The Best Strategies for Inflationary Times

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ABSTRACT

Over the past three decades, a sustained surge in inflation has been absent in developed markets. As a result, investors face the challenge of having limited experience and no recent data to guide the repositioning of their portfolios in the face of heighted inflation risk. We provide some insight by analyzing both passive and active strategies across a variety of asset classes for the U.S., U.K., and Japan over the past 95 years. Unexpected inflation is bad news for traditional assets, such as bonds and equities, with local inflation having the greatest effect. Commodities have positive returns during inflation surges but there is considerable variation within the commodity complex. Among the dynamic strategies, we find that trend-following provides the most reliable protection during important inflation shocks. Active equity factor strategies also provide some degree of hedging ability. We also provide analysis of alternative asset classes such as fine art and discuss the economic rationale for including cryptocurrencies as part of a strategy to protect against inflation.

Keywords: *Inflation hedge, inflation surprises, inflation shocks, portfolio management, asset allocation, risk management, commodities, gold, factor investing, bitcoin, cryptocurrency.*

JEL codes: *G11, G13, G15, G01, E31, E44.*

Introduction

Inflation has not been a serious and persistent economic problem in developed markets for decades. Both monetary and fiscal policy have contributed to economic circumstances that are disinflationary, resulting in lower and less volatile inflation (Exhibit 1). Today, those fearful of an inflation resurgence point to three factors that suggest the risk has increased.

Exhibit 1: US year-over-year CPI overlaid with inflationary regimes

The percentage increase in the US headline Consumer Price Index (CPI) basket over the trailing 12-month period. The pink shaded areas demarcate our quantitatively defined inflationary regimes, which are described in more detail later on. The red rectangles at the bottom of the chart are periods when the US economy was in recession, as defined by the National Bureau of Economic Research (NBER). The data are monthly, from 1926 to April 2021. See Appendix A for more details.
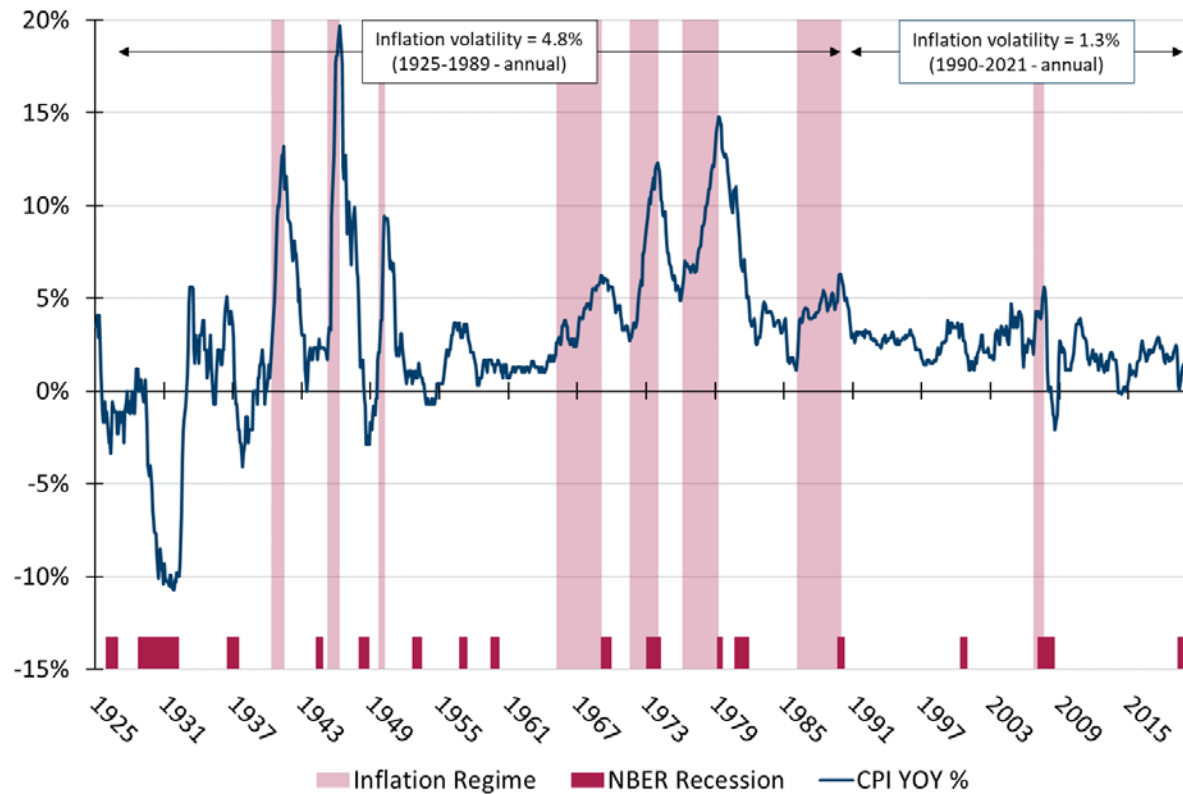
First, there has been an unprecedented increase in money creation. The US money supply (M2) has grown by $4.2 trillion, from $15.5 trillion to $19.7 trillion in one year (between February 2020 and February 2021). Second, there has been extraordinary fiscal accommodation. The Congressional Budget Office (CBO) estimates a US fiscal deficit of $3.1 trillion in 2020, or 15% of GDP. The CBO forecasts the deficit will shrink to $2.3 trillion in 2021, or 10% of GDP. In the entire modern history of the United States, there have only been two instances of consecutive double-digit deficit years.[2] Third, the bond market is signaling increased inflation as long-term yields have recently increased.

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[2] These periods occurred during World War 1 and World War 2. In 1918 and 1919, the deficit was 12% and 17%, respectively. In the 1942-45 period, the annual deficit was 12%, 27%, 21%, and 21%.

Rather than predicting when (or if) inflation will increase to disruptive levels, this paper seeks to answer a simpler question: what passive and dynamic investments have historically tended to do well (or poorly) in environments of high and rising inflation? The answer to this question may help investors reposition their portfolios so that they are better prepared should the current fears prove justified.

We define inflationary regimes as the times when headline, year-over-year (YoY) inflation is accelerating, and when the level moves to 5% or more. We detail the complete formulation of the regime classification later. Based on this definition, we identify the eight US inflationary regimes shaded pink in Exhibit 1. We argue that episodes of high and rising inflation rates are mostly due to unexpected inflation, and assets may reprice materially during such regimes. To assemble a critical mass of evidence, we use data from 1926, across three continents.

In Exhibit 2, we summarize our main findings for the US. We rank the various passive and dynamic strategies by the annualized average real returns during the eight inflationary regimes (the pink shaded zones in Exhibit 1). Weak returns are observed for nominal bonds. This is not surprising because rising inflation is typically associated with rising yields, and thus declining bond prices. Perhaps more notable is that equities also perform poorly, compounding the challenge of the 60-40 equity-bond investor. The best historical performance is observed for commodities. In fact, commodities show much higher real returns during rising inflation environments than at other times.

We start our empirical examination by detailing the economic mechanisms that link unexpected inflation to asset returns. Next, we set out to define what we mean by inflationary periods, identifying 34 episodes from 1926 across the US, UK and Japan.

We show that neither equities nor bonds perform well in real terms during inflationary regimes. Equities may be expected to deliver some inflation protection, as a firm's debt obligations are inflated away, and product prices may be adjusted to inflation. In reality, equities suffer from the less stable economic climate, and costs tend to rise with inflation more than output prices. Moreover, we find that no individual equity sector offers significant protection against high and rising inflation; even the energy sector is only slightly better than flat in real terms. Nominal bonds do not deliver inflation protection, as expected, and performance deteriorates as duration lengthens. Real returns to credit are also negative. Treasury Inflation-Protected Securities (TIPS) are robust when inflation rises, giving them the benefit of generating similar real returns in inflationary and non-inflationary regimes, both of which are positive.

Exhibit 2: Summary performance in US inflationary regimes

The real total returns of assets analyzed in the paper, through the eight US inflationary regimes shown in Exhibit 1 as well as the annualized return during inflationary, non-inflationary, and all periods. In the first column, the strategy is denoted as active or passive by '(A)' or '(P)', respectively Returns for energies and gold in grey italics are spot returns where we do not have futures data. These are not included in the combined regime calculation. The data vary by start date. Further details are provided in the body of this paper as well as in Appendix A.

	Specific inflation regimes								Combined regimes		
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007			
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008			
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%			
Length (mths)	14	13	7	48	30	38	46	11			
Strategy				Real return (total)						Real return (ann.)	
(P) Commodities - Energies	*-3%*	*2%*	*-6%*	*-16%*	*264%*	*57%*	201%	68%	41%	-1%	3%
(A) Trend – All assets	20%	23%	19%	135%	196%	100%	65%	17%	25%	15%	16%
(A) Trend – Commodities			1%	54%	173%	33%	132%	25%	20%	8%	10%
(P) Commodities – Industrial				115%	38%	-6%	306%	3%	19%	4%	7%
(A) Trend – Bonds				79%	54%	149%	6%	6%	15%	9%	10%
(P) Commodities – Aggregate		12%	6%	26%	85%	38%	84%	21%	14%	1%	4%
(P) Commodities – Gold					*166%*	154%	-18%	27%	13%	-1%	1%
(P) Commodities – Precious				28%	29%	185%	-27%	33%	11%	-2%	1%
(A) Trend – Equity	20%	23%	24%	77%	23%	-13%	13%	-3%	8%	11%	10%
(P) Commodities – Softs				-41%	243%	15%	11%	15%	8%	-3%	-1%
(A) Equity Factor – Cross-sectional Mom.	-15%	-18%	7%	35%	38%	44%	41%	26%	8%	4%	5%
(P) Commodities – Agri		12%	6%	-23%	197%	-21%	6%	33%	7%	-3%	0%
(A) Trend – FX				-14%	16%	42%	6%		4%	4%	4%
(A) Equity Factor – Quality (QMJ)				14%	-1%	-12%	40%	7%	3%	3%	3%
(P) Fixed Income – TIPS				-3%	13%	-2%	11%	6%	2%	3%	3%
(A) Equity Factor – Investment (CMA)				-7%	31%	-9%	24%	-10%	2%	2%	2%
(P) Long Equities – Energy Sector	-14%	-10%	25%	-19%	-19%	31%	31%	2%	1%	8%	6%
(A) Equity Factor – Profitability (RMW)				4%	-24%	-8%	18%	6%	-1%	2%	2%
(A) Equity Factor – Value (HML)	-4%	-17%	3%	-8%	36%	-11%	-3%	-7%	-1%	2%	2%
(P) Real Estate – Residential	-17%	4%	-4%	-2%	-7%	11%	0%	-13%	-2%	2%	1%
(A) Equity Factor – Low Vol (BAB)	-24%	-6%	-3%	28%	-13%	9%	-7%	-22%	-3%	8%	6%
(P) Fixed Income – 2 Yr. Treasury	-13%	-17%	-6%	-1%	-7%	-17%	11%	0%	-3%	2%	1%
(A) Equity Factor – Size (SMB)	-11%	-23%	-4%	45%	-43%	32%	-26%	-4%	-4%	1%	0%
(P) Fixed Income – 10 Yr. Treasury	-11%	-17%	-6%	-13%	-12%	-31%	8%	5%	-5%	4%	2%
(P) Fixed Income – High Yield	-4%	-11%	0%	-18%	-21%	-38%	-10%	-8%	-7%	6%	4%
(P) Long Equities – Market Composite	-24%	-27%	24%	-7%	-46%	-14%	12%	-17%	-7%	10%	7%
(P) Fixed Income – Investment Grade	-7%	-12%	-3%	-23%	-20%	-43%	-5%	1%	-7%	6%	3%
(P) Fixed Income – 30 Yr. Treasury	-17%	-17%	-6%	-20%	-28%	-41%	13%	2%	-8%	5%	3%
(P) Long Equities – Consumer Durables	-16%	-32%	24%	-30%	-62%	-27%	-28%	-36%	-15%	13%	7%

We find that traded commodities have historically performed best during high and rising inflation. In aggregate, they have a perfect track record of generating positive real returns during our eight US regimes, averaging an annualized +14% real return. This contrasts with normal periods when the commodity aggregate returns low single digits. We also evaluate residential real estate and find that while on average it holds its value during inflationary times (real returns are negative but not of significant magnitude) it lags commodities significantly. Collectibles such as art, wine and stamps are also examined later. We find strong real returns during inflationary periods (although still weaker than commodities), but clearly the extent to which these can form a sizeable part of institutional mandates is very limited given liquidity constraints. We also discuss the case for investing in cryptocurrencies like bitcoin as an inflation hedge.

We also analyze a number of dynamic strategies. We find that cross-sectional stock momentum is the best equity factor during our inflationary regimes, realizing an 8% annual real return, versus 4% in normal times. However, as we will argue later, the difference is not statistically significant for this volatile, high-turnover strategy. That said, active equity factors generally hold their own during inflation surges with quality having a small positive real return and value having a small negative return. We also follow the method of Hamill, Rattray, and Van Hemert (2016) and

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Harvey, Rattray, and Van Hemert (2021) and construct a time-series momentum (trend) strategy applied to liquid futures and forwards across assets. This trend strategy performs well during inflationary regimes with bond and commodity trend doing particularly well. This lines up with our intuition that inflation "shocks" do not tend to be overnight affairs, but rather prolonged episodes that play to the strength of trend strategies.

While trend strategies tend to outperform equity factor strategies in high and rising inflationary regimes, we are cognizant that the former have more limited capacity than the latter, a key consideration for many institutional investors. In this context, the modest protection provided by quality, for example, which averages 3% in inflationary times may still be useful, especially in comparison with the sharp losses experienced in long-only financial assets.

Why does inflation matter for asset prices?

Economic mechanism

There is a deep academic literature that focuses on the economic mechanisms that link unexpected inflation to asset prices.[3] It is essential to distinguish temporary and permanent (or longer lasting) inflation shocks. Asset prices such as equities and bonds are long-lived and are most sensitive to changes in perceptions about longer-term inflation. For example, a month-long disruption of a gas pipeline might cause gasoline prices (and inflation) to temporarily surge. The impact on asset prices would be minimal because market participants expect prices to return to normal in the next month. This example highlights two key challenges in conducting research linking inflation shocks to asset prices: the separation of permanent and temporary shocks and identifying the most relevant inflation horizon.

Treasury bond prices are obviously impacted by unexpected inflation. Their current prices reflect an expected real interest rate, an expected rate of inflation, and a risk premium. If there is an unexpected surge in inflation, the expected inflation embedded in the yield increases and the bond price usually falls. If the new level of expected inflation is permanent, bonds with higher durations will be more sensitive than those with shorter durations. Indeed, with bonds we exactly know the inflation horizon that is relevant given the fixed bond maturity. A change in the uncertainty about inflation rates may also impact the risk premium.

Equities are more complicated, and there are a number of ways through which increased inflation can impact equity prices.

First, higher and more volatile inflation creates more economic uncertainty, thus harming the ability of companies to plan, invest, grow, and engage in longer-term contracts. Moreover, while firms with market power can increase their output prices to mitigate the impact of an inflation

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[3] For example, early attempts to study the impact of unexpected inflation on asset returns include: Fama and Schwert (1977), Fama (1981), Gultekin (1983), Lee (1992), Kaul (1980), Beckers (1991), Boudoukh and Richardson (1993), Ferson and Harvey (1993), Ferson and Harvey (1994), Sharpe (1999) and Ang (2012).

surprise, many companies can only partially pass on the increased cost of raw materials. Margins therefore shrink.

Second, unexpected inflation may be associated with future economic weakness. While an overheating may cause companies' revenues to increase in the short-term, if the inflation is followed by economic weakness,[4] this will decrease expected future cash flows.

Third, there is a tax implication for companies with high capital expenditures. Given that depreciation is calculated based on the asset's historic cost (unadjusted for change in CPI), in an environment of high and rising inflation, the recognized expense will be artificially low. Because depreciation is subtracted from revenue when calculating tax liability, the latter will be artificially high in real space. Of course, many companies today rely heavily on intangible capital and are relatively immune to this effect.

Fourth, unexpected inflation could serve to increase risk premiums (increase discount rates), reducing equity prices.

Finally, similar to bond markets, high-duration stocks (particularly growth stocks that promise dividends far in the future) are especially sensitive to increased discount rates that result from changing perceptions of long-term inflation.

The inflation mechanism for commodities, like bonds, is relatively straightforward. Indeed, commodities are often the source of inflation. However, commodities are also a diverse asset class and while some move closely with inflation, others do not.

Expected and unexpected inflation

Investors seek to hedge unexpected inflation. Indeed, expected inflation is easy to hedge because bond prices already reflect it. Previous research has focused on two types of inflation risk measures.

The first is a measure of unexpected inflation, that is, the realized level of inflation minus the expected inflation (the actual at time *t* minus the forecast for time *t* made at time *t-1*). The expected inflation rate may be derived from professional forecasts or a statistical model. Typically, the change in the rate of inflation is used as a proxy for the unexpected inflation. This formulation assumes that the best forecast of next period's inflation rate is the current period's rate. Research has suggested that this simple model is a good approximation compared to other measures of inflation forecasts such as survey measures (Ang 2014).

However, there are still numerous issues in measuring unexpected inflation. For example, while the measure is straightforward when implemented for one month, one quarter, or even one year, it is not obvious how we should treat longer-horizon inflation. It is unlikely that the term structure of expected inflation is flat. Indeed, per our earlier example, a large monthly inflation shock could be irrelevant for asset prices if market participants believe it will be reversed in the near future.

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[4] In Exhibit 1, a negative inflection in real economic growth immediately follows five of eight US inflation regimes.

As a result, another approach measures the change in expected inflation. For example, this could be measured as the change in the break-even inflation (BEI) rate reflected in TIPS and nominal Treasuries. The BEI is the weighted average of inflation expectations over the life of the bond. Changes in the BEI have the advantage of reflecting changes in long-term or permanent inflation expectations. Unfortunately, BEI data is only available from 1997 limiting its usefulness in the analysis of historical inflation surges.

In our research, we will measure how asset returns vary in response to unexpected inflation. This is akin to an *inflation beta*. We expect bonds and equities to have negative inflation betas. Certain commodities will likely have positive betas. However, relatively little is known about the sensitivity of active strategies to unexpected inflation. One of our contributions is to detail the inflation-hedging properties of various equity factor strategies as well as dynamic trend strategies. Of course, inflation betas are measured with noise because our measure of unexpected inflation (change in inflation rate) focuses exclusively on the short-term and is unable to separate the temporary and permanent components.

Much of our focus centers on specific episodes where inflation surges to high levels. These inflationary regimes are likely a mixture of expected and unexpected inflation. For example, suppose inflation begins to rise. This provides a positive inflation surprise and expectations increase. At some point, the inflation rate starts to fall. Even though the level of inflation is still high, the rate is falling, leading to negative surprises (you thought the rate would be higher than the realization). That is, a high inflationary regime experiences both positive (at the beginning, acceleration) and negative (at the end, deceleration) inflation surprises. Our research focuses on the part of the regime where there are positive inflation surprises.

Defining inflationary regimes

Before detailing an ex ante inflationary regime rule, we must acknowledge that inflation is very hard to define. Of course, there are various different published versions of inflation, CPI headline, CPI core, Personal Consumption Expenditure Deflator, and GDP deflator. The results that we will present are largely robust under these different definitions.

However, there are two deeper issues that complicate the construction of an inflation index. First is the adjustment for quality. In 1990, the cost of a gigabyte of data was $10,000 (in today's dollars) and today it is less than one cent. Upon its release in 1985, a Cray 2 supercomputer would cost you $32 million, and today you carry the computing power of hundreds of Crays in your pocket for about $1,000. Technology is a deflationary force and the hedonic quality adjustments that are made in official CPI calculations are subjective to some degree.

Second, there is no single measure of inflation. The CPI, for instance, is based on a fixed-weight basket of goods. This basket may be appropriate for a portion of the population, but not representative for another portion. Indeed, everyone faces their own inflation rate. Yet, we use a single index, which may or may not reflect the experience of those investing in assets and the strategies designed to provide inflation protection.

While inflation is complicated to define, what matters for asset prices is what market participants believe is the most appropriate measure, and we settle on the CPI headline inflation. It has the added advantage of a long history.

While we mostly focus on the US, we also present similar analysis for the UK and Japan in Appendix B. We provide a cross-country analysis later in the paper. To reiterate, we are using the change in realized inflation as our measure of inflation surprise. Using survey-based inflation expectations would drastically shorten our sample period. Another alternative is to use the market-implied BEI, the gap between the nominal and inflation-protected bond yield. However, these measures suffer the same problem as the survey-based measures: a very limited history.[5]

We define inflationary regimes as time periods where the YoY realized inflation rate rises materially beyond 2%. Today, this level is often targeted by central banks across the world and, even when not explicit, is considered a psychologically important threshold.[6] We define "materially beyond 2%" as reaching 5% or more.[7] We define the regime end as the point at which CPI year over year reaches its peak without having fallen below 50% of its maximum annual rate in rolling 24-month observation windows. Using this observation window allows for the inflation rate to be volatile at a high level but to make successive higher highs without ending an inflationary episode. Alternatively, a new episode is determined to have started when inflation is already above 2% but has fallen to less than 50% of its trailing 24-month peak rate, and then starts to re-accelerate, as long as it reaches a faster inflation rate than 5%. Lastly, episodes shorter than six months were excluded for being too short to constitute a regime change, i.e., asset prices are most sensitive to longer-term rather than short-term inflation changes. In Exhibit 1, we highlight in pink the eight US inflationary periods since 1926 based on this method. In Exhibit 2, we give each regime a name based on the historical context, and we use these as labels throughout the rest of the paper.

One concern when comparing inflationary episodes is whether each regime is driven by a different component of the basket and is therefore unique. Inflation-components data produced by the Bureau of Labor Statistics (BLS) suggest this is not the case. Exhibit 3 uses the US inflation periods defined in Exhibit 1 and tracks how various components of the CPI basket move. The available data gives 125 regime-component pairs. Of these, 79, or 63%, experience annualized inflation of 5% or more, our threshold for defining an inflationary regime. Looking at the averages, in 100% of instances, the basket component experiences higher rates of price rises in inflationary regimes than outside of them, and the rate is at least twice as high in 59% of instances.

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[5] The UK introduced index-linked government bonds in 1981.

[6] For instance, James Bullard, President of the Federal Reserve Bank of St. Louis, has described the 2% target as an "international standard." See Bullard, 2018. Indeed, it can be argued that 2% was associated with price stability ever since the Reserve Bank of New Zealand pioneered central bank inflation targeting in the late 1980s.

[7] The fourth decile of the distribution of US YoY inflation since 1926 is 2%. The eighth decile is 5%.

Exhibit 3: Components of CPI basket during US inflationary regimes

The annualized rate of inflation for different basket components during the eight identified US inflationary regimes, as well as the average rise for inflationary and non-inflationary regimes, which is an arithmetic average of the annual inflation rate during these two types of regimes. The data vary by start point, with the earliest series beginning in 1926, at monthly periodicity. More detail on sources can be found in Appendix A.

	Specific inflation regimes								Combined regimes	
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (18%)	Other (82%)
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007		
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008		
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%		
Total price level chg (ann'd)	13%	19%	12%	4%	9%	10%	5%	6%		
Inflation component	Average ann'd price rise in regime								Average ann'd price rise	
Cereals and bakery products	9%	32%	16%	3%	20%	9%	6%	13%	13%	2%
Meat, poultry, fish and eggs					12%	10%	5%	4%	8%	2%
Dairy	15%	34%	23%	5%	12%	8%	5%	7%	14%	2%
Fruit and veg	28%	10%	11%	4%	10%	9%	7%	12%	11%	3%
Soft drinks			24%	2%	16%	14%	1%	3%	10%	3%
Other food					22%	11%	3%	7%	11%	2%
Food outside home				6%	10%	10%	4%	5%	7%	3%
Alcohol				3%	6%	6%	4%	3%	5%	2%
Household goods and services					9%	7%	2%	1%	5%	1%
Apparel	20%	20%	17%	5%	6%	5%	5%	0%	10%	1%
New Vehicles				2%	5%	7%	2%	-1%	3%	2%
Medical goods			4%	0%	3%	8%	8%	1%	4%	3%
Recreation goods & services								2%	2%	1%
Education goods & services								3%	3%	2%
Energy products				3%	20%	25%	13%	53%	23%	1%
Energy services	-1%	-1%	1%	1%	11%	11%	2%	18%	5%	2%
Tobacco products			6%	6%	5%	6%	10%	8%	7%	6%
Shelter				6%	8%	13%	5%	3%	7%	3%
Water and sewerage				4%	6%	8%	6%	5%	6%	5%
Medical services	1%	11%	5%	8%	8%	10%	8%	4%	7%	4%
Transport services	5%	4%	11%	6%	3%	8%	6%	6%	6%	3%
Personal goods and services			19%	4%	8%	7%	4%	3%	8%	2%

Financial assets

We now turn our attention to the performance of financial assets during the eight US inflationary regimes. In Exhibit 4, we tabulate the performance of a broad US equity index, the 10-year Treasury bond, and a 60-40 equity-bond portfolio. In the first columns, we show the total returns during the eight inflationary regimes, both in nominal terms (top panel) and real terms (bottom panel). At the top of the table, we report some additional statistics that characterize the different periods. The next three columns show the annualized return over inflationary, non-inflationary, and all periods. The final columns show the hit rate, defined as the proportion of regimes for which a given asset has yielded a positive return, and the t statistic, that provides a heteroskedasticity-consistent test of whether returns are significantly different in inflationary and non-inflationary times.

Starting with equities, we note that the nominal returns during inflationary periods are zero on average, with negative returns in 50% of the inflationary regimes. The real return averages -7% during inflationary times, with negative returns in 75% of the regimes. The real return is more relevant for most investors. These results are in line with the economic mechanisms presented earlier.

For the 10-year Treasury bond, the performance during high and rising inflation periods is also poor and this is not surprising for reasons we have already described. While in nominal terms the

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average annualized return during inflationary regimes is +3%, it is -5% in real terms. Consequently, the 60-40 equity-bond portfolio performs poorly during inflationary regimes, with a -6% real annualized return.

Exhibit 4: US equity and Treasury bond performance across inflationary regimes

Total returns to US equities, government bonds (1o-year maturity), and a 60-40 equity-bond portfolio during the eight US inflationary regimes defined in the previous section, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns), and the t statistic, which tests whether the returns in inflationary and non-inflationary times are different. If significant, the heteroskedasticity-consistent t statistic is marked with an asterisk. The data are from 1926 to 2020. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Length (mths)	14	13	7	48	30	38	46	11					
Strategy				Nominal return (total)						Nominal return (ann.)			
Equities	-13%	-12%	32%	10%	-32%	18%	35%	-12%	0%	12%	10%	50%	-3.2*
Government bonds	3%	0%	0%	4%	9%	-5%	30%	11%	3%	6%	5%	88%	-1.8
60/40	-7%	-7%	18%	8%	-17%	9%	35%	-3%	2%	10%	9%	50%	-3.6*
Strategy				Real return (total)						Real return (ann.)			
Equities	-24%	-27%	24%	-7%	-46%	-14%	12%	-17%	-7%	10%	7%	25%	-4.8*
Government bonds	-11%	-17%	-6%	-13%	-12%	-31%	8%	5%	-5%	4%	2%	25%	-5.1*
60/40	-19%	-23%	11%	-9%	-34%	-20%	12%	-8%	-6%	8%	6%	25%	-6.0*

In Exhibit 5, we take a different approach, which serves as a robustness check to our regime analysis. Moreover, it allows us to explore how the equity response depends on the starting level of inflation.

Exhibit 5: Real US equity return versus contemporaneous 12-month inflation rate change

The relation between the 12-month real US equity return and the contemporaneous 12-month change in the YoY inflation rate. The left panel plots the data, splitting the datapoints into above- and below-median inflation rate at the start of the 12-month evaluating window, and we add a trend line for both cases. The right panel shows the correlation, splitting the data points into five quintiles based on the inflation rate at the start of the 12-month evaluating window. We use all overlapping 12-months in the 1926-to-2020 sample period.

12m real equity return vs. inflation rate change   Correl. of 12m real equity returns and inflation rate change

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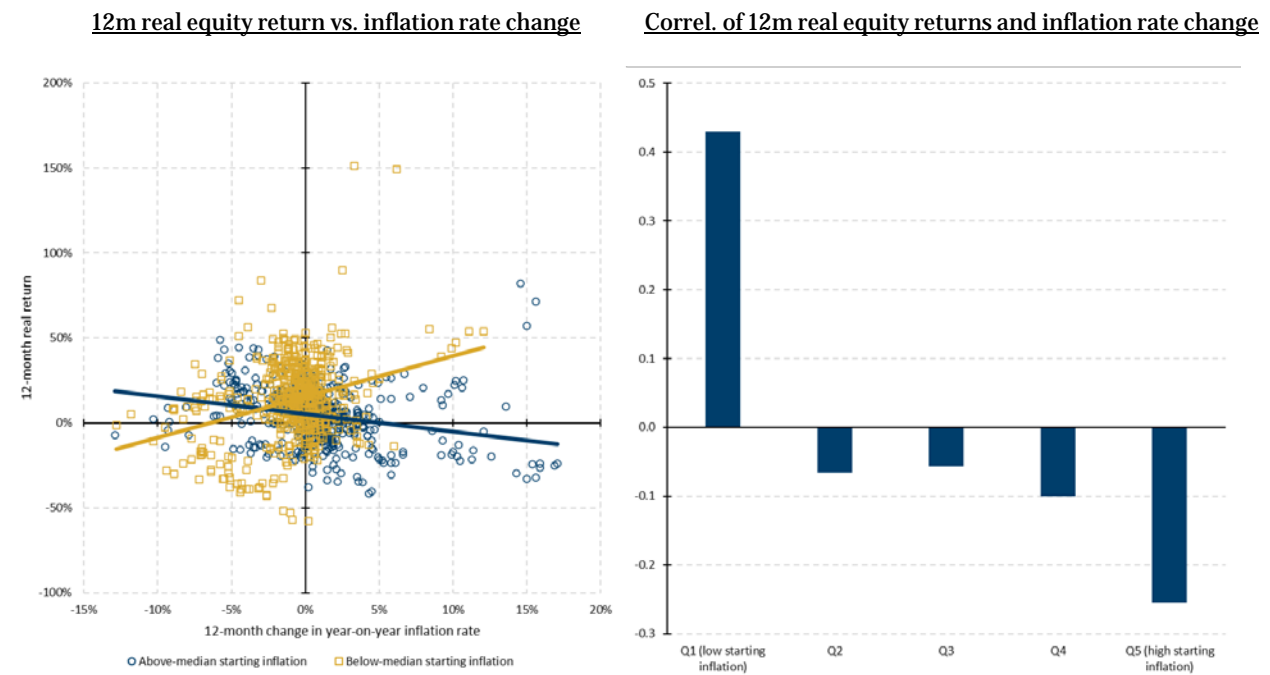
In the left panel, we show a scatter plot of the 12-month real return for equities versus the contemporaneous 12-month change in the YoY inflation rate. We choose the 12-month change because it is more likely reflective of long-term inflation shocks. We separate instances where the starting inflation rate is below (yellow) and above (blue) the median level since 1926 (2.6%).

The trend lines suggest that equities actually benefit from rising inflation if the starting level is below median (risk of deflation), but are hurt by rising inflation if it is above median (increased risk of inflation escalating). It is the latter effect that our regime analysis captures. A similar result can be gleaned from the right panel, where we report the correlation between the 12-month real equity return and the contemporaneous 12-month change in the inflation rate, for quintiles formed by the starting inflation rate. Only in the lowest quintile (starting inflation rate less than 1.0%) is the correlation positive at 0.4. In all other cases, there is a negative relationship between the real equity return and inflation changes, and (monotonically) more so for higher starting levels of inflation.

In Exhibit 6, we repeat this exercise for real 10-year Treasury returns. The negative relation between bond returns and inflation changes does not depend much on the starting level of inflation.

In Exhibit 7, we present the performance of different equity sectors. To conserve space, from now on, we will only report real returns. Only the energy sector has positive annualized real returns during inflationary regimes. However, at +1%, it significantly lags the commodity it produces (see next section). Possible reasons include operational issues (such as the impact of wage inflation or the fact that assets are often located in geopolitically turbulent geographies) and the hedging strategies of the companies themselves, which may confound the transmission mechanism between commodity inflation and higher profits for the producer.

Weak sectors include those with a high exposure to the individual consumer, such as durables (-15%) and retail (-9%). Technology ("business equipment" in the Fama and French categorization (Fama and French 1997)) is also -9%. Financials are weak as default risk dominates the benefits of possible rising rates and because there can be a lag between an inflationary regime and central bank tightening. In Appendix C, we show a more granular split of US equity sectors.

Exhibit 6: Real US bond return versus contemporaneous 12-month inflation rate change

The relationship between the 12-month real US 10-year Treasury return and the contemporaneous 12-month change in the YoY inflation rate. The left panel plots the data, splitting the data points into above- and below-median inflation rate at the start of the 12-month evaluating window, and we add a trend line for both cases. The right panel shows the correlation, splitting the data points into five quintiles based on the inflation rate at the start of the 12-month evaluating window. We use all overlapping 12-months in the 1926-to-2020 sample period.

<u>12m real bond return vs. inflation rate change</u>   <u>Correl. of 12m real bond returns and inflation rate change</u>
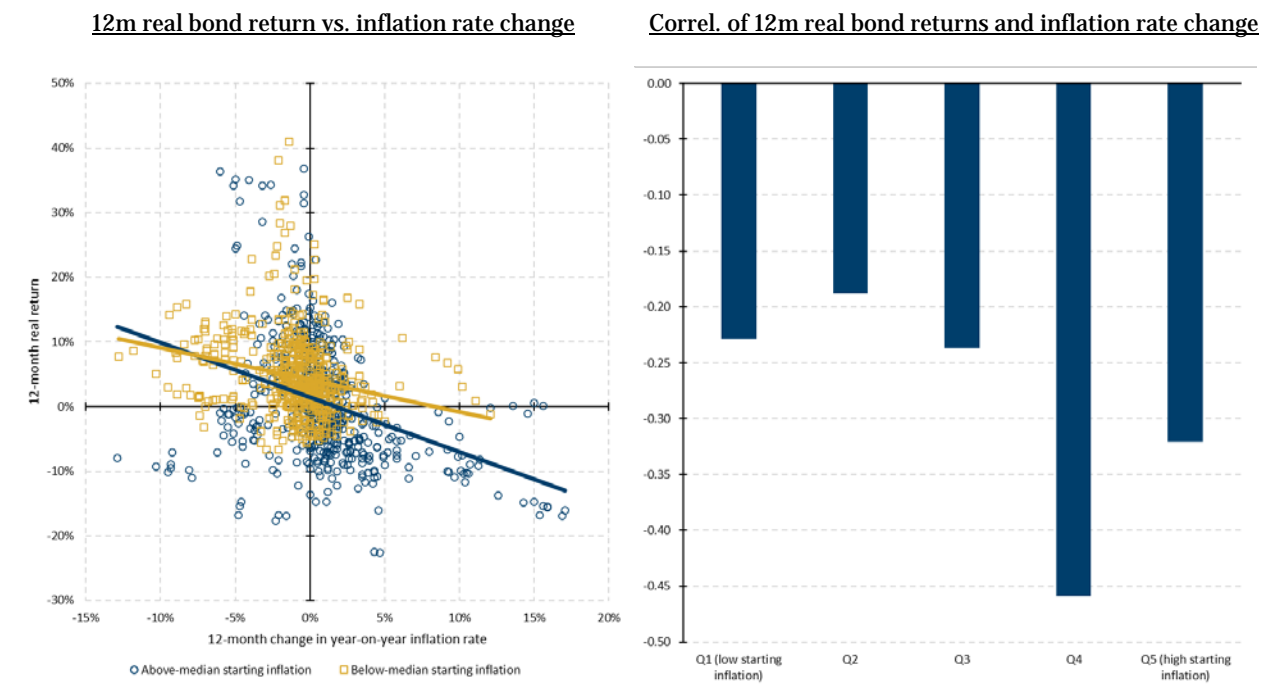
Exhibit 7: US sector performance in inflationary regimes

Total returns to 12 long-only sector portfolios, as collected on the Kenneth R. French website, during the eight US inflationary regimes defined in the previous section, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns) and the heteroskedasticity-consistent t statistic, which tests whether the returns in inflationary and non-inflationary times are different. The data are from 1926 to 2020. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy				Real return (total)						Real return (ann.)			
Consumer non-durables	-24%	-24%	11%	5%	-56%	-15%	42%	-7%	-6%	11%	8%	38%	-3.7*
Consumer durables	-16%	-32%	24%	-30%	-62%	-27%	-28%	-36%	-15%	13%	7%	13%	-5.0*
Manufacturing	-23%	-23%	27%	-9%	-52%	-12%	-2%	-15%	-8%	11%	7%	13%	-3.7*
Energy	-14%	-10%	25%	-19%	-19%	31%	31%	2%	1%	8%	6%	50%	-1.4
Chemicals	-25%	-17%	27%	-23%	-37%	-24%	9%	2%	-6%	11%	8%	38%	-3.5*
Business equipment (Tech)	-26%	-34%	19%	37%	-58%	-11%	-29%	-15%	-9%	12%	8%	25%	-3.9*
Telecoms	-32%	-25%	3%	-19%	-15%	-24%	41%	-27%	-7%	9%	6%	25%	-4.1*
Utilities	-43%	-20%	12%	-24%	-38%	-22%	8%	-3%	-9%	10%	6%	25%	-4.5*
Retail	-25%	-24%	19%	14%	-64%	-27%	6%	-15%	-9%	12%	8%	38%	-3.9*
Health	-18%	-8%	18%	25%	-42%	-2%	43%	-6%	-1%	11%	9%	38%	-2.2*
Financials	-20%	-29%	18%	23%	-53%	-5%	-24%	-35%	-9%	11%	7%	25%	-3.7*
Other	-20%	-36%	25%	-12%	-62%	7%	-4%	-21%	-10%	8%	5%	25%	-3.1*

Exhibit 8 goes into more detail on fixed income. In terms of Treasury bonds, the higher the maturity, the greater the sensitivity to rising inflation (which is typically paired with rising nominal yields). This is intuitive, as higher maturity bonds have a higher duration. The annualized

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real return during inflationary regimes is -3% for the 2-year, -5% for the 10-year, and -8% for the 30-year bond.

Exhibit 8: Fixed income in inflationary regimes

Total returns to 30-year, 10-year, and 2-year US Treasuries, and investment-grade and high-yield credit and 10-year TIPS, during the eight US inflationary regimes defined in the previous section (see Exhibit 1), as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns), and the heteroskedasticity-consistent t statistic, which tests whether the returns in inflationary and non-inflationary times are different. The data are from 1926 to 2020 for all assets other than TIPS, which are from 1959. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy	Real return (total)								Real return (ann.)				
US Treasury 30 yr	-17%	-17%	-6%	-20%	-28%	-41%	13%	2%	-8%	5%	3%	25%	-5.0*
US Treasury 10 yr	-11%	-17%	-6%	-13%	-12%	-31%	8%	5%	-5%	4%	2%	25%	-5.1*
US Treasury 2 yr	-13%	-17%	-6%	-1%	-7%	-17%	11%	0%	-3%	2%	1%	13%	-5.8*
USD Investment Grade credit	-7%	-12%	-3%	-23%	-20%	-43%	-5%	1%	-7%	6%	3%	13%	-8.1*
USD High Yield credit	-4%	-11%	0%	-18%	-21%	-38%	-10%	-8%	-7%	6%	4%	13%	-7.8*
TIPS				-3%	13%	-2%	11%	6%	2%	3%	3%	60%	-0.6

Neither investment-grade (IG) nor high-yield (HY) corporate bonds come close to protecting purchasing power, with both having a -7% real annualized return during inflationary regimes. Both underperform government issuance in the inflationary regimes. The duration of the IG index ranges between six and eight years, while HY is between four and six years. This is less than the 10-year Treasury, which has tended to be between seven and nine. The shorter duration is not consistent with the weaker performance and it is likely that recessionary fears (and subsequent default risk) intensify through an inflationary regime. The comparison makes clear that hedging IG and HY long positions with short government bond positions of similar duration did not provide inflation protection in the past.

Finally, Exhibit 8 shows the performance of TIPS, which have coupon and principal payments that are indexed to the price level. The US Treasury only started to issue TIPS in 1997. However, data from a synthetic TIPS is available back to 1959 (Marshall 2020). The TIPS performance during the most recent five inflationary regimes is robust, with a 2% annualized real return, but not better than the real return in non-inflationary times. It is noteworthy, however, that the starting TIPS yield in our inflationary regimes was +2.4%, whereas now it is -0.7%. The low yield means that TIPS are a very expensive inflation hedge going forward (investors bear negative returns in non-inflationary times).

Hard assets

In this section, we consider hard assets: commodities, residential real estate, and collectibles. Such tangible assets may naturally adjust to changes in the overall price level, and in some cases may explicitly be included in the basket of goods used to determine the inflation rate (e.g., oil).

In Exhibit 9, we conduct the same exercise as in the previous tables, with six commodity groupings, as well as gold and silver individually, and an aggregate commodity portfolio. Returns

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assume investment in commodity futures (plus a cash return to create a funded investment). All commodities have positive annualized real returns during inflationary regimes. In fact, it is during non-inflationary times that commodities tend to have a poorer performance of around +1% real. So historically, commodities have not only been robust to rising inflation, but have also benefitted from such an environment relative to normal times.

Exhibit 9: Commodities in inflationary regimes

Total returns to six baskets of commodity futures, as well as gold and silver individually, and an equal-weighted, monthly rebalanced basket of all commodities, during the eight US inflation regimes already defined, as well as the annualized return during inflationary, non-inflationary, and all periods. Returns in grey italics are spot returns prior to the existence of a liquid futures contract. These are not included in the aggregate calculations. All other returns are funded. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns) and the heteroskedasticity-consistent t statistic, which tests whether the returns in inflationary and non-inflationary times are different. The starting point for the data varies from 1946 (agris) to 1979 (energies) and runs through to 2020 at monthly periodicity. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy				Real return (total)					Real return (ann.)				
Industrials				115%	38%	-6%	306%	3%	19%	4%	7%	80%	1.7
Precious				28%	29%	185%	-27%	33%	11%	-2%	1%	80%	1.7
Agris		12%	6%	-23%	197%	-21%	6%	33%	7%	-3%	0%	71%	1.8
Softs				-41%	243%	15%	11%	15%	8%	-3%	-1%	80%	1.6
Livestock				69%	-21%	35%	97%	-23%	7%	1%	2%	60%	1.1
Energies	*-3%*	*2%*	*-6%*	*-16%*	*264%*	*57%*	201%	68%	41%	-1%	3%	100%	1.7
Gold					*166%*	154%	-18%	27%	13%	1%	1%	67%	1.6
Silver				9%	99%	210%	-41%	36%	12%	-5%	0%	80%	1.8
Commods Aggregate		12%	6%	26%	85%	38%	84%	21%	14%	1%	4%	100%	3.1*

How does performance differ between commodity groups? Foodstuffs do least well, but still generate strongly positive real annual returns between 7% and 8%. The "Ending of Bretton Woods" episode is particularly weak for agris and softs (e.g., sugar, coffee, and cocoa). In a sense, this is idiosyncratic as it coincides with legislation across the 1960s designed to bring food prices down (e.g., the 1962/63 repeal of the mandatory price support programs initiated in WW2). Precious and industrial metals do better, with returns of +11% and +19%, respectively. The stronger performance of the latter is perhaps reflective that, during an inflation, the substitute physical asset tendency is stronger than the substitute physical currency tendency. Energies lead by some margin at +41%.[8]

Some caution needs to be exercised in interpreting the commodity sector analysis. For example, with electric vehicle technology developing fast, it is likely that in the long term, oil and other brown economy fuels will lose the level of inflation performance they enjoyed in the past. However, over a shorter outlook, there are good reasons to think the pattern of history might hold. Alternative fuels are yet to reach critical mass; electric and hybrid vehicles made up just 4% of global automotive sales in 2020.[9] In addition, there are many other reasons that inflation could have different effects on certain sectors. Semiconductor shortages and the associated price hikes

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[8] Erb and Harvey (2005) analyse the inflation hedging ability of a broader set of commodities. Erb and Harvey (2013) analyse the inflation hedging performance of gold over long-horizons. They conclude that gold is too volatile to be a reliable hedge and the performance since 1975 is largely driven by a single year, 1979, when gold dramatically appreciated in value.
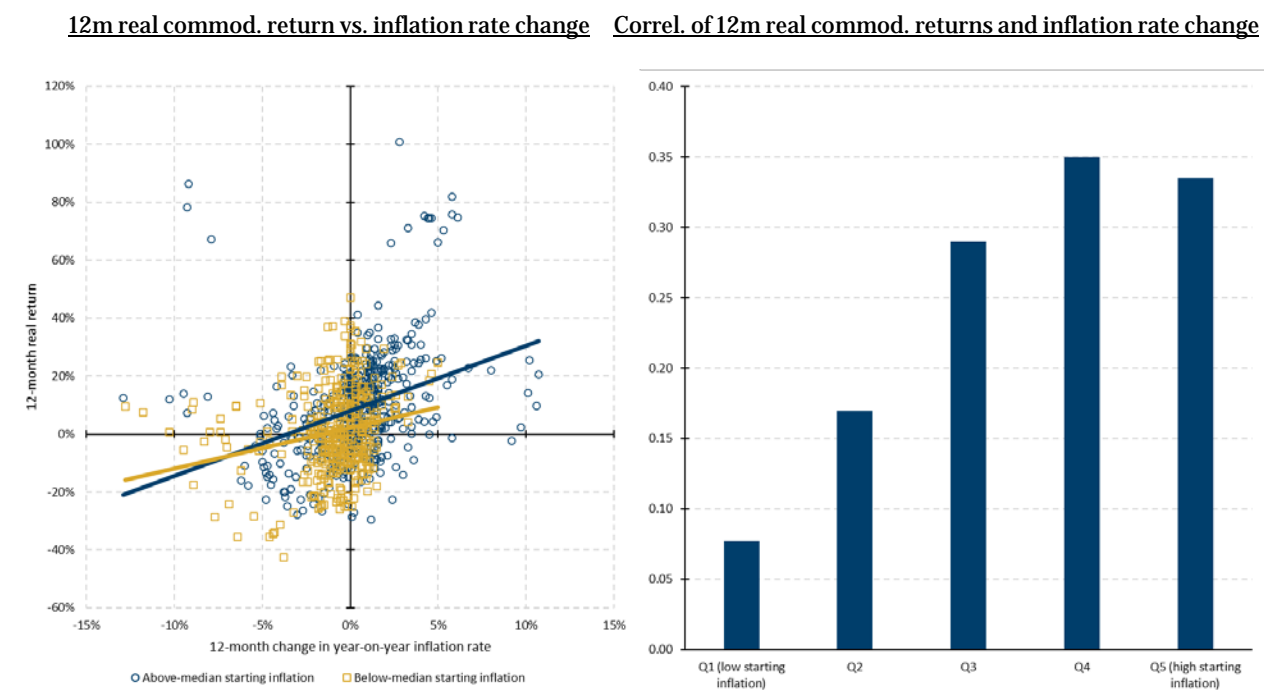
[9] Data from EV-Volumes.com.

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could impact the technology sector. Shortages of rare elements like lithium are another consideration which may mean that the inflationary impact on traditional commodities differs from that which is indicated by the past.

In Exhibit 10, we again take the different approach to evaluating aggregate commodity performance as a function of annual inflation rate changes, as we did in the previous section for equities and bonds. Consistent with the results above, we see a positive relationship between the 12-month real return to the equally weighted commodity basket and the contemporaneous 12-month change in the inflation rate, irrespective of the starting level of inflation. From the right panel, we can see that the positive relation tends to be somewhat stronger when the inflation rate is in the top two quintiles.

Exhibit 10: Real commodity returns vs. contemporaneous 12-month inflation rate change

The relationship between the 12-month real commodity basket return and the contemporaneous 12-month change in the YoY inflation rate. The commodities basket is an equal-weight futures basket. The left panel plots the data, splitting the data points into above- and below-median inflation rate at the start of the 12-month evaluating window, and we add a trend line for both cases. The right panel shows the correlation, splitting the data points into five quintiles based on the inflation rate at the start of the 12-month evaluating window. Quintiles are based on the full inflation dataset from 1926. If we start in 1947 (when the commodity series starts) correlations are slightly higher. We use all overlapping 12-months in the 1947-to-2020 sample period.

12m real commod. return vs. inflation rate change   Correl. of 12m real commod. returns and inflation rate change

Next, we turn to residential property. In Exhibit 11, we see that US residential real estate has a small negative annualized real return of -2% during inflationary regimes, while it is +2% at other times. So, the asset does not seem to benefit from inflation in the same way commodities do, but it could be argued that it is more robust than financial assets, with only a modest difference in the real returns between inflationary and other times. In Appendix B, we see that the UK real estate experience is similar to the US, while for Japan (where our data captures the value of residential land rather than housing), the real return is higher during inflationary regimes than at other times.

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Exhibit 11: Performance of residential real estate in inflationary regimes

Price return to US residential real estate during the eight US inflationary regimes already defined, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns), and the heteroskedasticity-consistent t statistic that tests whether the returns in inflationary and non-inflationary times are different. The data are from 1926 to 2020. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy				Real return (total)						Real return (ann.)			
Residential real estate	-17%	4%	-4%	-2%	-7%	11%	0%	-13%	-2%	2%	1%	25%	-5.1*

Next, we consider collectibles, in particular art, wine, and stamps. In Exhibit 12, we show how these assets have performed through the eight US inflationary regimes. We find that collectibles have lived up to their reputation as a store of value in inflationary times. Real annual returns are positive during inflationary episodes for all three asset groups, with art at +7%, wine at +5%, and stamps +9%. Moreover, we notice a possible distinction between art and stamps on the one hand, where performance markedly improves in inflationary periods relative to normal times, and wine, which experiences lower but more consistent returns between normal and inflationary times.

Collectibles are unlikely to be part of an institutional portfolio given the small traded volumes. For instance, the global wine market turnover was $364 billion in 2019, according to Fortune Business Insights, of which collectible wine is a small sliver. To put that in context, the World Bank estimated global equity market turnover at $60 trillion in 2019.

Exhibit 12: Performance of collectibles in inflationary regimes

Price returns to art, wine, and stamps during the eight US inflationary regimes already defined, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns). The data are from 1926 to 2020. See Appendix A for details on sources and methodology.

	Specific inflation regimes								Combined regimes			
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007				
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008				
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%				
Strategy				Real return (total)						Real return (ann.)		
Art	3%	-14%	-25%	96%	18%	54%	61%	-13%	7%	2%	3%	63%
Wine	156%	-39%	-6%	15%	-26%	120%	0%	-13%	5%	6%	6%	50%
Stamps	4%	-5%	-18%	35%	4%	204%	6%	16%	9%	3%	4%	75%

Dynamic strategies

So far, we have looked at passive investments in financial and hard assets. Now, we turn to dynamic strategies. We first consider long-short stock factor portfolios. Second, we study trend strategies applied to futures and forwards.

For dynamic strategies, implementation costs can be substantial. Therefore, we incorporate estimated costs, based on our live experience trading similar portf0lios, which capture the combined effect of transaction, slippage, funding, and short-selling costs. The estimates are at the maximum of the range set forth by Harvey et al. (2019): 2.0% and 0.8% per annum for stock factor

and future trend strategies respectively. See Appendix A for further discussion on the costs of implementation.

In Exhibit 13, we show the performance of some well-known factor strategies through the eight US inflationary regimes.

Exhibit 13: US equity style performance in inflationary regimes

Total real returns of various long/short equity strategies in inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns), and the heteroskedasticity-consistent t statistic that tests whether the returns in inflationary and non-inflationary times are different. These are the same strategies as were analyzed in Harvey et al. (2019). Data are from 1926 in the case of SMB and HML, from 1927 in the case of Momentum, from 1963 for RMW and CMA, from 1930 for BAB, and from 1957 for QMJ. More detail on sources and methodology can be found in Appendix A.

| | Specific inflation regimes | | | | | | | | Combined regimes | | | | |
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy				Real return (total)						Real return (ann.)			
SMB - 'Size'	-11%	-23%	-4%	45%	-43%	32%	-26%	-4%	-4%	1%	0%	25%	-1.8
HML - 'Value'	-4%	-17%	3%	-8%	36%	-11%	-3%	-7%	-1%	2%	2%	25%	-1.5
RMW - 'Profitability'				4%	-24%	-8%	18%	6%	-1%	2%	2%	60%	-1.5
CMA - 'Investment'				-7%	31%	-9%	24%	-10%	2%	2%	2%	40%	-0.1
Momentum	-15%	-18%	7%	35%	38%	44%	41%	26%	8%	4%	5%	75%	0.6
QMJ (Quality - Junk)				14%	-1%	-12%	40%	7%	3%	3%	3%	60%	-0.1
BAB (Bet-against-Beta)	-24%	-6%	-3%	28%	-13%	9%	-7%	-22%	-3%	8%	6%	25%	-4.2*

Smaller companies perform poorly in inflationary regimes. In real terms, the premium for being long small size and short large size is -4% a year in inflationary periods, compared to +1% in normal times. The factor is positive in just two of the eight episodes. This fits with intuition. The costs of inflation will have some economies of scale benefit to them. Take "shoe-leather costs," for instance (Fischer and Modigliani 1978), meaning the extra effort that companies have to make when the value of cash is more volatile—making more trips to the bank and wearing out their shoes being the analogy. Larger companies are more suited to reacting to these conditions, given that they are more likely to have the necessary infrastructure to make such adaptations seamlessly.

The profitability and value factors roughly hold their own during inflationary periods (-1% real return). The value performance might be surprisingly weak to some, given that higher-duration growth stocks are often assumed to be adversely sensitive to unexpected inflation as discount rates increase. Still, it is worth saying that value long/short is still much more inflation robust than the long-only financial assets discussed previously.

Cross sectional equity momentum historically performs well with real inflation regime returns of +8% on average and a 75% hit rate across the eight episodes; however, we are somewhat cautious with the result, given the low t statistic. In addition, the performance is highly sensitive to the dating of our regimes. For example, January 1975 was a very negative month for cross-sectional momentum, and our inflationary regime stops in December 1974. Equally, late 2008 through early 2009 was catastrophic for momentum, and our inflationary period ends in July 2008.

We also look at quality and low-beta premia, using portfolios as formulated by Asness et al. (2014) and by Frazzini and Pedersen (2014) (QMJ and BAB, respectively, in Exhibit 13). While quality holds up well in the inflation regimes, low beta is weak, with a real annual average return of -3%

and a hit rate of 25%. Possibly the duration effect is prevalent here, given that low beta is often a play on long-term stable cash flows (non-CPI linked utilities, for example).

Some caution needs to be exercised in comparing these dynamic factor returns to long-only equity. These dynamic strategies generally have low or even negative betas with the market. For example, over the full sample, the value factor has a beta of 0.2 and the low-beta factor has a beta of 0.1. The average returns are approximately the alpha of the strategy.

Next, we follow the methodology of Hamill, Rattray, and Van Hemert (2016) and Harvey, Rattray, and Van Hemert (2021) and construct a time-series momentum (trend) strategy applied to liquid futures and forwards. The strategy has a 10% ex-ante annualized volatility target, and the weights to historical lags in the trend definition is chosen such that it best approximates the BTOP50 trend-following index returns.

In Exhibit 14, we observe that the annualized real return during inflationary regimes is positive for each of the five trend strategies, covering the four asset classes plus the all-asset version. For bonds and commodities, the real returns are positive during each of the individual inflationary regimes. This seems intuitive, as bonds and commodities have a very clear exposure to inflation (suffering and benefitting from rising inflation respectively). Also, for bonds-and-commodities trend, the performance in rising inflationary periods is much higher than during other periods. The all-asset class trend also performs relatively well during rising inflation periods.

The dynamic strategies provide some advantages. While the trend-following strategies perform better than the equity factors, it is important to realize that the trend strategies have limited capacity, whereas the main equity factors have robust capacity. With than in mind, having a -1% real return for a value strategy, or a 3% average return for a quality strategy does not look that bad. The equity factors do not experience the large negative returns that passive equity and fixed-income investments experience during inflation shocks.

Exhibit 14: Trend strategies in inflationary regimes

Total real returns of futures trend strategies by asset class and combined, during the eight US inflationary regimes already defined, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final columns, we present the hit rate (proportion of inflationary periods with positive returns), and the t-stat on inflationary periods having higher returns. The data are from 1926 to 2020. See Appendix A for details on sources and calculation methodology.

|	Specific inflation regimes								Combined regimes				
	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate	t stat
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007					
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008					
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%					
Strategy				Real return (total)						Real return (ann.)			
Bonds trend				79%	54%	149%	6%	6%	15%	9%	10%	100%	1.9
FX trend					-14%	16%	42%	6%	4%	4%	4%	75%	0.5
Equity trend	20%	23%	24%	77%	23%	-13%	13%	-3%	8%	11%	10%	75%	-0.9
Commods trend			1%	54%	173%	33%	132%	25%	20%	8%	10%	100%	2.8*
All asset trend	20%	23%	19%	135%	196%	100%	65%	17%	25%	15%	16%	100%	2.8*

International inflation

We perform a similar analysis for the UK and Japan as we have done for the US. We define inflationary regimes using the same method (i.e., when inflation is accelerating above 5%, as already described), but based on local data. This results in the regimes presented in Exhibit 15.

In Appendix B, we detail how a variety of local assets performed in the inflationary periods for these countries, similar to the analysis in Exhibit 4 for the US. In Exhibit 16, we show a comparison of asset performance across all three nations. We note that the performance is always from the vantage point of a specific country (base currency), which matters for the realized inflation correction. For dynamic strategies, implemented with futures contracts, the base currency also matters for the interest earned on any unencumbered cash, just like investment funds often have different currency share classes. We report the annualized real performance during the different regimes for the three countries, and in the final columns of the table split the sample period in terms of how many countries are in an inflationary regime.

Exhibit 15: UK and Japanese headline inflation rates and regimes
The YoY headline inflation rate (blue line) and inflationary regimes (pink highlighted) for the United Kingdom (left panel) and Japan (right panel). UK data are collected from the Bank of England and Japan data are from Global Financial Data. We truncated the Japan chart's y-axis at 30% for readability; Japanese YoY CPI peaked at +780% in August 1946. The data are from 1926 to 2020. See Appendix B for more details on the regime classification.
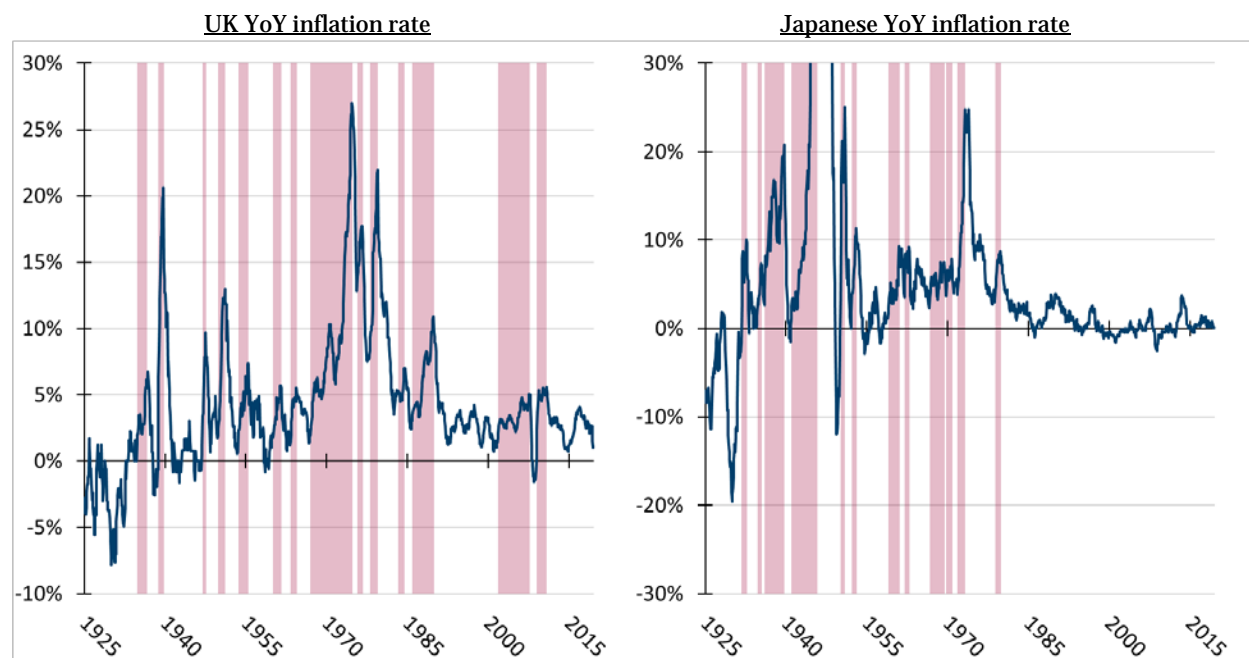
Equities tend to perform worst during their own country's inflationary periods. US equities, for instance, achieve +6% and +9% real annualized return in UK and Japan inflationary periods, compared to -7% in US regimes. The results also suggest benefits to international diversification. For example, taking the UK perspective, US and Japanese equities generate +6% and +9% real

annualized returns during UK inflation regimes, respectively.[10] Importantly, equities work well when none of the three countries has high and rising inflation (49% of the time), or when one of the three has it (32% of the time). Equities really only struggle when two or more countries are suffering. This is consistent with a global bout of inflation being very negative for equity markets.

Bonds clearly perform the worst during their own country's inflationary periods.

Commodities perform well during the inflationary periods of any one of these three countries. The effect is strongest during US inflationary regimes (running at a 15 percentage point differential between inflation and other regimes, compared to 8 for the UK and 7 for Japan). Commodities perform particularly well when all three countries are in an inflationary regime, which is about 4% of the months.

The all-asset trend strategy discussed in the previous section performs best during US inflationary periods, when the differential with normal times is 10 percentage points (+25% vs. +15%). A possible driver here is US global economic leadership, both in terms of fundamentals and market prices, giving it first mover advantage as trends develop. Also, the trend strategy performs particularly well when all countries are in the inflationary regime.

Exhibit 16: Annualized real returns during different regimes for different countries
Real annualized returns to assets in inflationary, non-inflationary, and all regimes for US, UK and Japan. The final segment of the table shows the real annualized return to the asset where 0, 1, 2 or 3 of the countries are in an inflation regime at the same time. Returns are expressed in a specific base currency, which dictates what inflation correction is applied and what interest is earned on unencumbered cash for the dynamic futures and commodities strategies. The data run from 1926 to 2020.

Asset	Base	US			UK			JP			Countries in inflation			
		Inflation	Other	All	Inflation	Other	All	Inflation	Other	All	0	1	2	3
% of time		*19%*	*81%*	*100%*	*34%*	*66%*	*100%*	*22%*	*78%*	*100%*	*49%*	*32%*	*15%*	*4%*
US equities	USD	-7%	10%	7%	6%	8%	7%	9%	7%	7%	8%	12%	-1%	-7%
UK equities	GBP	-2%	7%	5%	0%	8%	5%	3%	6%	5%	7%	11%	-7%	-7%
JP equities	JPY	-7%	6%	4%	9%	1%	4%	-10%	8%	4%	7%	5%	-11%	8%
US bonds	USD	-5%	4%	2%	1%	3%	2%	0%	3%	2%	5%	1%	0%	-8%
UK bonds	GBP	-2%	3%	2%	-3%	5%	2%	-2%	3%	2%	6%	1%	-1%	-12%
JP bonds	JPY	-10%	1%	-1%	-2%	-1%	-1%	-16%	4%	-1%	5%	-3%	-11%	-12%
Commods	USD	16%	1%	4%	9%	1%	4%	10%	3%	4%	-1%	8%	9%	21%
Commods	GBP	18%	1%	5%	8%	3%	5%	10%	4%	5%	0%	7%	8%	23%
Commods	JPY	12%	0%	2%	8%	-1%	2%	6%	2%	2%	-2%	5%	8%	16%
Trend	USD	25%	15%	16%	19%	15%	16%	20%	15%	16%	15%	15%	16%	48%
Trend	GBP	29%	14%	17%	17%	17%	17%	20%	16%	17%	16%	15%	16%	50%
Trend	JPY	16%	11%	12%	17%	10%	12%	2%	15%	12%	15%	8%	6%	41%

Structural change and the rise of cryptocurrencies

As with any historical analysis, we are faced with the usual question: Is this time different? For example, the inflation surge in the early 1970s was induced by an exogenous event: the OPEC oil

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[10] This is perhaps one of the drivers behind the large international equity allocations run by some of the major UK pension funds coming out of the inflationary 1970s and 80s. We do note that for international diversification, exchange rate effects still need to be accounted for. Converted into GBP, the real annualized returns during UK inflationary regimes are 4% and 9% for US and Japanese equities.

embargo. At the time, the US economy was highly dependent on that source of oil. Today is different as the US is not as dependent upon foreign oil sources. Moreover, while electric vehicles do not have critical mass today, such technological change in the future may make it much less likely that a surge in oil prices would have the same inflationary effect. Hence, caution needs to be exercised in interpreting the data. Indeed, this is precisely why most of our analysis focuses on regime behavior. Looking at averages over all regimes could be misleading because of one influential regime. For example, Erb and Harvey (2013) show that gold's seeming ability to hedge unexpected inflation is driven by a single observation: 1979.

There are other factors that need to be carefully weighted given the structural evolution of the U.S. economy. In the 1950s and 1960s, the U.S. was a manufacturing economy. Today, only 11% of GDP is driven by manufacturing.[11] The nature of companies has changed. Much of the capital deployed is not physical but intangible, including trade secrets, proprietary software, patented and unpatented R&D, client relationships, and legal rights. These may be more resilient to inflation.

Finally, we are in the midst of another technological disruption in the form of cryptocurrencies, including bitcoin.[12] Bitcoin is not controlled by any centralized authority – it is the result of a computer program that algorithmically increases the supply until it caps out at 21 million coins in 2140. This money supply rule induces algorithmic scarcity. This scarcity has some similarities to the scarcity of gold, given the limited amount of newly mined gold that comes to market each year.

Some have advocated the inclusion of bitcoin into a diversified portfolio as an inflation protection asset. However, caution is warranted given that bitcoin is untested with only eight years of quality data—over a period that that lacks a single inflationary regime. Moreover, bitcoin is more than five times more volatile than the S&P 500 or gold. This high volatility could lead to bitcoin being an unreliable hedge. Indeed, Erb and Harvey (2013) argue gold is an unreliable hedge over the short term because of its volatility.

Aside from this, there is evidence the price moves in bitcoin are not independent of economic events. While theoretically, bitcoin should have a zero inflation beta and zero market beta, reality is different. For example, in March of 2020 at the height of the COVID-19 crisis, investors began to reduce risk. The stock market dropped 34%, gold dropped 12%, and bitcoin plummeted 53% as investors poured money into safe-haven US Treasuries. As it became evident that the outlook was not as grim as first thought, investors returned to risky assets with the stock market reaching an all-time high, gold reaching its third highest value in history, and bitcoin surging more than 800% (in the 12 months following its March 2020 trough). This suggests that bitcoin is a speculative asset and it has a positive beta against the U.S. market. Our analysis shows that unexpected high inflation is negatively related to U.S. equity returns. The correlation of U.S. equity and bitcoin returns suggests that bitcoin may not deliver positive real returns in periods of unexpected inflation.

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[11] Per Bloomberg, ticker GDPRMANU Index, collected from the Bureau of Economic Analysis.
[12] For additional details, see Harvey, Ramachandran, and Santoro (2021).

Conclusions

Even if you forecast a rate of inflation in the 2-3% range over the next few years, it is likely that that forecast has a larger confidence interval than the same forecast at the end of 2019. Given the unprecedented monetary and fiscal interventions, most agree that inflation risk has increased. As such, it is time that portfolio managers review their asset positioning in the face of this heightened risk.

Our paper is *not* about forecasting whether inflation will surge or not. We provide some evidence as to what may happen to the performance of a wide range of asset classes as well as active strategies if inflation does surge. Our analysis spans nearly a century. The long sample is particularly important because inflation spikes in developed economies have been rare in the past 30 years.

Our analysis takes two approaches. The first is the inflation beta approach where an asset or strategy's returns are correlated with unexpected inflation. An asset with a negative unexpected inflation beta provides a hedge—on average. The second approach focuses on specific regimes where inflation has risen from a moderate level and crossing the 5% threshold. The advantage of this approach is that asset performance can be scrutinized in each regime. The inflation beta approach, in contrast, is just the average across all regimes.

Some of our analysis reaffirms what we already know. For example, Treasury bonds do poorly when inflation surges. Commodities, often being a source of inflation, do well. However, we offer additional insights. Commodities, for example, are a diverse set of assets and their inflation-hedging properties depend on the individual commodity. Most importantly, we show that unexpected inflation is very bad news for equity investors.

We also examine a number of active strategies. Our results suggest that trend-based strategies focusing on equity, bonds, FX, and commodities have strong hit rates during the eight inflation episodes and provide an impressive level of protection. We consider a range of equity portfolios and find that popular factors like value provide some benefit during our definition of inflationary times. While the average benefit is small, for example 3% real returns for a quality strategy to -1% for the value strategy, these factor portfolios perform far better than passive investments in stocks or bonds. The equity factors also have the extra advantage of high capacity.

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Appendix A: Further sources and calculation methodology

Inflation measurements

For the US we use the Bureau of Labor Statistics headline CPI index, as reported by Bloomberg. The components of inflation shown in Exhibit 3 are from the same source. In the early part of the history, some components report only quarterly or annually, and we therefore forward-fill the indices where there are gaps.

Performance statistics

For each of the asset performance tables we show the regimes relevant to the country in question. For each regime we show the real total return to the asset across the full time for which that regime endures (in case of Exhibits 4, A1 and A2, we also show the nominal returns). We also detail the length of the regime and the extent to which the headline CPI basket rose through it.

We then aggregate the data by showing the compound annual growth rate (CAGR) across all the regimes (8 in the US, 14 in UK and 12 in Japan). If we do not have data for an asset over all the regimes we calculate the CAGR for the regimes that we have. Similarly, we calculate the CAGR for the asset in all other months (i.e., where it was not within an inflationary regime), and then for the combined total.

After the aggregate returns, we present the hit rate, being the percentage of inflation regimes in which the real return to the asset was positive (similarly for the nominal return in the case of Exhibits 4, A1 and A2). Finally, we calculate the heteroskedasticity-consistent t statistic on a regression of the monthly returns to the asset on a constant plus a dummy variable which switches between 1 to indicate where we are in an inflationary regime and 0 where we are not. The t statistic is marked with an asterisk where it is < -2 or > +2 to demarcate where the finding is significant.

US equities and bonds

For US equities, we use Robert Shiller's data for the S&P 500 total return history. For US 10-year Treasury bonds, we use Global Financial Data's total return index. The 60/40 portfolio consists of a 60% S&P 500 and 40% US 10-year Treasury bond investment (capital weighted), rebalanced monthly. All returns to equities and bonds are assumed to be physical, cash-settled transactions.

US fixed income

Data for US Treasury nominal bonds of all three maturities are from Global Financial Data.

Both the IG and HY indices are calculated by Man Group based on data from Morgan Stanley Research. We take the IG spread and the BBB spread as a proxy for HY prior to 1980, and maturity data as reported by MS. We assume the indices were issued at par in January 1921 and that coupons are paid semi-annually to deduce the modified duration. We then take default rates collated by Moody's and assume a 40% recovery rate to calculate the total return.

The historical TIPS index is constructed by Goldman Sachs (Marshall, 2020). To transform into TIPS TR index, we use 10-year nominal yields to calculate Macaulay duration, assuming a par

rate, and then the estimated real yield to calculate modified duration. To calculate the inflation accrual, we lag historic CPI by three months.

Commodities

Nominal returns are funded, in other words the return of the contract plus the risk-free rate as reported by the Kenneth French website. The real returns are the funded returns, minus inflation. The strategies take whichever futures contract is most liquid within the Man AHL database. This is not always the first but will be in the early part of the curve. Groupings are as follows: industrials = copper; precious = gold, silver, and platinum; agris = wheat, corn and soybeans; softs = cocoa, cotton, coffee, and sugar; livestock = cattle and hogs; energies = Brent, WTI, and heating oil. Returns are equally weighted averages, month by month. Where one commodity in the group is not available, the average of the others is taken. The "Commodity Aggregate" category is a month-by-month, equally weighted average of all commodity groups. All returns are in USD. Gold spot returns are from the World Gold Council website.

Real estate

US residential real estate data are the Case-Shiller US house price index. In the early part of the series, the data is quarterly and we linearly interpolate the missing values to make monthly.

Collectibles

We focus on three long-term price series in particular: those for art, wine, and stamps. Goetzmann, Renneboog, and Spaenjers (2008) construct an annual art price index from 1756–2007 using repeat-sales regression, based on sales pairs (of the same work). Dimson, Rousseau, and Spaenjers (2013) construct a wine price index for the five Bordeaux Premier Grand Cru Classé chateaus from 1900–2012, using auction prices. Dimson and Spaenjers (2008) construct an index for stamps from 1899–2008 using the Stanley Gibbons Stamp Catalogue covering 127 collectible stamps. Data are compiled in Credit Suisse's *Asset Returns Yearbook*. These data are real and we transform them to nominal using the long-term GDP deflator calculated in the Bank of England's Millennium of Macroeconomic Data dataset. The series are annual and we linearly interpolate to get monthly values to match up with our regimes.

Dynamic equity factors

Nominal returns are funded; in other words, we used the return of the Fama and French long/short factor plus the risk-free rate as reported on the Kenneth French website. The real returns are the funded return (which adds the risk-free return), minus inflation. We assume 2% annual trading costs. The different factors are formed as a dollar-neutral portfolio that is long stocks which score high on the pertinent metric, and short those which score low. The "Small Minus Big" (SMB) factor is based on market capitalization; the "High Minus Low" (HML) factor uses the book-to-price ratio; the "Robust Minus Weak" (RMW) factor orders stocks on EBT margin; the "Conservative Minus Aggressive" CMA factor uses the annual change in total assets; and Momentum is based on the past 12-month return, skipping the most recent month.

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The last two factors we look at are "Quality Minus Junk" (QMJ) and "Bet Against Beta" (BAB). These are taken from the work of Asness et al. (2014) and Frazzini and Pedersen (2014). *Quality* in QMJ is defined as a combination of profitability (captured through a variety of profit and margin measures per unit of book value), growth (trailing five-year growth in profits), and safety (market beta, volatility of profits, financial leverage, and credit risk). Beta in the BAB strategy uses the CAPM model.

It is worth giving a bit more detail on how we arrived at the 2% figure for annual trading costs. This is a simplification because dynamic strategies such as cross-sectional momentum have much higher turnover than strategies like value. Partly this is just a matter of experience of the costs we feel trading similar strategies. However, a similar result can be arrived at via the following:

Total costs = Dividend withholding tax + Slippage + Financing

Assume a dividend withholding tax of 30% and a yield of 2% (average US level), that gives 0.6% for the first term. Given a holding period of three months and an average slippage of 6bps, the cost would be:

12m/3m x 2 (round trip trades) x 2 (gross book size) x 0.06% = 1.0%

We think 0.4% per annum is a reasonable expectation for financing, so we get:

0.6% (dividend withholding tax) + 1.0% (slippage) + 0.4% (financing) = 2.0%

Trend

We follow the methodology of Hamill, Rattray, and Van Hemert (2016) and Harvey, Rattray, and Van Hemert (2021) and construct a time-series momentum (trend) strategy applied to liquid futures and forwards (or proxies) across assets, but extend the data back further than their original work. For equities, we have data for Japan, the UK, the US, Italy, Australia, and France, from the 1926 start of our sample period. Other markets enter as they become available. For bonds we have US bonds (different tenors) available since 1926, while most European bonds are included from 1950, some years after the dust of the Second World War had settled. In commodities, we have soybeans, corn, and wheat starting between 1940 and 1950. Currencies still only start after the end of Bretton Woods in 1973. We assume annual transaction costs of 0.8%.

Appendix B: UK and Japan

As discussed earlier, we have defined high and rising inflationary regimes for the UK and Japan using the same method we applied to the US. We use the Retail Price Index (RPI) for the UK; and the Nationwide Consumer Price Index (CPI) for Japan. There are differences in the basket weights of the three headline inflation measures chosen, as would be expected in three regions with different consumption patterns. Shelter makes up 32% of the US CPI, 27% of the UK RPI, and 21% of the Japan CPI, as at September 2020. The US CPI is 60% services and 40% goods, whereas the other two are both broadly equally weighted in these categories. These differences are considered of secondary importance, however, when set against the requirement that the measure be widely disseminated, and in the broadest use. The regimes that this approach yields are as we have already shown in Exhibit 15.

In Exhibits B1 and B2, we show the nominal and real returns for equities and nominal bonds in the UK and Japan, as we did in Exhibit 4 for the US. The nominal returns are expressed in local currency (British pound and Japanese yen) and real returns are computed by adjusting for the local realized inflation. Results are broadly in line with the evidence for the US, as presented before, in that both equities and government bonds have negative real returns on average during inflation regimes.

It is noted that UK equities do somewhat better than US stocks. In real terms they are flat (fractionally negative) across the 14 regimes, with a 43% positive hit rate. As a reminder, the US does -7% with a 25% hit rate. Possibly there is a currency effect here. In 1926, when our data start, the pound traded just below $5. Sterling depreciated fairly consistently to present day levels below $2, but these depreciations were often particularly intense around inflationary regimes, as would be expected. It may be that such moves were advantageous to the foreign currency earnings of British stocks, which have always been proportionately significant. Possibly this provided some ballast for the performance of these securities.

Japan's inflationary regime in World War II also bears mention as the one example of a hyperinflation within our dataset. Between December 1941 and August 1946 Japan experienced a 1,432% rise in the general price level. Clearly, it is reductio ad absurdum, and hyperinflation is a very remote probability in the West today, but it is still interesting that in this instance even a diversified equity investor would have lost 95% of their purchasing power.

Exhibit B1: UK equity and Government bond performance across inflationary regimes

Total returns during the identified UK inflationary regimes, as well as the annualized return during inflationary, non-inflationary, and all periods. In the final column we present the hit rate, defined as the proportion of inflationary periods for which the return is positive. We consider both nominal returns (middle panel) and real returns (bottom panel). We provide further characteristics for the specific inflation regimes (top panel). The data are collected from the Bank of England, and run from 1926 to 2020.

| | Specific inflation regimes | | | | | | | | | | | | | | Combined regimes | | | |
	Abdication Crisis	UK enters WW2	Indian Independence	Korean War	Lead up to Suez Crisis	Berlin Wall Built	Harold Wilson becomes PM	OPEC Oil Embargo	Britain goes to the IMF	Iranian Revolution	The Miners' Strike	Big Bang	China demand boom	Eurozone Crisis	Inflation (34%)	Other (66%)	All (100%)	Hit rate
Start month	10-35	09-39	11-47	10-50	07-54	01-61	04-64	12-67	08-76	01-79	03-84	11-86	10-02	12-09				
End month	07-37	08-40	06-48	01-52	04-56	05-62	04-65	08-75	07-77	05-80	04-85	10-90	07-08	09-11				
Length (mths)	22	12	8	16	22	17	13	93	12	17	14	48	70	22				
Total price level chg	7%	21%	8%	16%	11%	7%	6%	122%	18%	29%	9%	32%	22%	10%				
Strategy							Nominal return (total)									Nominal return (ann.)		
Equities	16%	-17%	5%	1%	28%	-4%	0%	60%	31%	20%	37%	54%	78%	4%	8%	11%	10%	79%
Government bonds	2%	8%	3%	-6%	-8%	8%	-2%	45%	18%	13%	12%	44%	26%	17%	5%	7%	6%	79%
Strategy							Real return (total)									Real return (ann.)		
Equities	8%	-31%	-3%	-13%	15%	-10%	-6%	-28%	11%	-6%	26%	16%	46%	-5%	0%	8%	5%	43%
Government bonds	-5%	-10%	-5%	-20%	-17%	1%	-8%	-35%	0%	-12%	3%	9%	3%	7%	-3%	5%	2%	43%

Exhibit B2: Japanese equity and Government bond performance across inflation regimes

Total returns during the identified Japanese inflationary regimes, as well as the annualized return during inflationary, other, and all periods. In the final column we present the hit rate, defined as the proportion of inflationary periods for which the return is positive. We consider both nominal returns (middle panel) and real returns (bottom panel). We provide further characteristics for the specific inflation regimes (top panel). The data are collected from Global Financial Data and run from 1926 to 2020.

| | Specific inflation regimes | | | | | | | | | | | | Combined regimes | | | |
	Takahashi's reforms	Sino-Japan tensions	Sino-Japanese War	WW2	Dodge Line	Series of natural disasters	Typhoon Vera / Civil Unrest	Continuing of 'Economic Miracle'	Izanagi Boom	Tatenokai attempted coup d'etat	OPEC Oil Embargo	Iranian Revolution	Inflation (22%)	Other (78%)	All (100%)	Hit rate
Start month	09-32	08-35	12-36	12-41	01-51	02-53	12-59	12-62	08-67	09-70	10-72	10-79				
End month	07-33	04-36	07-40	08-46	10-51	12-53	11-61	09-63	04-70	09-71	02-74	09-80				
Length (mths)	11	9	44	57	10	11	24	10	33	13	17	12				
Total price level chg	9%	7%	68%	1423%	19%	8%	12%	9%	20%	10%	29%	9%				
Strategy							Nominal return (total)							Nominal return (ann.)		
Equities	78%	16%	42%	-19%	78%	-12%	13%	3%	53%	20%	2%	7%	11%	11%	11%	83%
Government bonds	11%	3%	14%	22%	5%	-3%	-4%	19%	19%	8%	-7%	2%	4%	7%	6%	75%
Strategy							Real return (total)							Real return (ann.)		
Equities	63%	8%	-15%	-95%	50%	-19%	1%	-6%	28%	9%	-21%	-2%	-10%	8%	4%	50%
Government bonds	2%	-4%	-32%	-92%	-12%	-10%	-14%	10%	-1%	-2%	-28%	-6%	-16%	4%	-1%	17%

In Exhibit B3, we show the return to UK residential property. Real returns are positive indicating some inflation protection, but low, and weaker than in normal regimes.

In Exhibit B4, we show the return to Japanese residential land, for which we have better data than for actual housing. Interestingly, Japan shows very strong returns to real estate, in particular contrast to the US, with a real CAGR of +12% and a perfect hit rate. Clearly these regimes take one through Japan's legendary real estate bubble. Indeed, at the peak in 1986, Tokyo real estate was changing hands at $139,000 per square foot, by which reckoning, it is often said, the Imperial Palace was worth more than the entire land value of California. Given these kind of historic extremes (and the crash that followed) we are hesitant to read too much into these results.

Exhibit B3: UK residential real estate performance across inflationary regimes

Total real returns during the identified UK inflationary regimes, as well as the annualized real return during inflationary, non-inflationary, and all periods. In the final column we present the hit rate, defined as the proportion of inflationary periods for which the return is positive. The data are collected from the Office of National Statistics and run from 1926 to 2020. In the early part of the series, the periodicity is annual and we linearly interpolate the monthly readings from these results.

| | Specific inflation regimes | | | | | | | | | | | | | | Combined regimes | | | |
	Abdication Crisis	UK enters WW2	Indian Independence	Korean War	Lead up to Suez Crisis	Berlin Wall Built	Harold Wilson becomes PM	OPEC Oil Embargo	Britain goes to the IMF	Iranian Revolution	The Miners' Strike	Big Bang	China demand boom	Eurozone Crisis	Inflation (34%)	Other (66%)	All (100%)	Hit rate
Start month	10-35	09-39	11-47	10-50	07-54	01-61	04-64	12-67	08-76	01-79	03-84	11-86	10-02	12-09				
End month	07-37	08-40	06-48	01-52	04-56	05-62	04-65	08-75	07-77	05-80	04-85	10-90	07-08	09-11				
Total price level chg	7%	21%	8%	16%	11%	7%	6%	122%	18%	29%	9%	32%	22%	10%				
Strategy	Real return (total)														Real return (ann.)			
Residential real estate	-7%	-12%	3%	-9%	-4%	4%	3%	26%	-9%	8%	1%	24%	34%	-8%	1%	3%	3%	57%

Exhibit B4: Japanese residential real estate performance across inflationary regimes

Total real returns during the identified Japan inflationary regimes, as well as the annualized real return during inflationary, non-inflationary, and all periods. In the final column we present the hit rate, defined as the proportion of inflationary period for which the return is positive. The data are collected from the Japan Real Estate Institute and run from 1926 to 2020.

| | Specific inflation regimes | | | | | | Combined regimes | | | |
	Typhoon Vera / Civil Unrest	Continuing of 'Economic Miracle'	Izanagi Boom	Tatenokai attempted coup d'etat	OPEC Oil Embargo	Iranian Revolution	Inflation (22%)	Other (78%)	All (100%)	Hit rate
	Characteristics									
Start month	Dec 1959	Dec 1962	Aug 1967	Sep 1970	Oct 1972	Oct 1979				
End month	Nov 1961	Sep 1963	Apr 1970	Sep 1971	Feb 1974	Sep 1980				
Strategy	Real return (total)						Real return (ann.)			
Residential real estate	56%	4%	39%	8%	13%	4%	12%	1%	3%	100%

Appendix C: More granular equity sectors

In Exhibit C1 we present real returns to sectors at a granular level. This supports the previous discussion around Exhibit 7 that no non-commodity sector provides meaningful inflation protection. Medical equipment is the only counterpoint, returning +1% real on average, across the eight regimes. Gold miners are the strongest sector on +7%, outpacing other commodity producers. Longer duration sectors such as software (-20% real annualized) are particularly weak.

Exhibit C1: US granular sector performance in inflationary regimes

Total returns to 49 long-only sector portfolios, as collected on the Kenneth R. French website, during the eight US inflationary regimes defined in the paper, as well as the annualized return during inflationary, other, and all periods. In the final column, we present the hit rate (proportion of inflationary periods with positive returns). The majority of the data are from 1926 to 2020, however 6 of the series start later. See Appendix A for details on sources and calculation methodology.

Strategy	US enters WW2	End of WW2	Korean War	Ending of Bretton Woods	OPEC oil embargo	Iranian Revolution	Reagan's Boom	China demand boom	Inflation (19%)	Other (81%)	All (100%)	Hit rate
Start month	Apr 1941	Mar 1946	Aug 1950	Feb 1966	Jul 1972	Feb 1977	Feb 1987	Sep 2007				
End month	May 1942	Mar 1947	Feb 1951	Jan 1970	Dec 1974	Mar 1980	Nov 1990	Jul 2008				
Total price level chg	15%	21%	7%	19%	24%	37%	20%	6%				
				Real return (total)						Real return (ann.)		
Agris	-23%	15%	24%	-7%	-42%	1%	-19%	53%	-2%	7%	5%	50%
Food	-22%	-24%	8%	3%	-38%	-26%	62%	-6%	-4%	11%	8%	38%
Soda				45%	-66%	-23%	-15%	-32%	-10%	14%	8%	20%
Beer	7%	-40%	21%	25%	-65%	-10%	92%	-1%	-3%	12%	9%	50%
Tobacco	-32%	-20%	-2%	8%	-38%	-2%	121%	-4%	-2%	11%	9%	25%
Toys	-48%	-26%	17%	-35%	-78%	-21%	-3%	-24%	-17%	9%	4%	13%
Recreation	20%	-36%	9%	76%	-76%	31%	16%	-42%	-7%	11%	8%	63%
Books	-34%	-47%	33%	-11%	-69%	4%	-17%	-42%	-15%	10%	5%	25%
H'hold	-24%	-21%	20%	8%	-61%	-32%	-2%	-6%	-9%	10%	6%	25%
Apparel	-13%	-22%	18%	6%	-76%	4%	-18%	-27%	-11%	11%	6%	38%
Health				16%	-86%	158%	28%	-17%	-5%	7%	4%	60%
Med. Eq.	1%	-12%	25%	99%	-54%	-9%	28%	-2%	1%	11%	9%	50%
Drugs	-19%	-8%	17%	15%	-38%	-5%	45%	-7%	-1%	11%	9%	38%
Chems	-25%	-17%	28%	-41%	-30%	-20%	2%	6%	-7%	11%	7%	38%
Rubber	-19%	-32%	28%	16%	-64%	-6%	-4%	-20%	-9%	12%	8%	25%
Textiles	-19%	-23%	23%	-27%	-65%	-14%	-6%	-34%	-12%	9%	5%	13%
Building materials	-18%	-24%	28%	11%	-57%	-7%	-7%	-25%	-8%	10%	6%	25%
Construction	-38%	-34%	32%	9%	-59%	46%	-5%	-16%	-7%	7%	4%	38%
Steel	-24%	-21%	27%	-24%	-15%	-23%	5%	-9%	-6%	6%	3%	25%
Fabricated Products				-27%	-53%	21%	9%	12%	-5%	3%	1%	60%
Machinery	-20%	-27%	28%	-19%	-44%	-2%	4%	-8%	-6%	10%	7%	25%
Electrical Eq.	-27%	-38%	19%	0%	-66%	1%	2%	-10%	-10%	12%	8%	50%
Autos	-16%	-32%	25%	-27%	-61%	-34%	-23%	-40%	-15%	12%	7%	13%
Planes	-24%	-43%	15%	-53%	-61%	52%	-15%	-25%	-13%	15%	9%	25%
Ships	-28%	-28%	18%	-12%	-30%	30%	-65%	4%	-10%	9%	5%	38%
Guns				-31%	-35%	38%	-8%	-4%	-4%	13%	8%	20%
Gold				26%	6%	78%	-4%	9%	7%	1%	2%	80%
Mines	-22%	-29%	35%	-6%	-14%	7%	9%	-6%	-2%	8%	6%	38%
Coal	-9%	-19%	23%	85%	4%	-29%	-2%	107%	5%	1%	2%	50%
Oil	-14%	-10%	25%	-20%	-19%	32%	32%	0%	0%	8%	6%	50%
Utils	-43%	-20%	12%	-24%	-38%	-22%	8%	-3%	-9%	10%	6%	25%
Telecoms	-32%	-25%	3%	-19%	-15%	-24%	41%	-27%	-7%	9%	6%	25%
Personal Services	-17%	-26%	3%	4%	-75%	7%	-47%	-17%	-14%	7%	3%	38%
Business Services	-24%	-17%	19%	36%	-68%	15%	-14%	-21%	-8%	10%	6%	38%
Hardware	-18%	-16%	19%	73%	-57%	-20%	-34%	-21%	-8%	13%	9%	25%
Software				-70%	-92%	76%	8%	-10%	-20%	10%	1%	40%
Chips	-9%	-19%	24%	-22%	-63%	1%	-28%	-17%	-10%	12%	7%	25%
Lab Eq.	-18%	-9%	15%	33%	-57%	29%	-25%	-4%	-4%	11%	8%	38%
Paper	-25%	-16%	35%	2%	-30%	-21%	-6%	-26%	-6%	7%	4%	25%
Boxes	-31%	-11%	35%	17%	-46%	-18%	18%	-4%	-4%	11%	8%	38%
Transport	-21%	-38%	24%	-41%	-60%	-13%	-4%	-5%	-12%	10%	5%	13%
Wholesale	-7%	-25%	19%	32%	-58%	12%	-16%	-15%	-6%	6%	4%	38%
Retail	-25%	-24%	19%	12%	-64%	-34%	15%	-16%	-10%	12%	8%	38%
Meals	-16%	-26%	20%	116%	-77%	0%	-5%	-16%	-7%	11%	7%	38%
Banks	-27%	-22%	12%	22%	-49%	-23%	-34%	-39%	-11%	13%	8%	25%
Insurance	-14%	-24%	18%	7%	-50%	13%	-7%	-31%	-7%	10%	7%	38%
Real Estate	-42%	-52%	36%	111%	-87%	45%	-54%	-47%	-17%	5%	1%	38%
Fins	-13%	-34%	23%	18%	-55%	-1%	-35%	-29%	-10%	11%	7%	25%
Other	-13%	-22%	21%	-25%	-74%	11%	6%	-25%	-11%	6%	2%	38%