GLOBAL MARKETS & RETURN DRIVERS

Analysis for the Ministry of Finance, Norway

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EXECUTIVE SUMMARY

The global market comprises several asset classes with different risk and performance characteristics. These asset classes provide investment opportunities and diversification benefits for long term investors. From the perspective of an institution with substantial assets, it is particularly relevant to examine the current breadth and historical evolution of the entire market and its sub components when making asset allocation decisions.

On this basis, MSCI was engaged by the Norwegian Ministry of Finance to analyze the global market portfolio and examine the key drivers affecting returns and cash flows of global equities over long investment horizons. The conclusions of this research project are summarized in this report. More specifically, the report covers four areas:

1. Analysis of the composition and historical evolution of the market portfolio
2. Decomposition of returns into income, growth and valuation adjustments
3. Analysis of cash flows and valuations in different economic environments
4. Long term impact of growth and inflation shocks on cash flows and returns

The first section covers all major asset classes including public equity, private equity, fixed income, real estate and infrastructure. The other sections focus on public equities. The overall market portfolio has doubled in size from 1999 to 2015. The fixed income market, the largest segment, has nearly tripled during the same time period whereas the proportion of public equity markets has declined.

A decomposition of the returns of public equities reveals that the return contribution from dividend growth increased and valuation adjustments decreased with increasing holding periods during the last two decades. Returns, cash flows and valuations varied across periods of economic expansion and recession. Returns were more volatile than cash flows while valuations rose during expansions and fell during recessions over the period Dec 1994 to Sep 2015.

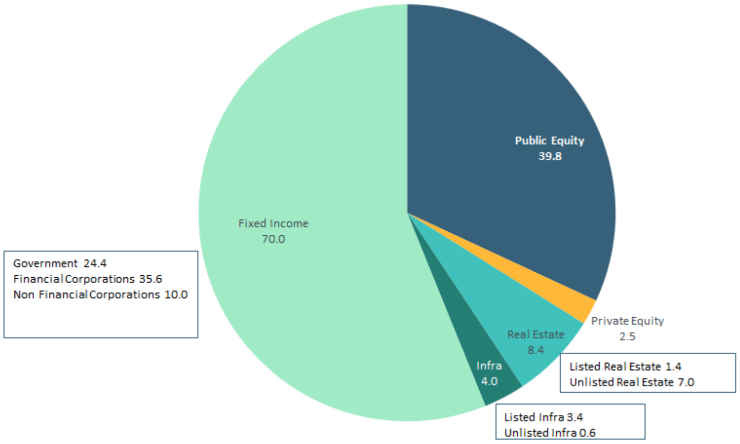
Finally, we provide an analysis of the sensitivity of US equity returns and cash-flows to shocks in real GDP growth and inflation. We conduct both a descriptive analysis and a structured, model based analysis using the MSCI Macroeconomic Risk model to gain insights into the long-term drivers of cash-flows and returns. Our model results indicate that both real GDP growth and cash-flow betas – the long-term sensitivities of cash-flows to GDP shocks – have driven long-term equity returns and risk.

GLOBAL MARKET PORTFOLIO

This section analyzes the composition and historical evolution of global markets with focus on five asset classes - Global Equity Market, Private Equity Market, Global Fixed Income Market, Private Real Estate Market, and Private Infrastructure Market.

Chart 1 shows the total size of the investable global market (USD 125 Trillion) as well as its breakdown by asset classes as of June 2015. Fixed income, representing 56% by market capitalization, is the largest segment followed by public equity at 32%. Real estate, infrastructure and private equity respectively form 6.8%, 3.2% and 2% of the global market portfolio.

Chart 1: Investable Global Market Portfolio as of June 2015 - Market Size (in Trillion USD)



Fixed Income: Debt Outstanding as determined by BIS (Bank of International Settlement). A fraction of 60% is applied on the Government issued debt estimates from BIS to account for holdings by Central Bank and Governments in order to obtain investable market size for Government debt securities. **Public Equity:** FIF Market Capitalization of MSCI ACWI IMI ex Infra ex Core Real Estate Index . **Private Equity:** As estimated by Burgiss and includes Venture Capital, Debt Financing and Buyout Funds. **Listed Real Estate:** FIF Market Capitalization of MSCI ACWI IMI Core Real Estate Index. **Unlisted Real Estate**: Estimated by IPD and includes professionally managed investment market based on individual fund size. **Listed Infrastructure**: FIF Market Capitalization of MSCI ACWI IMI Infrastructure Index. **Unlisted Infrastructure**: Estimated by IPD based on the third-party headline number (from RARE in 2012) that is used as a starting point for the unlisted equity portion of non-government-owned infrastructure.

A survey of the historical evolution of the investable global market portfolio reveals the overall growth of the market as well as the absolute and relative growth of the different asset classes as shown in Exhibit 2. The global market portfolio has nearly doubled from USD 64 Trillion in 1999 to USD 125 Trillion in 2015. The share of the fixed income market[1] has grown significantly from 45% in 1999 to 56% in 2015, whereas the proportion of the public equity market has declined from 41% to 32% over the same time period.

We examine each of the individual asset classes in more details and, wherever possible, break down the asset class by regions, sectors or asset types.

GLOBAL EQUITY MARKET

MSCI ACWI IMI, a global equity index consisting of both developed and emerging market companies is used as a proxy for global equity markets. It includes large, mid and small capitalization companies. A company's market capitalization may not be fully available for investment by international investors. In 2001, MSCI started to distinguish between full and free-float[2] adjusted market capitalization of companies in order to identify the investable portion of the equity market.

Exhibit 3 shows the historical evolution of the global equity market as seen by the evolution of full and FIF (investable) market capitalization of MSCI ACWI IMI over the past 20 years. Exhibit 4 separates listed real estate and infrastructure from MSCI ACWI IMI. Exhibits 5 and 6 present the regional and sectoral breakdown of MSCI ACWI IMI. These exhibits highlight the relative expansion and contraction of regions and sectors through time.

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[1] In order to obtain an estimate of the investable market size of the debt issued by governments, we applied a 40% haircut from 2008 to 2015 and 26% before 2008 to the total outstanding government debt estimates from the BIS to account for Central Banks and Governments holdings. These haircuts were obtained from the BIS 85th annual report. The left hand chart in Graph II.9 page 34 of the BIS report (http://www.bis.org/publ/arpdf/ar2015e.pdf) provides the BIS estimates of central bank and foreign reserves holdings of US, Eurozone, Japan and UK government bonds and their recent evolution. Note that the estimates of the debt issued by financial and non-financial corporations could reflect Central Banks holdings.

[2] Free float of a security is the proportion of shares outstanding that is deemed to be available for purchase in the public equity markets by international investors

PRIVATE EQUITY MARKET

Evaluating the total size of the private equity market is a challenging question all market participants face. Based on our analysis[3], at USD 2.5 Trillion, the private equity market formed 2% of the global market portfolio as of June 2015. Exhibit 7 shows the size and the breakdown of the private equity market by segment (Buyout, Venture and Debt, the Debt segment includes both Distressed Debt and Mezzanine).

FIXED INCOME MARKET

The fixed income market, representing the largest asset class in the market portfolio, has almost tripled from 1999 to 2015 and currently stands at USD 87 Trillion. The total debt outstanding estimates we report are determined by the BIS (Bank of International Settlements). It includes debt issued by governments, financial corporations and non-financial corporations, and excludes agency debt and mortgages. Exhibit 8 shows different regions in terms of total debt outstanding. As of Dec of 2014, nearly 44% of total debt outstanding was issued by USA & Canada, a relative drop from 50% in 1998.

PRIVATE REAL ESTATE MARKET

The private real estate market formed a significant 6.8% of the global market portfolio as of June 2015. Estimated by IPD, the real estate market size reported includes institutional, investable and professionally managed commercial real estate. Exhibits 9 and 10 show the regional and sectoral breakdown of the private real estate market.

PRIVATE INFRASTRUCTURE MARKET

Although rapidly growing in the last 7 years, the overall size of ‘institutional/investable’ private infrastructure market remains relatively small ($600bn). Exhibits 11 and 12 show the regional and sectoral breakdown of the private infrastructure market. While allocations have been fairly split across regions (Americas, EMEA, and Asia Pacific), they have been dominated by the Utilities and Transport sectors.

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[3] Our analysis relies on data provided by Burgiss. We show the evolution of committed capital across the major private equity market segments (Buyout, Venture Capital and Debt), as estimated by Burgiss from information on committed capital by limited partnerships. Evaluating the total market size of private equity is difficult due to lack of publicly available data. Although the information collected by Burgiss is comprehensive, the estimated market size is likely to represent only a small fraction of the actual market size (see Harris, Jenkinson and Kaplan (2014)).

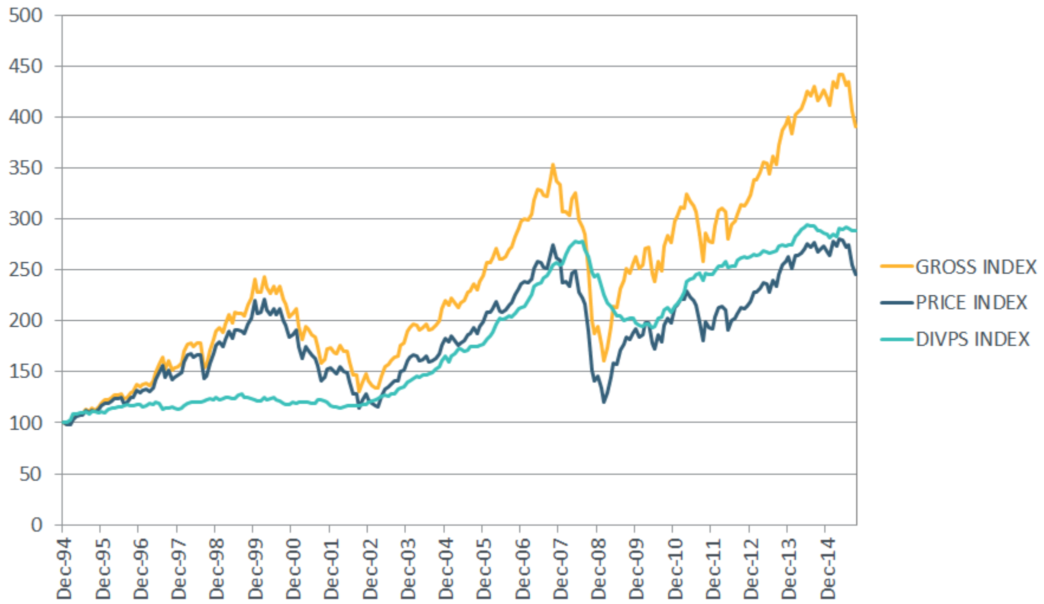
DRIVERS OF RETURN

This section examines different components of the total return of Global Equities, as measured by the MSCI ACWI Index, for the historical period Dec 1994 to Sep 2015. We find that dividend yield and dividend growth explain most of the return and risk in the long run. We also look at the historical development in dividend yield and factors that affect dividend growth in the short- and long run.

RETURN DECOMPOSITION

We decompose the total return of Global Equities, measured by the MSCI ACWI Index, in order to understand the various sources of return and their relative importance over different periods. Chart 2 breaks down the gross return for MSCI ACWI into price return and development in dividends per share. This chart shows that, over the past 20 years, global equity prices have grown approximately in line with dividends, indicating low long term contribution from valuation adjustments over this historical period.

Chart 2: MSCI ACWI - Return decomposition over 20 years



We decompose the returns of the MSCI ACWI Index in order to understand its various components and their relative importance over different horizons. Mathematically, the total return of an equity investment over a single period can be written as a function of prices and dividends:

$$R = \frac{P_1 + D_1 - P_0}{P_0}$$

In this simplified expression, P_0 and P_1 represent the price of the asset at the beginning and at the end of the holding period while D_1 represents gross dividend, assumed to be paid at the end of the holding period.

This equation can be rewritten to illustrate that total return over a single period may be decomposed into three parts: (1) starting dividend yield, (2) dividend growth and (3) a part representing valuation adjustments over the holding period plus a cross term due to the interaction of starting yield and dividend growth:

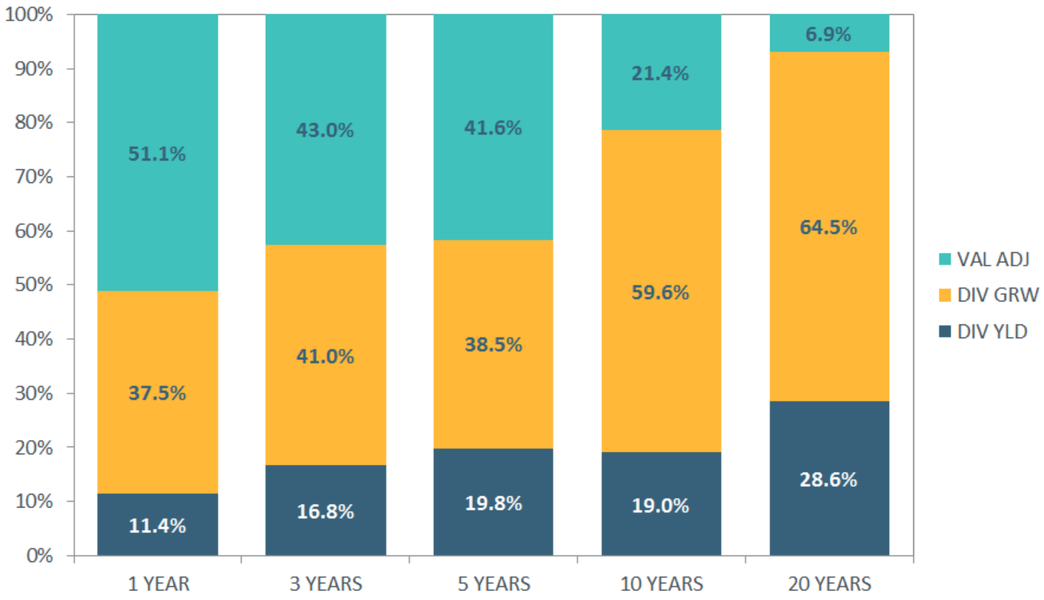
$$R = \frac{D_0}{P_0} + G + \frac{D_0}{P_0} G + \frac{P_1 - P_0(1+G)}{P_0}$$

In the last expression G represents dividend growth from D_0 to D_1 during the holding period. The intuition behind this expression is very simple. If prices grow in line with dividends, then P_1 would be replaced by $P_0(1+G)$ and the last term disappears, in other words there is zero valuation impact on total return. On the other hand, if prices grow by more (less) than dividends, the last term is positive (negative) resulting in positive (negative) contribution to total return.

As part of the MSCI Fundamental Data Methodology, the index level dividend yield is computed for all indexes. The index dividend yield at the start of the holding period forms the first component of this simple return decomposition. MSCI also calculates gross total returns as well as price only returns for all indexes. The difference between the two arises from reinvestment of dividends. For computation of the second return component, i.e., dividend growth, we first compute dividends per share as the product of dividend yield and price index levels and then calculate implied growth in dividends per share over the holding period. The valuation adjustment term (the last component) is derived by subtracting dividend yield and dividend growth from the index gross total returns and reflects the relative expansion or contraction in valuations.

The return decomposition of ACWI equities is presented in Chart 3. We use non-overlapping annual data for the 1-year horizon and overlapping annual data for longer horizons. This analysis covers the historical period Dec 1994 to Sep 2015 and shows that the average contribution of the valuation adjustment term to total returns became smaller as the investment horizon became increasingly longer. Valuation changes accounted for approximately 50% of total returns over 1-year periods while their contribution fell to 20% over 10-years and to less than 10% over 20-years, reflecting the declining importance of valuation changes over longer horizons. On the contrary, the average contribution from dividend growth increased with increasing time horizon. Dividend growth was the highest contributor to equity returns, accounting for at least 60% of total equity returns over 10-year and 20-year periods. Dividend yield is the second largest return contributor explaining nearly 30% of the total ACWI returns over 20 years.

Chart 3: Average absolute return contribution from Dividend Yield, Dividend Growth and Valuation Adjustments for different holding periods

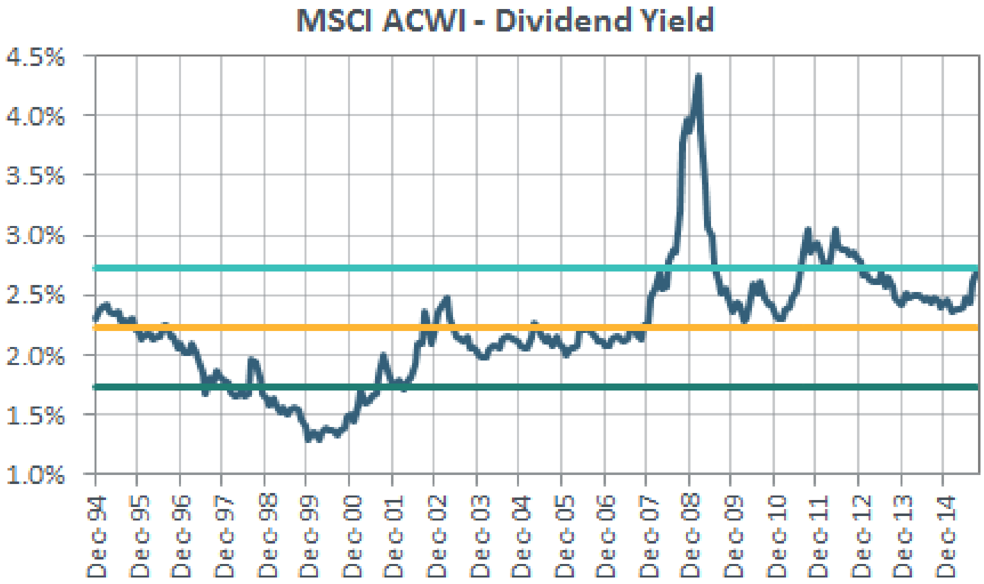


DIVIDEND YIELD

The average dividend yield was 2.23% over the period of the study and accounted for 28.6% of long term returns. Changes in dividend yield over this period have been very important for short term volatility and explained 51.1% of annual returns.

The development in dividend yield for MSCI ACWI is shown in Chart 4. Dividend yield over this period was volatile with a standard deviation of 0.5%. During the technology bubble of the late 1990s, equity valuations expanded dramatically as the market value of technology companies soared while earnings and dividends only grew modestly. The situation was reversed with rising dividend yield during the bear market of 2000 - 2003. We observe another cycle in valuations during the financial crisis. Dividend yield spiked in the bear market of late 2008 and then declined to more normal levels in the market recovery of 2009. The common element between these two crises is the mean reversion in yield, which has resulted in relatively muted return contribution from this component (relative to dividend growth) over long horizons. Chart 4 also allows us to compare the current dividend yield with its historical average level. Current dividend yield is higher than the historical average level by approximately one standard deviation. Finally, it is interesting to note that dividend yield has not declined in line with falling bond yields over this period.

Chart 4: MSCI ACWI – Dividend Yield



DIVIDEND GROWTH

Dividend growth per share accounts for 64.5% of total equity returns in the long-run (as shown in Chart 3). This section examines the impact of macroeconomic risks to dividend growth and the profitability of the corporate sector.

Growth in dividends per share has to be supported by growth in earnings and cash flow per share. Chart 5 shows the historical development in Dividends per Share (DPS) and in Earnings per Share (EPS). Cyclicality in DPS and EPS generally coincided with the overall business cycle, with EPS reacting more sharply to peaks and troughs in the cycle.

Chart 5: MSCI ACWI – Total Returns and Cash Flows

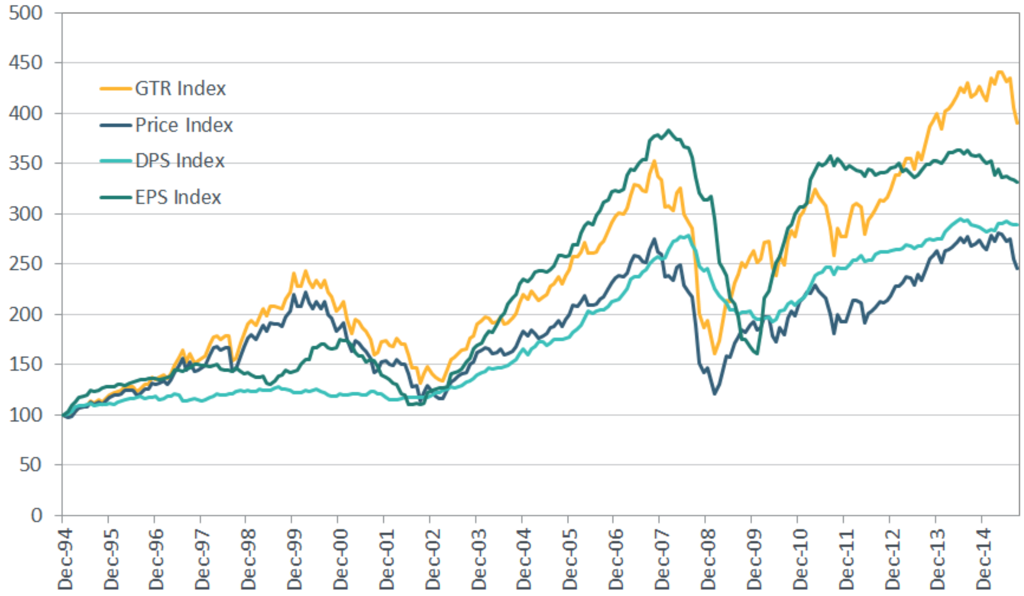
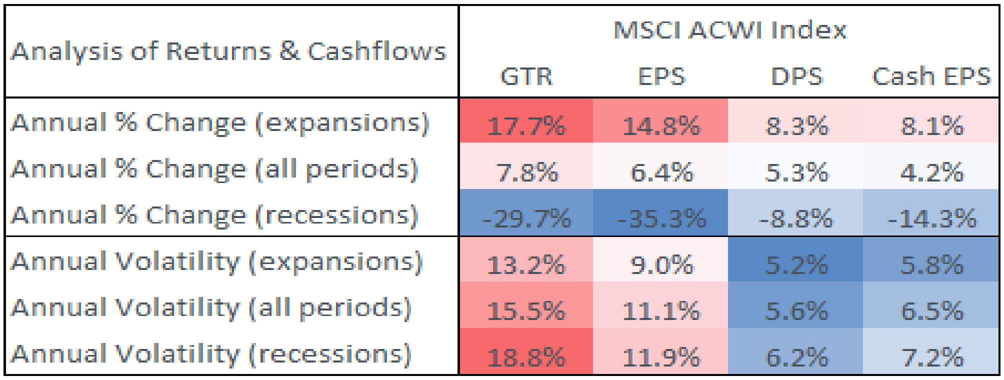


Table 1 shows the annual growth and volatility for Gross Total Return (GTR), Earnings per Share (EPS), Dividends per Share (DPS) and Cash Earnings per Share (Cash EPS) over the last 20-years. The table also illustrates how these measures respond to periods of expansion and recession. We measure expansions and contractions based on in-sample peak-to-trough data between Dec 1994 and Sep 2015.

All the return and cash flow series are highly correlated and reflect the business cycle. The GTR Index historically experienced higher growth and higher volatility compared to EPS, DPS and Cash EPS. Cash EPS is less volatile than EPS, which suggest that revaluation of the balance sheet is important for the volatility of Earnings per Share. DPS is the least volatile series, reflecting the smoothing of dividends and relatively stable payout policy. Changes for all measures were positive and had lower volatility during expansions, while they were negative and had higher volatility during contractions.

Table 1: Returns and Cash Flows



Analysis of Returns & Cashflows	MSCI ACWI Index			
	GTR	EPS	DPS	Cash EPS
Annual % Change (expansions)	17.7%	14.8%	8.3%	8.1%
Annual % Change (all periods)	7.8%	6.4%	5.3%	4.2%
Annual % Change (recessions)	-29.7%	-35.3%	-8.8%	-14.3%
Annual Volatility (expansions)	13.2%	9.0%	5.2%	5.8%
Annual Volatility (all periods)	15.5%	11.1%	5.6%	6.5%
Annual Volatility (recessions)	18.8%	11.9%	6.2%	7.2%

* For returns and valuations, recessions are defined as the return peak to trough time periods of 03/2000 - 03/2003 and 10/2007 - 02/2009. For cash flow and profitability, recessions are defined as the EPS peak to trough time periods of 12/2000 - 09/2002 and 02/2008 - 12/2009

LONG-TERM MACROECONOMIC MODEL ANALYSIS

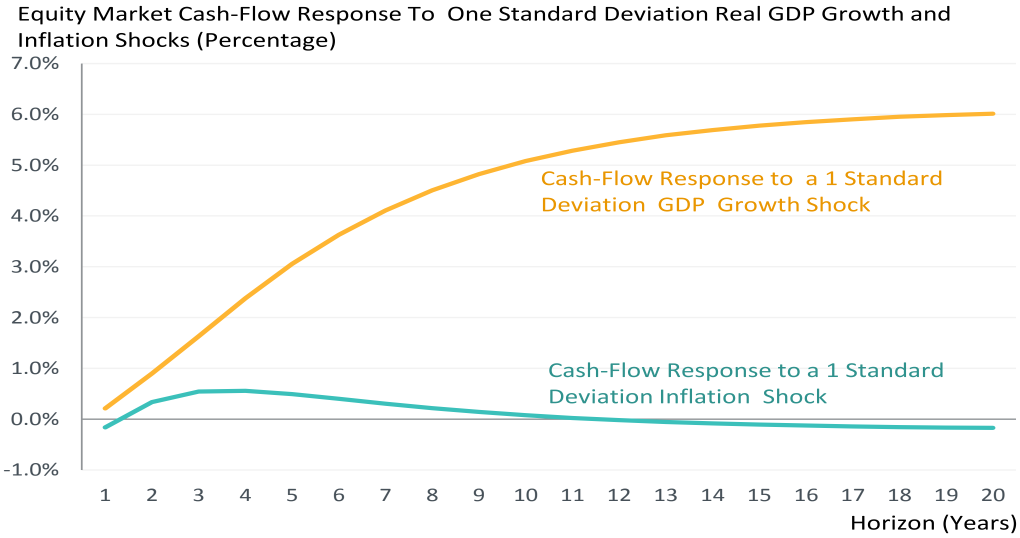
In this section, we apply the long-term MSCI Macroeconomic Risk Model to show how shocks to trend growth and inflation affect cash-flows, discount rates (bond yields), returns and risk over long horizons.

MACROECONOMIC RISK AND CASH-FLOWS

The MSCI Macroeconomic Risk Model estimates the impact of shocks to economic trend growth and inflation on growth in dividends per share. More precisely, following and extending the analysis in Hansen, Heaton, and Li (2008), the model estimates the relationship between a portfolio's growth in dividends per share, aggregate profit share (ratio of aggregate corporate profits to GDP), real GDP growth, inflation and their lagged values (see Appendix for the technical details). Thus, a one-time shock to trend growth or inflation can potentially have an impact on dividends per share for many quarters or years.

Chart 6 shows the estimated cash-flow betas with respect to trend growth and inflation risk for the US equity market portfolio. Inflation shocks seem to have a negligible impact on equity market cash-flows at all horizons. In contrast, the cash-flow betas with respect to growth shocks reveal an interesting pattern. Over short horizons, the impact of growth shocks on the equity market's dividends per share is close to zero. Over time however, this impact could grow persistently to higher levels. More precisely, over 20 years, the model indicates that dividends per share could increase by about 600bps relative to the model baseline (i.e. no shocks).

Chart 6: US Equity Market Cash-Flow Response to Trend Growth and Inflation Shocks

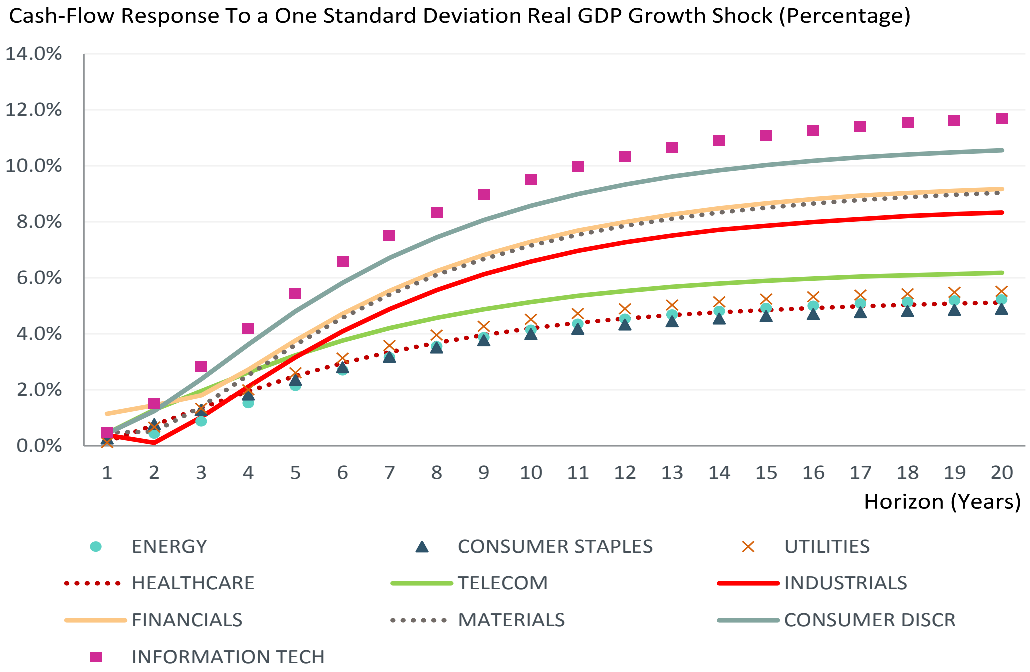


The chart plots the evolution of the response of US equity market cash-flows to one standard deviation shocks to GDP growth and inflation (cash-flow beta). All cash-flow changes are inflation adjusted and relative to the MSCI Macroeconomic Risk Model baseline. Baseline is no shocks. Cash-flows are the dividends per share derived from the MSCI USA equity market index.

To gain further insights into this result, we need to understand how the initial GDP growth shock impacts future GDP growth and corporate profits. The persistent shock to trend growth we impute (about 100bps positive shock over a year) means that over longer horizons, real GDP increases by 150bps relative to baseline, that is, an additional 50bps increase relative to its initial change. Corporate profits also increase (relative to baseline) by the same amount (150bps) in the long run. The larger change observed in dividends per share (600bps) could be primarily attributed to larger changes in dividend payout ratios. In addition, changes in payout policies, when they occur, typically lag the initial shock to the economy, up to 2 years. This lag effect could drive the persistence in the impact on dividends and its magnitude in the long-run. A second explanatory factor could be possible share dilution effects that are not explicitly modeled in our current framework.

The MSCI Macroeconomic Risk Model also shows how the impact of growth and inflation shocks on cash-flows varies across sectors. Chart 7 shows the 10 US GICS sector cash-flow betas with respect to growth shocks. We focus on shocks to real output growth instead of inflation as Chart 6 and our previous papers have shown that real economic growth risk dominates long-term cash-flow growth risk in equity portfolios.

Chart 7: Sector Cash-Flow Response to a One Std. Dev. Shock to US real GDP Growth



The chart plots the evolution of the response of US equity sector cash-flows to one standard deviation GDP growth and inflation shocks (cash-flow beta). All cash-flow changes are inflation adjusted and relative to the MSCI Macroeconomic Risk Model baseline. Baseline is no shocks. Cash-flows are the dividends per share derived from the 10 MSCI USA equity sector indexes.

As was also the case for the equity market, the impact of growth shocks on sector dividends per share is only revealed over longer horizons. In addition, meaningful differences emerge across the sector portfolios. Cyclical sectors such as Information Technology, Consumer Discretionary, Financials, Materials and Industrials exhibit greater cash-flow betas over longer horizons compared to market. In contrast, defensive sectors such as Utilities, Healthcare and Consumer Staples exhibit lower long-term cash-flow beta compared to market. In particular, Chart 7 shows that after 10 years (twenty quarters), Information Technology and Financials dividends per share have grown about twice as much as those for the market, whereas Health Care and Utilities dividends per share have grown by a slightly a lower amount compared to the market's.

As argued in the macro-finance academic literature (see in particular Bansal, Dittmar and Lundblad (2005), Bansal, Dittmar, and Kiku (2009), and Hansen, Heaton and Li (2008)), the persistence in the cash-flow betas over long horizons suggests that macro risk is a long-term and undiversifiable risk. As for all undiversifiable risk, it must be priced, at all horizons. In particular, across portfolios, differences in long-term expected returns should reflect the portfolios' long-term cash-flow beta to macro risk.

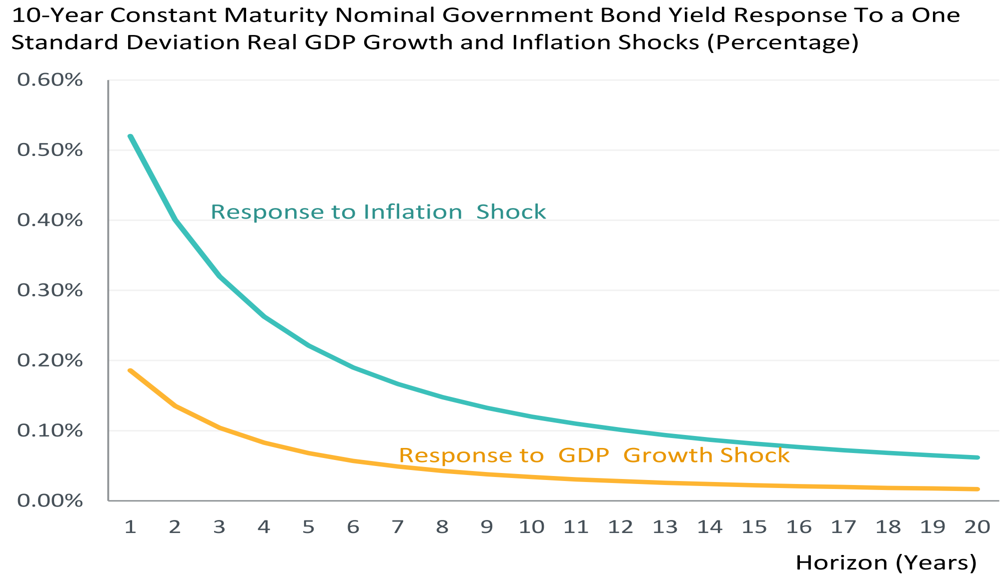
In the MSCI Macroeconomic Risk Model, macroeconomic risk impacts long-term returns and risk through its effects on both cash-flows and the discount factor. Having examined how macro risk affects cash-flows, the next section shows how macro risk affects discounting.

IMPACT OF MACROECONOMIC RISK ON REAL AND NOMINAL BOND YIELDS

We estimate discount factors by observing discount rates in government bond markets. Indeed the government bond yield curve informs the discount factor in the MSCI Macroeconomic Risk model (see Appendix for the technical details). Because macro events do not affect future cash-flows of bonds, their effects can only materialize via the pricing of the cash-flows (i.e. yields).

While equities are mostly driven by real economic growth risk, the MSCI Macroeconomic Risk Model indicates that nominal bonds are primarily driven by inflation risk. Chart 8 shows the impact of the same growth and inflation shocks on the US 10-year constant maturity nominal government bond yield over multiple horizons. As investors seek insurance against economic growth shocks in the form of bonds, it is not surprising that positive and persistent shocks to real trend growth initially increase the nominal bond yield (19bps increase relative to baseline, over a year). Over time, after about 5 years, economic growth reverts back to its baseline following the initial shock. While the nominal bond yield also reverts back gradually to baseline, it does so at a much slower rate. The impact of inflation is much more meaningful. Nominal bond yields experience a relative increase of 52bps over a year following the 100bps positive inflation shock. In other words, higher inflation is negative for nominal bond prices. Although our model indicates that higher inflation could be associated with lower future real economic growth, the negative effects of higher inflation overwhelm the beneficial effects on nominal bond prices during times of lower economic growth.

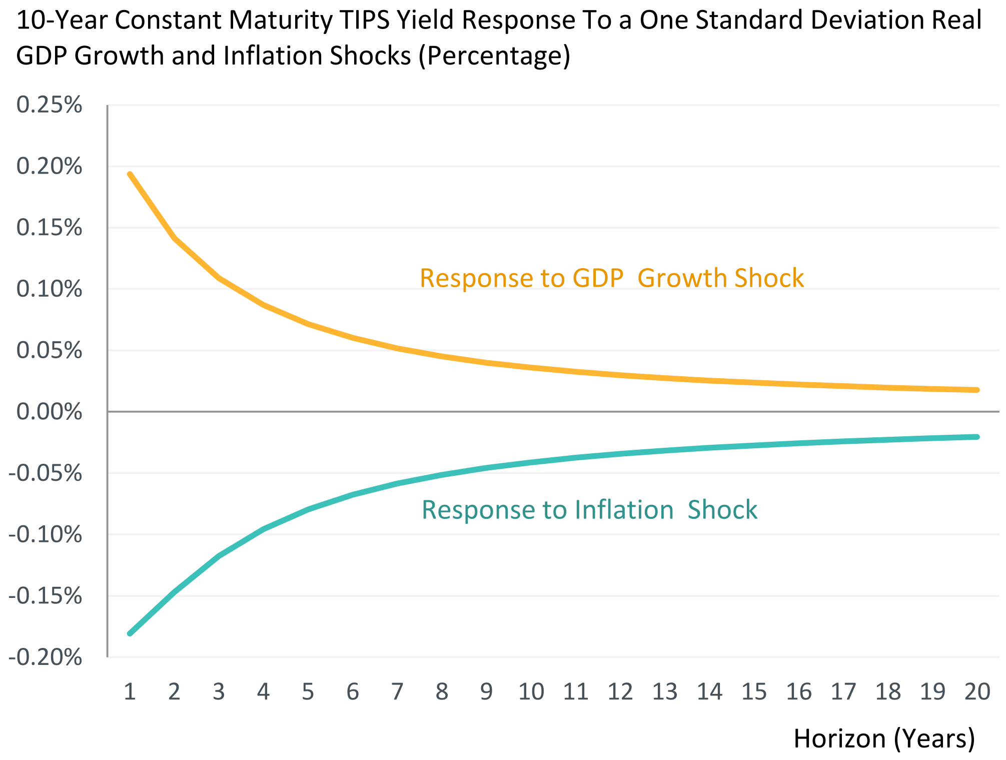
Chart 8: US 10-Year Constant Maturity Government Bond Yield Response to Trend Growth and Inflation Shocks



The chart plots the evolution of the response of the US 10-Year Constant Maturity treasuries bond yield to one standard deviation GDP growth and inflation shocks. All changes are relative to the MSCI Macroeconomic Risk Model baseline. Baseline is no shocks.

What about the impact of growth and inflation shocks on inflation protected bonds? As shown in Chart 9, unlike nominal bonds, the 10-year constant maturity real bond offers protection against inflation shocks: a positive 100bps shock to inflation decreases real bonds yields by about 18bps relative to baseline, over a year. Like nominal bonds, however, it also offers protection against growth shocks. Actually, both real and nominal bond yields increase by the same 19bps over a year relative to baseline.

Chart 9: US 10-Year Constant Maturity Inflation Protected Treasury Yield Response to Trend Growth and Inflation Shocks



The chart plots the evolution of the response of the US 10-Year Constant Maturity inflation protected treasuries bond yield to one standard deviation GDP growth and inflation shocks. All changes are relative to the MSCI Macroeconomic Risk Model baseline. Baseline is no shocks.

MACROECONOMIC RISK DRIVES LONG-TERM PORTFOLIO RETURN AND RISK

Macroeconomic risk can impact returns via its impact on cash-flows and discount rates. To better understand how economic trend growth risk drives long-term equity return and risk, the MSCI Macroeconomic Risk Model extends the Gordon model to longer horizons and decomposes the portfolio's compound (gross) return (**R(H)**) over H quarters into permanent and transitory components (see Appendix for technical derivations):

R(H) = Permanent(H) * Transitory(H)

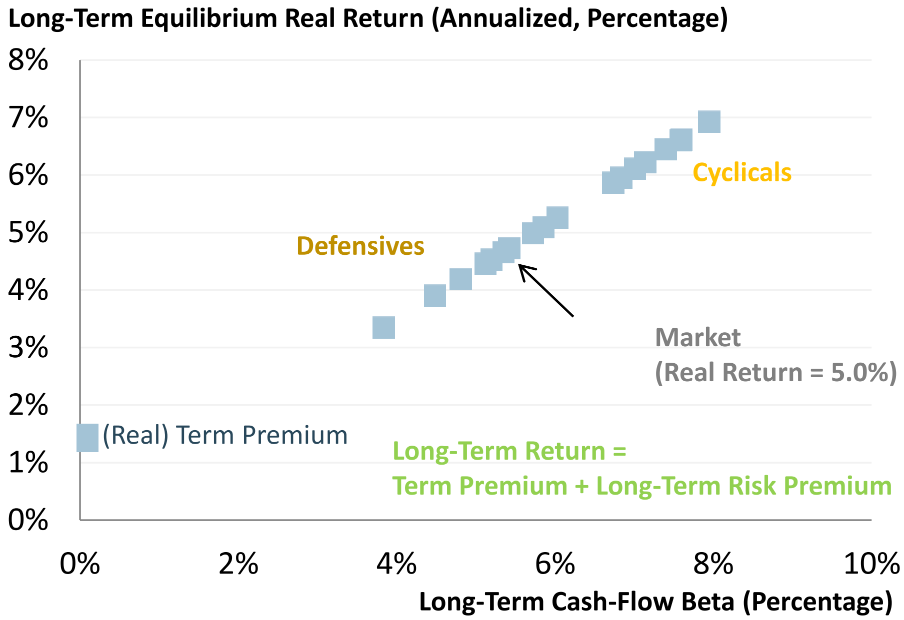
As shown in the Appendix, the variance of the permanent return grows indefinitely with horizon (**H**) (in proportion to **H**), while the variance of the transitory return remains constant. Thus, longer horizon (10 years or 40 quarters and beyond) expected return and risk are driven by the permanent component's expected return and risk. We show how economic growth risk drives the expected return and risk of the permanent component in sequence.

Chart 10 shows that the permanent component's expected real return (long-term real return, over 10 years) reflects the long-term cash-flow beta to GDP growth risk. This relationship between the model long-term returns and cash-flow betas provides an insightful characterization of the long-term return and risk trade-offs: the long-term efficient frontier. The intercept and the slope of this frontier respectively measure the term premium (i.e. the long-term equivalent of the risk-free rate), and the long-term discount factor sensitivity to GDP shocks. In other words, the discount factor links cash-flow betas and expected returns.

Thus the long-term return can be decomposed into two components: the (real) bond term premium and the long-term risk-premium. Both components are driven by macro risk. The real term premium (about 2.3%) is common across all portfolios and measures the difference between long (over 10 years) and short (3 months) real bond yields estimated by the model. It depends on both the long-term real GDP growth average and uncertainty. The term premium increases with GDP growth as investors typically decrease their demand for real bonds in good times, while it decreases with GDP growth uncertainty as investors seek insurance in the form real bonds in times of slow growth.

The long-term risk premium reflects both the cash-flow beta and the long-term discount factor sensitivity to GDP shocks. The latter is common across all portfolios. While cash-flow risk could be driven by other factors uncorrelated with GDP growth (in our model, inflation and pure cash-flows shocks uncorrelated with GDP growth), these other factors are not priced in long-run real returns. Only those shocks that are correlated with GDP growth in the long-run carry systematic risk and are being priced. For example, as cash-flows of cyclical sectors exhibit higher sensitivity to GDP shocks relative to market, the model indicates that these portfolios could also exhibit higher risk-premium and long-term return relative to the equity market. In contrast, defensive sectors earn a lower premium compared to market as these portfolios exhibit a lower cash-flow beta.

Chart 10: Long-Term Efficient Frontier - Expected Returns Reflect Long-Term Cash-Flow Betas to Macro Risk



The exhibit plots the long-term (10 years) real return against the long-term real cash-flow sensitivity to GDP or "cash-flow beta", as implied by the MSCI Macroeconomic Risk Model, for the US equity market and 10 GICS sectors. The "cash-flow beta" is the long-term real cash-flow change following a one-standard deviation shock to real GDP growth. The model long-term returns and cash-flow betas are inflation-adjusted. Cash-flows are the dividends per share derived from the MSCI USA equity market and sector indexes.

Having shown that long-term equity returns are driven by GDP growth risk, we now turn to the question of how macroeconomic risk drives long-term equity risk (i.e. the permanent return component's volatility). Table 2 shows that the MSCI Macroeconomic Model estimates the long-term risk (10 years and beyond) of the US equity market to be about 10.2% per annum. In the model, this risk is attributable to real GDP growth risk, inflation risk, and residual risk (see Appendix for the technical derivations). The latter represents contributions from cash-flow shocks that are uncorrelated with economic growth and inflation. As anticipated, Table 2 shows that real GDP growth is the primary driver of equity risk in the long-term: 92% of the long-term equity variance is attributable to real GDP growth risk.

Table 2: Macroeconomic Risk Drives US Equity Market Long-Term Risk

US Equity Market Long-Term Risk (Annualized, Percentage)	
Historical Standard Deviation (1970-2014)	**15.4%**
10-Year Horizon Risk From Campbell and Viceira (2003, Figure 4.2 b)	**11.0%**
Long-Term Risk (10 Years+) From MSCI Macroeconomic Risk Model	**10.3%**
Real GDP Growth Risk Contribution	*91.5%*
Inflation Risk Contribution	*0.1%*
Residual Risk Contribution	*8.4%*

The table compares the historical standard deviation of the MSCI US equity index returns from 1970 to 2014 to two measures of long-term equity risk: the 10-year horizon risk estimate reported by Campbell and Viceira (2003) in Figure 4.2 b, and the MSCI Macroeconomic Risk Model's estimate of long-term risk (10 years and beyond). The table also shows how the model's long-term risk can be attributed to real GDP growth risk, inflation risk and residual risk. The latter reflects contributions from cash-flow risk that are uncorrelated with GDP growth and inflation.

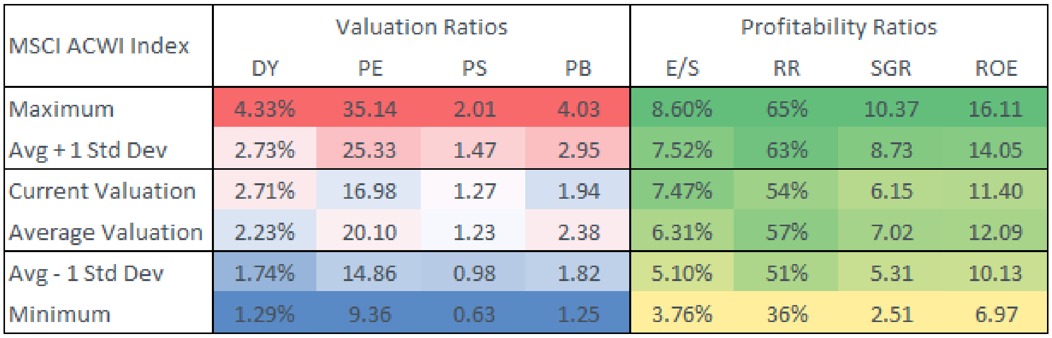
Table 2 also compares our model's long-term risk estimates to two popular alternatives: the historical standard deviation of US equity returns measured over the last 40 years, and the 10-year horizon risk reported in Campbell and Viceira (2003). While our model estimate of long-term equity risk is significantly lower than the former "naïve" estimate, it appears aligned with the latter, explicitly taking long-term predictability in equity returns into account. In our model, macroeconomic factors are driving the long-term predictability in returns. In turn, both long-term return and risk are mostly driven by macroeconomic risk.

VALUATIONS AND PROFITABILITY

Earlier we concluded that the largest contributors to total return over the last 20 years were dividend yield and dividend growth. These quantities are closely related with other valuation and profitability ratios. For example, dividend yield can be simply represented as the product of book to price, return on equity, and payout ratio. Over the long run, a company's ability to grow earnings and pay out dividends is related to the profitability of its investments. High return on investments means that either dividends can grow faster, or more dividends can be distributed per dollar invested.

In this section we examine more closely these underlying drivers of dividend yield and dividend growth. We start by examining index level valuation and profitability ratios. MSCI calculates key valuation ratios[4] such as dividend yield, price to earnings, price to book, and price to sales. Using these four ratios, we derive time series for index level profitability ratios (return on equity, retention ratio, net margin, sustainable growth rate). We analyze these time series over the entire 20-year period between Dec 1994 and Sep 2015. Table 3 shows that current levels are generally within one standard deviation compared to 20-year historical averages. More detailed analysis of index level valuation and profitability ratios is provided in the exhibits at the end of the report.

Table 3: Valuations and Profitability Ratios



MSCI ACWI Index	Valuation Ratios				Profitability Ratios			
	DY	PE	PS	PB	E/S	RR	SGR	ROE
Maximum	4.33%	35.14	2.01	4.03	8.60%	65%	10.37	16.11
Avg + 1 Std Dev	2.73%	25.33	1.47	2.95	7.52%	63%	8.73	14.05
Current Valuation	2.71%	16.98	1.27	1.94	7.47%	54%	6.15	11.40
Average Valuation	2.23%	20.10	1.23	2.38	6.31%	57%	7.02	12.09
Avg - 1 Std Dev	1.74%	14.86	0.98	1.82	5.10%	51%	5.31	10.13
Minimum	1.29%	9.36	0.63	1.25	3.76%	36%	2.51	6.97

Next, we look at specific factors that influence a company's ability to grow and pay out dividends. The Gordon constant growth model can be written as:

Expected Return = Dividend Yield + Dividend Growth

Dividend and growth in dividend are related to Return on Equity (ROE) as per the below:

Dividend = (1-Retention Rate) * ROE * Book Value of Equity

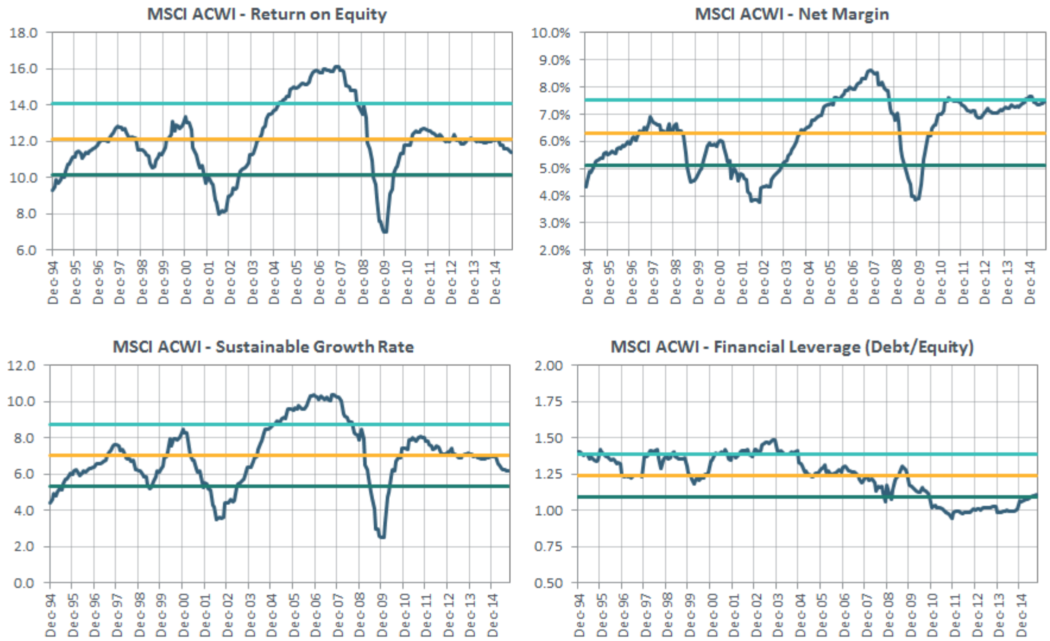
Dividend Growth = Retention Rate * ROE

---

[4] For further details please refer to the MSCI Fundamental Data Methodology Book, available on msci.com

While the level of Retention Ratio is a company's policy decision, ROE is an outcome of the company's operations and an indicator of its performance. Hence, the development of ROE is an important factor in the development of dividend and dividend growth. Factors driving ROE in turn include company's profit margin and financial leverage. Chart 11 shows the development in ROE, net margin and financial leverage.

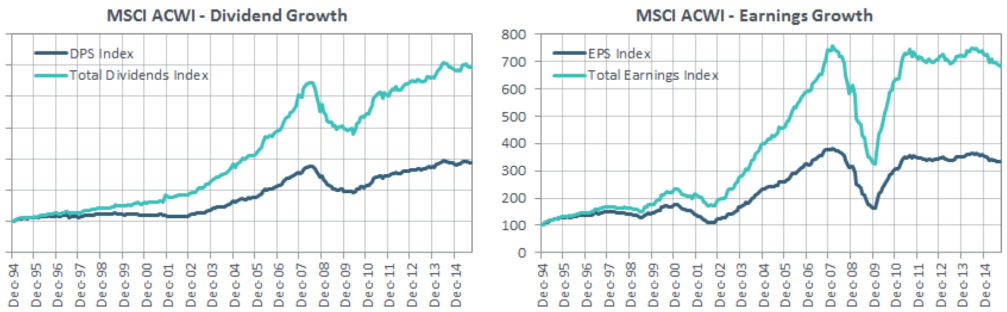
Chart 11: Profitability Ratio



Cyclicality in ROE corresponds to the cyclicality in the macroeconomic environment, peaking during expansions and falling during contractions. The average ROE over the period of analysis is nearly 12%, with the current level close to historical average, despite the fall we have seen in bond yields. Higher Net Margin has played an important role in maintaining ROE and counteracting the effect of structurally lower leverage post the financial crisis. Sustainable growth rate, currently at 6.1% is lower than the historical average of 7%.

Another factor affecting long term growth in dividend is dilution of equity. As a result of corporate events such as issuance of new equity, the number of outstanding shares of a company tends to increase over time, causing dividend per share to grow less than the aggregate growth in dividend. Chart 12 shows the development of aggregate earnings and dividends and the respective per share measures. The impact of dilution reduces the growth rate of dividends from 9% for aggregate dividends to 5.3% for dividends per share.

Chart 12: Dilution of Equity



REFERENCES

R. Bansal and A. Yaron (2004). *Risks For the Long Run: A Potential Resolution of Asset Pricing Puzzles*. Journal of Finance (59).

R. Bansal, R. Dittmar, and C. Lundblad (2005). *Consumption, Dividends, and the Cross-Section of Equity Returns*. Journal of Finance (2005).

R. Bansal, R. Dittmar, and D. Kiku (2009). *Cointegration and Consumption Risks in Asset Returns*. Review of Financial Studies Vol 22(3).

R. Bansal, D. Kiku, and A. Yaron (2010). *Long Run Risks, the Macroeconomy, and Asset Prices*. American Economic Review P&P Vol 100(2).

J.Y. Campbell and L. Viceira (2003). *Strategic Asset Allocation*. Oxford University Press.

T. Doan, R. Litterman, and C.A. Sims (1984), *Forecasting and Conditional Projection Using Realistic Prior Distributions*, Econometric Reviews 3.

D. Giannone, M. Lenza, and G. Primiceri (2015), Prior Selection for Vector Autoregressions, The Review of Economics and Statistics Vol 97(2).

A. Gupta, A. Kassam, R. Suryanarayan, K. Varga. (2014). *Index Performance in Changing Economic Environments*, MSCI Research Insights.

L.P. Hansen, J. Heaton, N.Li (2008). *Consumption Strikes Back? Measuring Long Run Risk.* Journal of Political Economy 116 (2).

R.S. Harris, T. Jenkinson, S. Kaplan (2014). *Private Equity Performance: What Do We Know?* Journal of Finance Vol. 69 Issue 5.

R.E. Lucas (1987). *Models of Business Cycles*. New York: Basil Blackwel.

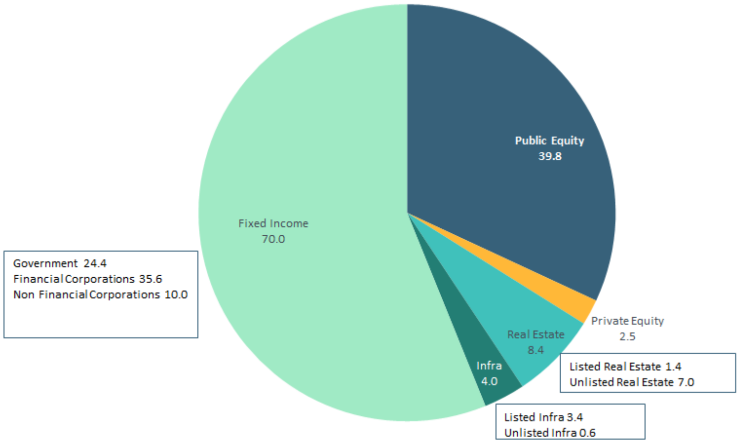
K. Winkelmann, R. Suryanarayanan, L. Hentschel, K. Varga (2013). *Macroeconomic Risk and Asset Cash-Flows,* MSCI Research Insights.

K. Winkelmann, R. Suryanarayanan, L. Hentschel, K. Varga (2013). *Pricing Macroeconomic Risk*, MSCI Research Insights.

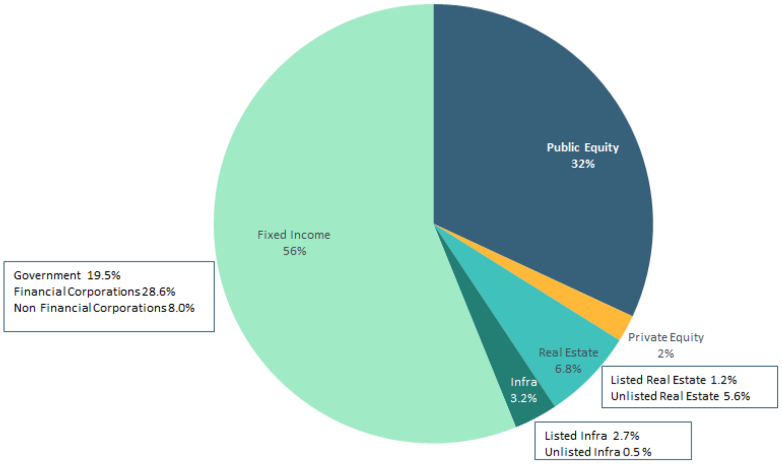
K. Winkelmann, R. Suryanarayanan, L. Hentschel, K. Varga (2013). *Deconstructing Risk-Parity*, MSCI Research Insights.

Exhibit 1: Investable Global Market Portfolio as of June 2015

Market Size (in Trillion USD)



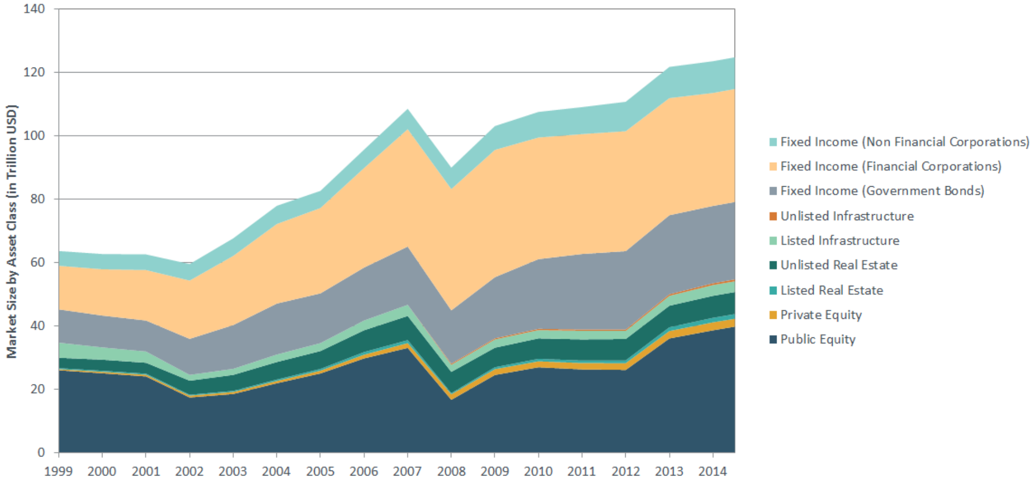
Relative Market Size (%)



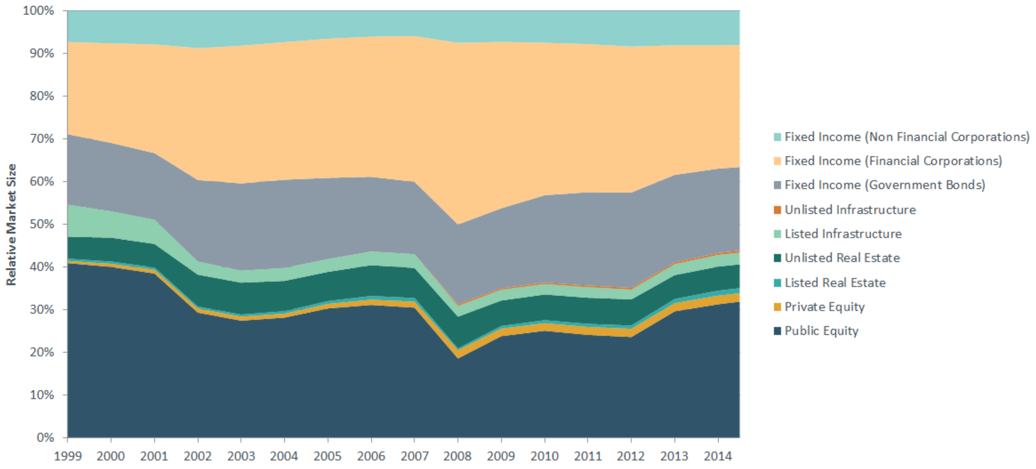
Fixed Income: Debt Outstanding as determined by BIS (Bank of International Settlement). A fraction of 60% is applied on the Government issued debt estimates from BIS to account for holdings by Central Bank and Governments in order to obtain investable market size for Government debt securities. **Public Equity:** FIF Market Capitalization of MSCI ACWI IMI ex Infra ex Core Real Estate Index . **Private Equity:** As estimated by Burgiss and includes Venture Capital, Debt Financing and Buyout Funds. **Listed Real Estate:** FIF Market Capitalization of MSCI ACWI IMI Core Real Estate Index. **Unlisted Real Estate**: Estimated by IPD and includes professionally managed investment market based on individual fund size. **Listed Infrastructure**: FIF Market Capitalization of MSCI ACWI IMI Infrastructure Index. **Unlisted Infrastructure**: Estimated by IPD based on the third-party headline number (from RARE in 2012) that is used as a starting point for the unlisted equity portion of non-government-owned infrastructure.

Exhibit 2: Evolution of the Investable Global Market Portfolio (Dec 1999 to Jun 2015)

Market Size (in Trillion USD)



Relative Market Size (%)



Fixed Income: Debt Outstanding as determined by BIS (Bank of International Settlement). A fraction of (60% since 2008 and 74% before 2008) is applied on Government debt estimates from BIS to account for holdings by Central Bank and Governments in order to obtain an investible market size for Government debt securities (see Graph II.9 left hand chart, page 34 of the BIS 85th annual report http://www.bis.org/publ/arpdf/ar2015e.pdf which provides the BIS estimates of central bank and foreign reserves holdings of US, Eurozone, Japan and UK government bonds and their recent evolution).

Exhibit 3: Evolution of Market Capitalization for MSCI ACWI IMI (Dec 1994 to Jun 2015)

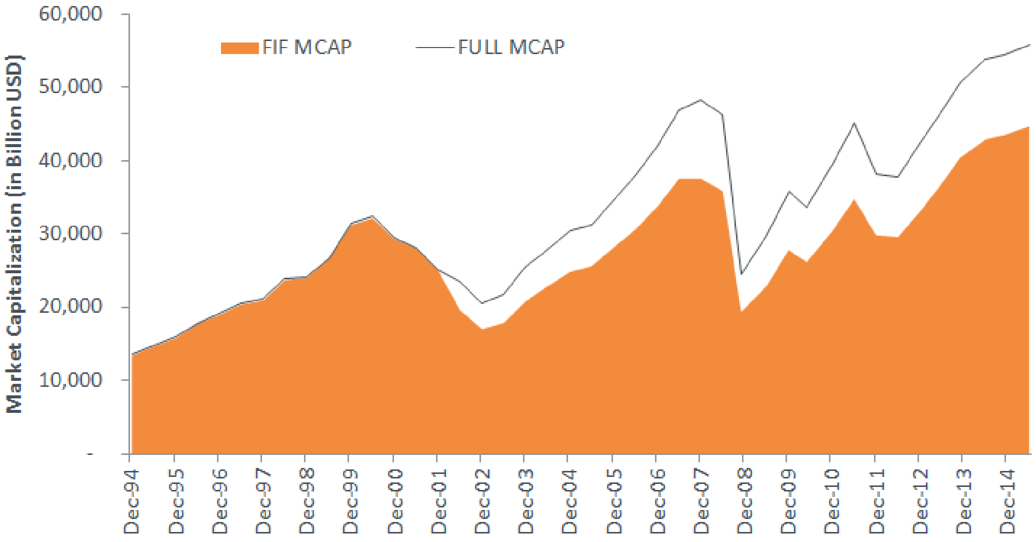


Exhibit 4: MSCI ACWI IMI – Analysis by Asset Type

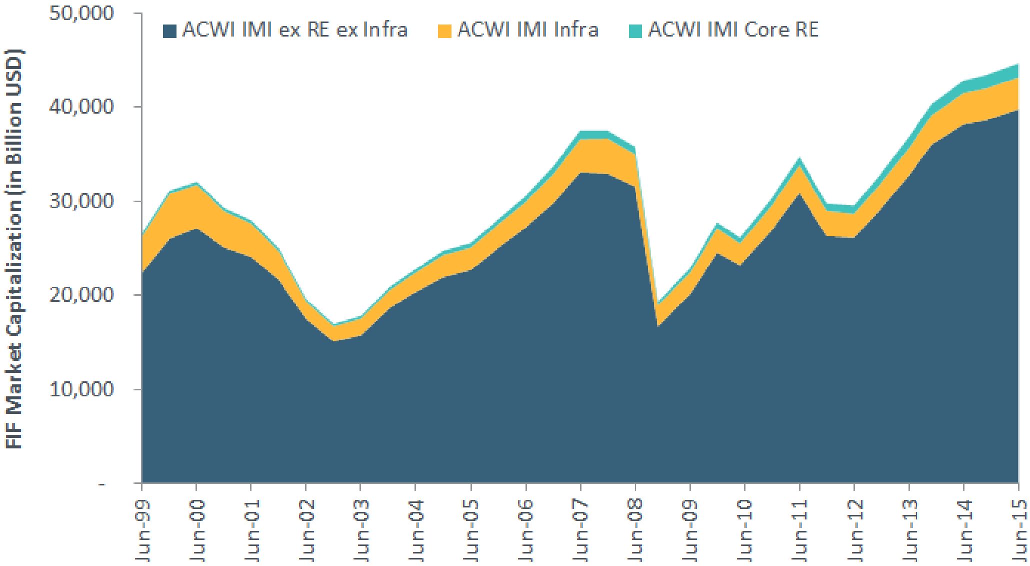


Exhibit 5: MSCI ACWI IMI – Allocation by GICS Sector

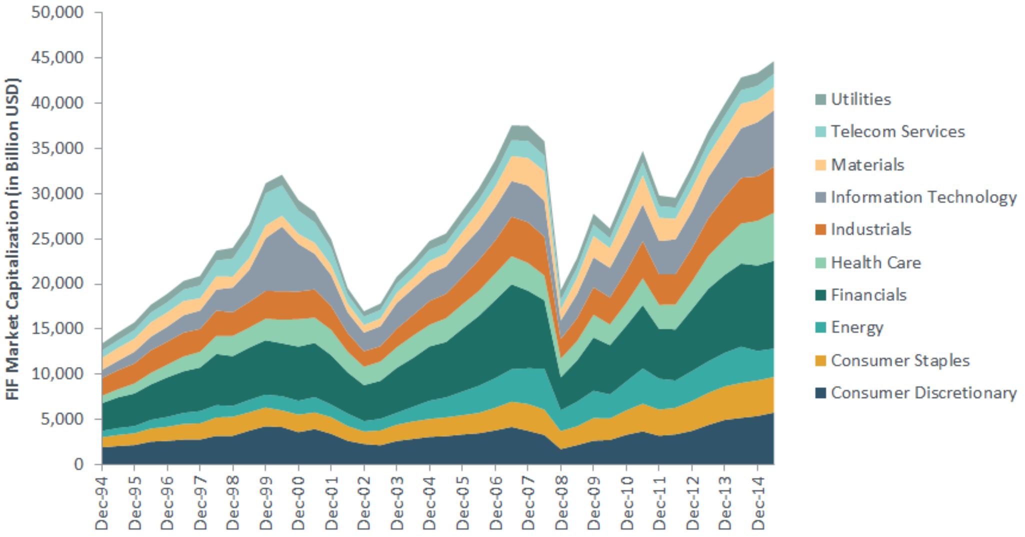


Exhibit 6: MSCI ACWI IMI – Allocation by Region

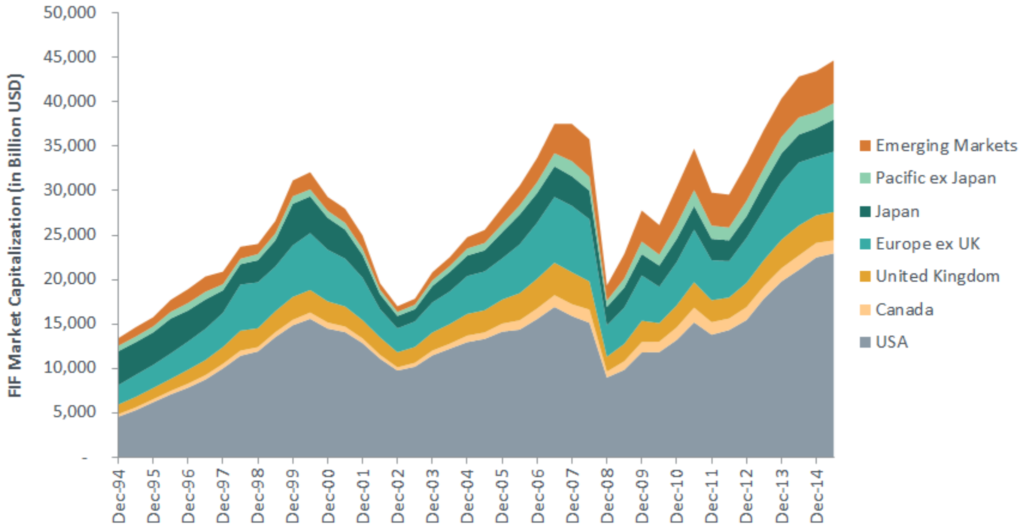
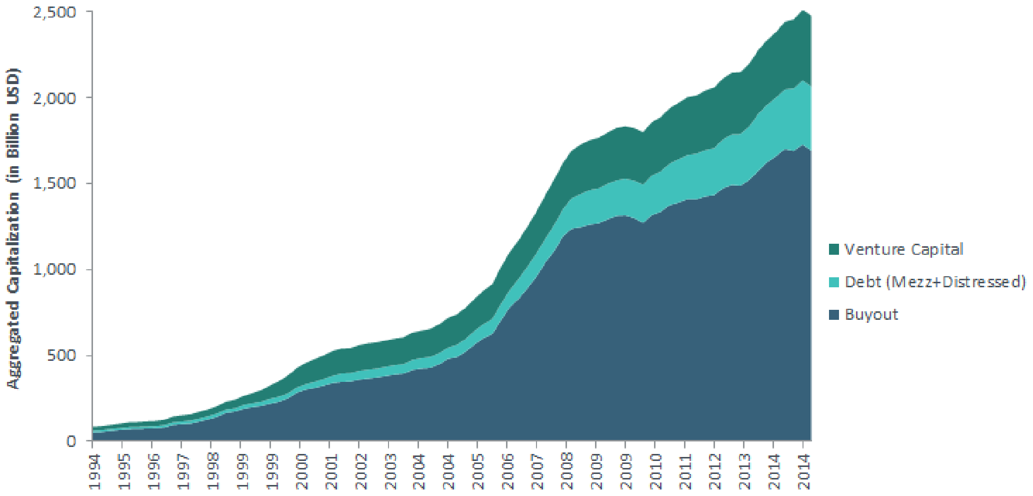
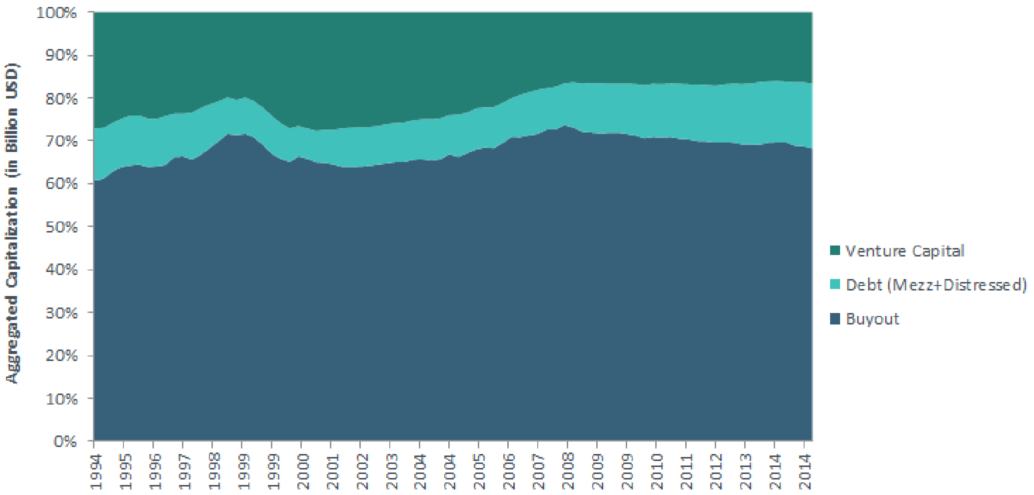


Exhibit 7: Evolution of Private Equity Market (1994 to 2015)

Market Size (in Billion USD)



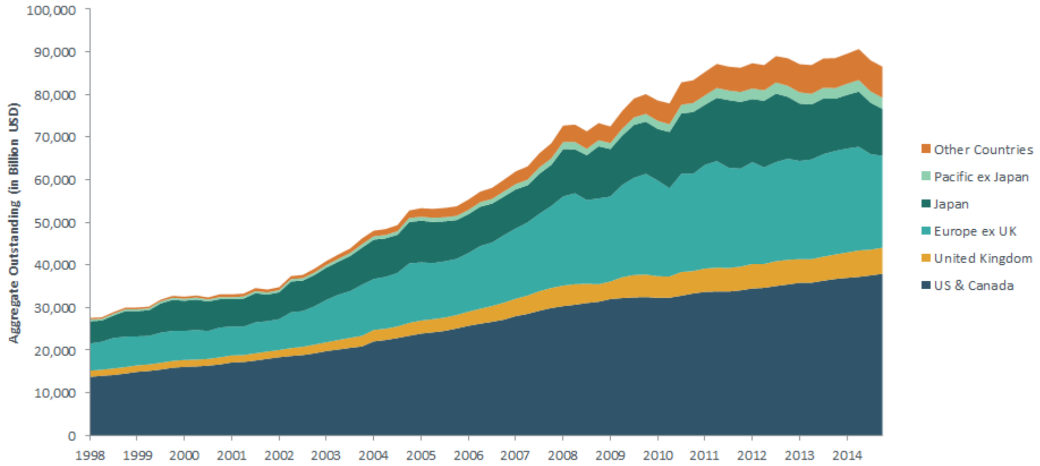
Relative Market Size (%)



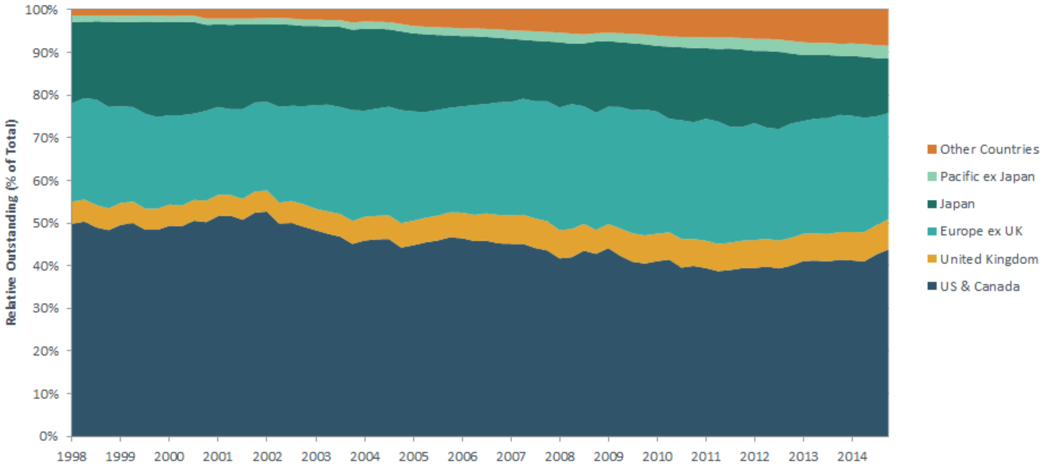
Evolution of committed capital across the major private equity market segments (Buyout, Venture Capital and Debt, Debt includes Mezzanine and Distressed Debt funds), as estimated by Burgiss from information on committed capital by limited partnerships

Exhibit 8: Debt Securities Outstanding

Market Size (in Billion USD)



Relative Market Size (%)



Total Debt Outstanding as determined by BIS (Bank of International Settlement) for each country and includes debt issued by government, financial corporations and non-financial corporations.

Exhibit 9: Professionally Managed Real Estate – Analysis by Region

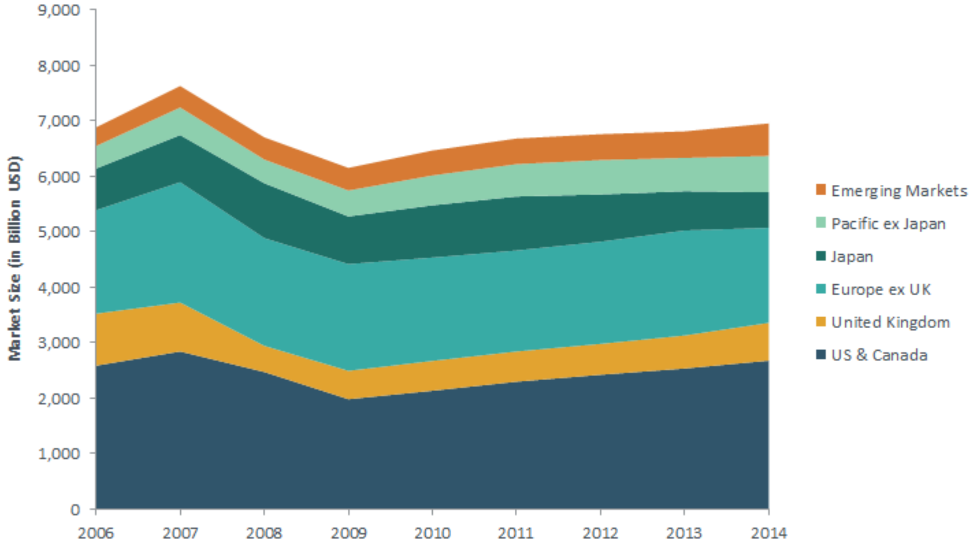
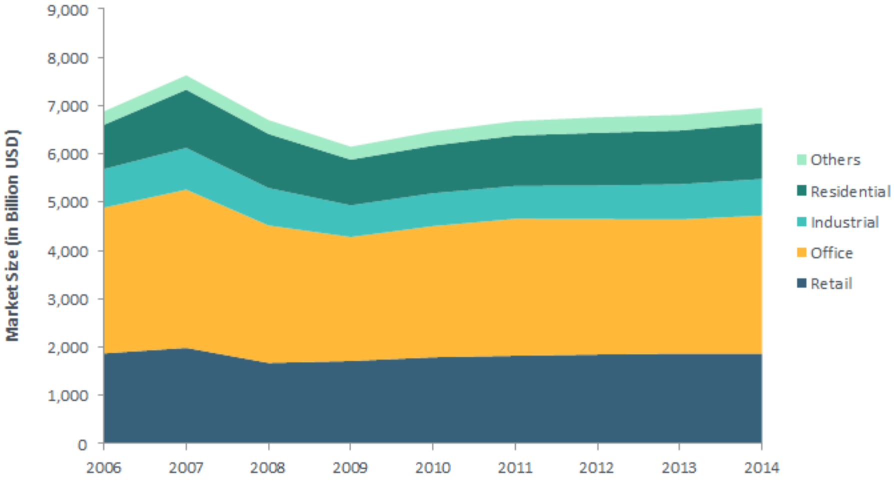


Exhibit 10: Professionally Managed Real Estate – Analysis by Sector



Estimated by IPD and includes institutional, investable and professionally managed commercial real estate based on the individual fund size. Market sizes were fully estimated using the full methodology in 2013 & 2014 with historic estimates generated using IPD USD capital growth time series. Sector estimates are based on the sector weightings of the IPD Real Estate databank by country. Please refer to https://www.msci.com/documents/10199/1c2f08e4-f319-4dea-9a51-f3b9ebb3f2ad for further details

Exhibit 11: Private Infrastructure Market – Analysis by Region

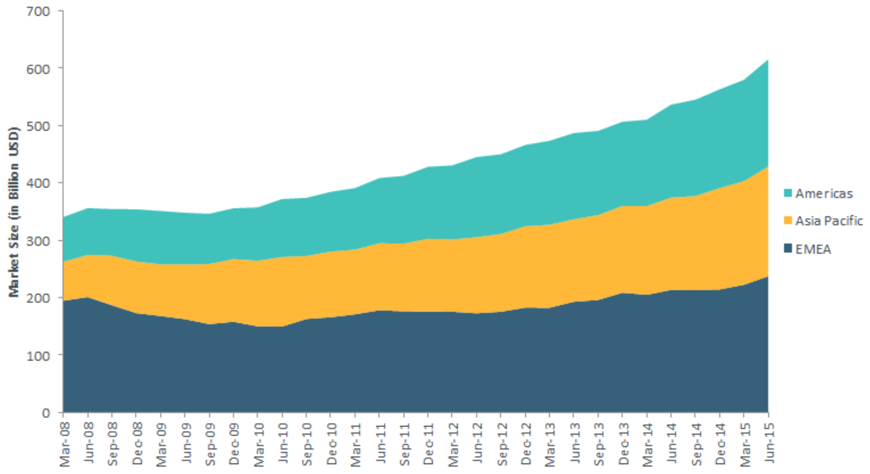
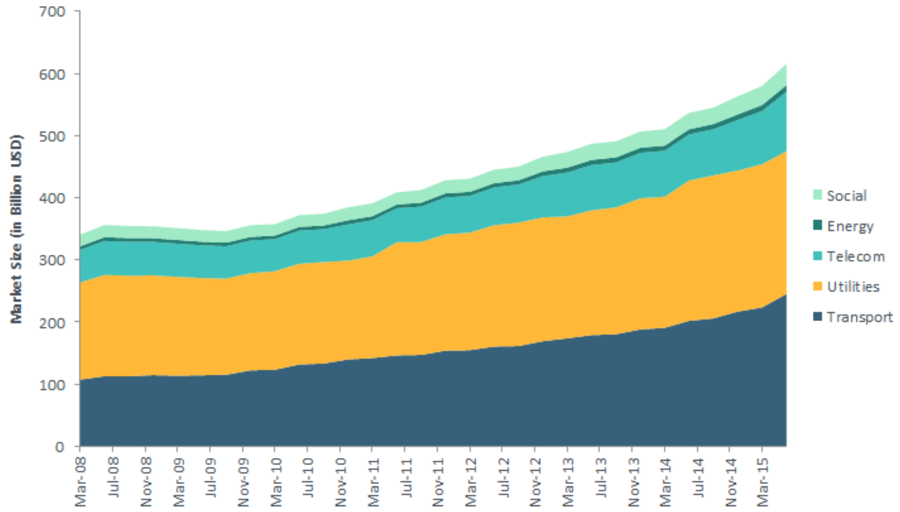


Exhibit 12: Private Infrastructure Market – Analysis by Sector



Estimated by IPD based on the third-party headline number (from RARE Infrastructure in 2012) that is used as a starting point for determining the unlisted equity portion of non-government-owned infrastructure. Geographic and sector percentages are applied based on MSCI ACWI IMI Infrastructure Index to the RARE headline numbers and then unlisted deflators/growth rates are applied to the sectors and regions. Please refer to http://www.rareinfrastructure.com/wp-content/uploads/RARE-Guide-to-Listed-vs-Unlisted-Infrastructure-Jan-13.pdf.

Exhibit 13: MSCI ACWI - Return decomposition over 20 years

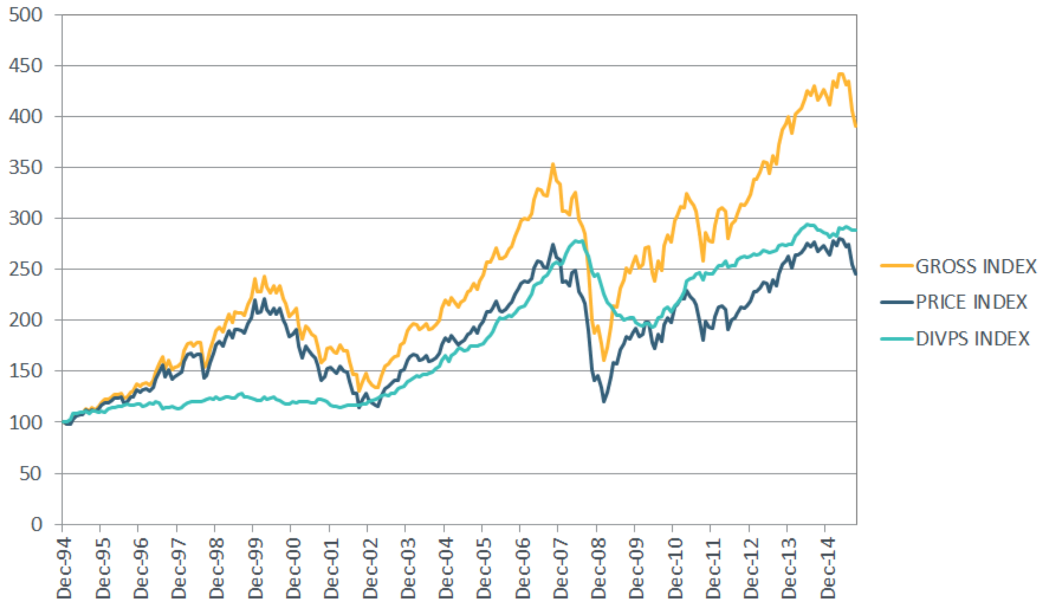
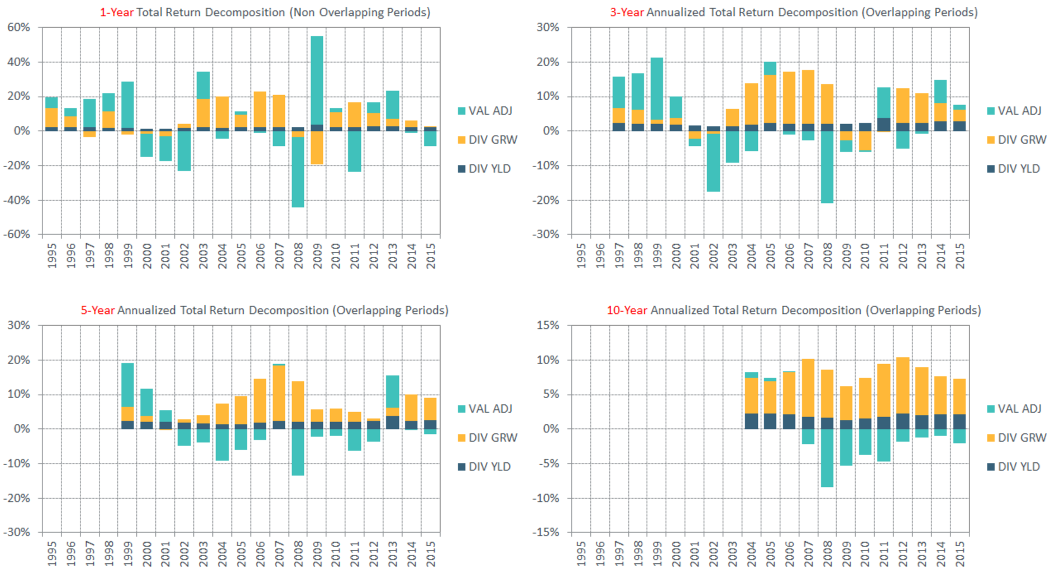


Exhibit 14: MSCI ACWI - Return decomposition over different time periods


1-Year Total Return Decomposition (Non Overlapping Periods)

3-Year Annualized Total Return Decomposition (Overlapping Periods)

5-Year Annualized Total Return Decomposition (Overlapping Periods)

10-Year Annualized Total Return Decomposition (Overlapping Periods)

Exhibit 15: MSCI ACWI - Return contribution over different time periods

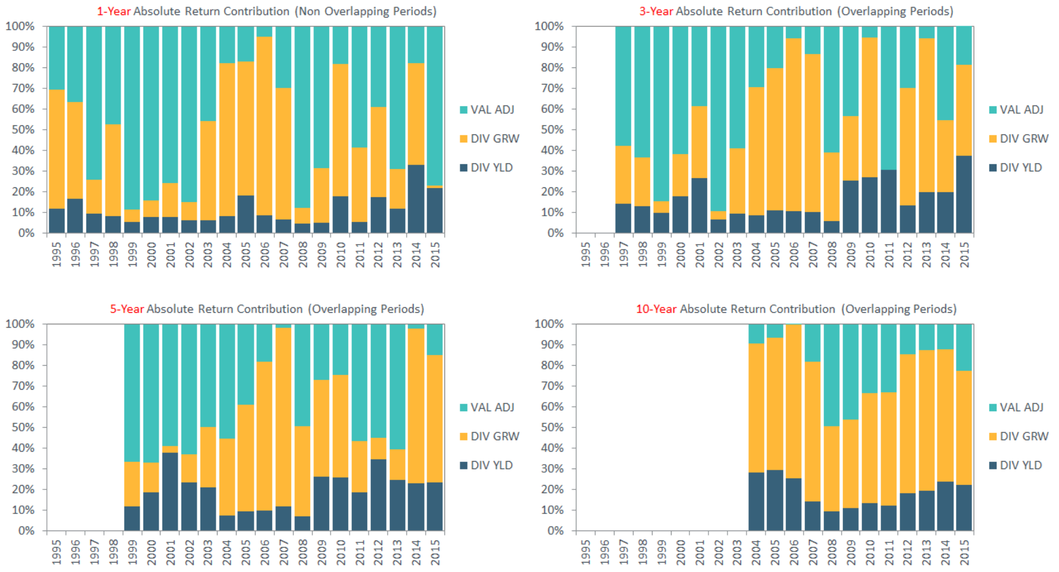


Exhibit 16: MSCI ACWI – Average absolute return contribution (%)

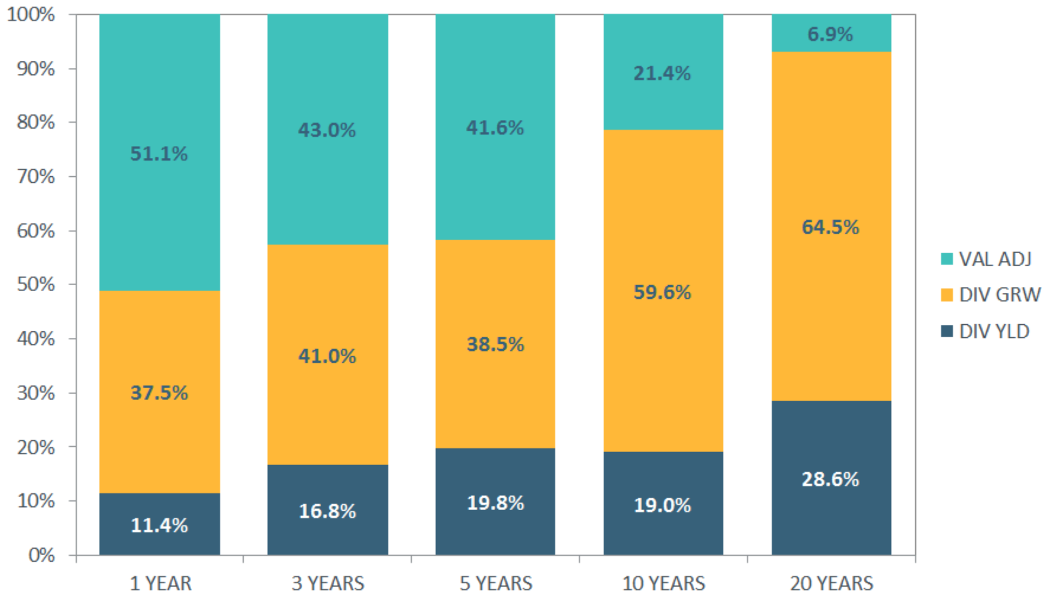


Exhibit 17: MSCI ACWI – Total Returns and Cash Flows

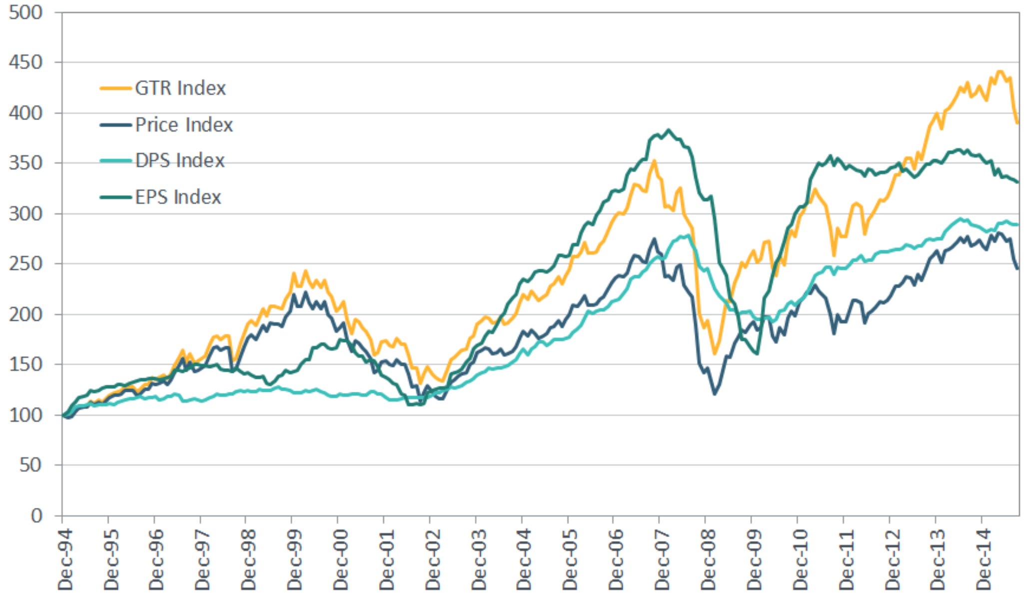
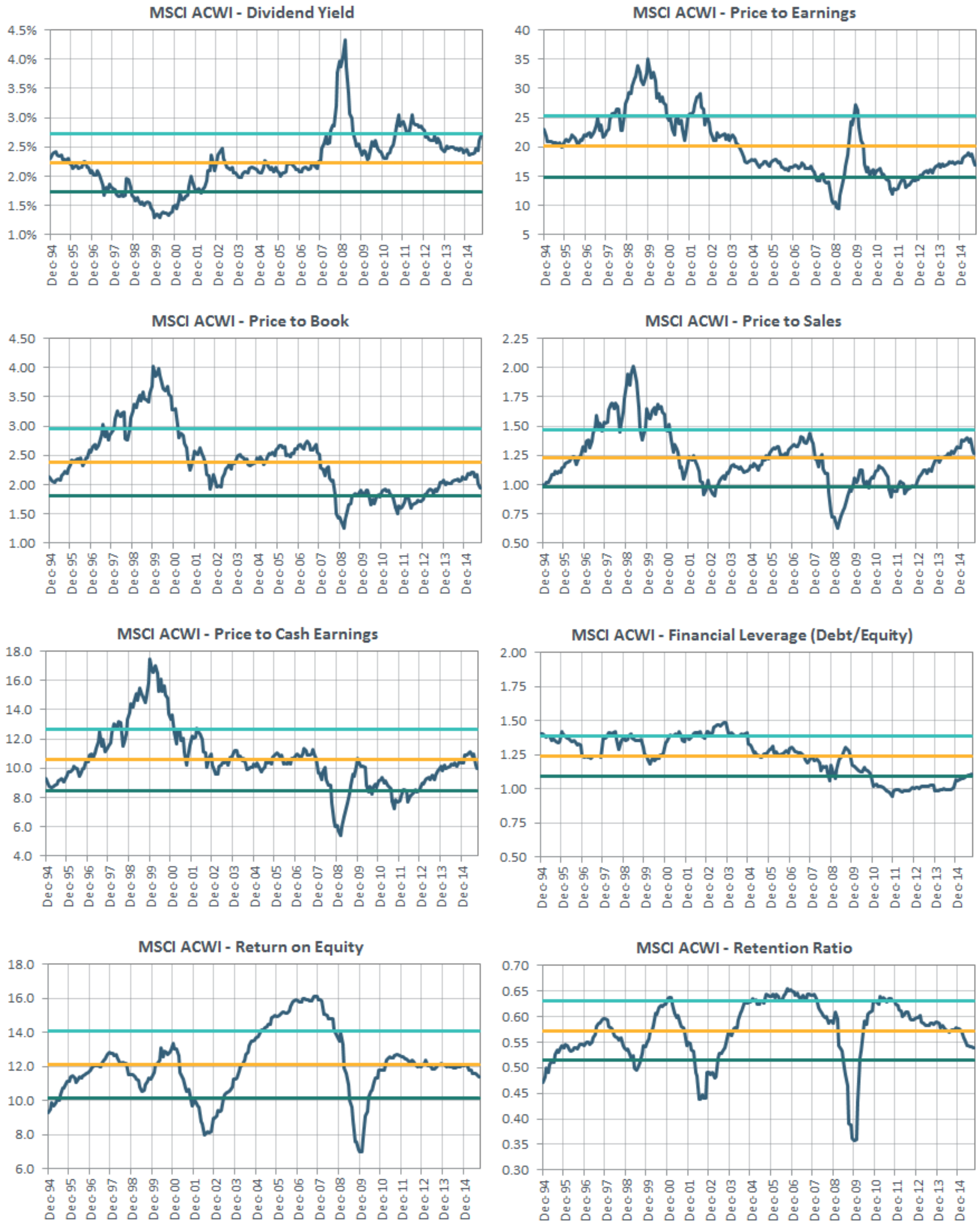
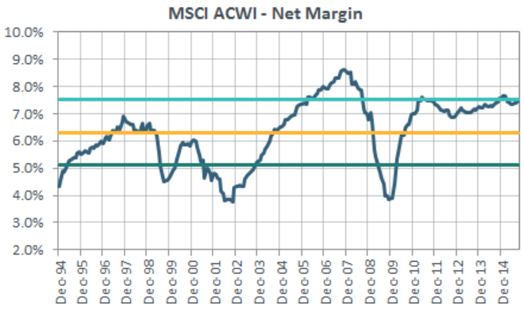
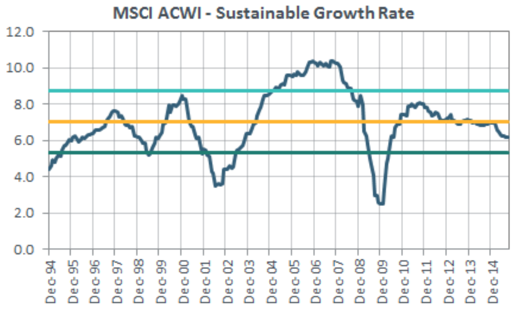
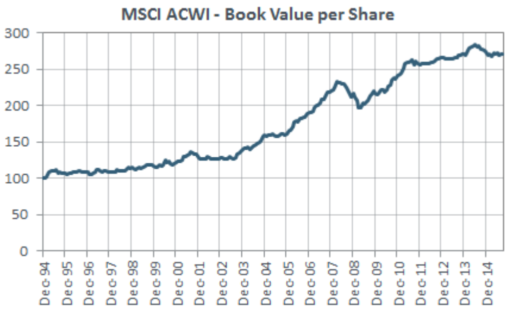


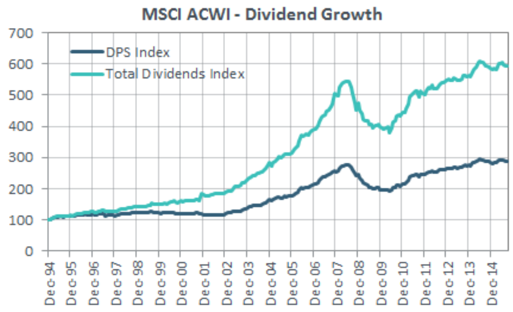
Exhibit 18: MSCI ACWI – Cash Flows, Valuations and Profitability

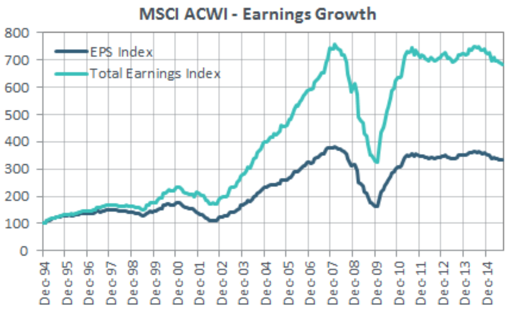


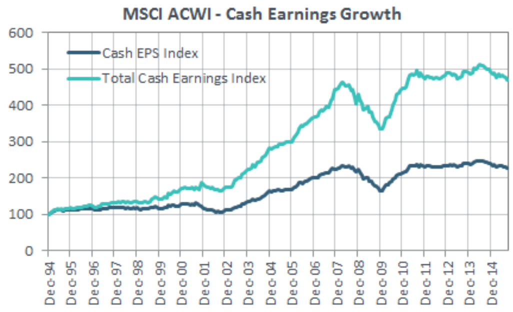

MSCI ACWI - Net Margin


MSCI ACWI - Sustainable Growth Rate


MSCI ACWI - Book Value per Share


MSCI ACWI - Dividend Growth


MSCI ACWI - Earnings Growth


MSCI ACWI - Cash Earnings Growth

APPENDIX: MSCI MACROECONOMIC RISK MODEL METHODOLOGY

OVERVIEW

In this Appendix, we provide a technical description of the MSCI Macroeconomic Risk Model: an innovative model that links macroeconomic factors to portfolio return and risk over multiple horizons. The model currently covers equity markets of 23 countries, accounting for about 95% of the global equity market capitalization, government bond and credit markets for major developed countries, and US private real estate.

The MSCI Macroeconomic Risk Model is of direct interest for investors who use macroeconomic information in their risk and asset allocation decisions. In particular, the model can be used to measure and attribute long-term portfolio return and risk to macroeconomic factors, such as GDP growth and inflation, and assess the impact of macroeconomic scenarios on global portfolio returns.

The model indicates that:

- Macroeconomic factors drive long-term portfolio return and volatility, and that
- Portfolio return premia over long horizons are compensations for long horizon cash-flows exposure to macroeconomic risk.

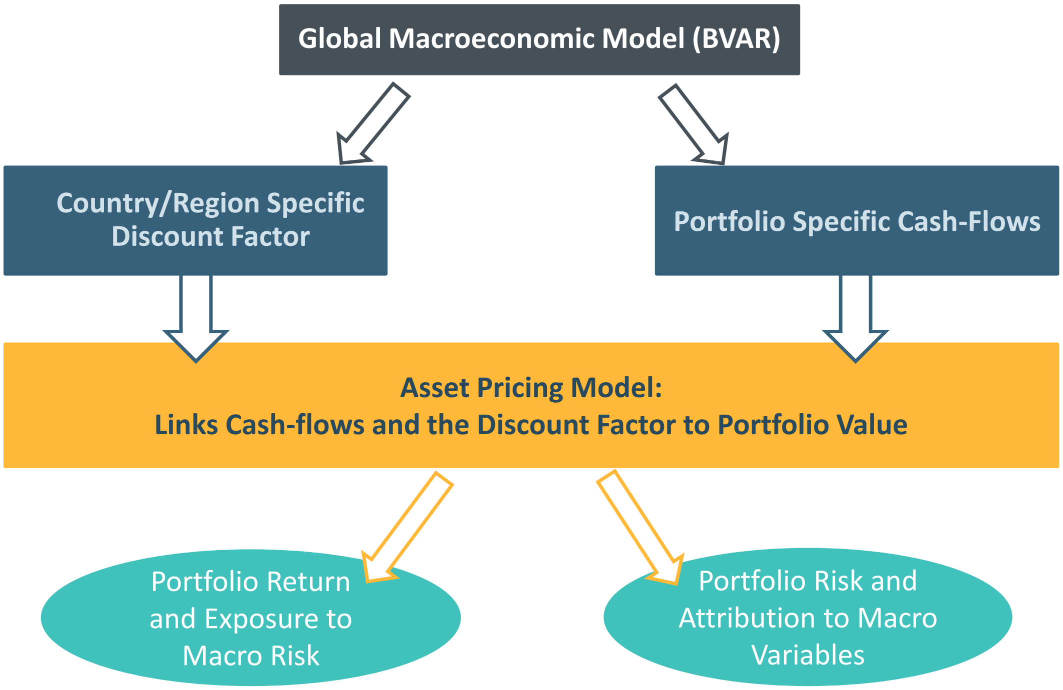
As investment strategies differ in their sensitivity to macroeconomic shocks, this leads to the question of how to incorporate macroeconomic scenarios into asset allocation decisions in a quantitative and structured fashion.

As shown in Exhibit A.1, the model actually comprises two components:

- A globally integrated macroeconomic forecasting model that generates timely forecast distributions for country specific macroeconomic variables including GDP and inflation.
- A globally integrated asset pricing model that links GDP and inflation to asset class and strategy factors, by country.

In this Appendix, we focus on the second component, namely, the asset pricing model. To understand the impact of macroeconomic shocks on portfolio return and risk, we need to go back to first principles. The most basic principle of modern asset pricing is that the competitive equilibrium value of an asset equals the expected discounted value of current and future asset cash-flows (see Exhibit A.1). The application of this fundamental principle leads to the conclusion that macroeconomic risk, which we define as the risk of persistent shocks to trend GDP growth and inflation, has an impact on portfolio return and risk via two channels: the discount factor and asset cash-flows.

Exhibit A.1: MSCI Macroeconomic Risk Model - Linking Macroeconomic Factors to Portfolio Value



MACROECONOMIC RISK DEFINED

To quantify the impact of macroeconomic risk on cash-flows and returns, we must first start by defining macroeconomic risk in context. In our framework and model, macroeconomic risk is the change in asset value due to *persistent* shocks to trend growth and inflation. In other words, investors should only care about monthly or quarterly changes to macroeconomic indicators if these changes are perceived to carry a lasting impact on *trend* growth and inflation. Thus, macroeconomic risk is about future trend growth and inflation uncertainty, not cyclical variations around trend. This definition is consistent with the early economic intuition in Lucas (1987) and the empirical findings of Bansal, Yaron and Kiku (2010) indicating that historically, cyclical shocks to economic growth in the US have had relatively small impact on subsequent growth and equity and bond returns, compared to large persistent shocks to trend growth.

Formally, we follow and adapt Hansen, Heaton, and Li (2008), and model the evolution of real GDP growth and inflation as a BVAR (Bayesian Vector Autogression) with three variables and 1 quarterly lag. The three variables are represented by x_t :

$$x_t = \begin{pmatrix} g_t - g_{t-1} \\ cp_t - g_t \\ \pi_t \end{pmatrix} \tag{1}$$

Where:

- g_t is the log of real GDP at time *t*
- $cp_t - g_t$ is the log profit share (ratio of corporate profits to GDP)

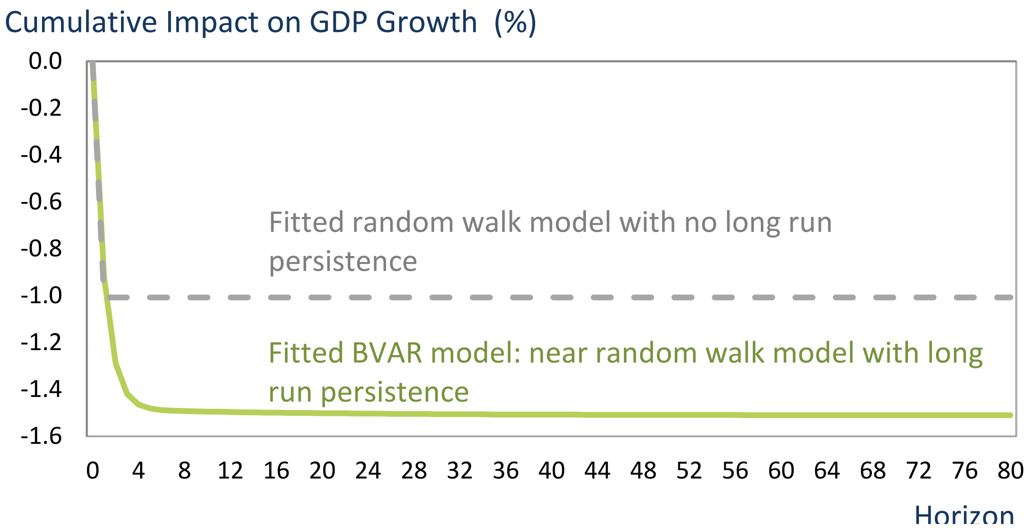
  cp_t is the log of corporate profits at time t
- π_t is the log of CPI inflation at time *t*

The profit share ($cp_t - g_t$) helps to capture a weak but persistent component of real GDP growth. Aggregate corporate profits signal future productivity, which in turn drives GDP in the long run. Thus, following shocks to profits or growth, the profit share eventually reverts back to its long-term average. For example, in the long-run, a relative increase in corporate profits of 150bps also means a relative increase of 150bps in GDP. The resulting relative change in the profit share is zero. This is consistent with standard empirical facts showing that the profit share has remained fairly stable over time historically. However, we find that the profit share is also highly persistent (with an autoregressive coefficient of about 0.95), meaning that profit share could take a long time before reverting back to its long-term average. In turn, a one-time shock to GDP growth could potentially carry long lasting, persistent effects on future growth. We show how we identify this persistent shock to GDP growth in the next section.

Before doing so, we demonstrate that these persistent effects on growth are empirically significant. Exhibit A.2 depicts the cumulative impact on US GDP over multiple horizons following a 1.01 percent (one quarterly standard deviation) negative shock to US GDP for the random walk model (i.e, no persistence in GDP growth) and our BVAR model, a near random walk model. We fitted both models to quarterly US GDP data from 1947 to 2011. The random walk model, shown with a dashed line, restricts the impact of the initial one percent negative shock to a permanent one percent decline in GDP. In contrast, the estimates of our near random walk BVAR model, shown in green (solid line), imply a one percent decline in

GDP followed by an expected gradual decline of an additional 0.5 percent. When we remove the restrictions of the random walk model, the data show predictable variations in GDP growth, driven by the persistence in profit share. The difference in the projected long-term decline in GDP implied by the two models is material and must not be ignored by investors.

Exhibit A.2: There is Evidence For Long-Term Persistence in Economic Growth



The Figure shows the cumulative impact on GDP growth over 20 years following a negative (one quarterly standard deviation or 1.01%) shock to US GDP growth, for the random walk with constant growth model (grey dashed line) and our BVAR model, a near random walk model with long run persistence in growth (green solid line). We fitted both models to quarterly US GDP data from 1947 to 2011, available from the Bureau of Economic Analysis.

ESTIMATING CASH-FLOW BETAS TO MACROECONOMIC RISK

Linking cash-flows and macro risk

To estimate portfolio cash-flows betas, or sensitivities to persistent growth and inflation shocks, we adapt Hansen, Heaton, and Li (2008): for each portfolio, we append the cash-flow growth ($d_t - d_{t-1}$) as a fourth variable to the macroeconomic state variable x_t :

$$z_t = \begin{pmatrix} x_t \\ d_t - d_{t-1} \end{pmatrix} \qquad (2)$$

where d_t is the log of the portfolio's dividends per share.

With one quarterly lag, the BVAR model describing the evolution of the portfolio cash-flows can be expressed as:

$$z_t = m + \Phi z_{t-1} + e_t \qquad (3)$$

Where:

- m is a 4-by-1 vector of intercept coefficients
- Φ is the 4-by-4 coefficient matrix. This matrix gives the sensitivities of each variable to their own lags and the lags of all the other variables. For example, the first row of the coefficient matrix Φ gives the sensitivities of the first variable, real GDP growth to its own first lag (first column) and first lag of all the other variables. More generally the *i*-th row and *j*-th column of Φ gives the sensitivity of the *i*-th variable in z_t to the *1*-st lag of the *j*-th variable.
- e_t is the time *t* model residual and contains a different value for each element of z_t. We assume the model residual to be serially uncorrelated over time, and normally distributed with zero mean.

In addition, we impose the restriction that portfolio dividends do not “Granger-cause” real GDP, inflation, nor corporate profits. This means that surprise changes to a particular portfolio’s dividends do not affect real GDP growth, inflation, nor corporate profits. On the other hand, portfolio cash-flow growth remains driven by surprise changes to these three macroeconomic variables. We can implement the Granger causality restriction by constraining the first three elements of the fourth column of the coefficient matrix Φ to be zero.

Identifying persistent shocks to output growth

VARs can be used to study the impact over time of shocks to a given variable or a combination of variables on all variables in the dynamic system. In order to do this, however, one must identify the shocks of interest. In our case, we want to identify four shocks in the VAR, specified in equation (3), such that:

- One of the shocks captures a persistent shock to real output growth. Our focus is to study the impact of this persistent shock on portfolio cash-flows.
- The second shock has only a transitory effect on real output growth.
- The third shock is a shock to CPI inflation.
- The fourth shock is a shock to the portfolio dividend growth, unrelated to real GDP growth, CPI inflation, and profit share.
- All shocks each have a variance of one, and are uncorrelated with each other, so that we can measure the uncorrelated impact of each shock (for example, the persistent shock).

Unfortunately, the model residuals e_t themselves are not the relevant candidates. In particular, they do not satisfy the third condition, as the elements of e_t are correlated with each other, unless a restriction is imposed. However, we can find our shocks of interest (u_t) to be linear combinations of the model residuals. That is, u_t will be in the form:

$u_t = Qe_t$, for an appropriately chosen matrix Q

One can show that the following choice of Q works:

$$Q = \left(Chol(B\Sigma_e B')\right)^{-1} B$$

where:

$B = (I - \Phi)^{-1}$,

Σ_e is the covariance matrix of the VAR residuals e_t,

A' denotes the transpose of a matrix A, and $Chol(A)$ denotes the lower triangular matrix in the Choleski decomposition of matrix A.

Cash-flows response to growth and inflation shocks

Once the parameters in the VARs have been estimated, the VAR models can be used to infer the impact of a shock to one variable to all variables over multiple horizons. More precisely, the cumulative impacts of shocks u_t to all the variables, at horizon *h*, can be extracted from:

$$\Gamma_h = \sum_{j=1}^{h} \Phi^{j-1} Q^{-1} \tag{4}$$

The first column identifies the impact of the persistent shock on real GDP growth, profit share, inflation and dividend growth. Likewise, the second column identifies impact of the transitory shock, the third column identifies the impact of the shock to inflation. And finally, the impact of pure portfolio dividend growth shock is given by the fourth column. For example, the cumulative impacts of the persistent shock to real GDP growth and inflation on portfolio cash-flow growth, at horizon *h*, are given by the fourth element of the first and third column of Γ_h.

Bayesian inference

We use our Deep History MSCI index data from 1970 to estimate the cash-flow model for the market, GICS sectors and factors. Although this is long history, the number of parameters we have to estimate is quite large (about 36). Such history is not long enough to limit the risk of over-fitting and ensure cash-flows responses to growth and inflation shocks over multiple horizons are robust.

To overcome these challenges, it is standard to impose statistical restrictions on the parameters and the residual covariance matrix in the form of prior distributions. Following Doan, Sims, and Litterman (1984), the prior distributions are grounded in observed empirical regularities in the variables. These priors are then updated based on available data using a statistical procedure called Bayes' rule.

In our cash-flow model, we form priors for the coefficients and the residual covariance based on longer time series for the market and long-only book-to-market sorted portfolios available from Kenneth French's website from 1957. In particular, to model the cash-flows of growth sensitive indexes such as Value Weighted, Equal Weighted, Momentum, and Cyclical sectors, we use estimates based on the long-only book-to-value top quintile portfolio as priors. For the defensive sectors and factors such as Minimum Volatility, High Dividend Yield and Quality, we use estimates based on the market portfolio as priors. Finally, the covariance matrix for the priors is based on the standard Minnesota priors structure (see Doan, Sims, and Litterman (1984)) and estimated based on observed data following Primiceri, Giannone and Lenza (2015).

DISCOUNT FACTOR ESTIMATION

Having explained how we model the link between cash-flows and the macroeconomy, we now describe how we estimate the discount factor and its relationship to real GDP growth and inflation. The discount factor depends on macroeconomic risk. Indeed, central to the MSCI Macroeconomic Risk Model is an assumption about a "representative" investor. This "stand-in" investor cares about the risk inherent in today's investment opportunity set, and also the uncertainty about the evolution of investment opportunities over time. It is the evolution of investment opportunities over time that is most sensitive to shocks to economic conditions. The discount factor that arrives at the equilibrium present value of uncertain future cash-flows reflects the representative investor's aversion to uncertainty, that is, aversion to persistent shocks to future trend economic growth and inflation. Thus there is an explicit link between the model discount factor and macroeconomic risk.

Risk and Uncertainty

Specifically, the economy's representative investor preferences are assumed to be governed by risk aversion and uncertainty aversion, with separate parameters for each. Formally, we follow Esptein and Zin (1989) to express the representative investor's preferences as:

$$V_t = [(1-\delta)C_t^{1-\rho} + \delta(R_t(V_{t+1}))^{1-\rho}]^{1/(1-\rho)} \qquad (5)$$

Where:

- V_t is the time *t* value of an investor's current and future stream of consumption $(C_t, C_{t+1}, \ldots)$.
- $R_t(V_{t+1}) = (E_t(V_{t+1}^{1-\alpha}))^{1/(1-\alpha)}$ is the "risk-sensitive adjustment", sensitive to future economic growth risk.
- δ is the deterministic time discount factor parameter.
- α is the relative risk aversion parameter.
- $1/\rho$ is the Elastiticity of Intertemporal Substitution parameter (EIS), which governs an investor's willingness to forgo current consumption for a certain level of future consumption.

The original formulation of these types of investor preferences comes from Kreps and Porteus (1978). They disentangle aversion to risk from aversion to later resolution of uncertainty. Epstein and Zin (1989) specialize to a case where the latter is governed by the elasticity of intertemporal substitution (EIS), which measures an investor's willingness to save today for more wealth tomorrow. Anderson, Hansen, and Sargent (2001), and Barillas, Hansen and Sargent (2009) show that this distinction between risk aversion and EIS can also be interpreted as a distinction between risk aversion and uncertainty aversion.

Separating risk aversion from uncertainty aversion helps investors to evaluate persistent shocks to the economy and how these shocks affect the evolution of the investment opportunity set. Indeed, the discount factor (S), which measures the willingness of the representative investor to trade-off current consumption for future consumption and captures an investor's sensitivity to real economic growth risk can be derived as:

$$S_{t,t+1} = \frac{\partial V_t}{\partial C_{t+1}} / \frac{\partial V_t}{\partial C_t} = \delta \left(\frac{C_{t+1}}{C_t} \right)^{-\rho} \left(\frac{R_t(V_{t+1})}{V_{t+1}} \right)^{\alpha-\rho} \tag{6}$$

When the inverse of the EIS is equal to risk aversion ($\alpha = \rho$), the discount factor only depends on current and next period's consumption. When the inverse of the EIS is different from risk aversion, however, the discount factor becomes sensitive to persistent shocks to future trend consumption growth through the risk-sensitive adjustment term $R_t(V_{t+1}) / V_{t+1}$

To keep the model derivations and its estimation tractable, we set the EIS parameter to be equal to 1. In the next section, we show how we estimate the two other preference parameters (δ, α) governing the representative investor's discount factor from the nominal bond markets.

Discount rates, growth, and inflation uncertainty

We estimate discount factors by observing discount rates in government bond markets. Indeed the government bond yield curve informs the discount factor and the representative investor's preferences. The main advantage of the bond data is that they contain no variability in future cash-flows. Because macro events do not affect future cash-flows of bonds, their effects can only materialize via the pricing of the cash-flows. Although some markets have real (inflation-adjusted) bonds, for the most part the most liquid bond markets are for nominal bonds. For example, the US inflation-adjusted bond market (the market for TIPS) has only been active since 1997, and it remained highly illiquid until about 2002. Because of the wider availability of pricing data, we will use the nominal bond market to estimate discount functions.

More precisely, for each country, we first derive a model-based zero-coupon, nominal yield curve as a function of the representative investor's preference parameters (δ, α), real GDP growth and CPI inflation. In a second step, as level and slope factors explain most of the risk of treasuries, we estimate the preference parameters (δ, α) by matching the historical average level and slope of each country's observed yield curve.

In the following sections, we first show how the model discount factor relates to growth and inflation shocks. We then show how bond yields can be also expressed as a function of growth and inflation shocks. Finally we show how we estimate the representative investor's preference parameters (δ, α).

The discount factor depends on growth and inflation risk

The evolution of the real discount factor (see equation (6)) can be expressed as a function of real GDP growth:

$$\ln(S_{t,t+1}) = s_{t,t+1} = \mu_s - \kappa_g (z_t - \overline{z}) + \lambda_s u_{t+1} \qquad (7)$$

Where:

$\overline{z} = (I - F)^{-1} m$ is the 4 by 1 vector of long-term mean (log) real GDP growth, (log) profit share, (log) inflation and (log) cash-flows growth (see equation (3)).

$k_g = [1,0,0,0]$, so that $(\kappa_g (z_t - \overline{z}))$ is the de-trended (log) real GDP growth (GDP growth minus its long-term mean).

$(-\mu_s) = -\log\delta + \mu_g + \dfrac{(\alpha-1)^2 \left|\gamma_g(\delta)\right|^2}{2}$ is the average short-rate , where

$\mu_g = \kappa_g \overline{z}$ is the long-term average real GDP growth, $\gamma_{g,h} = \kappa_g \Phi^{h-1} Q^{-1}$ is the 4 by 1 vector of responses of real GDP growth to the persistent growth shock, transitory growth shock, inflation shock and pure cash-flow shock (the latter is zero by construction in our model, a specific portfolio cash-flow has no impact on growth nor inflation). $\gamma_g(\delta) = \sum_{j=1}^{+\infty} \delta^{j-1} \gamma_{g,j}$ is the discounted long-term cumulative response of real GDP growth to all shocks. Thus, $\left|\gamma_g(\delta)\right|$ is measure of long-term growth uncertainty.

Finally, $\lambda_s = -\gamma_{g,1} - (\alpha - 1)\gamma_g(\delta)$ measures the short-term discount factor sensitivity to all shocks. Investors are averse to persistent shocks to trend growth only if they are uncertainty averse ($\alpha > 1$) and if real GDP growth is itself persistent ($\left|\gamma_g(\delta)\right| > \left|\gamma_{g,1}\right|$).

The real discount factor in equation (7) is used to price assets with inflation-linked pay-offs (TIPS). To price assets with nominal pay-offs (nominal bonds), we need to use the nominal version of the discount factor ($S^{\$}_{t,t+1}$):

$$\ln(S^{\$}_{t,t+1}) = s^{\$}_{t,t+1} = s_{t,t+1} - \pi_{t+1} = \mu_s - \mu_\pi - (\kappa_g + \kappa_\pi)(z_t - \overline{z}) + (\lambda_s - \lambda_\pi)u_{t+1} \quad (8)$$

Where the parameters μ_π (long-term average inflation), κ_π , and λ_π govern the evolution of inflation, π_{t+1} :

$$\pi_{t+1} = \mu_\pi + \kappa_\pi(z_t - \overline{z}) + \lambda_\pi u_{t+1}, \text{ where } \kappa_\pi = [0,0,1,0],\ \mu_\pi = \kappa_\pi \overline{z},\ \lambda_\pi = \kappa_\pi Q^{-1}$$

Thus the nominal discount factor is a function of both growth and inflation shocks.

Nominal and real bond pricing

Equations (7) and (8) can be used to derive the yield of zero-coupon inflation-linked bonds $y^{(n)}_{b,t}$ and of nominal bonds $y^{(n)}_{\$,b,t}$, at any time *t* and for any maturity *n*.

Indeed, yields reflect the expected future discount rates:

$$y^{(n)}_{b,t} = -\frac{1}{n}\ln(E_t(S_{t,t+n})) \text{ and } y^{(n)}_{\$,b,t} = -\frac{1}{n}\ln(E_t(S^{\$}_{t,t+n}))$$

And can be expressed as a function of growth and inflation shocks:

$y_{b,t}^{(n)} = \frac{1}{n}(E_n + B_n(z_t - \overline{z}))$ and $y_{\$,b,t}^{(n)} = \frac{1}{n}(E_{\$,n} + B_{\$,n}(z_t - \overline{z}))$

Where: $E_1 = -\mu_s - \frac{\left|\lambda_s\right|^2}{2}$, $B_1 = \kappa_g$, $E_{\$,1} = -(\mu_s - \mu_\pi) - \frac{\left|\lambda_s - \lambda_\pi\right|^2}{2}$, $B_{\$,1} = \kappa_g + \kappa_\pi$

$$E_n = E_{n-1} - \mu_s - \frac{\left|\lambda_s - B_{n-1}Q^{-1}\right|^2}{2},\ B_n = \kappa_g + B_{n-1}\Phi$$

$$E_{\$,n} = E_{\$,n-1} - (\mu_s - \mu_\pi) - \frac{\left|\lambda_s - \lambda_\pi - B_{\$,n-1}Q^{-1}\right|^2}{2},\ B_{\$,n} = \kappa_g + \kappa_\pi + B_{\$,n-1}\Phi$$

In turn the responses of real and nominal bond yields to the persistent growth and inflation shocks over horizon *h* are given by the first and third columns $\frac{1}{n}B_n\Phi^{h-1}Q^{-1}$ and $\frac{1}{n}B_{\$,n}\Phi^{h-1}Q^{-1}$.

Estimating the representative investor’s preference parameters

For countries where bond data are available, we estimate the preference parameters (δ, α) by matching the model implied level and slope of the yield curve to their historical average analog in the data.

More precisely, for each country, we solve for the preference parameters that minimize:

$$\underset{\alpha,\delta}{Min}(C)$$

Where:

$$C = C_1 + C_2$$

$$C_1 = \left(\frac{1}{T} \sum_{t=1}^{T} \frac{\left(y^{(10)}_{\$,Data,t} - y^{(5)}_{5,Data,t} \right)}{5} - \frac{1}{T} \sum_{t=1}^{T} \frac{\left(y^{(10)}_{\$,b,t} - y^{(5)}_{5,b,t} \right)}{5} \right)^2$$

$$C_2 = \sum_{n=5}^{10} \left(\frac{1}{T} \sum_{t=1}^{T} y^{(n)}_{\$,Data,t} - \frac{1}{T} \sum_{t=1}^{T} y^{(n)}_{\$,b,t} \right)^2$$

$y^{(n)}_{\$,b,t}$ and $y^{(n)}_{\$,Data,t}$ are the model implied and observed nominal bond yield at maturity (*n*) and time *t*. C_1 measures the distance between the average model and observed slopes, while C_2 measures the distance between the average model and observed levels. We focus on maturities from 5 to 10 years as these correspond to the maturities held in most institutional investors' portfolios geared towards long investment horizons.

For the historical average government bond yield curves, we use interpolated data (with a 3rd degree polynomial) from 1989, available from Datastream. This data is available for all the Developed Market countries we currently cover.

We find the uncertainty aversion parameter α to be about 20 in the US (and varies across countries from about 10 to 30), and the time discount factor δ to be about 0.98.

For the Emerging Market countries we currently cover, data on bond prices was either not available or not reliable. For these countries, we assume the time discount factor δ to be equal to 0.98 (the estimated value for DM countries), and calibrate the uncertainty aversion parameter, α , to match the observed historical average return on the equity market (see the following section for the derivation of the model based equity returns).

EQUITY PRICING

Equity prices can also be derived from equation (7) in a similar fashion. For each portfolio, we first extract the law of motion for the growth in (log) dividend per share:

$$d_{t+1} - d_t = m_d + k_d (z_t - \bar{z}) + l_d u_{t+1} \text{, where } \kappa_d = [0,0,0,1] \text{ and } \lambda_d = \kappa_d Q^{-1}$$

The equity price to dividend ratio is then given by:

$$\frac{P_{e,t}}{D_t} = E_t \left(\sum_{n=1}^{+\infty} S_{t,t+n} \frac{D_{t+n}}{D_t} \right) = \sum_{n=1}^{+\infty} \exp(K_n + L_n (z_t - \bar{z}))$$

Where: $K_1 = \mu_s + \mu_d + \frac{1}{2}\left|\lambda_s + \lambda_d\right|^2$, $K_n = K_{n-1} + \mu_s + \mu_d + \frac{1}{2}\left|\lambda_s + \lambda_d + L_{n-1}\Theta^{-1}\right|^2$

$$L_1 = \kappa_d - \kappa_g,\ L_n = \kappa_d - \kappa_g + L_{n-1}\Phi$$

In turn, we can derive an approximate relationship between equity real returns, macroeconomic factors, and cash-flows:

$$R_{t,t+1} = \frac{D_{t+1} + P_{e,t+1}}{P_{e,t}} = \frac{D_{t+1}}{D_t}\frac{P_{e,t+1}/D_{t+1} + 1}{P_{e,t}/D_t}$$

And $$\ln(R_{t,t+1}) = \ln(\frac{D_{t+1}}{D_t}) + \ln(\frac{P_{e,t+1}}{D_{t+1}} + 1) - \ln(\frac{P_{e,t}}{D_t}) \approx \mu_r + \kappa_r(z_t - \overline{z}) + \lambda_r u_{t+1} \quad (9)$$

where:

$\mu_r = \mu_d + \ln((1+K)/K)$ is the long-term (log) real return

$\kappa_r = \kappa_d + L\Phi/(1+K) - L/K$

$\lambda_r = \lambda_d + L\Theta^{-1}/(1+K)$

$K = \sum_{n=1}^{+\infty} \exp(K_n)$ is the long-term average price to dividend ratio, and

$L = \sum_{n=1}^{+\infty} \exp(K_n)L_n$ is the price to dividend ratio's sensitivity to growth, inflation and dividends shocks.

In equation (9), the long-term average return μ_r is approximately equal to the sum of the long-term dividend growth and the long-term average dividend yield ($\mu_r \approx \mu_d + 1/K$). The next section provides a more precise characterization of long-term returns and risk.

LONG-TERM EQUITY RETURNS AND RISK

Equation (9) can be used to derive returns over multiple horizons and decompose these returns into transitory and permanent components. More precisely, we can express the compound real equity return (***R(H)***) over *H* quarters as:

$$R(H) = \underbrace{\exp(\mu_r H + \gamma_r \sum_{t=1}^{H} u_t)}_{Permanent(H)} \times \underbrace{\exp(\alpha_r (z_H - z_0))}_{Transitory(H)} \qquad (10)$$

Where $R(H) = R_{0,1} \times R_{1,2} \ldots \times R_{H-1,H}$ is the compound return over *H* quarters, $\gamma_r = \lambda_r + \kappa_r (I - \Phi)^{-1} Q^{-1}$ is the long-term response of equity returns to all shocks (the persistent and transitory growth shocks, inflation shock, and dividend shock), and $\alpha_r = -\kappa_r (I - \Phi)^{-1}$ is the sensitivity of the transitory return component to growth, profit share, inflation and cash-flow growth.

Equation (10) shows that the permanent component (*Permanent(H)*) drives returns in the long-run. Indeed, the variance of this permanent component grows indefinitely as the horizon grows (more precisely, the variance of the logarithm of the permanent return is ($\left|\gamma_r\right|^2 H$)), while the variance of the transitory component remains bounded (quarterly real GDP growth rate, profit share, inflation rate and cash-flow growth all exhibit stable and finite variance). Thus, over long horizons, 100% of the variation in returns is driven by the permanent component.

In turn, μ_r and $\left|\gamma_r\right|$ characterize the long-term equity return and long-term equity risk. Let us examine their drivers in sequence.

Long-term equity returns are driven by long-term economic growth, growth uncertainty, and cash-flows exposure to economic growth uncertainty

Hansen, Heaton and Li (2008) show that the long-term return μ_r can be decomposed into a term premium and an equity risk premium component:

μ_r = **Term Premium** + **Risk Premium** (11)

Where:

- The **Term Premium** is approximately equal to: $\mu_g + \frac{\left|\gamma_g(1)\right|^2}{2} - \alpha \left|\gamma_g(1)\right|^2$ (12)
- The **Risk Premium** is approximately equal to: $\alpha \gamma_g(1) \cdot \gamma_d$ (13)

- α is the uncertainty aversion of the representative investor.
- $\gamma_d = \kappa_d \sum_{h=1}^{+\infty} \Phi^{h-1} Q^{-1}$ is the vector of long-term cash-flow betas to all shocks.
- Recall that $\gamma_g(1)$ is the vector of long-term cumulative GDP growth responses to the same shocks, and characterizes long-term GDP growth risk. Thus ($\gamma_g(1) \cdot \gamma_d$) measures the long-term covariance between real GDP growth and cash-flows.

The real term premium (about 2.3% in the US) captures the average spread between long (over 10 years) and short (3 months) treasury yields. Equation (12) shows that the term premium is driven by long-term economic growth average and growth uncertainty. It is increasing in the long-term real GDP growth (μ_g) and decreasing in long-term real growth uncertainty ($\left|\gamma_g(1)\right|$) (the representative investor's uncertainty aversion α is about 20 and greater than 0.5). Indeed, investors demand insurance in the form long-term real bonds in times of greater economic uncertainty, lowering the term premium. Equation (12) also shows that, as anticipated, the term premium decreases with the representative investor's uncertainty aversion α . Investors that are more averse to long-term growth uncertainty than the average investor in the market are willing to accept lower yields on long-term bonds to insure against long-term economic growth risks. In contrast, uncertainty tolerant investors command higher levels of long-term treasury yields.

According to equation (13), the risk premium (about 2.7% for the US equity market) is equal to uncertainty aversion (α) times the long-term covariance between real GDP growth and cash-flows ($\gamma_g(1) \cdot \gamma_d$). As real GDP growth is primarily driven in the long-run by the persistent shocks to its trend, an equity portfolio exhibits positive risk premium only if its long-term cash-flow beta with respect to these persistent growth is positive and significantly different from zero. In other words, equation (13) indicates that differences in long-term equity portfolio returns are mainly attributed to cash-flows' exposure to persistent shocks to trend growth (i.e exposure to long-term growth uncertainty).

Equation (13) also shows how investors' uncertainty aversion dictates their allocations to growth sensitive assets. Indeed, risk premium increases with uncertainty aversion. Individual investors that are more averse to long-term growth uncertainty compared to market, command a higher premium to allocate to growth sensitive equities. In contrast, long-term uncertainty tolerant institutional investors with greater capacity to withstand persistent shocks to the economy could profit from the prevailing long-term premium on growth sensitive equities such as cyclical sectors and value, small cap and momentum factor-based strategies.

In summary, the combination of equations (12) and (13) shows that long-term average real returns to an equity portfolio is driven by long-term economic growth, long-term growth uncertainty and its cash-flows' long-term exposure to growth uncertainty.

Long-term equity risk is primarily driven by trend growth uncertainty

Equation (10) shows that $\left|\gamma_r\right|$ measures the long run (over 10 years) equity portfolio risk and that long run equity risk mainly reflects cash-flows' and dividend yield's exposure to long-term economic growth uncertainty. For the US equity market, represented by the MSCI USA Index, we find the (annualized) long-run risk to be about 10.3%. This risk can be attributed to the four (uncorrelated) shocks governing the evolution of GDP growth, inflation and cash-flows in our model:

$$\left|\gamma_r\right|^2 = \gamma_{r,g,persistent}{}^2 + \gamma_{r,g,transitory}{}^2 + \gamma_{r,\pi}{}^2 + \gamma_{r,d}{}^2 \qquad (14)$$

- $\gamma_{r,g,persistent}$ is the long-term return response to the persistent shock to trend growth
- $\gamma_{r,g,transitory}$ is the long-term return response to the transitory shock to trend growth (almost zero by construction)
- $\gamma_{r,\pi}$ is the long-term return response to the inflation shock
- $\gamma_{r,\pi}$ is the long-term return response to the pure dividend shock (uncorrelated to the growth and inflation shocks)

Macroeconomic risk, trend growth risk in particular, is the primary driver of long-term equity risk. Empirically we find that growth shocks (primarily the persistent shocks to trend growth), contribute to about 91.5% of the overall long-run variance:

$$(\gamma_{r,g,persistent}{}^2 + \gamma_{r,g,transitory}{}^2)/\left|\gamma_r\right|^2 = 0.976\%/1.066\% = 91.5\%$$

In contrast, inflation shocks do not contribute much:

$$(\gamma_{r,\pi}{}^2)/\left|\gamma_r\right|^2 = 0.001\%/1.066\% = 0.1\%$$

The contributions from the pure dividend shocks are not negligible in the data:

$$(\gamma_{r,d}{}^2)/\left|\gamma_r\right|^2 = 0.089\%/1.066\% = 8.4\%$$

However, our model indicates that shocks to cash-flows that are uncorrelated to trend growth shocks are not priced in the long run, and therefore should not, in principle, carry any premium nor risk in the long run. Our findings suggest that this theoretical prediction seems to hold quantitatively well overall.

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