Investment Strategies No. 74

Simple rules to trade duration

Global Asset Allocation

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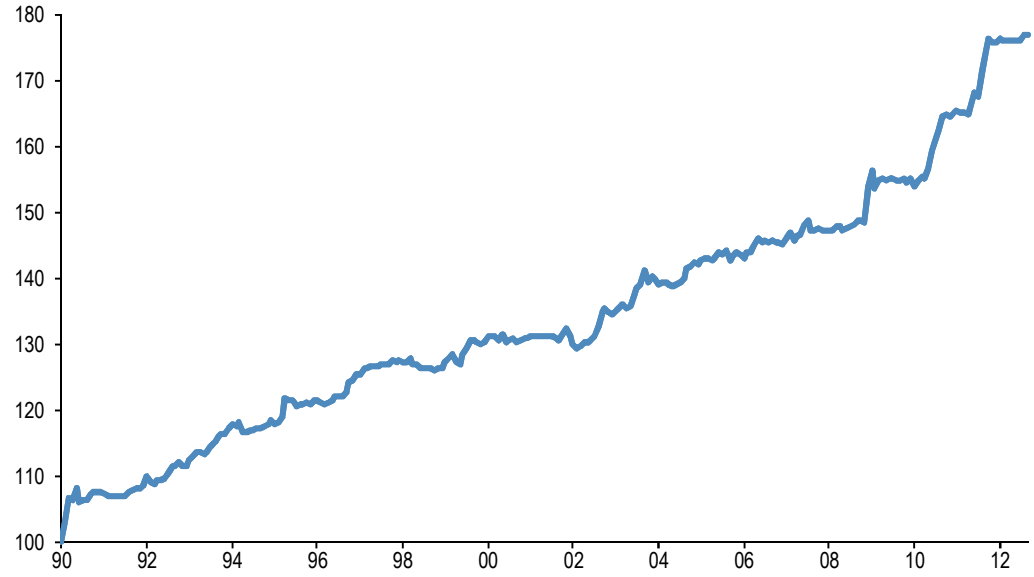
- In this paper, we describe a range of simple systematic rules for trading duration, through futures on 10-year US, German, Japanese and UK government bonds. These rules provide a complement to more qualitative and discretionary judgments on duration.
- We use signals based on **economic news**, **price momentum**, **past equity returns**, and **carry**.
- Individually, each of these signals has produced solid returns. Together, they would have generated a return to risk of 1.1, net of transaction costs, in G-4 10-year bond futures since 1990, as shown in Figure 1. That illustrates the benefit of combining a range of diverse signals in taking a duration view.
- At present, the combined strategy argues for a small short duration position overall, with bond bearish signals from rising manufacturing PMIs and equity prices, together with below average carry, outweighing the bullish signal from positive bond momentum.

Figure 1: Cumulative return of combined duration strategy in G-4 10-year futures
Index, 1990 = 100



Source: J .P. Morgan

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This paper describes a set of simple rules for trading duration, through 10-year government bond futures. These rules can be used on a standalone basis, or as a complement to more discretionary judgments about duration, including as an overlay to a long-only bond portfolio.

We combine five signals for duration timing:

- Manufacturing purchasing manager indices (PMIs)
- Equity analysts' earnings forecast revisions, from IBES
- Bond futures price momentum
- Equity price momentum
- The slope the yield curve, as a measure of carry.

Together, these signals seek to **capture a range of influences on bond yields, in a simple and transparent fashion**. Those influences include economic news (via the PMI and earnings revisions), investor perceptions of risk (via past equity returns) and value/carry (via the curve slope).

Many of these indicators have been discussed previously, both in our *Investment Strategies* series, and in academic studies. We build on these studies on a range of fronts. For one, we show how **changes in equity analysts' earnings forecasts capture much of the variation in GDP growth**, at an early stage in the data cycle, and thereby can predict bond returns. We also discuss how the **global economic indicators provide a better guide to future bond returns than the corresponding local indicators**. And we focus in particular on what precise form of these signals has worked best for duration timing over the recent past, and on the **diversification benefit of combining the signals**.

Our analysis is based on returns on 10-year government bond futures for the US, UK, Germany and Japan since 1990. All the signals are rebalanced monthly, mostly at the start of the month. We adjust returns for transaction costs, although these transaction costs do not affect returns significantly, because the signals take outright positions in highly liquid futures.[1]

The paper is organized as follows: we first describe the five signals we use for duration timing, then discuss the benefits of combining the strategies and the directionality of the strategy, and conclude with the current recommendations from this approach.

1. Manufacturing PMIs

We focus initially on two related measures of economic momentum: the IBES analysts' upgrade to downgrade ratio, and, first, manufacturing purchasing manager indices (PMIs). PMIs collate firms' responses on how business conditions, including orders, output and employment, have changed over the past month. Changes in J.P.Morgan's Global Manufacturing PMI have historically been both a good guide to shifts in global GDP, and a useful signal for market timing in equities, fixed income and commodities.[2]

Changes in PMIs are strongly serially correlated, in common with many other activity releases. For example, a fall in the Global Manufacturing PMI one month has on average been followed by a fall the following month close to two out of three times, and vice versa. The success of any economic momentum signal of this kind in predicting returns essentially relies on markets not fully accounting for the pronounced serial correlation in the activity data.

That would be consistent with some degree of "anchoring" in investors' expectations, such that they only take account of changed circumstances gradually. And indeed, there is strong evidence for anchoring in economists' forecasts at least, both for overall output and inflation and for individual data releases.[3]

A key question in using PMIs to forecast returns is whether, for a given country's bond market, the local PMI or the global PMI is the better predictor. The local PMI clearly should be more attuned to local conditions, and to local monetary policy. Against that, there are two reasons to favour the global PMI: first, the high correlation between long-term interest rates suggests they may respond more to global than local economic conditions; second, **movements in country PMIs contain some degree of noise, which is more likely to cancel out in the global PMI**.

Consistent with this second point, changes in country PMIs tend to be more closely related to past changes in the global PMI than their own past changes. For example, across major economies, the average correlation between monthly changes in country PMIs, and the previous month's change

[1] We assume transaction costs, per trade, of half a 32nd for Treasury futures, 0.01% of par for German Bund futures, and 0.02% of par for UK gilt and JGB futures.

[2] See Nikolaos Panigirtzoglou, *Using the Global PMI as a trading signal*, Jan 2012.

[3] See John Normand, Which Trade?, Jan 2004, and Seamus Mac Gorain, *Trading on Economic Data Releases*, Mar 2011.

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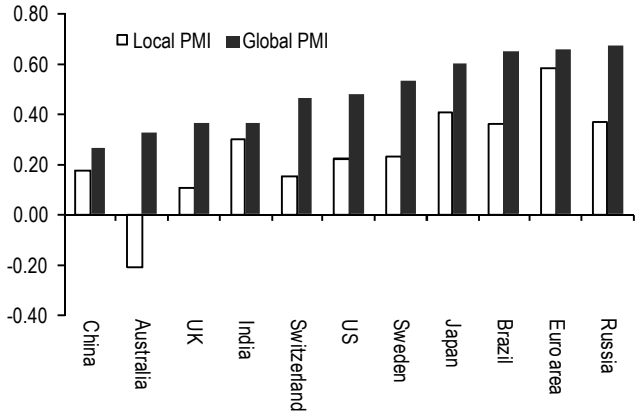
in that PMI, has been 0.24 over the past five years (Figure 2). By comparison, the average correlation with the previous month's change in the global PMI over that period was 0.49.

Figure 2: Serial correlation of manufacturing PMIs
Correlation of monthly changes with previous month's change in local and global PMI. Past five years.



Source: J.P. Morgan

How effective is the PMI as a duration signal? Figure 3 shows the return to risk of a simple trading rule, which goes long duration if the local or global PMI fell over the previous one, two, or three months, and short duration if it increased.

Figure 3: Return to risk of duration rule based on PMIs
Data since 1998.

	US	Japan	Euro area	UK	Combined
Local					
1m	-0.15	-0.19	0.39	0.39	0.22
2m	0.32	-0.02	0.43	0.73	0.58
3m	0.45	0.18	0.41	0.56	0.57
Global					
1m	0.37	0.15	0.61	0.45	0.49
2m	0.52	0.28	0.66	0.57	0.62
3m	0.39	0.03	0.51	0.45	0.44
Combined					
1m	0.13	0.01	0.55	0.52	0.42
2m	0.45	0.15	0.62	0.72	0.64
3m	0.43	0.12	0.46	0.56	0.53

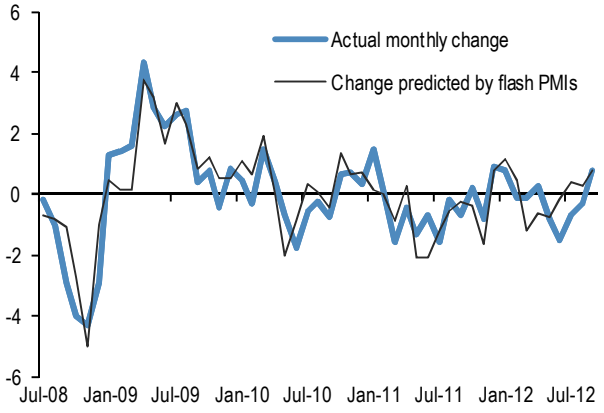
Source: J.P. Morgan

For simplicity, we do not apply a threshold to the PMI, i.e. any increase or fall is sufficient to generate a trading signal. The rule rebalances monthly, one day after the release of the latest PMI data. The release is on the first business day of the month for the global PMI, but around a week before the end of the month for the Eurozone flash PMI. The returns are calculated since the Global PMI becomes available in 1998.

The first panel of Figure 3 shows the return to risk of trading in each market, and all four in combination, using the local country PMIs; the second panel, the results using the global PMI in each country; and the third using both the local and global PMIs in combination i.e. going long only if both the global and local PMIs are falling, and short only if both are rising. We highlight four features of these results:

- First, **the two-month change in the PMI has historically been the best predictor** of the following month's returns, striking a balance between timeliness and the greater volatility and noise of monthly changes.
- Second, for the US, Japan and Euro area (but not the UK) the global PMI has been a better signal than the local PMI, in line with the discussion above.
- Third, once the returns for all four countries are combined there is little overall difference between using the local or global PMIs i.e. **the diversification of using different signals for each country counterbalances the fact that in three of the countries the global PMI is the better signal**.
- Fourth, there is a modest benefit to using the global and local PMIs in combination for all four countries.

Figure 4: Actual and predicted changes in Global PMI
Index points. Relationship between flash PMIs and Global PMI estimated recursively.



Source: J. P. Morgan

The US ISM and UK PMI are, like the global PMI, released on the first business day of the month. These releases are however foreshadowed by flash PMIs from China, the Eurozone and, since May, the United States. Already the Eurozone and Chinese PMIs provide a decent guide to the

global PMI outturn, partly as a simple matter of composition, but also because they give an early steer on the closely-integrated global manufacturing cycle (Figure 4).

In the past, a best guess of the global PMI, updated intra-month to take account of the early releases, would have provided a slightly better duration signal than waiting for the global PMI release at the start of each month. This is likely to be more all the more true in the future, to the extent that the US Markit Flash PMI becomes a barometer of the US manufacturing sector, comparable to the longstanding ISM survey.

In what follows, **we use the two-month change in the local and global PMI in combination**. Thus, for each country, we go long only if both the local and global PMI have fallen over the past two months, and short only if both have declined. We update the signal not just at the start of the month, with the release of the US, UK and Global PMI, but also intra-month, to take account of the earlier PMIs in Japan and the Euro area. A time series of the return from trading the PMI signal, together with each of the others in this paper, is shown in section 9.

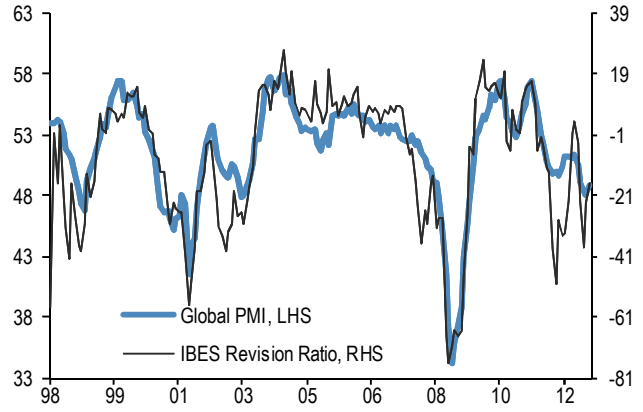
2. IBES earnings revision ratio

Of course, any one measure can provide only an approximate guide to swings in the economic cycle, underlining the importance of tracking a number of measures of economic momentum. One alternative and complementary signal comes from equity analysts' earnings forecasts.

In particular, we use the widely-followed earnings revision ratio, collated by the Institutional Brokers' Estimate System (IBES). This is calculated as the difference between the number of upward earnings revisions and downward earnings revisions over the past month, as a proportion of the total number of firms for which equity analysts provide 12-month-rolling earnings forecasts. As such, it is a **timely guide to whole-economy corporate earnings momentum**. The monthly version is released on the Tuesday after the third Friday of each month, and is available for a wide range of equity indices, including global equities (e.g. MSCI World) and country/region indices.

We interpret the revision ratio not as an equity market signal per se, but rather as a window from stock market earnings to overall economic prospects. In that respect it is similar to, and comoves closely with, the Global PMI (see Figure 5).

Figure 5: Global manufacturing PMI and MSCI World earnings revision ratio



Source: J. P. Morgan, IBES

Both indicators are closely related to global GDP growth. The **Global Composite PMI can explain 66% of the variation in global GDP growth since 1998, while the revision ratio can explain 58%,** though with the advantage of being released around a week and a half earlier.

Because the revision ratio and the PMI have different coverage, and come at a slightly different point in the monthly data cycle, each measure contains information not captured by the other. One illustration of this is that changes in the revision ratio predict changes in the global PMI, and vice versa (i.e. statistically, both indicators 'Granger cause' the other).

Figure 6: Regression of monthly PMI change on lagged PMI and revision ratio

	1	2	3
Lagged PMI change	0.45		0.23
	6.56		*3.26*
Previous revision ratio change		0.57	0.46
		9.05	*6.60*
Adjusted R-sqr	0.20	0.32	0.36

T-statistics in italics.

Source: J. P. Morgan

By way of example, Figure 6 shows a simple regression relating monthly changes in the PMI to its own previous two-month change (regression 1), the previous two-month change in the revision ratio (regression 2), and both together (regression 3). The changes are standardized so that the regression coefficients are comparable. These regressions confirm that the PMI can be predicted using its own lagged changes, and past changes in the revision ratio.

Figure 7 shows the return to risk of a simple trading rule, relating futures returns to changes in IBES revision ratios,

since 1990. As before, rebalancing is monthly, one day after the release of the new revision ratio. Just as in Figure 3, we show the return from using earnings revisions for local equity indices (e.g. MSCI US for the United States) and global equities (MSCI World). We do recognize, however, that with a significant share of stock market earnings coming from overseas, the link between local stock market earnings and local economic prospects is inexact.

Figure 7: Return to risk of duration rule based on earnings revision ratios

Data since 1990

	US	Japan	Euro area	UK	Combined
Local					
1m	-0.05	-0.35	0.17	0.79	0.33
2m	0.44	-0.16	0.18	0.74	0.55
3m	0.22	-0.02	0.62	0.46	0.52
Global					
1m	0.46	0.17	0.44	0.53	0.51
2m	0.17	0.15	0.48	0.42	0.38
3m	0.44	0.11	0.64	0.42	0.51
Combined					
1m	0.24	-0.12	0.38	0.83	0.50
2m	0.34	0.00	0.37	0.72	0.50
3m	0.37	0.06	0.73	0.56	0.58

Source: J. P. Morgan

We would note the following aspects of these results:

- Both the local and global revision ratios would have provided successful signals for trading duration.
- Similar to the PMI, the global revision ratio has proved a better signal on the whole for trading duration in individual markets, but the diversification benefit of using different signals offsets this benefit when trading all four markets together.
- The overall return to risk from the revision ratio signal would have been up to 0.6 since 1991. Measured over the same sample as the global PMI (i.e. since 1998), the return risk would have been somewhat higher, at up to 0.7.

Based on these results, our preference is to **use the 3-month change in the local and global revision ratios in combination.**

3. Futures price momentum

In addition to economic momentum, simple price momentum has also been a consistently successful signal for trading duration, as we have described previously in our *Investment Strategies* series.[4]

The underlying rationale here is the same: that investors initially underreact to news, and perhaps later overreact. By definition, price momentum relies on changes in expectations about key market drivers being serially correlated. We have discussed above how this is likely the case for economic expectations, and the repeated disappointment in growth outcomes this year is in keeping with this pattern. Similarly, **shifts in monetary policy have historically been very persistent**, with central banks typically hiking by more than expected in tightening cycles, and especially easing by more than expected in loosening cycles.

On the other hand, **the increased importance of government interventions in driving market prices post-crisis is perhaps a challenge for momentum**. For example, Euro area leaders' approach of meeting severe market pressure with new policy proposals, but seeming to row back when market pressure abates, has contributed to the now-familiar up-and-down cycle for peripheral asset prices (albeit within the context of a longer-term downward trend).

Figure 8 reviews the return to risk of bond momentum strategies since 1990. Specifically, the strategy goes long duration if our futures return index for each country is above its average for the past one, two, three, six or twelve months, and short otherwise. One advantage of comparing the current level to its past average rather than say, the one-month-ago level, is that it avoids trading due to base effects instead of recent market movements. The signal rebalances on the second day of each month, based on the previous day's closing prices, as do the two signals that follow. This date is chosen to match the rebalancing date of the Global PMI signal, for easier comparability.

Figure 8: Return to risk of futures momentum

Data since 1990

	US	Japan	Euro area	UK	Combined
1m	0.51	0.48	0.20	0.00	0.41
2m	0.43	0.54	0.40	-0.03	0.45
3m	0.33	0.62	0.30	0.41	0.58
6m	0.37	0.41	0.45	0.41	0.55
12m	0.42	0.53	0.52	0.42	0.62

Source: J. P. Morgan

[4] For example, Gianluca Salford, *Momentum in money markets*, May 2007, and Grace Koo and Nikolaos Panigirtzoglou, *Global bond momentum*, August 2008.

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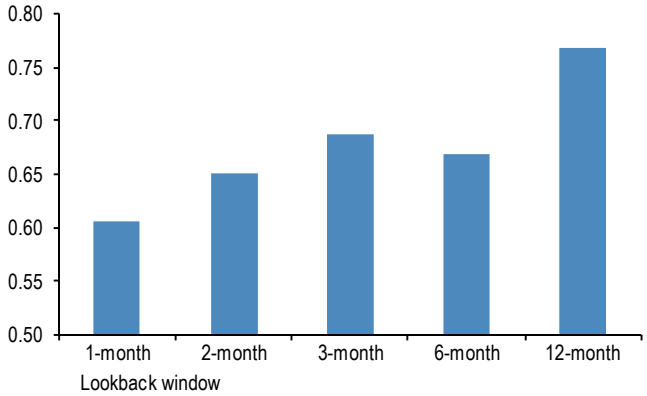
All of the momentum strategies have been solidly profitable in each country. Over this period, the best return has come from 12-month momentum, with a return to risk of 0.6 for all four countries combined, compared to 0.4 for 1-month momentum.

In interpreting this result, it is important to bear in mind that 12-month momentum has performed best because the signal was overwhelmingly long (77% of the time) during a near-relentless bull market. The difference in performance across different lookback windows essentially reflects the proportion of months each signal was long (Figure 9).

Figure 9: Proportion of months for which each signal is long



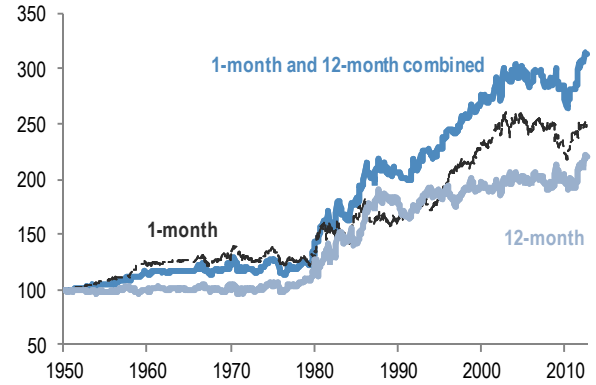
Source: J. P. Morgan

Of course, the rally of recent decades represents a somewhat unusual period for bond markets, and we might not expect a longer lookback window to perform so well in a different environment. For example, using US Treasury returns since 1950, we find relatively little difference in performance between 1-month and 12-month momentum overall, with essentially no return on 12-month momentum from 1950 to the mid-1970s (Figure 10).[5]

There is through a material improvement in return to risk from combining the two over this period i.e. going long only when both 1-month and 12-month momentum are positive, and short only when both are negative**. It is this combined signal (i.e. 1-month plus 12-month momentum) that we use in this paper,** essentially preferring to diversify across a shorter and longer lookback window.

Figure 10: Momentum returns in US Treasuries

Index, 1950 = 100, returns rescaled so each signal has 5% annualised volatility.



Source: J. P. Morgan, Global Financial Data

Finally, we note that although the broad result that momentum has proved a successful signal is robust, the precise information ratio is sensitive to exactly how the momentum signal is calculated, especially for shorter lookback windows. For example, Figure 11 shows the information ratio of three-month momentum, rebalanced monthly, depending on the day of the month the signal rebalances. The information ratio varies significantly (from 0.3 to 0.7) depending on this seemingly minor change to the specification, even as the strategy is profitable regardless of the rebalancing day. Essentially, the returns on any one specification is a noisy estimate of the underlying effectiveness of the momentum approach.

Figure 11: Return to risk of 3-month momentum across G-4 10-year bond futures

Data since 1990

Source: J. P. Morgan

[5] This would also be true using Treasury returns back as far as 1830, although, beyond a certain point, there are clearly data quality issues.

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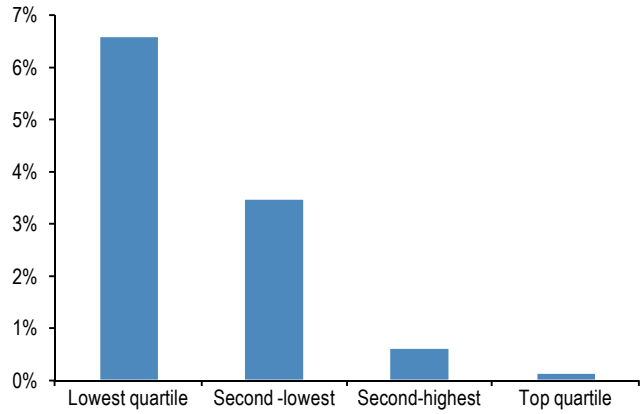
4. Equity momentum

Bond returns are related not only to their own past returns, but also to past returns on equities and other risky assets. Figure 12 shows the average annualized return on G-4 bond futures since 1990, depending on the return on each country's equity market in the previous three months. Since 1990, bond returns have been much stronger following periods of weak equity returns: for example, annualized bond returns were over 6% following the weakest quartile of equity returns, and close to zero following the strongest quartile.

More broadly, even after controlling for past bond returns, **bond returns have a statistically significant relationship with a range of indicators of past risky asset performance**, including not just equity returns, but also changes in equity implied volatility, and changes in high-yield bond spreads.

What explains this relationship? In documenting the predictive power of equity returns for subsequent bond returns, Ilmanen (1995) argues that it reflects increasing investor risk aversion at times of lower wealth (with equities proxying for wealth), leading in turn to greater demand for bonds. [6]

Figure 12: Bond futures returns depending on lagged equity returns
Per cent, annualised. Depending on equity return over previous three months.



Source: J. P. Morgan

Figure 13: Return to risk of equity momentum signal
Data since 1990

	US	Japan	Euro area	UK	Combined
1m	-0.06	0.18	0.11	0.02	0.07
2m	0.25	0.17	0.37	0.25	0.36
3m	0.26	0.44	0.40	0.27	0.47
6m	0.21	0.42	0.55	0.18	0.45
12m	0.09	0.35	0.20	0.05	0.21

Source: J. P. Morgan

Figure 13 shows the return to risk of a simple rule going long bonds if equities fell over the recent past, and short bonds if equities outperformed cash. As with bond momentum, we compare the current level of equities to its average over the past one, two, three, six and twelve months, and rebalance monthly with a one-day lag.

The strategy shows decent performance for lookback periods of two, three and six months, although not with a one-month lookback period.

We note that, in contrast to bond momentum, the equity momentum signal is short more often than it is long (i.e. reflecting that fact that equities typically outperform cash). Thus the solid return since 1990 comes despite having had a short duration bias during a very strong bond bull market.

At heart, the success of equity momentum in predicting bond returns relies on the same pattern of investor underreaction to news, and subsequent overreaction discussed earlier.

Whether strong equity returns should be expected to be followed by weak bond returns depends on what is driving both markets (i.e. what news investors are although to be underreacting to). For example, a growth slowdown, or a period of financial turbulence, would be expected to push stocks lower and bonds higher, in keeping with the rationale of wealth and risk aversion effects linking the two. On the other hand, further monetary policy easing (e.g. more QE) should benefit both stock and bond prices, other things equal.

Thus, the future returns on this signal rely in part on the negative bond-equity correlation which has persisted since the late 1990s being maintained. And indeed, the returns on this signal have been significantly stronger since the late 1990s than before.

[6] Time Varying Expected Returns in International Bond Markets, *Journal of Finance*, June 1995.

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5. Yield curve slope

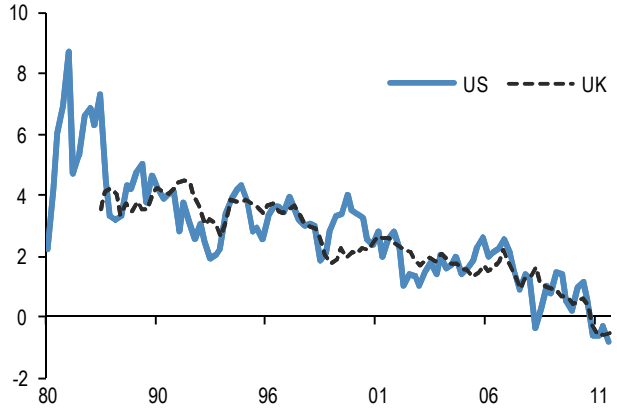
The signals we have discussed thus far are all indicators of momentum. That means that they work better in combination with a measure of value, given the low or negative correlation between momentum signals, which follow market trends, and value signals, which tend to go against them.

There are two obvious measures of value in bond markets: real yields and curve slope i.e. carry. Of the two, we prefer the latter. Real yields have been on a downward trend for three decades (Figure 14), and accordingly any duration strategy based narrowly on mean reversion in real yields would have been rather unsuccessful.

That is not to say that real yields are not a useful indicator. For example, overweighting government bond markets with high real yields relative to those with low real yields would have generated solid returns since 1980.[7]

But they are less clearly useful for outright duration trades. The longevity of the downward yield trend means that, although the present negative real yields in major bond markets surely presage disappointing returns ahead, we can have little confidence about when the probable reversion to higher yields will occur.

Figure 14: US and UK 10-year real yields
Per cent. Real yield from inflation-linked bonds for the UK. For the US, nominal yields less 10-year inflation expectations.



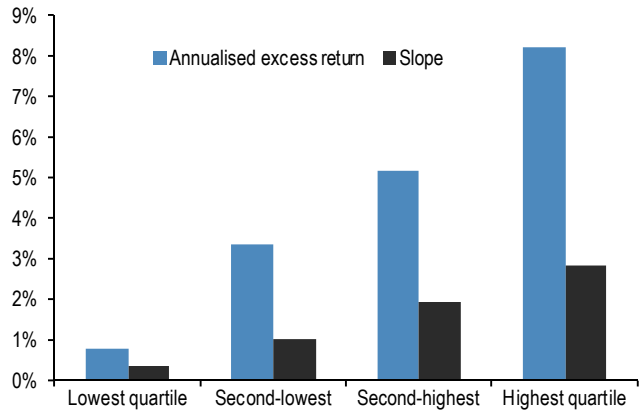
Source: J. P. Morgan, Federal Reserve, Bank of England

On the other hand, **the curve slope has been a reliable indicator both for both cross-market and outright bond returns**. A steep curve means high carry, of course, and relatedly tends to be associated with a high term premium. A steep curve also generally signals that loose monetary policy is supporting a weak economy, such that it acts as a slow-moving cyclical indicator, complementing the more tactical economic signals discussed earlier.

Figure 15 shows the annualized monthly excess return on G-4 10-year bond futures combined since 1990, depending on the ex ante 10-year to 3-month curve slope. We split returns into quartiles, depending on the curve slope compared to the previous ten years.

Over this period, the annualised excess return was 8% when the slope was in the top quartile and just under 1% when it was in the bottom quartile. Another way of expressing this result is that in the bond bull market of the past three decades, the vast bulk of excess returns on long-term bonds have come when carry was above average.

Figure 15: G-4 10-year bond excess return depending on curve slope
Per cent, annualized excess returns since 1990.



Source: J. P. Morgan

Figure 15 also shows the average curve slope (i.e. carry) for each quartile. Broadly, the excess return is around twice to three times the level of carry, meaning that on average a little less than half the return in a steep curve environment comes from carry, and more than half from declining yields. This is broadly consistent with the 50/50 return split between carry and capital gains typically exhibited by cross-market bond carry strategies.

A slightly more complex way of using the curve slope to predict returns is to scale the slope by the volatility of 10-year bond returns, in order to calculate a measure of carry-

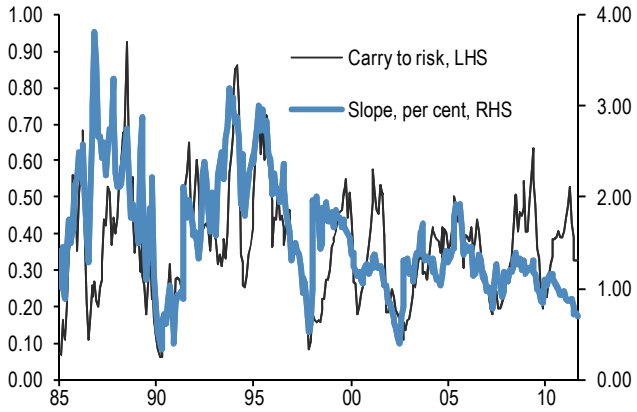
[7] See Asness, Moskowitz, and Pedersen (2010), *Value and Momentum Everywhere*, and Nikolaos Panigirtzoglou, *Valuing cross-market yield spreads*, Jan 2006.

to-risk.[8] The rationale of using carry-to-risk is that investors are more prepared to extend duration in search of higher yields in a low volatility environment.

The most pertinent example here is Japan, where carry (i.e. the slope of the curve) is unusually low, but carry-to-risk is not (Figure 16), as volatility has been depressed by years of unchanged policy rates.

We prefer to use carry-to-risk rather than carry as a signal, partly because of the possibility of a period of Japanisation in other major bond markets (i.e. flat curves and low volatility, as a result of persistently low growth and unchanged policy rates), and partly because historically, carry-to-risk would have been a slightly better outright duration signal than carry.

Figure 16: Carry and carry-to-risk in Japan



Source: J. P. Morgan

To illustrate this, Figure 17 shows the return-to-risk of two simple trading rules: (i) a naïve rule going long duration if the carry measure is above its 10-year average, and short otherwise, similar to the approach we have discussed in previous sections (ii) a more nuanced rule scaling the duration position based on how high the carry measure is compared to the past 10 years.

This second, more nuanced, rule essentially posits a linear relationship between our carry-to-risk measure, relative to the past ten years, and subsequent returns. Specifically, we set the bond futures position as 4*(Percentile of carry to risk – 0.5). So the position is +2 if carry-to-risk is at its highest over the past 10 years, -2 if it is at its lowest, and zero if it is at its median. This also means that the average absolute position size is roughly 1.

[8] We use the exponentially-weighted realised volatility of daily returns, with a decay factor of 0.97.

There is a significant benefit to taking the more nuanced approach, and this second rule would have generated a return to risk of around 0.7 for G-4 futures markets combined since 1990.

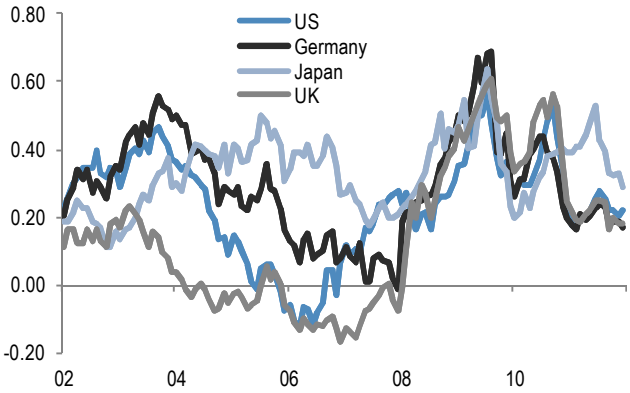
Figure 17: Return-to-risk of trading rules based on carry

	US	Germany	Japan	UK	Combined
Long if carry above average, short otherwise					
Carry	0.26	0.34	0.05	0.30	0.41
Carry-to-Risk	0.44	0.35	0.33	0.32	0.63
Duration position proportional to carry					
Carry	0.47	0.37	0.09	0.43	0.57
Carry-to-Risk	0.53	0.35	0.43	0.49	0.75

Source: J. P. Morgan

At present, our measure of carry-to-risk, shown in Figure 18, is slightly below its 10-year average for the US, Germany and Japan (although not the UK). That represents a headwind for bond markets, although carry-to-risk is not yet at the levels which have in the past signaled very low excess returns.

Figure 18: Carry-to-risk of G-4 10-year bonds
10-y ear less 3-month slope, relative to EWMA volatility



Source: J. P. Morgan

6. Combining signals

In this section, we present a present a combined strategy for trading duration in G-4 futures using the five signals described above:

- The two-month change in global and local manufacturing PMIs
- The three-month change in the earnings revision ratios for both MSCI World and local markets

- Bond momentum, expressed as a combination of 1-month and 12-month momentum for each futures market
- Equity prices, using 6-month momentum in each local equity market
- Carry to risk i.e. the 10-year to 3-month slope, relative to realized bond market volatility.

We focus our analysis of the combined strategy mainly on the period since 1998, when the Global PMI becomes available. For consistency, all the signals are rebalanced on the second working day of the month (i.e. one day after the release of the Global PMI), except for the revision ratio and Euro area and Japanese PMI signal, which each rebalance during the month, one day after release.

Figure 19 shows the correlation of returns on the five signals since 1998. The key point is that the returns on each signal are not very highly correlated with each other, underlining the diversification benefit of combining them. By far the highest correlation is between the economic signals and equity momentum; in sample, each of these signals captures similar information. Against that, the carry signal is either uncorrelated or slightly negatively correlated with all the others, illustrating the familiar benefit of combining value and momentum signals.

Figure 19: Correlation of duration signals
Since 1998

	PMI	Revision	Bond mom	Equity mom	Carry
PMI	1.00				
Revision	0.59	1.00			
Bond mom	0.27	0.06	1.00		
Equity mom	0.57	0.43	0.24	1.00	
Carry	-0.20	0.01	-0.01	-0.17	1.00

Source: J. P. Morgan

Figure 20 shows the return to risk of each signal for each country. The last column shows the return to risk for each signal in all four countries combined, while the last row shows the return to risk for each country using an equally-weighted combination of all five signals.

Figure 20: Return to risk of duration signals
Since 1998

	US	Japan	Euro area	UK	Combined
Bond momentum	0.65	0.01	0.45	0.26	0.50
Equity momentum	0.53	0.32	0.60	0.41	0.61
Revision ratio	0.56	0.24	0.73	0.61	0.68
PMI	0.45	0.15	0.62	0.72	0.64
Carry to Risk	0.46	0.14	0.39	0.49	0.58
Combined	0.94	0.27	1.07	0.85	1.03

Source: J. P. Morgan

The principal message from Figure 20 is the diversification benefit of trading a range of signals in combination. Trading all four markets based on all five signals would have generated a return to risk of 1, net of transactions costs, far above the average return to risk for each signal, of 0.6.

Similarly, the performance of the signals in JGB futures is somewhat disappointing, with a return to risk of 0.3 for all five signals together. But even so, this does not drag down the performance of the strategy across the four markets combined much, because the strategy's returns in JGB futures are relatively uncorrelated with its returns elsewhere.

In Figure 20, we combine the five signals using equal weights, i.e. with the same average absolute position size for each signal. Is it possible to improve performance by altering the weight of each signal? The answer, in sample, is 'only a little'.

To show this, we optimize the weights accorded to each signal in sample, allowing the look-ahead bias of knowing which signals performed best over the period. This optimization accords the highest weight by far to the carry signal, which offers the most diversification, then bond momentum, and roughly similar weights to the other signals (Figure 21).

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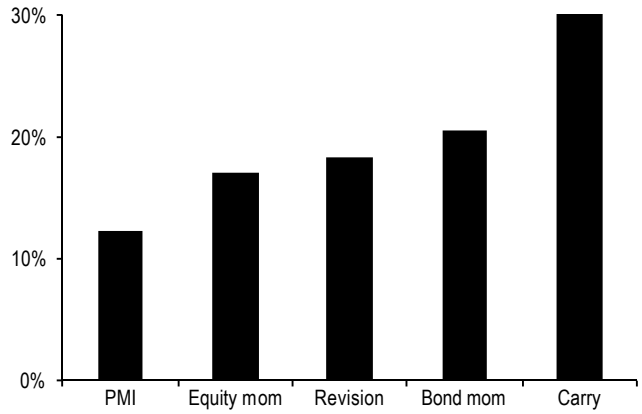
Figure 21: Optimized weights accorded to each signal
Per cent



Source: J. P. Morgan

This alternative weighting generates a return to risk of 1.07 since 1998, only slightly higher than the equally-weighted combination, and the time series returns of the two different weightings are very similar.

Although the simple approach of weighting the signals equally captures the great majority of the available diversification benefit in sample, **in combining the strategies we prefer to give more weight to carry and less to the more highly correlated equity and economic momentum signals**. That reflects a general preference to balance momentum signals with value. In that vein, we accord a 35% weight to carry, 20% to bond momentum, and 15% each to the equity and economic signals, following the optimized weights shown in Figure 21 relatively closely.

Figure 22 summarizes the returns of this weighted combination of the five signals, both since 1998 in keeping with the analysis above, and since 1990 (not including the PMI signal before 1998). The performance is very similar across both samples (see also Figure 1), with a success rate of over 60%.

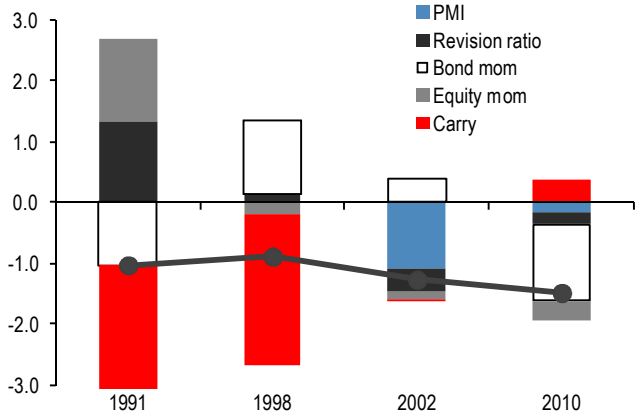
Figure 22: Return from combined duration timing strategy

	Since 1990	Since 1998
Annual return	2.5%	2.3%
Volatility	2.2%	2.2%
Return to risk	1.13	1.06
Success rate	65%	62%

Source: J. P. Morgan

When does the combined strategy perform poorly? There are four episodes of material year-on-year losses, each of around 1%, and each shown in Figure 23. In 1991 and 1998, low carry gave a bearish signal, while bond markets rallied on economic weakness (1991) and the aftermath of the Russian and LTCM crises (1998). In 2002, bond market returns were out of kilter with changes in PMIs, while in 2010, bond momentum was long, and was caught out by the sharp Q4 selloff. It is notable that in none of these episodes of year-on-year declines did all four signals record a loss, again illustrating the benefit of combining a range of diverse signals.

Figure 23: Episodes of year-on-year losses for combined strategy
Per cent



Source: J. P. Morgan

7. Directionality

One natural question for an approach tested over a period of such consistently strong bond returns is whether it is simply a bull market strategy. The combined signal does have a long bias, but only a modest one: it is long duration 57% of the time, and short 43% of the time, with a beta to the overall bond market of close to zero. Figure 24 shows how the position of the combined signal evolves over time.

The slight long bias overall is entirely due to the bond momentum signal, which is overwhelmingly long, as discussed above. Taken together, the other four signals are slightly net short duration on average, in sample. Removing bond momentum, so that the overall strategy is net short, would have reduced the return to risk only marginally, to 1.04 since 1990.

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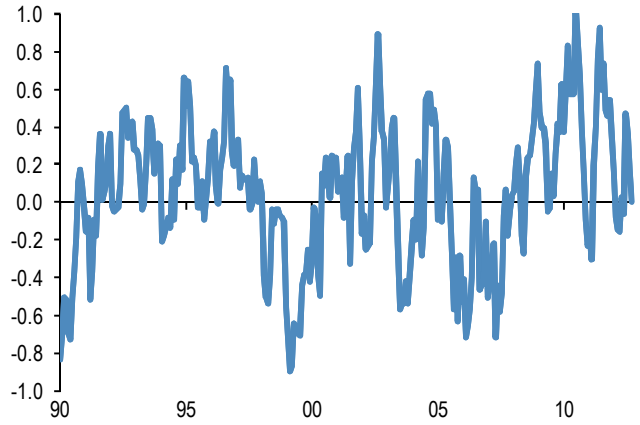
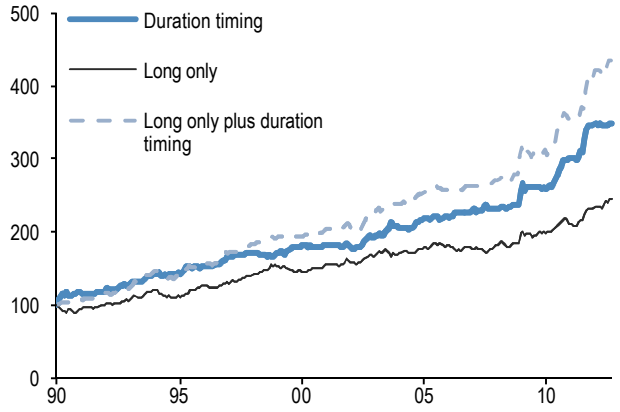
Figure 24: Position of combined duration signal
Positive means long duration, negative means short duration



Source: J. P. Morgan

Thus, the success of the strategy is not down to directionality as such. There is of course the broader question overshadowing any backtested strategy of whether the dynamics of bond markets in coming years will be the same as in the past two decades e.g. would the same signals work so well in a bear market.

Figure 25: Cumulative return of long only and duration timing strategy
Index, 1990 = 100. All signals weighted to have 5% volatility.



Source: J. P. Morgan

How would our duration timing strategy function as an overlay to a long-only portfolio? A long position in all four futures markets combined would have generated a return to risk of 0.8 since 1990, compared to 1.1 for our duration timing strategy. Because returns on the strategy are not closely related to overall bond market returns, there is a significant diversification benefit to combining it with a long-only portfolio. Indeed, a volatility-weighted combination of the two (i.e. long only futures return, plus duration timing strategy) would have generated a return to risk of 1.3 since 1990 (Figure 25).

8. Current positioning

Figure 26 summarizes the current stance of each of the signals. For the economic and price momentum signals, the position is binary for each country, varying between +1 (long) and -1 (short). For the carry signal, the position ranges linearly between +2 (maximum long) and -2 (maximum short), depending on how high our carry-to-risk measure is compared to the past ten years.

The last column averages the positions across all four countries, for each signal. Meanwhile, the last row averages the position of all five signals, for each country, using the weightings discussed in section 6, and shown in the table.

Figure 26: Positioning of duration signals

	Weight	US	Japan	Euro area	UK	Combined
PMI	15%	-1	-1	-1	-1	-1
Revision ratio	15%	-1	0	0	0	-0.25
Bond momentum	20%	+1	+1	+1	+1	+1
Equity momentum	15%	-1	+1	-1	-1	-0.5
Carry to Risk	35%	-0.2	-0.4	-1.1	0.4	-0.3
Combined		-0.3	+0.1	-0.5	0	-0.2

Source: J. P. Morgan

At present, **the combined strategy argues for a small short duration position overall**. That is mainly due to the rise in PMIs over the past two months, together with the broadly upward trend of equity markets. The carry signal also argues for a small short overall. Positive bond momentum in all four countries offers a bullish counterpart to these bearish signals, and means that the overall short position is a modest one.

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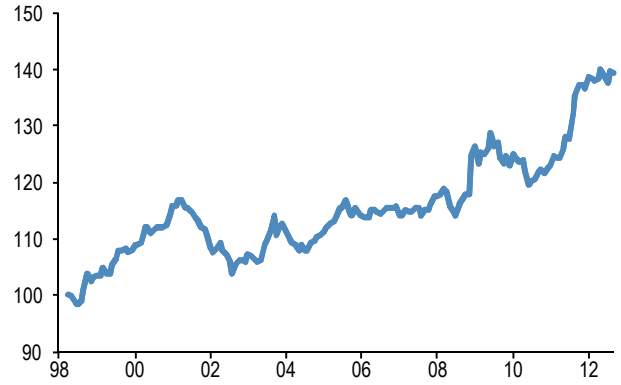
9. Past performance by signal.

Figure 27: PMI

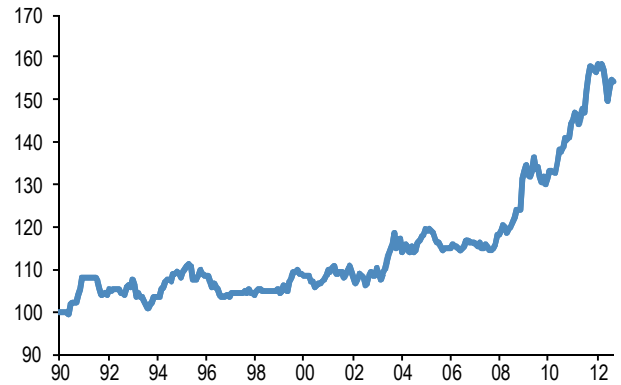
All four countries combined. Index, 1998 = 100



Source: J. P. Morgan

Figure 28: Earnings revision ratio

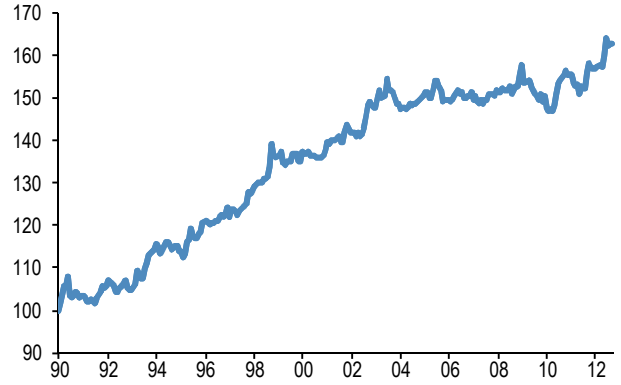
All four countries combined. Index, 1990 = 100



Source: J. P. Morgan

Figure 29: Bond momentum

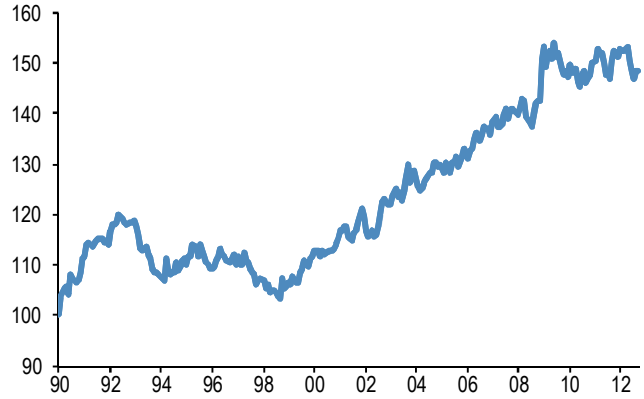
All four countries combined. Index, 1990 = 100



Source: J. P. Morgan

Figure 30: Equity momentum

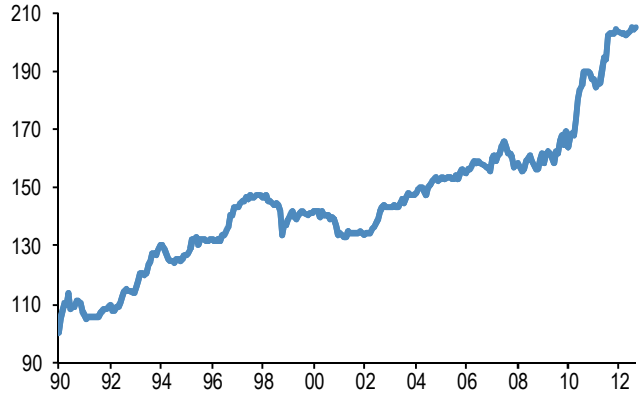
All four countries combined. Index, 1990 = 100



Source: J. P. Morgan

Figure 31: Carry to risk

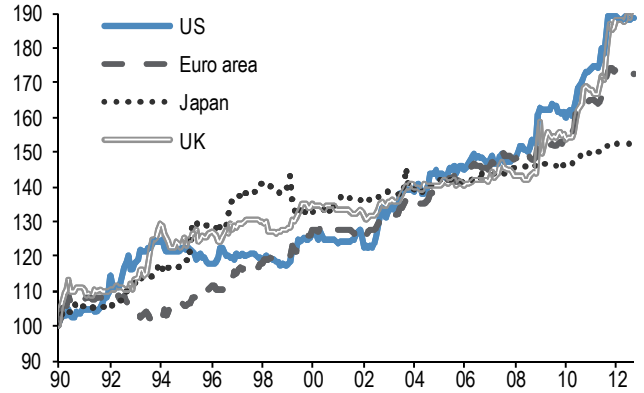
All four countries combined. Index, 1990 = 100



Source: J. P. Morgan

Figure 32: Combined strategy by country

All five signals combined. Index, 1990 = 100



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