebook (Meta Inc.), which in November cut 11,000 staff as a response to *"An economic slowdown including rising inflation and cost of capital"* (Criddle & Murphy, 2022). Many other technology companies have followed suit due to future profitability concerns. In 2022 alone, over 88,000 workers in the U.S. technology sector have been laid off so far (Vedantam, 2022).

2.2. Understanding inflation is crucial for investors

As a starting point, inflation poses a "stealth" threat to investors because it lowers the value of their real cash savings and investments with fixed future payments. Additionally, as the Federal Reserve may raise the federal funds rate to tame inflation, the present value of investments decreases if the future payments do not increase with inflation.

Debt investors

For investors in debt securities, such as bonds, the inflationary risk is crucial to consider. For all fixed-rate debt securities, the price immediately depreciates when there is an unexpected increase in inflation, as inflation causes the nominal return to adjust, as explained by the Fisher Equation (Fisher, 1930). Hence, fixed-rate bond investors are always compensated for the current expected inflation but not for unexpected inflation. As a historical anecdote, the 10-year U.S. treasury bond yield peaked at 15.8% in 1981. The peak constituted a 55% price drop in the 10-year treasury bonds from their price in 1972.

Floating rate debts may be better protected against inflation as their coupons can change over time to adjust for higher interest rates due to inflation increases. On the other hand, such bonds are generally issued by riskier counterparties and, therefore, often subject to default risk, unlike treasury bonds.

Equity investors

As we will further elaborate on in the literature review, there exists conflicting evidence of how inflation impacts equity values. Therefore, it is of utmost importance for equity investors to understand how to best hedge against inflation. Commonly held beliefs are that inflation tends to lead to devaluations of common stocks as consumer spending takes a hit when consumers lose purchasing power and that value stocks perform better and growth stocks worse when inflation increases. However, clear-cut evidence to back up such beliefs seldom exists. With our study, we contribute to understanding how the market reacts to unexpected inflation.

Real estate investors

It is generally believed that real estate is a great inflation hedge. There are several logical explanations as to why it might be the case. The first and most obvious case is that specific apartment rental contracts can be indexed to the annual CPI, resulting in that the rental income immediately reflects higher price levels. However, there is also an interest rate component, as most investors finance real estate assets with debt. For investors with debt, an increasing interest rate might directly hit profitability if investors have not fixed their interest rates. Therefore, real estate investments might provide a better or worse inflation hedge depending on the investor's financing choice.

There exists a long-term trend of increasing real rents across the U.S. between 1940 and 2000 among all real estate types (United States Census Bureau, 2000). These always-growing real estate prices might have contributed to the view that real estate is a good inflation hedge, as real estate continued to appreciate through the high inflation years of the 1970s and 80s and always seems to do. At the time, Fama and Schwert (1977) also published their paper presenting evidence that real estate provides a hedge against expected and unexpected inflation. Their findings are further discussed in our literature review and later in our discussion.

It is crucial for investors to know if real estate truly is a good inflation hedge. Otherwise, they risk making incorrect investment decisions based on common belief rather than observed data.

3. Literature review

Extensive research has shed light on the effects of inflation on the stock market using an abundance of different statistical methods and tests. However, the literature lacks theoretical examples of what one can expect in terms of intrinsic valuation changes for a typical stock when inflation changes. While some researchers have introduced theories as to why there should be a value effect, the prior literature has not provided a benchmark for this effect. Here we contribute by constructing a benchmark model based on actual numbers from a typical S&P 500 company. We find that a one percentage point increase in the inflation rate in all future periods negatively affects the intrinsic valuation between -3% and -4%.

Furthermore, many researchers have drawn conclusions regarding unexpected inflation, but few have provided reliable measures for unexpected inflation when considering the whole literature. For example, to the best of our knowledge, most previous measures of unexpected inflation are, at least to some extent, based on the assumption of a constant real interest rate. Simultaneously, as discussed below, there is evidence that the real interest rate decreases when inflation increases, which introduces much ambiguity regarding the previous conclusions drawn about unexpected inflation. Therefore, we introduce a new measure of expected inflation based on economists' forecasts which circumvents the need to make assumptions about the real interest rate when measuring unexpected inflation.

To start from the beginning, Fisher (1930) noted that, on average, investors are fully compensated for erosions in purchasing power. Consequently, the nominal interest rate always reflects the expected inflation rate and the expected real return.

Opposing the, at the time, commonly held belief that Fisher's hypothesis also applies to stocks, Nelson (1976) found empirical evidence suggesting that common stock returns and expected and unexpected inflation changes were, in fact, negatively related during the post-war period. He noted that an increase in inflation, anticipated or unanticipated, increases risk premiums, bringing more economic uncertainty. Creditors, therefore, require a more significant premium to compensate for the increased uncertainty, which, in turn, increases the cost of borrowing, discouraging investments and reducing economic activities. As a consequence, an increase in inflation leads to a decrease in stock prices. Bulent Gultekin (1983) replicated Nelson's (1976) study in 26 countries and came to the same conclusion.

Similarly, Bodie (1976) concluded, using annual, quarterly, and monthly data between 1953 and 1972, that the real return on equity is negatively related to both expected and unexpected inflation, at least in the short run. This outcome resonates well with Mundell's (1963) study, which showed that the real interest rate is negatively related to inflation. To complicate the picture, Fama (1981) found that when introducing measures of real activity into a stock return model containing inflation as an explanatory variable, inflation loses its explanatory power.

With the same outcome as Bodie (1976), Jaffe and Mandelker (1976) also found that stock returns and concurrent inflation rates had an inverted relationship in the period 1953 to 1971.

However, when extending the period using 95 years of data between 1875 and 1970, they found a significant positive relationship between inflation and stock returns, confirming that Fisher's conjecture may apply to common stocks in the long run. Later, Campbell and Shiller (1988) illustrated through the Dividend Discount Model that inflation has two main effects. First, under the Fisher Equation (Fisher, 1930), the discount rate investors use to discount future dividends increases, decreasing the present value. Secondly, future dividends increase due to higher inflation. However, they argue that due to sticky prices, the elasticity of future cash flows does not always equal one. Therefore, the effect of inflation on stock returns may be none or negative in the short run but should be positive in the long run. Strengthening this result, two recent studies by Kwofie and Ansah (2018) and Geetha et al., (2011) find the same to be true in the Ghanian, Malaysian, and Chinese stock markets, where they find the short-run stock returns and inflation relationship to be insignificant, but the long-run relationship to be positive.

As previous researchers had mostly found negative relationships between stock returns and inflation, Fama and Schwert (1977) investigated which other assets may constitute effective inflation hedges. They examined various assets and confirmed that stock returns were negatively related to the expected inflation rate component. Measuring unexpected inflation indirectly using treasury bills, they also conclude that stock returns are negatively related to the unexpected part of inflation. As for other assets, most interestingly, they find private residential real estate to be a complete hedge against expected and unexpected inflation. Measuring unexpected inflation indirectly through a treasury bond requires the real interest rate to be constant over the whole measuring period, which in Fama and Schwert's (1977) case is one year at its longest. We argue that a constant real interest rate during periods of inflation is unlikely considering the studies by Mundell (1963) and Bodie (1976). Additionally, Pennacchi (1991) found that instantaneous real interest rates and expected inflation are negatively related, and that real interest rates have a higher volatility and weaker mean reversion than expected inflation. More recent research has also questioned the constant real interest rate assumption and found it to be controversial (Ang et al., 2008). We discuss this point further in our research design when comparing our method with earlier ones.

Huang and Hudson-Wilson (2007) used the same method developed by Fama and Schwert (1977) and came to the same conclusion that real estate is an effective hedge against both expected and unexpected inflation. They further showed that different types of real estate have varying levels of hedging effectiveness against inflation. They found that office and residential real estate has the most robust hedging capabilities. However, some differing evidence also exists as Miles (1996) found commercial real estate in the UK to be an imperfect hedge against unexpected inflation and Kong et al., (1998) found real estate assets to be a poor inflation hedge compared to financial assets. Lastly, several studies found that real estate investment trusts ("REITs") are inferior inflation hedges (Yun Park & Muluneaux, 1990; Yobaccio et al., 1995; Liu et al., 1997; Gyourko & Linneman, 1998; Sing & Low, 2000).

To further build on Fama and Schwert's (1977) findings, Schwert (1981) focused on the unexpected component of inflation and analyzed the reaction of stock prices to new information about inflation when the Bureau of Labor Statistics releases its monthly CPI reports.

While confirming the negative relationship between the two, the results suggested a lagged and relatively weak impact of unexpected inflation on the stock market. Noteworthy is that Schwert (1981) also used an indirect method based on treasury bond yields for measuring inflation expectations. Our study also focuses on the information contained in CPI reports but uses a different method for measuring expected inflation. Since the setup measuring stock market reactions to CPI reports is quite similar, Schwert's (1981) study is a pivotal study to compare our results with.

To explain why inflation, particularly unexpected inflation, results in declining stock prices, Day (1984) showed through a multiperiod economy with a production model that this effect is consistent with equilibrium in a market with rational investors. The negative relationship arises because shocks to the real production output in the economy have the opposite effect on inflation. From his conclusion, we interpret as different reasoning that inflation may also signal a decline in real output to investors. Stulz (1986) confirmed the findings of Day (1984) and showed that the expected real rate of return for the market portfolio falls less when an increase in the money supply causes higher inflation rather than a worsening of the investment opportunity set.

Giving more clarity to the negative relationship between inflation and real activity, Kaul (1987) demonstrates that counter-cyclical monetary responses made by central banks reinforce the negative relationship. Mcqueen and Roley (1993) confirmed Kaul's (1987) findings and found that stock prices respond to real economic activities and announcements. This more straightforward explanation of why stock returns are negatively related to inflation asserts that high inflation will eventually lead to a monetary tightening response from the central bank, decreasing real returns. An alternative real-return explanation to why stocks decline when inflation increases is presented by Feldstein (1980), who claimed effective taxes can explain the effect. As fixed assets are recognized at historical cost, the straight-line depreciation amount will reflect the historical values of those assets. When a company's revenues increase solely due to inflation, the company has not increased its revenue in real terms but only in nominal terms. The effective tax rate will increase as the depreciation, which offsets the increased nominal revenues, will stay the same. As a result, the nominal profit increases and, subsequently, the paid taxes. However, the portion of the real profit paid in taxes has increased, making investors worse off earning a lower real net yield per unit of capital. In our benchmark model, we capture this effect by drawing up a depreciation schedule where old assets are straight-line depreciated over an extended period while inflation increases immediately. With a similar logic as Feldstein (1980), Stulz (1986) introduced the "Bracket Creep" theory, which refers to an increase in income taxes for taxpayers due to inflation. Since inflation increases nominal income, inflation may push taxpayers into higher tax brackets, where they end up paying more income tax without earning higher real wages. To adjust for the decrease in real after-tax personal income, investors rebalance their portfolios.

Problematizing previous explanations for the negative relationship between inflation and stock prices, Amihud (1996) used a new method measuring the unexpected inflation component using a CPI-linked bond in Israel. With the sole focus on the Israelian market, Amihud (1996) opposed some previously suggested reasons for the negative relationship between stocks and inflation. First, the tax-related explanation presented by Feldstein (1980) is insufficient to explain the outcome of Amihud's (1996) study, as Israel has a corporate tax system designed to be neutral to inflation.

Second, the personal tax brackets in Israel are adjusted for inflation, ruling out Stulz's (1986) explanation that investors rebalance their portfolios to adjust for the decrease in real after-tax personal income due to the "Bracket Creep." While it is true that Israelian tax system is adjusted for inflation annually, we believe further proof is needed to show that this tax adjustment is enough to offset the depreciation effect explained by (Feldstein, 1980) and any temporal bracket creep effects before dismissing Feldstein's (1980) and Stulz's (1986) explanations. Third, Modigliani and Cohn (1979) introduced a theory named "Money Illusion" to explain the negative stock price-inflation relationship, which states that unexpected inflation raises nominal interest and discount rates. While investors update their interest rates, they fail to adjust for the inflation effect on future earnings, which causes stock prices to fall when inflation increases. Campbell and Shiller (1988) has the same explanation for the phenomena. However, Amihud (1996) argued that Israel's prolonged exposure to inflation has investors more aware of the difference between real and nominal earnings. The negative inflation-stock price relationship persisted, undermining the theory that there would be a systematic failure to account for both a higher discount rate and higher future earnings that come with inflation. Bekaert and Engstrom (2010) support this view as they prove that the money illusion theory has a relatively limited explanatory power.

In a different market focus, Choudhry (2001) finds a positive relationship between current stock returns and current inflation in high-inflationary countries. This finding opposes the previous findings and suggests that stocks fully compensate investors for any erosions in purchasing power.

Wei (2009) discovered evidence of a stronger negative relationship between equity returns and unexpected inflation in a weak economy state compared to a strong economy state by examining the cyclical responses to unexpected inflation of the discount rate, the expected growth rate, and the equity risk premium. The empirical results indicated that unexpected inflation signals to investors changes in the expected real activity and the equity risk premium. This outcome resonates with our interpretation of Day's (1984) finding.

After the 1980s, the world's economy experienced very few inflationary shocks. Therefore, the relatively mild inflation economic climate has limited the research in the field among the more developed countries. More recent studies have often been conducted in countries and economies with high inflationary environments, often emerging markets. While such studies can provide insights into their specific market settings, it is often difficult to generalize the results to developed economies. Therefore, to compare with our study, we must instead rely on studies done in the 80s as reference points.

4. Research design and data

4.1. Benchmark model design

Before making any observations in the real world, we wish to establish what intrinsic value change one can expect from a typical S&P 500 company when inflation increases by one percentage point during normal inflation levels[1], assuming no other macroeconomic changes. However, as previous research has shown, higher inflation often coincides with lower real returns. By this example, we only wish to achieve a benchmark of how inflation itself impacts the intrinsic valuation of a typical S&P 500 company without taking potential higher risk premiums, lower real returns, or a heightened recessionary risk into account.

As it turns out, the benchmark effect heavily depends on the assumptions one makes about the asset proportions and the operating margin. We use a set of reasonable assumptions for a typical S&P 500 company and go through how each of these assumptions affect the valuation when inflation increases. To estimate the intrinsic value of our theoretical company, we use the Gordon growth model as specified below to arrive at the enterprise value.

$$V_t = \frac{FCF_{t+1}}{WACC - g} \tag{1}$$

Where V_t is the enterprise value at the valuation date t, FCF_{t+1} is the free cash flow available to all investors one year in the future from the valuation date, WACC is the weighted average cost of capital, and g the annual steady-state growth, which we assume to be equal to the inflation rate.

The Gordon growth model is challenging to use in real-world valuation practices due to its high sensitivity to changes in any of the assumptions and the required assumption that the company is in a steady state. However, it suits our purpose well for investigating a theoretical stock price change when inflation increases in all future periods. Simultaneously, this valuation method keeps disclosures of the model simple, as only one steady state input year is required. Hence, it also allows a more straightforward interpretation of what drives the value change compared to other valuation techniques. Furthermore, the Gordon growth model is commonly used to calculate the continuing value in discounted cash flow analysis. With a Gordon growth model based on real numbers, we wish to provide a hands-on and easy-to-follow example using a valuation technique commonly used by practitioners. For the value implications of the model, as evident from equation (1) above, value differences due to inflation will only be observed if the higher inflation rate causes the numerator and the denominator to increase or decrease at different rates.

[1] We define the normal inflation level as the Federal Reserve's inflation target of 2%.

We base the assumptions in our benchmark model on the Chevron Corporation, an oil and gas company that has substantial fixed assets recorded at historical cost that are depreciated using either straight-line or unit-of-production.[2] We assume that the company is in a steady state and has been in a steady state in previous years. To observe the value change that one percentage point higher inflation has on the intrinsic valuation, we construct the model in two scenarios and adjust all assumptions for one percentage point higher inflation in one of the scenarios. We refer to these scenarios simply as "Scenario 1" and "Scenario 2", with implied inflation rates of 2% and 3% for all future periods, respectively. The table below presents the assumptions used throughout the scenarios unless we explicitly state that we alter one variable to investigate the outcome.

Table 1. Basic model assumptions

	Scenario 1	Scenario 2
Inflation rate	**2.00%**	**3.00%**
Cost of Equity	8.50%	9.56%
Cost of Debt	2.60%	3.61%
Debt / (Equity + Debt)[3]	8.82%	8.82%
Tax rate	27.50%	27.50%

As inflation differs between the scenarios, we derive the cost of equity and debt in Scenario 2 by using the Fisher equation and assuming a constant real interest rate.[4]

$$(1 + r_N) = (1 + r_R)(1 + i) \tag{2}$$

Where $r_N = $ *nominal interest rate*, $r_R = $ *real interest rate, and* $i = $ *inflation*

[2] Except for inflation, we base the assumptions throughout the model on the historical full year 2021. We further argue that Chevron Corporation is a suitable candidate for representing a typical S&P500 company due to its size, assets, and margins. We also build models for two other companies, the 3M Company and Waste Management, and come to similar conclusions.

[3] Debt and Equity refer to their respective market values.

[4] In line with our assumption that no other macroeconomic changes take place in the economy:
Cost of Equity Scenario 2 = (1 + Cost of Equity Scenario 1) / (1 + inflation rate Scenario 1) * (1 + inflation rate Scenario 2) – 1

4.2. Stock market observations

After establishing the benchmark impact inflation has on stock prices, we intend to observe stock market responses to unexpected increases in inflation. Stock price variations are subject to a vast number of variables. If inflation is one of them, it is critical to minimize any noise factors impacting the measurement of the inflation effect. For example, there is some evidence from less developed economies that PPI may be a leading indicator for the CPI in some instances and can help predict or at least improve CPI forecasts (Clark, 1995; Ivo da Rocha Lima Filho, 2019; Sidaoui et al., 2009; Anggraeni & Irawan, 2018). As an anecdote, the Financial Times recently suggested in an article that global inflation is likely to have peaked, pointing to the fact that PPI has begun falling in many countries (Romei, 2022). The U.S. Bureau of Labor Statistics monthly reports PPI and CPI for the U.S. economy. From time to time, they publish monthly PPI numbers before CPI numbers, which, therefore, could alter the market expectation of the monthly CPI before the report is released. To avoid any potential influence the PPI or other unknown variables may have on inflation expectations, we conduct an event study with a one-day event window on all the days when the Bureau of Labor Statistics announces CPI inflation figures and measure inflation expectations immediately before each inflation report is released. By measuring the one-day stock market reaction to the CPI reports, any noise caused by other market news is reduced. Using this method, one can also be sure of the causality of any relationships found between the variables. For example, suppose a relationship is found between unexpected inflation and stock market returns on the event dates when the CPI reports are released. In that case, one can reasonably assume that unexpected inflation causes the stock market reaction. Under the efficient market hypothesis, the stock market reaction should, on average, be correct in pricing future value implications of new information. There are no reasons to believe this would not be the case for new information about the inflation level in the general economy. Hence, one can also determine the effect of inflation on the valuation of stocks by using this method.

We measure the expected inflation using Wall Steet economists' estimates surveyed by Bloomberg and calculate the median and average estimates of all available estimates each month. We then subtract this median from the actual inflation rate in each CPI report to measure the unexpected inflation. We strongly believe that this measure of unexpected inflation is superior to previously used methods in capturing the market's inflation expectation as it does not require the assumption of a constant real rate of return during the inflationary period. Below, we will further develop this argument after presenting the previously used method. Even if the market may have different beliefs about inflation than the estimates published by economists, the estimates may still function as a benchmark for market participants. Furthermore, in recent times, the inflation estimate has been frequently mentioned alongside the published inflation figure in newspaper articles, which may also have contributed to market participants putting a greater emphasis on it.[5]

[5] See for example, (Kerr, 2022; Megaw & Clarfelt, 2022)

Additionally, economists' models for forecasting inflation have improved with recent technology advancements incorporating better predictors and automatic model fitting. These advancements could be an argument for the market to have at least some degree of confidence in the forecasts. Lastly, if market participants' expectations are sometimes above and sometimes below the forecast numbers, one can argue that the median or average of the available forecasts is appropriate for measuring what the average market participant expects regarding inflation.

As discussed in the literature review, previous researchers have indirectly estimated the expected inflation by observing treasury bond yields and assuming that the expected real return is constant over time. While researchers have used slightly different methods, most have been based on the constant real interest rate assumption. This assumption results in a very convenient measurement of expected inflation. If the market is efficient, the yield of a treasury bond is equal to the constant expected real return plus the expected inflation. Since the expected real return is constant, all variations in the yield will be due to changes in inflation expectations. Therefore, it is theoretically possible to use the observed yield at time t-1 as a proxy for expected inflation if one also uses the same proxy to measure the observed inflation at time t, which would then be the realized return of the treasury yield.[6]

To compare our method of measuring expected inflation with the previous methods, let us first observe (Fama & Schwert, 1977)'s expanded specification of how expected asset returns can be expressed using the real interest rate, expected inflation, and unexpected inflation.[7]

$$E\left(\tilde{R}_{jt}\mid\phi_{t-1},\Delta_t\right)=E\left(\tilde{\imath}_{jt}\mid\phi_{t-1}\right)+E\left(\widetilde{\Delta}_t\mid\phi_{t-1}\right)+\gamma_j\left[\Delta_t-E\left(\widetilde{\Delta}_t\mid\phi_{t-1}\right)\right] \tag{3}$$

Where $E\left(\tilde{R}_{jt}\mid\phi_{t-1},\Delta_t\right)$ represents the expected nominal asset return on the asset j from t-1 to t, at time t. $E\left(\tilde{\imath}_{jt}\mid\phi_{t-1}\right)$ is the equilibrium expected real return implied by the information ϕ_{t-1} available at t-1, $E\left(\tilde{\Delta}_t\mid\phi_{t-1}\right)$ is the best possible inflation estimate that can be made using the information ϕ_{t-1} at t-1, $\gamma_j\left[\Delta_t-E\left(\tilde{\Delta}_t\mid\phi_{t-1}\right)\right]$ denotes the unexpected inflation as the difference between the actual inflation, Δ_t and the expected inflation $E\left(\tilde{\Delta}_t\mid\phi_{t-1}\right)$ that was estimated by the market at t-1 using ϕ_{t-1} while γ_j represents the coefficient for the impact unexpected inflation has on the asset j's return at time t. The tildes signify random variables.

To estimate equation (3) and the effect of expected and unexpected inflation on different assets, they use the regression model in equation (4).

$$\tilde{R}_{jt}=\alpha_j+\beta_j E\left(\widetilde{\Delta}_t\mid\phi_{t-1}\right)+\gamma_j\left[\Delta_t-E\left(\widetilde{\Delta}_t\mid\phi_{t-1}\right)\right]+\tilde{\eta}_{jt} \tag{4}$$

The model in equation (4) explains asset returns from time t-1 to t as dependent on the expected inflation at the time t observed at t-1 and the unexpected inflation, measured as the difference

[6] For a detailed explanation of this method, see Fama (1975)'s "Short-term interest rates as predictors of inflation" and (Fama & Schwert, 1979)'s "Inflation, Interest, and Relative Prices"

[7] Equation (3) constitutes a theoretical expression specified to observe to which extent asset returns at time t reflect the unexpected inflation component. For further details on how they arrive at this equation, see (Fama & Schwert, 1977) "Asset returns and inflation".

between the actual inflation at time t and the expected inflation observed at t-1. As evident in equation (4), a correct measure of the expected inflation is crucial to estimate both regression coefficients β_j and γ_j correctly. We argue that the assumption of a constant real interest rate poses a problem in correctly assessing the expected inflation. Later studies have shown (a) that inflation is significantly negatively related to real activities (Kaul, 1987); (b) that expected inflation and instantaneous real interest rates are significantly negatively related (Pennacchi, 1991); and (c) that real interest rates have higher volatility and a weaker mean-reversion than expected inflation (Pennacchi, 1991). Consequently, an expected inflation estimate based on a treasury bond may provide inaccurate measurements, especially during periods of increasing inflation, which typically coincide with changes in inflation expectations and therefore lowers the real interest rate, as Pennacchi (1991) suggests. Pennacchi's (1991) finding also weakens Amihud's (1996) method, as a change in expected inflation is related to a change in the instantaneous real interest rate, meaning that even a daily measure using a CPI-linked bond could be unreliable. We are not the first to question the constant real interest rate assumption. Ang et al., (2008) challenge the assumption as they note that previous empirical research often assumes a constant real interest rate, and empirical estimates for the real interest rate vary between constant (Fama, 1975), mean-reverting (Hamilton, 1985), or a unit root process (Rose, 1988). In their study, they further show, like Pennacchi (1991) that the real short interest rate is negatively related to both expected and unexpected inflation.

A further reason that motivates us to use a different measure of expected inflation than previous researchers have used is that central banks have introduced new monetary policies since the 1970s and 1980s. Even if one considers the indirect measure of expected inflation using a treasury bond to be a good measure, the effects of quantitative easing cannot be ignored. We argue that Fama and Schwert's (1977) method of measuring expected inflation has been rendered obsolete due to quantitative easing (or tightening), as these measures have distorted trading prices and yields for treasury bonds and may continue to do so in the future.

We rely on survey data of economists' forecasts to avoid having to assume a constant real interest rate and any measurement problems that may exist due to quantitative easing. Using survey data further allows for isolating the immediate market reaction to unexpected inflation. We argue that measuring the immediate stock market reaction on a one-day return basis when inflation reports are released will more effectively estimate the unexpected inflation coefficient, γ_j, as this method requires no assumptions other than that the inflation estimates by economists reflect what the market expects on average. Because of our somewhat different method, the interpretation of our estimation coefficients will differ slightly due to our shorter time frame and event study design. Fama and Schwert (1977) estimate their model using yearly, quarterly, and monthly returns. As our method uses the time frame of one day, we do not expect the expected inflation to explain the one-day return meaningfully. We derive this logic by imagining a zero-coupon bond with a maturity date of tomorrow. If the return over one year of the bond is 3% and the expected inflation can fully explain this return, one day would account for less than 0.01% of the total return.

Therefore, when using a regression model set up as the one specified in equation (4), we would expect the expected inflation coefficient, β_j, to be indistinguishable from zero.[8]

As our method revolves around the release of inflation reports, instead of testing for the expected inflation, we modify Fama and Schwert's (1977) model and specify the model to test whether the market reacts to the actual inflation level. The logic behind this specification is to test if the market reacts to the most crucial figure of the inflation report, the inflation level itself. Our initial specification is presented in equation (5) below.

$$R_{jt} = \alpha_j + \beta_j \Delta_t + \gamma_j \left[\Delta_t - E\left(\widetilde{\Delta}_t \mid \phi_{t-x} \right) \right] + \varepsilon_{jt} \tag{5}$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
Δ_t is the actual inflation level as published by the Bureau of Labor Statistics at time t,
and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x} \right) \right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x} \right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

In equation (5), t-x refers to the immediate time before t, when inflation reports are released. In most cases, economists publish their estimates during the week before the Bureau of Labor Statistics releases inflation reports.[9]

As an alternative specification, we replace the inflation rate, Δ_t, with the difference in the inflation rate on a month-to-month basis in equation (6) below. This measure is positive when inflation continues to accelerate and negative when inflation retracts. This specification investigates whether the market reacts to the inflation trend rather than unexpected inflation.

$$R_{jt} = \alpha_j + \beta_j [\Delta_t - \Delta_{t-1}] + \gamma_j \left[\Delta_t - E\left(\widetilde{\Delta}_t \mid \phi_{t-x} \right) \right] + \varepsilon_{jt} \tag{6}$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
$[\Delta_t - \Delta_{t-1}]$ is the difference in the inflation rate between time t, and time t-1, one month earlier, and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x} \right) \right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x} \right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

[8] We also observe that β_j is indistinguishable from zero when we regress equation (4) using our data.
[9] See Appendix 1 for an illustration of the distribution of estimates x days before the inflation reports.

In equations (5) and (6), the more exciting coefficient to observe is the unexpected inflation coefficient, γ_j, which may give us insight into how the market reacts to unexpected inflation, providing a piece of the puzzle of how inflation impacts nominal asset returns.

As a first step, we test the regressions in equations (5) and (6) with the return from a broad stock market index as the independent variable. Next, to test whether real estate makes a more effective hedge against inflation, we run the same model with the return of a broad real estate index as the independent variable. While measuring private residential real estate returns would have been ideal, we must rely on a real estate index as a proxy to measure one-day real estate returns. We repeat this process for each of the S&P 500 sector indexes to further investigate any sector-specific relationships.

4.2.1. Data sources

We use a panel dataset in the period 2002-2022, which includes monthly inflation figures, inflation forecasts by economists, daily S&P 500 Index returns, daily returns of the different S&P 500 sector indexes, and daily returns of the Dow Jones U.S. Real Estate Index.[10]

For inflation figures, we use monthly data from the U.S. Bureau of Labor Statistics from 2002-2022. The figures are not seasonally adjusted and represent all urban consumers in the U.S., which are the figures that receive the most attention from investors, economists, and newspapers as they represent the inflation rate in the general economy.

We rely on survey data of inflation estimates from many economists collected by Bloomberg to measure inflation expectations. The economists participating constitute Wall Street economists from renowned investment banks and other financial institutions. In the last couple of years, around 50 economists have participated in the survey every month. Since no ready-made panel dataset is available, we extract the available forecasts for each month separately.[11] Each estimate has the information presented in Table 2.

Table 2. Bloomberg inflation survey variables

Variable	Description
“Economist”	The name of the economist responsible for the estimate
“Firm”	The institution responsible for the estimate
“Estimate”	The inflation estimates for each specific month
“As of”	The date of the estimate
“Rank”	The forecaster rank based on the previous average error

[10] Due to the change in the definition of the S&P 500 Real Estate Index in 2016, we use the Dow Jones U.S. Real Estate Index as a substitute.
[11] For an example month, see Appendix 1.

The earliest inflation estimate that Bloomberg has recorded is on the 18th of November 2002. Hence, the first inflation data point that can be compared with the monthly inflation estimate is the 19th of November 2002. In the early years of the data, only a few estimates are available, and some months lack estimates. However, from 2005 and onwards, there are at least ten estimates available per month, with only a few exceptions.[12] As the time series continues, the number of available estimates per month steadily grows over time, and from 2010 onwards, there are over 35 estimates available per month. In the last couple of years, monthly estimates have grown to around 50. In total, the collected data comprises 8,180 monthly inflation estimates for 238 months between November 2002 and November 2022.

We are interested in getting inflation estimates as close to the release of the inflation report as possible to reduce any influence reports like PPI or other unknown variables may have on the inflation estimates. When observing how many days before the inflation reports estimates are released, over 87% of the estimates are published within one week before actual inflation figures are published.[13] In 114 of the months, PPI reports are released the day before CPI reports which raises the question of which estimates to include. The estimates closer to the CPI release date can potentially incorporate more knowledge and therefore be better estimates. Therefore, we also run the same tests, excluding estimates made too far ahead of the CPI release date. We test different levels, by only including estimates made 7, 3, and 1 day(s) before the release of each CPI report and arrive at very similar results. The data further has 88 estimates labeled as released on the same date as the inflation report. These are excluded to avoid any ambiguity regarding what they stand for.[14] Finally, we considered only including estimates by ranked economists, as these could be seen as more reliable due to their previous accuracy. However, doing so does not change any of our results. Thus, estimates by economists without a ranking are also included.

To reach one inflation estimate per month to compare with the monthly inflation, we use the median of each month’s estimates. The median of all economists’ forecasts in any given month is our estimate of the inflation expectation before each CPI report is released. As an alternative measure, the average estimate for every month is also calculated.

Daily returns in the broader stock market are defined as the changes in daily close prices of the S&P 500 Index. As a proxy for measuring daily real estate returns, the changes in daily close prices of the Dow Jones U.S. Real Estate Index are used. The other sector index returns included are calculated in the same way and include S&P 500 Communication Services, S&P 500 Consumer Discretionary, S&P 500 Consumer Staples, S&P 500 Energy, S&P 500 Financials, S&P 500 Health Care, S&P 500 Industrials, S&P 500 Technology, S&P 500 Materials, and S&P 500 Utilities.

[12] After 2005, there were only five months with less than ten estimates. The month with the fewest estimates has five estimates.
[13] Again, see Appendix 1 for a cumulative frequency table.
[14] Including the same-day estimates does not yield different results.

We considered excluding the period between 2007 and 2009 as the data might include unnecessary noise, especially in the real estate index following the subprime mortgage crisis. The total return of the Dow Jones U.S. Real Estate index from the highest point on the 7th of February 2007 to the lowest point on the 6th of March 2009 constituted -77%, indicating an unusual period. Including these years does not change our interpretation of the results from our regressions. Therefore, they are included.

In the whole period from 2002-2022, the U.S. Bureau of Labor Statistics released two CPI reports on public holidays. In these cases, the return of the next available trading day is used.

Table 3 below summarizes all variables included in our panel data set.

Table 3. Descriptive statistics

Variable	Description	No. of Observations	Mean	SD	Min	Max
date	The observation dates. Days when the CPI reports are released.	231	-	-	18 Nov 2002	9 Nov 2022
actual	The actual inflation rate published by the U.S. Bureau of Labor Statistics	231	2.40	1.87	-2.10	9.10
difference	The difference in the actual inflation rate from the previous monthly observation	225	0.02	0.48	-2.60	2.00
median_estimate	The median inflation estimates by economists published before each CPI report	231	2.40	1.84	-1.90	8.80
average_estimate	The average inflation estimates by economists published before each CPI report	231	2.39	1.83	-1.90	8.73
unexpected	The unexpected inflation based on the median estimate, calculated as actual - median_estimate	231	0.01	0.15	-0.40	0.60
avg_unexpected	The unexpected inflation based on the average estimate, calculated as actual - average_estimate	231	0.01	0.15	-0.45	0.59
sp500_return	The one-day return of the S&P 500 Index	231	0.03	1.25	-6.12	5.54
djusre_return	The one-day return of the Dow Jones U.S. Real Estate Index	231	0.11	2.11	-12.71	14.32
sp500_communcations	The one-day return of the S&P 500 Communications Index	231	-0.02	1.22	-5.81	6.32
sp500_consumer_disc	The one-day return of the S&P 500 Consumer Discretionary Index	231	0.04	1.46	-6.88	7.70
sp500_consumer_stap	The one-day return of the S&P 500 Consumer Staples Index	231	0.05	0.91	-4.89	4.37
sp500_energy	The one-day return of the S&P 500 Energy Index	231	-0.01	1.68	-5.68	7.80
sp500_financials	The one-day return of the S&P 500 Financials Index	231	-0.03	1.99	-11.56	11.25
sp500_healthcare	The one-day return of the S&P 500 Healthcare Index	231	0.08	1.07	-4.64	4.25
sp500_industrials	The one-day return of the S&P 500 Industrials Index	231	-0.02	1.37	-7.03	5.41
sp500_materials	The one-day return of the S&P 500 Materials Index	231	0.03	1.54	-7.44	6.06
sp500_technology	The one-day return of the S&P 500 Technology Index	231	0.06	1.51	-5.83	8.33
sp500_utilities	The one-day return of the S&P 500 Utilities Index	231	0.02	1.18	-5.10	4.76

5. Results

5.1. Benchmark model outcome – the benchmark impact of higher inflation

We calculate EBIT in both scenarios for our theoretical company. Cost of Goods Sold ("COGS"), Selling, General and Administrative ("SG&A"), and other expenses are estimated as percentages of net sales, fully reflecting the higher inflation rate.

Table 4. EBIT Forecast

	Scenario 1 2% inflation	Scenario 2 3% inflation	Estimation Comment
Net sales	158,718	160,274	
Cost of goods sold	-91,159	-92,053	57% of net sales
Gross profit	67,559	68,221	
SG&A + other expenses	-33,520	-33,849	21% of net sales
Depreciation of assets	-17,861	-17,861	11% of PPE (O.B.)
EBIT	**16,177**	**16,511**	
margin %	*10.19%*	*10.30%*	

We base the depreciation amount on previous years of the Chevron company, and assume the fixed assets to have a life length of nine years. We further assume all fixed assets to be depreciated using straight-line depreciation. Since we assume that the company is and has been in a steady state for the last nine years, the investments in Property, Plant, and Equipment ("PPE") have increased by 2% per year. Hence, we draw up a depreciation schedule to calculate the depreciation and PPE investment amounts in future years when inflation suddenly changes to 3%. See Appendix 3 for the complete depreciation schedule.

As evident in table 4, depreciation does not increase with inflation in Scenario 2. Since the depreciation amount is based on historical asset values that depreciate over nine years, the depreciation growth lags the new growth rate, even when new PPE investments grow by 3%.[15] Because depreciation lags inflation, the EBIT margin improves slightly compared to Scenario 1 since net sales have increased with inflation, while depreciation remains unchanged.

[15] The yearly depreciation growth gradually increases from 2% to 3% until all slower-growth assets have been replaced. Again, we refer to Appendix 3 for a better illustration of the mechanics.

Assuming the same tax rate as the Chevron Corporation's in 2021, we arrive at the gross cash flows presented in the table below.

Table 5. Gross cash flow

	Scenario 1 2% inflation	Scenario 2 3% inflation	Estimation Comment
EBIT	16,177	16,511	
Forecasted tax rate	27.5%	27.5%	Historical tax rate
NOPAT	11,728	11,970	
+ Depreciation	17,861	17,861	
Gross cash flow	**29,590**	**29,832**	
growth %		*0.82%*	

For calculating the free cash flow, we assume that the net working capital ("NWC") need is constant and the same as in previous years as a percentage of net sales. For this reason, NWC will grow with sales. As current assets and liabilities typically get replaced within a year, this assumption is equal to assuming that inflation entirely explains the growth of the current assets and the current liabilities between the two scenarios.[16]

We derive the PPE investment need from the depreciation schedule. In Scenario 2, the investment need is greater since we assume that investments are made at the end of the year and the first year of straight-line depreciation takes place in the year after the investment. Therefore, the higher inflation increases the investment need in Scenario 2.

Finally, the investments in intangibles also increase as the intangibles grow by 3% from the previous year instead of 2%.[17]

Table 6. Free Cash Flow

	Scenario 1 2% inflation	Scenario 2 3% inflation
Gross cash flow	29,590	29,832
Changes in NWC	-142	-213
Investments in PPE	-19,694	-19,888
Investments in intangibles	-88	-132
Free cash flow	**9,666**	**9,600**
growth %		*-0.68%*

Already in the first year with higher inflation, the free cash flows fall slightly, mainly due to increased investment needs.

[16] E.g., $Current\ assets\ Scenario\ 2 = Current\ assets\ Scenario\ 1\ /\ (1 + inflation\ rate\ Scenario\ 1) * (1 + inflation\ rate\ Scenario\ 2)$

[17] We further assume that intangibles are 100% Goodwill and are, therefore, not amortized. Otherwise, the amortization would be modeled like depreciation. Since the intangibles make up a minor portion of the balance sheet, not modeling amortization will have a minimal, if any, impact on the outcome.

However, as depreciation lags for the next nine years, the free cash flows will grow by less than 3% until finally reaching steady state growth starting from the 9th year. We illustrate this slower growth in table 7 below.

Table 7. Free cash flow development, scenario 2

Year	FCF	growth %
t+1	9,600	
t+2	9,845	2.55%
t+3	10,102	2.61%
t+4	10,372	2.67%
t+5	10,655	2.73%
t+6	10,952	2.79%
t+7	11,264	2.84%
t+8	11,590	2.90%
t+9	11,932	2.95%
(t+10)	12,290	3.00%

As the cash flows do not grow with the new steady state growth rate until year nine, we model these years separately and apply the Gordon growth model for all cash flows from year nine and forward. Finally, we arrive at the equity value for both scenarios.

Table 8. Equity value and share price

	Scenario 1 2% inflation	Scenario 2 3% inflation	Difference %	Estimation Comment
PV of Free Cash Flows	163,364	158,777	-2.81%	
Net Debt	-29,197	-29,197	-	End of Year, t
Value of Equity	134,167	129,580	-3.42%	
Price per share	167.71	161.98	-3.42%	(800 share units)[18]

As indicated in Table 8, in the above presented standard theoretical example, one percentage point increase in inflation from 2% to 3% in all future periods leads to a decrease in the equity valuation of -3.42%. Below we dissect the different parts driving this result by modifying the factors one by one and discussing which factors that influence the result.

As a start, let us observe the variables which influence the free cash flows. Depreciation is essential in the change in gross cash flow between the scenarios. Until the steady state in Year 9, the investments in PPE grow at a higher rate than the depreciation amount, creating a slightly greater net negative impact on the cash flows than in Scenario 1, where the investments and depreciation grow at the same rate in perpetuity. The difference is illustrated in Tables 9 and 10 below.

[18] For illustration purposes only.

Table 9. Scenario 1, net FCF impact of depreciation and PPE investment

Year	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10
Depreciation	17,861	18,218	18,583	18,954	19,334	19,720	20,115	20,517	20,927	21,346
growth %	-	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*
PPE investment	19,694	20,088	20,490	20,900	21,318	21,744	22,179	22,623	23,075	23,537
growth %	-	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*	*2.00%*
Net FCF impact	-1,833	-1,870	-1,907	-1,945	-1,984	-2,024	-2,065	-2,106	-2,148	-2,191
growth %		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%

Table 10. Scenario 2, net FCF impact of depreciation and PPE investment

Year	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10
Depreciation	17,861	18,240	18,648	19,088	19,559	20,064	20,604	21,181	21,795	22,448
growth %	-	*2.12%*	*2.24%*	*2.36%*	*2.47%*	*2.58%*	*2.69%*	*2.80%*	*2.90%*	*3.00%*
PPE investment	19,888	20,484	21,099	21,732	22,384	23,055	23,747	24,459	25,193	25,948
growth %	-	*3.00%*	*3.00%*	*3.00%*	*3.00%*	*3.00%*	*3.00%*	*3.00%*	*3.00%*	*3.00%*
Net FCF impact	-2,026	-2,244	-2,450	-2,644	-2,825	-2,991	-3,143	-3,279	-3,398	-3,500
growth %		10.76%	9.19%	7.90%	6.82%	5.89%	5.07%	4.33%	3.64%	3.00%

As can be seen in Tables 9 and 10, the negative impact on the free cash flows increases more rapidly than the perpetuity growth rate in Scenario 2, causing the free cash flows to grow at a lower rate than the perpetuity growth rate, as shown in Table 7. Hereafter, we refer to the above negative effect as the "depreciation effect."

Taxes impact the difference between the scenarios as the total depreciation amount remains unaffected by changes in the tax rate. A change in the tax rate impacts the difference between the scenarios in two ways. First, when taxes are higher, the depreciation effect described above will be greater relative to NOPAT, impacting the cash flows more negatively on a relative basis between the scenarios. Second, as the investments made in working capital, PPE, and intangibles increase with inflation and are not affected by taxes, the free cash flows are again impacted more negatively on a relative basis. The most significant driver is that higher taxes magnify the depreciation effect.

Table 11. Equity value change with a higher tax rate

	Scenario 1 2% inflation	Scenario 2 3% inflation	Growth %
Equity Value (27.5% tax rate)	134,167	129,580	-3.42%
Equity Value (40.0% tax rate)	100,619	94,567	-6.01%

Similar to the tax rate, the operating margin also plays a role. A lower margin will increase the depreciation effect for the same reason as the tax rate. When depreciation stays the same, a lower margin implies that depreciation is a greater part of NOPAT. Hence, the depreciation effect is more significant when the operating margin is lower.

Lastly, the working capital requirement instantly increases because of the higher inflation. Consequently, investors need to tie up more capital instantly to make up for this need. Table 12 shows this effect.

Table 12. Working capital investment need

Year	t+0	Scenario 1 t+1	Scenario 2 t+1
Working capital	7,093	7,235	7,306
Investment needed		142	213
Difference between Scenario 1 & 2			71
Growth in investment need			50%

The investment need increases immediately by 50%, creating a one-off negative impact on the cash flow in Scenario 2. In future periods, the working capital need grows with the perpetuity growth rate, not impacting the intrinsic value further.[19]

The initial result presented in Table 8 is, to a degree, also dependent on the firm's leverage ratio. For example, if the company were to be all-equity financed, the share price would decrease less in Scenario 2 compared to our assumption of a leverage ratio of 8.82%.

Table 13. Leverage ratio impact

Leverage ratio = Debt / (Equity + Debt)	Scenario 1 Equity Value	Scenario 2 Equity Value	Difference %
0.00% (All-equity financed)	167,317	162,159	-3.08%
8.82% (Our assumption)	134,167	129,580	-3.42%
10.00%	129,212	124,704	-3.49%
20.00%	81,140	77,322	-4.71%

All else equal, when the leverage increases, the negative impact of inflation increases. However, we do not account for the higher costs of debt associated with a higher leverage ratio in the table above. While the WACC grows slower between the scenarios due to a higher debt weighing and the tax shield associated with the debt, the increased net debt amount impacts the equity value more between the scenarios. That is, the increased net debt's negative effect exceeds the tax shield's positive effect. Since inflation does not impact the net debt amount between the scenarios, the debt will inherently be a larger portion of the enterprise value in Scenario 2 due to the lower equity value in Scenario 2.

Finally, it is noteworthy that the denominator in the Gordon Growth model, (WACC – g), grows more between the scenarios for firms with higher costs of equity. Thus, we can also conclude that firms with higher equity costs of capital will be worse affected by an increase in the inflation rate.

[19] As we assume that intangibles are not amortized, the dynamics of the intangibles mirror those of the working capital.

Using a benchmark model based on the income statement and balance sheet proportions of Chevron, a typical S&P500 company, we have shown that a one percentage point increase in the inflation rate from 2% to 3% in all future periods negatively impacts the share price by -3.42%. The negative effect is mainly attributable to fixed assets recognized at historical cost being depreciated over long periods using straight-line depreciation and increased working capital needs as inflation increases. Further, the equity value in companies with higher leverage ratios is more negatively affected by increases in inflation. We reach similar conclusions by repeating the exercise for the 3M Company and Waste Management. However, the share price effects are slightly smaller because depreciation and working capital play a less critical role in those firms. To conclude the section, assuming no real changes in interest rates or equity risk premiums, one percentage point higher inflation, even assuming that this is the case in all future periods, has a very marginal negative impact on the intrinsic valuation. Following our simple models, we estimate the negative effect on the share price to be somewhere between -3.0% and -4.0% for a typical S&P500 company.

A sensitivity analysis of the negative effect inflation has on the equity value considering different costs of capital is presented in Table 14 below.

Table 14. Sensitivity analysis of Cost of Equity and Cost of Debt, negative impact on equity value with one percentage point higher inflation

		Cost of Equity							
		6.0%	**7.0%**	**8.0%**	**8.5%**	**9.0%**	**10.0%**	**11.0%**	**12.0%**
Cost of Debt	**2.0%**	-2.99%	-3.18%	-3.34%	-3.41%	-3.48%	-3.61%	-3.74%	-3.88%
	2.6%	-3.00%	-3.19%	-3.35%	**-3.42%**	-3.49%	-3.62%	-3.75%	-3.88%
	3.0%	-3.01%	-3.20%	-3.35%	-3.42%	-3.49%	-3.62%	-3.75%	-3.89%
	4.0%	-3.02%	-3.21%	-3.36%	-3.43%	-3.50%	-3.63%	-3.76%	-3.89%
	5.0%	-3.04%	-3.22%	-3.37%	-3.44%	-3.51%	-3.64%	-3.77%	-3.90%
	6.0%	-3.05%	-3.23%	-3.38%	-3.45%	-3.52%	-3.65%	-3.78%	-3.91%
	7.0%	-3.06%	-3.24%	-3.39%	-3.46%	-3.53%	-3.66%	-3.79%	-3.92%
	8.0%	-3.08%	-3.25%	-3.40%	-3.47%	-3.54%	-3.67%	-3.80%	-3.93%

5.2. Regression results

Table 15 presents the results from our first specification, as described by equation (5).

Table 15. Stock market reactions to the actual inflation level and unexpected inflation

$$R_{jt} = \alpha_j + \beta_j \Delta_t + \gamma_j \left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right] + \varepsilon_{jt} \quad (5)$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
Δ_t is the actual inflation level as published by the Bureau of Labor Statistics at time t,
and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

Inflation, unexpected inflation, and daily returns are measured in percentage units.
(i.e., 1.000% = 1.000 in the table)

Independent variable, one-day returns	S&P 500	Dow Jones U.S. Real Estate	S&P 500 Communications	S&P 500 Consumer Disc.	S&P 500 Consumer Stap.	S&P 500 Energy	S&P 500 Financials	S&P 500 Health Care	S&P 500 Industrials	S&P 500 Materials	S&P 500 Technology	S&P 500 Utilities
Constant, α_j	.135 (.163)	.211 (.266)	.130 (.170)	.135 (.200)	.091 (.107)	-.087 [.197]	.131 [.218]	.244 (.118)	.027 [.150]	.071 [.168]	0.250 (.210)	.003 [.129]
β_j	-.043 (.077)	-.039 (.106)	-.063 (.083)	-.036 (.097)	-.015 (.046)	.031 [.078]	-.068 [.073]	-.066 (.051)	-.179 [.050]	-.014 [.056]	-0.076 (.103)	.009 [.043]
γ_j	-.360 (.893)	-.588 (1.730)	-.410 (.846)	-.541 (1.108)	-.191 (.531)	.582 [.870]	.135 [.892]	-.207 (.677)	-.544 [.613]	-.594 [.688]	-0.604 (1.039)	-.283 [.527]
R^2 [Adj. R^2]	.008	.004	.015	.007	.003	[-.004]	[-.005]	.016	[-.004]	[-.004]	.016	[-.008]
No. of Observations	231	231	231	231	231	231	231	231	231	231	231	231

Robust standard errors in parentheses () and normal standard errors in square brackets [].
*=p<0.05, **=p<0.01, ***=p<0.001

Table 16 presents the results from our second specification, as described by equation (6).

Table 16. Stock market reactions to the change in the inflation level and unexpected inflation

$$R_{jt} = \alpha_j + \beta_j[\Delta_t - \Delta_{t-1}] + \gamma_j\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right] + \varepsilon_{jt} \quad (6)$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
$[\Delta_t - \Delta_{t-1}]$ is the difference in the inflation rate between time t, and time t-1, one month earlier, and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

Change in inflation, unexpected inflation, and daily returns are measured in percentage units. (i.e., 1.000% = 1.000 in the table)

Independent variable, one-day returns	S&P500	Dow Jones U.S. Real Estate	S&P 500 Communications	S&P 500 Consumer Disc.	S&P 500 Consumer Stap.	S&P 500 Energy	S&P 500 Financials	S&P 500 Health Care	S&P 500 Industrials	S&P 500 Materials	S&P 500 Technology	S&P 500 Utilities
Constant, α_j	.043 (.085)	.127 (.154)	-.002 (.083)	.066 (.098)	.063 (.061)	-.004 [.113]	-.019 (.140)	.085 (.072)	-.014 [.092]	.042 (.106)	.094 [.101]	.041 (.080)
β_j	-.064 (.333)	-.326 (.808)	-.191 (.288)	-.061 (.373)	-.062 (.188)	-.009 [.282]	-.162 (.665)	-.083 (.273)	.010 [.231]	-.064 (.402)	-.053 [.251]	-.116 (.257)
γ_j	-.667 (.823)	-.509 (1.268)	-.565 (.788)	-1.053 (1.036)	-.249 (.568)	.822 [.917]	-.340 (1.220)	-.469 (.677)	-.776 [.749]	-.511 (1.000)	-1.209 [.815]	-.086 (.705)
R^2 [Adj. R^2]	.009	.009	.016	.014	.004	[-.004]	.003	.008	[-.002]	.004	[.008]	.003
No. of Observations	225	225	225	225	225	225	225	225	225	225	225	225

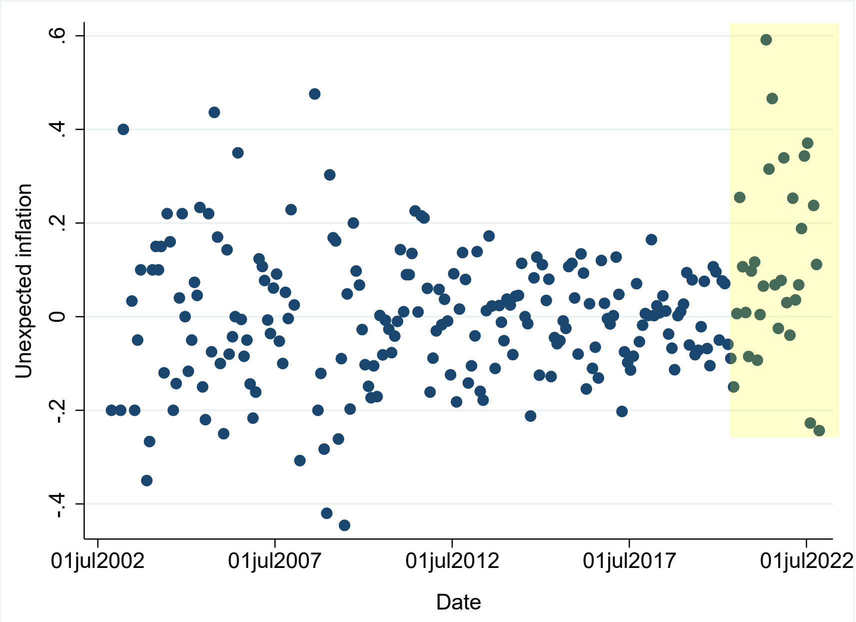
Robust standard errors in parentheses () and normal standard errors in square brackets [].
*=p<0.05, **=p<0.01, ***=p<0.001

Measured over the whole period 2002-2022, we find no significant coefficients in either of our specifications, suggesting that neither inflation nor unexpected inflation had any significant impact on stock prices on the days of CPI report releases. While this result differs slightly from Schwert (1981), who used a similar method and found a lagged and weak negative reaction to unexpected inflation, one should consider the role inflation has played in the economy in the last 20 years. Earlier studies in the research field have been done almost exclusively on periods with high and rising inflation. These two initial specifications do not only include the two recent high-inflation years but, for the most part, years with low and stable inflation.

Our benchmark model showed that inflation should impact stock valuations if inflation changes in all future periods. One could argue that unexpected inflation may contain new information about the expected inflation in future periods. Consequently, unexpected inflation may change the market's long-term inflation expectations. Therefore, with the finding from our benchmark model in mind, we would expect the stock market to react to unexpected inflation, as a change in the inflation rate in future periods has value implications for stocks. However, such an outcome is dependent on that the market views unexpected inflation as indicative of future expected inflation, leading to a change in the market's long-term inflation expectations. We argue that this may not necessarily be the case when inflation is low and stable, as the market might relate to unexpected inflation as "noise" during such low inflation periods. As a result, considering our findings in Tables 15 and 16, we theorize that the market has ignored unexpected inflation in the last 20 years due to the stable, low-inflation environment.

From 2002 to 2020, the average inflation rate was just below 2.0%, with a standard deviation of 1.2%. Both these numbers increased significantly in the last two years. From 2021 to 2022, the average inflation rate was 6.1%, with a standard deviation of 2.5%. It may not surprise anyone that we notice a change in the data regarding the inflation rate from 2021 and onwards. As our study focus is unexpected inflation, we instead investigate the unexpected inflation measure over the same period. In Chart 2 below, we plot all the unexpected inflation data points over time to examine whether we notice any changes.

Chart 2. Unexpected inflation observations over time



Studying Chart 2, an interesting pattern unfolds. After the financial crisis, the variation in the unexpected inflation measure drops significantly. This drop is likely due to the low inflation activity at the time. The variation and the measure of unexpected inflation stay low until 2021, when the variation increases dramatically.[20] Only this time, the variation seems skewed towards the measure's positive side. Comparing 2002-2009, when the variation in the unexpected inflation also was higher, with the post-2021 period, we note a positive skew in the mean in the post-2021 period only. This positive skew implies that inflation, on average, outpaced expectations in the last two years. We also confirm the suspicion that there is a shift in the data by finding statistically significant differences in the means and standard deviations when comparing the pre- and post-2021 periods. This shift motivates us to investigate the periods separately. Furthermore, observing the period 2021-2022 alone would constitute a similar setting to that of the 1980s when inflation had spiraled to 9%, and the inflation rate received more attention, much like in recent times.

As the inflation rate rose above the Federal Reserve target of 2% in early 2021, it gained more awareness from the general population. By observing data from Google trends for trending search engine words, we note that the keyword "Inflation" started trending rapidly upward at the beginning of 2021 and reached its highest point in August 2022, suggesting that inflation has become a critical topic. Further observing the keyword "Recession" in combination with "Inflation" paints an interesting picture. During the 2008 financial crisis, the keyword "Recession" trended upwards, while the trend for "Inflation" stayed flat, indicating that inflation was not an important topic at the time. In the post-2021 period, both keywords have topped the Google trends chart, which can be seen as anecdotal evidence that both of these themes are currently present in investors' minds.[21]

With the increased attention paid to inflation in unison with the significant shift in our data starting in 2021, we conclude that the post-2021 period constitutes a different market environment. Therefore, we theorize that the stock market may behave differently in such a setting. Moreover, as discussed above, the market might react differently post-2021 since market participants may have dismissed small peaks in inflation as "noise" previously when inflation was at normal levels. For example, suppose inflation is slightly above or below the 2% target. In that case, a slight change in the inflation rate may not affect market participants' long-term expectations regarding the inflation level in the economy. However, if inflation is high and receives more attention from market participants, they may act differently to CPI publications. Suppose the market expects a specific inflation rate before the subsequent CPI publication, and the reported inflation is higher than expected. In such a setting, the report may affect market participants' long-term expectations about inflation, leading to a valuation change, as shown by our benchmark model.

To test the theory that the stock market may react differently during the post-2021 period, we run the regressions as specified in equations (5) and (6), including only data points from 2021 and 2022. The results are presented below in Tables 17 and 18.

[20] For a closer look at the recent change in unexpected inflation, see Appendix 4.
[21] See Appendix 5 for a chart of the two keywords.

Table 17. Stock market reactions to the inflation level and unexpected inflation post-2021

$$R_{jt} = \alpha_j + \beta_j \Delta_t + \gamma_j \left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right] + \varepsilon_{jt} \tag{5}$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
Δ_t is the actual inflation level as published by the Bureau of Labor Statistics at time t,
and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

Inflation, unexpected inflation, and daily returns are measured in percentage units.
(i.e., 1.000% = 1.000 in the table)

Independent variable, one-day returns	S&P 500	Dow Jones U.S. Real Estate	S&P 500 Communications	S&P 500 Consumer Disc.	S&P 500 Consumer Stap.	S&P 500 Energy	S&P 500 Financials	S&P 500 Health Care	S&P 500 Industrials	S&P 500 Materials	S&P 500 Technology	S&P 500 Utilities
Constant, α_j	.940 [.922]	1.477 (.627)	1.224 [1.071]	.900 [1.207]	.551 [.640]	.855 [.931]	.704 [1.037]	.815 [.689]	.546 [.775]	.424 [.874]	1.268 [1.381]	1.380 [.779]
β_j	-.035 [.137]	-.065 (.117)	-.082 [.159]	.013 [.180]	-.021 [.095]	.012 [.139]	-.017 [.154]	-.084 [.103]	.005 [.115]	.096 [.130]	-.050 [.205]	-.058 [.116]
γ_j	-6.095** [1.676]	-7.127** (2.300)	-6.555** [1.947]	-8.320** [2.196]	-2.758* [1.164]	-4.221* [1.694]	-5.750** [1.886]	-2.885* [1.254]	-6.117*** [1.411]	-6.849*** [1.590]	-8.048** [2.513]	-4.977** [1.417]
R^2 [Adj. R^2]	[.340]	.470	[.306]	[.360]	[.144]	[.161]	[.250]	[.156]	[.433]	[.435]	[.276]	[.327]
No. of Observations	23	23	23	23	23	23	23	23	23	23	23	23

Robust standard errors in parentheses () and normal standard errors in square brackets [].
*=p<0.05, **=p<0.01, ***=p<0.001

Table 18. Stock market reactions to the change in inflation level and unexpected inflation post-2021

$$R_{jt} = \alpha_j + \beta_j[\Delta_t - \Delta_{t-1}] + \gamma_j\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right] + \varepsilon_{jt} \quad (6)$$

Where R_{jt} is the measured one-day return in the specific index j, at time t, when the monthly CPI report from the Bureau of Labor Statistics is released,
$[\Delta_t - \Delta_{t-1}]$ is the difference in the inflation rate between time t, and time t-1, one month earlier, and $\left[\Delta_t - E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)\right]$ is the unexpected inflation, calculated as the difference between the actual inflation, Δ_t, at time t, and the expected inflation, $E\left(\tilde{\Delta}_t \mid \phi_{t-x}\right)$, measured by economists' inflation forecasts at time t-x, immediately before time t, using their expertise, forecast models and other available information, denoted by ϕ_{t-x}.
The tilde denotes that $\tilde{\Delta}_t$ is a random variable.

Change in inflation, unexpected inflation, and daily returns are measured in percentage units. (i.e., 1.000% = 1.000 in the table)

Independent variable, one-day returns	S&P500	Dow Jones U.S. Real Estate	S&P 500 Communications	S&P 500 Consumer Disc.	S&P 500 Consumer Stap.	S&P 500 Energy	S&P 500 Financials	S&P 500 Health Care	S&P 500 Industrials	S&P 500 Materials	S&P 500 Technology	S&P 500 Utilities
Constant, α_j	.703 [.402]	1.074 (.587)	.707 [.471]	.902 [.515]	.394 [.277]	.885* [.403]	.614 [.454]	.269 [.302]	.569 [.340]	1.022* [.387]	.937 [.604]	1.024** [.343]
β_j	.391 [.901]	.150 (.920)	.265 [1.056]	1.181 [1.154]	.456 [.620]	.647 [.902]	-.225 [1.016]	.527 [.677]	.088 [.761]	-.289 [.866]	.459 [1.353]	.113 [.768]
γ_j	-6.735** [2.210]	-7.389** (2.356)	-7.007* [2.588]	-10.211** [2.831]	-3.496* [1.520]	-5.255* [2.212]	-5.395* [2.491]	-3.759* [1.661]	-6.256** [1.865]	-6.353** [2.124]	-8.801* [3.318]	-5.178* [1.884]
R^2 [Adj. R^2]	[.344]	.465	[.299]	[.391]	[.164]	[.181]	[.251]	[.153]	[.434]	[.423]	[.278]	[.320]
No. of Observations	23	23	23	23	23	23	23	23	23	23	23	23

Robust standard errors in parentheses () and normal standard errors in square brackets [].
*=p<0.05, **=p<0.01, ***=p<0.001

In Table 17, using the specification as in equation (5) when investigating the post-2021 period, we observe a strong significant negative relationship between unexpected inflation and the stock market index returns across all sectors on the CPI reporting days. While all indexes react negatively to unexpected inflation, the magnitudes vary across the sectors. Further, we find no significant relationships between the inflation level and the different index returns, meaning that the inflation level presented in the CPI report does not explain the variation in the index returns.

Across the indexes, we notice first and foremost, that our unexpected inflation measure is negatively related to the S&P 500 Index with a negative coefficient of -6.1, implying that 1.0% of unexpected inflation yields an average stock market reaction of -6.1%.

The real estate index has an even more negative unexpected inflation coefficient of -7.1, implying that 1% of unexpected inflation results in a negative reaction in the Dow Jones U.S. Real Estate Index of -7.1%. This result stands in direct contradiction to that of (Fama & Schwert, 1977), who found real estate to be a complete hedge against unexpected inflation. According to our results, real estate is the third worst unexpected inflation hedge across our sector indexes, performing only slightly better than Consumer Discretionary and Technology.

Consumer Discretionary has a coefficient of -8.3, the most negative across all indexes, while Consumer Staples has a coefficient of -2.8, the least negative across all indexes. The technology sector has a negative unexpected inflation coefficient of -8.0, the second most negative across all sectors. All other sectors have negative coefficients between -4.0 and -7.0, except for healthcare, which stands out with a less negative unexpected inflation coefficient of -2.9.

In Table 18, using equation (6) as the specification, we find no significant relationship between the monthly change in the inflation level and any of the index returns. The coefficients for unexpected inflation are still significant, as in Table 17, but we notice some minor differences in the value of the coefficients. Further, we note that three constants are positive and statistically significant; two at the 5% level and one at the 1% level. These significant positive constants weaken the result in their separate regressions since we would expect them to be undistinguishable from zero. The positive constants imply a standard positive response in these indexes, even when the unexpected inflation equals zero. Performing regression diagnostics on the regressions in Table 18, we find slight signs of multicollinearity. The correlation between the unexpected inflation and the monthly change in inflation is 0.65 for the post-2021 period, and the variance inflation factor ("VIF") is 1.75. We can derive one explanation for the high correlation between the change in the inflation rate and the unexpected inflation from the aggregate supply curve in the AS/AD framework.[22] When there are no inflation shocks, and the output is at potential, market participants may expect inflation in the coming period to be the same as in the previous period (Jones, 2017). Hence, the two variables in equation (6) contain similar information as illustrated in equation (7) below.

$$\Delta_t - \Delta_{t-1} \approx \Delta_t - E\left(\widetilde{\Delta}_t \mid \phi_{t-x}\right) \tag{7}$$

The expressions contain similar information since the market may often expect next month's inflation rate, $E\left(\widetilde{\Delta}_t \mid \phi_{t-x}\right)$*, to be the same as the inflation rate in the previous month,* Δ_{t-1}.

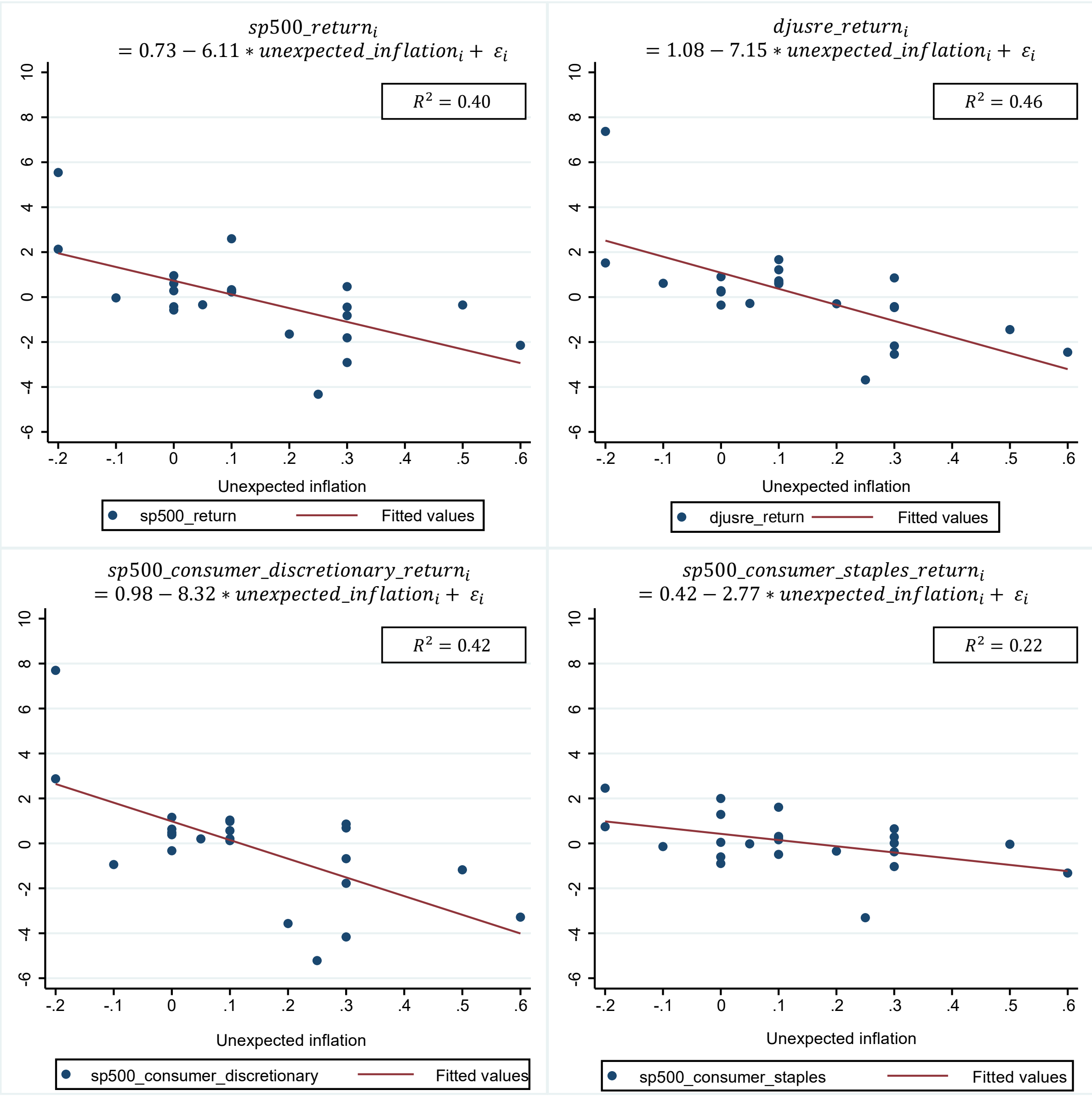
[22] Or more commonly known as the Phillips curve.

While the slightly heightened correlation between the two independent variables is not necessarily alarming, it is much higher than the regression diagnostics of the regressions in Table 17 using equation (6) as the specification. The correlation between the actual inflation rate and the unexpected inflation measure is 0.03 in the post-2021 period, and the VIF is 1.00. Hence, if one were to believe the coefficients and p-values in either of the two tables, there would be a clear preference for the results shown in Table 17.

Regarding the insignificant coefficients for the actual inflation and the change in the inflation level, no matter how we swap the specifications around, even when testing these variables univariately with the stock market indexes, neither of the two seems to explain the variation across the indexes. Therefore, we drop the variable from the model and observe the univariate results between unexpected inflation and the different stock market indexes. Doing so also solves the possible issue of multicollinearity in some regressions in Table 18, using equation (6) as the specification.

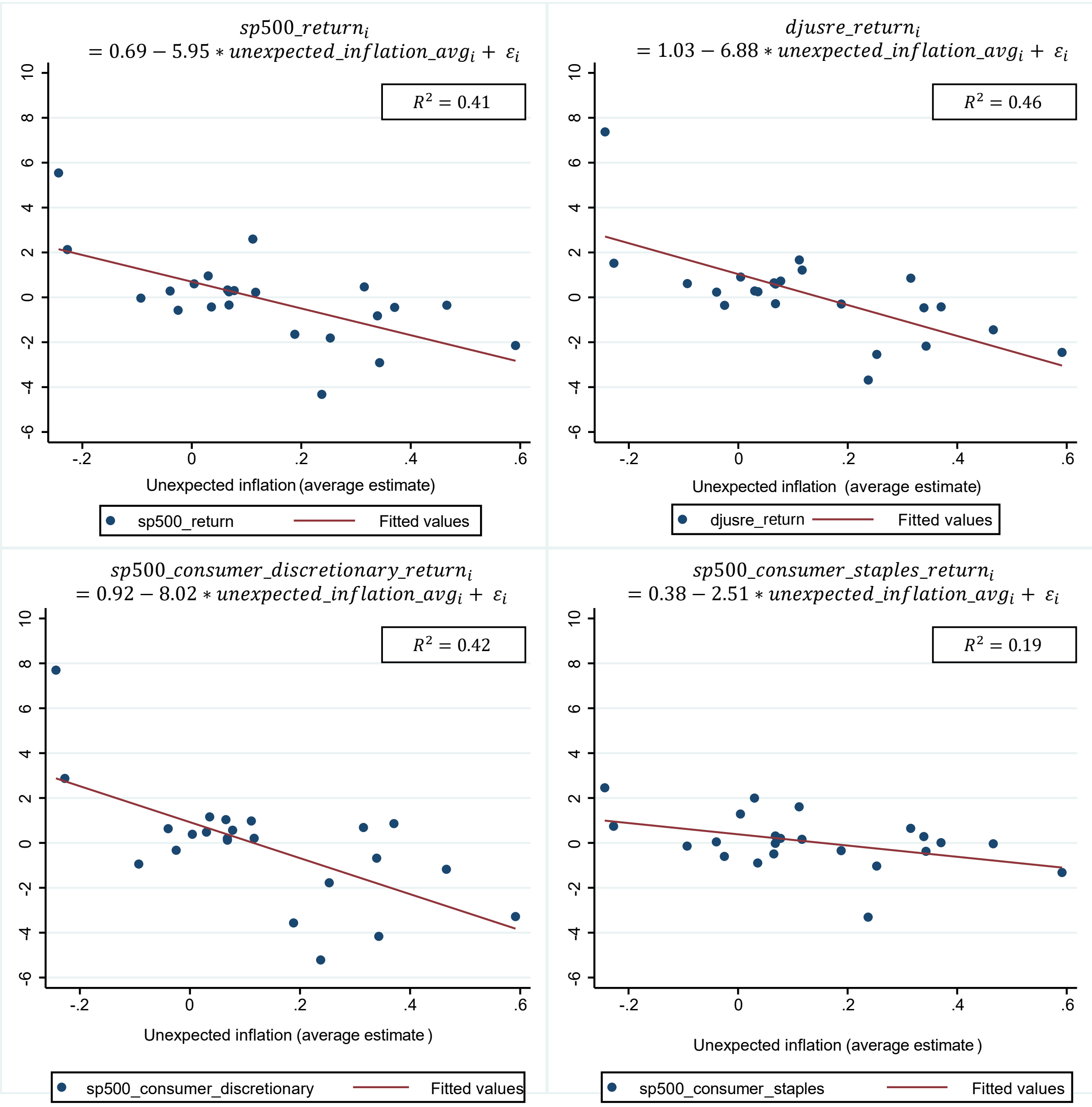
Chart 3 below plots the unexpected inflation against the S&P 500 Index, the Dow Jones U.S. Real Estate Index, the Consumer Discretionary Index, and the Consumer Staples Index. For plots of all other indexes, see Appendix 6.

Chart 3. Scatter plots of unexpected inflation and the S&P 500 Index, the Dow Jones U.S. Real Estate Index, the Consumer Discretionary Index, and the Consumer Staples Index



Using the monthly averages instead of median inflation estimates to measure unexpected inflation produces similar results. Chart 4 presents the results from the univariate regression using average inflation estimates.

Chart 4. Scatter plots of unexpected inflation (based on average estimates) and the S&P 500 Index, the Dow Jones U.S. Real Estate Index, the Consumer Discretionary Index, and the Consumer Staples Index



6. Discussion

6.1. Benchmark model outcome discussion

In our benchmark model, we concluded that an increase in the inflation rate in all future periods negatively impacts the equity value in a typical S&P 500 company between -3% and -4%. Nevertheless, this benchmark assumes no other changes in the economy or real interest rates, limiting our finding's use case for anything beyond a benchmark for the inflation effect on stocks.

Our model outcome aligns with the argument presented by Feldstein (1980) that the depreciation of historical asset prices causes the real effective tax rate to increase, as explained in the literature review. In the model, we show that inflation more negatively affects companies with higher tax rates. This is because when the increased profits due to the depreciation are taxed at a higher rate, they contribute, on a relative basis, more to a higher real effective tax rate when inflation is higher.

In addition to the depreciation effect, we also note that inflation increases the working capital requirement and forces the company to tie up more capital in the company immediately. This instantaneous one-off effect contributes to a lower cash flow in the first year when inflation increases and slightly lowers the valuation.

With our model, we prove using simple valuation techniques that higher inflation rationally can lead to lower equity values. We, therefore, note that the "Money Illusion" theory first presented by Modigliani and Cohn (1979) is not necessarily the reason for lower intrinsic equity valuations as inflation increases. We find it highly unlikely that the market, on average, would persistently make errors in simple valuation techniques because of increasing inflation and rather side with Bekaert and Engstrom (2010) who showed that the Money Illusion theory has limited explanatory power.

6.2. Regression results discussion

6.2.1. The unexpected inflation effect on common stocks

Considering our different regression outcomes when observing the pre- and post-2021 periods separately, we believe that the market has changed its interpretation of inflation figures. When inflation was low during the pre-2021 period, it seems that the market did not view unexpected inflation changes as material. Thus, this supports our developed theory that market participants might have viewed changes in inflation as “noise” during the pre-2021 period. Post-2021 data suggest that the market reacts to unexpected inflation, which is not what we observe when looking at pre-2021 data. Further, this change post-2021 cannot be explained by the inflation level or the change in the inflation level itself, as all coefficients for those variables prove to be insignificant in our regressions. We argue that the unexpected inflation measures post-2021 contain new information about long-term inflation expectations due to a different market environment. As inflation has spiraled upwards, the market has started paying attention to the inflationary risk again. We also anecdotally note this since “Inflation” as a keyword has been trending highly on the Google search term trend index, indicating that the keyword has increased in relevance. Because of the increased inflation risk, inflation has become a critical variable that the market monitors. Therefore, the market reacts to unexpected inflation since it changes its future inflation expectations. With the outcome of our benchmark model in mind, the higher expected inflation in future periods subsequently leads to declining valuations, which is what we observe in the post-2021 period.

However, the stock market reaction we capture in our regressions is more significant than that in our benchmark model. Below we discuss why this might be the case.

First, the change in future inflation expectations due to unexpected inflation varies over time, as we notice when comparing the pre- and post-2021 periods. Therefore, unexpected inflation's effect on future inflation expectations might be more significant during specific periods. While our measured unexpected inflation seems to change future long-term inflation expectations in the post-2021 period, the true magnitude of how much it does so is unobservable. Moreover, how strongly the market reacts to unexpected inflation may be subject to other unknown variables, such as market sentiment or additional anticipated macroeconomic variables or trends.

Second, we cannot observe how far into the future the market expects inflation to stay. Our benchmark model evaluates a 1% increase in inflation in all future periods. The market may anticipate a more significant increase in future inflation rates, but for a shorter time. These two effects are offsetting, complicating the interpretation of how our regression results compare to the benchmark model. For example, we cannot say that the market expects 2% higher inflation forever because we observe a twice as strong negative effect compared to the benchmark model. It could be equally true that the market expects a 5% higher inflation rate for a shorter time, affecting the valuation similarly.

Third, since our benchmark model ignores any real economic changes, the greater negative reaction we observe in our regressions might also be due to inflation signaling lower future real returns. That inflation could signal lower future real returns would resonate with some researchers before us who found negative relationships between real activities and inflation (Kaul, 1987; Day, 1984; Mcqueen & Roley, 1993). If one were to believe these studies, the observed value change on the CPI reporting days should reflect the aggregate of the lower intrinsic valuation observed in our benchmark model and any reactions due to lower expected real returns. Lastly, our model does not capture any increased risk premiums that unexpected inflation may cause. Nelson (1976) and Wei (2009) argued that unexpected inflation increases risk premiums, leading to a higher cost of capital and, subsequently, a more negative stock market reaction.

Comparing our results to previous research, we confirm the results of several previous studies made in developed economies, that stock prices are negatively related to inflation (Bodie, 1976; Bulent Gultekin et al., 1983; Fama, 1981; Fama & Schwert, 1977; Nelson, 1976). However, we do not come to the same conclusions as some studies made in high-inflationary countries, which find positive relationships between inflation and stock returns (Choudhry, 2001; Geetha et al., 2011; Kwofie & Ansah, 2018). Thus, our result further contributes to separating low-inflationary economies from economies with higher inflation rates. Therefore, one should observe the two different settings separately, and conclusions drawn in environments with constant high inflation may not apply to environments in normal market settings with low inflation levels. Therefore, we also argue that Amihud's (1996) dismissal of Feldstein's (1980) "depreciation effect," for which we find support in our benchmark model, may not be generalizable to all economies. Since Amihud (1996) conducted the study on the Israelian stock market, the results may not be generalizable to low-inflation economies, where other contributors to the stock market and inflation relationship may apply. While it might be true that the depreciation effect does not impact common stocks due to local tax rules in Israel, as Amihud (1996) suggests, the reasons for the negative relationship found in the Israelian market may not be the same in other markets. Hence, Amihud's (1996) conclusion that Feldstein's (1980) depreciation effect cannot explain the negative relationship between common stocks and inflation in Israel may not be relevant in low-inflationary economies like the U.S.

Also, comparing our study to Schwert's (1981), who used a similar method to observe stock market reactions to the information contained in CPI reports between 1953 and 1978, we come to a similar conclusion when observing our whole period 2002-2022. Although, Schwert (1981) found a weak and lagged negative stock market reaction to unexpected inflation. Observing the months Schwert (1981) studied, we note that about 40% had high levels of inflation. This percentage can be compared with our full study period, where about 8% of the months have high inflation levels. As discussed above, during periods of normal inflation, the information contained in CPI reports may not be material to the stock market. Therefore, the information in the CPI reports does not contribute to changing the market's future inflation expectations, even when unexpected inflation occurs. Considering the above, it is likely that Schwert (1981) would have found a much stronger stock market response to unexpected inflation if he had observed the high and low inflation periods separately.

Observing Chart 2 on page 29 can provide further proof that the market does not react to information contained in CPI reports during periods of low inflation. In Chart 2, which plots unexpected inflation over time, apart from the positive skew in 2021 and 2022, the values of the unexpected inflation data points in the post-2021 period are comparable to those in the 2002-2009 period. Hence, similar levels of unexpected inflation were present before but did not yield stock market responses. Instead, stock market reactions were only observed post-2021 when inflation increased. This supports our explanation that the market only reacts to unexpected inflation under certain market conditions, particularly when the inflation level is elevated.

6.2.2. Real estate as an inflation hedge

Concerning our finding that the Dow Jones U.S. Real Estate Index reacts negatively to unexpected inflation, this directly contradicts the commonly held belief that real estate is a good inflation hedge and the findings of Fama and Schwert (1977) and Huang and Hudson-Wilson (2007). Our benchmark model could partially explain why we see this effect. As shown by Damodaran (2022), U.S. real estate companies have substantially higher leverage than other firms. According to our model, higher-leveraged companies should react more negatively to increases in inflation if the depreciation and working capital effects persist. The depreciation effect in certain real estate companies may be more pronounced as buildings are depreciated over extended periods. In our model, we assumed nine years of straight-line depreciation. Most rental residential real estate in the U.S. is depreciated using the Modified Accelerated Cost Recovery System, which depreciates buildings and costs over 27.5 years (Internal Revenue Service, 2021). The longer asset life length further increases the negative depreciation effect, which harms investors and the company's real value. Additionally, real estate companies' balance sheets consist of more fixed assets than other companies, also making the depreciation effect more pronounced than in other firms.

An alternative theory we develop as to why we see a negative relationship between real estate and unexpected inflation is something we call the "Real Estate Inflation Hedge Illusion." As briefly mentioned in our historical background, when Fama and Schwert (1977) investigated if private residential real estate is a good inflation hedge, they did so at a time when inflation-adjusted real estate rents and values had been increasing for over 40 years. Without making any claims about whether this trend will continue, we note that the positive real estate trend may have impacted their measurement. Additionally, their method may have overlooked the interest rate risk that leverage introduces since they only observed property sales prices. Most real estate investors use debt to finance their investments because of the often considerable size of real estate investments. Since higher inflation may trigger central banks to increase interest rates (Kaul, 1987), the effect of such interest rate increases can be detrimental for highly leveraged investors. It may be the case that such increases in interest rates outweigh the returns from CPI-indexed rents. As a result, equity holders are substantially worse off.

Previous researchers have also found that publicly traded real estate investment trusts do not seem to hedge inflation (Yun Park & Muluneaux, 1990; Yobaccio et al., 1995; Gyourko & Linneman, 1998; Liu et al., 1997; Sing & Low, 2000). Our outcome confirms the studies above, but on a wider scope, as we observed the broader Dow Jones U.S. Real Estate Index, which includes several types of real estate. While we base the above reasoning on publicly traded real estate, a similar logic could be used for homebuyers who finance their homes primarily with floating-rate mortgages. If the negative effect of interest rate increases outweighs any value increases due to inflation, the above described effect may also apply to homebuyers. While the total property value may have increased due to inflation, the net effect on the homebuyer's stake in the property could still be negative. Thus, the homebuyer's wealth has decreased, even when it looks like the property was a good hedge against inflation when only looking at the sales price.

However, real estate investors who finance their investments with equity only do not experience an interest rate risk and may therefore not be hit by inflation in the same way. Additionally, the negative depreciation effect that we argue real estate companies suffer from does not apply to private individual homebuyers. Therefore, for individual homebuyers, residential real estate financed with cash only, may still offer an inflation hedge, as Fama and Schwert (1977) described.

More studies would be needed to investigate further the "Real Estate Inflation Hedge Illusion" and the impact of interest rate increases on real estate companies and individual homebuyers' wealth. One suggestion would be to investigate the unexpected inflation stock price reactions of listed real estate companies with low or no debt to and compare these with the reactions of real estate companies with higher debt ratios.

6.2.3. Other indexes – some remarks

Examining the unexpected inflation coefficients of Consumer Discretionary and Consumer Staples, we note an interesting but intuitive difference. Consumer Discretionary has an unexpected inflation coefficient of -8.3, the most negative across all indexes, while Consumer Staples has a coefficient of -2.8, the least negative across all indexes. Since rising inflation inevitably reduces some consumers' purchasing power (Oner, 2010), a shift in consumption from discretionary goods to staples is a logical consequence, as consumers need to reallocate their lower disposable real income. However, as Consumer Staples still react negatively, we cannot argue that such companies make effective inflation hedges, although they seem to provide better returns than companies in all other industries.

The Health Care index also sticks out with an unexpected inflation coefficient of -2.9, which is slightly more negative than Consumer Staples. The rationale behind this result could be similar to Consumer Staples. Health Care products are less price sensitive as consumers cannot substitute such goods, even when their purchasing power decreases. Instead, consumers will substitute other products, such as discretionary ones, for health care products. The same reasoning can be applied to any company with a higher pricing power. That the market reaction is still negative could likely be explained by a similar reasoning to the one we use above for common stocks.

Finally, the Technology index has an unexpected inflation coefficient of -8.1. The strong negative reaction seems to resonate with the common belief that inflation especially hurts growth stocks. As Kaul (1987) noted, unexpected inflation may lead to central bank responses, such as higher interest rates. As high-growth stocks like technology companies typically finance growth with debt, it becomes more expensive to expand operations, making investors worse off as growth projections decline.

6.3. Limitations

6.3.1. Benchmark model limitations

In our benchmark model we make some assumptions and simplifications:

- We assume that the company is in a steady state and only grows with inflation.
- We assume that all assets are straight-line depreciated over nine years.
- We simplify and assume no increased cost of debt as the leverage ratio increases.

There may be few companies for which these assumptions hold. However, we still believe that the benchmark provides some value. Our benchmark illustrates the approximate inflation effect on stocks using simple valuation techniques and that the intrinsic value effect is negative for a typical S&P 500 company – something the prior literature had left unanswered.

6.3.2. Stock market observations limitations

To problematize whether unexpected inflation contributed to the market changing its long-term expectations about inflation in 2021, it may not have been the case in the first couple of months when inflation started increasing. The Federal Reserve pushed a narrative in early 2021 that the inflation was "transitory", and not long-term (Tretina, 2022). This narrative could have impacted how the market viewed unexpected inflation at the time. On the 30th of November 2021 the Federal Reserve announced that the inflation was not transitory (Miller, 2021). However, it is likely that the market had already assumed this at an earlier point. Therefore, setting an exact cut-off point for the pre- and post-periods when the market theoretically should have started reacting to unexpected inflation is ambiguous, and impacts the magnitude of the reaction measurement. For example, when setting the cut-off point on the 30th of November, we observe a more negative market reaction to unexpected inflation. This ambiguity makes it impossible to declare that one percentage point of unexpected inflation will lead to a specific market reaction under some other market conditions. However, it is still possible to conclude the relative inflation effects across sectors and show that the effect is negative.

Further, we observed stock market responses to unexpected inflation using the general inflation level in the economy. Other inflation measures may better capture changes in the market's long-term inflation expectations. For example, studying the market response to unexpected core inflation could yield different results since core inflation excludes highly volatile prices such as food and energy. However, removing these prices from the measure would ignore the two major contributors to the current inflation.[23] Nevertheless, investigating core inflation could lead to a better understanding of the post-2021 period.

Finally, some other factor than what we have discussed may be the cause for the negative reaction we observe. With our finding, we do not rule out previous researchers' explanations for the negative stock market and inflation relationship.

[23] As explained in the "Historical background" section.

7. Conclusion

We have shown that the benchmark effect one can expect on the equity value when inflation increases by one percentage point in all future periods during normal inflation levels lies between -3% and -4% for a typical S&P 500 company. We further concluded that most of this negative effect stems from a "depreciation effect." The depreciation of old asset values artificially increases nominal profits and leads to a higher real effective tax rate, as (Feldstein, 1980) first argued. Higher taxes and lower operating margins contribute to increasing this depreciation effect. Additionally, we note that an increase in inflation immediately forces investors to tie up more capital in the firm as the working capital requirement increases, resulting in a one-off negative free cash flow impact. The leverage ratio and the cost of capital also play significant roles. Companies with higher leverage ratios and debt and equity costs of capital are more negatively affected by increases in the inflation rate.

Observing immediate stock market responses to the information contained in CPI reports published by the U.S. Bureau of Labor Statistics, we find no significant reaction to the inflation level, the monthly change in the inflation level, or unexpected inflation over the period 2002-2022. However, we notice a change in the unexpected inflation measure starting in 2021, hinting that the post-2021 period constitutes a different market environment. When observing the pre- and post-2021 periods separately, we find that unexpected inflation results in a significant negative reaction across all S&P 500 sectors on the days the U.S. Bureau of Labor Statistics releases its CPI reports. The reactions to unexpected inflation vary across the indexes. For the general stock market, the S&P 500 reacts by -6.1% for every percentage point of unexpected inflation. The most negative reaction we observe is in the S&P 500 Consumer Discretionary Index, which reacts by -8.3%, and the least negative is in the S&P 500 Consumer Staples Index, which reacts by -2.5% for every percentage point of unexpected inflation. In the post-2021 period, we also note that neither the inflation level nor the monthly change in the inflation level explains any market reactions across the different indexes. Since all sector indexes reacted negatively to unexpected inflation, we conclude that common stocks seem to be unsatisfactory inflation hedges.

Further, our results contradict the common belief that real estate assets are a hedge against unexpected inflation. We theorize that this result can be attributed to substantial leverage in real estate firms, which leads to an increased negative "depreciation effect," increasing the real effective tax rate. Additionally, the long-term increase in real estate values may have resulted in a "Real Estate Inflation Hedge Illusion" where real estate investors overlook interest rate risks and solely focus on the increasing sales price of properties. An extension of our study would be to investigate the interest rate risk versus property value appreciations in real estate companies and for private homebuyers. Also, studying the market reactions to unexpected core inflation could clarify which inflation measure captures changes in the market's long-term inflation expectations more effectively.

8. References

Amihud, Y. (1996). Unexpected Inflation and Stock Returns Revisited: Evidence from Israel. In *Source: Journal of Money, Credit and Banking* (Vol. 28, Issue 1). https://about.jstor.org/terms

Ang, A., Bekaert, G., & Wei, M. (2008). The term structure of real rates and expected inflation. *Journal of Finance*, *63*(2), 797–849. https://doi.org/10.1111/j.1540-6261.2008.01332.x

Anggraeni, D., & Irawan, T. (2018). *Causality Analysis of Producer Price Index (PPI) and Consumer Price Index (CPI) in Indonesia* (Vol. 7, Issue 1).

Bekaert, G., & Engstrom, E. (2010). Inflation and the stock market: Understanding the "Fed Model." *Journal of Monetary Economics*, *57*(3), 278–294. https://doi.org/10.1016/j.jmoneco.2010.02.004

Bernstein, J., & Tedeschi, E. (2021, April 12). *Pandemic Prices: Assessing Inflation in the Months and Years Ahead*.

Bodie, Z. (1976). Common Stocks as a Hedge Against Inflation. In *Source: The Journal of Finance* (Vol. 31, Issue 2).

Bulent Gultekin, N., Brennan, M. J., Santomero, A. M., & Stamhaugh, R. F. (1983). Stock Market Returns and Inflation: Evidence from Other Countries. In *THE JOURNAL OF FINANCE •: Vol. XXXVIII* (Issue 1).

Campbell, J. Y., & Shiller, R. J. (1988). Stock Prices, Earnings, and Expected Dividends. In *THE JOURNAL OF FINANCE* (Issue 3).

Choudhry, T. (2001). Inflation and rates of return on stocks: evidence from high inflation countries. In *Journal of International Financial Markets, Institutions and Money* (Vol. 11). www.elsevier.com/locate/econbase

Clark, T. E. (1995). *Do Producer Prices Lead Consumer Prices?*

Criddle, C., & Murphy, H. (2022, November 9). Meta cuts 11,000 staff in largest cull in company's history. *Financial Times*.

Damodaran, A. (2022). *Debt Fundamentals by Sector (US)*. Stern School of Business at New York University. https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/dbtfund.html

Day, T. E. (1984). Real Stock Returns and Inflation. In *Source: The Journal of Finance* (Vol. 39, Issue 2).

Fama, E. F. (1975). *Short-Term Interest Rates as Predictors of Inflation* (Vol. 65, Issue 3).

Fama, E. F. (1981). *Stock Returns, Real Activity, Inflation, and Money*.

Fama, E. F., & Schwert, G. W. (1977). ASSET RETURNS AND INFLATION. In *Journal of Financial Economics* (Vol. 5). North-Holland Publishmg Company.

Feldstein, M. (1980). *Inflation and the Stock Market*.

Fisher, I. (1930). The Theory of Interest. In *Macmillan, New York*.

Geetha, C., Mohidin, R., Chandran, V. V., & Chong, V. (2011). *THE RELATIONSHIP BETWEEN INFLATION AND STOCK MARKET: EVIDENCE FROM MALAYSIA, UNITED STATES AND CHINA*. www.managementjournals.org

Gyourko, J., & Linneman, P. (1998). *Owner-Occupied Homes, Income-Producing Properties, and REITs as Inflation Hedges: Empirical Findings*.

Hamilton, J. D. (1985). Uncovering Financial Market Expectations of Inflation. *Journal of Political Economy*.

Huang, H. ;, & Hudson-Wilson, S. (2007). Private Commercial Real Estate Equity Returns and Inflation. In *Journal of Portfolio Management* (Vol. 63).

Internal Revenue Service. (2021). *Publication 946 (2021), How To Depreciate Property*. Publication 946. https://www.irs.gov/publications/p946

Ivo da Rocha Lima Filho, R. (2019). Does PPI lead CPI IN Brazil? In *International Journal of Production Economics* (Vol. 214, pp. 73–79). Elsevier B.V. https://doi.org/10.1016/j.ijpe.2019.03.007

Jaffe, J. F., & Mandelker, G. (1976). The “Fisher Effect” for Risky Assets: An Empirical Investigation. In *Source: The Journal of Finance* (Vol. 31, Issue 2).

Jones, C. I. (2017). *Macroeconomics* (4th edition).

Kaul, G. (1987). The Role of the Monetary Sector. In *Journal of Financial Economics* (Vol. 18).

Kerr, J. (2022, November 11). US stocks record best day in over 2 years on cooler inflation data. *Financial Times*.

Kong, H., Ganesan, S., & Chiang, Y. H. (1998). The Inflation-Hedging Characteristics of Real and Financial Assets in Hong Kong. *The Journal of Real Estate Portfolio Management, 4*(1), 55–67. https://www.jstor.org/stable/24880710

Kwofie, C., & Ansah, R. K. (2018). A Study of the Effect of Inflation and Exchange Rate on Stock Market Returns in Ghana. *International Journal of Mathematics and Mathematical Sciences, 2018*. https://doi.org/10.1155/2018/7016792

Liu, C. H., Hartzell, D. J., & Hoesli, M. E. (1997). International Evidence On Real Estate Securities as an Inflation Hedge. *Real Estate Economics*.

Mcqueen, G., & Roley, V. V. (1993). Stock Prices, News, and Business Conditions. In *Source: The Review of Financial Studies* (Vol. 6, Issue 3). https://about.jstor.org/terms

Megaw, N., & Clarfelt, H. (2022, October 12). US stocks record best day in over 2 years on cooler inflation data. *Financial Times*. https://www.ft.com/content/0e8219d0-b50c-486a-8446-bc1000f6fabf

Miles, D. (1996). Property and inflation. *Journal of Property Finance*.

Miller, R. (2021, December 1). Jerome Powell Ditches ‘Transitory’ Tag, Paves Way for Rate Hike. *Bloomberg*. https://www.bloomberg.com/news/articles/2021-11-30/powell-ditches-transitory-inflation-tag-paves-way-for-rate-hike

Modigliani, F., & Cohn, R. A. (1979). Inflation, Rational Valuation and the Market. In *Analysts Journal* (Vol. 35, Issue 2).

Mundell, R. (1963). Inflation and Real Interest. In *Source: Journal of Political Economy* (Vol. 71, Issue 3). https://www.jstor.org/stable/1828985

Nelson, C. R. (1976). Inflation and Rates of Return on Common Stocks. In *Source: The Journal of Finance* (Vol. 31, Issue 2).

Oner, C. (2010). What is inflation? *International Monetary Fund*. https://www.elibrary.imf.org/view/journals/022/0047/001/article-A017-en.xml

Pennacchi, G. G. (1991). Identifying the Dynamics of Real Interest Rates and Inflation: Evidence Using Survey Data. In *Source: The Review of Financial Studies* (Vol. 4, Issue 1).

Romei, V. (2022, November 27). Global inflation likely to have peaked, key data indicators suggest. *Financial Times*.

Rose, A. K. (1988). Is the Real Interest Rate Stable? In *THE JOURNAL OF FINANCE •: Vol. XLIII* (Issue 6).

Santacreu, A. M., & LaBelle, J. (2022). Supply Chain Disruptions and Inflation During COVID-19. *Economic Synopses*, *2022*(11). https://doi.org/10.20955/es.2022.11

Schwert, G. W. (1981). The Adjustment of Stock Prices to Information About Inflation. In *THE JOURNAL OF FINANCE •: Vol. XXXVI* (Issue 1).

Sidaoui, J. ;, Capistrán, C. ;, Chiquiar, D. ;, & Ramos-Francia, M. (2009). *A note on the predictive content of PPI over CPI inflation: The case of Mexico*. http://hdl.handle.net/10419/83711

Sing, T.-F., & Low, S.-H. Y. (2000). The Inflation-Hedging Characteristics of Real Estate and Financial Assets in Singapore. In *Source: The Journal of Real Estate Portfolio Management* (Vol. 6, Issue 4).

Stulz, R. M. (1986). *Asset Pricing and Expected Inflation*.

Totonchi, J. (2011). *Macroeconomic Theories of Inflation*.

Tretina, K. (2022). Transitory Inflation: A Short History. *Forbes*. https://www.forbes.com/advisor/investing/transitory-inflation/

United States Census Bureau. (2000). *Historical Census of Housing Tables*. https://www2.census.gov/programs-surveys/decennial/tables/time-series/census-housing-tables/grossrents.pdf

U.S. Energy Information Administration. (2022). *SHORT-TERM ENERGY OUTLOOK*. https://www.eia.gov/outlooks/steo/report/electricity.php

Vedantam, K. (2022, December 2). Tech Layoffs In 2022: The U.S. Companies That Have Cut Jobs. *Crunchbase News*. https://news.crunchbase.com/startups/tech-layoffs-2022/

Wei, C. (2009). Does the stock market react to unexpected inflation differently across the business cycle? *Applied Financial Economics*, *19*(24), 1947–1959. https://doi.org/10.1080/09603100903282622

Yobaccio, E., Rubens, J. H., & Ketcham, D. C. (1995). The Inflation-Hedging Properties of Risk Assets: The Case of REITs. In *Source: The Journal of Real Estate Research* (Vol. 10, Issue 3).

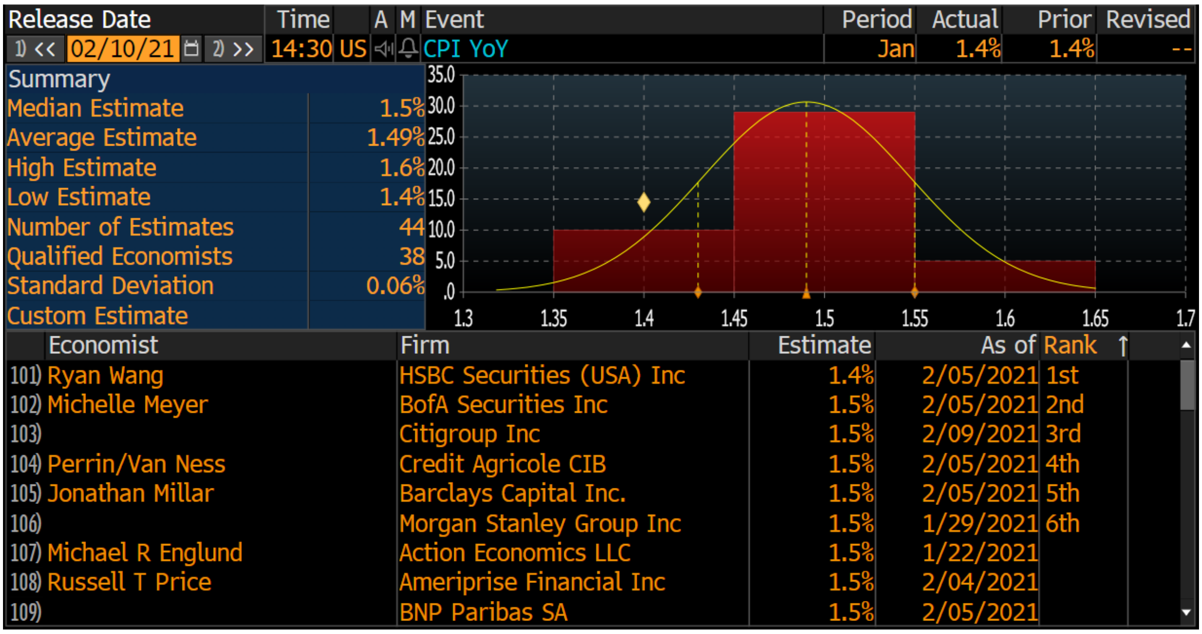
Yun Park, J., & Muluneaux, D. J. (1990). Are REITs Inflation Hedges? In *The Journal of Real Estate Finance and Exonomics* (Vol. 3).

9. Appendix

Appendix 1. Inflation estimates t-x distribution

Days before inflation report release	Frequency	Cumulative %
1	535	7.41%
2	436	13.44%
3	335	18.08%
4	1,095	33.24%
5	1,465	53.52%
6	1,294	71.43%
7	1,143	87.25%
8	343	92.00%
9	118	93.63%
10	56	94.41%
11	72	95.40%
12	87	96.61%
13	89	97.84%
14	67	98.77%
15	15	98.98%
16	10	99.11%
17	1	99.13%
18	6	99.21%
19	22	99.52%
20	9	99.64%
21	6	99.72%
22	1	99.74%
23	4	99.79%
25	1	99.81%
26	9	99.93%
27	1	99.94%
28	3	99.99%
30	1	100.00%
Total	**7,224**	

Appendix 2. Bloomberg historical inflation estimate example



As can be seen in the picture, estimates are made in steps of 10-basis points. The reported inflation figure is also rounded to the nearest 10 basis points.

Appendix 3. Depreciation schedule

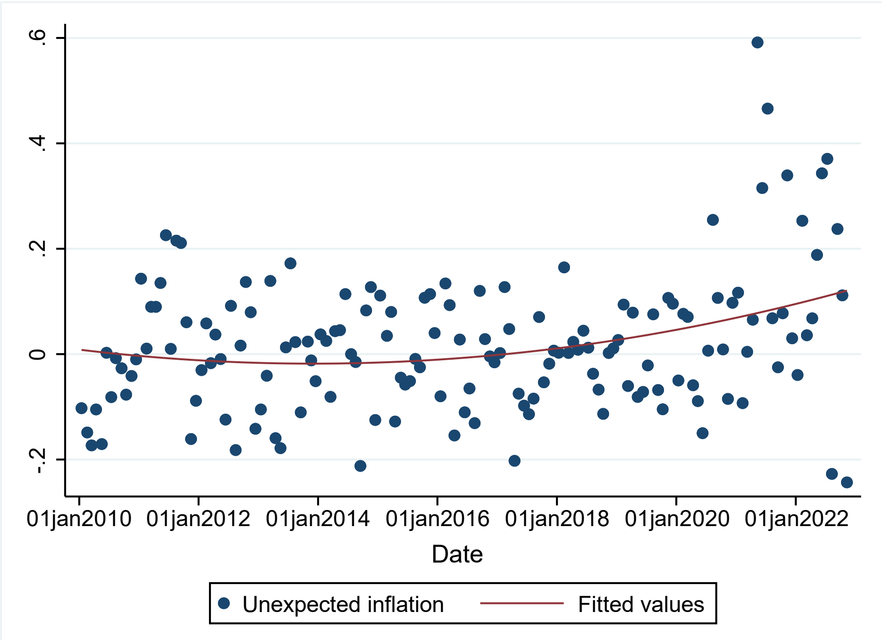
Inflation		2%	2%	2%	2%	2%	2%	2%	2%	2%	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**	**3%**		
Year		t-8	t-7	t-6	t-5	t-4	t-3	t-2	t-1	t	**t+1**	**t+2**	**t+3**	**t+4**	**t+5**	**t+6**	**t+7**	**t+8**	**t+9**	**t+10**	
PPE Investment		16479	16809	17145	17488	17838	18195	18559	18930	19308	**19888**	**20484**	**21099**	**21732**	**22384**	**23055**	**23747**	**24459**	**25193**	**25949**	
growth (inflation) %			*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	
Depreciation year																					
t-7			1831				Not enough historical data														
t-6			1831	1868			to calculate depreciation														
t-5			1831	1868	1905																
t-4			1831	1868	1905	1943															
t-3			1831	1868	1905	1943	1982														
t-2			1831	1868	1905	1943	1982	2022													
t-1			1831	1868	1905	1943	1982	2022	2062												
t	**Depreciation**		1831	1868	1905	1943	1982	2022	2062	2103		*n = 9*									Depreciation growth
t+1	**17861**	=	1831	1868	1905	1943	1982	2022	2062	2103	2145										**2.00%**
t+2	18240	=		1868	1905	1943	1982	2022	2062	2103	2145	2210									2.12%
t+3	18648	=			1905	1943	1982	2022	2062	2103	2145	2210	2276								2.24%
t+4	19088	=				1943	1982	2022	2062	2103	2145	2210	2276	2344							2.36%
t+5	19559	=					1982	2022	2062	2103	2145	2210	2276	2344	2415						2.47%
t+6	20064	=						2022	2062	2103	2145	2210	2276	2344	2415	2487					2.58%
t+7	20604	=							2062	2103	2145	2210	2276	2344	2415	2487	2562				2.69%
t+8	21181	=								2103	2145	2210	2276	2344	2415	2487	2562	2639			2.80%
t+9	**21795**	=									**2145**	**2210**	**2276**	**2344**	**2415**	**2487**	**2562**	**2639**	**2718**		**2.90%**
t+10	22449	=										2210	2276	2344	2415	2487	2562	2639	2718	2799	3.00%

Year t+10, all assets have been replaced by higher growth

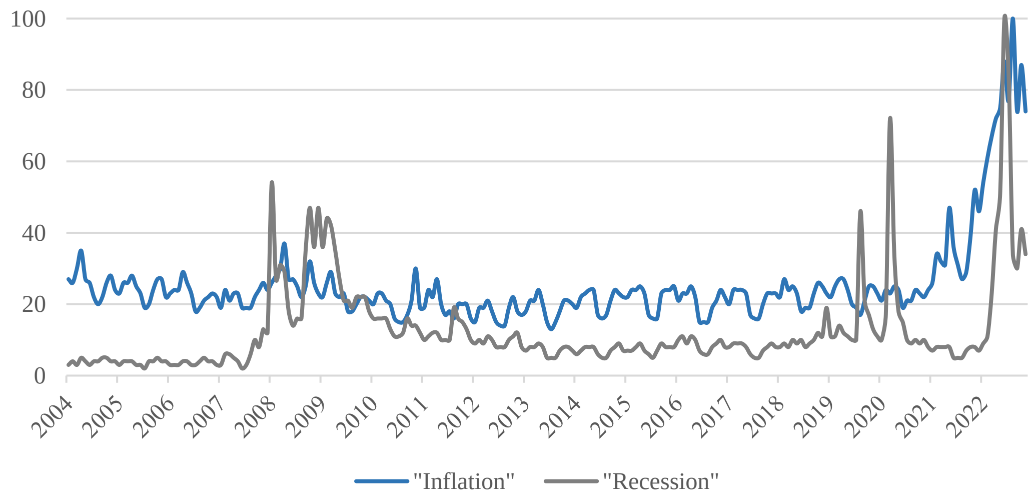
Since we assume that the company has been in a steady state for nine years, the PPE investment amount has grown with the inflation rate by 2% yearly. When inflation increases in year t+1, the PPE investment grows immediately by 3%. However, since assets are straight-line depreciated, the depreciation reflects previous asset values. It, therefore, grows at a slower rate than 3% until year t+10, when higher growth investments have replaced all assets.

Appendix 4. Unexpected inflation 2010-2022, polynomial time regression

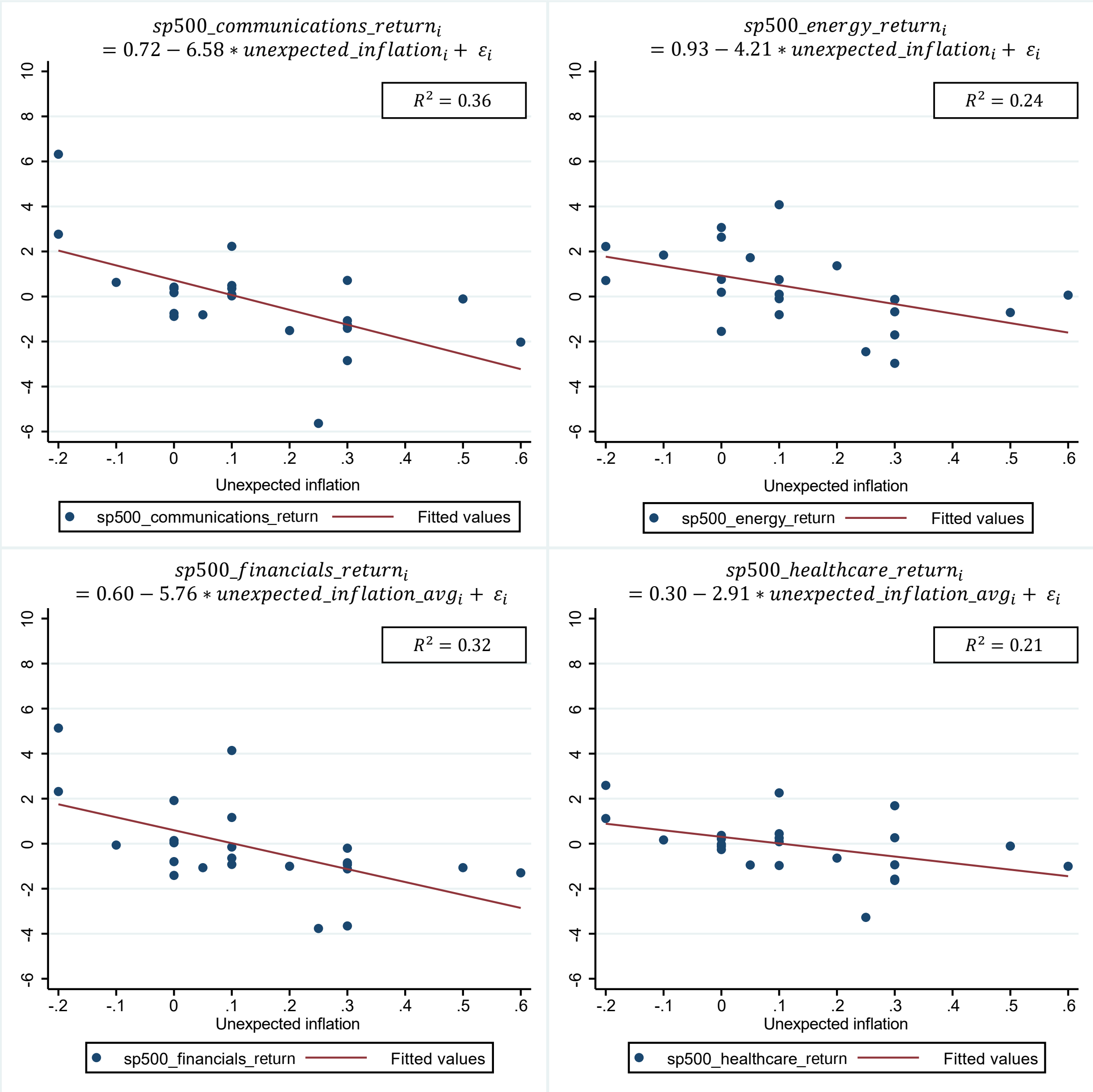
This graph shows the variation in the unexpected inflation measure from 2010 to 2022. A quadratic fitted line illustrates the positive skew in the mean starting in 2021.



Appendix 5. Google search term trend index “Inflation” & “Recession”



Appendix 6. Scatter plots of unexpected inflation and the S&P 500 Communications Index, the S&P 500 Energy Index, the S&P 500 Financials Index and the S&P 500 Healthcare Index



Appendix 6 (cont'd). Scatter plots of unexpected inflation and the S&P 500 Industrials Index, the S&P 500 Materials Index, the S&P 500 Technology Index and the S&P 500 Utilities Index