A quantitative framework for testing macro-economic and financial indicators

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ABSTRACT
Economic indicators are used to track changes in economic activity by measuring employment rates, GDP growth, probability of recessions and other variables. While economists and central banks may use these to predict stresses in the financial system, asset managers use them to position their portfolios. This study develops a systematic framework to analyse and test indicators from a practitioner's perspective. The indicators chosen are varied enough to show the flexibility of the framework. The performance of different asset classes is studied under the different phases of the indicators and the Granger causality test is used to assess lead-lag effects. Ideas for future research, potential improvements to the framework and certain limitations of this work are discussed.

KEYWORDS
Quantitative, macro-economic, indicators, multi-asset, Granger causality

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1. INTRODUCTION

1.1 Economic indicators are used by central banks or government institutions to measure stresses in the financial and economic health of countries, and to determine when to take policy action. Asset managers, analysts, news media, and economic pundits tend to use these indicators spuriously to reinforce their arguments. A good example of this is the Sahm Rule (Sahm, 2022), which states that when the three-month moving average of the national unemployment rate is 0.5 percentage points or more above its low over the prior twelve months, we are in the early months of recession. This rule was created by Dr Claudia Sahm for one specific purpose. The idea was to send stimulus checks automatically if the Sahm rule was triggered, which ensured fast action to make the effects of recessions less severe. The author of the rule clarifies and defends the purpose of her indicator in Sahm (2022), while strongly suggesting that the indicator is not a law of nature but just an empirical regularity. Even though the author explains how the rule could break or fail, it is still used as a recession predictor.

1.2 There are many other examples of selection bias. This occurs when an indicator is selected to fit an argument but not another that goes against it, or selecting certain time periods when the indicator works as proof for it always working, and so on. This study aims to protect against these common pitfalls and human biases. The aim is to develop a framework which generates standard indicators, can easily compare multiple indicators, and enables the user to study the effects of indicators on asset class returns across time periods. Standard tests and reports are produced to prevent cherry-picking data or analyses to support a certain argument. The understanding of asset class return behaviour in the different phases of these indicators can provide insights into taking tactical tilts in portfolios.

1.3 A brief literature review is provided in Section 2. Section 3 describes the methodology used to construct the indicators used in this framework. The results in Section 4 highlight the insights that can be gained from the framework. Ideas for improving and extending the framework – as well as its limitations – are discussed in the final section.

2. LITERATURE REVIEW

2.1 Some of the earliest work on economic indicators comes from the National Bureau of Economic Research (NBER)[1] in the United States of America where Mitchell & Burns (1938) analysed more than 70 economic time series to judge economic activity. Their work highlights the difficulties in developing indicators, as each recession or economic phase had unique characteristics, and the recessions and revivals had different frequencies.

1 Federal Reserve Bank of St. Louis, NBER-based recession indicators for the United States from the period following the peak through the trough [USREC], retrieved from FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/USREC, August 1, 2024

Stock & Watson (1988) used a time-series dynamic factor model to estimate the unobserved variable which was thought of as the overall state of the economy. They used four key macroeconomic time series as inputs, namely industrial production, personal income (total less transfer payments), total manufacturing and trade sales, and employee-hours in non-agricultural establishments. Dynamic factor models, a popular method for forecasting, have also been used by the European Central Bank in Rünstler (2016), and by Combes & Doz (2018) for forecasting French GDP.

2.2 The Organisation for Economic Co-operation and Development (OECD) publishes composite leading indicators (CLIs) for most major economies based on country-specific inputs in OECD (1987). It chooses different economic variables based on relevance, frequency, timeliness and sufficient history. Leading indicators are produced based on pre-selection of series, filtering, evaluation and aggregation. These CLIs are published regularly on the OECD website. The country-specific inputs and indicators make these CLIs more useful across different economies. For example, the CLI for Italy is based on six variables (consumer confidence indicator, manufacturing survey on future tendency, manufacturing survey on order books, deflated orders for manufactured goods, consumer price inflation and imports from Germany) whereas the one for South Africa is based on six different variables (share prices, car sales, spread of interest rates, manufacturing confidence indicator, manufacturing orders inflow divided by demand and building permits). A CLI level above 100 indicates that the economy is generally expanding and CLI below 100 means the economy is generally declining.

2.3 Comincioli (1996) evaluated the stock market as a leading indicator and explored relationships between stock prices and the economy. In his study, Granger causality tests, first introduced in Granger (1969), are used to statistically examine the relationship. The results indicated a Granger-causal relationship between the stock market and the economy. It was observed that while stock prices Granger-caused economic activity, no reverse relationship was observed. Granger causality tests are used in this framework to test relationships between indicators and asset return series.

3. DATA AND METHODOLOGY

3.1 The data used in this study is described in Table 1. It comprises of monthly returns in USD for four asset classes, represented by their corresponding indices: the JP Morgan Government Bond Index serves as a proxy for global bonds, the All Country World Index for global equities, the JP Morgan Global Cash Index for global cash, and gold as itself. For simplicity, these will be referred to as Global bonds, global equities, global cash, and gold throughout the paper. This research is constrained by the available data, and Table 1 shows the available dates for the return series of each asset class and Figure 1 shows the distribution of monthly returns.

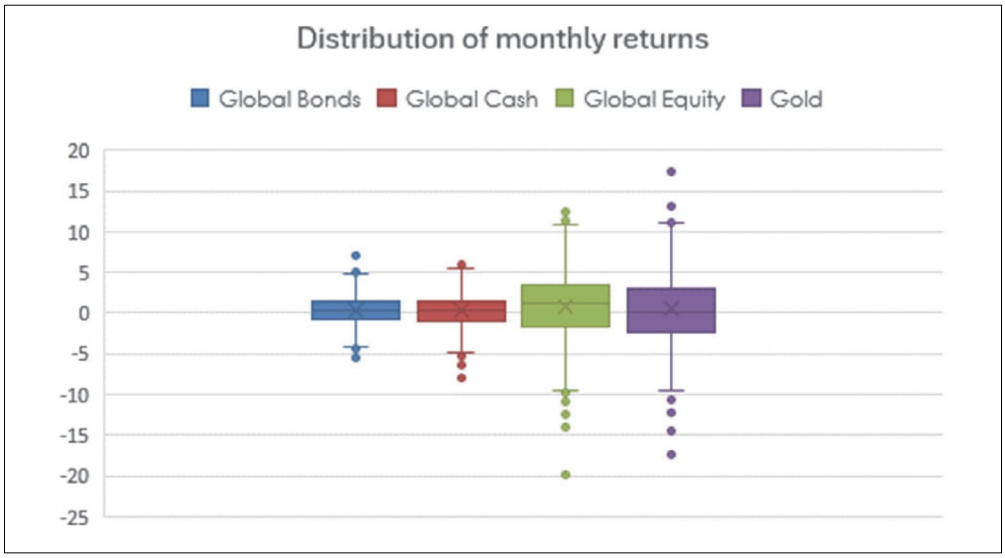

Figure 1. Distribution of monthly returns from different asset classes

Table 1. Properties of the return series used in this framework

Asset Class Name	Index Name	Period
Global equities	MSCI All Country World Index (ACWI)	Jan 1988–Jul 2024
Global bonds	JP Morgan Government Bond Index	Jan 1988–Jul 2024
Global cash	JP Morgan Global Cash Index	Jan 1988–Jul 2024
Gold	Gold	Apr 1968–Jul 2024

3.2 The four indicators used in this work are the standard OECD CLIs, the NBER recession indicator, an interest rate momentum indicator based on the Federal Funds rate and an indicator based on the Purchasing Managers' Index (PMI) which measure manufacturing activity. The OECD CLI is rebased to be centred around zero rather than 100. The level and change in the OECD CLI are used to define four phases namely recession, reflation, recovery and overheat. The NBER recession indicator is a binary indicator and is used as is. It is one when there is a recession and zero otherwise. The interest rate momentum indicator is a systematic way of capturing interest rate hiking, cutting and flat cycles. This indicator compares the level of interest rates at any time to the past six-month average, and has three phases – hiking, cutting and flat. The PMI-based indicator filters the raw published manufacturing PMI numbers with a Hodrick–Prescott (HP) filter (Hodrick & Prescott, 1997) to get a smoothed series. The level and change of this smoothed series are used to define four phases, like the OECD indicator. To achieve consistency in interpretation of the indicators, the PMI-based indicator is also rebased to be centred around 0, rather than 50. All these indicators are global, but the framework can

work on any indicator and any return series. Figure 1 shows graphically how the phases are defined. The four phases are defined as follows:

— Recession when the PMI or OECD CLI indicators are less than 0 and decreasing,
— Reflation when the PMI or OECD CLI indicators are less than 0 and increasing,
— Recovery when the PMI or OECD CLI indicators are more than 0 and increasing, and
— Overheat when the PMI or OECD CLI indicators are more than 0 and decreasing.

3.3 The history of the different indicators is shown in Figures 2 and 3. The PMI-based indicator and the OECD indicator through time are shown in Figure 2. The raw published values from both these indicators are smoothed to account for short-term volatility and the indicators are calculated based on the smoothed values shown. The calculation and history of the interest rate indicator is shown in Figure 3. The interest rate indicator is based on the Federal Funds rate and its six-month average.

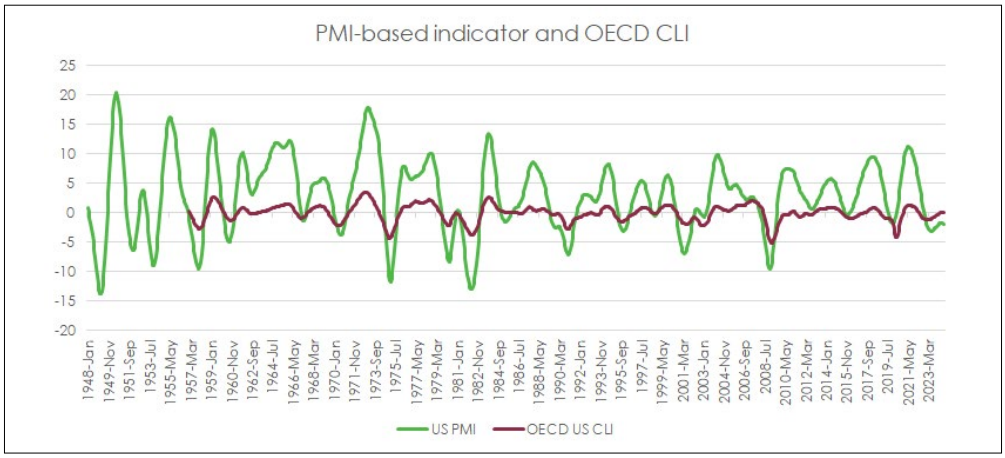

Figure 2. The smoothed PMI-based and OECD CLI indicators through time

3.4 There are two types of analyses built into the framework: coincidental and lead/lag. The coincidental analysis shows how asset classes behaved during certain phases of the indicators, for example to study the performance of equities during recessionary phases. The lead/lag analysis shows how asset classes behaved a certain number of months after the phases, for example to study the performance of equities in the three or six months following the month flagged as recession. Both these ways of analysing asset classes help in understanding and with taking tactical tilts in portfolios. The distribution of asset class returns is studied instead of only looking at the mean or median returns to get a better sense of the risk and return characteristics within phases. Granger causality tests are performed to test for Granger causality between the phase changes and asset class returns, strengthening the possibility of a cause-effect relationship between them.

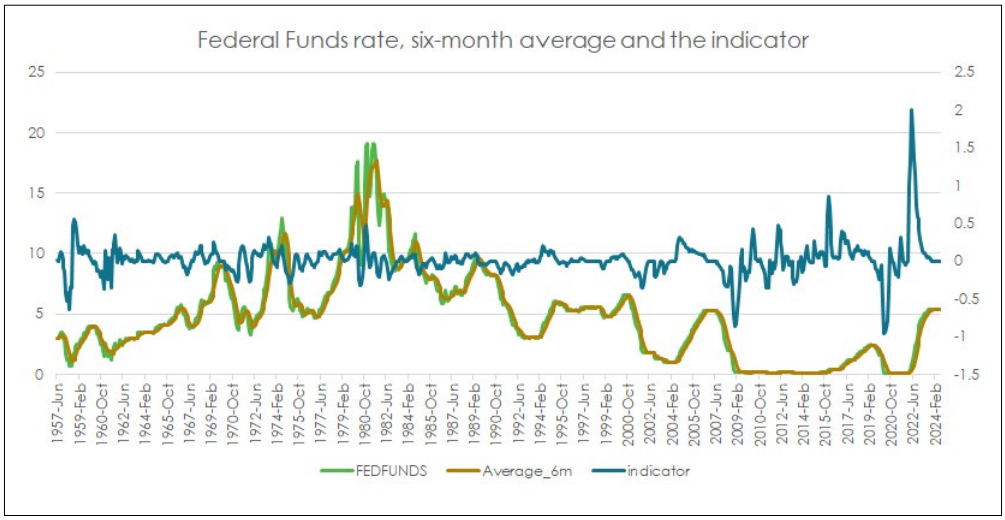

FIGURE 3. The interest rate indicator based on the federal funds rate and its six-month average. The rates are shown on the left axis and the indicator values on the right. When the indicator is above zero, the phase is a hiking cycle, below zero is a cutting cycle and close to zero is considered to be flat.

4. RESULTS

The results are split into sections based on the indicator used and the format of the results is kept consistent. The first plot in each section, figures 4, 6, 8 and 10, plots the median monthly returns for each asset class in each of the phases based on the respective indicator and the second plot, figures 5, 7, 9 and 11, shows the full distribution of returns using a box and whiskers plot. While the median plots provide a summary of the results, the distribution plots show the risk associated with each asset class return in every phase. Only coincidental returns are shown in this paper, but the same plots can be used to show lagged returns.

4.1 PMI-based indicator with four phases: recession, reflation, recovery and overheat

Figures 4 and 5 show the results using phases from the PMI-based indicator. Global equities, unsurprisingly, seem to underperform in recessionary phases but outperform in other phases. Bonds and cash outperform in recessionary phases and gold outperforms in both recessionary and reflationary phases. A similar pattern is seen using the OECD indicator in the next section.

4.2 OECD CLI indicator with four phases: recession, reflation, recovery and overheat

The OECD CLI and its four phases can be used to compare results with the PMI-based indicator. They track economic cycles using different underlying data. The plots show

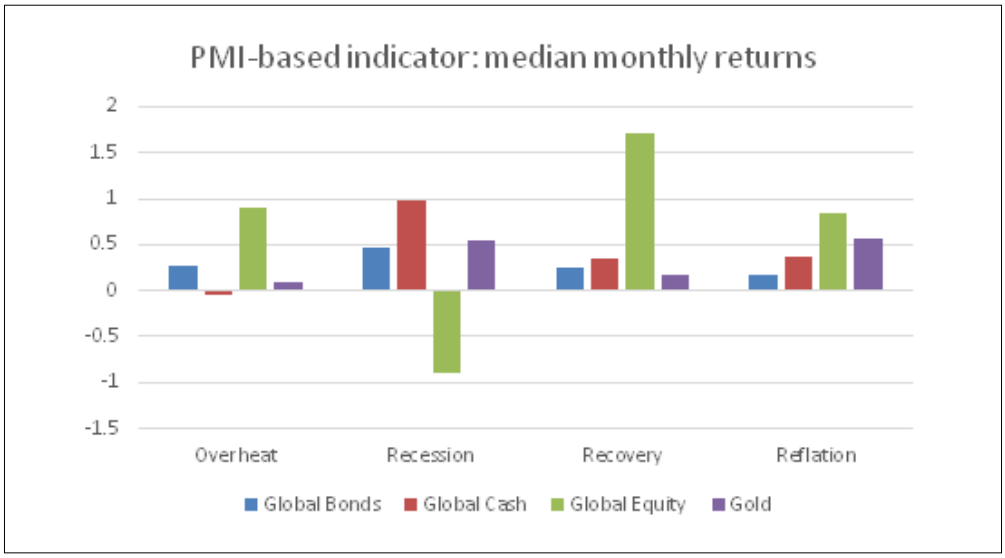

FIGURE 4. Median returns for asset classes based on phases using the PMI-based indicator

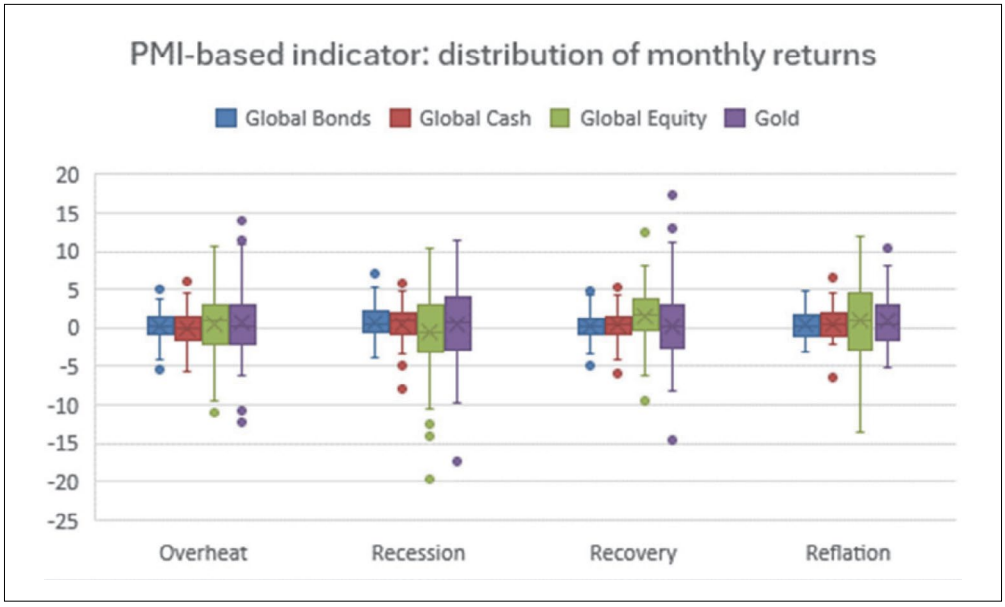

FIGURE 5. Distribution of returns for asset classes based on phases using the PMI-based indicator

similar patterns where equities underperform in recessionary phases while outperforming in recoveries. Bonds and cash do well in recessionary phases, while gold outperforms in both recessionary and reflationary phases.

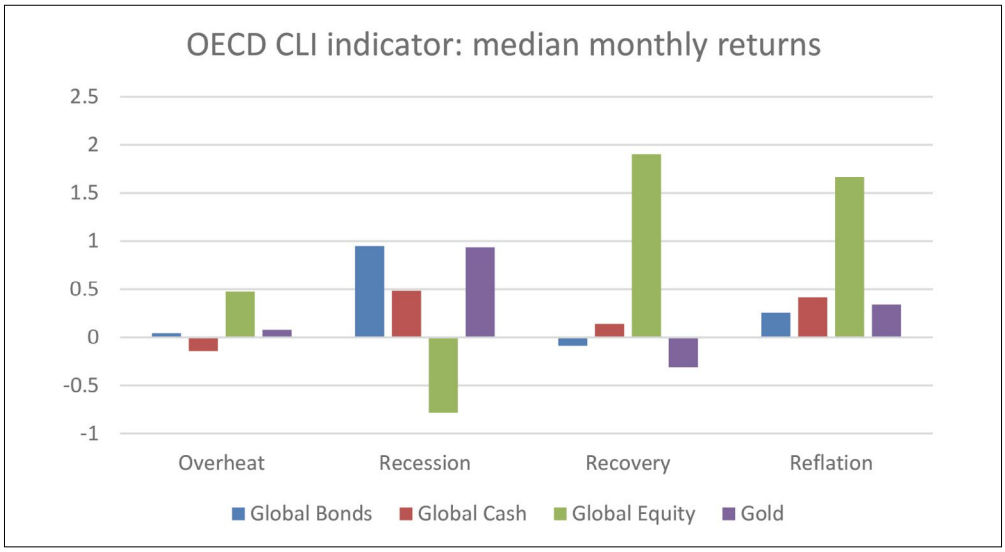

FIGURE 6. Median returns for asset classes based on phases using the OECD CLI indicator

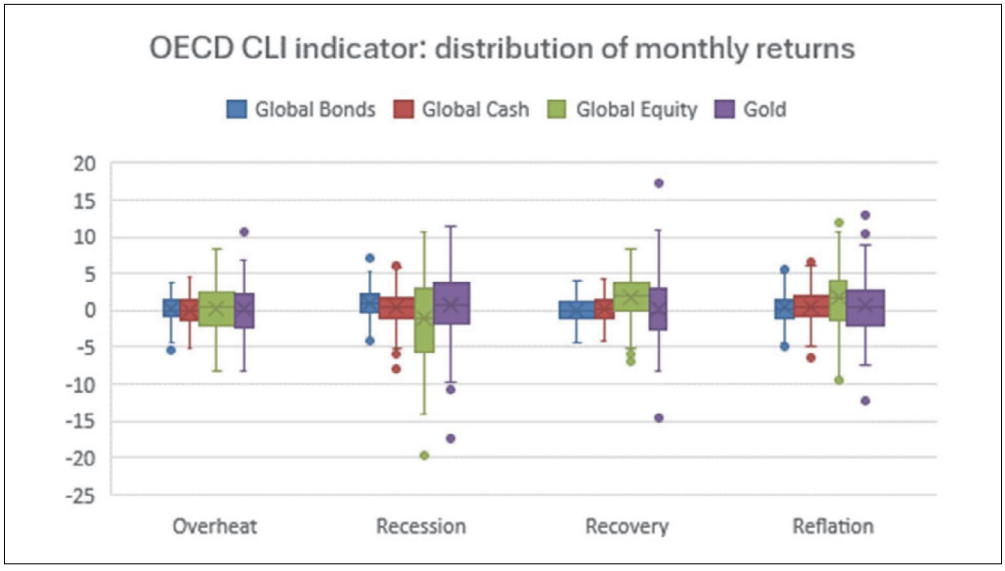

FIGURE 7. Distribution of returns for asset classes based on phases using the OECD CLI indicator

4.3 Interest rate indicator with three phases: hiking, cutting and flat

The interest rate indicator with three phases highlights the flexibility of this framework. Any indicator with any number of phases can be used to analyse any return series. Gold underperforms during flat cycles, while equities consistently outperform. Figures 8 and 9 show the distribution of monthly returns.

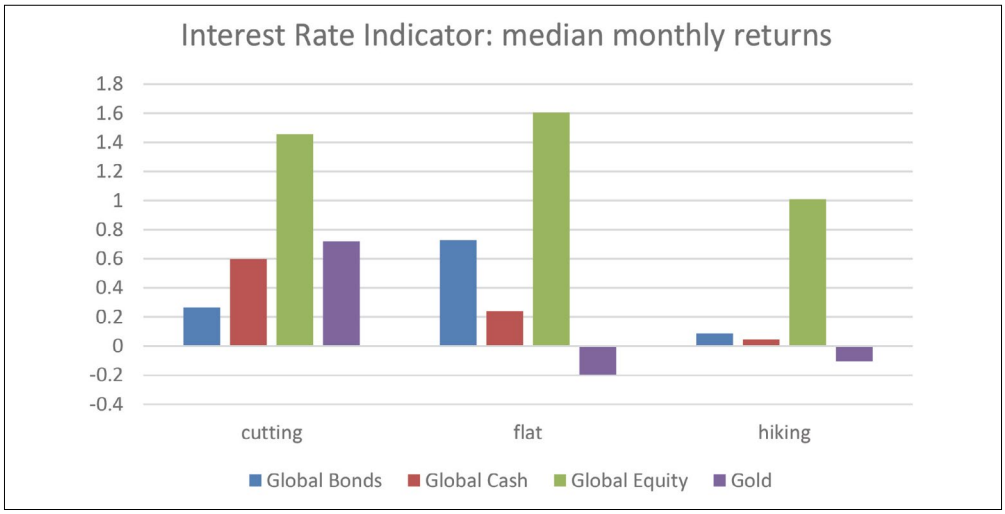

FIGURE 8. Median returns for asset classes based on phases using the interest rate indicator

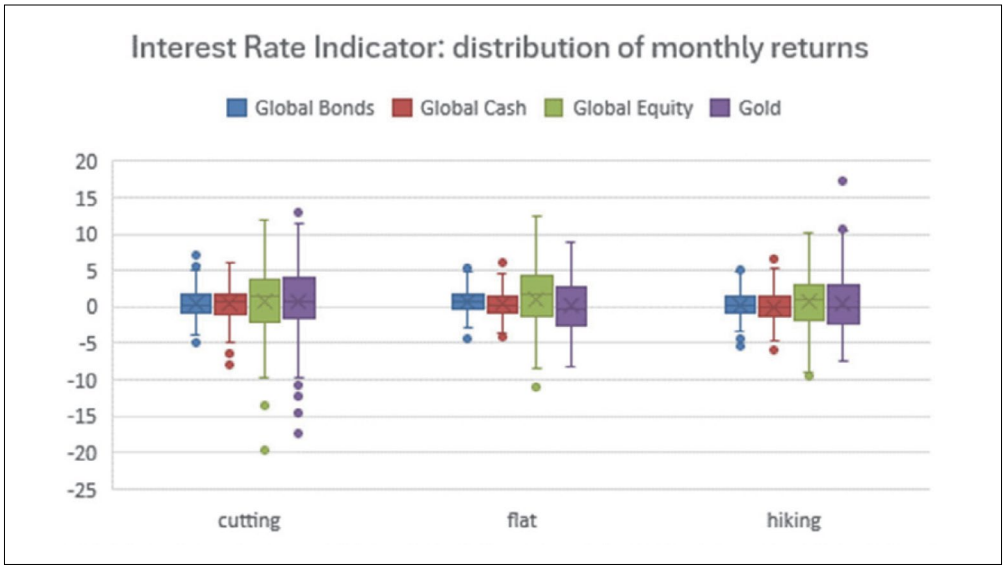

FIGURE 9. Distribution of returns for asset classes based on phases using the interest rate indicator

4.4 NBER recession indicator with two phases: recession and no recession

While the other indicators were developed by the authors, the NBER recession indicator is a standard indicator published and used by widely. This indicator and others can be tested for efficacy using the framework. Equities underperform in recessions and outperform otherwise, while gold, cash and bonds outperforms in recessions. These results are consistent with the PMI-based and OECD indicators.

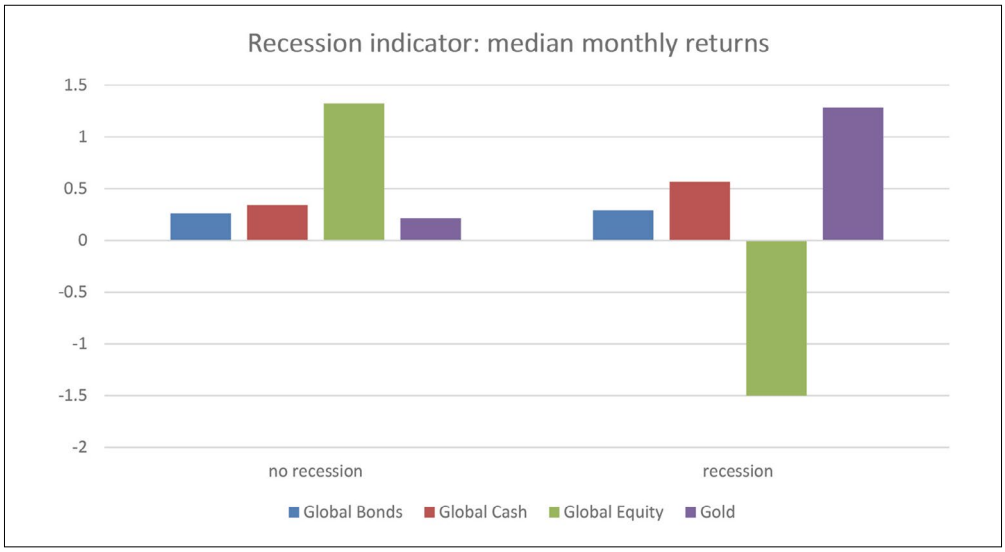

FIGURE 10. Median returns for asset classes based on phases using the NBER recession indicator

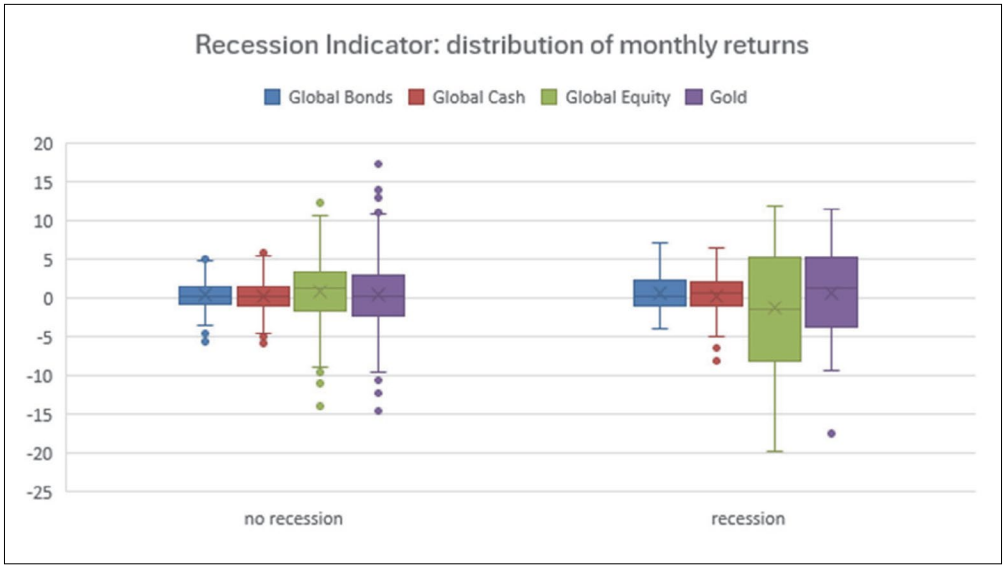

FIGURE 11. Distribution of returns for asset classes based on phases using the NBER recession indicator

4.5 Granger causality test

4.5.1 Granger causality test results on the PMI-based indicator are shown in Table 2. The test was conducted using the indicator phases and the subsequent returns over different periods from one month to one year. Low p-values (lower than 5%) mean that the null hypothesis was rejected and there is a Granger-causal relationship between

the series. The table shows that equity returns show strong relationships to the indicator roughly between 6 to 12 months lagged whereas bonds show stronger causality for a shorter horizon, less than 6 months.

Table 2. Granger causality test results for the PMI-based indicator and equity and bond returns

Asset class		Subsequent 3-month return	Subsequent 6-month return	Subsequent 9-month return	Subsequent 12-month return
Global equities	F test	0.08493	3.7244	13.095	20.9151
	p-value	0.3571	0.054	0.0003	0.00
Global bonds	F test	6.5514	4.0863	2.0744	0.9564
	p-value	0.0107	0.0436	0.1502	0.3284

5 DISCUSSION

5.1 There are some limitations or points to consider while thinking about this framework. This analysis relies on indicators with a long history, but each period will have idiosyncratic events in them so each period could be very different. For example, the causes of recessions have been different at different times, making it hard to get a leading indicator that works for all recessions. As with everything else in finance, and real life, just because something happened in the past doesn't mean it will happen in the future. Indicators can fail and there is uncertainty around their predictive power. One way to use this framework is to study and understand the behaviour of asset class returns, rather than forecast them. Another way is to use the indicator to tactically tilt portfolios rather than making major changes to the asset allocations.

5.2 While it is systematic to breakdown the indicator into different phases, care must be taken to ensure there are enough returns data in each of the phases for the analyses to have meaning. For example, the four-phase indicators can be split into two additional phases, namely early-recession and late-recession, but this will reduce the number of returns data points in each phase.

5.3 For the Granger causality test, if we use the unsmoothed PMIs as the inputs, we get poor results for causality. This raises the question of comparing smoothed versus unsmoothed PMIs. Monthly PMIs can be erratic, and a smoother series is desirable while building indicators because it is very difficult to say why an economy would switch phases back and forth monthly. Also, because we are investigating this from an asset manager lens, a smoother indicator is more desirable. It might be difficult to tactically shift portfolios back and forth monthly. Yet another reason for the need for a smooth indicator is that macroeconomic effects are slower to develop and take time to get better and worse.

5.4 There is a lot of scope for further improvements on this existing framework. Seasonality is one of the concepts that can be explored further statistically. It will help answer questions like whether certain asset classes consistently outperform or underperform in certain calendar months or quarters. An easy improvement to the framework would be to keep adding more indicators and more asset class returns to cover more countries and investment universes.

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REFERENCES

Combes, S & Doz, C (2018). Forecasting French GDP with dynamic factor models: a pseudo-real time experiment using factor-augmented error correction models. Paris School of Economics, Working Paper No 2018-28

Comincioli, B (1996). The stock market as a leading indicator: an application of Granger causality. *University Avenue Undergraduate Journal of Economics* **1**(1): Article 1

Granger, CJ (1969). Investigating causal relationships by econometrics models and cross spectral methods. *Econometrica*, Vol. 37, 1969: 425–435

Hodrick, R & Prescott, EC (1997). Postwar U.S. business cycles: an empirical investigation. *Journal of Money, Credit, and Banking* **29**(1): 1–16

Mitchell, WC & Burns, AF (1938). Statistical indicators of cyclical revivals. New York: NBER.

OECD (1987). OECD leading indicators and business cycles in member countries, sources and methods 1960–1985, No-39

Rünstler, G (2016). On the design of data sets for forecasting with dynamic factor models. Working Paper Series No. 1893, European Central Bank

Sahm, C (2022-12-30). The Sahm rule: I created a monster. Substack. Retrieved 2024-07-31

Stock, JH & Watson, MW (1988). A probability model of the coincident economic indicators. NBER Working Paper No. w2772