

Chapter 14: Factor Investing

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Abstract

Factor investing asks: how well can a particular investor weather hard times relative to the average investor? Answering helps her reap long-run factor premiums by embracing risks that lose money during bad times, but make up for it the rest of the time with attractive rewards. When factor investing can be done cheaply, it raises the bar for active management.

1. Passive-Aggressive Norway

Norwegians were shocked by their sovereign wealth fund's performance during the 2007-2009 financial crisis. Officially the Norwegian Government Pension Fund – Global, the fund was formed in 1990 to invest state revenues from oil and gas reserves in the North Sea. At the end of 2012, Norway's fund stood at \$650 billion, or more than \$130,000 per Norwegian. The fund is larger than Norway's annual economic output.

The fund's returns were humming along nicely at the start of 2007. Figure 14.1 plots cumulated returns from January 2007 to September 2009, encompassing the worst of the financial meltdown. While there were some rumblings and negative returns starting in the summer of 2007 as subprime mortgage prices declined,¹ the market started to plummet in 2008. Figure 14.1 shows that cumulated returns starting in 2007 reached -17% in October 2008, a month after Lehman Brothers went bankrupt. Thanks to frantic efforts by Washington to prop up the banking system and other major players, the Norwegian fund posted positive returns in December 2008. Then the first quarter of 2009 was a roller coaster downwards as these measures proved

¹ In August 2007, a crisis occurred for hedge funds specializing in quantitative investing techniques, see Chapter 17.

inadequate and policymakers put on further programs to stabilize the financial system. February 2009 was the lowest cumulated return marked in Figure 14.1, at -22%. From there, fund returns gradually climbed back.

[Figure 14.1 here]

Surprisingly, Norwegians weren't that upset with the large losses of the overall fund. It had been a long journey bringing the fund's asset allocation from 100% bonds when the fund was first formed, to 40% equities in 1998, and then to 60% equities over 2007-2009. (Since 2011, the fund has had a maximum allocation to real estate of 5% coming from the bond allocation.) The public was well informed of the risks and parliamentarians had made investment decisions understanding that large holdings of equities brought the risk of large losses. The reward was that over the long run, equities would earn a return higher than bonds.² After all, financial markets have always tended to bounce back.

Norwegians were angry with the negative returns generated by *active management*. The fund's manager, Norges Bank Investment Management (NBIM), was supposed to produce returns in excess of a benchmark provided by the Ministry of Finance. The active return is the fund return minus the benchmark return. Figure 14.1 showed that post-2007, cumulated active returns reached -5% during the worst months of the financial crisis. Many members of the public had been expecting active management to steadily add value – after all, wasn't that why those portfolio managers at NBIM were paid so much more than regular bureaucrats? Perhaps the extra fees paid to NBIM for active management were a waste of money, and the fund should be *passively managed* using low-cost index funds?

² This is the equity premium, which is discussed in Chapter 8.

The Norwegian fund is always in the public eye, and the actions and words of the responsible officials at the Ministry of Finance and NBIM are closely scrutinized by the press. The outcry at the active losses was special, partly because the losses occurred alongside contracting economic growth and the uncovering of other financial excesses – Norway, despite its stolid reputation, was not spared the effects of the financial crisis. Also, Norwegian parliamentarians are financially sophisticated; they have to be as they are ultimately responsible for the nest egg of a nation. (Ask the average member of Congress what's the difference between active and passive management, and he'll think you're referring to different exercise routines.)

The Ministry of Finance wisely did not immediately yank NBIM's active mandate despite the public outcry. Instead, it commissioned a four-month, in-depth study of the fund. William Goetzmann (Yale University), Stephen Schaefer (London Business School) and I were tasked with evaluating NBIM's historical performance, assessing its strategic plans for active management and its risk budgeting process, and describing and evaluating investing strategies that played to Norway's comparative advantages as a large, patient, and transparent investor. Released at the end of 2009 and presented in January 2010 at a public meeting introduced by the King of Norway, the report was quickly dubbed the "Professors' Report," or more conventionally, Ang, Goetzmann and Schaefer (2009).

We found that a major part of the fund's active returns before, during, and after the financial crisis could be explained by systematic factors. It was right for Norway to collect these risk premiums in the long run, which compensated Norway for losses during bad times like the financial crisis. Many of these factors could be collected more cheaply by *passive management*. The report recommended that NBIM's active mandate should not be rescinded, but that the

Norwegian fund should go beyond equities and bonds in its asset allocation: Norway should adopt a top-down approach of factor investing, especially for *dynamic factors*.

2 Factors Really Matter

The simplest factors are the equity and bond indexes which Norway selects as its benchmark returns. (I provide formal criteria for defining factors below.) Equities and bonds provide risk premiums which an investor can access very cheaply through index funds.³ The traditional approach to asset management has been to build on an equity-bond mix by adding other asset classes, notably subclasses of equities and bonds such as emerging markets and high-yield bonds, or *alternative assets* like real estate, private equity, and hedge funds. (This is referred to, incorrectly in the context of its original incarnation by Swensen (2009), as the *endowment approach*, see Chapter 13.⁴) Even without adding alternative asset classes, the equity-bond factor decision is the most important one taken by funds. And it explains the majority of the variation in performance.

2.1 Return Decomposition

To be concrete, I denote r as a fund's return. We'll subtract and add the benchmark return, r_{bmk} , to obtain a return in excess of the benchmark, which is the active return, and the benchmark return:

$$r = \underbrace{(r - r_{bmk})}_{\text{Active Return}} + \underbrace{r_{bmk}}_{\text{Benchmark Return}} . \quad (14.1)$$

³ See Chapters 6-9 for economic theory underlying these risk premiums.

⁴ Chapters 17 and 18 argue that hedge funds and private equity are not asset classes, respectively. Chapter 10 covers a factor decomposition of real estate.

The poor active returns, $r_{active} = r - r_{bmk}$, were what the Norwegians were up in arms about in 2008 and the beginning of 2009. The benchmark returns, r_{bmk} , are the result of the asset allocation decision (later it will be a factor decision) taken by the Ministry of Finance. Benchmark returns are often called passive returns, especially if they can be implemented by passive index funds as in Norway's case. The active returns, r_{active} , result from the decisions of NBIM to deviate from the benchmark.

Gary Brinson, Randolph Hood and Gilbert Beebower, all practitioners, wrote a major study in 1986 showing that approximately 90% of a typical fund's return variance is explained by the asset allocation decision. Their result is stated in terms of variances:

$$\underbrace{\text{var}(r)}_{100\%} = \underbrace{\text{var}(r_{active})}_{\sim 10\%} + \underbrace{\text{var}(r_{bmk})}_{\sim 90\%}, \quad (14.2)$$

where approximately 90% of the variance of total returns, $\text{var}(r)$, is accounted for by the variance of passive or benchmark returns.

For Norway, the effect of factors is even more dramatic than the set of funds studied by Brinson, Hood and Beebower. Figure 14.2 reports the variance attribution of Norway's fund returns into its active returns and benchmark returns for the whole fund, and the equities and fixed income portfolio components of the fund as computed in the Professors' Report. From January 1998 to September 2009, 99.1% of variation in the fund's returns was explained by the equity-bond decision taken by Parliament. For the equities and bond portfolios, the passive benchmark accounted for 99.7% and 97.1% of return variation, respectively. Norway's factor attributions are so high because NBIM worked under very strict risk constraints that only allowed it extremely small deviations from the benchmark. In effect, Norway is a huge index fund.

[Figure 14.2 here]

The asset allocation decision – the asset classes where you collect your risk premiums – is by far the most important decision in understanding the fluctuations of your fund over time. If you want to explain why your fund's performance is different relative to your competitor's, however, your fund's benchmark allocation becomes less important.⁵ Many endowments, for example, have similar asset allocation policies (see Chapter 1), and thus the active bets taken by Harvard are a major determinant in whether Harvard beats Yale in one particular year. But for just your fund compared to itself over time, the most important investment decision you make is the top-down choice on asset allocation.

2.2 More Sophisticated Return Decomposition

Risk managers often use more sophisticated return decompositions by drilling down into asset-class or position-level data.⁶ (These are derived by subtracting and adding one just as in equation (14.1).) In all of these decompositions, the asset class decision is the most important taken by the fund.

A decomposition of a total fund return into a benchmark return, a component where the asset classes in the benchmark are timed (called *tactical asset allocation*), and a component where securities are picked within each asset class (called *security selection*) is given by:

$$r_i = r_{bmk} + r_{timing} + r_{selection} \quad (14.3)$$

In its full glory, this can be written as

⁵ See Hensel, Ezra and Ilkiw (1991) and Ibbotson and Kaplan (2000). Brown, Garlappi and Tiu (2010) report that 70% of the (time-series) variance of endowment returns is due to passive policy decisions.

⁶ See also Lo (2008).

$$r = \sum w_i r_i = \underbrace{\sum w_i^b r_i^b}_{r_{bmk}} + \underbrace{\sum (w_i - w_i^b) r_i^b}_{r_{timing}} + \underbrace{\sum w_i (r_i - r_i^b)}_{r_{selection}},$$

where the weights in each asset class, w_i , apply at the beginning of each period and the returns generated by each asset class, r_i , are realized at the end of the period. These are the weights held and the returns realized by the manager, respectively. The superscript *bs* denote the weights (w_i^b) and returns (r_i^b) of the asset classes in the benchmark.

Equation (14.3) has partitioned the active returns into a timing and selection component. One advantage of this decomposition is that we can assign each separate source of return to different responsible parties. In Norway's case, the Ministry of Finance is responsible for the passive benchmark decision. NBIM, the fund manager, is responsible for the active decision away from the benchmark. According to equation (14.3), NBIM can generate positive active returns by timing the allocations between equities and bonds, or by choosing securities that outperform within the equities or fixed income asset classes.

Here's a return decomposition for a fund concerned about returns in excess of inflation:

$$\underbrace{r - \pi}_{\text{Real Return}} = \underbrace{(r - r_f)}_{\text{Risk Premium}} + \underbrace{(r_f - \pi)}_{\text{Real Cash Return}}, \quad (14.4)$$

where π is the inflation rate and r_f is the risk-free return on U.S. T-bills. A real return can also be decomposed using a benchmark, r_{bmk} , with asset class weights w_i and returns r_i , similar to equation (14.3):

$$\begin{aligned}
 r - \pi = & \underbrace{(r_f - \pi)}_{\text{Real Cash Return}} + \underbrace{\sum w_i^b (r_i^b - r_f)}_{\text{Strategic Asset Allocation}} \\
 & + \underbrace{\sum (w_i - w_i^b) r_i^b}_{\text{Tactical Asset Allocation}} + \underbrace{\sum w_i (r_i - r_i^b)}_{\text{Security Selection}} .
 \end{aligned} \tag{14.5}$$

If we aim to beat inflation, then equation (14.5) makes clear that strategic asset allocation is an active decision and aims to pick asset classes that produce returns in excess of the risk-free return.

Norway seeks to maximize its international purchasing power. The fund's spending rule set by Parliament is approximately 4%. This can be interpreted as a long-run real return (this is probably too optimistic, see Chapter 11).⁷ The expanded return decomposition in equation (14.5) indicates that the Ministry of Finance, and hence Parliament, is making active decisions in real terms. First, by choosing a currency basket, it decides on a cash return. In 2013 at the time of writing, investors seeking positive real returns are disadvantaged by negative cash returns (T-bill yields are lower than inflation). Second, members of Norway's Parliament decide on fixed benchmark weights in different asset classes (w_i^b) which have (hopefully positive) returns in excess of cash ($r_i^b - r_f$). The other two components in equation (14.5) are the benchmark-timing and security selection components, for which NBIM takes responsibility.

2.3 Factors

A large body of academic literature, and long investing experience, has uncovered certain classes of equity, debt, and derivative securities that have higher payoffs than the broad market index. Stocks with low prices relative to fundamentals (value stocks) beat stocks with high prices relative to fundamentals (growth stocks) over long periods, giving rise to a *value-growth*

⁷ For further details on payout policies from sovereign wealth funds and endowments, see Chapter 1.

premium. Over the long run, stocks with past high returns (winners) out-perform stocks with low or negative past returns (losers), leading to *momentum* strategies. Securities that are more illiquid trade at low prices, and have high average excess returns, relative to their more liquid counterparts. Thus, there is an *illiquidity* premium.⁸ Bonds that have higher default risk tend to have higher average returns reflecting a *credit risk* premium. And because investors are willing to pay for protection against high volatility periods, when returns tend to crash, sellers of *volatility protection* in option markets earn high returns, on average.

We combine long positions in these classes of securities with under-weight or short positions in the securities that under-perform. Thus, we can collect these premiums:

Value-Growth Premium = Value stocks minus growth stocks

Momentum Premium = Winning stocks minus losing stocks

Illiquidity Premium = Illiquid securities minus liquid securities

Credit Risk Premium = Risky bonds minus safe bonds

Volatility Risk Premium = Selling out-of-the-money puts offset by stocks or calls to
produce market-neutral positions

These are dynamic factors, because they involve time-varying positions in securities which change over time. Dynamic factor premiums do not come for free. As Chapter 7 explains, while dynamic factors often beat the market over long periods of time, they can grossly underperform the market during certain periods – like the 2008-2009 financial crisis. Factor risk premiums

⁸ At least within asset classes. There is scant evidence of illiquidity premiums across asset classes, as discussed in Chapter 13.

exist in the long run because they compensate the investor for bearing losses during bad times.

The factors are not appropriate for everyone because factor strategies are risky.

An important concept of dynamic factors is that they remove market exposure. Optimally constructed value-growth nets out the market portfolio and is exposed to the returns of value stocks less the returns of growth stocks. Similarly by going long winners and short losers, momentum removes the market portfolio. In practice, factor portfolios need not be constructed with an equal number of stocks or equal dollars in opposite long-short positions. (These are called *unbalanced portfolios*.) There is no need to take short positions, but the fewer the short positions, the greater the market exposure. Put another way, the fewer short positions, the greater the correlation of the factors with the market portfolio. For example, there are many vehicles that invest in value stocks but these usually only take long positions. Without netting out growth stocks, the main driver of returns of these funds is the market portfolio. As the number of short positions in growth stocks increase, more market movements are removed and the more the factor reflects the *difference* between value stocks and growth stocks.

Industry often uses the terms *smart beta*, *alternative beta*, or *exotic beta* for dynamic factors. I stick with the term “factors” because, in asset pricing theory, beta has the strict meaning of measuring exposure to a risk factor. (These risk factors actually have a beta of one with respect to themselves.) Beta measures the magnitude of the exposure to a risk factor: we invest in factors, not betas.

Factors Define Bad Times

Each factor defines a different set of bad times. Value strategies got crushed during the financial crisis. They also got slammed during the roaring 1990s internet bull market. In the late 1990s and

early 2000s, venerable value managers, like Warren Buffet of Berkshire Hathaway, Jeremy Grantham who heads GMO Asset Management, and Julian Robertson who ran the hedge fund Tiger Management, became old-fashioned laggards. Grantham almost had to sell or close his firm. Robertson did close his fund in 2000, but went on to seed the funds of many of his associates (these hedge funds are affectionately known as “tiger cubs”).

The financial crisis was a bad time for many factors. Liquidity evaporated in commercial paper markets, mortgage-backed securities markets (especially for subprime mortgages), markets involving securitized fixed income products, and the repo market (which allows investors to borrow short-term funds). As investors clamored for liquid assets, the prices of illiquid securities tanked and there were heavy losses for illiquidity risk strategies. Investors sought safety, so prices of risky bonds nose-dived and credit spreads shot upwards. Volatility went sky high, benefiting the purchases of volatility protection but inflicting heavy losses on the providers of it. Momentum strategy portfolios plummeted in spring 2009 when battered financial firms, shorted by momentum strategists, were buoyed by waves of bailouts and easy money.

It is precisely because factors episodically lose money in bad times that there is a long-run reward for being exposed to factor risk. *Factor premiums are rewards for investors enduring losses during bad times.*

Factors Dominate in Large Portfolios

In very large portfolios, it is very hard to find excess returns that are not related to factors. Many mispricing opportunities (or *alpha*, see Chapter 10) are not scalable – we expect small pockets of inefficiency to lie in areas of the market that are illiquid, or where information is not freely available. Manager decisions, both internal and external, tend to be correlated as it is hard to find

truly independent portfolio strategies. Large investors hold tens of thousands of securities, and security-specific bets are swamped at the portfolio level by macro-economic and factor risks.

This is not to say that large-scale security selection is impossible, but in general the bigger the portfolio, the harder it gets. A farmer, for example, may certainly be able to select a farm with the best soil and conditions for planting (farm security selection). But if there's a severe drought, having chosen the best farm is not going to help (rain is the factor).

Thousands of correlated individual bets by managers effectively become large bets on factors.

An equity manager going long 1,000 value-oriented stocks and underweighting 1,000 growth stocks does not have 1,000 separate bets; he has one big bet on the value-growth factor. A fixed income manager who squeezes out the last bits of yield by finding 1,000 relatively illiquid bonds funded by short positions in 1,000 liquid bonds (through the repo market) has made one bet on an illiquidity factor.

2.4 Factor Attribution

In the Professors' Report, we showed that about 70% of all active returns on the overall fund can be explained by exposures to systematic factors. Panel A of Figure 14.3 graphs cumulated active returns for the Norwegian fund from January 1998 to September 2009. The figure shows the regime shift in 2008 that erased all of Norway's cumulated active returns since the beginning of the sample.

[Figure 14.3 here]

Panels B and C of Figure 14.3 plot illiquidity and volatility factors, which explain a large part of the active returns of the fund. Panel B plots an *illiquidity factor*, which is formed by taking the differences in yields between liquid newly issued government bonds (on-the-run) and relatively

illiquid seasoned government bonds (off-the-run). Higher values indicate more illiquid markets. Illiquidity spreads widened in 1998 as a result of the Russian default crisis and the failure of Long-Term Capital Management, a large hedge fund (see Chapter 17). The second dramatic widening at the end of the sample is due to the financial crisis. The illiquidity spread grew dramatically in the latter part of 2008 after the failure of Lehman Brothers and reaches its greatest extent in January 2009. As the financial system stabilizes over the last few months in 2009, illiquidity risk falls. The volatility risk factor in Panel C represents returns from selling volatility (see Chapters 1 and 7). Returns from the volatility strategy fall off a cliff in 2008, which wiped out 10 years of cumulated gains. The negative active returns during the 2008-2009 financial crisis coincide with both more illiquid markets (Panel B) and pronounced losses on short volatility strategies (Panel C).

In Panel D of Figure 14.3, I ask whether the negative active returns over 2008-2009 could have been anticipated. This is a different question than whether the negative active returns could have been perfectly forecast. (“Prediction is very difficult, especially if it’s about the future,” said Nobel laureate physicist Nils Bohr.) The figure graphs the actual active returns each month in dots, and the active returns explained by factor exposures in the solid lines. There are two lines: one estimates the factor exposures over the full sample and the other uses rolling windows. The latter updates the factor exposures each month and uses information available only at the prevailing time. Remarkably, the two lines almost coincide.⁹ The two lines account for much of the variation in actual active returns: they track the fairly stable active returns prior to the onset

⁹ Interestingly, the estimation using the expanding window predicts much more severe losses in September 2008 than what actually occurred. This is consistent with NBIM’s skill in managing time-varying factor exposures by changing either internal or external investment strategies.

of the financial crisis, they follow down the large losses during the financial crisis, and factors also explain the bounce back in active returns in late 2009 when markets stabilize.

My interpretation of Panel D is that had the factor exposure of the fund been properly communicated prior to 2008, the active losses during the financial crisis would not have caused such a strong reaction in the Norwegian public. Had the responsible parties warned that sooner or later markets always become illiquid and volatility shoots upwards, (but that bearing such risks is worth it, and things eventually turn out fine), then the negative active returns in 2008 might have been within anticipated loss limits. The Norwegians did not find the losses from equity positions, however large, surprising because they were aware of the downside risk.

The Professors' Report showed that Norway's active returns have large exposure to systematic, dynamic factors that are appropriate for Norway because the factors earn risk premiums over the long run. The factor exposures, however, did not come about through a process which deliberately chose which factor premiums should be harvested and optimally determined the sizes of the factor exposures. We recommended that the Norwegian fund should take a top-down, intentional approach to factor exposures. That is, Norway should practice dynamic factor investing; the fund's benchmarks should also include dynamic factors just as they do static, long-only bond and equity factors.

3 The Factor Recipe

Just as eating right requires looking through foods to their underlying nutrients, investing right requires looking through asset class labels to underlying risk exposures. Assets are bundles of factors, and assets earn returns because of their underlying exposures to factor risks. (Chapter 6 covers factor theory in more detail.)

3.1 Factors => Assets

An asset owner should take a stand on which risk factors are appropriate and then implement those factor exposures with appropriate assets. Figure 14.4 illustrates this process. Some risk factors are themselves asset classes, like plain-vanilla stocks and bonds, which can be implemented cheaply. These are passive factors earned by simply going long the equity or bond market.

[Figure 14.4 here]

Many dynamic factors cut across asset class boundaries. Value-growth strategies buy cheap securities with high yields and sell expensive securities with low yields. Foreign exchange's version of value-growth is *carry*: carry strategies go long currencies with high interest rates and short currencies with low interest rates. In fixed income, buying high yielding bonds with long maturities funded by low yielding bonds with short maturities is called *riding the yield curve*, and is related to the *duration* risk premium (see Chapter 9). In commodities, positive *roll returns* are accomplished by buying cheap long-dated futures contracts that increase in price as their maturities decrease (see Chapter 11). And finally in equities, value-growth is, well, value-growth.

Momentum is also pervasive and observed in equities, fixed income, foreign exchange, real estate, commodities (where it is often called *CTA*, for the type of fund which often pursues it), within and across asset classes, and in asset classes all over the world.¹⁰ Similarly, selling volatility protection can be done in options markets where the underlying securities are equities, fixed income, commodities, or foreign exchange. An investor should decide on whether

¹⁰ An exception is that momentum is very weak in over-the-counter equities markets, as Ang, Shtauber and Tetlock (2011).

momentum or volatility strategies are appropriate, and then implement them with appropriate asset classes in the cheapest way possible.

3.2 Canada Pension Plan Investment Board

Canada Pension Plan Investment Board (CPPIB), the fund manager of the Canada Pension Plan, uses two very simple factors – stocks and bonds.¹¹ CPPIB holds many other asset classes – it is chock full of private equity, infrastructure and other sexy illiquid assets, but it does not consider them to be asset classes. CPPIB looks through “private equity” and other labels and treats these investments as a combination of its two factors, stocks and bonds.

Figure 14.5, Panels A and B show factor investing à la CPPIB (which it calls the “total portfolio approach”) and are drawn from CPPIB’s 2013 annual report. Consider a private equity (buyout) investment in Panel A. CPPIB does not have a separate allocation to private equity and theoretically could hold almost all its portfolio in private equity subject to staying within the overall risk limits for the fund. In this particular example, \$1 invested in the private equity fund is economically equivalent to \$1.30 invested in public equities and a short position in bonds. This private equity investment is levered, and CPPIB accounts for this by the -\$0.30 position in fixed income. In reality, CPPIB performs a more complicated matching procedure which involves pairing the private equity fund by sector and geographic region, with adjustments for the artificially low volatility of reported private equity returns (see Chapter 11).

[Figure 14.5 here]

Panel B illustrates a factor investing decision for real estate. In this example, \$1 invested in the real estate deal is economically equivalent to \$0.40 in public equities and \$0.60 of debt. Again,

¹¹ This is drawn from the case “Factor Investing: The Reference Portfolio and Canada Pension Plan Investment Board,” CaseWorks ID #120302.

CPPIB's process is a bit more complicated: it assigns real estate to one of three risk classes (low, core, or high), and does some matching by geography and industry, but the general idea is that real estate is a bundle of risk factors.

The matching procedure in Figure 14.5 is not just academic. CPPIB funds the investment in private equity by transfers from its factor portfolios of equities and bonds. This benchmark portfolio is called the Reference Portfolio, and it can be managed by 12-15 people using cheap, passive index funds. The factor Reference Portfolio at writing is 65% equities and 35% bonds, with further breakdowns for domestic and foreign equities, and domestic and (hedged) foreign sovereign bonds.¹² The factors in the Reference Portfolio are chosen so that the fund has a reasonable chance of meeting the liabilities of the Canada Pension Plan. The factor decision in the Reference Portfolio is taken at the very top by the board of CPPIB.

The management team of CPPIB is responsible for any deviations from the Reference Portfolio, which they are required to justify. As David Denison, the former CEO of CPPIB, explained:

Our decision to vary from the Reference Portfolio is our responsibility. If we want to build up a real estate team – we have to recover that cost. Do we really want to spend those extra dollars? We have to have the conviction that it will yield, net of costs, incremental returns for the Canada Pension Plan fund.

The example investments in Figure 14.5 in private equity (Panel A) and real estate (Panel B) are made by CPPIB because the portfolio managers think they can create value, net of costs, above the Reference Portfolio. Put simply, CPPIB is hunting for alpha. Viewed in this fashion, the

¹² The Reference Portfolio was revised on April 1, 2012. Prior to that date it was still 65% equities and 35% fixed income, but the equity portfolio was divided into domestic, foreign developed, and emerging market equities, and the bond portfolio comprised domestic fixed income, domestic real bonds, and (hedged) foreign sovereign bonds.

factor decompositions in Figure 14.5 are *factor-mimicking portfolios* (see Chapter 7), and the alpha is the return CPPIB can generate over and above the factor exposures. These factor-mimicking portfolios are how the investments in private equity, real estate, infrastructure, and other non-factor assets are funded. The alpha (net of costs) that CPPIB generates justifies having more than 900 employees in active management around the world in Toronto, London, and Hong Kong, rather than a bare-bones staff of 15 managing a few index funds.

Panel C of Figure 14.5 is CPPIB's asset mix and exposure mix at March 31, 2013. At this date, CPPIB managed CAN \$183 billion. The fund holds 0.0% in foreign sovereign bonds, one of the Reference Portfolio's factors, but its economic exposure to foreign government bonds is 6.1%, which it achieves through its real estate, private equity, and infrastructure deals. Conversely, CPPIB holds 16.9% of its portfolio in real estate and infrastructure and yet it reports 0.0% economic exposure in these asset classes. For CPPIB, real estate and infrastructure are merely vehicles for obtaining Reference Portfolio factor exposure and are themselves not asset classes. Finally, CPPIB holds 34.9% of its portfolio in foreign developed market equities, but its economic exposure is 48.7%. The economic factor exposure in equities is far higher as it includes the implied equity exposure from real estate and infrastructure investments.

CPPIB's governance structure is crucial in allowing the organization to pursue factor investing and hire talented people (see Part III of the book for delegated investing). The Reference Portfolio means that management is "fully accountable for every dollar that we spend... This keeps management focused and accountable," says Denison. CPPIB can do this partly because it is independent of political meddling. There are no ex-officio government officials on its board. CPPIB does not submit its investment strategy or business plans for government approval, nor does it need approval for its compensation policies. The independence structure of CPPIB is

enshrined in the fund's enacting legislation and changing its independence charter is, in the words of Donald Raymond, its senior vice-president and chief investment strategist, "more difficult than changing the Canadian constitution."

When I've taught my case study on CPPIB, some quip that CPPIB's factor investing procedure is "complicated." Isn't it just easier to find and invest in a private equity deal? If you do that, you are implicitly giving yourself long equity exposure combined with short credit exposure. That is, you're getting the factor exposures anyway. The difference is that CPPIB handles and tries to explicitly control the factor risk. A major advantage of factor investing is that you know what the fundamental drivers are behind your assets, and understand the circumstances under which your portfolio may do badly. It more accurately identifies alpha. As the Professors' Report recommends, it is better to get a top-down handle on factor exposure rather than having it result haphazardly from ad-hoc, bottom-up decisions.

One valid criticism of CPPIB's factor investing procedure is that it doesn't go far enough! The factors in the Reference Portfolio are simple: static equities and bonds. There are no dynamic factors in CPPIB's benchmark, at least not yet.

3.3 What is a Factor

The Professors' Report to the Norwegian Ministry of Finance lists four criteria for determining what should be a factor. A factor should:

1. Be justified by academic research

The factors should have an intellectual foundation, and only factors with the strongest support in academic research should be included in an investor's benchmark. Research should demonstrate compelling rational logic or behavioral stories or both in explaining

why the risk premiums arise. We do not need unanimity concerning the mechanism that generates the risk premium – which if you’ve met financial economists know is impossible. (Economists are even divided over the source of the equity risk premium, for example (see Chapter 8), but I am highly confident that equities have higher returns than bonds over the long run and that equities are a risk factor.) On this criterion, value-growth, momentum, and short volatility strategies are appropriate risk factors. New research can identify new factors, or qualify earlier consensus on known factors, or even disqualify factors, and can inform investment policy accordingly.

2. Have exhibited significant premiums that are expected to persist in the future

Not only should we have some understanding about why the risk premium has existed in the past, but we should have some basis for believing that it will prevail in the future (at least in the short term). Factors are systematic by definition – they arise from risk or behavioral tendencies which will likely persist (again in the short term) even if everyone knows about the factors and many investors are pursuing the same factor strategies.¹³

3. Have return history available for bad times

Factor risk premiums exist because they reward the willingness to suffer losses during bad times. Having some data points to measure worst-case scenarios is necessary for assessing risk-return trade-offs and risk management (see below). We also want a reasonable length of data to perform these exercises.

4. Be implementable in liquid, traded instruments

¹³ This chapter does not discuss the factors that are used by many (mean-variance) risk models. Most of these factors are constructed based on decompositions of a covariance matrix of (residual) returns and not based on economic theory generating risk premiums.

As in CPPIB's Reference Portfolio, factor strategies should be dirt cheap, something best accomplished by constructing them from liquid securities. Scalability is an important requirement for large investors.

Factor strategies often involve leverage. You need to over-weight value stocks and simultaneously under-weight or short growth stocks. Going long value and short growth is a *dynamic leverage* strategy. Even if shorting is not possible, factor strategies still work: Israel and Moskowitz (2013) show that there are still significant value and momentum factor premiums available even if an investor cannot short, but the profitability of these factor strategies is dented by 50-60%.

Limiting ourselves to liquid securities might make it seem impossible to construct a factor illiquidity premium, but this is not so. You can collect an illiquidity premium by taking long positions in (relatively) illiquid assets and short positions in (relatively) liquid assets, all in liquid markets. It turns out that illiquidity premiums within (liquid) asset classes are much larger than illiquidity premiums across asset classes involving private equity, hedge funds, and other illiquid assets (see Chapter 13). These types of illiquid assets also present tricky principal-agent problems and can be accessed only in murky markets where scant information is available.

The four criteria deliberately exclude the trendy factor du jour. A factor should only be considered for a benchmark if it is widely recognized. A factor that predicts returns by some statistical analysis of social networking data (yes, there are some, see Chapter 8) is best left to active management. Many of the factors that we recognize today – like value-growth and momentum – were originally labeled as anomalies, or alpha, as they could not be explained by

existing risk factors. As the literature matured and there was growing acceptance of these strategies by institutional investors, they became beta, or were treated as factor premiums in their own right.

The set of factors is not static. Options trading on centralized markets was introduced in the late 1960s, and these markets blossomed after the seminal option pricing formula of Black and Scholes (1973). Before then, it was not possible to obtain large-scale exposure to volatility risk. The high yield bond market rose to prominence in the late 1970s and 1980s, due largely to the financier Michael Milken, the “Junk Bond King” (who went to prison for securities fraud). Prior to this we could not access a high yield, or junk, credit risk premium. Finally, we could only collect the carry factor in foreign exchange markets when the world’s currencies became untethered from gold and freely floated in 1970s.

There is no consensus on the complete set of factors. Academic studies using statistical analysis suggest that a limited number, usually less than 10, can capture most variation in expected returns.¹⁴ These are, however, statistical and not economic descriptions of data. Some factors, like CPPIB’s bond and equities, and some dynamic factors like value-growth and momentum, are tried and true. I recommend that even if you can confidently identify and invest in 10 or more factors, don’t. Keep things simple. Start with a select few. The point is that putting a factor into a fund’s benchmark removes a component from the active return that doesn’t really belong there and can be obtained more cheaply.

Some factors disappear. The *size effect* – that small stocks outperform large stocks – was brought to investors’ attention by Banz in 1981 and reached its peak just after that. There are good

¹⁴ See Connor and Korajczyk (1993) and Jones (2001).

academic justifications why small stocks might do better than large stocks: smaller stocks are more illiquid, they are less likely to be followed by analysts, so information is scarcer than large stocks, small stocks don't have the same operating cushions that large firms do, and they operate in riskier segments of the economy. Since the mid-1980s, however, there has been no size premium after adjusting for market risk (see Chapter 7). That is, small stocks do have higher returns than large stocks, but not after taking out their exposure to the market factor. The creation of small stock mutual funds allowed the ordinary investor to participate and bear size-related risk. Thus, the risk-bearing capacity of the economy changed after industry created new products to capitalize on the size premium. Those industry developments caused size to disappear. Those early investors in small caps experienced a bonanza. Prices of small stocks rose back to long-run equilibrium and early investors enjoyed a tidy risk-adjusted capital gain.

As I write, there is a flurry of new products created by industry to exploit many factor risk premiums. I take a special interest in funds taking advantage of the high average returns to low risk stocks, or *the risk anomaly*, which I describe in Chapter 10. Stocks with low volatilities, or low (past) betas, seem to be too cheap as they have anomalously high returns. Low volatility could be a factor, according to the criteria I lay out, but admittedly the academic literature on the risk anomaly is still much smaller than the literature on value-growth, momentum, and selling volatility protection. As the asset management industry creates products to trade low volatility risk – as it has been doing with gusto (although perhaps not as cheaply as asset owners would wish) – these products will allow investors to buy low risk stocks. Perhaps the prices of low risk stocks will rise to where they should be, giving early low volatility investors a handsome capital

gain, and the risk anomaly will go the same way as size.¹⁵ I'd really like this to happen because the low risk mystery will then be resolved, but I'm not expecting it.

3.4 How Are You Different from Average?

How do we allocate to factors, especially dynamic factors?

The skeptics will facetiously reply that we can allocate to dynamic factors just as badly as we do regular asset allocation. They have a point. Industry is besotted with mean-variance analysis (see Chapter 3), which is great for those rare investors with mean-variance preferences. (I don't know any, do you?) In mean-variance land, you still have to assign means and variances, along with correlations, to all the assets and there is not much difference between using factors and regular asset classes.¹⁶ This is really a statement about the shortcomings of mean-variance optimization.

As Part I of this book stresses, modeling the investor is about identifying her bad times, and how well she can handle losses when the bad times materialize. We capture these notions with *utility functions*: a rich array defines bad times as low wealth, when your consumption falls below what you're used to, and even when your neighbor bests the performance of your own portfolio (see Chapter 1). Factors perform badly during bad times, as they did for Norway in 2008-2009. The key in factor investing is comparing how the bad times encapsulated in factors compare to the bad times of an investor. Each investor will have a different set of bad times defined by her liabilities, income stream, how she tolerates losses (or not), and other salient investor characteristics.¹⁷

¹⁵ See also Cochrane (2013b).

¹⁶ See Kaya, Lee and Wan (2011) and Idzorek and Kowara (2013). Even in a mean-variance factor context, using factors does shrink, considerably, the number of means, variances, and correlations that need to be estimated, so there are some important differences between unconstrained approaches and factor models. See Chapter 3.

¹⁷ See Cochrane (1999, 2013a).

We can, and should, use all the impressive machinery of utility functions and fancy optimization in allocating to factors. I am, however, not a big fan of blindly applied brute-force mathematical procedures. I now lay out a procedure for thinking about factor investing which focuses on an individual's bad times. We start with a very special investor who actually takes on no dynamic factor risk whatsoever...

Mr. Market

The market is the quintessential typical investor – the market, by definition, embodies the average effect. *The average investor holds the market portfolio.* The market portfolio is a passive, long-only portfolio of all securities held with market capitalization weights. Thus, the average investor collects no dynamic factor risk premiums Mr. Market holds all securities and does not continuously trade select securities which give rise to factor risk premiums.

If you are average, then, you passively hold the market and consequently do not trade any dynamic factors. You're done! And if you do this with cheap index funds, you'll outperform two-thirds of active managers (see Chapter 16). What the mean-variance framework, and the equilibrium CAPM, gets spot-on right is that the market portfolio is well diversified; the market is the most diversified portfolio you can passively construct.

If you are different from average, then you will optimally *NOT* hold market weights. Which tilts you hold away from the market will depend on your investor-specific characteristics. The important question is: "How are you different from average?" Do you have a longer horizon than the typical investor, like Norway? Are you terrified of highly volatile periods because you need to meet a fixed liability stream? Do you tremble when the market crashes because your income is

directly linked to market performance, so you get double-whacked as your financial wealth comes crashing down just as you lose your job?

Each factor defines a different set of bad times. The investor should ask, are those bad times defined by the value-growth factor bad times for me? And if they are bad for me, do they hurt less than for a typical market participant?

There are three steps, then, in the factor allocation process:

1. How am I different from average?

Identify your comparative advantages. The Professors' Report enumerated these for the Norwegian fund: (1) transparency and a long-term mandate, (2) large size, (3) long-term horizon and the lack of immediate cash liabilities, and (4) the fund manager NBIM is capable, has a strong public service ethos, and mitigates the problem of agency which is the central challenge of delegated investment management.

Identify your comparative disadvantages. Size is a two-edged sword for Norway, and being large means small-scale alpha opportunities do almost nothing for the overall portfolio. If you're an endowment, perhaps you can't afford big losses because your university will have trouble meeting payroll (this happened to Harvard, see Chapter 13).¹⁸

Or do you tend to go-with-the-flow and lavish attention on the latest hot stock?

2. What losses during bad times can I bear?

In each factor's definition of bad times, assess your risk-bearing capacity. This is essentially your risk aversion with respect to each factor. If you are so risk-averse you can't afford any losses during a factor's set of bad times, then you should take the

¹⁸ See "Liquidating Harvard," Columbia CaseWorks ID #100312.

opposite positions in those factors. That is, perhaps you should be doing growth instead of value, or buying volatility protection instead of selling it.

3. Rebalance!

Mr. Market is special in another way: *the average investor never rebalances*. As Chapter 4 explains, for everyone who rebalances by buying low and selling high, there must be someone on the other side who loses money by buying high and selling low. During the financial crisis, CalPERS did a terrible job at rebalancing and sold equities when equity prices were at their lowest, and expected returns were at their highest.¹⁹ Who was on the other side? Norway was the world's biggest buyer of equities in the last quarter of 2008.

Rebalancing is tricky because for dynamic factors, you don't necessarily want to rebalance to dollar positions. In fact, for strict long-short dynamic factor positions, your dollar position is zero! But you want to rebalance as it forces you to cut your exposure when things have gone well, and add exposure in the opposite case, bringing you back to your optimal exposure to dynamic factors. You need to decide on rebalancing to risk exposures, volatility weights, exposures determined by contributions to risk or value-at-risk, etc. (I cover some of these cases in Chapter 4.) Pick a set of (risk) weights, then rebalance.

If you good at rebalancing, you're ready for *factor timing*. Many factors are predictable (although the degree of predictability is very small, see Chapter 8), and you can exploit mean reversion in factor returns by incorporating valuation information in your investment process. You want to add more factor exposure beyond what rebalancing

¹⁹ See "California Dreamin': The Mess at CalPERS," Columbia CaseWorks ID#120306 and Chapter 15. Also see Ang and Kjaer (2011).

implies when those factors are cheap. Rebalancing already forces you to buy low and sell high; with factor timing you can buy even more when factor strategies become dirt cheap.

In my view of factor investing, *it is optimal for investors to hold non-market weighted portfolios.*

Traditional asset management, as exemplified by Norway, (often unwittingly) takes on large amounts of factor risk. An influential article by Charles Ellis (1975) calls active management a “loser’s game” because for every winner there is a loser and after transactions costs, there are only losers, on average. Active management can be a (relatively expensive) way to access factors, and it is optimal for investors to have different factor exposures. Active management, expressed through factor risks, may not be a loser’s game. While for every person on one side of a factor trade, there is a person on the other side, both investors are happy because they improve their risk-return profiles by offsetting factor positions. For example, certain investors are happy to forego the premium for selling volatility to avoid the periodic crashes. Instead, they purchase protection that pays off when volatility spikes. This makes everyone better off.

Investors find rebalancing standard stock-bond positions hard, and rebalancing dynamic factor positions is even harder. As Chapter 4 discusses, behavioral tendencies make investors most likely to give up on factor strategies after a string of recent stinging losses, which is the worst time to dis-invest because the low prices mean expected returns are high. Retail investors are especially prone to invest *pro-cyclically*, instead of *counter-cyclically*. This is one reason why Vanguard has yet to introduce pure momentum factor funds because small investors are likely to lose their shirts in poor factor timing.²⁰ George “Gus” Sauter, the former CIO of Vanguard says, “We have data that show that with narrowly defined investments, investors are not invested in

²⁰ Personal conversation with Sauter at the 2012 World Investment Forum. The quote is from Clark, K., Listen Up, Bond Investors: Vanguard Investment Chief Gus Sauter Sees Low Returns Ahead for Some of His Most Popular Products, cnmoney.com, December 2012.

them on the way up. They pile in at the top and then ride them on the way down.” An initial allocation to factor strategies is not enough; you must have the conviction to rebalance.

CAPM

The *Capital Asset Pricing Model (CAPM)* is a good place to show how the process works.²¹

According to the CAPM, investors should hold the market portfolio with risk-free T-bills, as shown in Figure 14.6. Tracing out the combination of T-bills, which is the intercept on the y-axis, with the market portfolio, shown in the circle, yields the Capital Allocation Line (CAL).

Investors hold portfolios on this line. There is a special investor who holds a 100% market portfolio (Mr. Market). If you are more risk-averse than the market, you will hold less than 100% of the market and lie to the left of the market portfolio on the CAL. If you are less risk-averse than the market, then you will lever up the market portfolio and short T-bills. In this case, your portfolio will lie to the right of the market on the CAL.

[Figure 14.6 here]

The investors more risk-averse than Mr. Market will earn lower average returns than the market. They're perfectly fine with this because they're more risk averse, so they sacrifice the higher returns for the safety of lower-yielding T-bills. (These investors have optimal betas of less than one.) If you are more risk-seeking than Mr. Market, you will earn higher average returns than the market portfolio. You don't feel the pain of bad times as much as the average investor, enabling you to earn higher returns. (The investors more risk tolerant than Mr. Market hold portfolios with optimal betas greater than one.) Thus, whether you have large or small holdings of market factor risk depends on whether you are more risk-averse or more risk-seeking than the market investor.

²¹ See Chapter 6 for an exposition of the CAPM.

In equilibrium, any person who is more risk-averse than Mr. Market is balanced by a person less risk-averse than Mr. Market.

The CAPM gives us directions on how to construct the optimal factor portfolio, which turns out to be the market-capitalization weighted portfolio of all risky assets (the market factor, of course!). It seems easy now, but when the CAPM was initially derived in the early 1960s there was no way to gain market factor exposure. It took 20 to 30 years until retail investors could gain cheap access to the market factor portfolio thanks mainly to the Vanguard Group (see Chapter 17).

Value-Growth

Let's do an example of a dynamic factor allocation by taking value-growth.

There are two main theories of the value-growth premium. Rational stories define different bad times when value stocks underperform growth stocks. Some of these stories, as Chapter 7 details, describe situations in which the market portfolio does badly (this is a *conditional CAPM*), so if you're already wary of bad market draws you should definitely stay away from value. We saw this happen during 2008-2009. But other rational stories define bad times in terms of low investment growth, or when "long run" consumption growth is low. When these episodes happen, you ask whether you can shoulder the losses in value-growth strategies more easily than the market. If so, value-growth is for you.

In the behavioral stories, value firms are neglected because investors inordinately focus on high-flying growth stocks. They over-extrapolate past high growth into the future, causing them to over-estimate future growth opportunities. Stocks with past high growth are bid up too high, and thus value stocks are relatively cheap. According to this line of reasoning, are you drawn to hot

stocks that are in the news because they have been recently successful? If you are, you are not a good candidate for value-investing. On the other hand, if you can stomach investing in stocks out of favor or close to distress, then value investing might be your thing.

This approach is very different from slamming a value-growth factor into a mean-variance optimizer. We start with the needs and characteristics of the asset owner (his utility function, in the language of an economist). We compare his bad outcomes with the bad times as defined by the value-growth factor. This requires an economic understanding, not just a statistical optimization procedure, of why these risk premiums exist. The appropriateness of a factor strategy depends on whether the investor can tolerate the factor's bad times more readily than the average investor, or how he differs in behavior from the average investor.

3.5 Dynamic Factor Benchmarks

Dynamic factors imply non-market capitalization weighted holdings, which change through time. Unlike the CAPM, there is no unique way to construct an optimal dynamic factor portfolio.

Mechanics

Consider three stocks, which we label “Growth,” “Neutral,” and “Value” with market weights 20%, 50%, and 30%, respectively.²² We assume that these are the only three stocks traded, and we have given these labels on the basis of the stock prices relative to fundamental value. We construct a value-growth factor which is long the value stock and short the growth stock. Suppose the desired portfolio is 100% equities with a loading of 5% on the value-growth portfolio. The optimal benchmark is the market portfolio plus the value-growth:

	Market Portfolio	Value- Growth	Benchmark Portfolio
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²² This is drawn from Section IIIB of Ang, Goetzmann and Schaefer (2009).

		Factor	
Value	0.20	0.05	0.25
Neutral	0.50		0.50
Growth	0.30	-0.05	0.25
	1.00	0.00	1.00

The value-growth factor picks up the differences in returns between the value stock and the growth stock and is a long-short portfolio (in jargon it is *a zero-cost mimicking portfolio*). The weight of exposure to value-growth, which is 0.05, is chosen by the investor.

The desired portfolio is a combination of the market weights now adjusted for the value-growth exposure. Note that the optimal portfolio is not a market-weighted portfolio; it overweights value and is tilted away from growth to achieve the desired exposure. In practice, the desired portfolio may have negative weights if the loading on value-growth is high enough, which would require dynamic leverage of the overall portfolio.

Now suppose that the value stock has done well and its new, higher price now makes it “Neutral.” “New Neutral” (formerly “Value”) moves from a market capitalization weight of 0.20 to 0.40. The old “Neutral” stock has declined in price from a 50% weight to 30%, making it “New Value.” The “Growth” stock retains its original characterization—it’s still a growth stock, and therefore keeps its original weighting of 30%. The value-growth factor changes: it drops the old value stock (which is now neutral) and brings on board the new value stock (which was previously neutral). Now we have:

	Market Portfolio	Value-Growth Factor	Benchmark Portfolio
New Neutral (formerly Value)	0.40		0.40
New Value (formerly Neutral)	0.30	0.05	0.35
Growth	0.30	-0.05	0.25

	1.00	0.00	1.00
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The optimal portfolio reflects the change. In a pure market portfolio benchmark, there is no rebalancing to take into account of the dynamic value-growth effect. The factor benchmark does.

Although highly stylized, this simple example illustrates three key points about factor benchmarks:

1. The desired exposure to the value-growth factor is set by the investor (here, a weighting of 5%).
2. The benchmark portfolio is no longer market-weighted and instead reflects the value-growth exposure desired by the investor.
3. The benchmark portfolio is “passive” in the sense that it is based on a set of systematic rules, but is “dynamic” in the sense that its composition changes over time.

All the major index companies put out non-market weighted indexes, as do some asset management companies. Arnott, Hsu and Moore (2005), for example, construct portfolios with securities weighted by various metrics of fundamental value and offer a way to collect a value premium.²³ These exposures are not determined directly by the investor, but are a first step in collecting dynamic risk premiums. True factor investing calls for an individual-specific benchmark, and there has been an increasing trend to customization in the index business.

²³ See comments by Perold (2007), Jun and Malkiel (2008), and West (2010).

GM Asset Management

The dynamic factors involve trading, and thus minimizing costs and turnover are essential components in constructing factor benchmarks. The largest investors have constructed and trade their own factor portfolios.

GM Asset Management, the fund manager of the parent company's pension plan, has built in-house dynamic factor portfolios for value and momentum.²⁴ James Scott (2012), the managing director of GM Asset Management's global public markets business, says that their approach is "consistent with the management of alpha and risk at the plan level and surplus plan management as suggested by Ang, Goetzmann and Schaefer (2009)."

GM Asset Management starts with an institutionally-investible universe. They do not short any growth stocks or loser stocks – they either underweight them relative to market weight, or hold them at a zero weight. Their measure of fundamental value takes an average of Book/Price, Forward Earnings/Price, Price/Sales, Trailing Earnings/ Price, and Trailing Cash Flow/Price. They define momentum as the past 12 month return (but drop the most recent month, following standard academic practice, to avoid a reversal effect). Portfolios are rebalanced monthly and designed for low turnover. The factor portfolios have only small exposures to value and momentum, reflecting GM Asset Management's desire for only small factor exposures (they have tight *tracking error*). They have built U.S. value and momentum portfolios, as well as international versions.

²⁴ For further details see "GM Asset Management and Martingale's Low Volatility Strategy," Columbia CaseWorks ID #110315. This section reflects conversations with Scott and Scott's presentation at the 2013 World Investment Forum.

GM Asset Management benchmarks all its equity managers to these in-house factor portfolios.

Managers have to prove they are generating excess returns beyond those available passively from the factor benchmarks. They assess managers by a regression:

$$r_{active} = r - r_{mkt} = b_0 + b_1 r_{mkt} + b_2 r_{size} + b_3 r_{value-growth} + b_4 r_{momentum} + \varepsilon, \quad (14.6)$$

where r_{mkt} is a standard market-weighted aggregate benchmark, r_{size} proxies for the size effect (they take the Russell 2000 minus the Russell 1000), and $r_{value-growth}$ and $r_{momentum}$ are the returns of their in-house value-growth and momentum factor portfolios. The factor exposures are the coefficients b_1 to b_4 , and the manager's active return comprises a true alpha, b_0 , plus movements due to market, size, value-growth, and momentum exposures.

Academics will recognize equation (14.6) as an industry version of Fama and French (1993).²⁵

GM Asset Management believes that market, value, and momentum are sources of risk premiums, and they can obtain all this exposure very cheaply through their own index factor portfolios. GM Asset Management likes tilts to value and momentum, but wants to select managers that can deliver stock selecting prowess in excess of these factor exposures (they want to see $b_0 > 0$, $b_3 > 0$, and $b_4 > 0$). They believe that size does not contribute to a risk premium, consistent with the lack of a size effect we now observe in data. They also would like to see a fund manager not take excessive market risk. Thus, all else equal, they prefer to see managers with benchmark-like exposures to the market and size ($b_1 \approx 0$ and $b_2 \approx 0$).

GM Asset Management uses the factor benchmarks as just one tool to select and evaluate managers. GM Asset Management also finds their approach useful in controlling factor

²⁵ Fama and French (1993) have market, size, and value-growth factors. Carhart (1997) augments this with a momentum factor.

exposures at the total equity portfolio level. They use this tool only internally; they do not give factor benchmarks to their managers. In fact, most portfolio managers would feel extremely uncomfortable being given a factor benchmark that combines the value and momentum effects. Perhaps the wide-spread adoption of factor benchmarks will change this.

Raising the Bar for Active Management

We could go beyond GM Asset Management and evaluate all managers, not just equity managers, using factor benchmarks. In an ideal implementation of factor investing, we would give customized factor benchmarks directly to managers instead of passive market-based indexes.

For example, we could evaluate:

A private equity manager using a benchmark incorporating EQUITY MARKET + BOND MARKET + LIQUIDITY + CREDIT factors. CPPIB does this, but uses only the first two factors.

A corporate bond manager using BOND MARKET + CREDIT + VOLATILITY factors. If we can obtain credit exposure cheaply elsewhere, the manager should be giving us something extra to justify her fees.

A value equity manager using EQUITY MARKET + VALUE-GROWTH. GM Asset Management does this now, except it does not give the factor benchmark to the manager.

By taking into account factor exposures, we raise the bar for active management. We want to pay active managers well when they create value (see Chapter 15), but we need to ensure the returns

they are generate are higher, net of fees, than what we can get more cheaply in low-cost dynamic factor benchmarks.

Risk-Return Factor Analysis

An important part of factor allocation is to look at the distribution of portfolio returns with different exposures to the factors. This is where fancy statistical analysis is useful. Many investors do this with the long-only factors like equity and bonds, where simulations are employed to compute risk-return trade-offs for a select few combinations of equity-bond mixes. We can extend this process to dynamic factor allocation. Most investors dislike downside outcomes more than they like upside gains (they have *loss aversion* utility functions, see Chapter 2), so I recommend concentrating on downside risk measures.

The Professors' Report illustrated this for the factor weights implied by NBIM, along with less and more aggressive allocations than what they implicitly did during the financial crisis. Factor allocation usually produces returns that are highly left-skewed. That is, they can occasionally produce some very large losses. Viewing the potential of these losses as a function of the size of the factor exposures allows investors to calibrate their desired holdings to the factor risks.

Factors and Governance

Few in Norway dispute that factors are important and deserve close attention. A major challenge, however, is deciding who sets the factor exposures. The factor decision, like all investment strategy considerations, cannot be divorced from the governance structure.

The Professors' report recommended that asset owners categorize factors by horizon, and within each horizon bucket set appropriate performance reviews and investment strategy. Figure 14.7

contains three (simplified) horizons: short-term, medium-term, and long-term.²⁶ Most fund managers, especially active managers seeking alpha, have short time horizons and work in a crowded space. At the other end, asset owners represented by boards, a Ministry of Finance, trustees, or investment committees, usually set long-term asset allocation weights. For Norway and CPPIB, this is the long-term equity-bond allocation set at the highest levels, which are Parliament and the board, respectively.

[Figure 14.7 here]

Dynamic factor strategies occupy the middle ground as their verification horizons are in the order of 2-5 years. Value strategies, for instance, underperformed for up to five years during the late 1990s in the midst of the internet mania. Many short-term asset managers harvest factor risk premiums (which sometimes masquerade as alpha). If the asset owner does not know the factor exposures, then she can be surprised and angry – as the Norwegian public was with NBIM – when the factors perform badly. *Factor benchmarks do not penalize a manager for underperformance when the losses are due to poor factor performance.*

Asset owners also benefit from explicit factor benchmarks if they choose to set portions of their portfolio to factor exposures. The ATP Group, Denmark's largest pension fund, is responsible for the financing the retirement of most working Danes. ATP divides its financial assets into a hedging portfolio, which is managed to match the funds' liabilities, and an investment portfolio, whose aim "is to generate an absolute return that is sufficient to preserve the long-term purchasing power of pensions."²⁷ The investment portfolio is itself divided into risk groups: interest rates, credit, equities, inflation-linked assets, and commodities. ATP rebalances these

²⁶ Figure 14.7 is adapted from Knut Kjaer.

²⁷ From the 2011 annual report of the ATP Group.

factors to maintain approximate risk allocations (it practices a form of *risk parity*, see Chapter 3). It also practices factor timing. The factor benchmarks allow ATP to invest counter-cyclically, so that factor exposures are increased as a factor strategy looks attractive.

Problems arise if neither the asset owner nor the fund manager takes responsibility for dynamic factors in the medium-term gray area. Many asset owners, for example, just gave up on volatility strategies after large losses in 2008, which was right at the time a counter-cyclical investor would have been increasing exposure (see Chapters 2 and 4). Bringing a volatility risk factor, like all dynamic factors, into the fund's overall benchmark would enhance asset owners' ability to commit to the factor strategy over the long haul.

3.6 Summary

Factor investing compares how you feel about bad times to how the average investor feels. If you are average, you hold the market portfolio – and there is nothing wrong with being average. If you differ from average, you tilt to dynamic factor risk exposures. You hold factors whose losses during bad times can be endured more easily by you relative to the typical investor. Or, you might hold negative positions in factors – which is equivalent to paying insurance premiums to protect against factor losses. Factor investing leads to optimal non-market capitalization indexes. Investors ought to be able to invest in cheap factor portfolios, and customize their factor exposures to investor-specific circumstances and characteristics. Innovation in the asset management industry is taking us closer to this optimal case.

4 Macro Factor Investing

So far we have taken an investment, or style, approach to factor investing as our factors have all been tradeable investing strategies. An alternative approach to factor investing can be based on (non-traded) macro factors. This is academically purer, but much harder to implement.

This is because asset classes do not move one-for-one with macro factors, and in fact, many of their movements are perverse or at least unintuitive. Equities, for example, are a claim on real assets yet a terribly inadequate choice for tracking inflation (see Chapter 8). Real estate is a better inflation hedge but it is only partially “real” (see Chapter 11). Bond prices reflect inflation risk, but other factors such as monetary policy risk and illiquidity risk are important drivers of long-term bonds (see Chapter 9).

Academic Model

Taking a macro view requires a framework for how macro factors simultaneously affect many asset classes. Ang and Ulrich (2012) is one model which could be used for macro-factor investing. We develop a model where real bonds, nominal bonds, and equities are jointly determined by two macro factors, inflation and economic growth, along with a factor capturing how the Fed sets monetary policy. If there is an inflation shock, for example, the model shows how the prices of all asset prices move. Macro factors are responsible for a very large amount of variation in expected returns: economic growth accounts for approximately 60% of variation in the equity risk premium, while expected inflation accounts for 40% of variation in real rates and 90% of variation in nominal bonds.

Bridgewater Associates

A practitioner framework where macro factors affect asset prices has been developed by Bridgewater Associates, a large hedge fund. Bridgewater's All Weather Strategy considers inflation and economic growth as macro factors, as shown in Figure 14.8. Although Bridgewater deviated from its originally intended strategy during the financial crisis, it is worth examining the overall framework. Bridgewater estimates how different assets perform during periods when growth is high or low, or when inflation is rising or falling. They fill in a 2×2 matrix corresponding to these scenarios. In Figure 14.8, they expect that nominal bonds do well when growth is falling and inflation is falling. Equities, on the other hand, outperform when growth is high and inflation is subdued. This is clearly a much more simplified version compared to a formal model like Ang and Ulrich (2012), but the idea is the same: we want to see how assets react when macro factors change.

[Figure 14.8 here]

Alaska Permanent Fund Corporation

Table 14.9 reports the asset allocation of Alaska's sovereign wealth fund, officially the Alaska Permanent Fund Corporation, which is funded by mineral lease rentals and royalties.²⁸ Alaska places its asset classes into different groups motivated by how they respond to different macro factor risks. The company exposure category contains equities, naturally, and "benefits from times of growth and prosperity." Note that corporate bonds are also lumped in the same category – not in a separate fixed income allocation. Chapter 9 shows that corporate bonds are affected by many of the factors that affect equity – if a company is doing poorly, both bondholders and shareholders suffer. The correlations between corporate bond returns and stock returns, both in

²⁸ Adapted from <http://www.apfc.org/home/Content/investments/assetAllocation2009.cfm>

excess of Treasury bonds, turn out to be high: at 48% for Baa grade bonds and 65% for high yield bonds (see Figure 9.17 and Section 4.3 of Chapter 9). Alaska does not consider them separate asset classes as they respond in the same way to macro risk.

[Table 14.9 here]

Alaska is also interesting because it follows the Merton (1971) model outlined in Chapter 4 for long-horizon investing. It has a special opportunities class, with a target allocation of 18%. Long-horizon investors take positions in a portfolio that is optimal for short-run investors, called the *myopic* portfolio, as well as an opportunistic portfolio (Merton actually labels it a *long-run hedging demand* portfolio) in which the long-horizon investor takes advantage of time-varying expected returns. When there are special deals for distressed assets, or it believes there are good deals in more illiquid investment opportunities which Alaska can exploit because of its long horizon, it invests through its Special Opportunities allocation. If there are no such attractive opportunities, the allocation not invested resides in the Company Exposure asset class.

In summary, Alaska's macro factor investing looks through asset class labels by categorizing the way different asset classes react to economic growth, inflation, and other macro risks.

5 Sovereign (Risk-Free) Bonds

My factor investing advice – to start with the market portfolio and see how your preferences differ from the average investor must allow for an important exception: sovereign bonds that are “safe” assets. I recommend not holding, or starting from, market weights for risk-free bonds. Factor investing, however, still applies to these assets. Indeed, the special nature of these investments means taking into account factors is especially valuable.

5.1 Do Not Hold Market Weights in Sovereign Bonds

In simple economic models, safe assets issued by governments are in *zero net supply*. There are no aggregate weights for risk-free assets because for every person with a long position in risk-free assets, someone is shorting to provide that long position. Risk-free assets have meaningful prices, but these are prices in which parties contract with each other to borrow or lend.²⁹ All other risky securities – stocks, corporate bonds, etc. – are in *positive net supply* and represent real wealth. Thus, for corporate bonds, I recommend you start with the standard factor investing procedure.³⁰

This same concept applies to all government debt, not only short-term T-bills. *Ricardian equivalence* is the name given to the principle that any liability of a government has to be repaid at some point (“tax now or tax later”), and in simple economic models without frictions, government debt is not net wealth: if we wrote down an aggregate balance sheet for the economy across generations, we would also see zero net supply.

The profession has moved beyond these simple cases and shown that government debt can be net wealth and fulfills many other purposes other than borrowing or lending.³¹ The simple economic models are useful to show that *the baseline case for investing in sovereign safe assets should not be market weights*. Market weights for sovereign debt are not very meaningful. To determine

²⁹ A major paper by Cox, Ingersoll and Ross (1985) shows there are few restrictions on the risk-free interest rate process in equilibrium. They assume all safe bonds are in zero net supply.

³⁰ Aren't corporate bonds similar in that for every company that issues (sells) bonds there is a buyer? Why are corporate bonds net wealth? Miller and Modigliani (1958, 1961) tell us that in frictionless markets, there is no difference between corporate bonds and equities. We know this world is far from reality, but the main point that corporate bonds and equity are both claims on a risky corporation which generates profitable investment opportunities, on average, remains the same. This is not true for risk-free government debt.

³¹ David Ricardo, after whom Ricardian equivalence is named, was one of the giants who established economics as a field in the early 1800s. The seminal reference is Barro (1974), who overcomes Ricardian equivalence by assuming distortionary taxes. Lucas and Stokey (1983) is another standard reference. A summary article is Ricciuti (2003).

optimal holdings of safe assets, we should understand the roles that safe assets play and why governments issue debt, how much, and how often they default.

5.2 Factors in Safe Assets

Government debt, like any other asset, is simply a bundle of risk factors. The problem is that so many risk factors, some acting at cross purposes, are at work in safe assets. Look at what the IMF says:³²

Safe assets are used as a reliable store of value and aid capital preservation in portfolio construction. They are a key source of liquid, stable collateral in private and central bank repurchase (repo) agreements and in derivatives markets, acting as the lubricant or substitute of trust in financial transactions. As key components of prudential regulation, safe assets provide banks with a mechanism for enhancing their capital and liquidity buffers. As benchmarks, safe assets support the pricing of other riskier assets. Finally, safe assets have been a critical component of monetary policy operations.

Whew! Let's just discuss a few factors:

Credit Risk

An ideal store of value has zero default risk. The private sector, then, has great difficulty creating enough safe assets (the literature calls these *information-insensitive assets*) to meet demand.³³

But sovereign debt also has credit risk. Sovereigns default all the time.³⁴ Tomz and Wright

³² IMF, Global Financial Stability Report, 2012.

³³ See Gorton (2010).

³⁴ Reinhart and Rogoff (2011) is a comprehensive treatise. They show that from the 1930s to the 1950s, nearly half of countries were in default.

(2013) compute that there is a 1 in 50 chance that a given country is in default at any time, but for the post-1980 sample the annual probability of default more than doubles, to 4%.

Even the United States has defaulted. Twice. In 1934, it slashed the value of a dollar from \$20.67 per troy ounce of gold to \$35. Reinhart and Rogoff (2008) classify the U.S. abrogation of the gold clause as a default, which it was because at the time all major currencies were backed by gold. Then, in a little-known episode in April and May 1979, T-bill investors did not receive their interest payments on time.³⁵ The Treasury blamed processing problems and the failure of Congress to act on the debt ceiling (the latter is a perennial problem). At first, Treasury did not want to pay any additional interest, which triggered a class action lawsuit. The government paid only after much lobbying.

If we were to rank countries on credit risk, then we might rank three (randomly selected) countries in order of most safe to least safe as: Norway, United States, and Brazil.

Collateral

Safe assets are used as collateral to borrow money or short other assets.³⁶ Ranking the debts of countries on the ability to post them for collateral we have: United States by far, and then Norway and Brazil depending on specific circumstances (like whether you're a Norwegian or Brazilian investor).

³⁵ Zivney and Marcus (1989) examine this interesting episode.

³⁶ A model of the collateral role for safe assets is Gorton and Ordóñez (2013).

Transactions

Safe assets function like money for carrying out transactions.³⁷ The word central bankers use for this is *liquidity* (which is different from the notion of an illiquidity premium).³⁸ A major aim of monetary policy during the financial crisis, at least in this country, was to alleviate liquidity shortages (see Chapter 9). If we were to order our set of countries in this role from the most useful role in facilitating transactions to the least, it would be United States, and then Norway and Brazil again with the order of the latter two depending on circumstances.

Another related role of risk-free assets, particularly currency (the sovereign bond with an instantaneous maturity), is a numeraire. We like to think of values as being independent of the units we use to measure them (your height is the same whether you measure it in inches or centimeters, for example), and numeraires transfer values from one unit to another. However, the choice of numeraire matters. Norway can report its return in local currency, U.S. dollars, or a currency basket. Each choice has consequences for the fund's volatility and perceived risk by the public.

Macro Factors

Chapter 9 discusses in detail how economic growth and inflation influence interest rates, and hence safe asset prices. High economic growth makes countries more likely to honor their commitments, all else equal. Ranking countries from high growth to low, we have Brazil, and then United States and Norway. If we order our countries from low to high inflation, with low inflation better for safe asset investors but high inflation better for investors with an eye to investment returns (see below), we have United States, Norway, and then Brazil.

³⁷ This literature dates back to Sidrauski (1967) and Tobin (1969). A recent example is Krishnamurthy and Vissing-Jorgensen (2012).

³⁸ Important early references are Woodford (1990) and Holmstrom and Tirole (1998). There is a huge resurgence of papers on this topic after the financial crisis.

Reserve Status

“Exorbitant privilege” was the phrase used by Valéry Giscard D’Estaing, the French finance minister in 1960, for the role of the U.S. dollar as a reserve currency and the ability of the U.S. to print all the dollars it wanted. The U.S. dollar is still the world’s leading reserve asset, and our other two countries would then rank Norway and, a distant third, Brazil.

Caballero and Farhi (2013) argue that demand for reserve assets, especially U.S. sovereign bonds, has been steadily increasing. The supply of safe U.S. assets is limited by the health of the federal budget and the fact that the U.S. is shrinking as a proportion of the world economy. Our exorbitant privilege is that we can borrow cheaply through large reserve demand among foreigners (especially in emerging markets). As crises erupt, the U.S. government is likely to encounter fiscal challenges and just when foreigners really want reserve protection, it might not be forthcoming.³⁹

Summary

The flipping order of our three countries in each of these considerations showcases the problem of how safe assets embody so many different factor risks. Market weights capture none of these effects; some investors prefer safety, others most value liquidity, and still others want investment opportunities from rosy macro fundamentals.

Figure 14.10 compares the market weights of the U.S., the Euro area, and Japan, in Panels A to C, respectively, using the Citi Yieldbook database. I overlay COFER weights, which are the weights of central banks and reserve managers reporting to the IMF, along with GDP weights of

³⁹ This is a new incarnation of the Triffin dilemma, named after the economist Robert Triffin. Under Bretton Woods, major currencies were backed by gold and the U.S. dollar had the same role as gold. Triffin argued this was unstable because the supply of safe assets would become insufficient, or foreign dollar holdings would be too large for the U.S. to support at the statutory peg. Triffin was prescient and Bretton Woods collapsed in the early 1970s. See Obstfeld (2011).

each country adjusted for purchasing power parity (PPP). There are huge differences. In Panel A, the reserve demand for U.S. Treasuries is much higher than the market weights, which have been declining since 1985 apart from an upward tick caused by new, large issuances of debt after the financial crisis. In Panel B, market weights of Euro-area safe debt is well above reserve demand and higher than the output of the Euro area. Panel C shows the situation is reversed for Japan. Japan's market weight is about 30% at the end of the sample, but Japan's fraction of the world economy is less than 10% and shrinking.

[Figure 14.10 here]

Market weights are simply inappropriate for sovereign safe assets.

5.3 Safe Asset Weighting Schemes

I compare the performance of some country-weighting schemes for government bonds for the set of sovereign issuers in the Citi Yieldbook database from 1990 to 2010.⁴⁰

In Table 14.11, Panel A, I examine countries by various macro variables. Many macro variables predict sovereign returns: over the full sample, countries that are poorer, as measured by nominal GDP per capita, tend to have lower returns. There is a significant inflation risk premium; countries with higher inflation have higher sovereign bond returns to compensate investors for bearing higher inflation risk. Normalized measures of the amount of government debt predict returns, especially during and after the financial crisis.

[Table 14.11 here]

⁴⁰ I construct year-on-year returns in U.S. dollars with a constant duration of 5.0 taking only developed countries. The macro data are from the IMF. Regressions in Panel A use country fixed effects. In Panel B, I set the maximum deviation from the market weight at 5% and do not allow short positions. Thus, a country with a market weight of 7% has weights between [2%, 12%], and a country with a market weight of 2% is allowed to take weights between [0%, 7%]. Rebalancing is done annually.

In Panel B, I consider various weighting schemes from macro variables, along with market capitalization and GDP weights. Starting with market weights, I overweight (underweight) countries with favorable (unfavorable) values of the macro variable at the beginning of each year and track returns over the next year. The sign of the overweights is dependent on the sign of the predictive coefficients in Panel A. I report means and standard deviation of returns, along with raw Sharpe ratios (which do not subtract a risk-free rate, see Chapter 2).

Panel B shows that market weights actually have done fairly well. We can do better by tilting towards countries that have faster growth, countries with high inflation, and countries with low Debt/GDP ratios.⁴¹ Since the financial crisis, GDP weights have done very well, with raw Sharpe ratios of 1.73 compared with 1.58 for market weights. This accounts for a large degree of the recent popularity of GDP weights for safe assets – the Norwegian fund is included in the herd.⁴² This is a nice fact, but it lacks a coherent story.

GDP weights are a solution in search of a problem. What factor are you trying to capture with GDP weights? If it is capacity to pay, or credit risk, then we are better off using solvency ratios or political risk measures. If it is investment potential, then we should design a proper return-enhancing index based on the macro predictors in Panel A of Table 14.11. It can't be liquidity, as the largest GDP countries tend to have more liquid sovereign bond markets (China is an important exception). Finally, if we want to overweight countries with higher economic growth potential, then we should do GDP growth rather than GDP levels.

⁴¹ The Debt/GDP measure is a nonlinear characteristic because very low measures are bad, but also very high measures are bad. Nonlinearity is much less pronounced in the developed country sample, which is used in Table 14.12.

⁴² The Norwegian SWF uses GDP weights but has a requirement that NBIM “shall seek to take account of differences in fiscal strength between countries in the composition of government bond investments.”

5.4 Optimal Weights of Safe Assets

The factor investing method starts by listing the factors that matter for an asset owner. Is liquidity the most important? Perhaps we want to emphasize creditworthiness. Or we prefer our fund to hold only reserve countries. Or maybe the number one priority is the return potential. The country weights should reflect the importance of these factors. Market capitalization or GDP weights will probably not reflect these factors' importance to an asset owner. Decide on the factors, then reflect the importance of these factors by sovereign weights.

What about the optimal holdings of safe assets within a given country? Figure 14.12 plots the market values of all U.S. Treasury issues at December 31, 2011 using data from Bloomberg.

Panel B removes U.S. T-bills and uses only longer-dated U.S. T-notes and T-bonds.⁴³ If you used a market weighted index, your holdings are skewed towards short-dated maturities because the U.S. Treasury issues most of its debt with short maturities.⁴⁴ Do you really want a maturity structure like Figure 14.12 if you are bound to market weights?

[Figure 14.12 here]

The level factor, or the average interest rate across maturities, is by far the most important factor for fixed income (see Chapter 9). The level factor accounts for 90% or more of the variation of safe asset returns and yields.⁴⁵ We could create a level factor portfolio quite easily by taking

⁴³ At issue, Treasury notes have maturities between two and 10 years, while Treasury bonds have maturities between 20 and 30 years. When issued, T-bills carry maturities less than one year.

⁴⁴ There are not many theories on how a government should select a maturity structure for its debt. The leading paper is Angeletos (2002), who shows how to derive an optimal maturity structure which ensures against fiscal shocks and allows the government to smooth taxes.

⁴⁵ See Litterman and Scheinkmann (1991).

select bonds across the maturity structure. Exposure to the level factor is labeled *duration*, and once the level factor is constructed, an investor selects an appropriate duration target.⁴⁶

An objection might be, but if you select a few bonds (somewhat arbitrarily), aren't you missing out on a lot of issues? Yes. But a dirty secret is that many investors never hold all the bonds in fixed income indexes. In many cases, it is impossible to hold all the securities because some issues just don't trade, or are held disproportionately by a few investors. Investors have often resorted to *factor replication* to track fixed income indexes.⁴⁷ They still track fixed income indexes well despite owning only a fraction of the number of bonds because factors dominate, especially the level factor, in fixed income portfolios.

5.5 Summary

Rarely should an investor base his holdings of risk-free, government bonds on market capitalization weights or outstanding issue sizes. Safe assets collect many different sources of factor risk, many at odds with one another. The factor investing approach starts with listing the factors that are most important for an asset owner, and reflecting these factors in the optimal country weights.

6 Passive-Aggressive Norway Redux

As part of the active management review in 2009, NBIM wrote a letter to the Ministry of Finance stating:⁴⁸

⁴⁶ Term structure movements across countries are highly correlated, as Kose, Otrok and Whiteman (2003) and Jotikasthira, Le and Lundblad (2010) show. Setting one duration target across all countries is a reasonable thing to do.

⁴⁷ The quality of many fixed income indexes is far below equity indexes. See Goltz and Campani (2011).

⁴⁸ Letter to the Ministry of Finance dated 23 December, 2009.

Active management will expose the Fund to systematic risk factors to a greater or lesser extent. The management and control of systematic risk must therefore be part of our management task.”

NBIM acknowledged the importance of factors, but wanted them to be under its control. This is an important debate about where the factor decision should be made. In another letter dated February 2, 2012 to the Ministry of Finance, NBIM wrote:

The investment strategy should be designed in such a way that the Fund can harvest risk premia dynamically... Norges Bank believes that the strategic benchmark index should not be adjusted to take account of systematic risk premia for equity investments.

As I write this, the Ministry of Finance has not made a final recommendation on whether the dynamic factor decision should be at the asset owner level (Parliament) or at the fund manager level (NBIM). (The issue was discussed in the Ministry’s 2013 report to Parliament.)

Nevertheless, NBIM has gone ahead and introduced factors into its internal benchmarks. In 2012, NBIM introduced an *operational benchmark* for equities which explicitly takes into account systematic risk factors. There are just two factors so far: value-growth and size. (Note that I believe size by itself does not yield a risk premium in excess of market exposure.) I anticipate there will be reporting of exposures to the systematic risk factors so that the ultimate owners of the fund, the Norwegian people, are informed of the factor risks taken by NBIM and a repeat of the 2008-2009 controversy hopefully will not occur. At the very least, the public will be better informed about the risks of such an event.

David Blitz at Robeco, an asset management firm, and other practitioners have already dubbed the passive harvesting of dynamic factors “the Norway model.”⁴⁹ In the public presentation of the Professors’ Report, I said factor investing is “passive but dynamic” and “index but active.” Factor investing aggressively pursues passive investments. It is a way of accessing returns based on a strong historical and academic foundation in a cost-effective manner. It is scalable. It can be done simply, and without the agency issues and information problems of illiquid asset markets. It allows investors to pay only for active management that produces results unavailable passively. Many investors might consider following Norway and aggressively harvest dynamic factor risk premiums in a cheap, passive way.

⁴⁹ Blitz, D., “Strategic Allocations to Factor Premiums: The Next Big Thing?” Robeco Insight, 7 October, 2012. See also Chambers, Dimson and Ilmanen (2011).

Figure 14.1

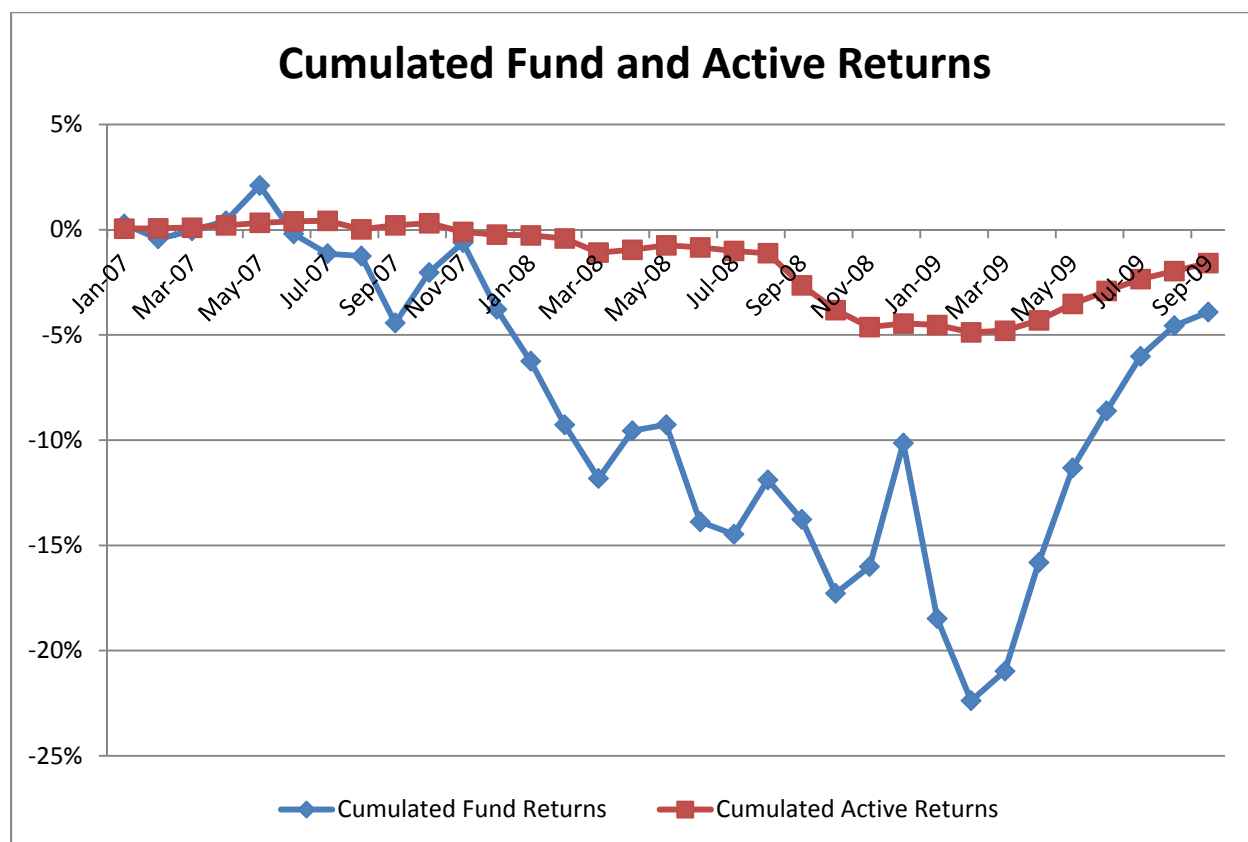


Figure 14.2

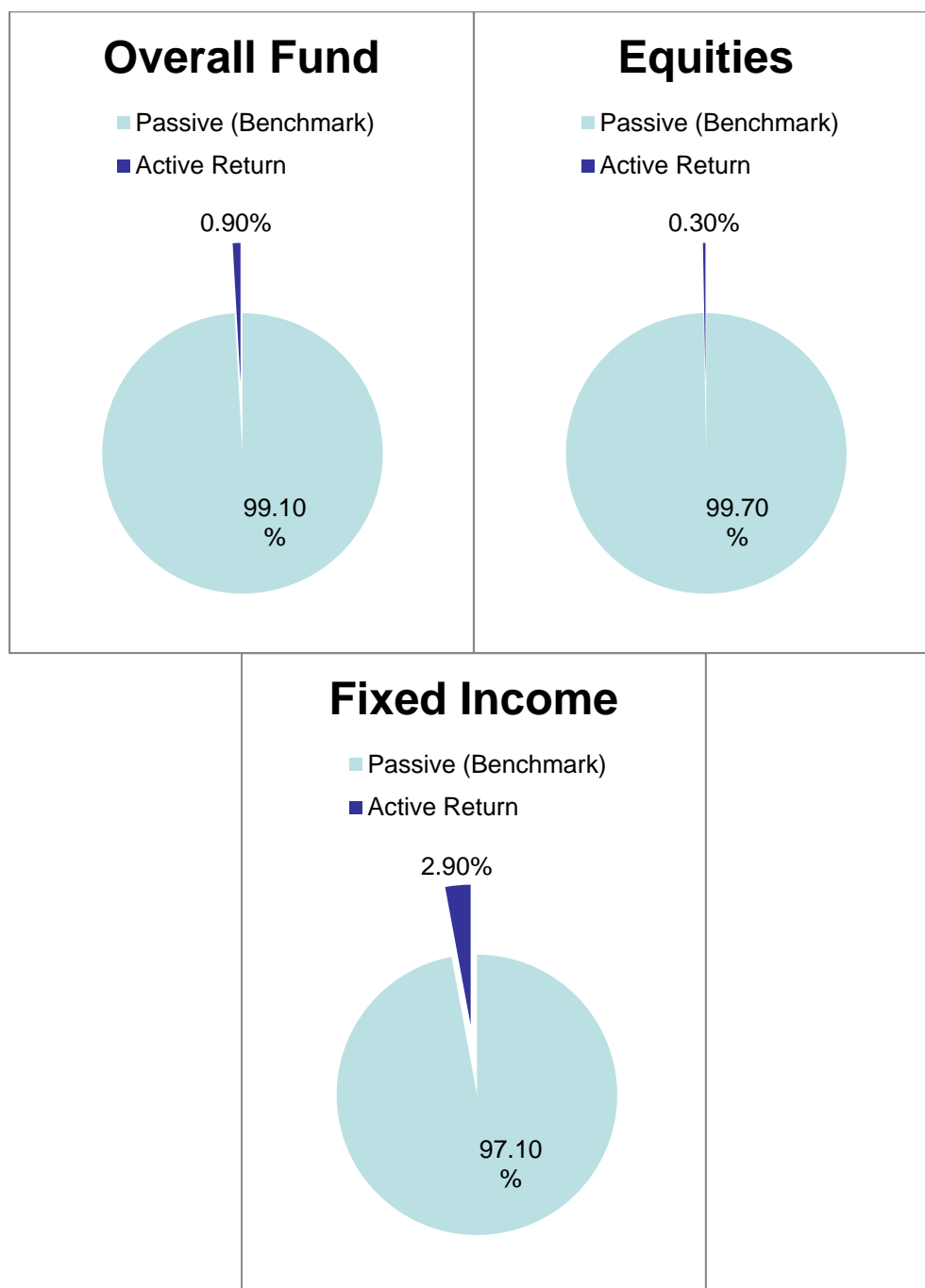


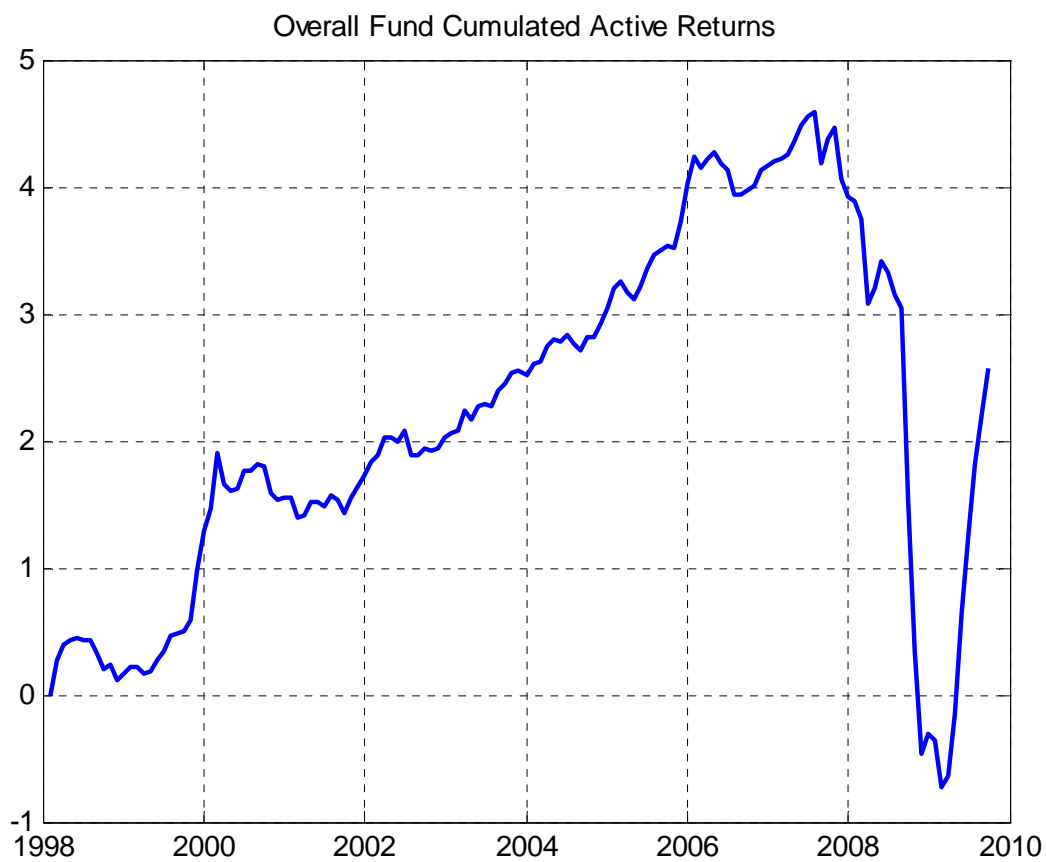
Figure 14.3**Panel A**

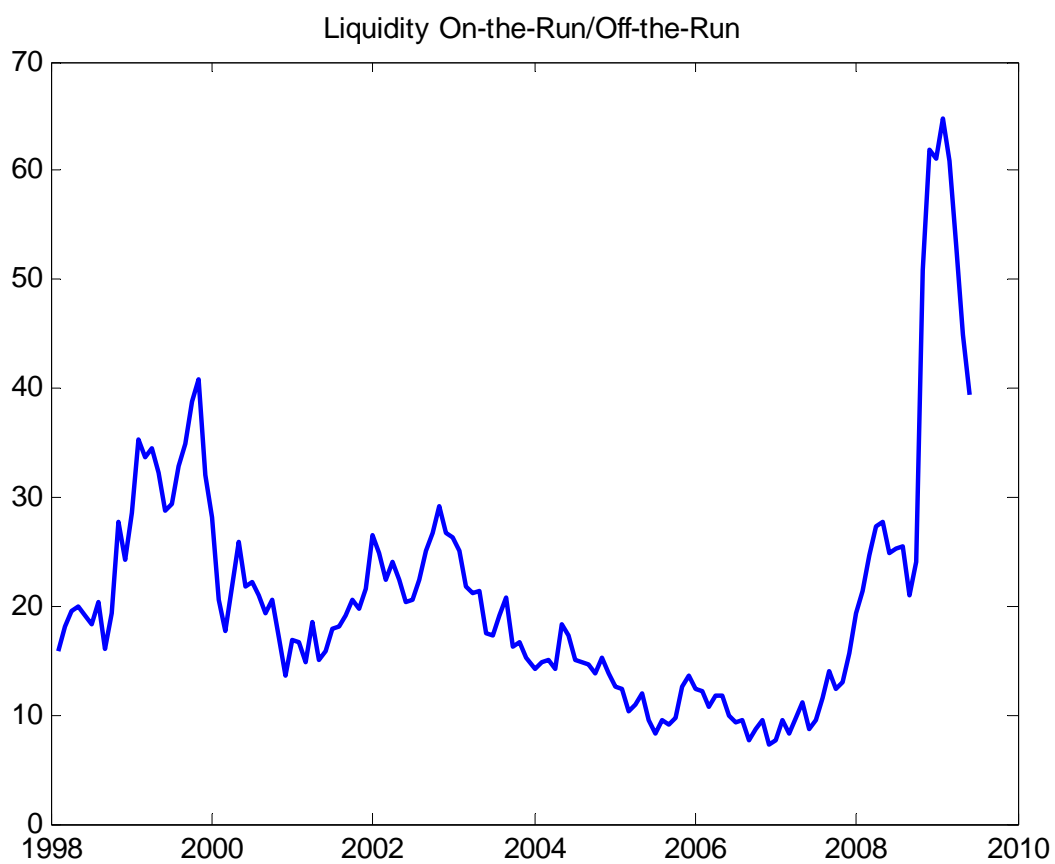
Figure 14.3**Panel B**

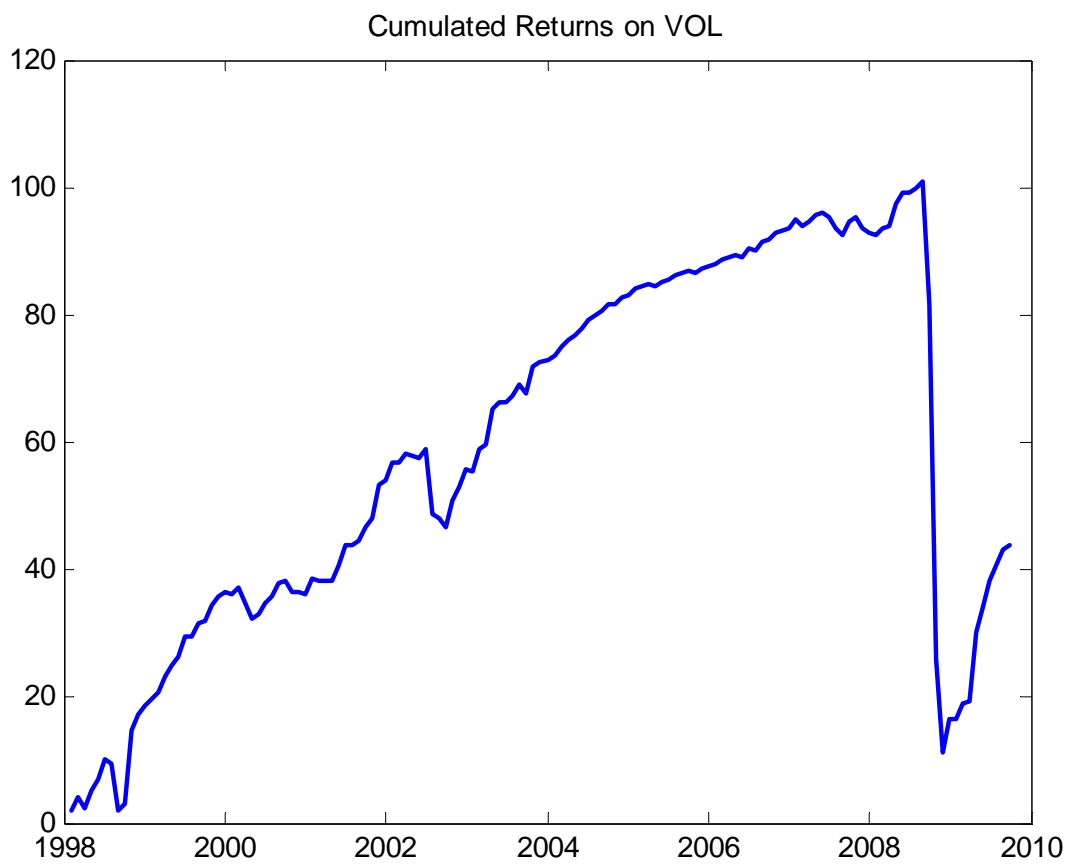
Figure 14.3**Panel C**

Figure 14.3

Panel D

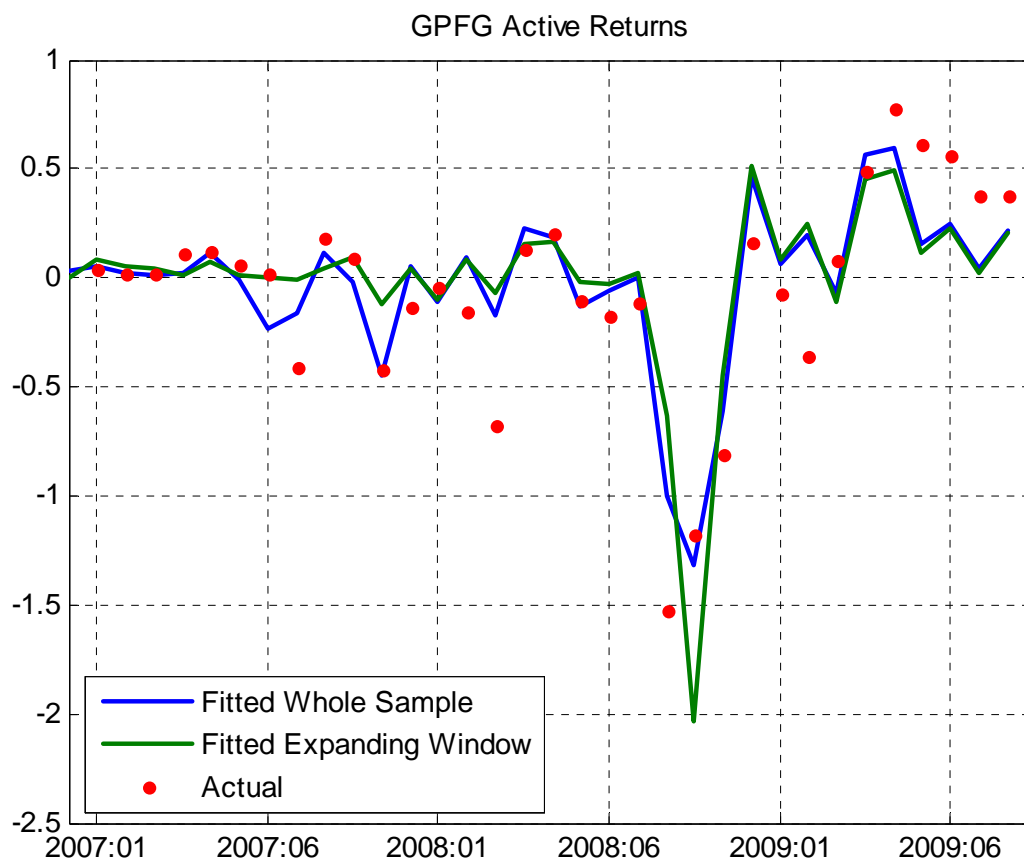


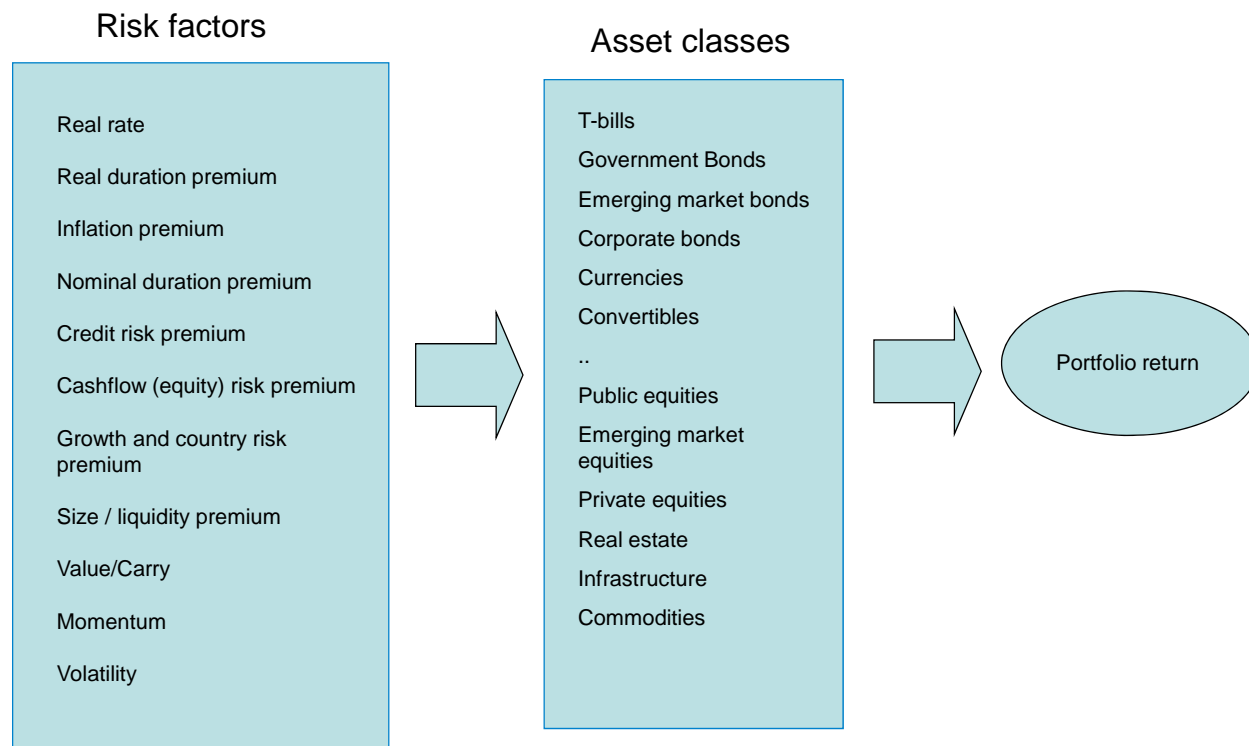
Figure 14.4

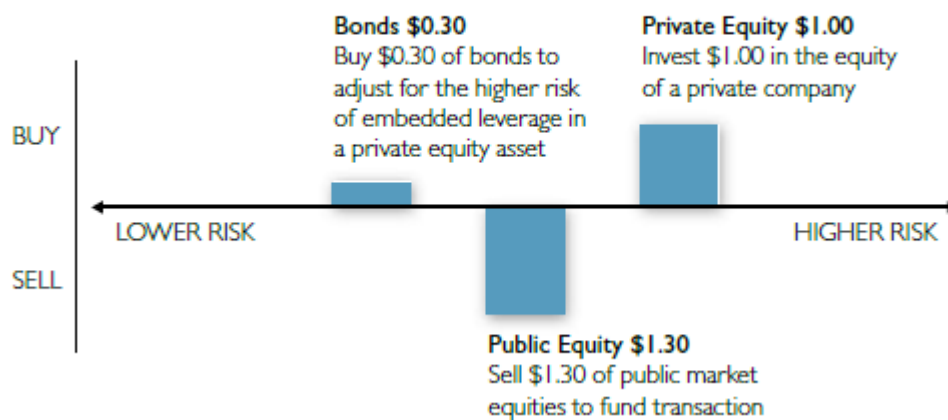
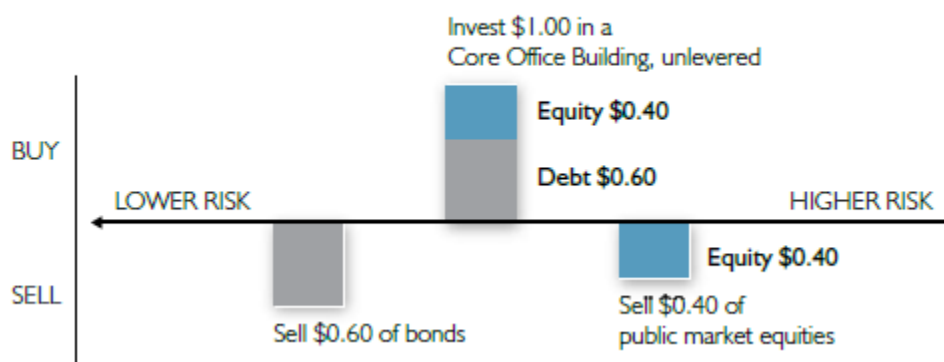
Figure 14.5**Panel A****FUNDING A PRIVATE EQUITY TRANSACTION USING THE TOTAL PORTFOLIO APPROACH****Panel B****FUNDING A REAL ESTATE TRANSACTION USING THE TOTAL PORTFOLIO APPROACH**

Figure 14.5**Panel C**

AS AT MARCH 31, 2013		Asset Mix		Exposure Mix	
ASSET CLASS	(\$ billions)	(%)	(\$ billions)	(%)	
CANADIAN EQUITIES	15.3	8.4%	17.6	9.6%	
Public	13.1	7.2%			
Private	2.2	1.2%			
FOREIGN DEVELOPED MARKET EQUITIES	64.0	34.9%	89.4	48.7%	
Public	35.4	19.3%			
Private	28.6	15.6%			
EMERGING MARKET EQUITIES	12.4	6.7%	12.1	6.6%	
Public	10.6	5.7%			
Private	1.8	1.0%			
FIXED INCOME	60.7	33.1%	53.2	29.0%	
Non-marketable bonds	24.4	13.3%			
Marketable bonds	28.1	15.3%			
Inflation-linked bonds	0.4	0.2%			
Other debt	8.6	4.7%			
Money markets and debt financing	(0.8)	-0.4%			
FOREIGN SOVEREIGN BONDS	—	0.0%	11.2	6.1%	
REAL ASSETS	31.1	16.9%			
Real estate	19.9	10.8%			
Infrastructure	11.2	6.1%			
TOTAL¹	183.5	100.0%	183.5	100.0%	

¹ Excludes non-investment assets such as premises and equipment and non-investment liabilities.

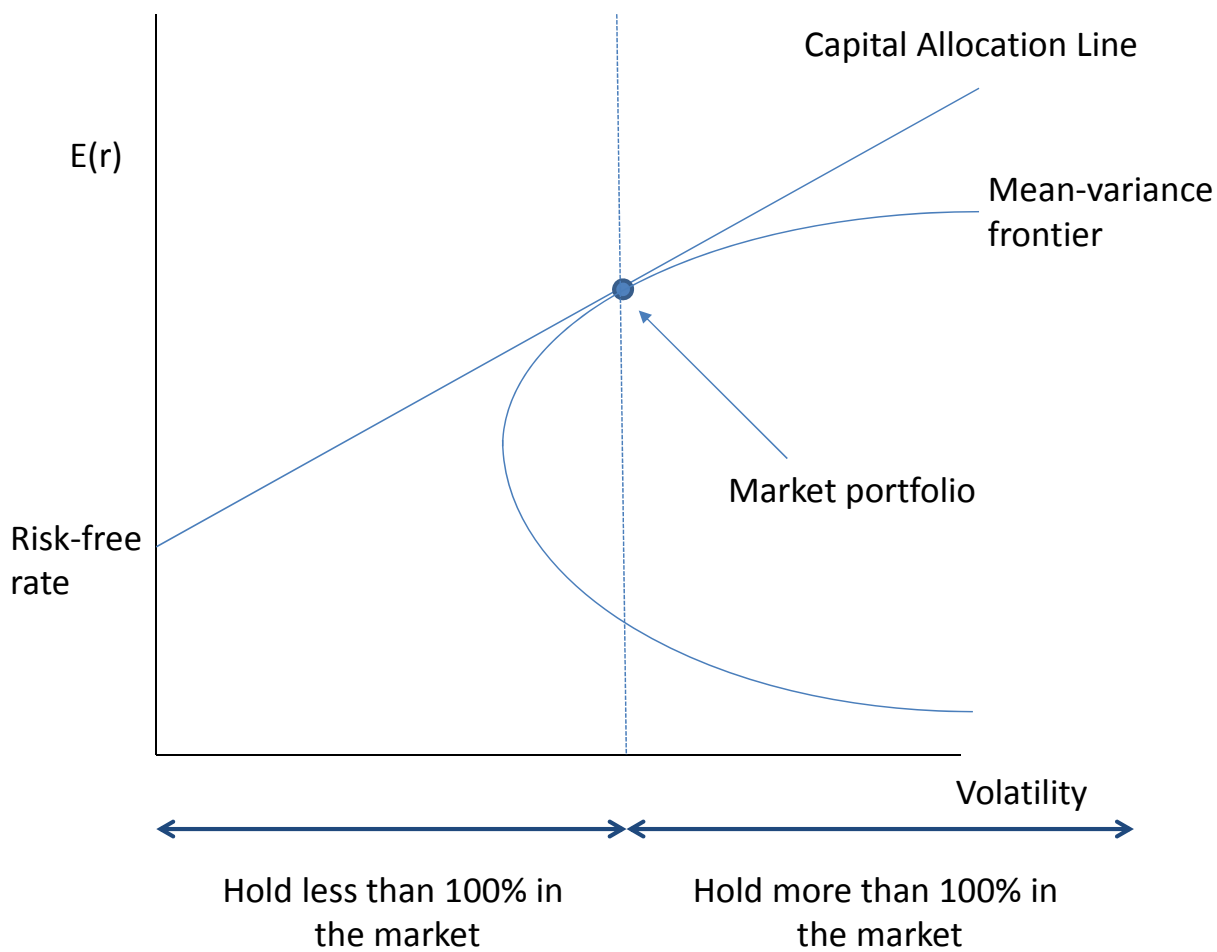
Figure 14.6

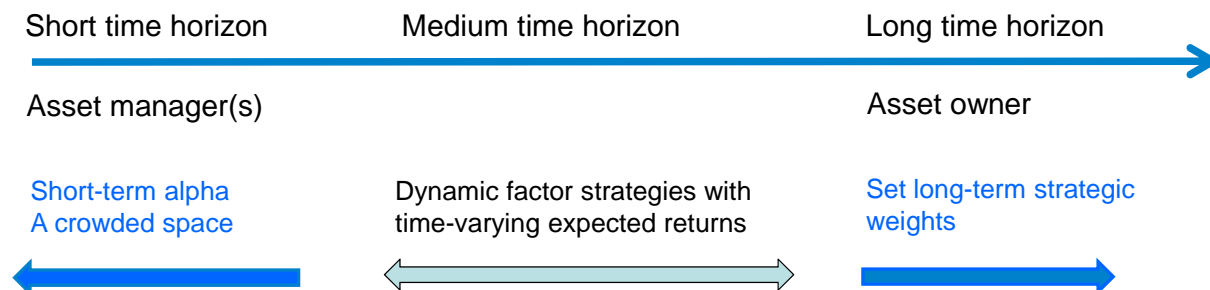
Figure 14.7

Figure 14.8

Bridgewater's All Weather Strategy

	GROWTH	INFLATION
RISING	25% of Risk <ul style="list-style-type: none">• Equities• Corporate Spreads• Commodities• EM Debt Spreads	25% of Risk <ul style="list-style-type: none">• Inflation-Linked Bonds• Commodities• EM Debt Spreads
FALLING	25% of Risk <ul style="list-style-type: none">• Nominal Bonds• Inflation-Linked Bonds	25% of Risk <ul style="list-style-type: none">• Nominal Bonds• Equities

Table 14.9**Alaska Permanent Fund Asset Allocation at April 2012**

Asset Class	Weights	Comment
Cash	2%	Aim: To meet expected liabilities and manage liquidity needs from rebalancing
Interest Rates	6%	Examples: Safe sovereign bonds Aim: To provide insurance against severe equity market correlations and to provide high liquidity
Company Exposure	55%	Examples: Global equities, corporate bonds, bank loans, private equity Aim: Benefit from times of growth and prosperity
Real Assets	19%	Examples: Real bonds, real estate, infrastructure Aim: Hedge inflation risk
Special Opportunities	18%	Examples: Absolute and real return mandates, emerging markets, distressed debt Aim: Take advantage of special investment opportunities The allocation is not fixed, and the allocation not invested resides in the company exposure risk class

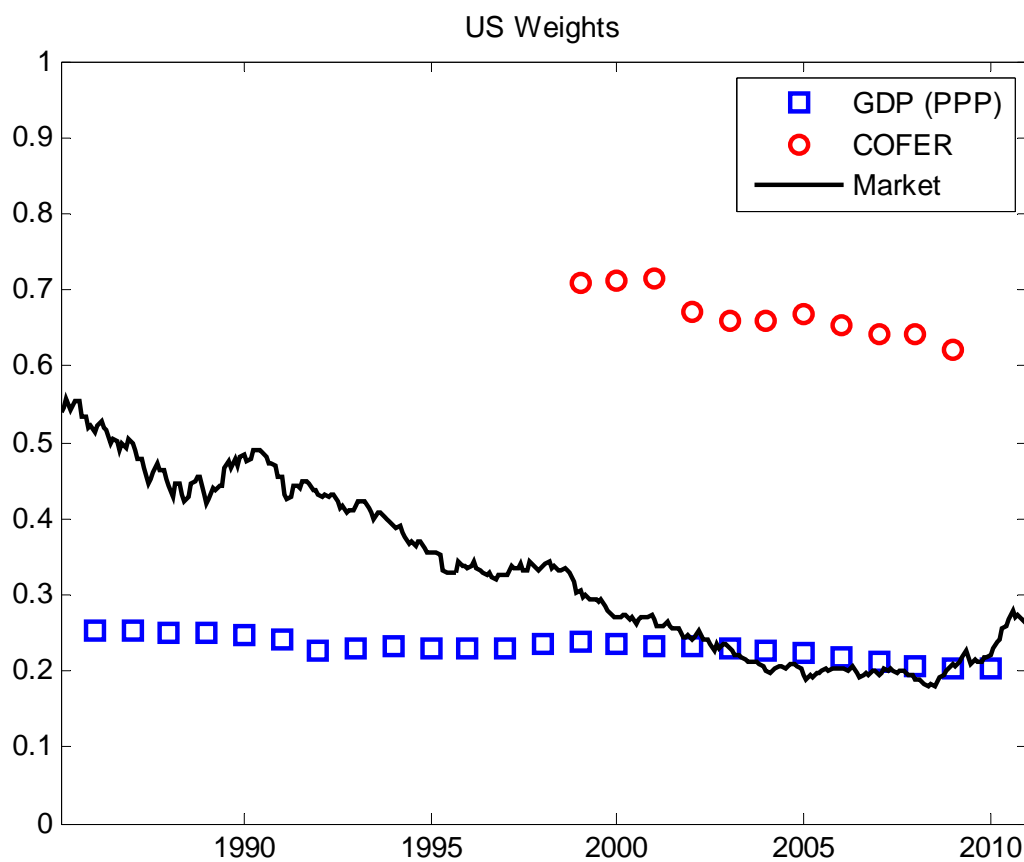
Figure 14.10**Panel A**

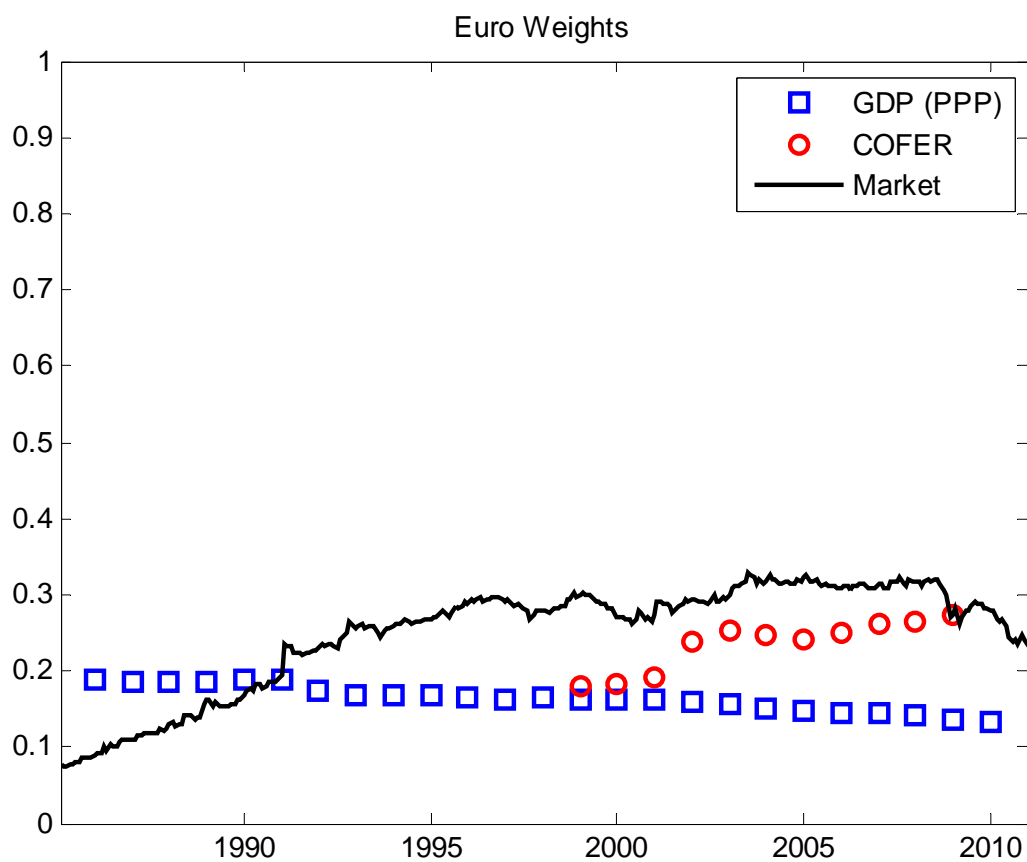
Figure 14.10**Panel B**

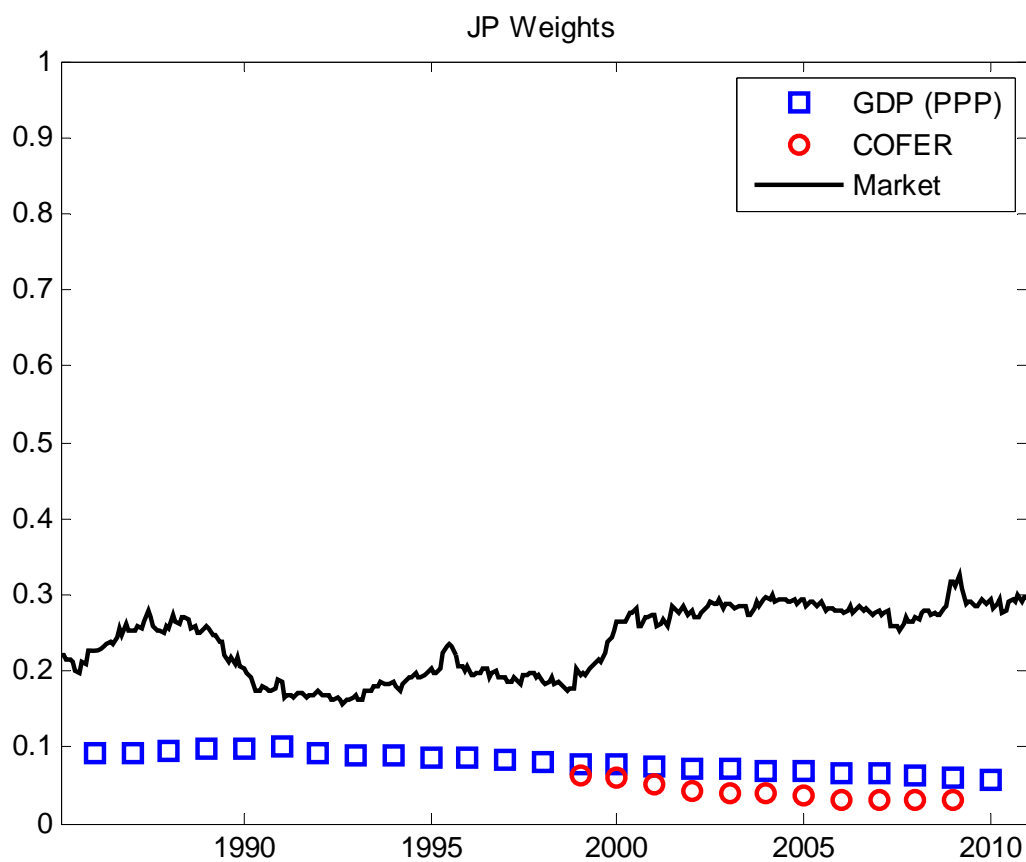
Figure 14.10**Panel C**

Table 14.11**Panel A****Predictive Regressions of Sovereign Bond Returns**

	1990-2010			2007-2010	
	Beta	t-stat		Beta	t-stat
Real GDP growth	0.573	1.24		1.530	1.64
Nominal GDP per capita USD	-0.945	-2.16		0.927	0.98
GDP (PPP)	-0.603	-1.48		0.098	0.10
GDP (PPP) per capita	-0.451	-1.01		1.181	1.26
GDP (PPP) share of world	-0.604	-1.48		0.098	0.10
Inflation rate	1.864	3.79		0.832	0.88
Unemployment rate	0.041	0.09		-1.960	-2.12
Govt expenditure/GDP	-0.157	-0.34		-2.347	-2.57
Govt net lending/borrowing/GDP	1.364	2.74		2.316	2.54
Govt net debt/GDP	-0.899	-1.92		-1.726	-1.79
Govt gross debt/GDP	-0.692	-1.60		-0.616	-0.65
Current a/c/GDP	0.294	0.64		1.780	1.92

Figure 14.11**Panel B**

		1990-2010				2007-2010		
	Sign	Mean	Std	Raw SR		Mean	Std	Raw SR
Real GDP growth	+	7.58	7.31	1.04		6.87	3.83	1.79
Nominal GDP per capita USD	-	7.80	7.92	0.98		6.42	4.45	1.44
GDP (PPP)	-	7.99	8.61	0.93		6.67	3.58	1.86
GDP (PPP) per capita	-	7.64	8.27	0.92		6.33	4.26	1.49
GDP (PPP) share of world	-	7.99	8.60	0.93		6.70	3.54	1.89
Inflation rate	+	7.97	7.89	1.01		6.59	3.58	1.84
Unemployment rate	+	7.43	7.87	0.94		6.14	4.47	1.37
Govt expenditure/GDP	-	5.41	5.88	0.92		7.31	3.77	1.94
Govt net lending/borrowing/GDP	+	5.72	6.66	0.86		7.01	3.67	1.91
Govt net debt/GDP	-	7.16	7.05	1.02		6.81	3.25	2.09
Govt gross debt/GDP	-	7.27	7.14	1.02		6.96	3.01	2.31
Current a/c/GDP	+	7.58	7.64	0.99		6.77	4.31	1.57
Market		7.35	7.49	0.98		6.47	4.10	1.58
GDP weighted		7.63	6.84	1.11		6.31	3.64	1.73
Mktcap/GDP weighted		7.23	6.04	1.20		6.55	6.59	0.99

Figure 14.12