SOCIETE GENERALE
Cross Asset Research

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Equity

Global Quantitative Research

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Global Quantitative Strategy

Dow to 40,000 by 2030? US pension funds certainly seem to think so

London
Andrew Lapthorne
(44) 20 7762 5762
andrew.lapthorne@sgcib.com

Rui Antunes
(44) 20 7762 5875
rui.antunes@sgcib.com

John Carson
(44) 20 7762 4979
john.carson@sgcib.com

Georgios Oikonomou
(44) 20 7762 5261
georgios.oikonomou@sgcib.com

New-York
Andy Kim
(1) 212 278 5455
andy.kim@sgcib.com

'Dow 40,000' sounds like a crazy forecast and it is. But this is what many investors seem to implicitly expect, particularly in the US. Our models point to long-term equity returns being significantly lower.

■ Storing up problems for the next generation seems to be a recurring global theme these days. One such problem is the overly optimistic returns expectations embedded within many corporate and state pension funds. **We estimate US pension funds are factoring in a nominal 9% equity return in the long-term. In the UK it is some 100bp lower.**

■ How realistic are these expectations? Well if history repeats itself, following such a poor 10-year return period as we've experienced, on average the S&P 500 has delivered 11% real over the next ten years. However, given the sharp rebound in equity prices since March 2009, half of that gain is already behind us. An analysis of Shiller PEs and future returns also indicates average real returns of just 1.7% going forward!

■ A decomposition of historical returns into building blocks also indicates that with US dividends yield below 2% and real dividend growth typically 100bps or more below trend GDP growth, an implied real return of 3% from US equities is a realistic assumption. But this is before deducting fees and trading costs.

■ So why do investors expect so much more? Well in part the higher volatility of earnings growth relative to GDP and dividend growth gives the impression that higher growth is possible; optimistic consensus sell-side profit expectations don't help either. Our calculations reveal that consensus 12-month forward earnings forecasts have over-estimated S&P reported profits by $2.3 trillion dollar during the last 20 years. To put that number in context, during the same period the S&P paid out roughly $3 trillion in dividends.

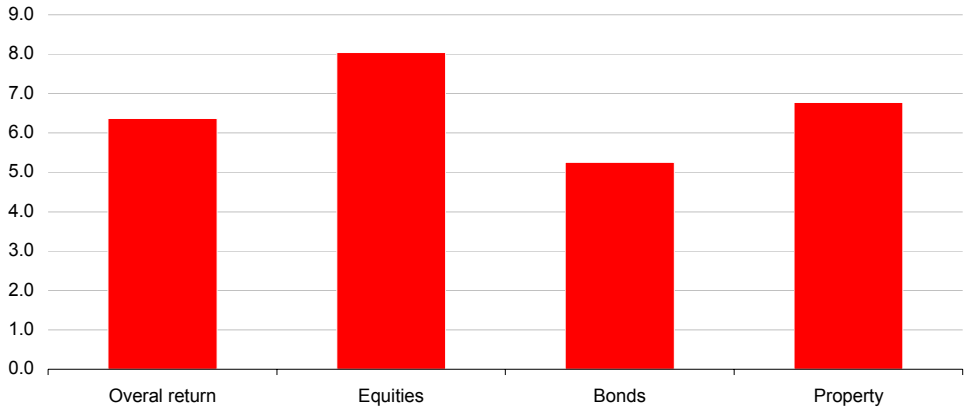
■ The reality is that current valuations still imply returns which are far below many investors expectations. This should clearly be a concern for both companies and governments going forward. It should however be no surprise to Warren Buffett, who said back in 2007: '*What is no puzzle, however, is why CEOs opt for a high investment assumption: It lets them report higher earnings. And if they are wrong, as I believe they are, the chickens won't come home to roost until long after they retire'.*

Be wary of high equity return assumptions

UK pension fund return assumptions

A quick scan through a selection of the latest UK reports and accounts indicates pension fund return assumptions near 6.8% with equities expected to return around 8% -see below. This is similar to 2008 when according to Mercer's FTSE 100 survey the median return assumption from equities was 7.8%[1].

UK report and account pension fund return assumptions

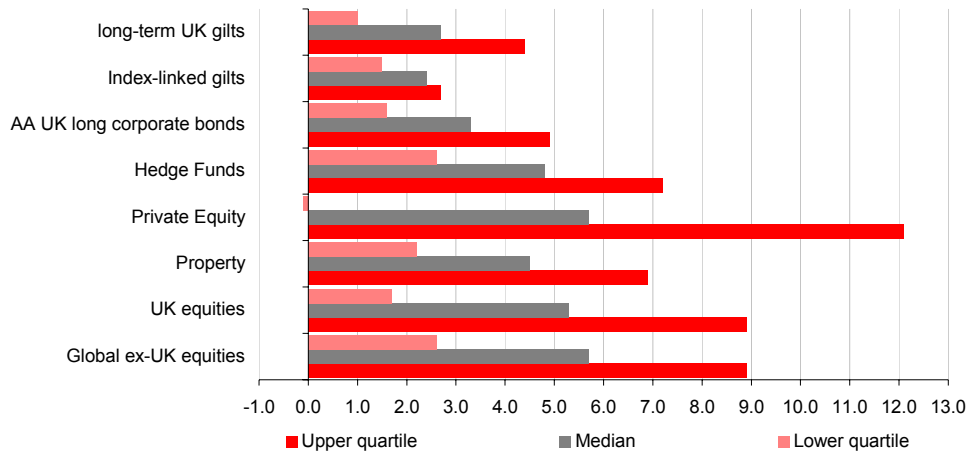


Source: SG Cross Asset Research, Various pension fund reports and accounts)

Pension fund consultant return assumptions

These expected long-term equity return assumptions unsurprisingly are similar to those produced by consultants. The chart below shows median expected real return for equities to be around 5.5%, which when added to current inflation expectations of 2.5-3.0% implies 8-8.5% norminal.

Range of expected real returns over 10 years according to Watson Wyatt



Source: Actuarial valuation - our approach, Watson Wyatt, available at WatsonWyatt.com

[1] See Mercer Quarterly briefing on Pension Accounting available on http://uk.mercer.com

US pension fund return assumptions

In the US we have only be able to find overall asset return assumptions – these average c. 8% for the Dow Jones 30 companies. However if we use the asset allocations of pension funds shown in Tower Watson's latest Global Pension Asset Study 2010, which shows 61% of assets are held in equities, 19% in bonds and 20% in 'other', we can approximate an expected equity return of around 9% if we assume a generous return of 8% on "other" assets and a 5% return on bonds. Not only is 9% high, but how come US pension companies systematically have higher return assumptions than those in Europe? Indeed some even assume diffierent returns rates for different regions.

As Warren Buffet described in his 2007 letter to shareholders:

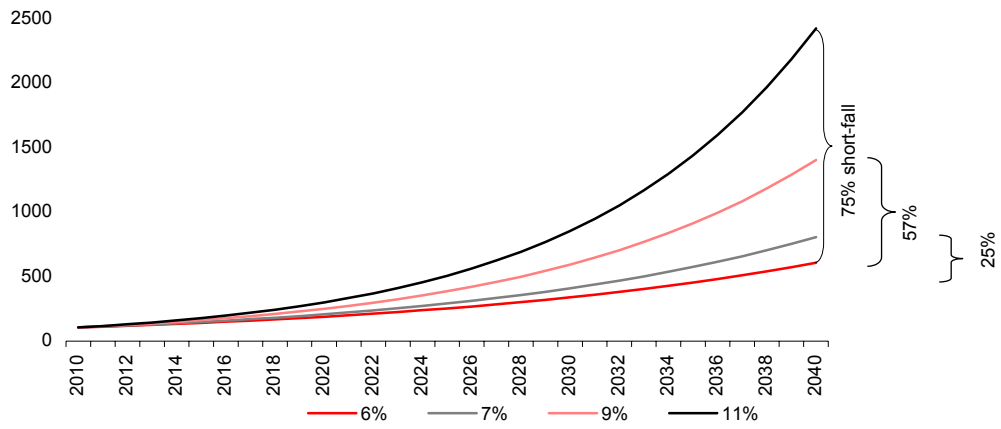
'Some companies have pension plans in Europe as well as in the U.S. and, in their accounting almost all assume that the U.S. plans will earn more than the non-U.S. plans. This discrepancy is puzzling: Why should these companies not put their U.S. managers in charge of the non-U.S. pension assets and let them work their magic on these assets as well? I've never seen this puzzle explained. But the auditors and actuaries who are charged with vetting the return assumptions seem to have no problem with it.

What is no puzzle, however, is why CEOs opt for a high investment assumption: It lets them report higher earnings. And if they are wrong, as I believe they are, the chickens won't come home to roost until long after they retire.'

Of course many of these return assumptions are often based on historical return patterns or the returns of indices rather than actual returns generated, so exclude intermediary costs such as management fees and trading costs. However small errors in long-term return assumptions lead to outsized liability mismatches 30 years down the line.

History is littered with investors being promised high returns to help justify high level of current spending. A case in point is the heavy pushing of endowment mortgages in the UK in the late 1980s, which promised £100,000 in 25 years based on £50 per week savings- a near 14% annual return. Many of these policies matured 25 years late 70% below the expected £100,000 target.

Return short-fall after 30 years versus a 6% nominal return

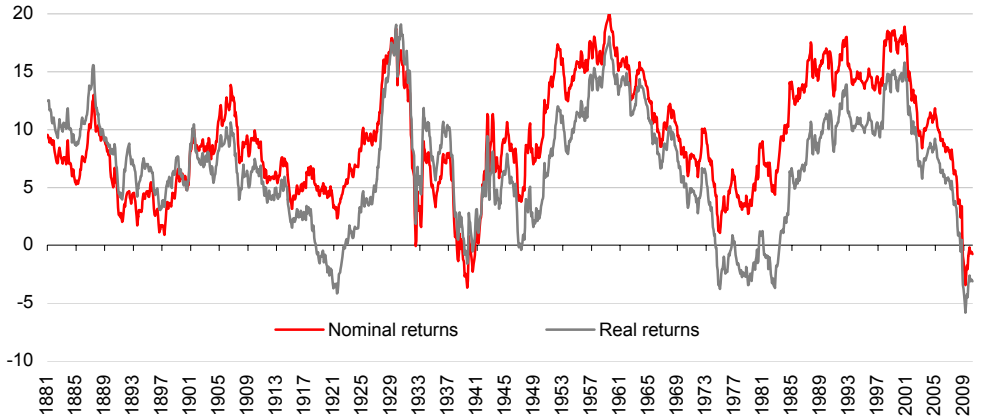


Source: SG Cross Asset Research

It's been so bad that things can only get better – really?

The argument for some expecting a prolonged period of equity market strength seems largely based on the fact that equity returns during the last 10 years have been absolutely terrible (see below). Using data from Robert Shiller's extremely useful website, S&P 10 year real returns from March 1999 to March 2009 were minus 5.8% annualised, worse than any 10 year period since 1881.

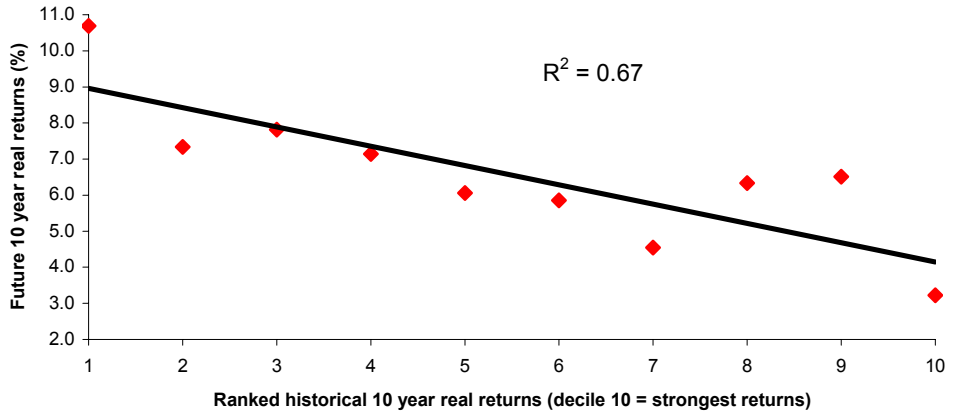
S&P 10 year compound real returns from 1881 to current day (annualised rate)



Source: Robert Shiller

So does a dreadful recent period for equities imply an improved outlook going forward? Given the data above, this would indeed appear to be the case. Grouping historical 10 year returns into deciles shows a negative relationship between historical 10 year returns and future 10 year returns. This correlation is driven by extreme deciles where the strongest 10 year returns lead to the worst 10 year periods and vice-versa. We assumed (arbitrarily) that the investor had the choice to buy and hold the index for ten years either in February or August – however switching to an annual purchase or other starting months did little to change the overall result.

Relationship between historical 10 year returns of the S&P and future 10 year returns



Source: SG Cross Asset Research

This relationship is detailed in the table below, which shows the breakdown of future 10 year returns based on prior 10 year returns. After the worst period of 10 year returns (decile 1), 10 year real returns averaged 10% annualised - with no negative periods - and only a 4% instance of a real gain of 5% (or less).

Breakdown of future 10-year returns based on prior 10-year returns (by decile, real total returns)

	Deciles based on prior 10 year returns (1 = weakest)									
	1	2	3	4	5	6	7	8	9	10
Average gains	10.7	7.3	7.8	7.1	6.1	5.9	4.5	6.3	6.5	3.2
Maximum gain (%)	18.8	17.0	17.2	12.4	14.4	14.2	15.4	14.7	14.1	9.5
Minimum loss (%)	3.0	1.9	-3.5	-3.5	-3.7	-2.8	-2.5	-2.5	-3.4	-5.0
Percentage of loss (%)	0.0	0.0	16.7	25.0	20.8	4.2	25.0	4.2	8.3	12.5
Percentage of gain 5%+ (%)	4.3	29.2	45.8	37.5	37.5	25.0	54.2	29.2	29.2	70.8

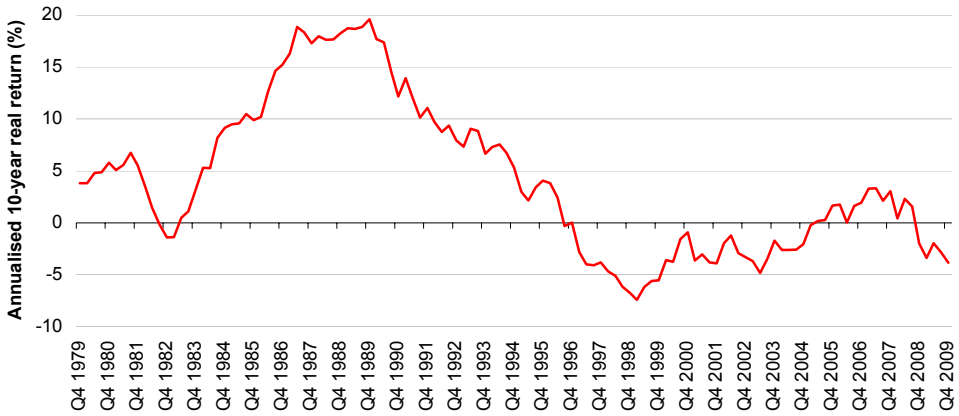
Source: SG Cross Asset Research

Therefore, given that historical returns are amongst the worst seen then this surely bodes well for equity returns going forward. However, US equities have already made gains of 68% since the trough in March 2009. Spread over 10 years this equates to a 5.3% gain per annum already. Yes, it can be said that periods of extremely weak equity markets subsequently lead to stronger future equity market performance, but it must also be said that a decent chunk of those expected returns may have already been made.

The lost decade in Japan simply led to another lost decade

Assuming that equity markets will put in a strong 10 year performance simply because the last 10 years were poor is, in our view, a fairly weak investment case. After all, there are plenty of precedents where this clearly has not happened - Japan being the most obvious.

Japan's terrible decade (1990-2000) was followed by... another terrible decade

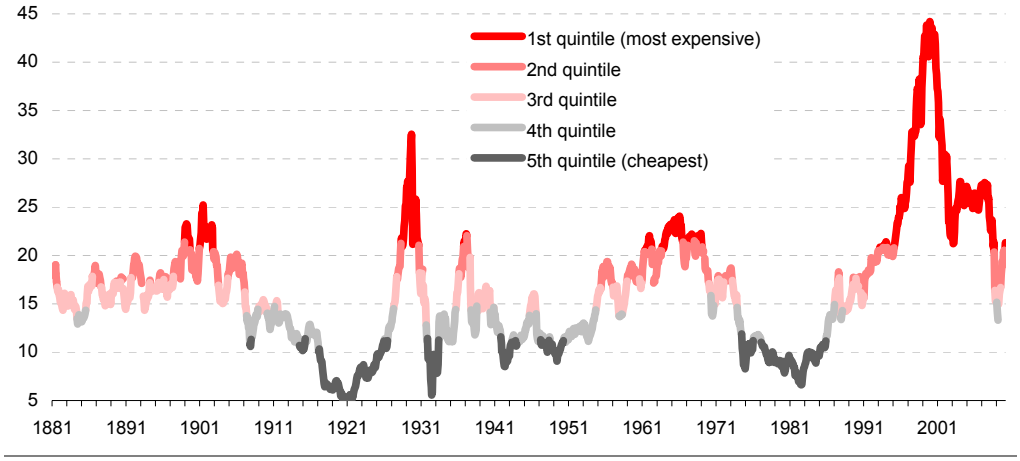


Source: Thomson Financial Datastream, MSCI

Price/Earnings as forecaster of long-term returns

In a recent edition of Popular Delusions[2], Dylan Grice performed a similar exercise using the Shiller PE multiple as a valuation starting point. As the chart below shows, current S&P 500 valuations are in the highest historic quintile (i.e. most expensive) and this starting point of valuation has historically led to average real returns of 1.7% (see chart below) with a standard deviation of 3.7%.

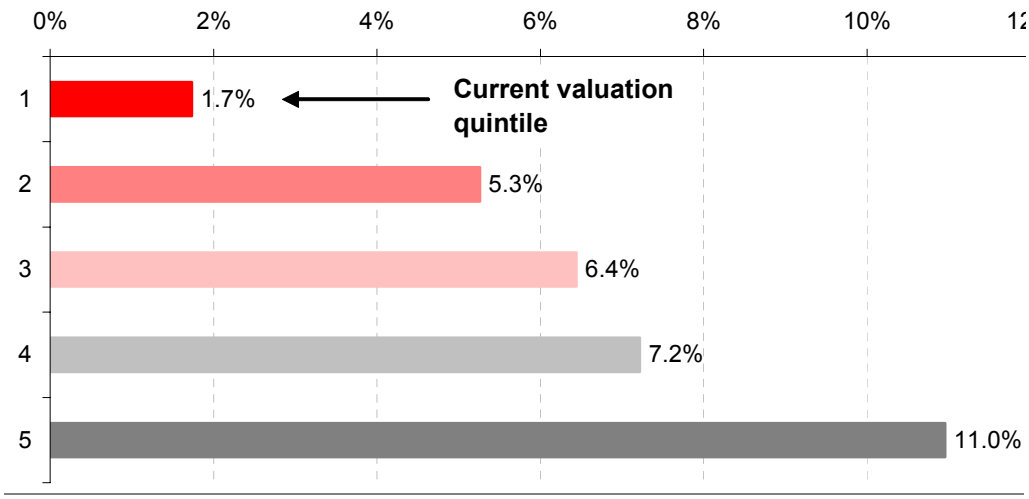
Shiller PE close to top quartile valuation (S&P relative to 10 year earnings, both deflated by CPI)



Source: SG Cross Asset Research, Robert Shiller

An important question when performing such analysis is just how relevant are historical US stock market returns, when it could be argued that the US has been perhaps the most successful and prosperous economy during the last 100 years. Surely there is a classic case of survivorship bias. Why not, for example, use Russian stock market returns from 1881? [3]

10 year real S&P returns by valuation quintile



Source: SG Cross Asset Research, Robert Shiller

[2] What to do when there's nothing to do? – Popular Delusions, 31 March 2010

[3] For an interesting discussion on the relevance of historical long-term returns see "The Myth of 1926: How much do We Know about Long-Term Returns on US stocks", Journal of Investing Winter 2009.

What assumptions drive decomposing historical returns?

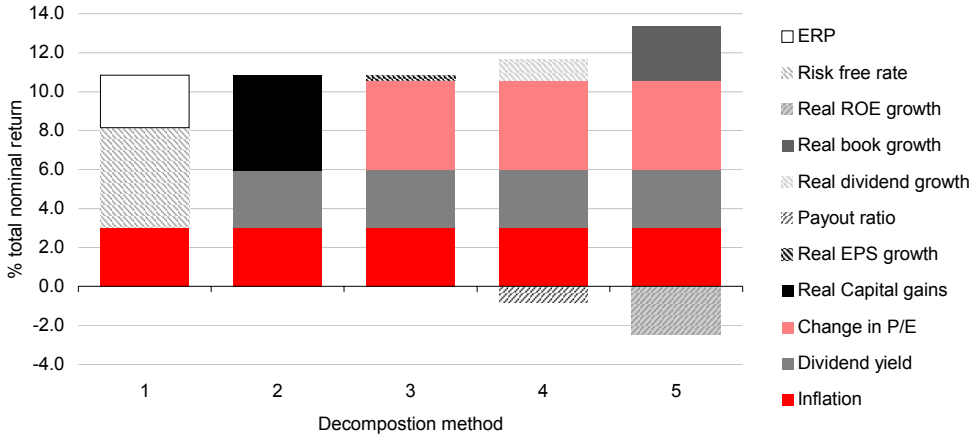
There have been numerous studies that have examined historical returns of equities and their relationship to bond yields. For us, whilst these studies are useful references, the resulting equity risk premium was not an active choice but rather it was something that the investor received passively. However, we do find decomposing historical returns into underlying components extremely useful and regular readers will be aware that we have a long history of decomposing historical equity returns into dividend yield, real dividend growth and the change in dividend yield.

Roger Ibbotson and Peng Chen in the Financial Analysts Journal[4] decomposed historical equity returns using six different methods:-

1. Building Blocks = Real Risk Free Rate + Inflation + Equity Risk Premium;
2. Capital Gain and Income = Inflation + Real Capital Gains + Real Dividends;
3. Earnings = Inflation + Real EPS growth + change in P/E + Real Dividends;
4. Dividends = Inflation + Real EPS growth + change in Payout Ratio + Real Dividends;
5. Return on Book Equity = Inflation + growth in Real Book Value + growth in Real ROE + change in P/E + Real Dividends; and
6. GDP per Capita = Inflation + Real growth in GDP per Capita + increase in equity markets relative to overall economic productivity + Real Dividends.

The above is a useful starting point for any discussion on equity returns. Using methods one to five above, we decompose US MSCI data from 1980. We use data from this point simply because it is readily available for illustration purposes.

Decomposition of US equity returns (nominal, since 1980)



Source: SG Cross Asset Research, MSCI

What can we realistically (and accurately) forecast?

Looking down the six methods of decomposition above, the question we have to ask is how many of these factors can realistically (or more accurately) be forecast?

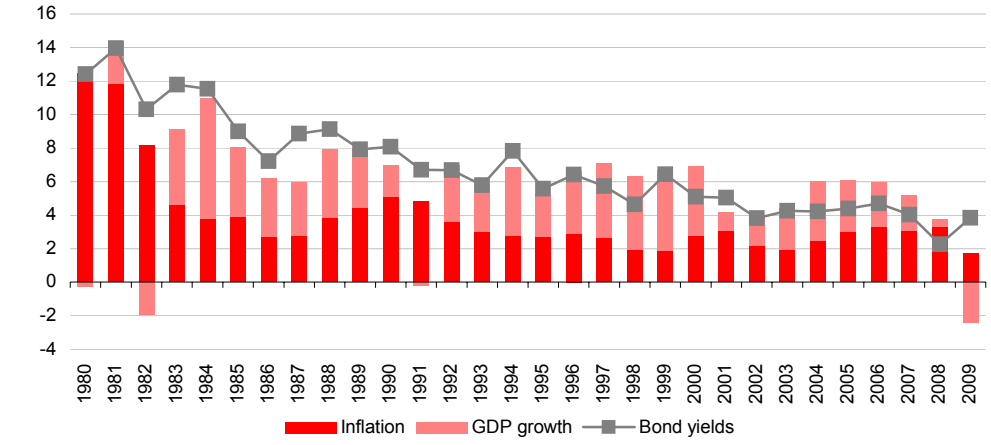
[4] See Financial Analysts Journal – volume 59, No 1. Jan/Feb 2003, p88-98

Inflation – does it provide a natural hedge?

Let's start with inflation. The assumption is that via a growth in earnings, dividends or book value, equity holdings will exhibit some form of inflation - hence the view that equity markets provide an inflation hedge. We could therefore say that we do not need to concern ourselves on forecasting inflation or indeed nominal returns. However, in each example above, there is also a capital gain or multiple change component to account for. So, if inflation rises rapidly, the key is how that might affect your exit price - and in a diversified asset portfolio, how much higher inflation might impact the performance of your other assets, notably bonds. Not only do we not know what inflation will be but neither do we know how that unknown might affect terminal values.

We get very little information from market prices to tell us what growth or inflation might be going forward. For example, nominal bond yields (see below) tell us more about what has occurred rather than what is likely to happen in the future and whilst inflation-linked bonds will provide the bond investor with an inflation hedge, no such mechanism exists in the equity market.

US 10 year bond yields, trailing year-on-year real GDP growth and inflation (%)



Source: SG Cross Asset Research

What about growth?

Whilst long-term inflation is highly unpredictable, making forecasting nominal quantities next to impossible, real GDP growth (as we show in the table) is far more stable. US real GDP has risen on average by 2.7% since 1980 with a standard deviation of just 0.8%.

US Real GDP growth (1980-1999)

(%)	Compound Average	Minimum	Maximum	Standard Deviation
Real GDP growth	2.7	1.1	4.9	0.8
Real Dividend growth	1.1	-1.7	8.6	2.5
Real Earnings growth	0.3	-10.8	18.2	6.9

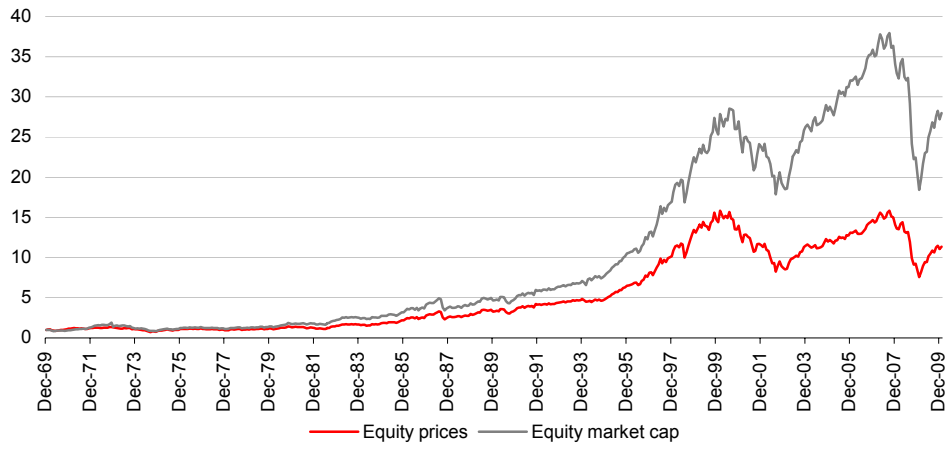
Source: SG Cross Asset Research
* Simple average and maximum and minimum are based on annualised 5-year compound averages

Our analysis also confirms what many other studies have shown, namely that quoted sector compounded earnings and dividend growth does not exceed real GDP growth in the long-run. Robert Shiller's much quoted data shows real dividend growth to have been around 1.1% during the last 139 years, whilst earnings have grown by 1.4%.

One reason for a disappointing profit performance versus GDP growth is that the quoted equity market is continually diluted by new issuance. For example, an investor in the S&P 500 would have had to sell existing positions to fund, say, the purchase of Google when it listed in 2004. Over time, this equity dilution mounts up. In an excellent paper, Bernstein & Arnott[5] discussed this topic in detail and come up with a very simple way of measuring dilution by comparing the change in market capitalisation versus the change in index price level.

Below we show two such series for the MSCI US index since 1969. The gap is significant and equates roughly to two percent dilution per annum. Coincidently, this is similar to the conclusion reached by Bernstein & Arnott with a completely different dataset and time period.

Equity dilution: comparing the rise in US equity market capitalisation against the index

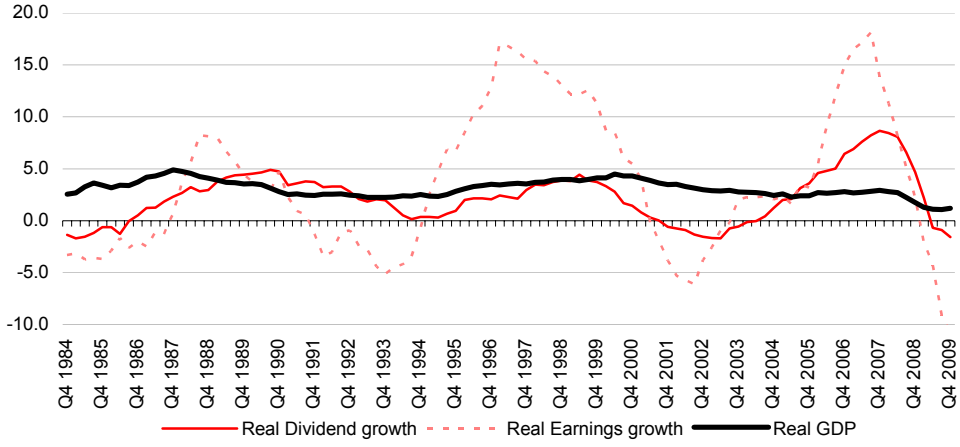


Source: SG Cross Asset Research, MSCI

[5] Bernstein, William J. and Arnott, Robert D., Earnings Growth: The Two Percent Dilution. Financial Analysts Journal, Vol. 59, No. 5, pp. 47-55, September/October 2003. Available at SSRN: http://ssrn.com/abstract=489602

So why do investors expect so much more? Volatility in earnings growth (see below) no doubt helps create the impression that higher growth is indeed possible and bottom-up consensus forecasts do little to dispel the idea that double-digit earnings growth is possible.

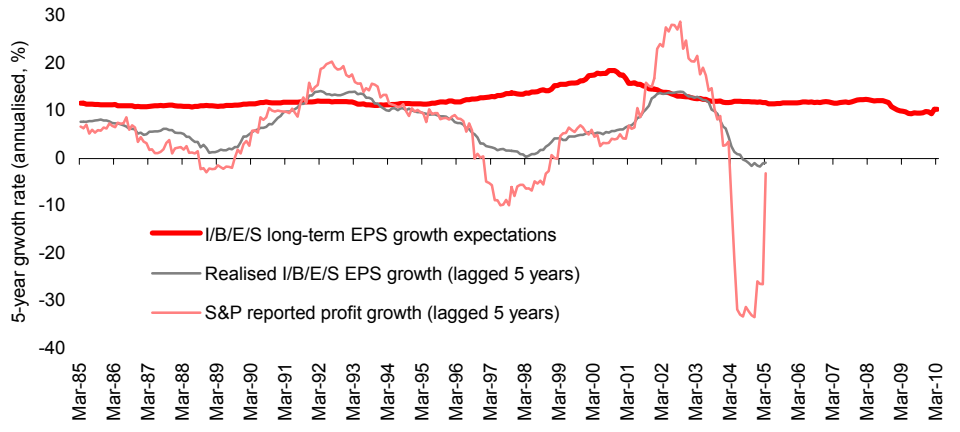
Real GDP, earnings and dividend growth (5 year averages, annualised)



Source: SG Cross Asset Research

Consensus IBES long-term EPS growth expectations (typically defined as five years) are perennially optimistic (see chart below). We plot the series against the actual realised growth in earnings five years later. So how seriously should we take these estimates? Well some, most notably Alan Greenspan[6], often quote such numbers as justification for higher equity market valuation. Sadly, we find that these numbers over-estimate long-term earnings growth by between 500 and 750 bps depending on whether you compare them to operating or reported profits. Using them to predict long-term equity returns will therefore lead to a massive over-estimation of profits.

Consensus long-term EPS growth expectations are way off the mark – US S&P500



Source: SG Cross Asset Research, I/B/E/S, Standard & Poor

[6] http://www.federalreserve.gov/boarddocs/hh/2000/february/testimony.htm

It is not just long-term growth expectations which contribute to exaggerated profit growth. Nearer term forecasts also create the impression that equities deliver more in terms of earnings than they actually do. The chart below shows the difference between year 1 forecast earnings and three measures of actual reported profit: S&P reported profit (which includes most things such as write-downs and other exceptional items); MSCI profit (which is defined as pre-exceptional EPS from operations); and IBES actual profit (which is pretty much anything you like).

Year-ahead profit forecasts over-estimated actual earnings by 26% on average through 1990-2009 when compared to S&P reported profits or 7% when compared to the rather more liberal IBES reported profit number. The numbers shown below are massive in economic terms. For example, based on forecast IBES data, cumulative earnings on the S&P 500 during the last 20 years was US$8,800bn however, using S&P data gives just US$6,500bn of earnings. That's a twenty year short fall of US$2.3 trillion dollars. To put that number into context, roughly US$3 trillion has been paid out in dividends over the same period!

Weighted average annual (Year 1) forecast error in the US (1990-2009)

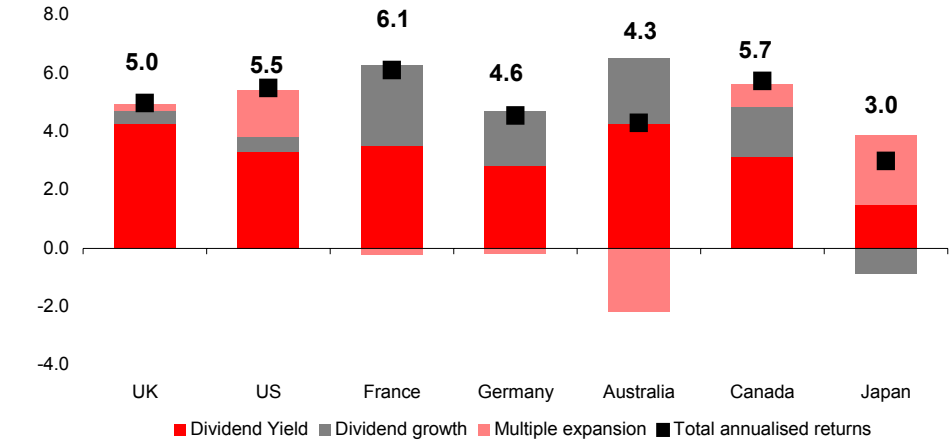
Source: SG Cross Asset Research

So valuation must surely provide the key?

So far we have discussed two major elements of historical nominal returns: inflation (which we can't forecast) and dividend/earnings growth (which has historically been less than trend real GDP growth), having averaged somewhere between 1-2% historically (depending on the data series used).

A substantial part of a long-term equity return comes from the initial price you pay, in other words, the spot valuation, which is encouraging as at least we can measure valuation. For example, one of our most popular charts - particularly amongst income fund managers - shows that since the 1970's, the bulk of real equity returns has come from dividend yield (see chart below), with additional returns coming through dividend growth and then valuation change - essentially the classic Gordon growth model.

Decomposition of real equity returns since 1970



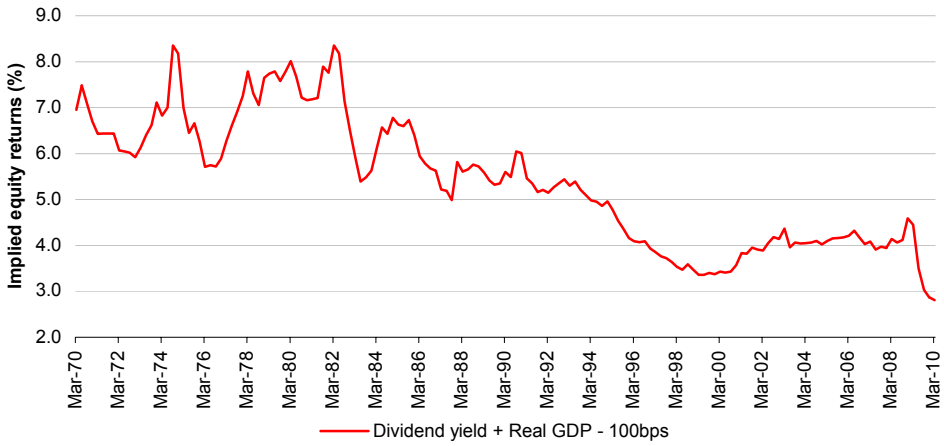
Source: SG Cross Asset Research, MSCI, Thomson Financial

As we have already discussed, stock market earnings and dividends have historically failed to match growth in the real economy[7]. So, looking forward, real GDP growth should represent the upper bounds on any long-term earnings growth assumptions, with a more realistic estimate some 100bps lower to take account of equity market dilution.

Using these basic inputs we can then create a very simple long-term equity return forecasting model, which consists of the current dividend yield plus trend real GDP growth (for which we've used 10 year averages).

7 For an interesting look at the relationship between economic growth and equities see Cornell, Bradford , Economic Growth and Equity Investing (February 16, 2010). Financial Analysts Journal, Vol. 66, No. 1, 2010. Available at SSRN: http://ssrn.com/abstract=1553823

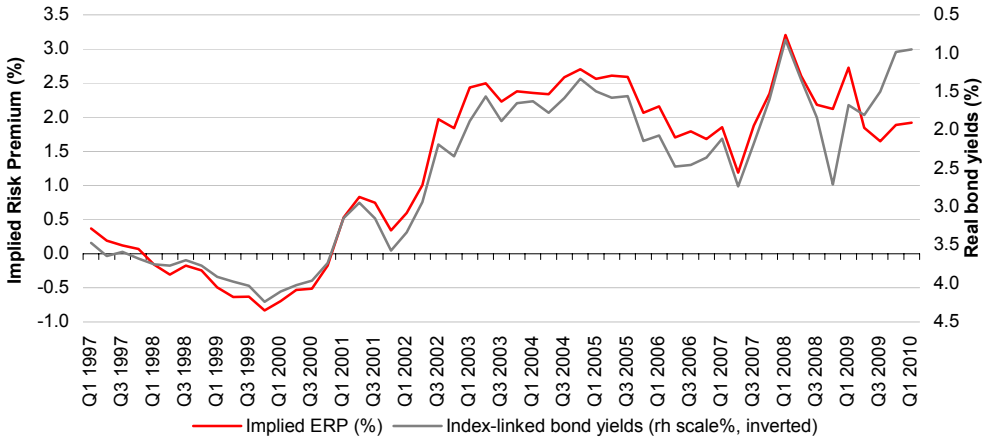
US long-term estimates of future real equity returns: based on dividend yield plus trend real GDP (minus 100bps for equity market dilution)



Source: SG Cross Asset Research

We can then take such forecasts and deduce an implicit forward looking equity risk premium by subtracting a real bond yield. Index-linked bond yields have a more limited history, so by means of example we show data for the US from 1997. As shown below, the movement in the long-term equity risk premium has largely been dictated by a decline in real yields and has been in the range of 1.5-3% during the last eight years. Note the recent break-down in this relationship, with real yields going much lower whilst the implied equity risk premium (courtesy of weak equity) prices stayed put at around the 1.8-2.0% range.

Implied equity risk premium and index-linked bond yields in the US (%)

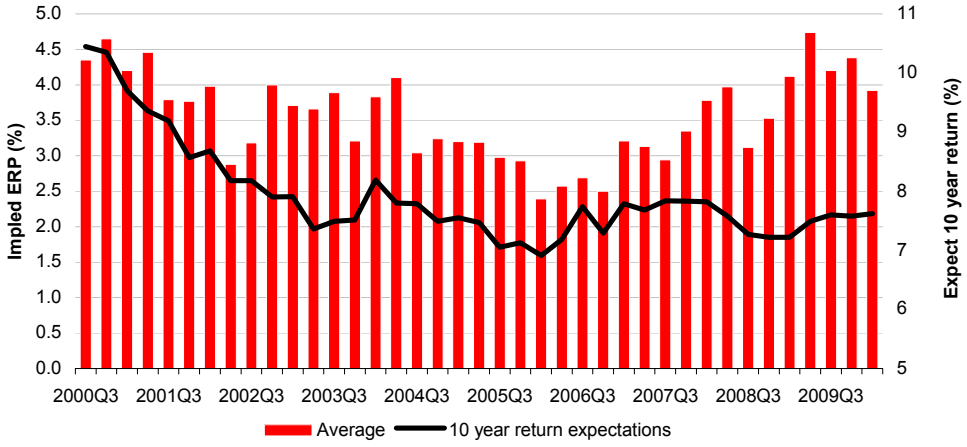


Source: SG Cross Asset Research

How does this tie in with equity risk premium expectations?

Duke University and CFO Magazine[8] regularly conducted a survey of chief financial officers. The survey asks CFO's about their long-term (10-year) return expectations for the S&P 500 and by subtracting the nominal bond yield they extract an implied equity risk premium (ERP)[9], a time series of which is given below. As we show, long-term equity return expectations since 2002 have remained anchored around 7-8%. However, the equity risk premium remains at an elevated level. Does this stem from the view that equities have become *more* risky? No, it's simply a residual of their return expectations, i.e. it is the lower bond yield driving ERP higher.

US Duke CFO Survey: Implied Equity Risk Premium (%)



Source: Duke CFO Magazine Global Survey

We have asked our clients for their opinions on the equity risk premium on a number of occasions. The last such survey was carried out in November 2008 which gave us similar results to one we conducted in 2002. Around 50% of respondents in the US and Europe provided an answer of between 4-5%[10]. When I first started in this job (many moons ago), my then boss told me to inform anybody that rang him asking for an equity risk premium number to plug into their spreadsheets that "the answer is four"! Quite frankly, I hadn't a clue what he was talking about back then but certainly everyone seemed more than happy with the confident answer I gave. As far as I can tell, return expectations (and with it the equity risk premium) seem to be firmly anchored on past nominal returns and it is this anchoring that is driving valuation models rather than any sensible analysis of actually what might be possible.

SG investor equity risk premium survey results –November 2008

	Europe	US	Japan	Emerging markets
Average	4.7%	4.6%	4.4%	6.8%
Median	4.5%	4.3%	4.0%	6.0%
Most common response	5.0%	5.0%	4.0%	5.0%
Standard deviation	1.6%	1.6%	1.6%	2.7%
Responses	210	207	175	165

Source: SG Cross Asset Research

8 see http://www.cfosurvey.org/index.htm

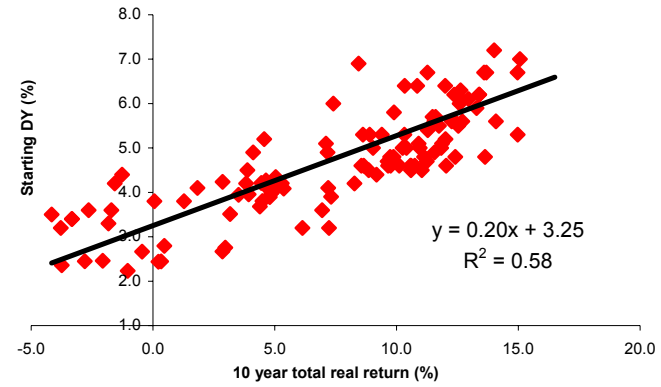
9 see Graham, John R. and Harvey, Campbell R., The Equity Risk Premium amid a Global Financial Crisis (May 14, 2009). Available at SSRN: http://ssrn.com/abstract=1405459

10 Also see Fernandez, Pablo, Market Risk Premium Used in 2008 by Professors: A Survey with 1,400 Answers). Available at SSRN: http://ssrn.com/abstract=1344209

Dividend yield proves a solid forecaster of long-term returns

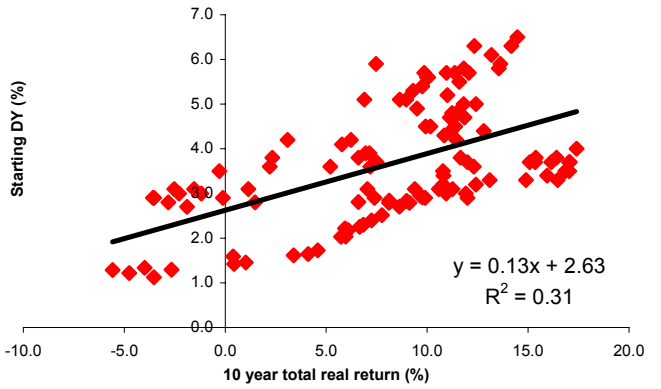
Another possibility is to back-test future 10 year returns given a starting level of valuation. We performed such an exercise using dividend yield in the latest edition of our Global Income Investor ('Quality income scarce as low yields narrow the focus', 28 January 2010); as we show below, during the past 40 years there has been a strong relationship between the starting level of dividend yield and long-term real returns.

UK: Dividend yield as a predictor of 10 year total real returns



Source: SG Cross Asset Research, MSCI

US: Dividend yield as a predictor of 10 year total real returns



Source: SG Cross Asset Research, MSCI

Using data since 1970, we show below that the higher starting dividend yield, the greater the 10 year real returns. This relationship also holds if we use five year returns but is less marked. However, it fails when it comes to short holding periods such as one year returns. If we use nominal returns the relationship is even stronger.

Dividend yields and their relationship with long-term real returns (since 1970, %)

US					
Average Dividend yield	**5.5**	**4.2**	**3.4**	**2.9**	**1.7**
Yield low	5.0	3.8	3.2	2.8	1.1
Yield high	6.5	4.9	3.7	3.1	2.8
Average 10 year real return (%)	11.1	10.2	12.1	4.9	3.0
Best 10 year real return (%)	14.5	17.4	17.1	12.0	9.1
Worst 10 year real return (%)	6.9	2.3	-0.3	-3.6	-5.6
Probability of 10 year loss (%)	0	0	5	33	26

UK					
Average Dividend yield	**6.4**	**5.2**	**4.6**	**4.0**	**2.9**
Yield low	5.7	5.0	4.5	3.8	2.2
Yield high	11.6	5.6	4.9	4.4	3.8
Average 10 year real return (%)	12.4	10.9	9.8	4.5	0.2
Best 10 year real return (%)	16.5	15.0	13.6	9.2	7.2
Worst 10 year real return (%)	7.4	4.6	3.9	-1.6	-4.2
Probability of 10 year loss (%)	0	0	0	9	50

Japan					
Average Dividend yield	**2.9**	**2.0**	**1.1**	**0.8**	**0.5**
Yield low	2.3	1.7	0.9	0.7	0.4
Yield high	5.2	2.2	1.6	0.9	0.7
Average 10 year real return (%)	4.1	12.3	13.1	-1.8	-7.0
Best 10 year real return (%)	9.7	33.0	28.8	7.4	1.4
Worst 10 year real return (%)	-4.2	-12.3	-6.1	-8.4	-11.9
Probability of 10 year loss (%)	13	21	23	78	96

Europe ex-UK					
Average Dividend yield	**5.8**	**4.4**	**3.6**	**2.9**	**2.0**
Yield low	5.3	4.1	3.4	2.8	1.5
Yield high	6.6	5.1	4.0	3.2	2.7
Average 10 year real return (%)	13.7	10.4	7.9	9.2	5.6
Best 10 year real return (%)	17.0	15.6	17.1	14.5	10.4
Worst 10 year real return (%)	8.8	0.4	-0.9	1.3	-3.2
Probability of 10 year loss (%)	0	0	12	0	21

Source: SG Cross Asset Research, MSCI

The current 'starting' dividend yield of 1.9% in the US suggests a performance going forward in line with the lowest quintile, as indeed does a 3.5% dividend yield in the UK. In Japan, the current dividend yield of 1.6% suggests mid-quintile returns, which is mildly encouraging. In Europe ex-UK, the relationship is less solid than in other regions but perhaps this is because we are carrying out the analysis on a regional rather than a country level, as is the case for the US, Japan and the UK.

Conclusion

'Why deal with something today which you can put it off until tomorrow?' is the mantra of the indebted world. Corporate managers have little incentive to put conservative assumptions into their pension fund calculations when many of the liability mismatches will likely occur well beyond their watch. For our work, 4% real growth is at the upper end of expectations with a very real risk of yet more losses over the next ten years. Higher inflation may help, especially if those in the pension scheme have their inflation tracking capped at lower levels. Pension under funding is already proving to be a drag on growth, with several companies already struggling to invest or expand due to their historical pension commitments.

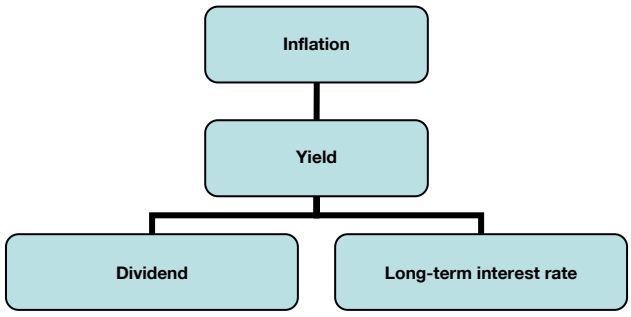
Does this hamper equity in the short-term? For one those with lower return expectations can continue to buy, those with higher expectations will simply have to make up the short-fall by saving more or reducing benefits. Also during the last 10 years equities have happily ignored over-valuation signals whenever cyclical momentum is positive. However once that momentum fades, it may be a long way down until you start hearing that equities are "cheap".

Appendix I: The Wilkie Model

The Wilkie investment model was introduced by actuary David Wilkie in 1986[11] to explain and predict the behaviour of various economic variables. Originally, it only included models for inflation, dividends, dividend yield and long-term interest rates and was applied to the UK market. In 1995[12], Wilkie revised and extended his model to cover wages, short-term interest rates, property yields and index-linked yields. He also introduced his model to other countries. The Wilkie model and its extensions are widely used today in the actuarial world and elsewhere to forecast the aforementioned economic series and predict market returns.

In the context of this model, inflation is the key driver of all economic series. The direction of influence and cross dependencies in the original Wilkie model are shown below; notably share dividends and long-term interest rates are influenced by both the dividend yield and inflation levels, while the dividend yield is only dependant on inflation. On the other hand, inflation is only described by its own previous values.

Direction of influence in original Wilkie model



Source: SG Quantitative research, Wilkie (1986)

[11] Wilkie(1986). "A stochastic investment model for actuarial use": www.soa.org/library/monographs/.../investment.../m-as99-2-06.pdf

[12] Wilkie(1995). "More on a stochastic asset model for actuarial use": www.inqa.com/files/Conferences/MoreOnAStochasticAssetModel1995BAJ1.pdf

The 4 equations describing the dynamics of the Wilkie original model are shown below:

(1) Inflation

$\nabla \log Q(t) = QMU + QA(\nabla \log Q(t-1) - QMU) + QSD.QZ(t)$,

where $Q(t)$ = Retail price index, $\nabla \log Q(t) = \log Q(t) - \log Q(t-1)$, $QZ(t) \sim iidN(0,1)$ and QMU,QA,QSD constants[13].

(2) Dividend Yield

$\log Y(t) = YW.\nabla \log Q(t) + YN(t)$

where $YN(t) = \log YMU + YA(YN(t-1) - \log YMU) + YSD.YZ(t)$,

$Y(t)$ = Dividend yield, $YZ(t) \sim iidN(0,1)$ and YW,YMU,YA,YSD constants[14].

(3) Dividends

$D(t) = D(t-1).\exp\{DW.DM(t) + DX.\nabla \log Q(t) + DMU + DY.YSD.YZ(t-1) + DB.DSD.DZ(t-1) + DSD.DZ(t)\}$,

where $DM(t) = DD.\nabla \log Q(t) + (1-DD).DM(t-1)$,

$D(t)$ = Dividend index, $DZ(t) \sim iidN(0,1)$, DW,DX,DMU,DY,YSD constants[15].

(4) Long-term interest rates

$C(t) = CW.CM(t) + CMU.\exp\{CN(t)\}$,

where $CM(t) = CD.\nabla \log Q(t) + (1 - CD).CM(t-1)$,

$CN(t) = CA1.CN(t-1) + CA2.CN(t-2) + CA3.CN(t-3) + CY.YSD.YZ(t) + CSD.CZ(t)$,

$C(t)$ = Long-term interest rate, $CZ(t) \sim iidN(0,1)$ and CW,CD,CMU,CA1,CA2,CA3,CY,CSD constants[16].

According to the above equations, the inflation model is designed to depend only on its own previous levels, the dividend yield on the current level of inflation and previous dividend yields, the dividends index on the current level of inflation, the residuals of the yield model as well as previous dividends, while the long term interest rates are dependant on the current and previous level of inflation, the residuals of the yield model and previous interests rates. It is also worth noticing the mean reverting properties of the above equations.

[13] Wilkie(1995): QMU=0.047, QA=0.58, QSD=0.0425.

[14] Wilkie(1995): YW=1.8, YA=0.55, YMU=0.0375, YSD=0.155.

[15] Wilkie(1995): DW=0.58, DD=0.13, DMU=0.0016, DY=-0.175, DB=0.57, DSD=0.07.

[16] Wilkie(1995): CW=1.0, CD=0.045, CMU=0.0305, CA1=0.9, CA2=0, CA3=0, CY=0.34, CSD=0.185.

Predictions

We have applied the Wilkie model in the UK market (FTSE All Share) using the 1995 revised coefficients. Below we present the model's prediction for inflation and dividend yields levels, as well as capital and total returns over the next decade. Instead of using the 4.7% inflation rate used in the 1995 edition of the model, we adjusted it downwards to 3%.

Wilkie model predictions over the next decade

Year	Inflation	Yield	Dividend	Price Index	Price Return	Total Return
2010	3.7%	3.2%	91.6	2898.4		
2011	3.5%	3.6%	95.3	2681.1	-7.5%	-3.9%
2012	3.2%	3.8%	99.4	2637.1	-1.6%	2.1%
2013	3.2%	3.9%	103.9	2666.0	1.1%	5.0%
2014	3.1%	4.0%	108.4	2740.6	2.8%	6.8%
2015	3.1%	4.0%	113.0	2827.0	3.2%	7.2%
2016	3.0%	4.0%	117.9	2942.6	4.1%	8.1%
2017	2.9%	4.0%	123.2	3073.4	4.5%	8.5%
2018	3.0%	4.0%	128.7	3200.9	4.2%	8.2%
2019	3.1%	4.0%	134.4	3336.3	4.2%	8.3%
2020	3.0%	4.0%	140.2	3473.0	4.1%	8.1%

Source: SG Quantitative Research, FTSE, Bloomberg

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