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Long-term market outlook

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Contents

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This Market Report will establish a set of investment beliefs for the 15 year horizon we shall be using in the ensuing Portfolio Reports, for the "Government Pension Fund – Global" and the "Foreign Reserves", respectively.

The first chapter presents three alternative scenarios for the world economy. The scenario that we consider to be most likely will be the basis of most of our market analysis. The two other scenarios are less likely, but include some of the major downside risks to the market returns. These scenarios will be used for stress-testing our recommendations of asset allocation in the ensuing Portfolio Reports.

The developments described in the scenarios will represent the macroeconomic environment, or state of the world, on which the expected returns and volatilities in the global capital markets are conditioned. The different asset classes and their co-variation will be discussed separately in chapters 2-7.

Chapter 2 briefly considers the foreign exchange markets, where our long term assumption will be one of no expected changes. But we will discuss some major risk factors.

Chapter 3 establishes the covariance matrix that we shall be using in the Portfolio Reports. We use both yearly and monthly data to extract reasonable estimates for our 15 year horizon. We find only a modest horizon effect on the estimates.

Chapters 4 and 5 discuss the expected returns in fixed income and equity, which are the two asset classes where the Pension Fund and the Foreign Reserves are currently invested. Our underlying assumption is that the pricing in these markets will tend to revert to a long term mean level. In these chapters we pay special attention to the small cap equity segment and to the high yield fixed income segment, to assess whether these two segments should be included in the benchmark portfolio.

Chapters 6 and 7 discuss private equity, real estate and infrastructure, which are asset classes where neither the Pension Fund nor the Reserves are currently not invested. The purpose is to establish expected returns and co-variation patterns that will later be used to assess the benefits of including any of these asset classes in the portfolio. Again, the assumption is that the pricing will have some mean reversion properties.

The investment beliefs discussed is this Report will be the basis for our recommendations on asset allocation. That part of the analysis will be presented in separate Portfolio Reports for the Pension Fund and the Foreign Reserves.

1. Long term scenarios for the world economy

1.1. The world economy today

We start the process of building scenarios by discussing the recent trends and imbalances in the world economy. The stronger integration of China, India and Russia into the world economic activity is a particularly important trend that will have far reaching consequences for global inflation, real rates and financial markets. We start by a brief discussion of some themes we think will be very relevant going forward.

1.1.1 Globalisation

The world economy has become more and more globally integrated in recent years. The increasing trade between nations has not been a smooth process, but a process that have had major setbacks during wartimes and during cold wars. The opening of Eastern Europe, China and Russia has recently been a major event in this process. Eastern Europe and China have provided the world with new labour and Russia has opened up its huge natural resource base for the world economy. World trade got an extra boost after the entry of the East European countries into the EU and the accession of China into the WTO.

China in particular is building its industrial capacity in a ferocious way. China is investing about 40% of its total income into new infrastructure and new production capacity every year. This is possible because households in China have to save much of their income for lack of a proper welfare system. Industrial production in China has been increasing at an annual rate of 15 % and exports at a rate of 25% for several years. China is today the third largest exporter in the world, surpassed only by the US and Germany, but larger than Japan. China is the world's largest producer and exporter of clothes, shoes, toys, sporting goods, and household appliances. About eighty percent of all clothes sold in Japan are produced in China. More than half of world production of electronic goods is produced in China and Taiwan. India is becoming more important as an outsourcing destination for services. Call centres and software development are increasingly being outsourced to India.

Many US, European and Japanese companies have built capacity in China for export to the west. We have seen a change in this pattern in the last years as China is becoming more and more important as an end market for cars, mobile phones and other products. Some western companies are now building plants to supply the domestic market in China. Other Western companies like WalMart, H&M and IKEA are not producing themselves in China and Eastern Europe, but are buying a lot of goods on orders from local manufacturers. If WalMart was a country it would be the seventh largest export destination for Chinese goods.

1.1.2 Inflation.

Import price inflation in most developed countries has been very low compared with inflation on domestic goods and services. Prices on electronics and apparel have fallen a lot due to lower tariffs on Chinese exports after the entry of China into the WTO. Prices on other products from furniture to hand-tools are also under price pressure from Chinese producers. The downward trend in import prices on goods has been extra strong in countries with much foreign trade as a percent of GDP and in countries that have seen their currencies appreciating against the USD.

The fall in prices of goods has been possible for two reasons. Productivity in China is growing at an annual rate of about 10% and wage growth has been in the same range. This means that unit price growth on Chinese goods is around zero. Combined with low absolute wages and a currency pegged to the USD, this has made Chinese products very competitive on the global markets. The disinflationary effects in developed countries are mainly due to the substitution effect, viz. that cheap Chinese goods are taking market share from local producers. The US and the Scandinavian countries were very early at exploiting the new opportunities of cheap production in Eastern Europe and in Asia. The trend of outsourcing began at the labour intensive part of the product spectrum, but is now rapidly spreading into more advanced goods.

Another important factor for consumer price inflation has been the fall in telecommunication prices and the fall in airline fares. The global fall in telecommunication prices is mainly a result of the rapid technological progress in this sector. As more functionality is getting digitalized in a network with steadily increasing capacity, more and more services will fall in price. Some services that historically have been produced locally in the UK and in the US have been outsourced to India recently, but the effect of this has not been large enough to affect the general inflation level in these two countries.

The low inflation on imported products has improved consumers' purchasing power as nominal wage growth has been quite stable in most western economies. More competition from Asia and Eastern Europe, both in the products and in the labour markets, has kept down wage inflation in western countries. Wage growth in sectors like construction, lodging and other low skilled sectors has been held down by immigration.

Strong demand for energy and metals in Asia has pushed up global prices for such products. Strong demand from China is behind nearly all additional demand for metals and at least 30% of the growth in oil demand in recent years. Strong construction activity and high consumer demand in the US are behind another 20% to 30% of the increase in oil demand. This has changed relative global prices substantially. Terms of trade for oil and metal exporters like Norway, Russia, Brazil and the oil exporters in the Middle East have improved dramatically in line with more demand for oil and metals from China, while terms of trade for China and other manufactured goods exporting economies has deteriorated.

1.1.3 Trade imbalances

The introduction of China and other countries into the world trade exchange has created huge trade imbalances. Most striking is the trade deficit in the US, which adds up to approximately 7% of GDP. Nearly every other nation in the world has a trade surplus with the US. It is worrying that the trade deficit does not yet seem to have stabilized. Several explanations for the increasing trade deficit have been launched. A strong USD is one explanation; excessive consumer demand in the US relative to its trade partners is another. There is also a more structural explanation behind the growing trade deficit. Companies in the US has been the most aggressive to take advantage of cheaper locations for manufacturing, be that in Mexico or in Asia. This process will go on as long as these countries are willing to trade manufactured goods against USD financial assets.

We believe that the trade deficit is mainly structural in nature, but excelled by strong relative demand in the US. US companies have been early movers when it comes to exploiting new business opportunities world wide. The US has been, and still is, a melting pot where students from China, India and other countries meet in schools and in universities. This has created an environment where ideas and business opportunities are spreading fast on a global basis. It is easy for US companies to find highly skilled Chinese speaking people that could help them setting up a factory in Taiwan or in mainland China. It should not be much of a surprise to see

US companies outsourcing production of electronics to Taiwan or China or car production to Mexico and Canada. Nor should it be surprising to see American and UK banks setting up call centres as well as software development in India.

German and Scandinavian companies have been just as fast to exploit the possibilities in Eastern Europe as their US and Japanese counterparts in Latin America and in Asia. The power balance between labour unions and companies has changed dramatically in this process, particular in Germany. German workers have to work longer days for less pay than just a few years ago. This has of course improved German competitiveness significantly. This improvement has lead to huge internal trade surpluses against for example Italy and Spain. Large internal imbalances are creating frictions within the European Union. Part of the frictions stems from the fact that many countries have not yet got control over fiscal spending. This is particularly a problem in Greece, Portugal and Italy.

1.1.4 Financial imbalances

We have already mentioned the huge trade deficit in the US. The counterpart to this is trade and payment surpluses in Japan, China, OPEC, Russia and in some EU countries. Japan has pursued a currency policy that partly aims to help a weak domestic economy through a stable exchange rate. The government has aimed at keeping their currency cheap by selling JPY against USD over time. That has resulted in steadily increasing foreign exchange reserves in Japan. Most of the reserves have been invested in US Treasury bill and bonds. Other countries in Asia have also been piling up reserves in recent years. This is partly a consequence of huge trade surpluses and partly a consequence of a huge inflow of money into the region. This inflow has been particularly strong in China where international companies have sold USD for CNY to build new factories, to buy stakes in Chinese companies or to buy real estate. India has seen a lot of foreign money mainly coming into the local stock market. Almost all foreign money in China is in the end directed into the central bank of China, because this is the only player that is allowed to keep huge amounts of foreign currency. The foreign direct investments (FDI) as well as speculative money that flows into China is in this way eventually transformed into low risk US Treasury bonds owned by the central bank in China.

Oil exporters are also getting more eager to save some of their recent huge oil revenues. In contrast to the seventies and the eighties they are now investing excess oil revenues into international bonds and stocks. International investors have bought more than the total net issuance of US Treasury bonds from the year 2000 despite the huge swing in public finances in the US from a surplus to a deficit. The huge inflow of money to the US has been more than enough to finance the ever growing trade deficit. Moreover, the inflow has been strong enough to push bond yields down to what many observers have seen as extreme low levels in recent years.

1.2. The scenarios

We choose to present only three scenarios, mainly characterised by different inflation levels, different levels of GDP growth and different (conditional) natural real interest rate levels in the next 10-15 years. We assume gradual convergence from today’s levels into states characterised by different levels of inflation, interest rates, and GDP growth. These states are not new equilibriums, but temporary plateaus before a normalisation beyond our 15 year horizon.

In general both current and expected inflation levels, as well as the output gap will be important for the level of future policy rates set by the central banks. The real rates, measured as the nominal policy rate minus current inflation, will be higher the higher the difference between current inflation and the central banks' inflation targets. Real policy rates will rise even more if the activity in the economy is higher than what is considered the trend growth by central banks. The Taylor rule is putting this into a more formalized framework by quantifying the factor loadings in this relationship. Real policy rates should equal the natural real rate as long as inflation is well behaved, and the economy is growing along the trend line. By a well behaved inflation we mean that the current inflation is oscillating around a trend of for example 2.5%. An inflation of 2.5% and a trend growth of 2.5% are often seen as an ultimate equilibrium where the economy could remain in the absence of external shocks.

This concept of equilibrium is narrow in the sense that it puts more emphasis on core CPI stability and trend growth in GDP than on other economic variables like credit growth or asset prices. Non sustainable trends in international trade, in credit expansion, and in stock markets and house prices seem to be at least partly neglected in these theoretical equilibrium considerations. An alternative theoretical framework assumes that the economy is in constant disequilibrium. New technology, new regulations and trade patterns are among variables that change the way the global economy is working from year to year.

Figure 1.1 exposes the traditional framework for central bank policy. Inflation as well as growth could be too high in a period due to external shocks, for example if fiscal policy has been to loose, or after a period of a weaker currency. The central bank will raise real rates and bring inflation and real growth back to the desired growth rates of for example 2.5%. The central hypothesis is that central banks can manoeuvre the economy towards to the (red) equilibrium point in the chart below. Central banks will raise real rates if inflation is too high and lower them if inflation is too low. This is actually a quite strong assumption as we will discuss in more detail.

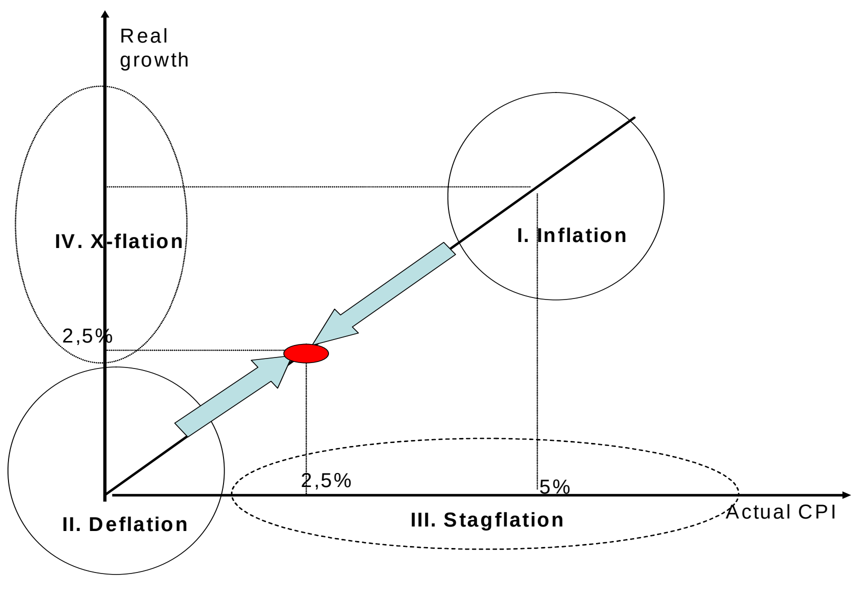


Figure 1.1: Visualizing the Taylor rule for central bank policy**.**

The strong forces of globalisation have made many economists ask if the world economy is now drifting away from the red point and to the left towards the Y- axis. We have called this area (marked as IV) X-flation. If this is correct the world economy is moving into a situation of “good deflation” in the sense that we do not have to worry about low inflation as long as the economy is growing rapidly without creating too many imbalances. The economists who suggest that we are going in this direction are pointing to the fact that a lot of new labour resources will continue to come into the global economy after the opening up of India, China and the Eastern Europe. This could therefore be seen as a prolonged supply shock of cheap labour and natural resources into the world economy.

The world has gone through several phases of high inflation and low inflation. There has been a close relationship between the level of inflation and the level of economic growth. The first decade of the 20th century was a period of strong growth and low inflation. Inflation did rise during the first and second world wars and in the seventies. Inflation is basically associated with excessive demand for scarce resources.

High growth and especially high investment growth would normally put downward pressures on prices and upward pressures on real interest rates. The real interest rate can be thought of as the price of savings that equals financial savings and investments in a market economy. The more investment that is needed, the higher must the real interest rate be for the consumers to save sufficiently. But savings may also be a function of some more basic needs, for instance to provide oneself and one’s family with education, health care and pensions. In some economies people have to save first in order to be allowed to borrow from banks. A lot of the saving in the world today is not determined by real interest rates, but by excess oil revenues in some countries, and the lack of a safety net in others.

We believe that we may be approaching a two speed world, with slow growth in the US, Europe and in Japan and fast growth in Russia, Asia and Latin America. In theory real interest rates should be determined by the global investment level. In reality the global policy rate is probably mostly determined by the US Federal Reserve. Furthermore, the international bond market is dominated by issues from the developed countries. We should thus focus mostly on factors that could bring future real interest rates up or down in the developed world.

We know that GDP growth is likely to be lower in the next 10 to 15 years because employment and hours worked will fall. We can not know if inflation will fall in the developed world as a consequence of lower growth. Inflation on goods could fall, but inflation on health care and other services could rise. If investment in new production capacity takes place in the fast growing developing part of the world economy, western central banks will worry less about keeping real interest rates low. This is exactly what we have seen in the latest years. Real interest rates have been low in the sense that households have saved too little and consumed too much. Consumption of housing services has been particularly strong. Central banks tend to set real policy rates as low as possible without creating inflation. There is a possibility that real rates will continue to stay low, given that the saving for investment constraint stays out of the policy equation.

The balance between investments and consumption in developing countries is a crucial determinant of whether the opening of these countries will be inflationary or deflationary for the world economy. A combination of rapidly falling prices for capital equipment and strong investments in new capacity in China, at the same time as consumption in China has been held down by a weak welfare system, has created an export surplus and a pressure on world prices for the products China are producing. Productivity is important in this context. Labour productivity growth in the production of goods is running at more than 10% in China due to learning, and the emergence of larger production entities. An increasing specialisation in world trade, where China is producing cheap consumer goods and the more advanced economies are producing capital goods, could potentially lead to strong global growth combined with low inflation. The lower global product inflation could dampen nominal wages in the service sectors of the developed economies. If one adds to this the fact that central banks have recently flooded the global financial system with low price credit, one can potentially get even lower inflation rates as credit growth slows in the future.

If global house prices and credit growth were to fall in the coming years, we could be faced with the negative effects of globalisation. Labour markets and investment activity in the developed countries could deteriorate as China and India are exporting more and more advanced products in the years to come. Japan in the seventies and early eighties was a in a similar position as China is today. The US industry got a competitive shock as Japan penetrated the market for cars, motorcycles, and electronics. If the recent strong growth in the world economy has indeed been a result of unsustainable growth in house prices and credit, we could expect total growth in world consumption and investment to cool off. More consumer demand from China and India could still help keeping world economic growth strong, but most analysts believe that these countries are too dependent on export demand to be able to play this role. More details about this negative scenario will be given below.

We have also constructed a stagflation scenario for the developed world. Stagflation is characterized by low growth and high inflation. We assume that real policy rates would be kept high in an environment like this. Central banks would worry about inflation despite low growth and try their best to bring down the unintended inflation, in order to retain their credibility in the financial markets.

In the stagflation scenario we assume that global inflation rates will rise to a level of 7% within our 15 years horizon. In the deflationary scenario we assume that it will fall to -1%. These inflation levels are taken to represent less likely, but not extreme scenarios.

Extensive academic research suggest that the level and volatility of inflation and real economic growth are the most important factors behind real returns on stocks, bonds, real estate and other financial assets. Periods of high inflation has been associated with high volatility in the inflation rate, while low inflation at least in the post WW2 period has been linked to periods with low volatility. Volatility in real economic growth seems to follow the inflation volatility cycles. This should not be much of a surprise because changes in inflation are often related to real shocks, like wars, and supply shortfalls for energy and other raw materials. An increase in the inflation volatility, or in real growth volatility, will tend to increase risk premiums in the bond market as well as in equity markets. Real estate and credit spreads would also be affected negatively by increased volatility.

In addition to the volatility effect that makes it difficult for companies to plan for the future, there will be an important effect on financial asset markets from the real policy rates. As inflation and volatility rises, central banks would normally respond by raising real interest rates. Higher real policy rates will lift real bond yields and hurt the stock market through higher real cost of equity. A higher real bond yield could also be considered as a higher alternative cost for all other financial assets.

We propose to split the world into the developing world and the developed world when we build the scenarios. We know that the labour force will decline in developing countries and grow rapidly in the developing part of the world. Economic growth will slow in the developed part of the world as hours worked will decline in the future**.** Growth in developing markets will most likely continue to be higher than in developed countries. This split of the world economy is very important, because expected real rates and expected real return in stocks will not only depend on the total growth in the world economy, but on the combination of growth in the two parts we have defined. Almost all market capitalization in the global stock market is in developed world countries. A lot of that value is related to economic activity in the developing part of the world.

There are different factors behind profit levels in different segments of the global stock market. Oil companies and companies in the resource and chemical sector mainly depend on the world demand for building materials and for transportation. We know that it is mainly growth in the developing world that push demand for these goods upwards today and will do so tomorrow as well. The situation in the banking and health care sector is very different. The aging of the population in the developed part of the world is the most important demand and profit driver for the health care and pharmaceutical companies. Credit growth in developing countries is one very important factor behind profit in the global financial sector.

Standard economic theory suggests that expected global real interest rates depend on expected global growth. This standard result could be different in a world that have been exposed to a huge labour supply shock, and in fact have just one global currency. In recent years global real interest rates have been very low despite strong global growth. One explanation for this could be that Federal Reserve is the dominant central bank in the world and that global real rates are determined by the policy of the Fed. Global real interest rates could then be low in a situation where global growth is high if US growth is low. Low economic growth in the US could in fact trigger both lower global real rates and higher growth globally.

The table below sums up the some of the possible combinations of trend growth and trend inflation in a world characterized by two economic regions. Every combination of trend growth and CPI in the developed world and in the developing part of the world are in principle possible at the same time, but some of them are less likely.

Combinations of high and low growth and inflation in a world of two economic regions:

Trend Growth GDP			Trend CPI	
Developed	**Developing**		**Developed**	**Developing**
Low	Low		High	High
Low	Low		High	Low
Low	Low		Low	High
Low	*Low*		*Low*	*Low*
.	.		.	.
.	.		.	.

Our deflation scenario is focused on low growth and low inflation in the developed world, but not necessarily in the developing world. The scenario can thus be thought of as a combination of the following four scenarios for the whole world economy; (**Low, Low**, High, High) (**Low**, **Low,** High, Low) **(Low, Low**, Low, High) and (**Low**, **Low**, Low, Low). The main reason why we emphasize this is the fact that growth and CPI in the developed world will matter most for the return in financial markets. A prolonged period of low growth in one region only is more likely than the same number of years of low growth for the total world economy. Growth in Japan has for example been low in the nineties at the same time as the growth in the rest of the developed world was strong.

The outlook for returns in the stock market will in general be a mix of the outlook for each of the two parts of the world economy, but probably biased towards the level of growth in developed markets. But the really interesting question is what level of real yield we can expect in an international bond portfolio, given our two world model. Lower growth in developed economies combined with an aging population could put more pressure on public finances. This effect should *ceteris paribus* push up real rates. But another outcome may be just as likely. More global trade has historically led to higher efficiency in the production of goods. We believe that the integration of China and India into the world economy will work the same way as when Japan, Korea and Taiwan were integrated in the seventies and the eighties.

The world may enter a period with strong growth in developing countries at the same time as developed countries will experience an even lower growth than we have seen the latest ten years. The average growth in the world economy may remain at an historical average at the same time as growth in the developed world is slowing down. The inclusion of China and India may hold global inflation at a low and stable level. This is our base scenario. It is possible that central banks in the developed world will react to the slowing trend growth by lowering real policy rates, given a low and stable global inflation. We will discuss this and other possibilities under the different scenarios.

1.2.1. The base scenario

Our main long term scenario is essentially an extension of the last ten years' average level of global inflation, global average real growth, and the global average real short interest rate. The real policy rates and risk premiums are based on historical risk premiums and the premiums we otherwise find reasonable given the conditions described for the base scenario. We expect a continuation of a low inflation within a band around the 2% level targeted by the major central banks, and a continuation of a trend growth for the world economy as a whole. We believe that the base scenario represents the most likely development for the world economy and financial markets in the next 15 years.

The main assumptions under this scenario are as follows:

- No major world wide pandemics or conflicts between the major nations.
- Stability in world trade: We will not have any cut offs in the supply to the world markets of energy, metal, food or any other important products.
- Stability in fiscal and monetary policy in the main countries / regions in the world: Fiscal spending will increase in tandem with global GDP growth. We also assume that real policy interest rates will be kept in the 2% range.
- The trade imbalances between the US and the rest of the world will be resolved through less consumption demand in the US, and a weaker US dollar against Asian currencies in particular.
- A normalisation of house prices through lower real house price inflation than real wage growth the next 15 years.

We believe that the global housing market is priced above its long term equilibrium, but also that the Federal Reserve and the ECB will be able to manage the adjustment to a new balance by setting appropriate policy rates. This will probably put some downward pressures on real interest rates in the US and in the rest of the world. We assume a soft landing for house prices, meaning that real appreciation in house prices will be low for the next 10 to 15 years. Lower house price inflation should increase the saving rate for households in the US. This is one of the main factors behind our expectation of lower consumption growth in the US. The other main factor that will work for lower growth is that employment growth will decline in the years to come, due to less immigration and less population growth.

Lower consumption growth in the US will lead to lower investments, particularly in real estate. General business investment could be held up by strong global demand and a weaker USD. We assume that real GDP growth will be around 2.5% or below the next 15 years, in stead of the 3% we have seen the last 10-15 years, both due to less population growth and to the correction of the household imbalances. Fiscal policy in the US is assumed to stay relatively loose and there is a risk of an even looser policy the next 15 years as growth dampens down. We expect the US trade deficit to stabilise beneath today's level.

Labour productivity growth (output per hour) in the US, Japan and the Euro Zone has been around 1.75% to 2% historically. We expect real GDP growth to be slightly lower in Europe than in the US. A growth rate of 1.75% is about 0.5% lower than the average growth rate the last 10 years. The main reasons for the expected growth difference between the US and Europe is the lower population growth in Europe. Immigration into Western Europe has been high in recent years and could offset the negative future demographics in the graph below. We expect the reversion of house prices and saving rates to have less impact on expected growth in Europe than in the US, because saving rates are a lot higher in Europe than in the US.

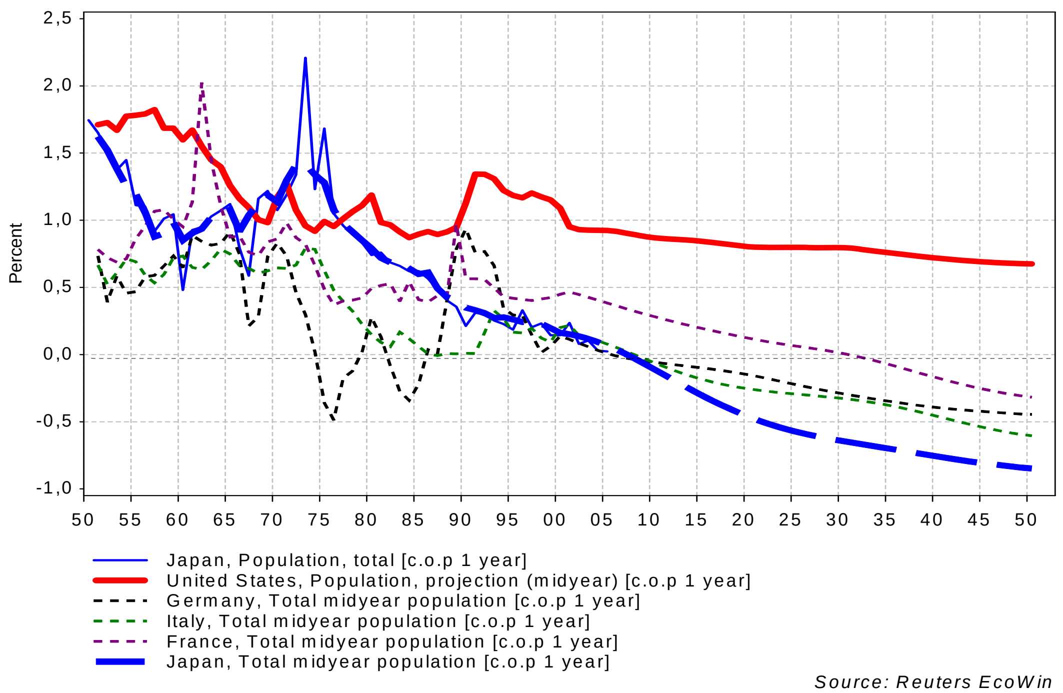


Figure 1.2: Paths of population growth 1950-2050 in the major countries

In Japan we do not expect immigration to grow by much. We expect real growth in Japan to be 1.5%, in line with growth the last 10 years, despite the fact that Japan will have the lowest population growth the next 10 to 15 years. We do not expect house prices in Japan to fall further in real terms. House price inflation should therefore be a positive stimulus to the Japanese economy in the future. We also believe that Japan will benefit from more trade with the rest of Asia as that region continues to grow strongly.

We expect the economies outside the US, Japan and Europe to grow faster, perhaps by as much as 6%. This means that we are optimistic on growth in Russia, India, Brazil and China. China has been growing by 10% real the latest 10 years. We expect this growth to slow down as the economy in China matures.

The expected inflation in the main regions should be in line with the expected differences in growth, i.e. somewhat higher in the US than in Europe. This is also partly based on historical performance, where inflation in the US tends to be higher than in Europe. We expect the USD to weaken more than the EUR against the Asian currencies. This should put some pressure on US inflation through higher import prices, and probably some downward pressures on US growth as well, at least for a few years. The outsourcing process is on the other hand more advanced in the US than in Europe. This means that it could be more room for substituting local goods with imported goods in the US in the years to come.

We expect inflation in Japan to stay close to its historical zero range and only slowly move towards the global average level of 2%. The argument is similar to the one we used for Europe. We expect inflation in the major emerging markets to be in the 4% range. This is based on our belief that China and India in particular will grow strongly and that food, energy and metal price inflation will stay high or even rise further from today's levels.

1.2.2. A deflationary scenario

We base the discussion on all scenarios on the assumption that the world economy could be split into two parts, one mature with slow growth and one vibrant with high growth. GDP growth in each region will depend on growth in hours worked, on capital deepening and on general learning. Learning as well as capital deepening and future growth in hours worked is low in the mature part of the world, but very high in the developing part of the world.

We know that exogenous shocks will have an impact on inflation and growth as well as on returns in the stock and bond markets. In the base scenario we assumed that we shall have no major shocks and that that today's imbalances will be contained.

Our deflation scenario is linked to the emergence of negative shocks to the world economy, as well as to policy mistakes. Today's high house prices in the developed world have the potential to produce that kind of shocks. Imbalances in house prices will take longer time to correct in a low inflation environment, and a correction could take as long as 10 to 15 years.

Sustained high oil and metal prices could be a burden for oil importers. But we do not believe that high raw material prices will be as important to world growth as they were in the seventies. Higher oil prices could actually put downward pressure on real rates through the savings of revenues to oil exporters. This argument will therefore be downplayed in the deflation scenario.

Central bank policy could worsen the deflationary pressure after a correction in the house market. A likely response from the Fed to a sustained period of lower growth and inflation would be to hold real interest rates very low. Low real rates in US would easily spread to countries in Asia and lead to more activity and more production capacity. Low growth in the US could actually lead to an increase in global production capacity, which may not be sustainable in the long run. An overproduction problem in China or in Asia in general could in the next round put downward pressure on world economic growth, as well as on global inflation. A combination of more savings in the US and overproduction in China could put downward pressure on global price levels for a long time period.

A lot of attention has in recent years been paid to the risk of the global economy going into deflation. The classical reasoning says that a shock to the economy could trigger a retrenchment of consumption and investment. The Fed did worry that the burst of the stock market bubble in combination with the 9/11 terrorist assaults could be such an event. Policy interest rates were lowered to record lows as a precautionary measure, but we know by now that this was not the event that brought the world economy into deflation and recession. Japan, Hong Kong, Switzerland and Germany have all suffered from low inflation and low consumer demand after bubbles in their real estate markets. The combination of a weak banking system and falling house prices has historically been a toxic recipe for deflation and low GDP growth.

The extraordinary surge in real house prices and the high rates of investment in housing in recent years in the US in particular could thus be the right mixture for a new deflationary period. We believe that the combination of higher energy prices, higher prices on building materials, a huge supply of new unsold houses and higher interest rates will have the potential to trigger a prolonged period of adjustments to more saving and less borrowing and spending in the household sector. Real house price inflation has not been particularly strong in the US compared with some other countries, but the speculative behaviour of US households has still been pronounced. A correction in the housing market could therefore be most severe in markets where the building of new houses has been strongest. Spain and the US seem to be most at risk using this criterion.

Reversing the household saving rate from the current -2% in the US to a more normal range of around 5% would take at least 1% off the GDP growth for the next years. Global growth could be hit substantially by such an increase in the saving rate in the US. There would be less demand for Asian consumer goods and probably less demand for oil, metals and machinery. We expect that a major correction of the US savings rate could reduce growth in Europe to below the 1% mark. Inflation could fall to between 0% and -1%, depending on the response in Asia to the reduced demand from the rest of the world. A worst case would be if China reacted by giving their exporters some kind of help to maintain production levels or refused to revalue their currency against the USD. Government intervention could create an overproduction problem that would put more downward pressure on prices globally.

There would also be a risk that countries in Asia and elsewhere start to compete for market shares in the US and in Europe by devaluing their currencies against the each other. This could generate a deflationary environment of the kind we saw after the Asian crisis in the late nineties, or it could even bring the total global trade exchange system to the brink of failure.

How would the major central banks react if the global economy were going into a period of low inflation triggered by more savings in the US? Given our assumption that a crash in the housing market causes the increase in savings, we find it plausible that policy rates will be lowered to a level very close to zero under this scenario. Nominal policy rates at that level mean that real policy rates would be in the range 0-1 per cent. This is in accordance with the Taylor Rule, which predicts low real policy rates in the case of a lower inflation rate or a higher output gap than desired.

It seems reasonable to assume that China will try to encourage domestic consumption in the case of a weaker demand from Europe and the US. Oil and metal prices could stay at high levels given that China is successful in keeping domestic demand strong in this kind of environment. Higher energy, food and other raw material prices could put additional pressures on the US and European consumer and stimulate to even more savings.

There may also be other ways into a scenario of global deflation, where the housing market is not needed as a trigger. Japan and Asia have been putting pressures on many product prices since the Asian crisis in 97/98. If investments in China are too high, China could run into an overcapacity problem like the one we saw in Japan in the nineties. It is possible that an excess capacity situation like this could escape central government control. Local banks or local governments could support their local champions and simply refuse to get rid of excess capacity. If this happened at the same time as supply of labour from the rural areas had an unintentional surge, the downward pressures on wages and production cost could become even stronger.

The consequences for the stock markets if the world economy were to enter a deflationary phase as described above would most likely be quite bad. The financial sector constitutes 30% of the global stock market and it would have a tough time if house prices and credit growth in the household sector were to decline to levels close to zero. Oil companies would see less demand for energy. Companies with strong exposure to consumer demand would probably be hurt. The financial sector would on the other hand be helped by lower real rates in this case. We believe that the equity risk premium will most likely rise under a scenario like this, but real interest rates would probably collapse. Valuation in the stock market would be hurt as a consequence of a higher ERP, but could on the other hand be underpinned by lower level of interest rates.

1.2.3. A stagflation scenario

A high inflation and low growth scenario is more likely in the developed part of the world than in the rest of the world. We do not believe that such events as global energy price inflation or increasing prices for imported goods from China would be sufficient to produce a sustained inflationary pressure. Some other kind of shock to the economy has to strike.

The aging of the population will lead to slower growth in the developed part of the world, but this can hardly be a shock to the economy, because the impulse is well understood and announced. Less immigration or a reversal of recent immigration trends could also put pressure on growth and make labour resources in developed countries scarcer. This has more potential to act as a shock.

Large income inequalities could lead to political pressures of taxing the rich and paying more to the low income domestic sectors. This would be a kind of intended inflationary shock imposed by the government. Huge demand for nursing of the elderly could also be inflationary, especially in combination with less immigration.

A widespread outbreak of the bird flu or some other disease that could not be controlled could lead to lower production, trade and less travelling and immigration. This would be a negative shock to the world production capacity that could generate global inflationary impulses. More workers would be needed for care and less would be available for production.

We have seen only very moderate inflationary pressures in the world economy after the Asian crises in the late nineties. Inflation has mainly been falling since the early eighties. The low inflationary pressures we have seen in the latest 15 years may partly be explained by progress in management and technology, but more importantly by the opening of Russia, China and Eastern Europe to global trade. There is always a possibility that some countries will fall out of the world trade exchange in the future reversing some of the positive inflation factors. But the potential volumes of demand growth are still enormous in these countries, as well as in many other developing countries where many households do not have access to the most basic consumer goods. Demand is held back in these countries by the lack of jobs and the low pay for those who have jobs. Many developing countries have been tempted to increase public expenditures beyond the limits of public finances. Too many jobs in the public sector or high pay rises in this sector will increase demand for products produced in the private sector or imported from producers abroad. China, India and other developing countries will have to balance income growth and employment in the public sector very carefully to avoid this kind of demand driven inflation. These economies are going to get so large during the next 15 years that their inflation rates may have a huge impact on world inflation.

We believe that the investment / consumption balance in developing countries poses one of the biggest risks for more global inflation going forward. China has more people than the US and Europe together. Add India and one gets a dominant part of the world population. These two countries are not yet very important in terms of GDP. Despite this, China is becoming a very important agent in the markets for oil, food, metals, apparel, sporting goods, electronic products and so on. China is probably already more important than the US as a price setter in many global products markets. China and India in particular have an increased potential of becoming a new source of global inflation as they are getting more important in terms of GDP. China is trying to balance an economy that is currently characterized by high investment growth and high household savings. Inflation is kept down by a very high productivity growth. Credit allocation through the banking system is not functioning well. Speculative bubbles are popping up from time to time. The high saving rate in Chinese households are rooted in the lack of a welfare system. The government has a great challenge of improving the welfare system without losing the huge amount of bank deposits. Inflation could rise in an abrupt way if households start to use their savings for consumption. Inflation in China could very rapidly be exported to the rest of the world through export prices.

China is important as a buyer of commodities, but not yet as a buyer of more advanced products, such as software from Microsoft or banking services from Citibank. The additional demand from China has created inflation in crude oil, iron ore, copper, soy beans and freight rates. This is not the kind of inflation that Western governments worry too much about. But increasing commodities and especially food prices have the potential of pushing prices on finished goods upwards.

It is hard to think of a rise in global inflation without a rise in wage inflation, particularly in the western economies. Wage inflation is currently kept down by the outsourcing of production to China and Eastern Europe, as well as by strong labour immigration from Latin America, Asia and Eastern Europe. Immigration to the US has always had a dampening effect on wage inflation in low skilled service jobs, for example in the distribution and the lodging sector. We have seen the same trends in Europe in recent years after the opening of Eastern Europe. Immigration could slow as East Europe and Latin America get richer, or it could slow if jobs are getting harder to find or if governments increase efforts to hunt down illegal immigrants. This could happen because the current level of immigration has made it a sensitive political issue both in the US and in Europe.

Demography is another challenge for the western economies that will need a lot more labour to nurse the elderly in the future. A longer expected lifetime is also putting a burden on public budgets to support more old people. Budgets in the western world could easily go into higher deficits if governments do not come up with sustainable solutions to the greying of the population. Excess public spending in the developed world has historically been a major reason for inflation and could be it again.

Europe could also be a candidate for triggering higher inflation. Many countries are having problems keeping their budget deficits in line with the rules of the EMU stability pact. Some countries also struggle with wage inflation and a loss of export competitiveness. There has already been talk about the long term viability of the EMU project. It is hard to figure out what could be the economic consequences if one or more countries should choose to leave the EMU. There is then an obvious risk that we will get competitive devaluations. This could push the economies into a classical wage-price spiral.

There is also another obvious way global inflation could pick up. We have described how world trade and outsourcing have helped keeping global inflation down despite an expansive monetary policy and rising energy and raw material prices. Inflation could rise substantially if the globalisation process went into reverse. A blockade of China over e.g. the Taiwan dispute would eliminate large supplies to the world market and could lead to scarcity of many consumer goods.

The combination of some or all of the factors mentioned above could push global inflation higher. Higher import prices to Japan, the US and to Europe would dampen consumption growth in these regions. It is possible that the deterioration in terms of trade experienced by China could turn around the next 15 years. This could create more unemployment and lower growth as the world economy adapts to this new situation. This could cause higher global inflation and low growth in the western world at the same time as growth is strong in China and India. This could occur if these countries are climbing the value added ladder faster than is expected today.

Western central banks would probably raise real short policy rates in a situation where inflation is rising continuously over time, even if growth in GDP is lower than the potential. Central banks will tend to acre pre-emptively to avoid the generating a wage and price spiral. The US may be more likely to experience higher inflation than the rest of the world if the USD were to depreciate at the same time as the world went into an inflationary period. Real policy rates could increase to a level well above the historical natural real rate. We believe that 2% is a reasonable estimate for the average short real policy rates under this high inflation and low growth scenario. However, monetary policy is likely to be less effective in this scenario; hence long real rates may stay somewhat higher for a prolonged period.

We have to bear in mind that most of the financial assets are issued in the developed world and the returns depend mainly on economic growth in this part of the world. We could therefore have low growth and poor performance in the main financial markets despite a sound average growth in the world economy. Return on bonds would obviously be hurt by rising inflation and rising nominal bond yields, but real bond returns the next 15 years will also depend on what the average real bond yield would be in the period.

A rising inflation would be bad for equity returns, as a consequence of a likely rise in the ERP (Equity Risk Premium). The worst case for stocks would be if real bond yields went up at the same time as the expected growth in real earnings per share start to fall along with the economy. This would be the kind of combination of real rates and risk premiums we saw in the late seventies /early eighties. A rising ERP by 1% in combination with a 1% rise in long real bond yields, combined with a fall in the estimated real dividend growth from 2% to 1% would be a serious setback for the stock market. According the Gordon's model for valuation of the stock market we could see a 50% fall in stock prices in this kind of environment.

We could get into a period of high inflation, low growth and higher real interest rates if central banks decided to fight an unacceptably high global inflation in a dedicated way. The central bank would presumably only do this if inflation were considered a serious long term problem. A fiscal policy out of control in some main countries could be one source for this kind of inflation. More government spending has historically led to more inflation and higher real rates as demand for scarce savings increase. A combination of higher import prices, energy and food prices and a loose fiscal policy could make the perfect conditions for low growth and a high inflation.

There is a special challenge that global rates to a large extent are set by the US Federal Reserve. Fed will most likely be setting nominal and real interest based on the future conditions in the US economy. If the Fed has to fight an internal inflation problem in the US with high real and nominal rates, this could be a threat to the global growth.

We have pointed to many factors that could lead to a higher inflation and lower growth, especially in the developed world. The main question is in what way central banks and in particularly the Fed will react to a situation like this. We think the most likely outcome will be higher real rates, despite lower growth. It is difficult to estimate how much higher real rates will be. We have put the future inflation as well as the growth pattern into a Taylor formula just to see what policy rates that came out of an exercise like this. A standard Taylor rule gives somewhat higher real policy rates than we shall assume.

1.3. Challenges in the global economy in our three scenarios

We will conclude by briefly discussing how we see the following major issues being resolved or lived with under each scenario.

- A big and increasing US trade deficit
- The consequences of a stabilisation or a fall in global house prices

- Higher global energy and metal prices
- The demographic (pension) problem
- The balance between savings and investment in emerging Asia
- Supply distortions in the global trade patterns. Pandemics, trade frictions, wars, or blockades

This list is not exhaustive but certainly hints at some problems that have to be solved or kept in control.

A big and increasing US trade deficit

Many analysts believe that the world economy could not grow in a range between 2.5% and 3.5% given the huge US trade deficit. They often draw historical parallels to other countries that have run external deficits in the same range. But this comparison may not be very relevant. The US could run big deficits as long as the rest of the world benefits from this. Why care about import to the US as long as someone finds it in their interest to export to the US and invest the proceeds in USD assets? The huge volume of exports looks quite good from a Chinese perspective. International companies are coming into China with money that ends up in the central bank. These companies are giving millions of poor peasants work at the same time as Chinese companies learn modern production and management techniques. The point we try to make here is that under the assumptions of no disturbance in the US/China relationship there is nothing that says that the US external deficit has to reverse. The US has been running deficits against Germany and Japan for the last 30 years without creating any major problems.

Strong US consumer demand fuelled by rising asset prices has been an important factor behind the widening of the trade deficit. The trade balance could stabilize or even shrink if domestic demand in the US were to cool down. Higher interest rates or a weaker housing market are some obvious triggers. Higher energy prices are now a burden, but could in the longer run encourage production of alternative energy sources like ethanol, and open for more energy friendly cars in the US. The potential savings from more fuel efficient cars in the US is enormous. The potential of growing crops for the production of ethanol should also be huge. Tourism and other service exports should benefit if the USD were to fall significantly against the total exchange weighted basket.

Trade frictions with Japan in the early eighties led to a wave of FDI from Japan into the US. Real estate was bought and car production facilities were set up in the southern part of the country. Today it is the Koreans that are doing exactly the same thing. It could easily be the Chinese that will do this tomorrow. This process could accelerate in line with a larger trade deficit.

The consequences of a stabilisation or a fall in global house prices

Real house prices have risen strongly in many countries the last five years. The strong gain in house prices has been driven by a combination of cheap credit and rising incomes supported by stronger labour markets globally. Buying one or two more houses have also been considered a good investment by many households, thus creating artificial demand for new houses. There are several signs of weaker prices and activity in the housing markets, especially in the US. The recent rise in house prices may not be sustainable, because prices have been rising much faster than income. We probably need a period of slower growth in house prices to close the gap between income and house prices. The service price for owning a house is also rising along with higher interest rates and higher insurance and energy prices. More low income groups have become house owners in the US in recent years, and these groups are under severe pressure from rising service costs. The service cost would increase further with rising import prices.

House prices are central in our three scenarios. We expect real house prices to rise by 0% to 2.5% the next 10 to 15 years under the base case. Falling house prices and lower consumption growth is one key variable to the low growth we are assuming in both the deflation and the stagflation scenario. Whether we get low inflation or high inflation in combination with low growth depends on other factors, like fiscal policy, the development in Asian currencies, and some other risk factors.

Higher global energy and metal prices

We have seen a substantial rise in energy and metal prices during the latest two years. Real oil prices and metal prices are very close to the high levels from the early eighties. Metal prices have been driven by strong demand mainly from China. China is consuming 25% of most metals in the world and consumption is rising very fast. Metal consumption is driven by urbanization in China. Moving people into cities requires electricity, roads, water and new buildings. Urbanization in China is at the same stage as it was in the US before the Second World War, so there should be a lot more to come.

We expect demand for metals to stay strong for the next ten to twenty years because of the urbanization in China and India. This doesn’t mean that we expect any substantial inflation pressure from rising metal prices. Metal prices are already at a level where it is profitable to increase supply. There is no total supply problem in terms of resource restrictions. This is to some extent also the case for oil. The problem with oil is that much of the resources are in countries that are hostile to Europe and the US and in countries with high political risks.

In summary we do not find it likely that a lack of metals and energy will generate inflation under any of our three scenarios.

The demographic (pension) problem

We believe that the demographic challenge will be resolved trough a mix of higher taxes, a higher retirement age and lower pensions for the retirees. Some countries like the Netherlands have already a pension system that largely cope with the demographic problem, while others like Norway are in the transition process. We expect more countries to follow this path in our base scenario and in our deflation scenario. But our stagflation scenario is partly based on more demand from surging budget deficits, and thus implicitly on less willingness to deal with public expenses. Figure 1.4 shows the connection between population growth in Japan and economic growth. The lesson is that economic growth will decline as population growth declines.

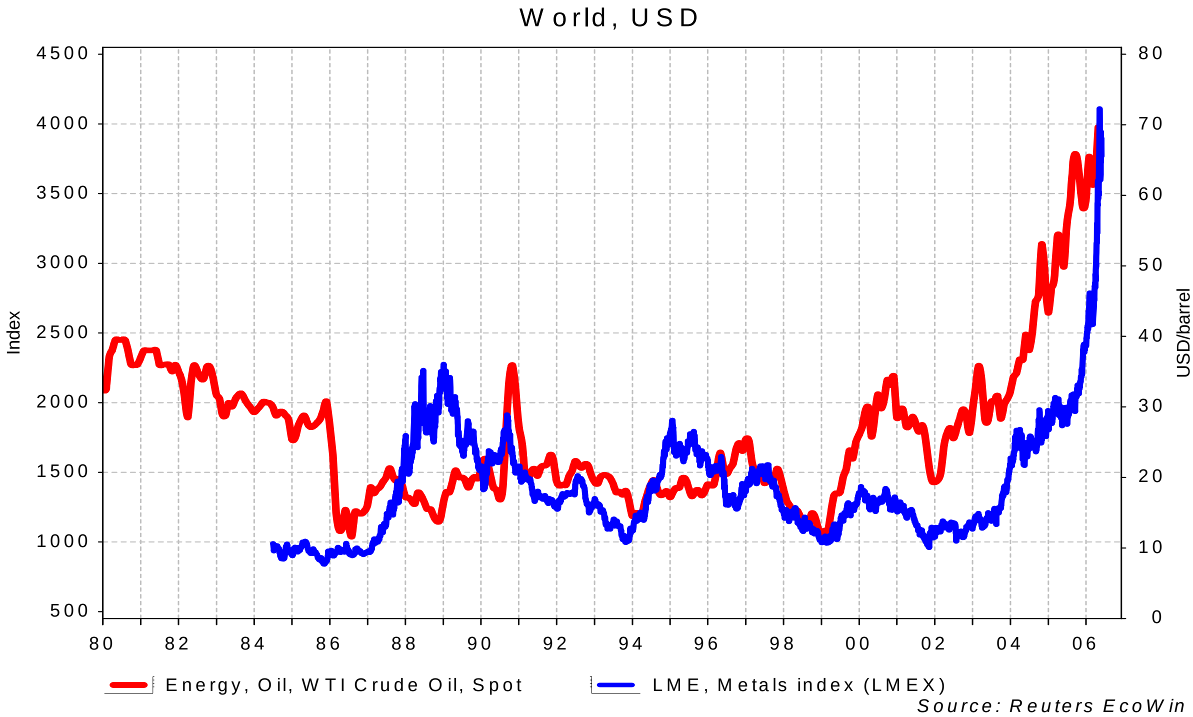


Figure 1.3: Price of crude oil and price index for metals 1980-2006. Source: Reuters.

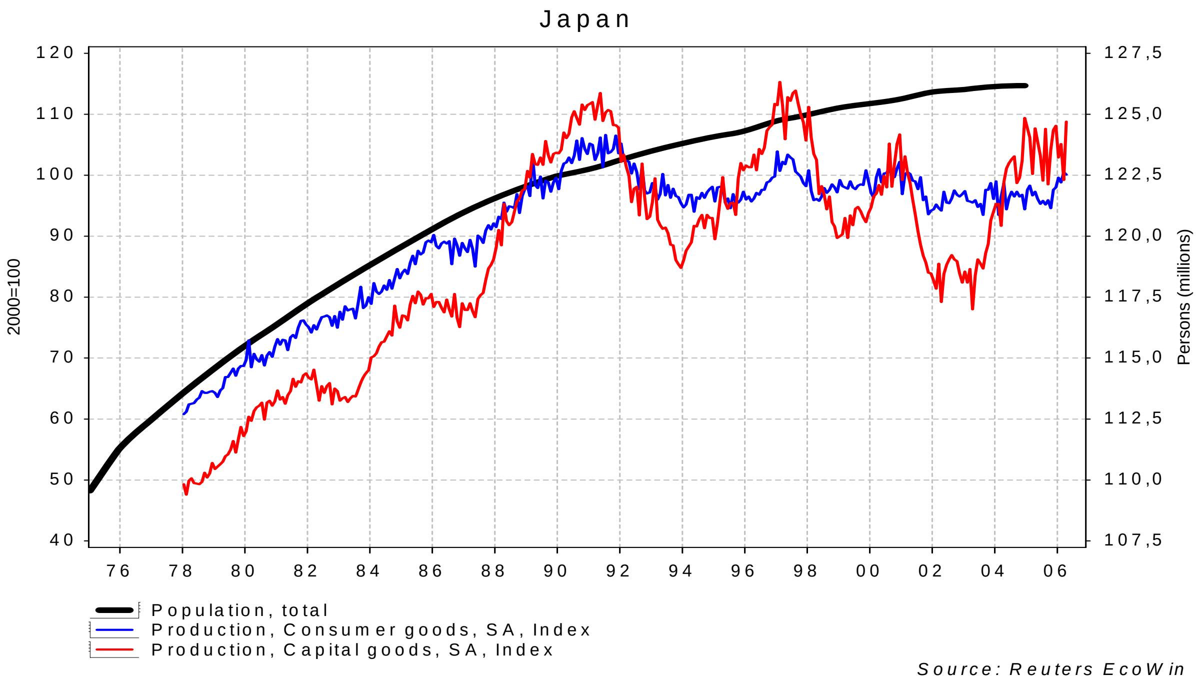


Figure 1.4: Population and production paths for Japan 1975-2006. Source: Reuters.

The balance between savings and consumption in emerging Asia

There is an obvious risk of overinvestment and a build-up of excess capacity in China. This issue is related to the amount of household savings and bank lending behaviour. We know that the Chinese government is aware of these problems and are working hard to resolve them. In principle it is quite easy to increase consumption and decrease investments in China. An implementation of a broad based welfare system would probably cut household spending substantially. Better lending standards and less political interference in the lending process would also help on the bad lending practice. We have already seen government actions in setting up public institutions to take over bad loans from the banks. The Chinese authorities have so far been quite successful in resolving their economic problems.

In our base scenario we expect China to continue along a balanced path towards a well functioning market economy with a welfare system. Distortions of the saving balance, the production balance or the allocation of capital is part of the basis for our inflationary as well as our deflation scenarios. This means that we consider the future development in China to be more important for world inflation and hence the policy response in the major economies than the development in the US. This view is based on the fact that China already is the marginal price setter for many products, as well as China is getting more important for new products every year.

Supply distortions in the global trade patterns: Pandemics, trade frictions, wars or blockades.

Such events are highly unpredictable and difficult to analyse. None of our scenarios depend significantly on major supply distortions, but we do know that such distortions could have large effects on the world economy. The effects of a global pandemic could be particularly destructive. It is hard to analyse the consequence of a 10% drop in the population in the Western world. Travelling would be severely limited and demand for care and drugs would explode. People would stay at home in the hope of not being contaminated. There is an open question what would happen to global production under such circumstances. It is easy to imagine people fleeing from poor countries into richer countries in hope of treatment. What would happen to real estate prices if 10% of the population just disappeared? It is reasonable to think that a scenario like this would be quite devastating to financial assets.

An introduction of some kind of trade barriers to Chinese export seems more a more likely event than a global pandemic. We think the consequences of this kind of measures would be inflationary both in the short term as well as in the longer term. The main reason is that someone else would have to replace what China is producing today. This will take time and the second cheapest producer is not necessarily close to China in terms of costs.

It would probably stretch US resources if the US got itself into some military conflict or trade blockade of China. A larger budget deficit in combination with fewer goods imported from China seems like a prescription of more inflation and higher interest rates. A freezing of China foreign USD assets would also have far reaching consequences. China could be tempted to move their currency reserves out of USD assets if tensions with the US should rise. This could have large effects on the USD and could trigger more inflation in the US.

Appendix: Economic growth and inflation rates in the scenarios

The table below displays the growth and inflation rate paths assumed in our three scenarios. Notice that these are projections of actual rates, whereas the rates relevant for pricing in the financial markets are mostly expected rates. We return to the pricing issue in the respective chapters on probability distributions for returns.

	Base scenario		**Deflation scenario**		**Stagflation scenario**	
	GDP growth	Inflation rate	GDP growth	Inflation rate	GDP growth	Inflation rate
The US						
2006	3.0 %	3.7 %	3.0 %	3.7 %	3.0 %	3.7 %
2011	2.8 %	2.5 %	2.4 %	1.0 %	2.5 %	5.6 %
2016	2.6 %	2.5 %	1.9 %	-0.2 %	1.9 %	6.4 %
2021	2.5 %	2.5 %	1.5 %	-1.0 %	1.5 %	7.0 %
Europe ex UK						
2006	2.0 %	2.3 %	2.0 %	2.3 %	2.0 %	2.3 %
2011	1.9 %	2.0 %	1.4 %	0.4 %	1.4 %	5.0 %
2016	1.8 %	2.0 %	1.0 %	-0.4 %	1.0 %	6.2 %
2021	1.75 %	2.0 %	0.8 %	-1.0 %	0.8 %	7.0 %
UK						
2006	2.6 %	2.1 %	2.6 %	2.1 %	2.6 %	2.1 %
2011	2.3 %	2.0 %	1.7 %	0.3 %	1.7 %	4.9 %
2016	2.0 %	2.0 %	1.1 %	-0.5 %	1.1 %	6.1 %
2021	1.75 %	2.0 %	0.8 %	-1.0 %	0.8 %	7.0 %
Japan						
2006	3.1 %	-0.1 %	3.1 %	-0.1 %	3.1 %	-0.1 %
2011	2.4 %	1.1 %	1.9 %	-0.6 %	1.9 %	4.0 %
2016	1.9 %	1.6 %	1.2 %	-0.8 %	1.2 %	5.7 %
2021	1.5 %	2.0 %	0.8 %	-1.0 %	0.8 %	7.0 %

Table 1.1: Expected paths for economic growth and inflation in our three alternative scenarios.

2 Return measures and foreign exchange markets

2.1 Introduction

This report is concerned with expected return estimates that are relevant to the objective of the Fund. In this context the Fund is seen as national wealth, and the purpose becomes maximization of Norway's real purchasing power on future imports.

The maximization of the purchasing power of the Fund implies that the relevant numeraire for return measurement is a basket of currencies reflecting the future import composition of Norway. The local nominal returns in different currencies must be translated into numeraire returns by employing the appropriate basket of currencies, and they must then be deflated into real terms by using a measure of basket inflation. Local inflation will, however, still be important for the analysis because estimates of local nominal and real return could be functions of local inflation.

The basket numeraire is the relevant measure even if a strategic regional shift involving only two currencies is being considered. The currency effect on total return from shifting investments from Japan to USA is different depending on whether it is measured in USD-terms or in terms of the numeraire basket. Hence, fair value indicators or assessments of long run equilibrium for currencies should be computed in the numeraire basket.

This chapter first discuss the composition of the numeraire basket. Then follows a discussion of potential contributions to expected return from currencies.

2.2 The numeraire basket

The weights in the basket, i.e., the currency composition of the Fund that represents neutrality in terms of currency risk, is based on an argument related to the intended use of the fund. In macroeconomic terms, use of the Fund will correspond closely to increased imports in the future. Hence the purchasing power of the Fund is related to the basket of imports that Norway will buy in the future.

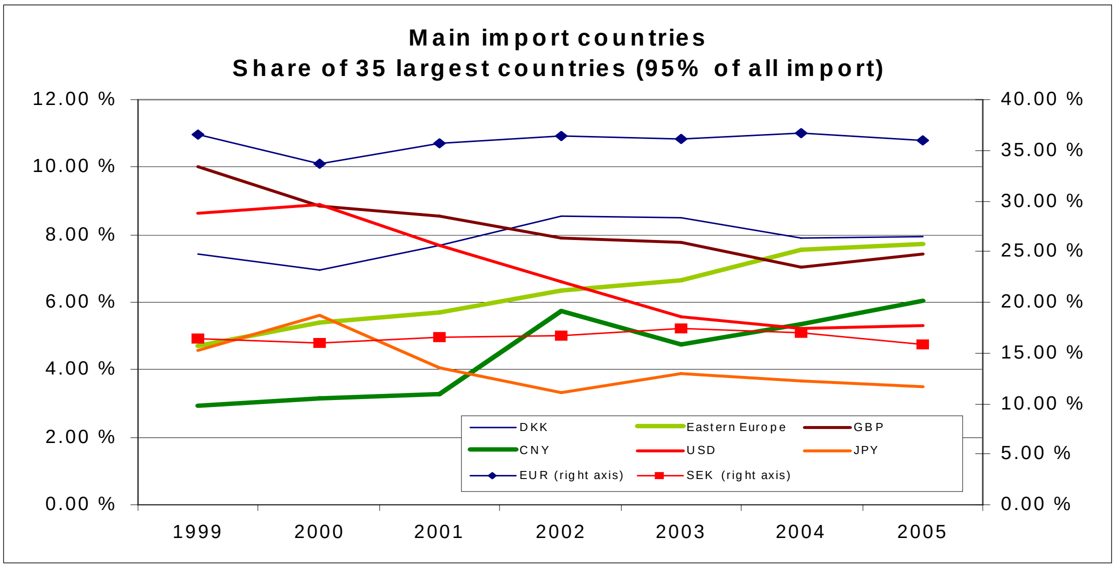


Figure 2.1: *Development of Norway's import structure. Source: Norges Bank and CBS.*

To forecast the future import structure of Norway is difficult. However, one might ascertain that both the current import basket and the relative size of the economies we are importing from, are important indicators. Looking at the development of the import basket over the last 50 years one finds a relatively stable picture. Notable developments are the increase of Japan's share in the fifties and the increase of China's and Eastern Europe's share in the last ten years. A study of the import basket reveals, however, that geographical proximity still is a major determinant. Around 15% of Norwegian imports are from Sweden and 35% from the Euro zone.

A pragmatic choice of basket weights is to take a weighted average of the current import basket and projected global GDP weights. We assign 2/3 weight to the import weights and 1/3 to the projected GDP weights. The latter are obtained by extrapolating the last decade of GDP growth for each country over the next 15 years. This is an attempt to capture the way emerging markets, in particular China and Eastern Europe, will be entering the future import basket. The resulting basket weights are shown in table 2.1, which also shows the currency weights of the strategic benchmark as of May 31, 2006. We see that the strategic benchmark is not completely currency neutral.

Region	Currency bloc	Currency weights	Benchmark weights
Europe		**61.5 %**	**56.0 %**
	EUR-bloc	55.1 %	43.5 %
	GBP	6.4 %	12.5 %
Asia / Oseania		**19.0 %**	**9.0 %**
	JPY	7.6 %	6.9 %
	CNY	11.4 %	1.4 %
America / Africa		**19.5 %**	**35.0 %**
	USD-bloc	19.5 %	35.0 %

Table 2.1. *Currency weights in the numeraire basket and in the benchmark. Source: Norges Bank.*

As we have expressed our view of the future purchasing power in terms of relative currency weights, we need to construct a basket numeraire where the relative weight of each currency remains constant. This approach is different from other synthetic currencies such as the ECU or the SDR, where there is a fixed number of currency units. To construct a synthetic currency with fixed relative weights, we first express all currencies in a common numeraire, compute the currency return for each currency, and then define the basket numeraire *return* by weighting together the currency returns with the weights from table 2.1. The basket numeraire is then anchored to one particular (arbitrary) date by defining its value in terms of a specific currency on that date. By construction, a fixed weights strategic benchmark, with weights identical to the weights in the basket numeraire, would show zero currency risk.

In the following we give the name "IMP" to the basket numeraire, i.e., the synthetic currency unit. We anchor the IMP so that the value of one IMP is equal to one USD on December 31, 1973. The USD/IMP currency rate as of February 28, 2006 is then 0.7953. The method of construction ensures consistency in all currency cross rates.

Figure 2.2 shows the nominal development of the main currencies denominated in the numeraire (IMP). We see that JPY has appreciated around 300 percent since end of 1973. Moreover we see substantial volatility in the USD and two devaluations in the CNY since 1987.

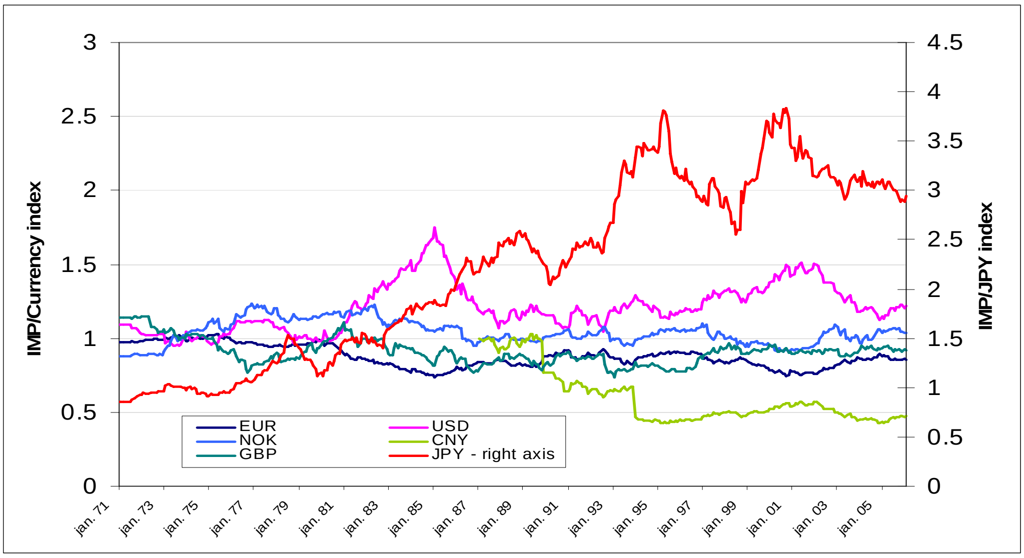


Figure 2.2: *Index of nominal IMP currency rates. A rising curve implies an appreciating currency relative to the IMP. Index set to 1 at 31.12.1973. Data are available for CNY only from January 1987. IMP/JPY-index is measured on right axis, all other indices on left axis. EUR prior to 1999 is a synthetic rate calculated by Datastream. Source: Datastream and Norges Bank.*

A similar chart for the real rates is shown in figure 2.3. Real rates are here computed by using consumer price inflation (cpi) in both the foreign currency and in the numeraire. Numeraire inflation is the weighted average inflation in the composite currencies of the IMP. Remembering the objective of the fund, one could argue that export price inflation is a more relevant measure than the cpi. However such an approach would hinge on the assumption that Norwegian imports is similar to the average export composition of all countries. That is probably not the case. Hence we choose the cpi because of better data availability.

We see that accounting for differences in inflation reduces variability somewhat, which may reflect the expected relationship between nominal exchange rate movements and relative inflation. In particular it seems that the nominal depreciation of CNY could be accounted for by high CNY inflation relative to numeraire inflation.

However, there are still substantial real movements in the currency rates, indicating a violation of purchasing power parity in the strictest sense.

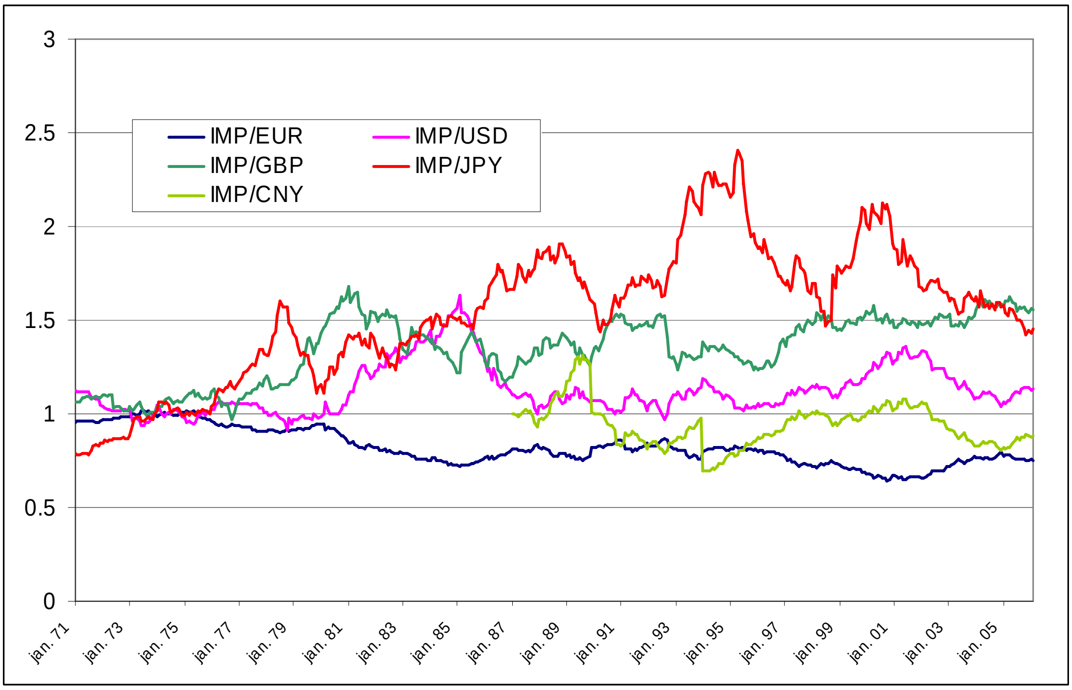


Figure 2.3: *Index of real IMP currency rates. A rising curve implies an appreciating currency relative to the IMP. Index set to 1 at 31.12.1973. Data are available for CNY only from January 1987. EUR prior to 1999 is a synthetic rate calculated by Datastream. Source: Datastream and Norges Bank.*

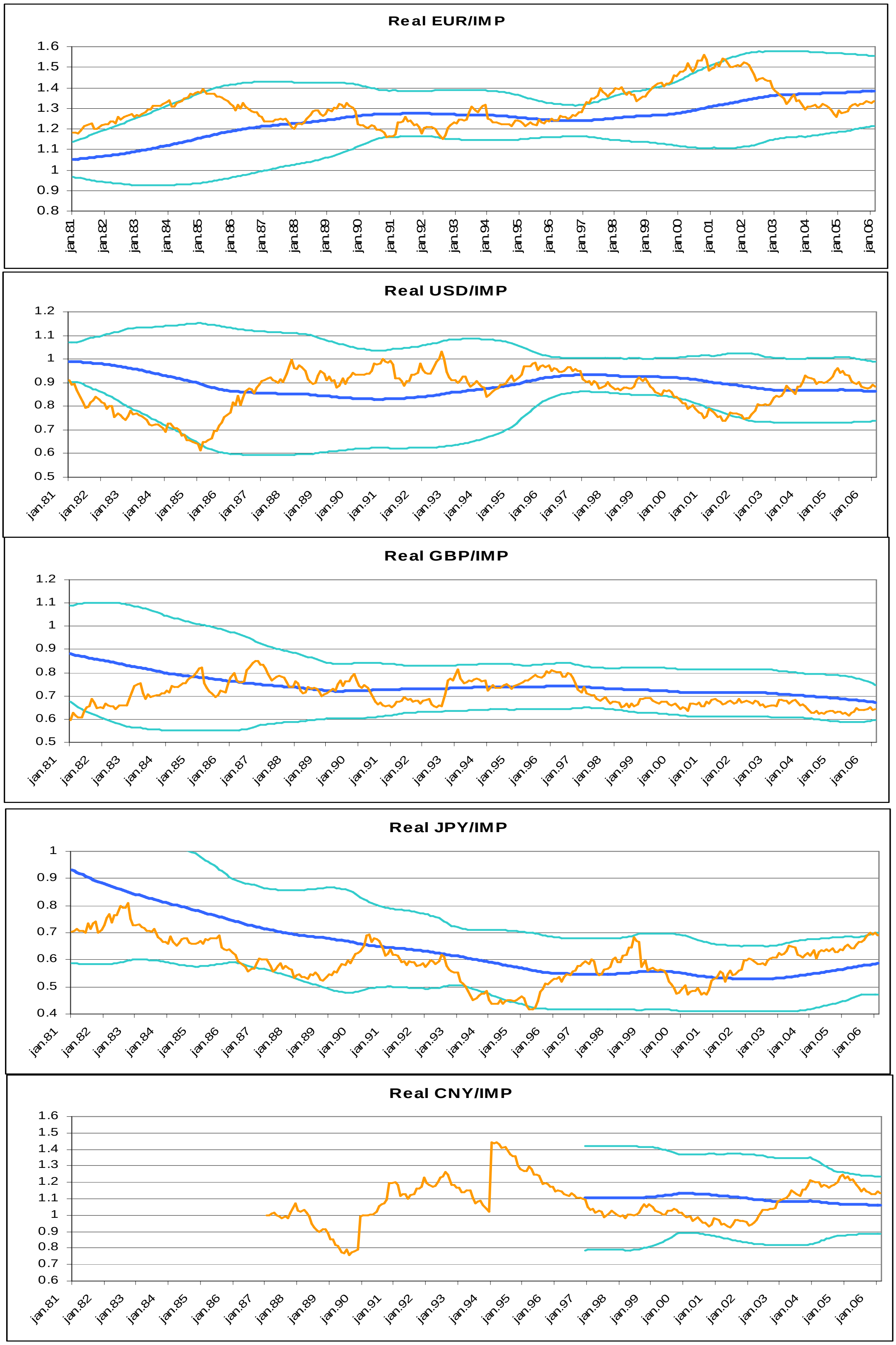


Figure 2.4: *Deviation from purchasing power parity. Real currency rates, 10 year moving average of real currency rates, and +/- 2 standard deviations around the moving average. Source: Norges Bank*

2.3 Contribution to expected return from currencies

The way the numeraire basket has been constructed has an impact on the covariance structure of the currencies involved. The covariance matrix must have the property that the solution to the minimum variance optimization problem is equal to the weights in the basket. After all, the basket has fixed weights that represent currency risk neutrality by definition. Suppose one currency rise in value, measured in the basket. That rise depresses the value of other currencies when measured in the same basket, thus implying a bias towards negative correlation among the constituent currencies. This effect is larger for currencies with high weights in the basket.

	EUR	USD	GBP	JPY	CNY
EUR	3.89 %				
USD	-0.92	5.38 %			
GBP	-0.15	0.05	5.36 %		
JPY	-0.24	-0.11	-0.17	10.30 %	
CNY	-0.92	0.99	0.04	-0.11	5.46 %

Table 2.2: *Empirical standard deviations (annualized) and correlations among the constituent currencies of the numeraire basket, measured in IMP. Monthly data from 1995.1 to 2006.2. Source: Norges Bank.*

This intuition is confirmed in table 2.2. We see the very strong negative correlation between USD and EUR. Moreover we see the correlation close to unity between CNY and USD, reflecting the Chinese peg to USD. The minimum variance portfolio given the matrix in table 2.2 is indeed the basket weights. A more comprehensive study of risk, where the entire covariance matrix is discussed, is given in the next chapter.

There are several commonly used fair value indicators for currency rates. These are to a large extent variations over a common theme where differences in characteristics between the foreign and the home numeraire are taken to be a predictor of the currency rate. Popular variables are inflation differentials, interest rate differentials, business cycle misalignment or difference in currency rate momentum. The strongest theoretical foundation is connected to inflation differentials. In theory, supply and demand should work to produce nominal changes in the exchange rate in order to offset inflation differentials, so that purchasing power parity is obtained. Otherwise an arbitrage-like situation could arise. In the following we focus on deviations from purchasing power parity.

When considering a basket currency such as the IMP, one should keep in mind that a currency with a large weight in the basket is by definition closer to fair value when measured relative to the IMP, than a currency with a small weight in the basket.

In figure 2.4 we have plotted the real currency rate versus its 10 year average and a band describing +/- 2 standard deviations away from average. The figure is based on the hypothesis that the real currency rate should mean revert around its long term average, reflecting the pull to parity. By using a 10 year moving average rather than a fixed value as a definition of purchasing power parity, we are assuming that the equilibrium currency rate could move over time, e.g., as a response to changes in relative productivity growth or structural changes.

From figure 2.4 it appears that EUR and GBP are trading above fair value while USD, JPY and CNY are trading below fair value. Following this analysis, table 2.3 shows the potential return contribution from expected currency movement to the total nominal return of the fund, measured in units of the IMP.

	Appreciate to reach PPP (cheap)	Depreciate to reach PPP (rich)	Annualized return contribution, 15y reversal time
EUR		3.59 %	-0.24 %
USD	2.27 %		0.15 %
GBP		4.44 %	-0.29 %
JPY	14.96 %		0.93 %
CNY	6.29 %		0.41 %

Table 2.3. *Annualized potential return contribution to nominal total return from currency. Source: Norges Bank.*

In table 2.3 we are assuming that our best estimate of the real currency rate 15 years ahead is the equilibrium or PPP values. Furthermore we are assuming that the initial deviation from parity is eliminated by movements in the nominal exchange rate rather than by changes in relative inflation.

Table 2.3 belies the precision of this analysis. In particular Japan and China are examples where the nominal exchange rate is managed by the central bank; hence the supply and demand effects that the hypothesis is relying upon may not work according to theory. Caution should be applied in using these estimates.

The simple PPP analysis in figure 2.4 indicates an appreciation of the renminbi. While the direction is probably not controversial, the size of the appreciation could be much larger than indicated here. The equilibrium value estimate in table 2.3 is based on a history where the currency is pegged to the dollar. The real uncertainty is what happens if the Chinese central bank is no longer able to maintain that policy. Hence, the PPP analysis may not be very relevant in this case.

The relevance of the analysis above is limited in that it is based on one signal, from the time series of currency rates and inflation only. While PPP theory concentrates on one part of the balance of payments - tradable goods and services - many would argue that trade in financial assets is also an important determinant of exchange rates.

Despite the deviations from the basket currency weights shown in table 2.1, there is only a small degree of currency risk in the current benchmark. Applying the benchmark weights to the covariance matrix in table 2.2 produces an annualized currency volatility of only 0.69%. The main reason for this low number is the very high correlation between CNY and USD, combined with the benchmark underweight in CNY and overweight in USD relative to the weights in the numeraire.

This latter point illustrates a political risk that is not captured in the analysis above. If China submits to international pressures to revalue its currency, i.e., to break the current peg to the USD, the current underweight to China may represent substantial risk. With a view to the history of Japan, whose currency in real terms has appreciated substantially over a long period of time, the opportunity cost in lost purchasing power by not being invested in China could be large.

To alleviate that risk would require a quasi exposure to the renminbi, because a direct exposure to China in any substantial amount is prohibited through capital controls. However, it is very uncertain what happens to existing correlation patterns if the renminbi is allowed to appreciate. One could perhaps argue that the renminbi will appreciate less versus neighbouring currencies. In particular, Singapore dollar, Malaysian ringgit and Taiwan dollar are currencies that are likely to co-vary with the renminbi. The South Korean won has already appreciated quite substantially and might not follow the renminbi. The Japanese yen is probably more dependent on the western world and might thus have a looser link to the renminbi.

The main argument for believing that investing in neighbouring currencies will provide a hedge towards the renminbi is that neighbouring countries can be expected to let their currencies appreciate versus the dollar, because they have substantial imports from China. The dangers of imported inflation could in that case outweigh the reduced competitiveness versus the western world. Another argument could be that the stock of companies that currently have been hurt by China's competitiveness would increase in value when this competition is reduced through an appreciation of the renminbi. However, both these arguments are very uncertain. Hence, gaining a quasi exposure to the renminbi would be a challenging task with uncertain outcome.

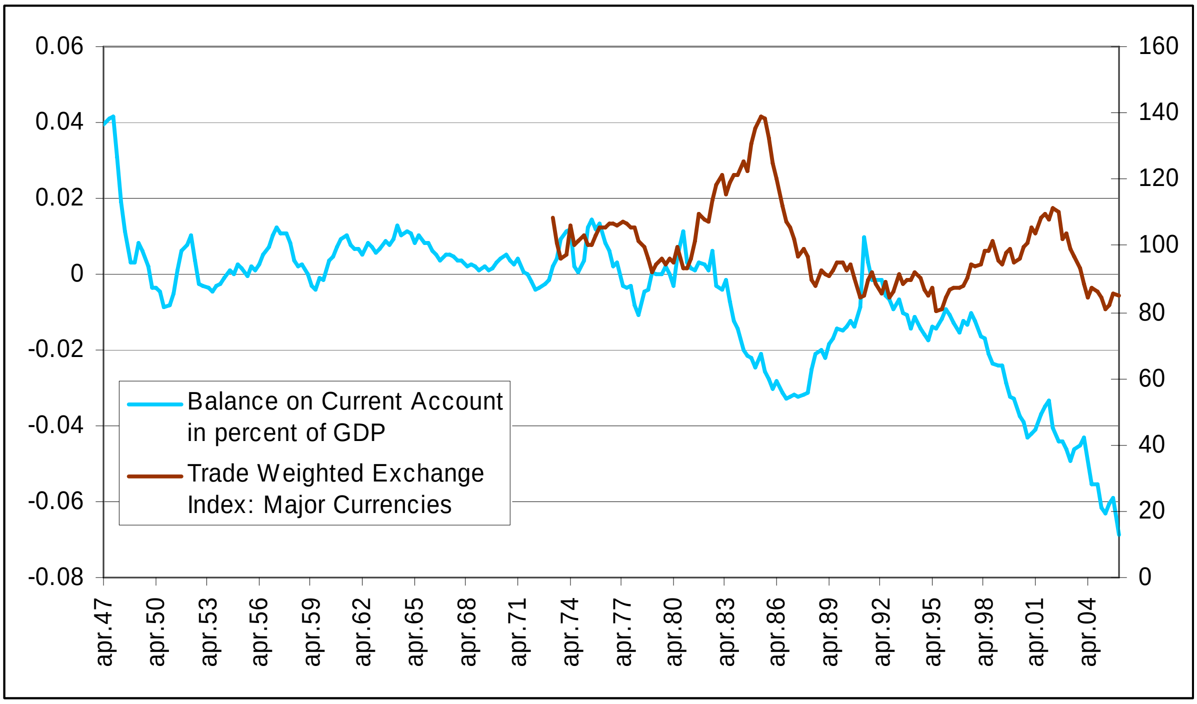


Figure 2.5: *The current account balance in the US and the Federal Reserve trade weighted index of major currencies against the US dollar. Source: Federal Reserve Bank of St. Louis.*

Figure 2.5 shows the steadily growing current account deficit in the US. The two main forces behind this deficit are an increased US demand for foreign goods and an increase in foreign demand for US assets. The latter effect can be seen as a consequence of increased international diversification among non-US institutional investors during the nineties, or it can be seen as an indication of high expected return for assets in the US. Moreover, central bank demand for US bonds has been high in later years, in particular from Asian countries. There has been a real appreciation of the US dollar since the mid nineties, but real depreciation since late 2001. This depreciation accelerated in 2004, whereas 2005 was a period of relative calm. We can see this same pattern also in figure 2.4 (inverted currency rate).

Deutsche Bank[1] has tried to identify important themes driving the currency markets by monitoring rolling correlations between FX performance and different drivers. They find that FX markets are at present primarily driven by current account considerations. The correlation between currencies and the current account is now approaching 2004 highs (90%).

The unwinding of the US current account imbalance can take different forms. The worst case scenario is a sudden loss of confidence to US capital markets, triggering a substantial down-weighting of US assets in portfolios of foreign investors. This would create a substantial depreciating pressure for the US dollar.

Blanchard et.al. (2005) analyse the link between the current account deficit and the value of the US dollar. They show that in the absence of anticipated portfolio shifts, the anticipated rate of depreciation of the dollar depends on the change in the ratio of US net debt to US assets. For plausible assumptions they find an upper bound on the annual rate of depreciation to be 2.7%. If on the other hand the share of US assets in foreign portfolios decline by 2% over the coming year, this upper bound increases to 8.7%. They conclude that a substantially stronger depreciation of the dollar is likely, certainly against the yen and the renminbi, and probably also against the euro.

Summing up, we find that a simple PPP analysis does not reveal extreme misalignments of the major currencies, possibly with the exception of Japanese yen. We identify two rather obvious risks connected to the current account deficit of the US and to the pegging-policy of China. Both pose a risk of depreciation of the dollar, and probably appreciation of the renminbi. However, the timing and size of these effects can only be described by very unreliable estimates. Some market participants look to the PPP analysis for the USD and conclude that a significant depreciation of the dollar is not likely. Hence, we are not able to substantiate a specific view on the currency contributions to our expected returns.

We therefore revert to our default long term view of no expected contribution to Fund returns from currencies. However, we will keep the identified risks and possible biases in mind when we interpret the outcome of our portfolio analysis.

[1] See Deutsche Bank Global Markets Research - FX Strategy, May 25, 2006; "DB FX Theme Radar".

3. Risk and correlations between asset markets

3.1 Expected volatilities in equity and bond markets

In last year's Market Report (Staff Memo 2005/10), the expected equity market volatilities were estimated from the historical real annual total return data of Dimson et al. The estimated volatilities were 20 % for USA and Europe, and 25 % for Japan. These estimates were modified by arguing that the assumption of mean reverting stock prices reduces the effective risk over long horizons (by about one-sixth over a 15-year investment horizon).

The estimates were based on the *real* return history covering the entire post-WWII era, a period comprising a wide spectrum of economic, financial and structural fundamentals (e.g. both strong inflation and disinflation, including a period of deflation in Japan). The estimates may thus be interpreted as representing averages over a wide range of possible future scenarios.

An alternative approach, which we will investigate in the following, is to condition the (nominal) risk and correlation expectations on a future economic scenario. We shall be considering the base scenario introduced in chapter 1 with continuation of low and stable price inflation. We do not have sufficient data for in-depth analysis of the two alternative scenarios from chapter 1, but we shall consider a scenario with re-emergence of higher and more volatile price inflation.

To do so, we estimate the realized volatility over periods characterized by high and low realized price inflation, respectively. Data availability being limited, we switch to *monthly* nominal total return data from FTSE, covering the period 1986-2005, in order to boost the number of observations[1]. Although this period does not cover the very high inflation rates of the 1970s, it nevertheless exhibits a drop in average inflation rates from the sub-period 1986-1995 to the sub-period 1996-2005, as well as a drop in inflation variability. This feature is observed in all major developed economies (table 3.1). We therefore take these two sub-periods to represent "high" and "low" inflation periods, respectively.

	USA	**Japan**	**Europe**
Inflation 1986-1995	3.4 %	1.3 %	4.0 %
Standard deviation	1.3 %	1.5 %	1.0 %
Inflation 1996-2005	2.5 %	0.0 %	2.4 %
Standard deviation	0.8 %	0.9 %	0.5 %

Table 3.1: *Average (geometric) annual inflation rates (Consumer Price Inflation - CPI), and their standard deviations, in USA, Western Europe and Japan in the periods 1986-1996 and 1996-2005. Data from IMF, OECD, and Datastream.*

The volatility of total nominal stock and government bond returns during these two periods is shown in Tables 3.2a and 3.2b.

[1] When simulating the portfolio, expected *nominal* returns will be used as input.

	USA	Japan	Asia/Pacific-ex-Japan	UK	Europe-ex-UK
Stock volatility 1986-1995	15 %	23 %	22 %	18 %	16 %
Stock volatility 1996-2006	16 %	17 %	20 %	14 %	19 %
Stock volatility 1986-2006	15 %	20 %	21 %	16 %	18 %

Table 3.2a: *Historical volatility of nominal total stock returns. Monthly nominal return data from FTSE World (as of July 2006).*

	USA	Japan	Asia/Pacific-ex-Japan	UK	Europe-ex-UK
Bond volatility 1986-1995	4 %	5 %	6 %	6 %	3 %
Bond volatility 1996-2006	4 %	2 %	4 %	3 %	3 %
Bond volatility 1986-2006	4 %	4 %	5 %	5 %	3 %

Table 3.2b: *Historical volatility of nominal government bond returns. Monthly nominal return data from Citigroup World Government Bond Index (3-7 years), as of July 2006. Asia/Pacific-ex-Japan is here proxied by Australia, while Europe-ex-UK is a market cap-weighted index of France, Germany, Italy and Netherlands.*

With the exception of the Japanese and UK stock markets, there is no significant difference in volatility between the two periods. The same is true for the bond markets. The drop in the Japanese stock market volatility reflects the high volatility caused by the stock market crash in 1990. Table 3.2a shows that nominal stock market volatility in the 20-year period 1986-2005 was 15-21 % across the regions, whereas bond market volatility was 3-5 %. This is 3-5 percentage points below the volatility estimates reported last year, for both asset classes. The source of this difference is primarily the longer data history underpinning last year's volatility expectations, which included the periods of significantly higher volatility in the 1970s. Also, this year we discuss nominal volatilities, which are unaffected by inflation rate variability.

The rather small difference in inflation rates and variability between the two sub-periods may be one reason for the mostly insignificant volatility differences. More importantly, stock market volatility has many sources entirely unrelated to realized or anticipated inflation. The relationship between inflation and stock market volatility is therefore hard to estimate. Historically, however, low stock market volatility has been associated with periods of low and stable inflation, whereas high stock market volatility has been associated with periods of high inflation (the 1970s) or deflation (the 1930s), when markets were "bearish". A theoretical explanation would be that the equity risk premium increases and becomes more volatile with rising and more volatile inflation expectations (investors perceive higher risks and/or become more risk averse). In the bond markets, on the other hand, the link between bond yields (and hence prices) and inflation expectations provides a clear relationship between the latter and bond volatility.

For our base scenario (low and stable inflation, economic growth at trend), the past 20 years is therefore a reasonable time period for evaluating future volatility. Our volatility expectations are then given by tables 3.2a and 3.2b (15-21 % for stock markets and 3-5 % for bond markets, depending on region), with mean reversion further reducing the effective long term stock market risk.

The above volatility estimates for bonds are deduced from government bond indices, while the relevant benchmark for the Fund is Lehman Global Aggregate, which is a broader investment grade index. However, national/regional Lehman Global Aggregate indices do not show higher volatility than corresponding Citigroup government bond indices, partly reflecting diversification effects. Figure 3.1 shows that Lehman Global Aggregate indices have exhibited 5-year rolling volatilities between 3 and 4 % in recent years.

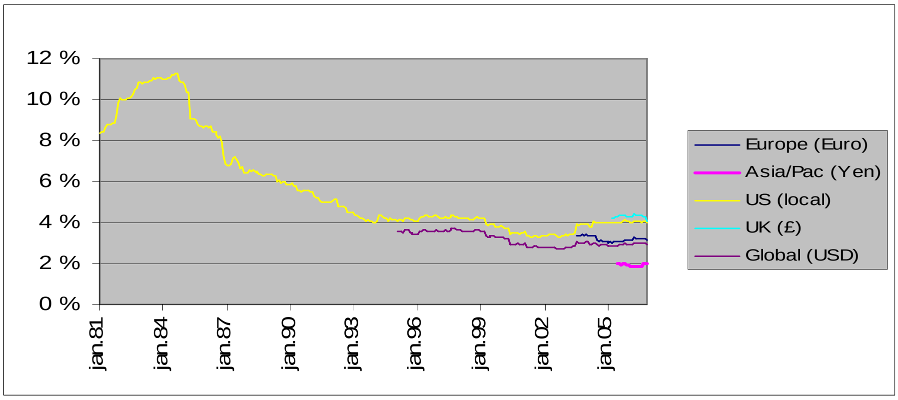


Figure 3.1: *Rolling 5-year volatility (annualized) of regional Lehman Global Aggregate indices. Monthly data from Datastream.*

In the alternative stagflation scenario, both stock and bond volatilities should be adjusted upwards. Monthly US government bond return data dating back to the early 1970's (Lehman US Aggregate Government, from January 1973) show dramatically increased bond volatility as the Federal Reserve started raising interest rates to fight high inflation. Annualized bond volatility reached up to 14 % on a 1-year rolling basis, 9 % for 5-year rolling, and 7 % for 15-year rolling, as seen from Figure 3.2.

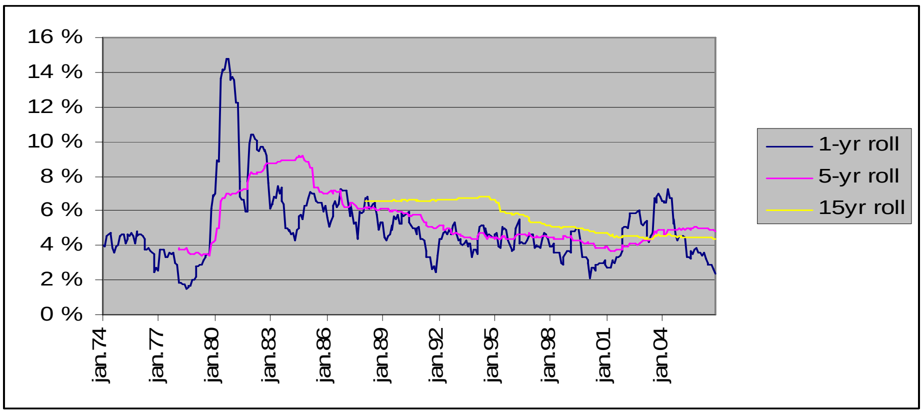


Figure 3.2: *Rolling 1, 5 and 15-year volatility (annualized) of US Government bonds. Data: Lehman US Aggregate Government index since January 1973 (monthly), from Datastream.*

The reaction of central banks to high inflation is critical to a volatility forecast. Assuming central banks will fight inflation in a stagflation scenario (as opposed to accommodating it; see Chapter 1), volatility of the order of 10 % should be expected over extended periods. However, since stagflation is thought to take effect gradually, our 15-year volatility forecast for the stagflation scenario is somewhat lower than these peak volatilities. We choose to add five percentage points to our volatility forecast for the base scenario, which gives volatility forecasts in the range 8-10 % depending on region.

Stock return volatility is less sensitive to the scenario. Total return data for the US (MSCI, from 1970) do not show any significant rise in volatility during the 1970's that can be directly linked to the stagflation of the period. Still, as pointed out earlier, bear markets tend to be more volatile than bull markets. Since the stagflation scenario is bearish, it is reasonable to hike the volatility forecast by a few percentage points. We choose to raise stock volatility by two percentage points relative to the volatility forecast for the base scenario.

In the deflation scenario, only the stock market volatility needs to be hiked, by the same amount, we assume, as in the stagflation scenario (two percentage points). The rationale is again the high volatility of bear markets.

Tables 3.3a-b summarize the volatility forecasts across regions and scenarios.

	Bonds USA	**Bonds Japan**	**Bonds Asia/Pacific ex Japan**	**Bonds UK**	**Bonds Europe ex UK**
Base scenario	4 %	4 %	5 %	5 %	3 %
Deflation	4 %	4 %	5 %	5 %	3 %
Stagflation	9 %	9 %	10 %	10 %	8%

Table 3.3a: *Summary of bond market volatility forecasts (nominal) across regions and scenarios.*

	Stocks USA	**Stocks Japan**	**Stocks Asia/Pacific ex Japan**	**Stocks UK**	**Stocks Europe ex UK**
Base scenario	15 %	20 %	21 %	16 %	18 %
Deflation	17 %	22 %	23 %	18 %	20 %
Stagflation	17 %	22 %	23 %	18 %	20 %

Table 3.3b: *Summary of stock market volatility forecasts (nominal) across regions and scenarios.*

3.2 The correlation matrix

In Staff Memo 2005/10 the expected (real) correlations between asset classes were set equal to the historical correlations in annual real total return data (Dimson et al.) covering the post-Bretton Woods period 1973-2004. The correlation matrix for stocks and bonds is shown in Table 3.4 (exchange rate correlations have been omitted to save space).

Two issues are addressed in the following. First, we discuss whether expected correlations should be conditioned on our economic scenarios for the next 15 years. Secondly, we investigate whether the relatively high-frequency data used when estimating long-term correlations introduce significant biases in the correlation estimates. In addition, it is now *nominal* return correlations that we are estimating.

	Bonds US	**Bonds Japan**	**Bonds Europe**	**Stocks US**	**Stocks Japan**
Bonds Japan	0.46				
Bonds Europe	0.68	0.71			
Stocks US	0.34	0.32	0.43		
Stocks Japan	0.02	0.28	0.03	0.48	
Stocks Europe	0.27	0.42	0.48	0.80	0.59

Table 3.4: *Expected correlation matrix for stocks and bonds (real returns), reported in Staff Memo 2005/10 (local currency). Correlations with exchange rates are not shown.*

3.2.1 Nominal correlations conditioned on inflation rates

As for conditional volatilities, we estimate conditional nominal return correlations over the two sub-periods (1986-1995 and 1996-2006), characterized by falling inflation rates, using the *monthly* data sample described in section 3.1. The results are shown in Table 3.5a-c.

Bond-bond correlations are shown in Table 3.5a. Most of the correlations increased from the first to the second period, with the exception of correlations with the Japanese bond market. Increased capital market integration and global disinflation have contributed to this trend. The low correlations between Japan and the rest of the world reflect the peculiar interest rate environment in Japan since the 1990s.

Stock-stock correlations, shown in Table 3.5b, mostly show modest increases, again attributable to increased capital market integration.

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Bonds US					
Bonds Japan	0.3 (H) 0.1 (L)				
Bonds Asia/Pac-ex-Jap	0.3 (H) 0.6 (L)	0.1 (H) 0.2 (L)			
Bonds UK	0.4 (H) 0.7 (L)	0.4 (H) 0.1 (L)	0.2 (H) 0.6 (L)		
Bonds Europe-ex-UK	0.4 (H) 0.8 (L)	0.4 (H) 0.2 (L)	0.2 (H) 0.6 (L)	0.6 (H) 0.8 (L)	

Table 3.5a: *Nominal return correlations (local currency) between government bond markets in the two periods 1986-1995 and 1996-2006, with high (H) and low (L) realized price inflation, respectively, as of July 2006. Monthly nominal return data from the Citigroup World Government Bond Index.*

	Stocks US	Stocks Japan	Stocks Asia/Pac-ex-Jap	Stocks UK	Stocks Europe-ex-UK
Stocks US					
Stocks Japan	0.3 (H) 0.4 (L)				
Stocks Asia/Pac-ex-Jap	0.6 (H) 0.7 (L)	0.3 (H) 0.5 (L)			
Stocks UK	0.8 (H) 0.8 (L)	0.3 (H) 0.4 (L)	0.7 (H) 0.6 (L)		
Stocks Europe-ex-UK	0.6 (H) 0.8 (L)	0.4 (H) 0.5 (L)	0.7 (H) 0.6 (L)	0.7 (H) 0.8 (L)	

Table 3.5b: *Nominal return correlations (local currency) between stock markets in the two periods 1986-1995 and 1996-2006, with high (H) and low (L) realized price inflation, respectively, as of July 2006. Monthly nominal return data from FTSE World total return indices.*

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Stocks US	0.3 (H) -0.2 (L)	0.1 (H) -0.1 (L)	0.3 (H) -0.1 (L)	0.2 (H) -0.1 (L)	0.2 (H) -0.2 (L)
Stocks Japan	0.0 (H) -0.2 (L)	0.1 (H) -0.2 (L)	0.1 (H) -0.2 (L)	0.1 (H) -0.2 (L)	0.2 (H) -0.2 (L)
Stocks Asia/Pac-ex-Jap	-0.1 (H) -0.2 (L)	0.0 (H) -0.1 (L)	0.4 (H) 0.0 (L)	0.1 (H) -0.1 (L)	0.1 (H) -0.1 (L)
Stocks UK	0.1 (H) -0.3 (L)	0.0 (H) -0.1 (L)	0.3 (H) -0.1 (L)	0.4 (H) -0.1 (L)	0.3 (H) -0.2 (L)
Stocks Europe-ex-UK	0.0 (H) -0.4 (L)	0.0 (H) -0.1 (L)	0.2 (H) -0.2 (L)	0.1 (H) -0.2 (L)	0.4 (H) -0.3 (L)

Table 3.5c: *Nominal return correlations (local currency) between stock and government bond markets in the two periods 1986-1995 and 1996-2006, with high (H) and low (L) realized price inflation, respectively, as of July 2006. Monthly nominal return data from FTSE World total return and Citigroup World Government Bond indices.*

The most significant and consistent shifts, however, are seen in stock-bond correlations (table 3.5c), where correlations generally move from positive to negative across the two periods, in all markets. Similar "decoupling" has also occurred in earlier low-inflation periods, according to Morgan Stanley (2004), who points out that there have in fact been four major periods of zero or negative stock-bond correlations in the past 87 years in the United States, each associated with extended periods of sub 2 percent price inflation (notably during 1960-1965 and the late 1920s / early 1930s). None of these periods have lasted for more than eight years, however. In a related study, Ilmanen (2003) documents a negative relationship between inflation and the correlation between S&P 500 and the 20-year bond *yield* in the United States between 1928 and 2001, and also finds similar results for Japan and Germany.

Figure 3.3 shows the extent of this relationship over time for four markets (US, Japan, UK, and France). Plotted are rolling 10-year (real and nominal) correlations between stocks and bonds against rolling geometric 10-year average of CPI. As expected, the pattern is a complex one. One still can notice some common long-term trends for US, Japan and France, whereas for UK it is harder. For instance, the correlations rose steeply in the US and UK during the high-inflation 1970's.

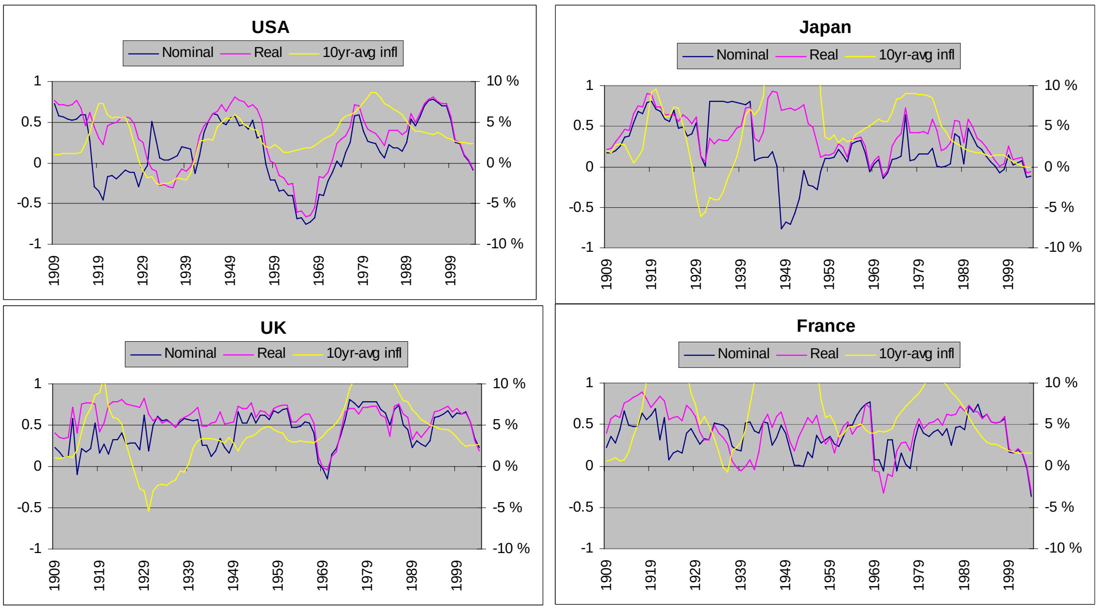


Figure 3.3: *Rolling 10-year correlations between stock and bond returns (real and nominal), and the rolling geometric 10-year average inflation rate (CPI), in USA, Japan, UK and Germany. Annual data from Dimson et al.*

There are many factors that affect the correlation between stock and bond returns. However, this particular relation to the inflation environment is often explained by means of real shocks predominantly impacting the economy during low-inflation periods, with their low inflation variability, as opposed to nominal, or price level shocks typically hitting the economy during high-inflation periods when inflation volatility is higher. Other explanations relate to falling inflation expectations (Li 2002).

We hesitate to extrapolate these negative stock-bond correlations into a medium-term future period (15 years), since negative correlations remain atypical in a historical perspective. Negative correlations might, however, persist for some time. This is suggested by figure 3.4, showing rolling 12-month correlations between nominal total returns (monthly) of stocks and government bonds.

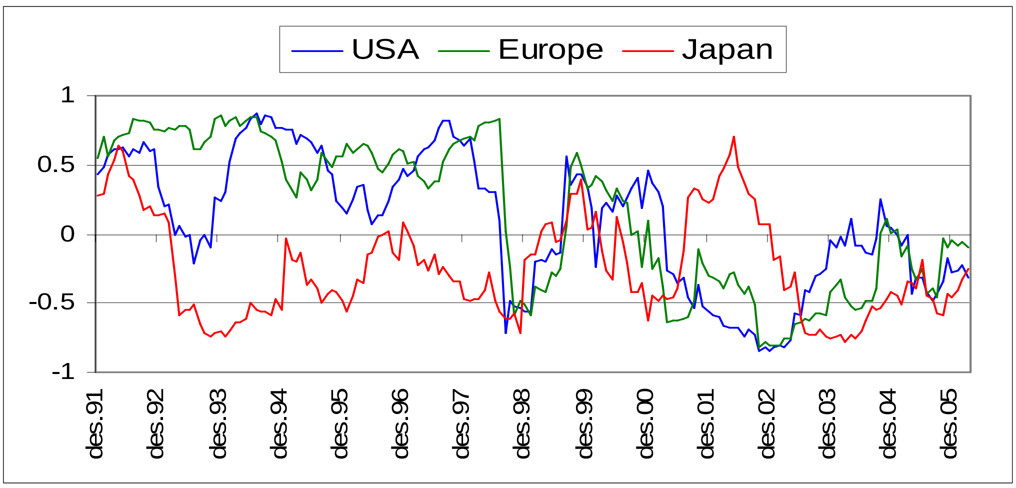


Figure 3.4: *Rolling 12-month correlations between monthly nominal stock and government bond total returns in the US, Europe and Japan. Data from FTSE World and Citigroup World Government Bond Index.*

The 12-month correlations are seen to still be in negative territory in all three regions (-0.25 in USA and Japan, and -0.1 in Europe). There is a striking similarity between the correlation patterns of the US and Europe, which indicates that similar drivers may be at work in the two regions.

A reasonable approach may be to reduce the stock-bond correlations relative to the expectations reported in Staff Memo 2005/10, on the assumption that the current negative correlations will persist for some time. Another possibility is to use the entire data sample 1986-2006, akin to retaining the estimation procedure of last year (with the exception that the high-inflation period 1973-1985 is omitted, and *monthly nominal* instead of *annual real* return data are used). The correlation matrix from the entire data sample 1986-2006 is shown in Tables 3.6a-c[2].

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Bonds US					
Bonds Japan	0.3				
Bonds Asia/Pac-ex-Jap	0.5	0.2			
Bonds UK	0.4	0.3	0.3		
Bonds Europe-ex-UK	0.5	0.3	0.4	0.6	

Table 3.6a: *Nominal return correlations (local currency) between government bond markets in the period 1986-2006, as of July 2006. Monthly nominal return data from Citigroup World Government Bond Index.*

	Stocks US	Stocks Japan	Stocks Asia/Pac-ex-Jap	Stocks UK	Stocks Europe-ex-UK
Stocks US					
Stocks Japan	0.4				
Stocks Asia/Pac-ex-Jap	0.6	0.4			
Stocks UK	0.8	0.4	0.7		
Stocks Europe-ex-UK	0.7	0.4	0.6	0.7	

Table 3.6b: *Nominal return correlations (local currency) between stock markets in the period 1986-2006, as of July 2006. Monthly nominal return data from FTSE World total return indices.*

[2] We thus extract bond-bond and stock-stock correlations from the entire period 1986-2006, despite the fact that these correlations increased from period 1986-1995 to period 1996-2006 (see text). Correlations might thus be somewhat underestimated. On the other hand, since further global disinflation is not part of the base scenario, expected correlations going forward (in particular bond-bond correlations) may be lower than the 1996-2006 correlations.

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Stocks US	0.0	0.0	0.1	0.1	0.0
Stocks Japan	-0.1	0.0	0.0	0.0	0.0
Stocks Asia/Pac-ex-Jap	-0.1	0.0	0.2	0.0	0.0
Stocks UK	-0.1	0.0	0.2	0.2	0.1
Stocks Europe-ex-UK	-0.2	0.0	0.0	0.0	0.0

Table 3.6c: *Nominal return correlations (local currency) between stock and government bond markets in the period 1986-2006, as of July 2006. Monthly nominal return data from FTSE World total return and Citigroup World Government Bond indices.*

In comparison with the expectations reported in Staff Memo 2005/10, these updated estimates are indeed lower for stock-bond correlations (with some exceptions). Inter-stock market correlations are not significantly different, while inter-bond market correlations are lower for Japan, as one would expect given the low correlations 1996-2006 (table 3.5a). Tables 3.6a-c may thus capture some key structural trends that might last for some more years, but were diluted when our correlation matrix included the 1973-85 period.

Before settling on specific numbers, however, we shall investigate the relevance of estimating long-term correlations using high-frequency data. This question becomes doubly important if we are to switch from annual to monthly historical data as the basis for forming our expectations.

3.2.2. The term structure of return correlations

As noted earlier, the correlation expectations reported in Staff Memo 2005/10 were derived from historical real return data at an *annual* frequency. The correlation estimates above are based on more recent (nominal) data at *monthly* frequency. In both cases, and in particular the latter, the data period is much shorter (annual, monthly) than the investment horizon of interest (15 years).

As explained in detail in the Appendix, this time period mismatch, rooted in data shortage (too few non-overlapping 15-year return observations), can potentially cause biased estimates of long-term return correlations. More specifically, if asset class returns share common stochastic trends (are co-integrated), which may or may not be the case (see Appendix for review of empirical tests), correlation coefficients will typically depend on the length of the time horizon, as some econometric studies suggest they do. If that is the case, our correlation estimates derived from monthly or annual return data may not be representative for long-term correlations. They may, in fact underestimate them.

To investigate this issue, we perform an econometric analysis of the nominal return time series for stocks and government bonds, using our monthly data sample for the period 1986-2006 as above. We adopt a canonical correlation analysis (see for example Hamilton 1994) in the spirit of Pan, Liu and Roth (2001), who apply it to eleven nominal European stock market indices (for which they find that most of the correlations increase with the horizon length).

In the following we choose to look at stock and bond markets separately, since it is more questionable whether stock and bond returns share common stochastic trends (a full-scale analysis of stock and bond markets together is presented in the Appendix; however, some of the results for stock-bond correlations are difficult to interpret).

Table 3.7 shows results for the five stock markets, for the entire sample 1986-2006, and, as a stability check, for the two sub-periods 1986-1995 and 1996-2006. The first correlation ("sample") is the conventional monthly sample correlation (as in Tables 3.5 and 3.6). The next four correlations ("month", "year", "5 year", "inf. hor.") are the estimated scaled correlations, representative for investment horizons of one month, one year, five years and an infinitely long time period, respectively (the result for monthly horizon should ideally be equal to the monthly sample correlation; they are seen to be close enough). Together these estimates are representative measures for the "term structure" of the real return correlations.

Whole sample (1986-2005)				
	US	Japan	Asia/Pac. ex Japan	UK
Japan (sample)	0.38			
Japan (month)	0.38			
Japan (year)	0.33			
Japan (5 year)	0.31			
Japan (inf. hor.)	0.30			
Asia/Pacific ex.jap. (sample)	0.62	0.37		
Asia/Pacific ex.jap. (month)	0.61	0.35		
Asia/Pacific ex.jap. (year)	0.70	0.44		
Asia/Pacific ex.jap. (5 year)	0.73	0.47		
Asia/Pacific ex.jap. (inf. hor.)	0.75	0.49		
UK (sample)	0.77	0.36	0.66	
UK (month)	0.76	0.34	0.65	
UK (year)	0.90	0.41	0.80	
UK (5 year)	0.95	0.42	0.86	
UK (inf. hor.)	0.95	0.42	0.88	
Europe ex. UK (sample)	0.72	0.44	0.62	0.75
Europe ex. UK (month)	0.72	0.45	0.62	0.75
Europe ex. UK (year)	0.83	0.55	0.62	0.81
Europe ex. UK (5 year)	0.87	0.59	0.62	0.84
Europe ex. UK (inf. hor.)	0.88	0.60	0.62	0.85

High inflation (1986-1995)				
	US	Japan	Asia/Pac. ex Japan	UK
Japan (sample)	0.34			
Japan (month)	0.33			
Japan (year)	0.32			
Japan (5 year)	0.32			
Japan (inf. hor.)	0.32			
Asia/Pacific ex.jap. (sample)	0.58	0.30		
Asia/Pacific ex.jap. (month)	0.58	0.29		
Asia/Pacific ex.jap. (year)	0.57	0.29		
Asia/Pacific ex.jap. (5 year)	0.57	0.29		
Asia/Pacific ex.jap. (inf. hor.)	0.57	0.29		
UK (sample)	0.76	0.33	0.67	
UK (month)	0.76	0.31	0.69	
UK (year)	0.88	0.44	0.78	
UK (5 year)	0.92	0.47	0.81	
UK (inf. hor.)	0.92	0.47	0.81	
Europe ex. UK (sample)	0.63	0.43	0.65	0.70
Europe ex. UK (month)	0.63	0.41	0.66	0.71
Europe ex. UK (year)	0.65	0.45	0.67	0.72
Europe ex. UK (5 year)	0.66	0.46	0.67	0.73
Europe ex. UK (inf. hor.)	0.66	0.46	0.67	0.73

Low inflation (1996-2005)				
	US	Japan	Asia/Pac. ex Japan	UK
Japan (sample)	0.44			
Japan (month)	0.50			
Japan (year)	0.51			
Japan (5 year)	0.51			
Japan (inf. hor.)	0.51			
Asia/Pacific ex.jap. (sample)	0.67	0.48		
Asia/Pacific ex.jap. (month)	0.69	0.51		
Asia/Pacific ex.jap. (year)	0.70	0.56		
Asia/Pacific ex.jap. (5 year)	0.70	0.57		
Asia/Pacific ex.jap. (inf. hor.)	0.70	0.57		
UK (sample)	0.79	0.41	0.63	
UK (month)	0.81	0.46	0.65	
UK (year)	0.90	0.63	0.67	
UK (5 year)	0.93	0.68	0.68	
UK (inf. hor.)	0.94	0.69	0.68	
Europe ex. UK (sample)	0.79	0.49	0.61	0.84
Europe ex. UK (month)	0.81	0.51	0.62	0.84
Europe ex. UK (year)	0.81	0.54	0.61	0.89
Europe ex. UK (5 year)	0.81	0.55	0.61	0.91
Europe ex. UK (inf. hor.)	0.81	0.55	0.61	0.91

Table 3.7: *Estimated term structure of correlations between stock markets for 1986-2006 and the two sub-periods 1986-1995 and 1996-2006 (local currency). The canonical correlation analysis is described in detail in the Appendix.*

Focusing on the entire sample period 1986-2006, the results show that most stock market correlations do indeed increase with horizon. The main exception, USA-Japan, could be interpreted as lack of a common stochastic trend (due to the Japanese stock market crash in 1990 and its subsequent lacklustre performance), a hypothesis that is challenged, however, by the contrary result for Europe-Japan.

The results for the two sub-periods 1986-1995 and 1996-2005 show weaker horizon effects. This does not necessarily invalidate the horizon effect, in particular since each sub-period contain fewer observations, yielding larger statistical uncertainty.

To summarize, we find some evidence for horizon effects in stock market correlations, but the analysis reveals how difficult it is to evaluate the magnitude and significance of the effect.

Whole sample (1986-2005)			
	US	Japan	UK
Japan (sample)	0.27		
Japan (month)	0.28		
Japan (year)	0.21		
Japan (5 year)	0.18		
Japan (inf. hor.)	0.17		
UK (sample)	0.45	0.32	
UK (month)	0.46	0.33	
UK (year)	0.69	0.53	
UK (5 year)	0.79	0.61	
UK (inf. hor.)	0.82	0.64	
Europe ex. UK (sample)	0.55	0.35	0.61
Europe ex. UK (month)	0.56	0.34	0.61
Europe ex. UK (year)	0.61	0.37	0.66
Europe ex. UK (5 year)	0.62	0.38	0.69
Europe ex. UK (inf. hor.)	0.62	0.38	0.69

High inflation (1986-1995)			
	US	Japan	UK
Japan (sample)	0.35		
Japan (month)	0.36		
Japan (year)	0.29		
Japan (5 year)	0.26		
Japan (inf. hor.)	0.25		
UK (sample)	0.36	0.36	
UK (month)	0.38	0.39	
UK (year)	0.66	0.59	
UK (5 year)	0.80	0.69	
UK (inf. hor.)	0.82	0.71	
Europe ex. UK (sample)	0.37	0.41	0.56
Europe ex. UK (month)	0.42	0.44	0.57
Europe ex. UK (year)	0.50	0.49	0.59
Europe ex. UK (5 year)	0.53	0.51	0.60
Europe ex. UK (inf. hor.)	0.54	0.51	0.60

Low inflation (1996-2005)			
	US	Japan	UK
Japan (sample)	0.13		
Japan (month)	0.12		
Japan (year)	0.32		
Japan (5 year)	0.44		
Japan (inf. hor.)	0.48		
UK (sample)	0.67	0.05	
UK (month)	0.69	0.03	
UK (year)	0.69	0.43	
UK (5 year)	0.69	0.66	
UK (inf. hor.)	0.69	0.74	
Europe ex. UK (sample)	0.75	0.20	0.75
Europe ex. UK (month)	0.77	0.16	0.75
Europe ex. UK (year)	0.77	0.25	0.80
Europe ex. UK (5 year)	0.78	0.31	0.81
Europe ex. UK (inf. hor.)	0.78	0.33	0.82

Table 3.8: *Estimated term structure of correlations between government bond markets for 1986-2006 and the two sub-periods 1986-1995 and 1996-2006 (local currency). The canonical correlation analysis is described in detail in the Appendix.*

We now turn to the results for government bonds, shown in table 3.8 (Asia/Pacific-ex-Japan has here been omitted). Again focusing on the full data sample 1986-2006, the correlations again show horizon effects, some of very large magnitude. Again, the exception is the USA-Japan correlation, whose term structure is downwards sloping. A look at the results for the two sub-periods reveals a similar picture, with now also the USA-Japan correlation showing an upwards sloping term structure in the period 1996-2006.

3.2.3. Summary of correlation expectations

We choose to base our nominal return correlation expectations on tables 3.6a-c, which we believe capture some structural relationships which might persist over a 15 years investment horizon, notably relatively low correlations between stocks and bonds. At the same time, we adjust the inter-stock and inter-bond correlations upwards for a potential horizon effect, whose magnitude and significance is highly uncertain, but which could be in the order of ten percentage points, according to our term structure analysis. We do not apply any such correction to stock-bond correlations, given that our analytical results are difficult to interpret (see Appendix), and our doubts concerning the theoretical justification (common stochastic trends less likely between these markets).

Correcting tables 3.6a-c for an inter-stock and inter-bond horizon effect of ten percentage points (adding 0.1 to these correlations), we arrive to a matrix of expected nominal correlations shown in tables 3.9a-c. Compared with our previous forecasts in Staff Memo 2005/10 (see table 3.4), the most significant difference is a reduction in the stock-bond correlations. The table represents our best estimates, but the uncertainty is naturally considerable, and any portfolio conclusions should be stress-tested with alternative correlation patterns.

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Bonds US					
Bonds Japan	0.4				
Bonds Asia/Pac-ex-Jap	0.6	0.3			
Bonds UK	0.5	0.4	0.4		
Bonds Europe-ex-UK	0.6	0.4	0.5	0.7	

Table 3.9a: *Expected nominal bond market correlations (local currency) for the next 10-15 years (correlations corrected for horizon effects).*

	Stocks US	Stocks Japan	Stocks Asia/Pac-ex-Jap	Stocks UK	Stocks Europe-ex-UK
Stocks US					
Stocks Japan	0.5				
Stocks Asia/Pac-ex-Jap	0.7	0.5			
Stocks UK	0.9	0.5	0.8		
Stocks Europe-ex-UK	0.8	0.5	0.7	0.8	

Table 3.9b: *Expected nominal stock market correlations (local currency) for the next 10-15 years (correlations corrected for horizon effects).*

	Bonds US	Bonds Japan	Bonds Asia/Pac-ex-Jap	Bonds UK	Bonds Europe-ex-UK
Stocks US	0.0	0.0	0.1	0.1	0.0
Stocks Japan	-0.1	0.0	0.0	0.0	0.0
Stocks Asia/Pac-ex-Jap	-0.1	0.0	0.2	0.0	0.0
Stocks UK	-0.1	0.0	0.2	0.2	0.1
Stocks Europe-ex-UK	-0.2	0.0	0.0	0.0	0.0

Table 3.9c: *Expected nominal correlations between bond and stock markets (local currency) for the next 10-15 years (no corrections for horizon effects).*

3.2.4. Correlation expectations in the alternative economic scenarios

Correlations *within* bond markets and stock markets are, for simplicity, assumed to be invariant to economic scenarios. We thus assume away the likelihood of increased correlations during periods of financial turbulence that would likely occur with increased frequency in the alternative scenarios.

As for correlations *between* bond and stock markets, however, we assume that they will increase substantially as inflation expectations rise in the stagflation scenario. Figure 3.3 shows that this has indeed happened in high-inflation periods, with 10-year rolling correlations sometimes reaching or exceeding the 50 % level. For the stagflation scenario, therefore, we choose to raise all bond-stock correlations by fully 50 percentage points relative to the low (close to zero) correlations we assume for the base scenario.

In the deflation scenario, on the other hand, we retain the low bond-stock correlations of the base scenario.

Appendix: The term structure of return correlations

A-1 Introduction

There is a wide range of considerations that need to be taken into account when determining the correlation matrix for the simulation model. One of these is what frequency and period should be used when estimating the correlation matrix. In the report from last year the sample correlation matrix, based on yearly real returns for stocks and bonds for the three regions Europe, North-America and Asia/Oceania covering the period from 1973 to 2004, was used. Table A.1 below shows that correlation matrix.

Table A.1: Sample correlation matrix of yearly real returns, 1973-2004

Correlations	FI Europe	FI Amerika	FI Asia/Os.	Equities Europe	Equities Amerika	Equities Asia/Os.
FI Europe	1					
FI Amerika	0.68	1				
FI Asia/Oseania	0.71	0.46	1			
Equities Europe	0.48	0.27	0.42	1		
Equities Amerika	0.43	0.34	0.32	0.80	1	
Equities Asia/Oseania	0.03	0.02	0.28	0.59	0.48	1

Several studies argue that there is a horizon effect with respect to correlations between stock markets. This appendix examines whether the return horizon (week, month, year) used to calculate the correlations is important for the level of the correlations. Since we are essentially trying to obtain an estimate/assessment of the 15 year portfolio return distribution, we would ideally want to use an estimate of the 15 year correlations between the assets in which the fund is invested. If we require that non-overlapping observations to be used, we will have too few observations to obtain any reliable estimates, even when using data that covers the entire last century. In addition, the sample correlations estimated using a century of data would cover periods that are not necessarily representative for our scenarios.

If asset returns are multivariate normal and independent, the correlation at any return horizon would be an unbiased estimate of the 15 year correlation looking forward. In that case we could use yearly, monthly or weekly returns to get an unbiased estimate of the 15 year correlation matrix. On the other hand, if real returns are *not* multivariate normal and independent, the return horizon used to estimate the correlations might be important. One reason for why there might be a horizon effect in correlations suggested by e.g. DeFuso, Geppert and Tsetsekos (1996) and Pan, Lui and Roth (2001) is that the market indices share one or several common stochastic trends (i.e. they are co-integrated).

A set of I(1) variables[3] are said to be co-integrated if there exists a linear combination which makes the variables I(0). Thus, if there is co-integration in a system, there exist one or several I(1) factors (common stochastic trends) that “drives” the variables. There are several methods suggested in the literature with respect to extracting stochastic trends by decomposing the system into permanent and temporary factors. Beveridge and Nelson (1981) provides a methodology for decomposing integrated economic time series into the sum of non-stationary trend components (permanent components) and stationary components (transitory

[3] I(1) refers to a variable that is integrated of order one. This means that the variable is non-stationary, and becomes stationary, I(0), when differenced once.

components) in a univariate framework. Stock and Watson (1988) generalizes the Beveridge/Nelson methodology to co-integrated systems.

The basic intuition behind a term structure of correlations in a co-integrated system is the following. At short horizons there is an idiosyncratic variability in each variable that blurs the long-run (fundamental) correlation between the variables. However, as the return horizon lengthens the common trend(s) will increasingly dominate the relationship between the indices as the variance of the temporary components becomes less important. For example, if two I(1) variables are co-integrated, then a single stochastic trend drives both variables. This common trend will dominate the behaviour of the two series in the long run and will cause the correlation to approach 1.0 over long horizons. In other words, each variable may deviate from the common stochastic trend, but as the idiosyncratic shocks to each variable die out, each series will adjust back to the common stochastic trend. When we move away from the bivariate case, the interpretation is as follows. If the set of *N* variables follow only *one* stochastic trend we still have that the correlation between the variables will approach 1.0 in the limit. If the number of stochastic trends is greater than one but less than *N*, the correlations between the variables will scale with the investment horizon, and converge to a long run correlation. In the case when the number of stochastic trends equals N, there is no horizon effect.

Several studies have examined whether stock markets are co-integrated, and/or if they have become increasingly correlated over time due to increased market integration. The results are mixed. Taylor and Tonks (1989) studies the co-integration between UK, US, Germany, Netherlands and Japan using monthly data on stock price indices for two sub-periods, 1973-1979 and 1979-1986. They find that stock price index of the UK are co-integrated with the stock price index of the US, Germany, Netherlands and Japan for the later period but not for the former period. Kasa (1992) explores common stochastic trends for the US, UK, Japan, Germany and Canada using monthly and quarterly data from 1974 to 1990. Their results suggest that there is a single common stochastic trend driving these countries' stock markets. Byers and Peel (1993) examines the interdependence between stock price indices of the US, the UK, Japan, Germany and the Netherlands using bivariate and multivariate co-integration (Johansen, 1988) techniques for the period 1979-1989, but unlike Taylor and Tonks they do not find any co-integration either for the group as a whole or between any of the pairs of markets.

To examine the issue of a term structure of correlations, we apply a method used in Pan, Liu and Roth (2001) which is based on a canonical correlation methodology.[4] Pan, Liu and Roth (2001) examine a set of 11 stock market indices, and find that most of the correlations scale with the horizon. However, they do not examine other asset classes. Essentially, the methodology decomposes the system of prices into permanent and temporary components (canonical variates), and then derives the term structure of correlations from the variances and covariances of these components.

There are several benefits of using this methodology. First, it takes into account the possible existence of common stochastic trends among multivariate time series. Secondly, it is robust to using overlapping observations. This makes it especially useful in our case since the base scenario in the strategy report is a low inflation scenario. When obtaining a conditional correlation matrix for a low inflation regime, we want to restrict our sample to a relatively

[4] The methodology in Pan, Lui and Roth (2001) is based on a decomposition method developed in Tsay and Tiao (1990).

short time period that covers the period from the mid 1990s until today. Similarly, when we examine alternative scenarios for e.g. a high inflation regime, we want a correlation matrix that is representative for a high inflation period. The method thus gives us an efficient way of estimating these correlations in relative short samples as well as a way to examine whether going from yearly to monthly return horizons affect our correlation estimates.

However, there are also problems associated with this methodology. First of all, using "high" frequency (monthly) data for a relatively short time period (about 10 years) to detect a long-run relationship between the variables may fail to give us any reliable estimates of such a relationship. Also, the relatively short time period used when we estimate the conditional correlations (high/low inflation periods) exposes us to the risk of picking up spurious relationships. Thus, we will use the results from this analysis with caution, and the results from the analysis will only one part of an overall assessment of the correlation matrix. The main objective of this analysis is to say something about whether using monthly returns instead of yearly returns affect our correlation estimates.

A-2 Methodology

The model is set up in the following manner. The price process is assumed to be described similarly as in e.g. Fama/French (1988) where the natural logarithm of stock prices, p_t, is governed by the following stochastic process

$$\begin{aligned} \mathrm{p_t} &= \mathrm{x_t^1} + \mathrm{x_t^2} \\ \mathrm{x_t^1} &= \mu_1 + \mathrm{x_{t-1}^1} + e_{1,t} \\ \mathrm{x_t^2} &= \mu_2 + \rho x_{t-1}^2 + e_{2,t} \end{aligned}$$

where $\mathrm{x_t^1}$ is the *permanent* price component and $\mathrm{x_t^2}$ is the *temporary* price component with $0<\rho<1$. The price process, p_t, is assumed to be generated by the sum of a random walk (non-stationary) component, $\mathrm{x_t^1}$, and a stationary component, $\mathrm{x_t^2}$. The canonical correlation methodology starts by solving for the eigenvalues of the coefficient matrix $\mathbf{A} = \boldsymbol{\beta}_1\boldsymbol{\beta}_2$ where

$$\begin{aligned} \boldsymbol{\beta}_1 &= (\mathbf{P}_t\mathbf{P}_t^{'})^{-1}(\mathbf{P}_t\mathbf{P}_{t-1}^{'}) \\ \boldsymbol{\beta}_2 &= (\mathbf{P}_{t-1}\mathbf{P}_{t-1}^{'})^{-1}(\mathbf{P}_{t-1}\mathbf{P}_t^{'}) \end{aligned}$$

Thus, $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are essentially the coefficient matrices for a multiple regression of p_{t-1} on p_t, and p_t on p_{t-1} respectively. Thus, the temporary component is assumed to follow an AR(1) process.

Let **K** be the vector matrix with the normalized eigenvectors that solves the characteristic function $(\mathbf{A} - \lambda\mathbf{I})\mathbf{K} = 0$ and calculate the canonical variates (factors) associated with the eigenvalues λ as $\eta = \mathbf{K'P}$. These canonical variates, η, are uncorrelated by construction and can be interpreted in the following fashion. The first canonical variate, η_1, is the variate that gives the maximum first-order serial correlation from the set of all linear combinations of the time series in $\mathbf{P}$ (asset prices). The second canonical variate, η_2, gives the linear combination of the assets that is uncorrelated with η_1, and obtains the largest remaining first order serial correlation, and so on. The number of canonical variates is the same as the number of assets in $\mathbf{P}$. From the canonical variates the price vector can now be expressed as:

$$\begin{aligned}\mathbf{P} &= (\mathbf{K}')^{-1}\mathbf{K}'\mathbf{P} \\ &= (\mathbf{K}')^{-1}\eta \\ &= \mathbf{W}\eta\end{aligned}$$

The next step is to determine how many of the canonical variates that are random walks (have a unit root), and how many that are stationary. This can be done by ordering the variates based on the ordering of their associated eigenvalues from the highest to the lowest, and test how many have unit roots. In out setup we use Augmented Dickey Fuller (ADF) test to determine how many variates, *k*, are random walks. When that is determined, each price series' can be written as a linear combination of the canonical variates such that for asset *i* the price series is:

$$\mathrm{p}_{\mathrm{i,\,t}} = \mathrm{x}^1_{\mathrm{i,t}} + \mathrm{x}^2_{\mathrm{i,t}}$$

where the permanent price component is:

$$\mathrm{x}^1_{\mathrm{i,t}} = \sum_{h=1}^{k} w_{i,h}\eta_{j,t}$$

and the temporary price component is:

$$\mathrm{x}^1_{\mathrm{i,t}} = \sum_{h=k+1}^{n} w_{i,h}\eta_{j,t}$$

Here $w_{i,j}$ is the (i,h)*th* element in $\mathbf{W} = (\mathbf{K}')^{-1}$. Accordingly, the asset return can be decomposed in a temporary and permanent component such that $\Delta \mathrm{p}_{\mathrm{i,\,t}} = \Delta \mathrm{x}^1_{\mathrm{i,t}} + \Delta \mathrm{x}^2_{\mathrm{i,t}}$. Based on the number of canonical variates that are random walks (*k*) and the canonical variates themselves, we can now calculate the term structure of correlations between two assets *i*,*j* as:

$$Corr(\Delta^q p_{i,t}, \Delta^q p_{j,t}) = Cov(\Delta^q p_{i,t}, \Delta^q p_{j,t}) \Big/ \sqrt{Var(\Delta^q p_{i,t}) Var(\Delta^q p_{j,t})}$$

where

$$\begin{aligned}Var(\Delta^q p_{i,t}) &= \sum_{h=1}^{k} w^2_{i,h} Var(\Delta\eta_{h,t})q + \sum_{h=k+1}^{n} w^2_{i,h} Var(\Delta^q \eta_{h,t}) \\ Cov(\Delta^q p_{i,t}, \Delta^q p_{j,t}) &= \sum_{h=1}^{k} w_{i,h} w_{j,h} Var(\Delta\eta_{h,t})q + \sum_{h=k+1}^{n} w_{i,h} w_{j,h} Var(\Delta^q \eta_{h,t})\end{aligned}$$

From this we can now derive the entire term structure of return correlations for different assets by changing the holding period, *q*. The intuition is that the importance of the two components in the variance and covariance changes as the time horizon *q* changes. As q increases, the permanent price component becomes more dominating. As $\mathrm{q} \to \infty$, the limiting correlation is the correlation between the two permanent return components. In addition, if $n=k$, if no canonical variate has a unit root the correlation is invariant to the return horizon.

A-3 Estimation results

The dataset used in this analysis are monthly nominal returns of three asset classes (stocks, bonds and exchange rates) from January 1986 to March 2006 for five regions (four regions for bonds). The regions examined are US, Japan, Asia/Pacific (ex. Japan), UK and Europe ex. UK. For bonds we examine the correlations between the same regions except Asia/Pacific (ex. Japan) due to lack of data. Furthermore, we examine the correlation structure between regions for each asset class separately, and we restrict the estimation to four horizons; monthly correlations, yearly correlations, 5 year correlations and the limiting (infinite) correlation.

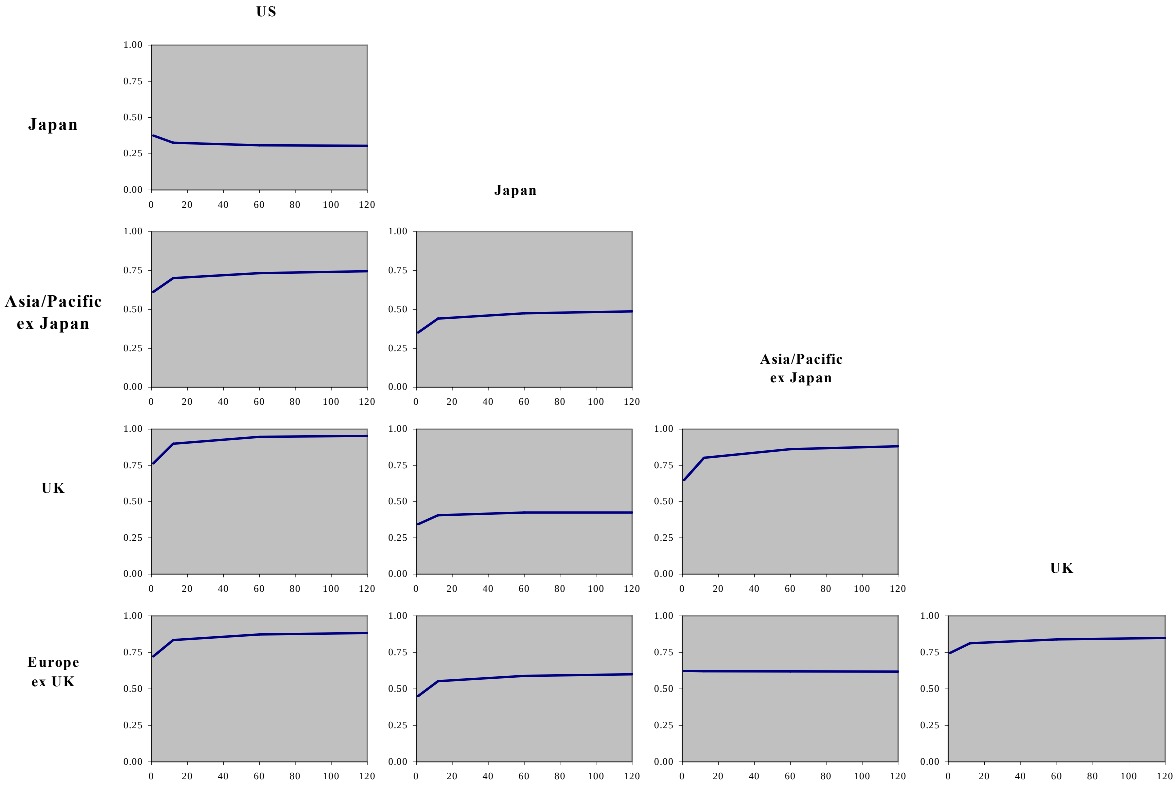
Correlation estimates for stocks

The estimated correlations between nominal returns in five equity markets for four different return horizons is shown in table A.2 and figure A.1. Similarly as in Pan, Liu and Roth (2001), we find support for 3 stochastic trends in the data. We see that the correlations between all markets increases with the horizon, except in the cases of USA and Japan, for which the correlations decreases when the return horizon increases, and Asia/Pacific (ex. Japan) and Europe (ex. UK) which has no horizon effect.

Table A.2: Term structure of correlations between stocks in five regions (1986-2006)

Monthly correlation (q=1)				
	US	Japan	Asia/Pacific ex Japan	UK
Japan	0.38			
Asia/Pacific ex Japan	0.61	0.35		
UK	0.76	0.34	0.65	
Europe ex UK	0.72	0.45	0.62	0.75
Yearly correlation (q=12)				
	US	Japan	Asia/Pacific ex Japan	UK
Japan	0.33			
Asia/Pacific ex Japan	0.70	0.44		
UK	0.90	0.41	0.80	
Europe ex UK	0.83	0.55	0.62	0.81
5 year horizon (q=60)				
	US	Japan	Asia/Pacific ex Japan	UK
Japan	0.31			
Asia/Pacific ex Japan	0.73	0.47		
UK	0.95	0.42	0.86	
Europe ex UK	0.87	0.59	0.62	0.84
Limit/infinite horizon				
	US	Japan	Asia/Pacific ex Japan	UK
Japan	0.30			
Asia/Pacific ex Japan	0.75	0.49		
UK	0.95	0.42	0.88	
Europe ex UK	0.88	0.60	0.62	0.85

Figure A.1: Term structure of correlations between stocks in five regions (1986-2006)[5]



[5] In the figure, the x-axis is the return horison in months and the y-axis is the correlation estimate.

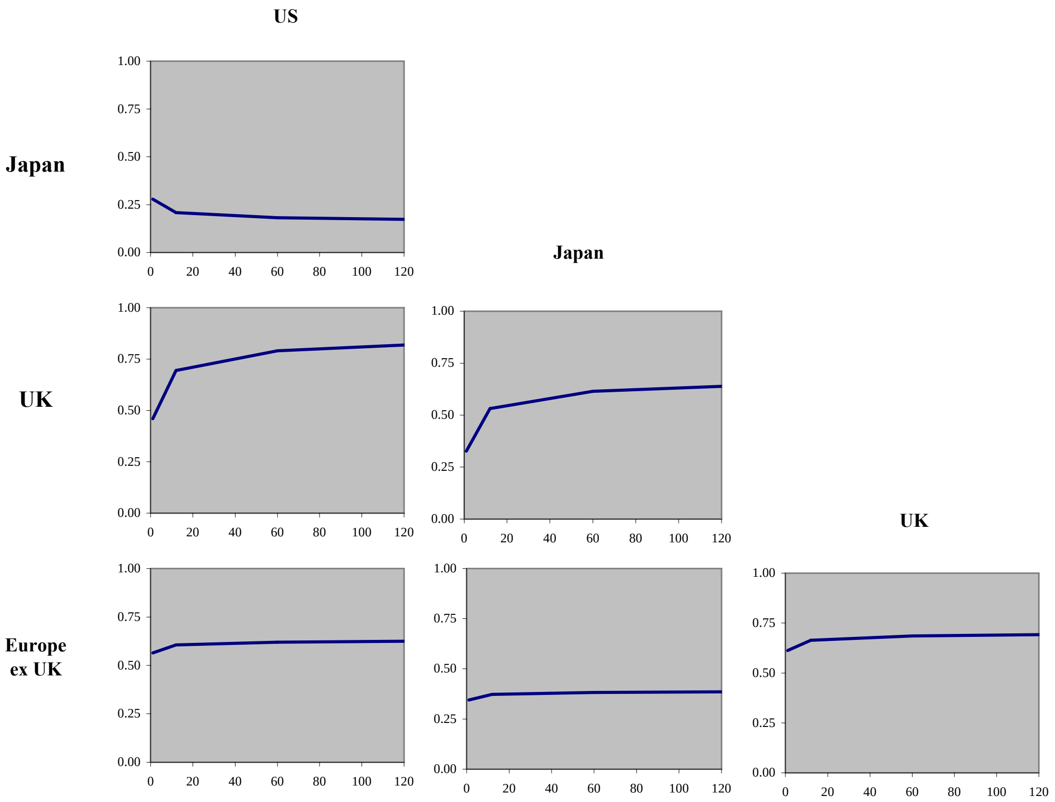
Correlation estimates for bonds

Table A.3 shows the estimated correlations between the bond indices for four regions. Similarly as in the case of stocks, we find that there are 3 stochastic trends. Also for bonds all the correlations, except in the case of USA and Japan, increases with the horizon.

Table A.3: Term structure of correlations between bonds in four regions (1986-2006)

	US	Japan	UK
Monthly correlation (q=1)			
Japan	0.28		
UK	0.46	0.33	
Europe ex UK	0.56	0.34	0.61
Yearly correlation (q=12)			
Japan	0.21		
UK	0.69	0.53	
Europe ex UK	0.61	0.37	0.66
5 year horizon (q=60)			
Japan	0.18		
UK	0.79	0.61	
Europe ex UK	0.62	0.38	0.69
Limit/infinite horizon			
Japan	0.17		
UK	0.82	0.64	
Europe ex UK	0.62	0.38	0.69

Figure A.2: Term structure of correlations between bonds in four regions (1986-2006)



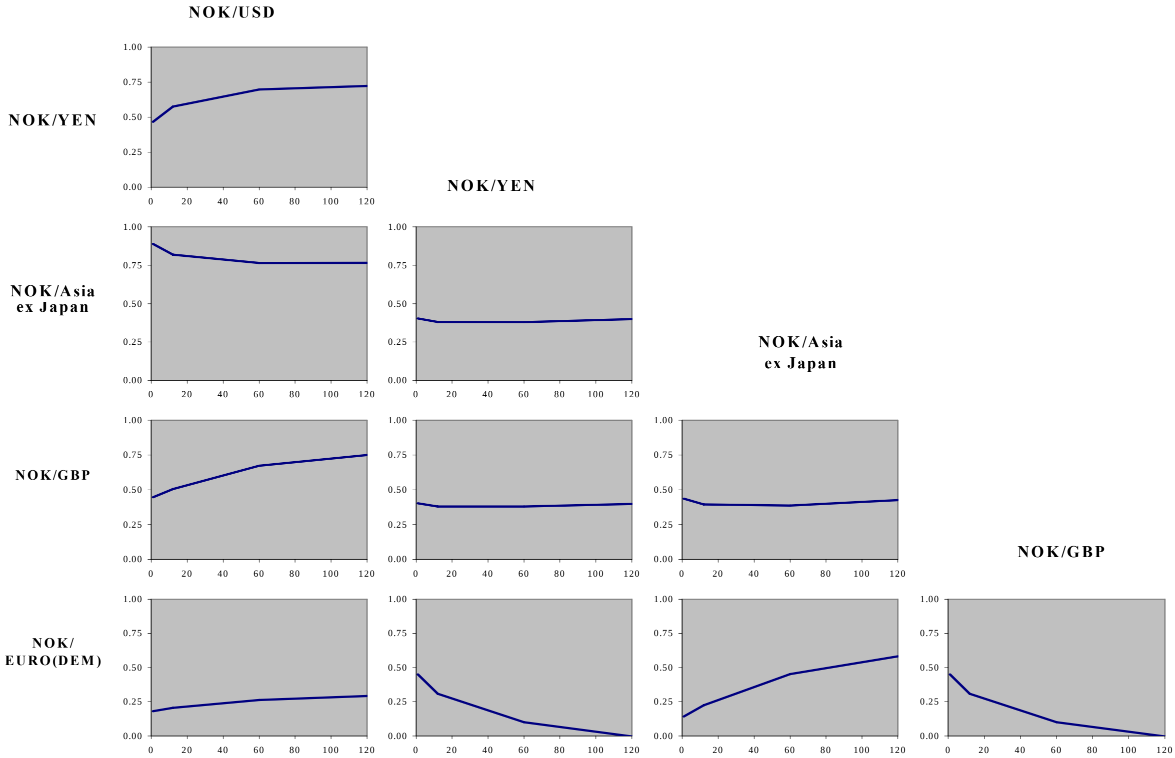
Correlation estimates for exchange rates

Table A.4 shows the estimated term structure of correlations between the exchange rates of NOK/USD, NOK/Yen, NOK/Asia-ex-Japan, NOK/GBP, NOK/Euro(DEM).

Table A.4: Term structure of correlations between exchange rates (1986-2006)

Monthly correlation (q=1)				
	NOK/USD	NOK/Yen	NOK/ Asia ex.Jap	NOK/GBP
NOK/Yen	0.47			
NOK/Asia-ex-Japan	0.89	0.49		
NOK/GBP	0.45	0.40	0.44	
NOK/Euro(DEM)	0.18	0.38	0.14	0.45
Yearly correlation (q=12)				
	NOK/USD	NOK/Yen	NOK/ Asia ex.Jap	NOK/GBP
NOK/Yen	0.58			
NOK/Asia-ex-Japan	0.82	0.56		
NOK/GBP	0.51	0.38	0.40	
NOK/Euro(DEM)	0.21	0.55	0.22	0.31
5 year horizon (q=60)				
	NOK/USD	NOK/Yen	NOK/ Asia ex.Jap	NOK/GBP
NOK/Yen	0.70			
NOK/Asia-ex-Japan	0.77	0.74		
NOK/GBP	0.67	0.38	0.39	
NOK/Euro(DEM)	0.26	0.72	0.45	0.10
Limit/infinite horizon				
	NOK/USD	NOK/Yen	NOK/ Asia ex.Jap	NOK/GBP
NOK/Yen	0.72			
NOK/Asia-ex-Japan	0.77	0.80		
NOK/GBP	0.75	0.40	0.43	
NOK/Euro(DEM)	0.29	0.79	0.58	0.00

Figure A.3: Term structure of correlations between exchange rates (1986-2006)



A-4 Summary

The results from this analysis indicate that there is a horizon effect in return correlations both for stocks and bonds. The most important result with respect to our purpose is that most of the horizon effect is occurring when changing from a monthly return frequency to a yearly frequency, while the remaining horizon effect seem to be relatively small.

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4. Fixed income markets

4.1 Introduction

This chapter will establish an expected return vector for the fixed income benchmark of the Fund. That benchmark is the Lehman Global Aggregate index with fixed regional weights and market capitalization weights within regions, across countries and to a large degree across sub-asset classes like treasuries, agencies, corporate credit etc.

When formulating the expected return estimate we will make separate estimates for the regions North America, UK, Europe ex UK, and Japan. Moreover, we will distinguish between public sector securities like treasuries, agencies, etc. on the one hand and corporate credits on the other. The share of corporate bonds in the benchmark is close to 25%.

In establishing the expected return estimate for government securities, we make use of several building blocks. First we discuss the natural real rate and various determinants for this hypothetical equilibrium rate. The expected return for our time horizon, stemming from a fixed duration trading strategy similar to the normal rebalancing of the Fund benchmark, will depend on both this assumed equilibrium level for real rates, our inflation forecasts and the current level of interest rates. This approach assumes that nominal rates mean revert around an equilibrium level, which itself is moving through time. The relative importance of the current rates versus the equilibrium level depends on the half life of the mean reverting process. In economic terms this translates into how quickly the economy reverts back to potential output from the current point in the business cycle. Expected return on corporate bonds will follow from the analysis on government bonds with the addition of a premium due to credit risk.

The line of reasoning presented above makes use of assumed relationships between variables that are not directly observable, like the natural rate of interest and the expected inflation rate. In the following we discuss these building blocks in detail.

Section 4.2 discusses the concept of the natural rate of interest and prepares the ground for a discussion of expected return from government bonds in section 4.3. We have separate arguments for the US, the euro zone, the UK and Japan and we discuss each region in relation to our three different scenarios (see chapter 1). Section 4.4 discusses the risks for fixed income markets in the three scenarios. Section 4.5 treats the expected excess return due to the credit premium for investment grade corporate credit. Section 4.6 ends this chapter with a discussion on including high yield bonds in the benchmark index.

4.2 The natural real rate of interest

Proponents of the natural real rate of interest identify this rate as the rate that prevails when the output gap is closed and when inflation is stable. A stable inflation usually means inflation equal to the target set by the central bank, if applicable. Hence, the concept fits with a neo-classical view where the economy is seen to evolve according to trend growth in the long run, but could temporarily be in a cycle away from this trend. Thus the interest rate will mean-revert around the natural rate in conjunction with the business cycle.

In the classical Solow growth model the steady-state real rate varies with the savings rate, the rate of technological progress and with the rate of population growth. Without population growth the real rate is the marginal product of capital and the long term real rate should equal the long-run or trend growth rate of the economy.

From the Solow model one would expect that a rise in the savings rate would lower the long-run average real rate of interest. A rise in the rate of technological progress or in the population growth would on the other hand raise the long-run average real rate. Bliss (1999) contains a discussion of the relevance of this and other classical models such as the Ramsey model and the Diamond model. His conclusion is that neither model is any good, and that some implications are contradictory among the models. Hence we have only a poor understanding of the drivers behind the long run real rate.

The concept of a "natural rate of interest" is not useful to real business cycle theorists. From their point of view each stage of the business cycle, peak, recession, trough and recovery, may constitute equilibrium. Hence there is no "natural real rate of interest" that the economy reverts to. Good and bad times in the economy are in this world simply a reflection of persistent real supply-side shocks, like e.g. random changes in the rate of technological progress, to which rational agents respond by altering their supply of labour and consumption. This implies that observed changes in output are viewed as changes in the natural rate of output, not deviations of output from a smooth deterministic trend.

A compromise between these two views is the notion of a *time varying* natural rate of interest. Now there still is a trend growth in the economy, but it is no longer constant and its relevance is to a very long time horizon. Real rates mean revert around a natural rate of interest, which itself varies over time. An important question is whether the natural rate of interest varies in a predictable manner or as a random walk.

Laubach and Williams (2001) assume that the natural rate of interest varies over time in response to shifts in preferences and the growth rate of output. Their estimation method has been repeated in several studies of European and American markets. The essence of the model is a reduced form IS curve describing the output gap with lags, the gap between the natural rate and the current rate, and a Philips curve explaining inflation with lagged inflation and output gap. The method relies on the Kalman filter to produce contemporaneous estimates of observed variables (inflation, GDP and current short interest rate) and unobserved variables (potential GDP, natural real short rate). When estimating the transition equation for potential output, they allow shocks to both the level of potential output and to its growth rate. Simple, uncorrelated random walks are applied to both components.

When estimating the natural rate, they model its transition through time based on the classical connection between the real rate and growth from the intertemporal utility maximization problem. Hence the natural rate is estimated as a function of the growth rate of potential output and one additional variable capturing "other determinants". Intuitively, changes in the growth rate of output could be attributed to changes in technology and productivity, while other determinants include changes in population growth or in the discount rate (i.e. households' rate of time preference). The estimated coefficient for the growth rate of potential output is close to unity. The estimated variability in both factors is small.

The neo-classical framework does not allow for any effect from inflation to the natural real rate. That framework does not explicitly account for risk, and there is no role for an active and effective central bank or for tax effects. Yet, arguments can be made on all these accounts for an effect from inflation on the real rate.

There is a possible *policy effect* because central banks want to attack rising inflation expectations by increasing the nominal short rate faster than the rise in inflation. Hence rising inflation should cause increased real rates, consistent with application of the Taylor rule in policy setting. One should be able to see this effect in the short end of the yield curve. If the central bank is not successful, inflation would keep on rising faster than expected, hence bringing the real rate down. If it is successful, real rates would remain on the high side until policy is eased. A lag of two to three years from an interest rate increase to signs of reduced demand in the economy is usually assumed. In both cases the policy effect is transitory in nature, hence less relevant for the natural real rate of interest.

Second, intuitively the inflation risk premium for long term bonds versus short term bills should depend on the level of inflation. Historically the volatility of inflation has been higher when inflation is high. Moreover, an unusually high (or low) level of inflation may be perceived by the market as less stable than a normal level of inflation. Hence, the required yield for investing in long term nominal bonds should increase. This *risk premium effect* should be reflected in the nominal term premium, thus increasing long term real rates when inflation is high. Again, the effect is less relevant for the short term natural rate.

Third, taxation of nominal yields makes pre-tax real yields inflation dependent. The *tax effect* arises because it is nominal yields that are taxed, and nominal yields, and thus tax, increase when inflation is high. Hence, the investor must demand a higher pre-tax required real rate to obtain the same after-tax real rate as earlier. The tax effect applies to all maturities and could be perceived as a structural effect that also applies to the natural rate. The mathematical effect of this argument is that pre-tax real rate should increase by (1/(1-s) -1) percentage points for each percentage point increase in inflation, where s is the tax rate. For instance, a tax rate of 30% implies an increase by 0.43 percentage points per percentage point increase in inflation.

A recent and comprehensive study of the relationship between real rates and inflation is Ang and Bekaert (2005). They seek to decompose changes in the nominal rates into changes in real rates, expected inflation and the inflation risk premium. Their vehicle is a term structure model with regime shifts where states are combinations of high and low real rates and inflation. The model describes both a real and a nominal term structure. The difference between the modelled yields of real and nominal bonds reflects expected inflation and the inflation risk premium. Expected inflation can, however, also be derived from the factor dynamics of the model, hence the modelled inflation risk premium can be isolated.

Their model is estimated on US data from the period 1952 through 2000. A number of stylized facts produced with the model are discussed. Some results particularly relevant for our discussion are the following: The unconditional real term structure is relatively flat, but hump shaped peaking at around two years maturity. There is no significant term premium for real rates. The correlations between the short real rate and both expected and unexpected inflation are negative, but the statistical evidence concerning expected inflation is weak. However, the correlations between both expected and unexpected inflation and five year real rates are robustly positive although estimated with high standard errors. The unconditional inflation risk premium for five year bonds, measured as the difference between yields of nominal and (modelled) index linked bonds less expected inflation, is estimated to be 0.97 per cent. It is lower in low inflation regimes (0.47) and higher in high inflation regimes (1.04). The inflation risk premium increases with maturity and fully accounts for the generally upward sloping nominal curve. Real rates tend to be pro-cyclical, i.e., they are lower in recessions and higher in expansions, while inflation and nominal rates are counter cyclical.

Aligning these findings with our discussion above; there seems to be poor support for the policy effect. The negative correlation between short real rates and unexpected inflation indicates that positive inflation shocks reduce real rates. The less certain relationship between real short rates and expected inflation could, however, indicate an activist central bank.

The risk premium effect seems to be confirmed in the study, but the implication for the shape of the nominal curve is rather complex. Intuitively a higher risk premium should be reflected in a larger term premium in the nominal yield curve. The finding of both a positive correlation between inflation and long real rates, an inflation risk premium that is larger when inflation is high and a relatively flat real term structure in high inflation regimes suggests that the nominal term premium should increase when inflation is high. Moreover, the negative correlation between the short end of the real curve and inflation works in the same direction , dampening the variation in the short end and making the nominal curve steeper in high inflation cases. This intuition is, however, difficult to confirm. Figure 4.1 is taken from Ang and Bekaert (2005) and shows the estimated real and nominal term structures for various regimes.

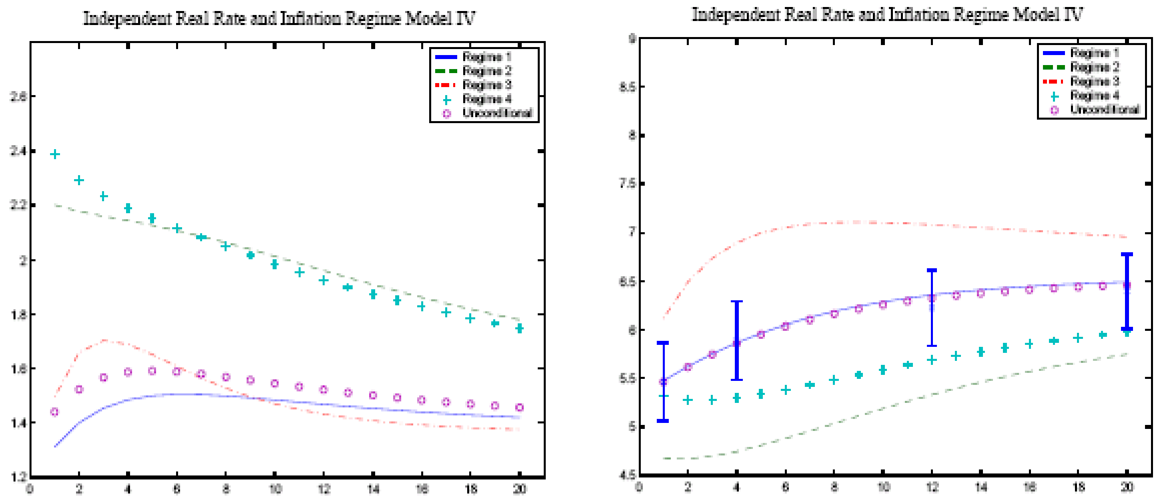

Figure 4.1: *Term structure of real (left panel) and nominal (right panel) interest rates under different regimes in a regime shifting model as presented in Ang and Bekaert (2005). Regime 1 has low and stable real rates and high and stable inflation. Regime 2 has high and stable real rates and low and stable inflation. Regime 3 has low and volatile real rates and high and volatile inflation. Regime 4 has high and volatile real rates and low and volatile inflation. Units on the y-axis are percentage and units on the x-axis are maturity in quarters of a year. In the right panel, vertical bars and faint x's in the middle of the bars indicate the standard deviation and historical average of the observed nominal rates Data is CRSP zero coupon rates in USA and seasonally adjusted all urban consumer price inflation, covering the period 1952 to 2000. Source: Copy from figures 3 and 7 in Ang and Bekaert (2005).*

The depicted term structures are estimates of typical shapes of the curve given different scenarios. Inflation is the main driver of the regimes as it is the regime shifting variable and influences the real state variable as well.

In figure 4.2 we show a simple plot of inflation, the term premium and the short real rate estimated as yield on a three month bill less the realized inflation over that period. We average these numbers over the US, UK, France, Germany and Japan. Only the time series for the US and UK span the whole period.

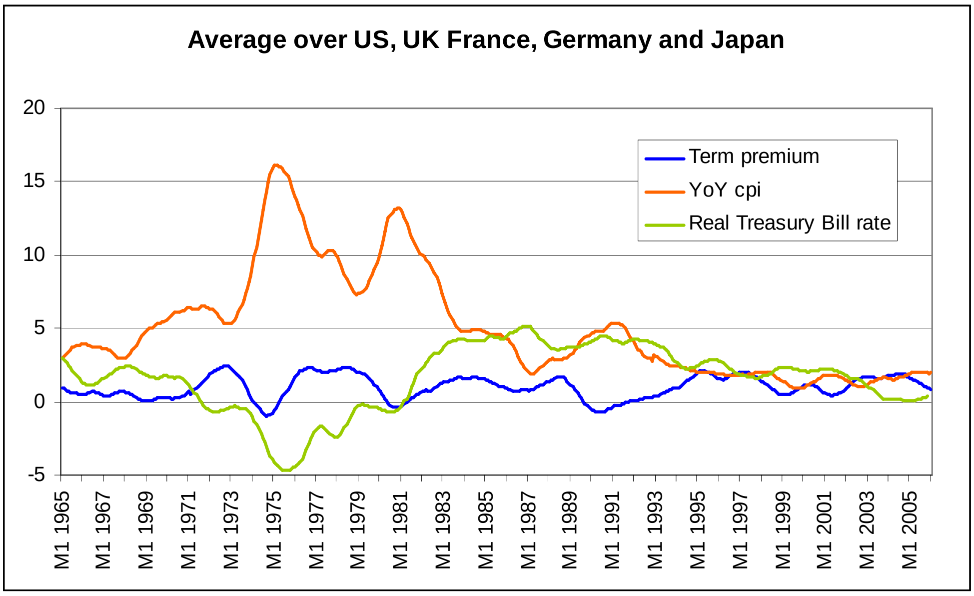

Figure 4.2: *Term premium measured as the difference between 10 year government bonds and 3 months government bills; and year on year ex post inflation from monthly data. Real rates are computed as difference between 3 month nominal rate and the ex post inflation covering the same period. Average levels for US, UK, France, Germany and Japan. Source: IMF and Norges Bank.*

Figure 4.2 seems to confirm a negative correlation between the short real rate and inflation in particular in the first half of the sample, but both the real rate and inflation has been trending downwards since the early nineties. One explanation for this could be that inflation was unexpected in the first half of the period and expected in the latter. An unexpected positive inflation shock would bring down the real rate and might explain the picture in the mid seventies. *Expected*, declining inflation, however, may be reflected in the nominal rates and stronger than on a one-to-one basis because of reduced inflation risk premium (long rates) in a less volatile low inflation environment, because of the tax effect, and perhaps even because of expansionary monetary policies which aim at reducing the real rate. This could be consistent with the development since the early nineties in figure 4.2. Note however that Ang and Bekaert (2005) find a negative correlation with both expected and unexpected inflation for short rates and a positive correlation with both expected and unexpected inflation for long rates.

The relationship between the term premium (yield on a 10 year government bond less three months bills) and inflation is not clear from figure 4.2. The average term premium in the sample is close to 1 per cent. Even the period of very high inflation from mid seventies to mid eighties did not see a term premium very far from that average.

A common representation of the yield curve is the "level", "slope" and "curvature" factors that move the yield curve in corresponding shapes. These three factors explain most of the variation in the nominal yield curve. Duffee (2002) concludes that level shocks correspond to near-permanent changes in interest rates and only minimal changes in the risk premium. Slope shocks corresponds to business-cycle-length fluctuations in both interest rate level and the risk premium, while twist shocks correspond to short-lived "flight to quality" variations in the risk premium.

Ang and Piazzesi (2003) develop a VAR model of the yield curve, restricted so that the curve does not allow arbitrage opportunities. They compare a model with latent factors only, to a model that also includes macro variables representing inflation and real activity. They find that both the traditional level factor and the slope factor are related to the dynamics of inflation, whereas the curvature factor is poorly accounted for by macro variables. In particular a large part of the slope factor can be attributed to inflation; when inflation is high, the slope flattens because the short rate increases relative to the long rate.

A similar exercise is done in Diebold, Rudebusch and Aruoba (2006). However, their point of departure is a Nelson-Siegel type of yield curve, hence applying restrictions that ensure positive forward rates at all maturities and a discount rate that approaches zero as maturity increases. They compare a yields-only model with a model that also includes macro variables (manufacturing capacity utilization, the federal funds rate and annual price inflation). When attributing the traditional factors to macro variables they confirm the finding that the curvature factor is little related to macro variables. The slope factor responds directly to both inflation, the funds rate and to capacity utilization. In particular, an increase in the policy rate immediately reduces the tilt of the curve. An increase in inflation also tends to flatten the curve, but this effect is less pronounced. The level factor seems to be guided by unexpected inflation shocks; surprises in inflation seem to produce a long-run boost to the level factor. The level factor is also influenced by the policy rate, but these shocks are temporary and smaller in magnitude.

Our interest concerns what happens to the expected return of our benchmark in different inflation scenarios. The benchmark strategy is to rebalance the portfolio according to an approximately constant duration index. The return of that index could be approximated[1] by buying a 5.5 year zero coupon bond in the beginning of the year, selling that 4.5 year bond one year later and reinvesting the proceeds in a new 5.5 year zero coupon bond. Hence it is the 5.5 year nominal rate and the spread between the 5.5 year rate and the 4.5 year rate that guide our estimate of expected return. Both the inflation dependent inflation risk premium and the positive correlation between long rates and inflation substantiate a belief in an increase in long rates, i.e., 5.5 year rates, under a high inflation scenario relative to our current state.

4.3 From interest rates to expected return

Our view on the future development of interest rates translates into expected returns in the following way: As most of the portfolio consists of nominal bonds, it is the future path of nominal rates that defines the future returns from the portfolio. We allow for letting the nominal rate and inflation converge to their future levels at different speeds, implying that the real rate and inflation are independent processes.

[1] The benchmark is a market weighted index of bonds with duration in the vicinity of 5. Changes in the shape of the curve will influence the return on such an index. We represent this intuition by concentrating on interest rates of approximately 5 years duration.

To find the future level of nominal rates to which the market mean reverts in each scenario, we begin by making an assumption on what the short real conditional "natural" rate will be. Hence we allow for a time varying natural rate and we believe that growth, and to a lesser extent inflation, are determinants of the natural rate. Both these variables differ across our scenarios. Next we add a scenario dependent term spread and our scenario dependent inflation estimate to arrive at the future nominal 5.5 year interest rate. Moreover, we need to make assumptions about how quickly inflation and the nominal rate will move towards their future mean reverting levels (steady states). Having obtained the nominal return estimate, we translate this to real returns by deducting expected inflation in each of the following 15 years. Hence the path of inflation does affect the real return estimate in this sense.

There are a few caveats to this line of reasoning. First, expected inflation is not observable, and nor is, strictly speaking, current inflation. What is observable is the realized change in inflation indices, hence the starting point for the path of inflation should not necessarily be the last observed index change. Rather, we will compute averages over the last 12 months of observed YoY changes in the index and use that as our estimate of current perceived rate of inflation.

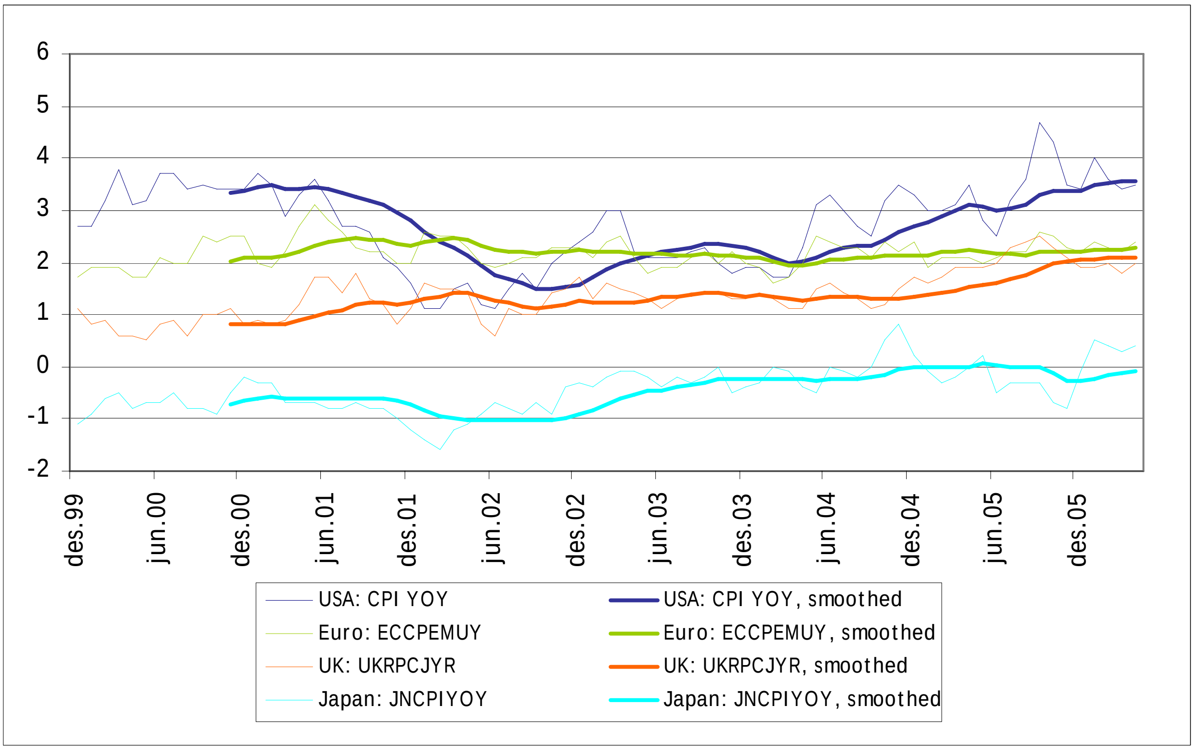

Figure 4.3: *Development of broad inflation indices in four regions. Actual year on year changes and 12 months average of changes for each region. Source: Bloomberg and Norges Bank.*

In figure 4.3 we show the actual and smoothed development of broad inflation indices. In the US we employ the US CPI Urban Consumers YoY NSA index, in the Euro-area the Eurostat Eurozone MUICP All Items YoY NSA index, for the UK the UK CPI EU Harmonized YoY NSA index and for Japan the Japan CPI Nationwide YoY index. All these indices are broad (headline) indices that include all consumption items. Lately core inflation indices, which in most countries exclude energy and foods, have shown lower inflation rates.

We will use the latest observation of the smoothed series as our estimate of current short term inflation. Hence we employ estimates of 3.7, 2.3, 2.1, and -0.1 percent for current perceived inflation in the US, Euro area, the UK and Japan, respectively.

Second, note that we are not making a direct assessment of the future path of real interest rates. The current 5.5 year real *rate* is a function of the current 5.5 year nominal rate and expected inflation over the *next 5.5 years*. We choose a simplified model that abstracts from the term structure of expected inflation. We need inflation estimates for calculating future real returns. Next year's real *return* from holding nominal bonds is a function of the evolution of the 5.5 year nominal rate and *next year's* YoY inflation. We obtain expectations of the next year's inflation by assuming a level 15 years ahead, and describing a path for year on year inflation from the current level to that future level.

The difference between the yield on an inflation indexed bond and a nominal bond should in principle reflect market participants' expectation of the sum of future inflation and an inflation risk premium. This relationship is, however, clouded by differences in liquidity and institutional demand for the two different assets. Disturbances are probably larger when the assets are new, and index linked bonds are a recent invention, in particular in Europe ex UK and in Japan.

In the US the index linked bonds are linked to the broad index shown in figure 4.3. In other countries the type of index employed varies, for instance excluding fresh food in Japan and excluding tobacco in the Euro area. In general broad indices that include energy are in use. Other sources of distortion in comparative analysis are that the bonds are indexed to inflation with varying degrees of lags, and protection in case of deflation varies. In the US there is a floor of 100 on the notional principal thus in effect introducing optionality in the inflation protection.

A long term average of the real yield from these bonds could therefore reflect other attributes in addition to the underlying macro fundamentals. However, as a check on our views and assumptions, a study of the market based real yields and implied inflation could be helpful.

In table 4.1 we see that the expected 10 year inflation and inflation risk premium is highest in UK and lowest in Japan. The real rate is quite similar in UK and Europe ex UK, about half a percentage point higher in USA and lower in Japan.

	Yield to maturity 10 year maturity		Difference (Exp. infl. + infl. risk prem.)
	Index linked	Nominal	
USA	2.6	5.2	2.6
UK	1.8	4.7	2.9
Euro area	1.9	4.1	2.2
Japan	1.0	1.9	0.9

Table 4.1: *Yield to maturity on index linked and nominal bonds for USA, UK, France (euro-area inflation and nominal bonds) and Japan as of late June 2006. Bonds with approximately 10 years of remaining maturity. Source: Bloomberg and Norges Bank.*

Comparing these estimates of the market's expectation of inflation over the next 10 years to the estimates of current short term inflation in figure 4.3 we see that inflation is expected to fall in the US, to remain relatively stable in Europe, and to increase slightly in Japan.

Figure 4.4 shows the recent development in the 10 year real rate and the term structure for the four regions. After some years of convergence between the US and European real rates the US rate has again risen above the European level. Japan is still trailing below Europe, but real rates have increased in the last year.

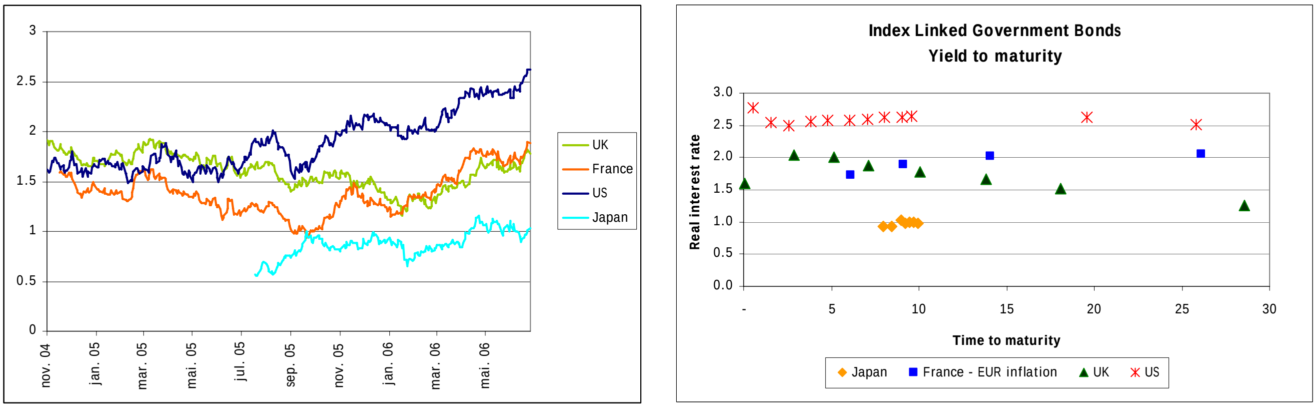

Figure 4.4: *Recent history of 10 year index linked yield to maturity (left panel) and term structure of yield to maturity of index linked bonds in four different regions (as per 28 June 2006). Source: Bloomberg and Norges Bank.*

In chapter 1 we have described three different global scenarios. Our base case is an inflation rate close to the assumed central bank targets in each region. Our high inflation scenario is stagflation, where around 5-7% inflation is coupled with low growth, while our deflation scenario has inflation at -1% coupled with low growth. These inflation levels are assumed to be representative of our scenarios for the 15 year horizon. In the extreme scenarios we do not differentiate between regions.

4.3.1 The US

Our point of departure is an estimate of the natural rate. Here we adopt the method of Laubach and Williams (2001). A recent application of their method is Fels and Pradhan (2006a). Their current estimate of the natural short rate in the US is 2.25% real or 4.15% nominal, 85 basis points below the current Fed funds rate. The average inflation over the period 1962 to 2006 is 4.39%.

We shall employ their estimates, but allow the natural short rate that prevails on a 15 year horizon to depend on our inflation scenario because of the tax effect. We do not allow the full mathematical effect to come through, since not all market participants will adjust their required real rates. We somewhat arbitrarily settle for about a quarter of the mathematical effect and assume an average capital tax rate of 25%. Hence we assume an effect on the natural rate of approximately 8 basis points per percentage point deviation from the average inflation rate of 4.39% during the estimation period.

Moreover, we assume that our high and low inflation scenarios are also associated with different growth assumptions. Growth of potential output is an important driver for the natural rate. We assume low growth in both the high and low inflation cases.

Hence, our conditional natural rate estimate in *the base case* is 2%, which is 2.25% less a tax effect of 25 basis points. Our high inflation - low growth estimate is 2.25% plus a tax effect but less a growth effect, producing an unchanged conditional steady state for the short real rate of 2%. Our low inflation - low growth estimate is 2.25 less both the tax effect and a growth effect, ending at 1.0%. The term "natural rate" for the interest rate targets in the high and low inflation case should be used with caution. The concept of a "conditional natural rate" for each scenario is somewhat of a misnomer, although our intention is to capture the time variation in the natural rate.

Next, we expect the nominal 5.5 year rate to rise more in a high inflation scenario because of an inflation dependent term spread over the natural rate. The risk premium effect will imply a higher mark up over the natural rate in high inflation scenarios. Our point of departure here is the unconditional estimate of the inflation risk premium of Ang and Bekaert (2005), which coincides with the historical average term premium for nominal yields. Again, this premium is probably influenced by the historical level of inflation. We therefore adjust the unconditional estimate of 1% down to 80 basis points for our base case. In the high and low inflation scenarios we assume 1% and 0.6% respectively. Ang and Bekaert (2005) find estimates of 1.04 and 0.47 in their high and low inflation regimes. Table 4.1 summarizes these assumptions.

The current (June 28, 2006) 5.5 year rate in the US is 5.12% and our estimate of the current year-on-year headline consumer price inflation in the US is 3.7%. The effect of the assumptions in table 4.2 on the expected return from rebalancing to a 5 year duration portfolio over the next 15 years depends on how quickly the current levels are assumed to converge to their long term conditional equilibriums.

Scenarios - USA	Low inflation Low growth	Base case	High Inflation Low growth
Conditional natural short real rate	1.0	2.0	2.0
Inflation level 15 years from now	-1.0	2.5	7.0
5.5 year term spread over natural rate	0.6	0.8	1.0
15 year steady state for 5.5 year real rate	1.6	2.8	2.9
15 year steady state for 5.5 year nominal rate	0.6	5.3	10.1
Pull on nominal rate to steady state	strong	strong	strong
Transition to scenario inflation	slow	quick	slow
	Expected real (nominal) return		
15 year, geometric	2.5 (3.3)	2.5 (5.2)	1.4 (7.2)
	Attribution (nominal, arithmetic)		
Yield	1.8	5.3	8.7
Capital gain/loss	1.4	-0.1	-1.5
Rolldown effect	0.1	0.0	0.1

Table 4.2: *The US. Assumptions about the natural interest rate, inflation rate and term premium over the natural rate in three different inflation scenarios. Source: Norges Bank.*

We assume that the importance of the natural real rate is greater when inflation is close to target and the economy is in good working order, because central bank policy is most effective in such a scenario. In our base case scenario we consequently believe that the inflation rate quickly converges to the central bank target. We assume that the recent increases in interest rates will have an effect on inflation in the coming years, bringing the headline inflation down from the current level to 3.1% next year and to 2.7% in three years' time. The expected mean inflation rate for the entire 15 year period is 2.7%, which is close to the estimate for the 10 year expectation in the Livingston survey.

We assume that nominal rates will stay flat at current levels for the entire period, which implies that real rates will increase towards 2.7% as inflation falls. The flat curve will make roll down returns negligible. The expected return is in this scenario 2.5% in real terms and 5.2% nominal.

In the high inflation - low growth (stagflation) scenario we assume that inflation moves towards a 7% level at the end of the 15 year period. In the beginning of the period we assume that the central bank tries to fight unexpected inflation shocks by increasing the real rate rather quickly, and this action will be reflected in the 5 year rate as well. Inflation will, however, continue to rise and gradually the central bank will revise its inflation target upwards to avoid a too costly reversion to current inflation levels. Hence, the real 5 year rate stays relatively flat the last 10 years of the 15 year period, while inflation continues to rise.

The current curve in the US is very flat, in particular in the 2-10 year area. As our assumptions imply that most of the movements in interest rates takes place in the beginning of the period we assume only a small roll-down effect of 10 basis points on expected return. In this scenario the expected bonds return will be negative the first couple of years and then converge to the real rate towards the end of the period. Expected geometric return for the whole 15 year period is 1.4% in real terms and 7.2% nominal. The realised annual inflation over the period is 5.7%.

In the deflation scenario we assume that inflation will move towards -1% on a 15 year horizon. In this scenario the central bank tries to fight unexpected deflationary impulses by lowering real rates in the beginning of the period. However, the policy is assumed to be unsuccessful, and the inflation continues to fall. The nominal rate is helped quickly downward by the central bank in the first few years, from the current 5.12% level to around 2.5% three years from now. The nominal rates continue to fall as a reduction in economic growth filters through, while real rates remains relatively constant as inflation moves downwards and into deflation.

The expected return under this scenario is 2.5% real and 3.3% nominal. Again we assume a roll-down effect around zero. In an environment with falling rates the curve is not likely to be steep. The return will be quite good the first few years due to the capital gains effect as interest rates fall. The annual inflation over the 15 year period will in this scenario be close to 0.8%.

To describe the scenarios more precisely, we show graphs of the development of interest rates, inflation and annual return over time. Figure 4.5 shows the base case. We see that the nominal rate is stable over the entire period, while the real rate converges to its natural level as inflation approaches its long term scenario level.

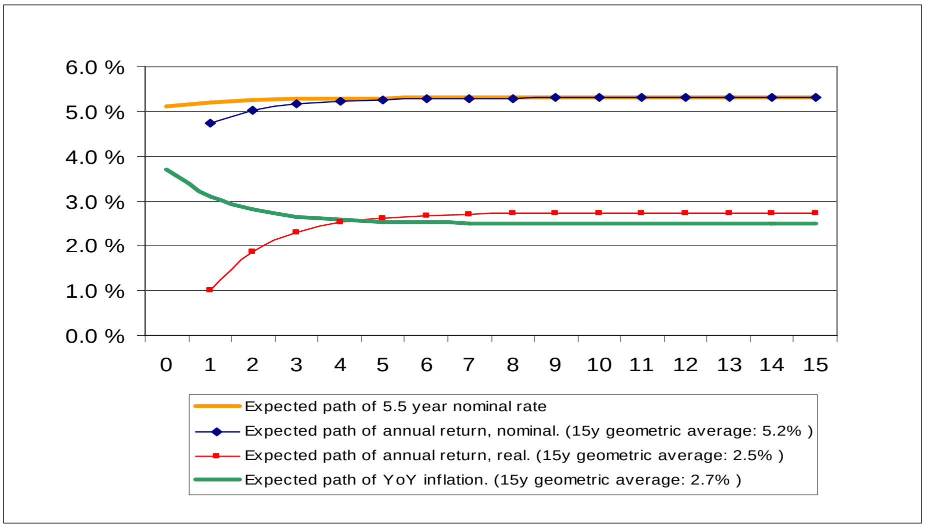

Figure 4.5: *The US. Base case scenario for a 15 year horizon: Expected path of the nominal 5.5 year interest rate, the inflation rate, and the nominal and real annual return from buying a 5.5 year bond, selling it as a 4.5 year bond one year later, and reinvesting in another 5.5 year bond. Source: Norges Bank.*

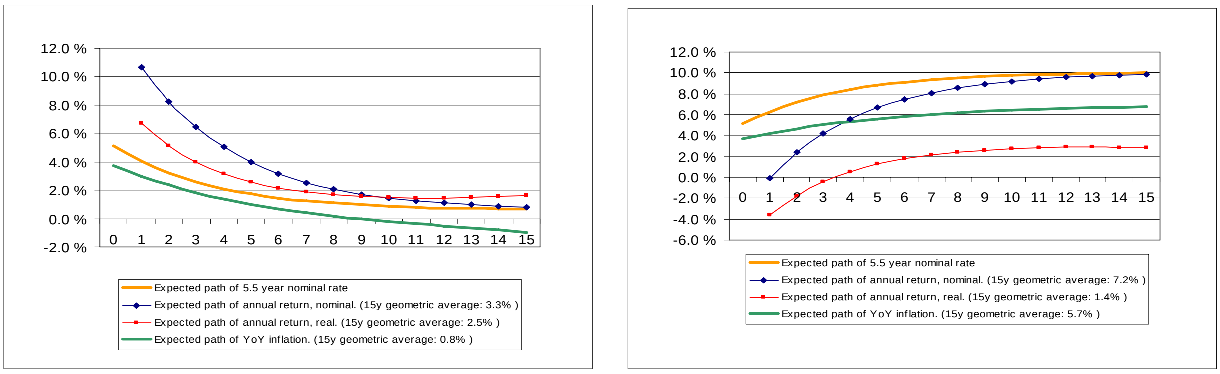

Figure 4.6: *The US. Low inflation scenario (left panel) and high inflation scenario (right panel): Expected path of nominal 5.5 year rate, inflation and nominal and real annual return from buying a 5.5 year bond, selling a 4.5 year bond one year later, and reinvesting in a 5.5 year bond over 15 year horizon. Source: Norges Bank.*

Figure 4.6 shows corresponding graphs for the return in the low and high inflation scenarios. In both cases the central bank tries to fight the development, producing a corresponding initial change in the real rate. After a few years the policy proves ineffective and a new inflation target is accepted for the remainder of the 15 year period. The paths of inflation in our scenarios are assumed to converge slowly to the assumed scenario levels, except in the base case when monetary policy is effectively bringing inflation to target.

Robustness of various assumptions in the stagflation scenario

The worst scenario for the fxed income market is the stagflation scenario. However, even in that case the expected real return is not extremely bad at 1.4%. The expected return number is a function of the scenario (path of inflation over 15 years and the growth assumption), the conditional natural rate and the term premium assumptions. To investigate the robustness of the expected return number for changes in these assumptions we have tried a different path for inflation as well. Here the scenario evolves so that the inflation climbs to 7% after 5 years, stays high for another three years and then falls towards 2% at the 15 years horizon. The average inflation over the period is close to our present stagflation case at 6%.

Only changing the path of inflation produces a higher expected return because of the capital gains as the nominal rate decline together with inflation in the last part of the period.

Regarding the other assumptions, the term premium is assumed to be 1% in the stagflation scenario. This is less than the historical average over the last 40 years and around half the average over the last high inflation period in the seventies to mid eighties. Hence this is already a conservative estimate.

A more vulnerable assumption is the conditional natural rate in a stagflation scenario. Low growth would likely reduce the natural rate; however we have assumed this effect to be countered by a tax effect, thus summing up to an unchanged natural rate relative to the base case. Estimates of the natural rate indicate that a reduction in potential growth (the trend growth rate) will lower the natural rate. In our stagflation scenario we assume that GDP growth will be reduced by about 1 percentage point 15 years from now, however the trend growth will likely be reduced less as the economy is assumed to recover after the 15 year period. In Laubach and Williams' estimation, the trend growth rate declined from about 3.5 to 3.0 in the period from 1965 to the mid seventies, and they argue that the natural rate seems to move one-to-one with potential growth.

Hence, given the nature of our stagflation scenario, a reduction in the conditional real natural rate from 2 percent to 1 percent, seems like an assumption biased to the low side. Such an assumption would yield a decrease in the expected return of 40 basis points, from 1.4 percent to 1.0 percent expected real return.

Combining a reduction in the conditional natural rate with a change in the path of inflation, as described above, the expected return is still larger. Such a combination would yield an expected return of 2.1 percent rather than the 1.4 percent we arrived at for our stagflation scenario.

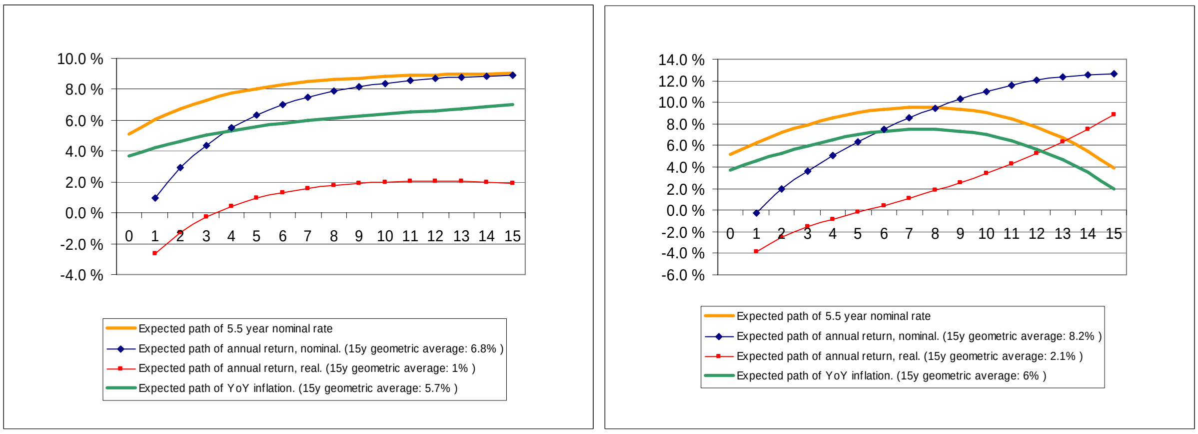

Figure 4.6b: *The US: Alternative assumptions in the high inflation (stagflation) scenario. Left panel: the conditional natural rate is reduced by one percentage point. Right panel: combination of reduced conditional natural rate and altered path of expected inflation. Source: Norges Bank.*

4.3.2 Europe and the UK

In this section we apply the same line of reasoning as above to the case of Europe ex UK and the UK. In view of the very large uncertainty surrounding estimates of the natural rate, we shall require strong arguments not to assume the same natural rate in all regions. One argument for different regional rates seems, however, relevant: Important determinants of the natural rate include the savings rate, productivity growth and population growth. There is some basis for having different estimates of these variables between Europe and the US.

Fels and Pradhan (2006b) estimate the natural rate for the euro-area currently to be around one percentage point lower than in the US, i.e., around 1.3%, and the difference has widened in later years. They argue that this is consistent with observed divergence in drivers such as productivity and population growth. Moreover, the propensity to save has dropped in the US while it has risen in the euro area. But they also show very large fluctuations over time in their estimate of the natural rate, and more so for the euro estimate than for their US estimate. They argue that the post EMU drop in the natural rate could be explained by the ECB quickly acquiring credibility in terms of commitment to keep inflation low.

Even though some other estimates are lower than the Fels and Pradhan estimate (e.g. Wintr et al (2005) find a natural rate for the euro area close to 0.5% using the same Laubach and Williams methodology), there are also several estimates that are higher. Amato (2005) puts the natural rate at 2.5% for both the euro-area and the US. Slightly older estimates in Cuaresma et al (2003), Gerdsmeier and Roffia (2003) and ECB Monthly Bulletin (2004) all have estimates in the vicinity of the US estimate. Boone (2006) also employs the Laubach and Williams methodology, albeit with a different measure for the output gap, and arrives at 2.25 for both the euro area and the US. He comments on the fragility of the Kalman filter specification; a slight alteration in specification of relative volatility of variables produces significant differences in the natural rate estimate.

Summing up, we accept that both a lower savings rate and lower population growth point to a lower estimate for Europe than for the US. Hence we choose to lower *the base case* estimate of the natural rate by half a percentage point to 1.5% for both Europe ex UK and the UK. We also adopt a lower inflation outlook for these two regions in the base case scenario, due to a perceived lower inflation target for the European Central Bank. In the base scenario we set a 2.0% level for inflation 15 years from now. The term premium for bonds is still assumed to be the same as in the US.

In the global *stagflation scenario* we assume the same conditional natural rate as in the base case, i.e., 1.5%, as we did for the US. In the *deflation scenario* adopt the same assumption as for the US case, i.e. a natural rate of 1%.

Our estimate for expected returns in the two European regions will therefore only differ due to the difference in the current interest rate levels. Current (June 28, 2006) 5.5 year interest rate is 3.8% in euro area and 4.8% in the UK. Current inflation levels are 2.3% in the euro area and 2.1% in the UK. Table 4.3 shows the resulting expected returns.

	Low inflation Low growth	Base case	High Inflation Low growth
Scenarios - Europe and the UK			
Conditional natural short real rate	1.0	1.5	1.5
Inflation level 15 years from now	-1.0	2.0	7.0
5.5 year term spread over natural rate	0.6	0.8	1.0
15 year steady state for 5.5 year real rate	1.6	2.3	2.4
15 year steady state for 5.5 year nominal rate	0.6	4.3	9.6
Pull on nominal rate to steady state	strong	strong	strong
Transition to scenario inflation	slow	quick	slow
Expected real (nominal) return			
15 year, geometric, Europe ex UK	2.2 (2.5)	2.0 (4.1)	1.0 (6.3)
15 year, geometric, UK	2.9 (3.0)	2.5 (4.5)	1.7 (6.9)
Attribution (nominal, arithmetic) Europe/UK			
Yield	1.5 / 1.7	4.2 / 4.4	8.0 / 8.3
Capital gain/loss	1.0 / 1.3	-0.2 / 0.2	-1.8 / -1.5
Rolldown effect	0 / 0	0 / 0	0.1 / 0.1

Table 4.3: *Assumptions and expected returns in the Euro Area and the UK. Source: Norges Bank.*

In figure 4.7 we show the path of different variables in the base case scenario for Europe ex UK and the UK. We see the effect of the differences in current pricing. The real rate is currently relatively high in the UK and relatively low in the rest of Europe. We assume in the base case that the real rates will converge in the two regions.

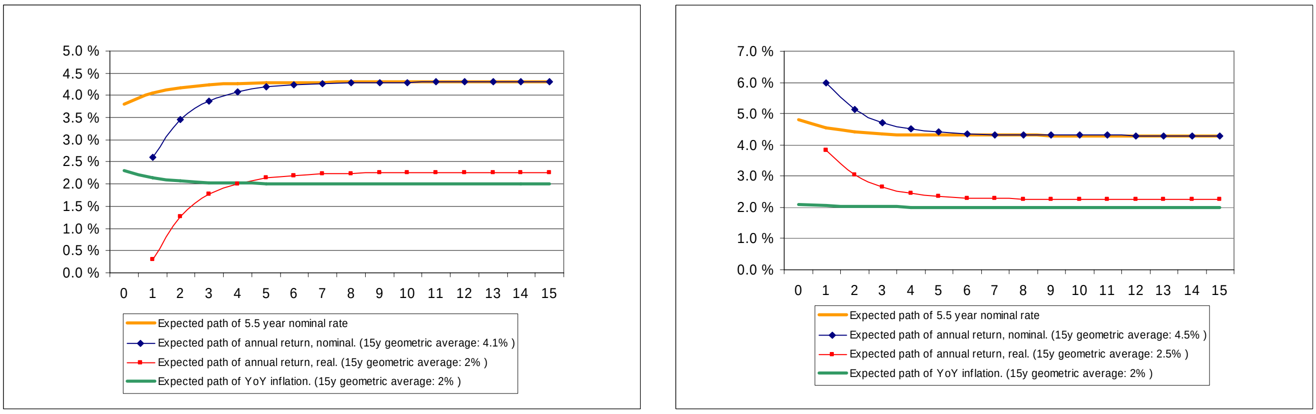

Figure 4.7: *Base case scenario. The left panel is Europe ex UK, and the right panel is UK. Source: Norges Bank.*

In the two extreme scenarios the central bank is assumed to combat the inflationary and deflationary development in the beginning of the period, and then gradually accept the new level of inflation. In the stagflation case for the UK, we assume that the real rate will increase in the first few years before it reverts to its conditional long term level, which is lower than the current real rate level in the UK.

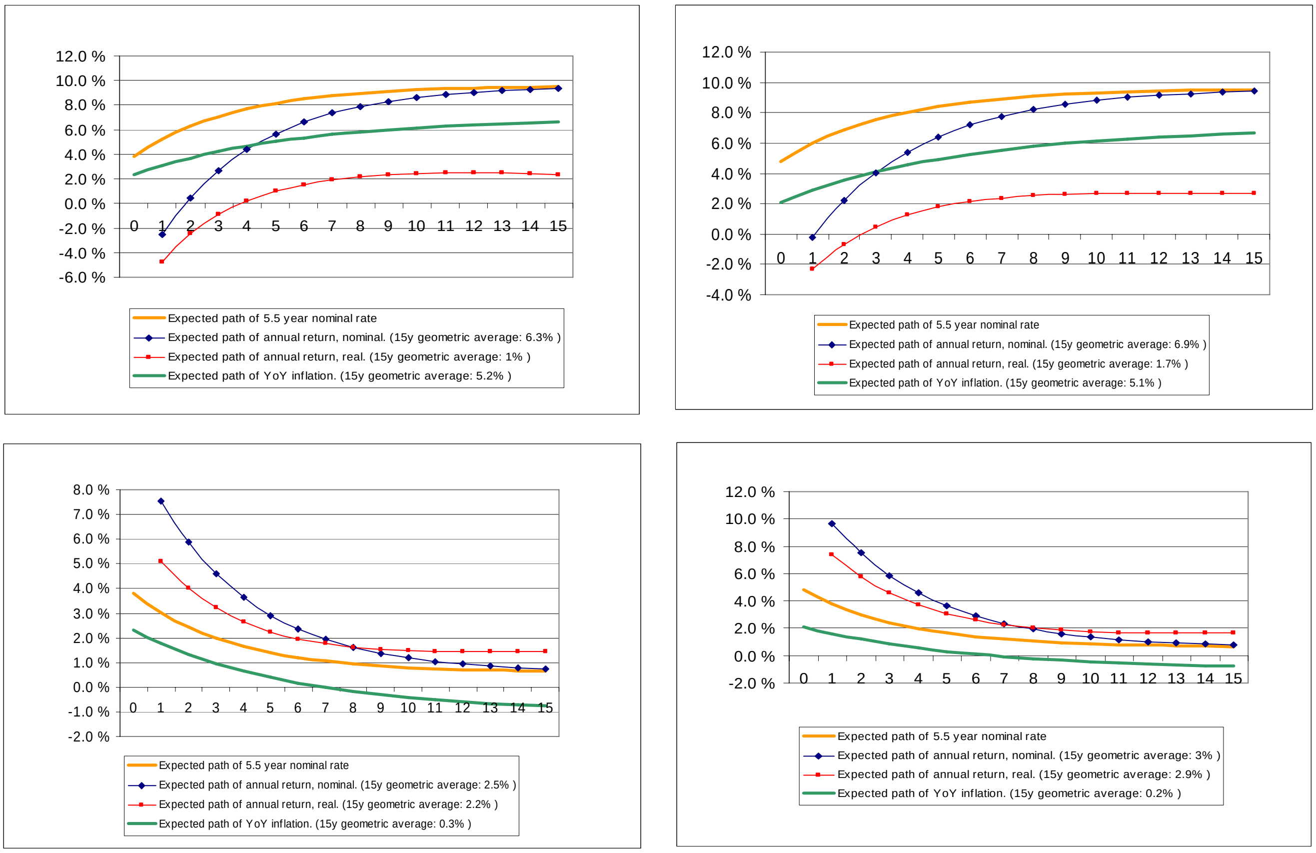

Figure 4.8: *The left panels describe Europe ex UK. The top panel is the stagflation scenario and the bottom panel is the deflation scenario. To the left is Europe ex UK and to the right is the UK. Source: Norges Bank.*

4.3.3 Japan

Given the very recent steps towards normalization of monetary policy in Japan and its history of deflation up until a few months ago, the outlook in Japan is harder to describe than the cases of Europe and the USA. We have chosen to adopt the same estimates for the conditional natural rate as in Europe, mostly based on a demographic situation resembling Europe rather than the US. The growth prospects remain uncertain. We also put the inflation target in the base case equal to that of Europe, but we assume that the path towards that target in the base case is slower than in Europe. Many analysts doubt that inflation will reach such a level within this horizon, but the central bank might wish to establish a cushion to provide policy latitude in case of renewed deflationary problems. The natural rate is a less studied subject for Japan, and we are not aware of recent numerical estimates for that country. Table 4.4 summarizes our assumptions and shows the resulting expected returns.

The current (June 28, 2006) 5.5 year interest rate is 1.4% in Japan and the current level of inflation is -0.1%, measured as the 12 month average of year-on-year change in the consumer price index. We present the expected paths of the nominal rates, inflation and real and nominal annual return in the following figures. Note the slow progression towards conditional equilibrium in the base case depicted in figure 4.9. Realised inflation in the 15 year period will be 1.2% with these assumptions.

Scenarios - Japan	Low inflation Low growth	Base case	High Inflation Low growth
Conditional natural short real rate	1.0	1.5	1.5
Inflation level 15 years from now	-1.0	2.0	7.0
5.5 year term spread over natural rate	0.6	0.8	1.0
15 year steady state for 5.5 year real rate	1.6	2.3	2.4
15 year steady state for 5.5 year nominal rate	0.6	4.3	9.6
Pull on nominal rate to steady state (halflife)	strong	strong	strong
Transition to scenario inflation (halflife)	slow	slow	slow
	Expected real (nominal) return		
15 year, geometric	1.7 (1.1)	1.7 (2.9)	0.6 (4.8)
	Attribution (nominal, arithmetic)		
Yield	0.8	3.9	7.4
Capital gain/loss	0.3	-0.9	-2.6
Rolldown effect	0.0	0.0	0.2

Table 4.4: *Assumptions and expected returns for the case of Japan. Source: Norges Bank*

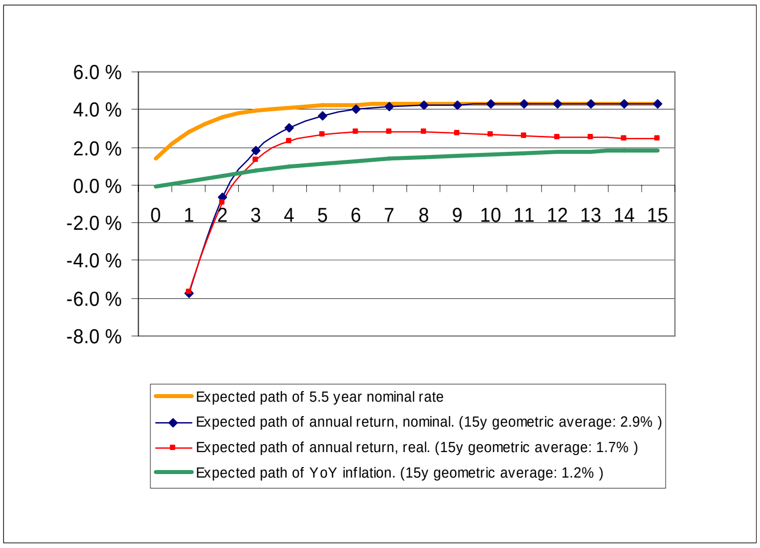

Figure 4.9: *Japan: Expected paths of 5.5 year nominal interest rate, inflation and real and nominal annual return in the base scenario. Source: Norges Bank.*

In figure 4.10 we show the low and high inflation scenarios. The average inflation over the 15 year period is -0.7% and 4.2%, respectively, in the low and high inflation scenarios. Notice the extremely bad returns the first few years in the high inflation scenario. Japan appears to be a country with low potential and a large downside risk for this set of scenarios.

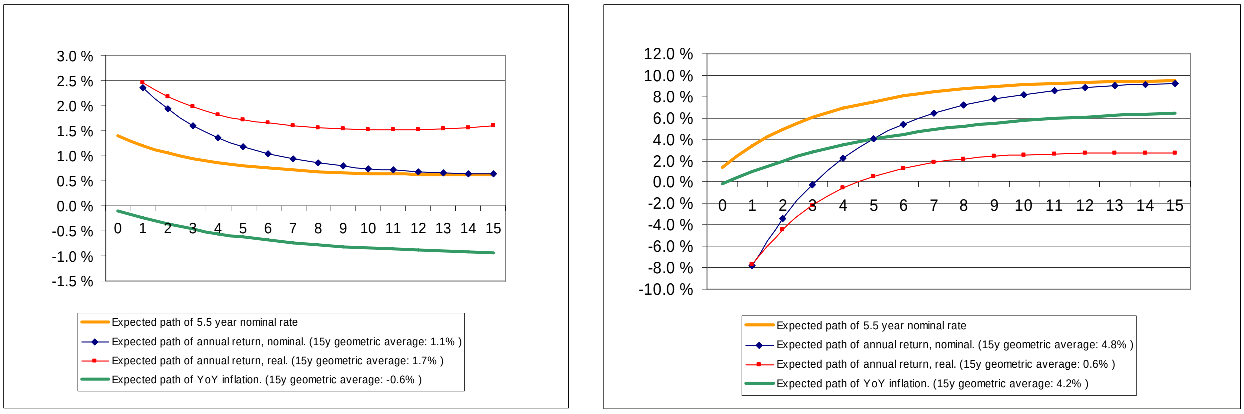

Figure 4.10: *Japan: Expected paths of 5.5 year nominal interest rate, inflation and real and nominal annual return. Deflation scenario (left panel) and stagflation scenario (right panel). Source: Norges Bank.*

Summing up, table 4.5 gives the expected return for government bonds in the four regions and for the three scenarios. The table gives expected geometric real return for a 15 year time horizon.

	USA	Europe ex UK	UK	Japan
Deflation scenario	2.5	2.2	2.9	1.7
Base case scenario	2.5	2.0	2.5	1.7
Stagflation scenario	1.4	1.0	1.7	0.6

Table 4.5: *Expected geometric real return on government bonds for the coming 15 years. Source: Norges Bank.*

4.4 Expected return on corporate bonds

The Lehman index comprises about 55% government bonds and about 20% corporate bonds, while the remainder of the index consists of various bonds falling mainly within an intermediate category of creditworthiness, but more similar to government than to corporate bonds. The average rating of the corporate bonds is in category A of Standard and Poor's grading. The proportion of corporate bonds is approximately identical in Europe and the US, while in Japan all fixed-income investments are in government bonds. We will assume a common risk premium for A rated corporate bonds both in Europe and in the US.

The observed credit margin may reflect a number of differences between government securities and credit bonds, such as differing tax treatment, liquidity differences, compensation for expected loss resulting from bankruptcy, risk premium, and possibly also implicit option contracts. Estimates of expected excess return generally control for the expected bankruptcy loss and for the value of any options.

Here we adopt an unconditional estimate of 80 basis points in excess expected return on single A rated bonds. This estimate is based on various studies such as Elton et al (2001), Verloot (2002) and Dimson et al (2002) and the discussion in Ilmanen (2004). See last year's market report, Norges Bank Staff Memo 2005/10, for more details.

4.5 High yield bonds

A high-yield bond is a bond with a lower credit rating than investment grade (BB/Ba or less).[2] There are three main types of high-yield issuers; original issuers, fallen angels and leverage buyouts (LBOs). Original issuers are often young growing companies, emerging market companies or venture capital projects. New loans with lower priority raised by investment grade issuers also fall into this category. A fallen angel is a bond that was originally issued as investment grade, but has since been reduced to a high-yield bond. In a LBO, a public firm is taken private with the use of debt such as bank loans and bonds. Because of the large amount of debt relative to equity in the new firm, the bonds are typically rated below investment grade.

Currently, the Fund's fixed income benchmark is restricted to bonds with investment grade. The reasons why the Fund should consider inclusion of high-yield bonds are (i) that the high yields might more than compensate for the additional risk and/or (ii) that the high-yield bond segment might offer the Fund a significant diversification benefit. High-yield bonds are included in the Fund's investment universe, but there is currently no designated group in NBIM that specializes in the analysis of this type of securities. Hence, the expected benefits from including high-yield bonds in the benchmark should also cover the costs of building up skills in this area.

The Lehman Brother's Global High-Yield Index

A natural way to include high-yield bonds in the Fund's benchmark would be to use the Lehman Brother's Global High-Yield (GHY) Index. The GHY index was created on January 1, 1999. At the end of March 2006 the market value of the index was around $945 billion. To be included in the index, a security must be rated Ba1/BB+/BB+ or lower using the middle rating of Moody's, S&P and Fitch. The maturity of the security must be at least 1-year (regardless of optionality) and the security must be denominated in USD, EUR, GBP, DKK or NOK.[3] Figure 4.11 shows the sector and quality breakdown of the GHY index at the end of 2005.

[2] Because of low credit rating, high-yield borrowers must promise to pay high coupon rates to entice bondholders to invest. High coupon rates increase the credit risk further since these companies are least able to afford high interest charges. Elton et al (2001) find that the credit spread risk is also higher for high yield bonds than for investment grade bonds. Moreover, the tax effect is larger due to high coupon rates.

[3] Securities with coupon that converts from fixed to floating-rate must have at least 1-year until conversions date. CMBS must have an expected maturity of at least 1-year.

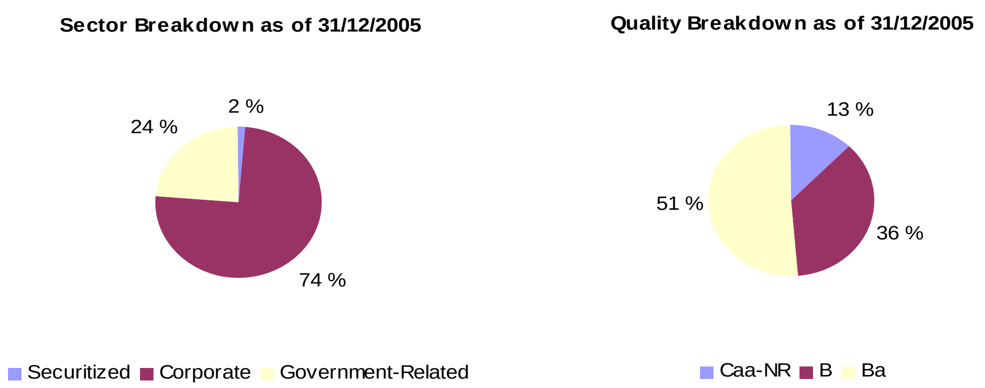

Figure 4.11: *Sector and quality breakdown of the Lehman Brothers Global High-Yield Index.*

Around ¾ of the global high yield index consists of corporate bonds. The residual part consists mainly of government-related securities. Around half of the index value has a quality of Ba. The GHY index consists of five sub-indices: U.S. Corporate High-Yield Index, Pan-European High-Yield Index, Emerging Markets High-Yield Index, CMBS High-Yield Index, and Pan-European Emerging Markets High-Yield Index. Table 4.6 below presents some facts about the sub-indices.

Sub-indices	**Currency**	**Min. amount outst.**	**MV 03/2006**	**%**
U.S. Corporate HY	USD	USD 150 mill	USD 590 bill	62
Pan-European HY	EUR, GBP	EUR 100 mill	USD 101 bill	11
Emerging Markets HY	USD	USD 500 mill	USD 203 bill	21
CMBS HY	USD	No min trans. size	USD 17 bill	2
Pan-Euro Emerging Markets HY	EUR	EUR 500 mill	USD 34 bill	4

Table 4.6: *Lehman Brother's Global High-Yield Index*

With a market value of $590 bill, or 62 percent of the GHY index value, the US Corporate High-Yield Index is clearly the dominating sub-index. To get a broader picture of the size of the high-yield markets, we compare their size and growth to the respective investment grade markets in table 4.7.

Indices	**MV at start USD bill (%)**	**MV 03/2006 USD bill (%)**	**Growth Ann. %**
Global market, Jan-1990-Mar-2006			
- Aggregate	4 000	21 462	10.9
- High-yield	59	945	18.6
- Share HY	(1.4)	(4.2)	
Pan-European market, Jan-1999-Mar-2006			
- Aggregate	5 472	8 159	2.5
- High-yield	5	101	19.7
- Share HY	(0.1)	(1.2)	
U.S. market, Jan-1987-Mar-2006			
- Aggregate	2 150	8 272	8.6
- High-yield	37	590	18.6
- Share HY	(1.7)	(6.6)	

Table 4.7: *Size and growth of the high-yield markets relative to investment grade markets*

Time periods with available data from high yield bonds varies considerably between markets. For the global indices, the starting market values are from 1990. For the Pan Euro and US indices, market data start from respectively 1999 and 1987. The table shows high growth in the high yield segments, at 18.6 percent annually for the global index in the period 01/1990-03/2006. In spite of high growth in the high-yield segments, their sizes are still quite low measured as a percentage of the respective total markets, at most 6.6 percent for the US market.

The U.S. Corporate High Yield Index is probably the most interesting for inclusion in the Fund's benchmark. The bulk of the index consists of industrial bonds (86.2 percent at the end of 2005). The two other sectors are Utility (11.4 percent) and Financial (2.4 percent). At the end of 2005, 42 percent of the index value consisted of Ba rated bonds, 42.8 percent were B-rated bonds, and 13.4 percent were Caa-rated bonds. The residual 1.8 percent were non-rated bonds or bonds rated below Caa.

Analysis of returns
In what follows, we compare historical returns on the GHY index and sub-indices to returns on Lehman's Global Aggregate Index (LGA), which includes both government bonds and investment grade credit bonds. We do not have separate returns data for the emerging market sub-indices of the GHY index. Table 4.8 reports returns characteristics of high-yield bonds versus investment grade bonds based on the longest available time series for the markets.

		Arithmetic				Geometric
	Period	Months	std.dev	Annual rate	std.dev	annual rate
Global						
-Aggregate	1990 - 03/2006	0.59 %	1.50 %	7.27 %	5.21 %	7.12 %
-High Yield	1990 - 03/2006	0.89 %	2.63 %	11.28 %	9.12 %	10.81 %
Pan Euro						
-Aggregate	1999 - 03/2006	0.48 %	2.97 %	5.96 %	10.27 %	5.42 %
-High Yield	1999 - 03/2006	0.58 %	4.12 %	7.21 %	14.27 %	6.15 %
US						
-Aggregate	1987 - 03/2006	0.60 %	1.19 %	7.46 %	4.13 %	7.37 %
-High Yield	1987 - 03/2006	0.71 %	2.16 %	8.88 %	7.47 %	8.58 %

Table 4.8: *Return characteristics of high-yield bonds versus investment grade bonds, based on monthly returns and the longest available time series for each market.*

The excess returns on high-yield bonds over investment grade bonds seem quite large. Notice, however, that all three time series used in the calculations are short. The returns difference is larger for the global market than for the European and US markets. This is due to different time periods as well as the fact that the global indices include more bonds than the sum of the Pan Euro high-yield index and the US Corporate high-yield index, notably high yield bonds in emerging markets.

One problem with the high-yield markets is that they can appear to have less volatile returns than is actually the case. One reason for low observed volatility is that high-yield bonds often have short effective durations due to aggressive call features, which implies less volatility as interest rates fluctuate. Another reason is that "stale" or out-of-date prices may dampen observed volatility.[4] This influence can be reduced by looking at lower frequency return data. If we use annual returns to compute the standard deviation for the U.S. Corporate High-Yield

[4] Nunn et al (1986) propose that the occurrence of price runs (i.e. identical prices in two consecutive months) is the most pronounced symptom of illiquidity. Based on a sample of government bonds, they show that as a bond becomes less liquid, the quality of the recorded prices deteriorates.

Index over the period 01/1987- 03/2006, we get 14.01 percent compared with 8.88 percent using monthly data over the same period. Based on annual returns over the period 1970-1997, Riepe (1998) estimates the standard deviation of US high-yield returns to be 12.4 percent.

Figure 4.12 shows the yield spread between Lehman U.S. Corporate High-Yield Index and Lehman U.S. Treasury Index in the period 1987-2005. For comparison the figure also shows the yield spread between the investment grade credit bonds segment of the US market (BAA segment from Moody's) and the Lehman Treasury Index.

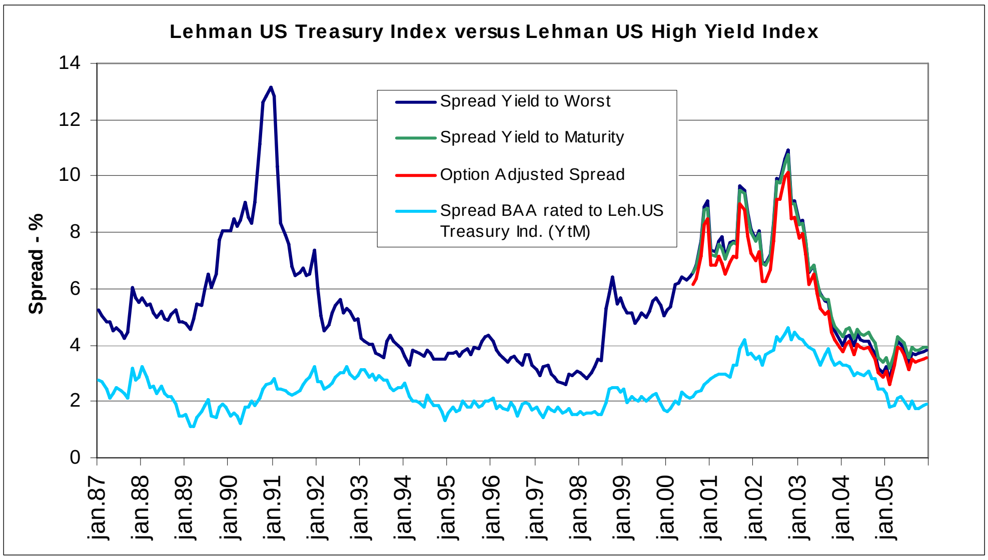

Figure 4.12: *Yield spread between US high-yield bonds and US treasury bonds and between US investment grade credit bonds and US treasury bonds. January 1987 – December 2005.*

There has been considerable volatility in the yield spread for high-yield bonds during the period, with exceptional increases around 1990 and in the period 2001-2003. The level of the yield spread was somewhat lower in 2005 than in 1987, and the average yield spread was 5.46 percentage points over the period. The comparable average investment grade yield spread was 2.41 percentage points. The two yield spreads seem to be positively correlated, but there is obviously a lot more uncertainty in the high yield segment of the market. Unfortunately, we do not have longer time series for the high-yield segment, but in Figure 4.10 we show the investment grade yield spread from 1919 to 2005. The light blue curve is identical to the BAA curve in Figure 4.11, while the dark blue curve is based on a different data source for Treasury bond yields. Figure 4.13 indicates that the current level of the yield spread is close to its long term average.

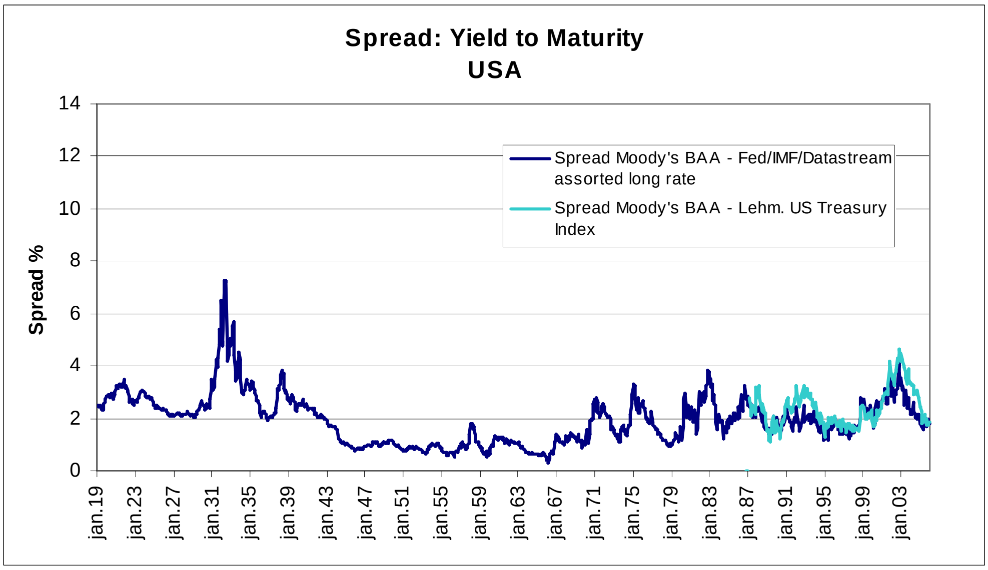

Figure 4.13: *Yield spreads between Moody's BAA bonds and Treasury bonds from 1919 to 2005 and between Moody's BAA bonds and Lehman Treasury Index from 1987 to 2005.*

To estimate the long-term expected return on high-yield bonds one cannot look solely on the yield spread. This is because defaults, early calls, and illiquidity in the high-yield markets imply that investors do not capture the full amount of this spread. Default is a greater concern for high-yield bond holders than for other creditors. High-yield bonds also tend to have aggressive call features which truncate some of the upside for bond holders, and low liquidity.

The long-term expected returns on high-yield bonds can be estimated in two different ways. One approach is to estimate the expected long-term risk premium as the difference between the arithmetic average annual total return of a high-yield bond portfolio and the arithmetic average annual total return of a duration matched government bond portfolio over a long period of time. Using this approach and data for the period 1970-1998, Riepe (1998) estimates the risk premium of the US high-yield market to be 2.05 percentage points. Using the same approach and data for the period 1978-06/2003, Altman and Bana (2004) estimate the risk premium to be 1.14 percentage points. The reason for the lower estimate is the large losses in the US high-yield market in the years following 1998, cf. Figure 4.12.

The alternative approach is to start out with an option adjusted estimate of the yield spread and then deduct an estimate of the reduction in returns caused by defaults (loss rate). The loss rate is calculated from estimates of default rates and recovery rates.[5] We then end up with an estimate of what compensation investors expect to receive for taking on default risk and liquidity risk.

Altman and Bana (2004) report an arithmetic average default rate of 3.25 percent over period 1971-2002. Using the historical average recovery rate of around 40 percent reported in the same paper, we get an estimated loss rate of 1.95 percent. Credit Suisse First Boston (CSFB) estimates the loss rate on US high-yield bonds to be much higher, 3.5 percent over the period 1985-2004. Using the Altman and Bana (2004) data for the period 1985-2002, we get a loss rate of 2.74 percent. The lower estimate from the data in Altman and Bana (2004) might be

[5] The default rate is the proportion of firms defaulting per year, and the recovery rate is the proportion of defaulting firms that do not eventually go bankrupt. The loss rate is calculated as the default rate times one minus the recovery rate.

caused by an empirical negative relationship between default rates and recovery rates. If we use the long term average high-yield credit spread of around 5.5 percentage points and deduct a loss rate of 3.5 percent, we get a rough estimate of the long-term expected risk premium on high-yield bonds over government bonds of 2 percentage points.

As a long term investor, the Fund should be willing to take on liquidity risk. The main worry is the default risk. Figure 4.14 shows the variation in default rates during the period 1971-06/2003. The numbers are taken from Altman and Bana (2004).

The figure shows that default rates have been quite volatile, especially over the period after 1985. Measured by standard deviation, the default rate volatility was 3.20 percent over the full period and 3.72 percent over the period 1985-06/2003. Because default rates are serially correlation, the standard deviation probably understates the risk a little. The main risk in a diversified high-yield bond portfolio is that the future average default rate is much higher than has been the case in the past. The important question is thus whether or not the available data set represents a full credit cycle.

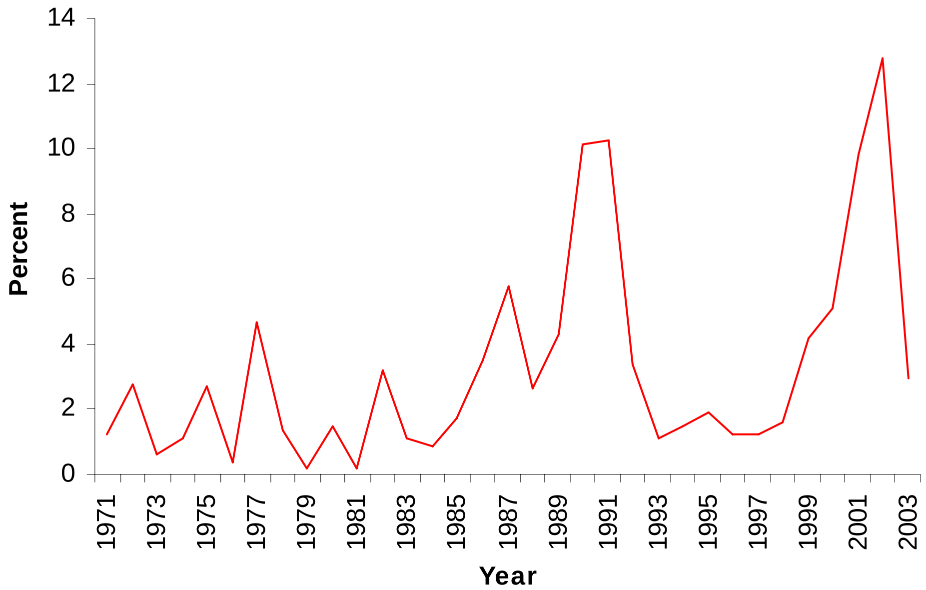

Figure 4.14: *Historical default rates on US high-yield bonds – 1971-06/2003. Altman and Bana (2004)*

The potential for diversification benefits

To investigate the potential for diversification benefits, we first investigate the effects on returns and volatility of including the high-yield segments to the investment grade Global, Pan Euro and US aggregate indices. The result from this exercise is presented in Table 4.9. The broad portfolios are constructed based on market value weights, and the time period investigated is 01/1999-03/2006.

	Avg. weight high-yield	Artithmetic returns	std. dev.	Sharpe ratio	Geometric returns
Global					
without HY	0 %	4.39 %	5.70 %	0.77	4.32 %
with HY	4.28 %	4.73 %	5.55 %	0.85	4.69 %
Pan Euro					
without HY	0 %	5.80 %	10.27 %	0.56	5.42 %
with HY	0.70 %	6.34 %	10.48 %	0.61	5.72 %
US					
without HY	0 %	5.33 %	3.75 %	1.42	5.39 %
with HY	5.98 %	5.58 %	3.61 %	1.55	5.46 %

Table 4.9: *Effects on returns and volatility of including high-yield segments in the Global, Pan Euro, and US aggregate indices. Numbers are calculated using monthly returns over the period 01/1999-03/2006.*

The growth of the high yield segments are reflected in increasing weights during the time period. The average weight over the period is shown in the first column on the left hand side. The portfolios that include high-yield bonds have both higher realized returns and lower volatility. The increase in the Sharpe ratio is largest when we include the U.S. Corporate High Yield Index into the U.S. Aggregate Index. As discussed above, however, estimated standard deviation based on monthly returns may be seriously downward biased due to stale prices.

Using monthly returns and the longest available time period for each pair of markets, the diversification benefits are also reflected in low correlation coefficients between aggregate indices and high-yield indices, as shown in Table 4.10. The longest available time period is for the US market where we have monthly returns data back to July 1983.

	Global		Pan Euro		US	
	Aggregate	High yield	Aggregate	High Yield	Aggregate	High Yield
Global						
-Aggregate	-	-	-	-	-	-
-High Yield	0.13	-	-	-	-	-
Pan Euro						
-Aggregate	0.91	0.17	-	-	-	-
-High Yield	0.53	0.70	0.62	-	-	-
US						
-Aggregate	0.73	0.24	0.51	0.16	-	-
-High Yield	0.13	0.88	0.09	0.70	0.34	-

Table 4.10: *Correlation coefficients between aggregate indices and high-yield indices. Calculations are based on monthly returns series over the longest period available for each pair of markets.*

An important characteristic of high-yield bonds shown in many studies is that they behave more like equities than like Treasury bonds. It is the financial position of the low-grade company, rather than interest rates, that drive low-grade stock and bond prices. Theoretically, this can be shown by varying the credit quality of a bond in a Merton-type of model, where bond values are expressed as a function of the stock value. Table 4.11 shows correlation coefficients between the returns of bond indices (investment grade and high-yield bonds) and stock indices (large/mid cap and small cap stocks).

	Global		Pan Euro		US	
	Aggregate	High yield	Aggregate	High Yield	Aggregate	High Yield
FTSE World	0.07	0.61	-	-	-	-
S&P/Citigroup small World	0.17	0.59	-	-	-	-
FTSE Europe	-	-	0.20	0.57	-	-
S&P/Citigroup small Europe	-	-	0.20	0.63	-	-
FTSE US	-	-	-	-	0.04	0.51
S&P/Citigroup US small cap	-	-	-	-	0.06	0.55

Table 4.11: *Correlation coefficients between bond indices (investment grade and high-yield) and stock indices (FTSE large/mid cap and S&P/Citigroup small cap). Correlations are based on the longest available monthly returns series.*

As expected, the high-yield indices and the stock indices have quite high correlation, while the correlation between investment grade indices and stock indices are low. Another feature of high-yield bond performance is a tendency to follow the economic cycle. Riepe (1998) reports that during 13 recessions in the U.S. economy, dating back to 1926, the average correlation between stocks and high-yield bonds is 0.57, and the correlation between high-yield and investment grade bonds is 0.31. In 13 economic expansions, the similar correlations are respectively 0.41 and 0.38. Thus, U.S. high-yield bonds may have behaved more like equities during recessions and more like bonds during expansions.

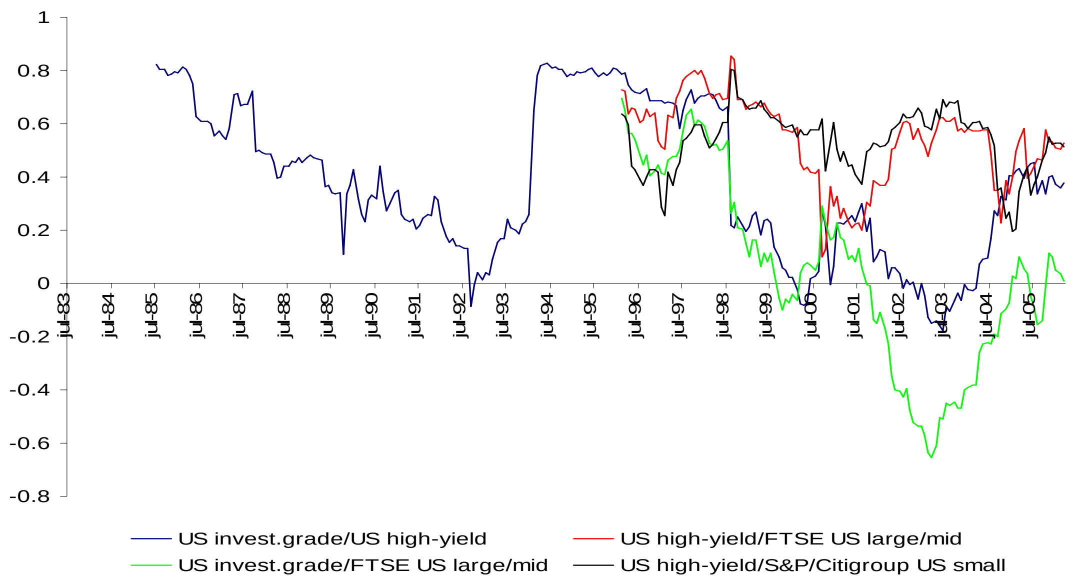

Figure 4.15: *Two-years rolling correlation between Lehman US high-yield, Lehman US investment grade, FTSE large/mid cap, and S&P/Citigroup small cap. Correlations are based on monthly returns series and the longest available time series for each pair of markets.*

Figure 4.15 shows two-years rolling correlations between high-yield bonds, investment grade bonds, large/mid cap stocks, and small cap stocks in the US markets. The figure shows that the correlation patterns have been quite unstable. During the period 07/1983-03/2006, the two-year correlation between investment grade bonds and high yield bonds has varied between 0.8 and -0.2. The correlation between investment grade bonds and large/mid cap stocks is another quite unstable relationship, falling from around 0.7 in 1996 to around -0.7 in 2002. From 1996 to the current time, correlations between high-yield bonds and stocks have for the most part been somewhere in the interval 0.2-0.6.

A final characteristic of high-yield bonds with respect to diversification benefits is that the return distribution does not seem well described by the normal distribution, and less so than the return distribution of stocks and investment grade bonds. This feature is illustrated in figure 4.16. The historical return distribution of the high-yield indices are more skewed and have fatter left-hand tails than the normal distribution. One explanation for this phenomenon is a high default probability.

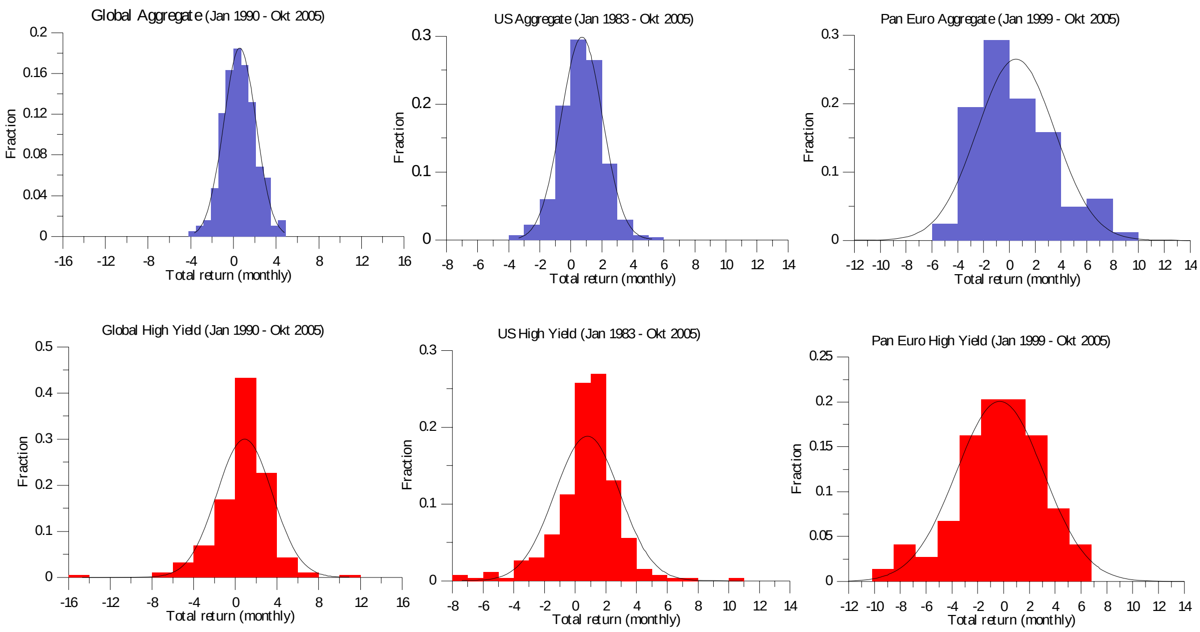

Figure 4.16*: Histograms of monthly returns on investment grade bond indices versus high-yield bond indices. Plots are based on monthly returns and the longest available time series for each index.*

The correlations between high-yield bonds and other asset classes are quite unstable over time. However, in general the correlation between high-yield bonds and investment grade bonds is lower than the correlation between high-yield bonds and stocks. Thus, the good diversification properties from an inclusion of the high-yield segment vis-à-vis the investment grade segment may largely disappear when we also include small cap into the Fund's stock portfolio. Moreover, there is a danger that the estimated risk in high-yield bond indices are seriously downward biased due to stale prices and non-normal return distributions.

Implementation costs

Two fairly recent studies compare transaction costs in different segments of bond markets. Chakravarty and Sarkar (2003) estimate and compare bid-ask spreads in the corporate, municipal, and Treasury market in the US over the period 1995-97 using a data set on secondary bond market transactions by insurance companies. Table 4.12 reports mean and standard deviation of bid-ask spreads per $100 par value for Treasury bonds and corporate bonds.

	Treasury	AA bonds	A bonds	BAA bonds	Below BAA
1-day window					
Mean	0.08	0.14	0.20	0.21	0.28
Std.dev	1.11	1.54	0.64	0.67	1.17
2-day window					
Mean	0.09	0.16	0.25	0.23	1.07
Std.dev	1.44	2.48	2.35	2.54	3.11
5-day window					
Mean	0.07	0.13	0.11	0.14	1.16
Std.dev	1.38	2.68	2.39	2.78	3.20

Table 4.12: *Traded bid-ask spreads in the US Treasury and corporate market. 1995-97. Chakravarty and Sarkar (2003)*

The 1-day window panel includes only days with at least one buy and one sell transaction in a bond. This leaves 7 168 corporate bond trades and 3 912 Treasury bond trades in the sample. The mean bid-ask spread is defined as the difference between the mean daily selling price and the mean daily buying price. In the 2-day and 5-day window panels, spreads are calculated in a similar manner, but over non-overlapping two and five day periods. This implies that the samples include many more trades involving less actively traded bonds.

The mean bid-ask spread increases as the credit rating deteriorates, from 8 cents to 28 cents for the 1-day window observations, and from 7 cents to 116 cents for the 5-day window.[6] There are also large variations in the spreads, as documented by the large standard deviations, especially in the 2 and 5-day window calculations. Chakravarty and Sarkar (2003) also estimate the determinants of the bid-ask spread using a regression approach where the daily bid-ask spread per $100 par value are regressed over time and across bonds on several explanatory variables including maturity, the square of maturity, the bond age, the trade size, announcement dummies and credit rating dummies. The credit rating dummies are highly significant and indicate that lower-rated bonds have higher spreads. In particular, AAA/AA rated bonds are found to have substantially lower spreads than high-yield bonds.

	AAA	AA	A	BBB	High-yield
Mean	0.220	0.200	0.570	1.014	0.879
Std.dev	0.189	0.165	0.599	0.561	0.387
Minimum	0.007	0.030	0.018	0.149	0.248
Maximum	1.410	0.826	2.216	2.220	2.501

Table 4.13: *Summary statistics on the daily percentage bid-ask spreads for international bonds. Gwilym et.al (2002)*

Using daily price data from Financial Times Interactive Data (FTID) for 104 international bonds, including sovereigns, corporates, banks, and supranationals, over the period Jun19-Sep7, 2000, Gwilym et.al (2002) find a significant relationship between bid-ask spreads and credit rating. Table 4.13 shows summary statistics for the daily percentage spread found for different rating classes. Around 10 percent of the issues in the sample were high-yield bonds.

[6] No data is reported for AAA corporate bonds since there are only 48 observations of such bonds in the sample.

What do other Fund's do?
Few Funds have passive investment strategies in high yield bonds, but many Funds have active mandates. In general American funds are more active in the high yield markets than European Funds. Two natural candidates for comparison with the Fund are US CalPERS and Dutch ABP. In US CalPERS, a maximum of 10 percent of the fixed income portfolio can be invested in high-yield bonds. The External High Yield Program which totals 4.94 percent of the CalPERS portfolio is the only U.S. fixed income investments that are managed externally. Dutch ABP has 5 percent % of its actual bond portfolio invested in high yield bonds.

Conclusions
In spite of a large growth in the high-yield segment in recent years, the size of the market is still limited, currently $945 bill. The US corporate high yield market constitutes 62 percent of the market. The high-yield segment has good diversification properties vis-à-vis the investment grade segment of the fixed income market. However, the correlation between high-yield bonds and stocks is high.

Several factors make it difficult to estimate risk and expected returns in the high-yield market. First, there is a danger that conventional estimates of risk are seriously downward biased due to stale prices and non-normal return distributions. Second, since available data series are short, it is difficult to get a reliable estimate of the historical average excess return in the markets. The longest time series available are from the US market. However, because of large changes in the US market 20 years ago, data before 1985 may be of limited relevance. On the other hand, the main risk in a diversified high-yield bond portfolio is that the future average default rate is much higher than has been the case in the past. Since the recent past includes several disastrous years for high-yield investors, it may be argued that the available data represents a full credit cycle.

Several studies show that the average bid-ask spread is significantly higher in high-yield bonds than in Treasury bonds and investment grade credit bonds. There is also a larger variation in the spread on high-yield bonds. Implementation costs of a passive investment strategy in high-yield bonds can therefore be substantial. Moreover, if a substantial part of the index turns out not to be investable, the yield spread on the index may not be obtainable. The combination of high risk, low liquidity, and low transparency may suggest that this market is better suited for active management than for passive management.

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5. Listed Equity Markets

5.1. Introduction

In Norges Bank (2005) (Staff Memo 2005/10) we argued that the current expected long-term equity risk premium (ERP) most likely has fallen to around 2.5 percentage points above the expected return on long term government bonds. This point estimate is of course highly uncertain, and we assigned an estimation uncertainty (standard deviation) of +/- 1.5 percentage points to it. This value for the expected long-term ERP was essentially derived from recent academic studies, institutional investor surveys, and the estimates of large pension funds. The estimation uncertainty reflected the standard deviation of the reported expectations.

We do not have new information that warrants a revision of this long-term estimate, which, by its nature, requires *significant* new information or insights in order to be modified. What caused investors and researchers to revise downward the expected equity premium over the last few years was a renewed focus on valuations in the aftermath of the stock market declines in 2000-2002. It was understood that the stock market valuation, even after the crash, was incompatible with an expected ERP close to historical realizations, given reasonable forecasts for future earnings growth. Econometric studies of historical returns and dividend growth rates, relying on different versions of the dividend discount model and forward-looking (projected) dividends, gave further impetus to these revisions, as they suggested that the expected ERP must have been significantly lower than realized ERP throughout the last century, the high realized ERP being caused by a mixture of falling expected ERP, good luck, and survivorship bias. Examples of this approach are studies by Fama and French (2002) and Claus and Thomas (2001). The latter study, developing a so-called abnormal earnings model that equates the current stock price to the current book value of equity plus the present value of future expected abnormal earnings, finds that the expected ERP above 10-year bonds has fluctuated within a narrow range around 3% for the six largest stock markets (with the exception of Japan, for which the estimate is considerably lower). Their analysis covers the period 1985-1998.

The proposition that expected ERP is (and has been) low compared with historical realizations has found further backing in equilibrium theories of asset pricing. Mehra and Prescott (1985), using a consumption-based capital asset pricing model, pointed out that the expected ERP could be even below one percent given the historical consumption variability and reasonable risk aversion parameters. A summary of this “equity premium puzzle” literature can be found in, for instance, Siegel and Thaler (1997).

The new and sound emphasis on valuations has catapulted the dividend discount model, and various valuation ratios, into the foreground, displacing the simple historical extrapolation methods or “new economy” theories prevalent in the late 1990’s. As we shall see in the following, our long-term estimate of 2.5 percentage points for the expected ERP remains *largely compatible* with the dividend discount model, with the possible exception of the US stock market. This exception may be interpreted as a sign of temporary disequilibrium.

Below the current valuations of the five main regional stock markets are discussed, for our base scenario (economic growth at trend, and low and stable inflation) in section 5.2-5, and for our two alternative scenarios (deflation and stagflation) in sections 5.6-7.

5.2. The US stock market

5.2.1 Recent market developments

The US stock market, as measured by the FTSE World total return index, has risen about 5 % over the last year (by end of July 2006). The dividend yield has also risen, from 1.7 to 1.8 %. This yield remains very low compared with historical values (figure 5.1). At the same time, the 10-year government bond yield has risen nearly a full percentage point to around 5 %.

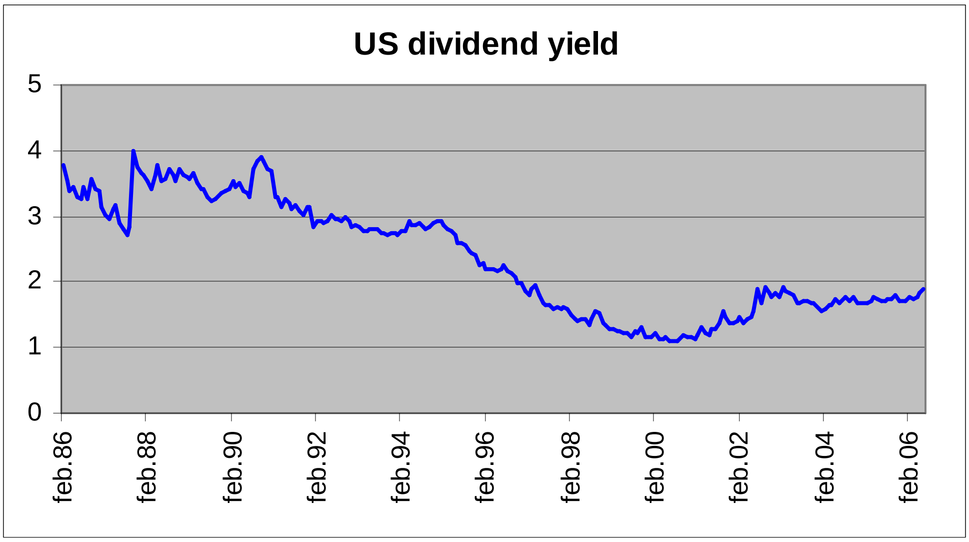

Figure 5.1: *The US dividend yield. Source: Annual US stock index data from R. Shiller.*

5.2.2 Estimating ERP using the dividend discount model

We now take this bond yield as a proxy for nominal return expectations, and use the dividend discount model to estimate ERP:

$$ERP = DY + G - R10,$$

where DY is the dividend yield, G is the expected nominal (real) growth of dividends and R10 is the 10-year nominal (real) government bond yield. In Norges Bank (2005) we argued that a reasonable expectation for long-term real dividend growth is slightly below the real growth rate of the economy.

The current real 10-year bond yield (by end of July 2006) is 5.0 % less the expected long-term inflation rate. The latter can be backed out from the yield difference between 10-year nominal government bonds and TIPS. Alternatively, one can rely on extrapolation, approximating the expected inflation rate with the recent realized inflation rate, as measured by the growth rate of CPI over the last few years. It turns out that the latter method is in fairly close agreement with the TIPS method over the last two years, when a rolling five-year history is used. According to the TIPS method, the expected inflation rate is 2.6 %, while the extrapolation method suggests an expected rate of 2.5 %. Relying on the extrapolation method, the real 10-year bond yield is now around 2.5 % (5.0 % - 2.5 %).

In Norges Bank (2005), we adjusted the dividend yield upwards by one percentage point to correct for stock repurchases. Applying this same correction gives an ERP of 2.3 % for the US stock market as shown in table 5.1, up from 1.4 % last year.

	Memo: Real GDP growth	Real dividend growth (g)	Dividend/Price (D/P)	Stock repurchases (rp)	Real government bond yield (R)	ERP= D/P+g+rp-R
US	*2.5 %*	2.0 %	1.8 %	1.0 %	2.5 %	2.3 %
Europe	*1.75 %*	1.45 %	2.7 %	0.75 %	2.0 %	2.9 %
UK	*1.75 %*	1.45 %	3.1 %	0.75 %	2.0 %	3.3 %
Asia/Pacific	*2.5 %*	2.0 %	2.9 %	0.75 %	2.5 %	3.2 %
Japan	*1.5 %*	1.2 %	1.0 %	0.75 %	1.0 %	2.0 %

Table 5.1: *Computing the ERP for the main regional stock markets,*

Last year's estimate was based on a projected real return on long-term government bonds (estimated then to 2.8 %). Our current estimate is an expected real bond return of 2.6 %, confer chapter 4 above.[1] Employing this number would not significantly alter our ERP estimate.

Hence, the analysis suggests that the US stock market is fairly priced, relative to a long-term ERP of 2.5 %. The small deviation from an equilibrium ERP of 2.5 % is not significant, given the statistical and systematic uncertainty. We will discuss two specific sources of uncertainty intrinsic to this analysis; the expected real dividend growth, and the stock repurchase correction.

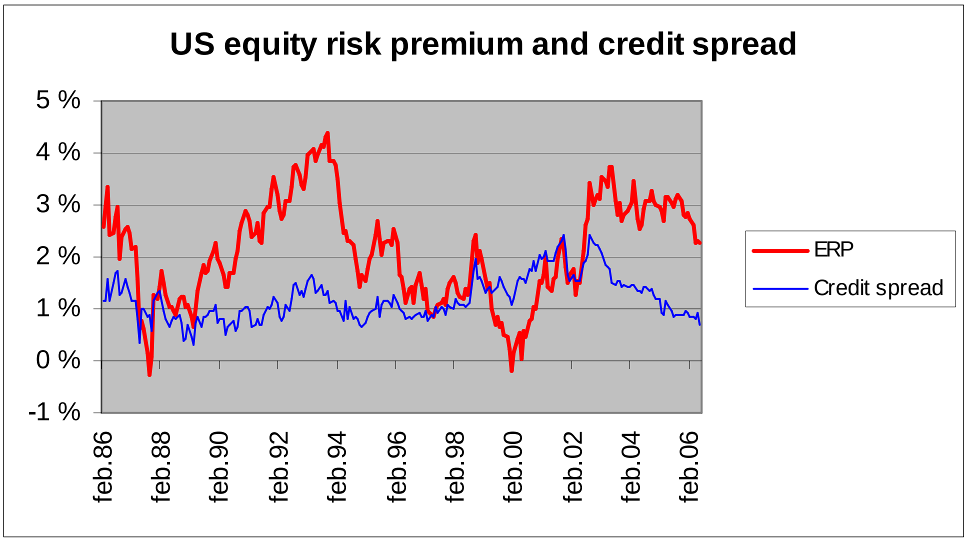

Figure 5.2: *Estimated equity risk premium in the US, using the model described in the text. Also shown is the high-grade credit spread in the US corporate bond market (the spread between AAA-rated bonds and 10-year Treasuries).*

[1] The expected real bond return has been calculated for a government bond portfolio with a duration of approximately 5 years and an investment horizon of 15 years. Strictly speaking, this expected return could be the expectation of investors holding this particular portfolio over this particular holding period. Hence, it is not necessarily the average market expectation which, ideally, we should estimate and use.

The above analysis can be performed not only on current information, but on available information in the past as well (real *yield* expectations are used). Figure 5.2 shows the estimated expected ERP since 1986, conditioned on available information at each point in time. The estimated ERP appears to have fluctuated widely, but has not exceeded 4.4 %. Key observations are that ERP appears to have been low throughout the period, and at times extremely low and even slightly negative. In fact, in 1987 and 1997 it fell well below the high-grade (AAA) credit spread in the US corporate bond market (the spread between AAA-rated bonds and 10-year Treasuries; see figure 5.2), an anomaly given the subordinated status of stocks relative to bonds. Such ultra-low or negative ERP values should be attributed to a breakdown of the valuation model, or irrationality. They are seen to precede major stock market crashes, as “Black Monday” in October 1987, and the major decline starting in the autumn of 2000. The suppressed ERP values thus seem to signal markets far out of equilibrium, driven by “irrational exuberance” and requiring major corrections.

The arithmetic average of ERP since 1986 (figure 5.2) is 2.1 %. However, if we exclude the periods when ERP was below the AAA credit spread, the average is 2.4 %, close to our long-term equilibrium assumption of 2.5 %. One interpretation is therefore that ERP has fluctuated around an equilibrium value of 2-2.5 % since (at least) 1986, but that the stock markets has departed from equilibrium twice (1987 and late 1990s).

The current expected ERP (2.3 %) is within the 2-2.5 % range which we associate with recent equilibrium values. ERP has fluctuated between 2.5 and 3.5 % since mid-2002, occasionally over- or undershooting this range. These fluctuations are largely driven by fluctuations in the real interest rate, the dividend yield having been quite stable (see figure 5.1). In our base scenario, expected ERP can reasonably be expected to continue its fluctuations within this corridor, driven by fluctuating real rate expectations (and real earnings growth expectations), without major repricing occurring (change in the dividend yield).

5.2.3 Main sources of uncertainty

As mentioned above, this analysis is based on uncertain assumptions. Firstly, the estimate of the long-term expected ERP is uncertain (which motivates a stipulated estimation uncertainty of 1.5 percentage points). In the medium term expected ERP fluctuates with investor behaviour (risk aversion), and perceived risk exposure (risk factors, current and prospective economic conditions[2]). The notion that there is a stable long-term equilibrium value is therefore debatable. More specifically, the current economic environment, notably the rising commodity prices and the global financial imbalances, could drive ERP higher over the coming years. Secondly, two inputs to the analysis are generally seen as difficult to pin down with sufficient precision; the expected real dividend growth, and the stock repurchase correction. In the following we discuss the uncertainty around these two inputs.

US dividend growth has shown a cyclical pattern, as seen from figures 5.3 and 5.4. Between 1871 and 2004 (yearly data from R. Shiller), the fitted (OLS) real growth rate is 1.0 %, with no clear sign of a structural change of slope (but change in growth volatility; see figure 5.3). This dividend growth rate is one percentage points below the rate we have assumed. If we zoom in on the period 1986-2005, using monthly data from FTSE, we see higher-frequency variations around a linear fit with an annual growth rate of 1.2 %. Hence the *long-term* growth

[2] For example, when estimating a ”fair value model” for US bonds, credit and equities, JPMorgan (2005) finds that ERP varies with inflation volatility, real GDP growth volatility, and the 10-year real bond yield.

rates appear quite stable over time, and are indeed below the long-term real growth rate of the US economy, as we have hypothesized. Our estimate of 2 % real growth rate might be a few tenths of a percentage point on the optimistic side.

On the other hand, it is often argued that the relevant variable is the expected *earnings* growth, since it is earnings growth that determines future payouts (dividends, stock repurchases). Real earnings growth has been marginally higher than real dividend growth; on average it has been 1.7 % for the post-WWII period and 1.4 % for the period 1871-2004 (figure 5.3). Many analysts simply assume that real earnings growth equals the real growth of the economy (thereby ignoring potential “dilution” effects from non-listed companies). In light of this, our assumption of the expected dividend growth does not appear excessive.

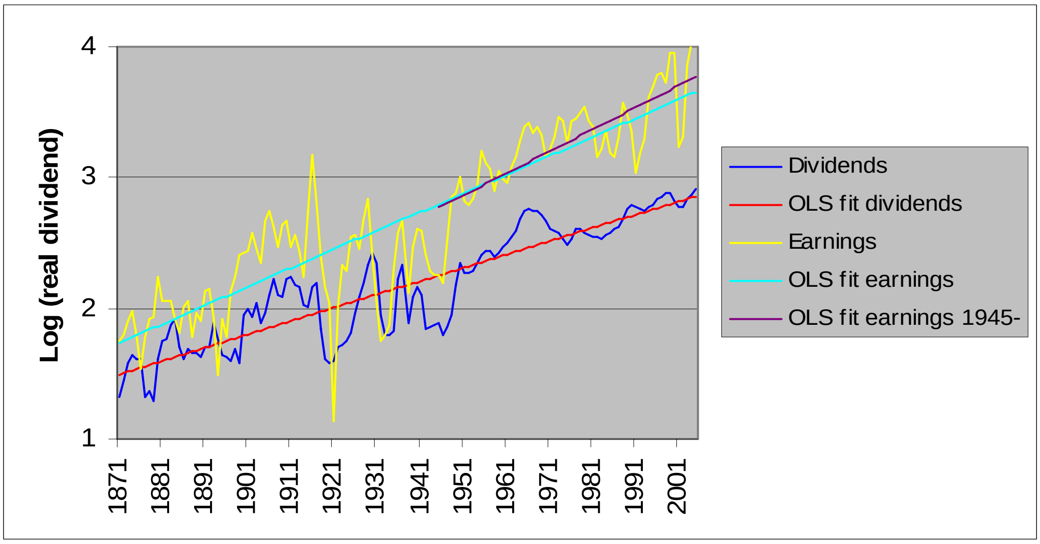

Figure 5.3: *Natural logarithm of real dividends and earnings in the US, and associated OLS fits, yielding real dividend and earnings growth rates, 1871-2004. Real dividend and earnings data are from R. Shiller.*

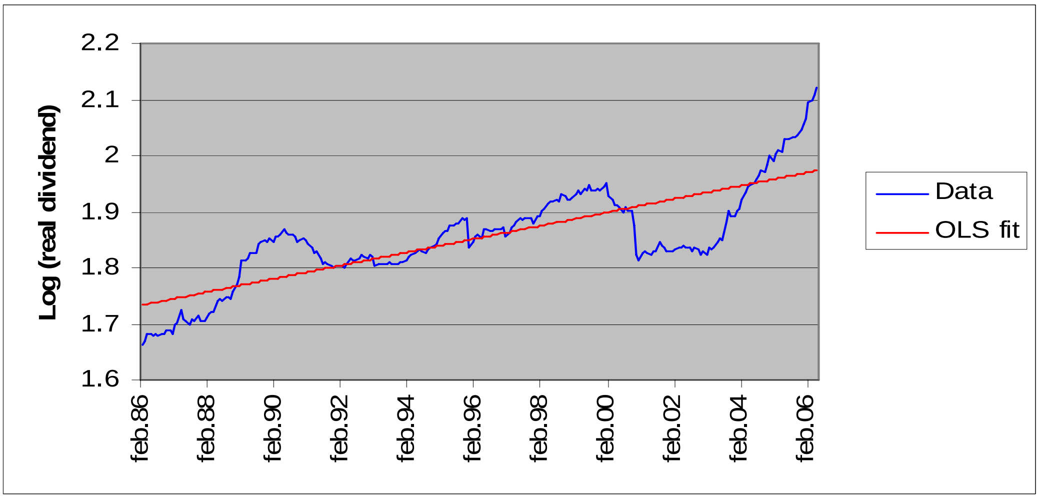

Figure 5.4: *Natural logarithm of real dividends in the US and associated OLS fit, yielding real dividend growth rate, February 1986 - May 2005. Data are from FTSE World USA index.*

A more important source of uncertainty is the cyclicality around the trend. Figure 5.4 shows that the real dividend growth has been far above trend over the last three years. The current ERP could possibly be above the 2-3 % corridor provided that the real growth rate of dividends is *rationally* expected to be cyclically above our assumed real trend growth.

This discussion shows that the growth rate of real dividends is uncertain, especially over medium-term horizons. The estimation uncertainty associated with an estimate of the expected medium-term ERP must account for this error source.

Another, and potentially more important error source is the upward correction applied to the dividend yield to account for firms' repurchase (retirement) of own stocks. As mentioned, we have applied a correction of one percentage point, which is the upper limit of the range 0.75-1.0 percentage points calculated by Liang and Sharpe (1999). Their range is rooted in historical dividends and share repurchases over the period 1982-1998, which saw a strong growth of the latter in the late 1990's. However, as Carlson (2001) points out, there are two problems with such large corrections, which were also discussed in the original paper by Liang and Sharpe. First, employee stock options may recently have offset much of the repurchase effect. Liang and Sharpe argue that stock repurchase is in fact often done to neutralize option-related stock issuance. They find that the latter became a significant offsetting factor in the late 1990's. Secondly, total payouts must be long-term sustainable if future dividend growth is not to fall. Liang and Sharpe estimate that a total payout ratio of 50-60 % is sustainable. Total payouts being dividends, net stock repurchase and stock option payouts, this caps sustainable payments to shareholders to 40-50 % (dividends plus net stock repurchase). Only a small portion of this (about one sixth) is repurchase payouts. According to this sustainability (long-term) view, the upward correction to the current dividend yield is well below the range 0.75-1.0 percentage points; it is closer to 0.3 percentage points.

Taken at face value, such a low correction would, ceteris paribus, reduce our estimated ERP by 0.7 percentage points, bringing it down to 1.6 % for the US, well below a projected long-term ERP of 2.5 %. The implication would be that the US stock market is overvalued today, requiring a significant downward correction. However, the possibility that the expected real dividend growth is cyclically higher than the long term trend would weaken this conclusion.

The uncertainty around the repurchase correction is the main problem with the dividend yield as a valuation measure. We therefore check our results by using the earnings yield (E/P) as indicator. As we shall see, a related uncertainty then arises; that of the expected payout ratio.

5.2.4 Earnings yield

Figure 5.5 shows the earnings yield (E/P) on S&P 500 since 1968. Like the dividend yield it is currently low in a historical context (5.5 %). Real earnings for S&P 500 have been growing at an average rate of 1.4 % since 1968 (figure 5.6), marginally above the real dividend growth rate for the period. As is the case for dividend growth, the real earnings growth has picked up sharply over the last two years.

The ratio of dividend payout to earnings has historically been fluctuating around 0.5, but was lower during the second half of the 1990's (figure 5.7). However, this payout ratio does not capture the effect of net stock repurchases.

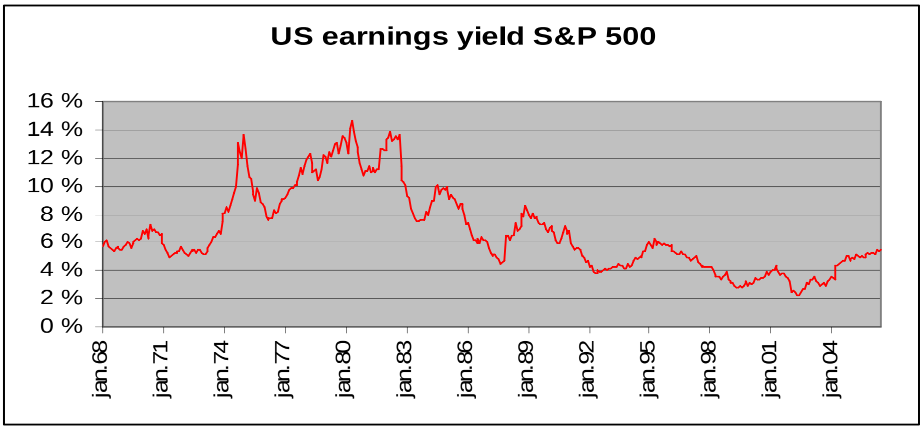

Figure 5.5: *Earnings yield on S&P 500 since 1968. Data from Datastream.*

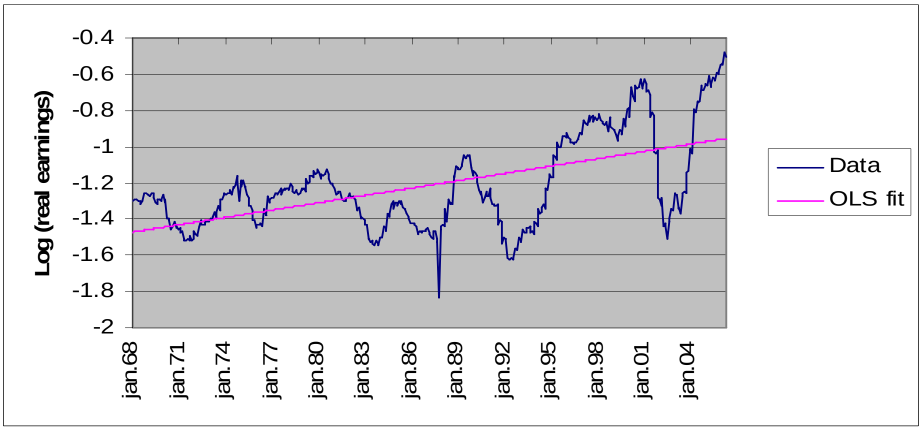

Figure 5.6: *Natural logarithm of real earnings in the US (S&P 500) and associated OLS fit, yielding real earnings growth rate, January 1968 - April 2006. Data from Datastream.*

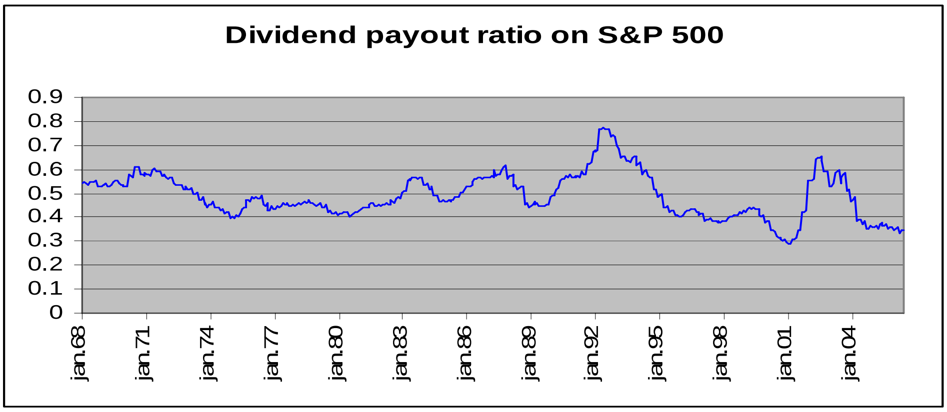

Figure 5.7: *Dividend payout to earnings ratio on S&P 500 since 1968. Data from Datastream.*

We now assume an expected payout ratio of 0.5, where the payout includes stock repurchases. That gives us a current *implied* dividend yield of 2.75 % (0.5 times 5.5 %), a value close to the currently *observed* but *corrected* dividend yield of 2.8 % (see above; corrected upwards by one percentage point to account for stock repurchases). Based on the historical average, the expected long-term real growth rate of earnings may be set at 2 %, implying that the expected real long-term growth rate of dividends is also 2 %.. This shows that the expected ERP derived from the earnings yield analysis must be close to the expected ERP derived from the dividend yield analysis. (The difference in expected ERP is negligible; 2.25 % vs. 2.3 %).

Hence, this simple calculation using earnings yields does not add important new information. This should come as no big surprise, since the two analyses are closely related, given the relatively stable nature of the payout ratio. The only interesting point to note is that our simple assumption of a constant payout ratio of 0.5 brings us to the same result as that of the dividend yield analysis, without making any uncertain corrections for stock repurchases. However, the uncertainty has not gone away; it has simply moved to another input factor (the expected payout ratio).

5.2.5. Price-to-Book ratio

Price-to-Book (P/B) is a more stable (less cyclical) valuation measure than D/P and P/E. The current P/B (by end of July 2006) is around 2.9, having come down substantially since the peak in 2000. However, some analysts argue that the current value is still above a long-term equilibrium, which is close to 2.0 (Société Generale, 2006). Our point estimate of expected ERP of 2.3 % (and expected real bond return of 2.5 %) can be reconciled with the current P/B value of 2.9 provided the expected real earnings-per-share growth is 2.3 %, somewhat above the historical trend growth.

According to this calculation, continued above-trend real earnings growth is needed to support current valuations and an expected ERP of approximately 2.3 %. In our dividend yield analysis, a high stock repurchase correction was needed. In both cases, the impression is that the risk around the point estimate of expected ERP (2.3 %) is skewed to the downside.

5.2.6. Conclusion regarding expected ERP for the US stock market

The expected *long-term equilibrium* ERP is 2.5 % above the return on 10-year Treasuries. In the medium term, we expect ERP to be somewhat lower, with a point estimate of 2.3 %. The estimate uncertainty is skewed to the downside, because i) We have used a high correction for share buybacks; and ii) The price-to-book value requires an above-trend real earnings-per-share growth to sustain an ERP of 2.3 %.

5.3. Europe ex UK

5.3.1. Recent market developments

The European stock market outside UK is in the Pension Fund benchmark represented by the FTSE World total return index (Europe-ex-UK). This index has risen nearly 25 % over the last year (by end of July 2006), while the dividend yield has increased to approximately 2.7%. The 10-year government bond yield in euros has risen from 3.3 % a year ago to currently 4%, while the long term real yield is around 2 %, measured by the long dated indexed French government bonds.

5.3.2. Estimating ERP using the dividend discount model

The expected long-term (equilibrium) ERP for the Europe-ex-UK stock market is assumed to be the same as for the US stock market (2.5 percentage points), on the assumption that deep and developed markets, integrated financially and strongly co-varying with each other, will not have significantly different long term risk premia.

Table 5.1 above summarised the basic data that will be used to calculate the ERP in Europe ex UK. The table reports dividend yield at face value, whereas the correction for buybacks of stocks of 0.75 % is reported separately. This correction is lower than for the US, reflecting less use of stock repurchases in Europe.

GDP growth is expected to be slower in Europe than in the US. The expected dividend growth is also assumed to be lower than expected GDP growth, as was the case for the US. The ratio between real GDP growth and real expected growth in real dividends has been set close to a historical average, implying a dividend growth of approximately 1.5 %. The lower real growth rates for dividends than for GDP may partly be explained by the use of different deflators; CPI for the dividend and the GDP deflator for the GDP. Since the early eighties consumer prices have grown more than the GDP deflator.

For Europe ex UK the assumptions quoted in the table gives an estimated ERP of 2.9 percentage points, which is quite close to the assumed long term equilibrium level of 2.5 percentage points. Thus there are no indications of significant deviations from the long term equilibrium.

5.4. The UK stock market

5.4.1 Recent market developments

The UK stock market, as measured by the FTSE World total return index, has risen nearly 20 % over the last year (by end of July 2006). The dividend yield has edged up marginally, to about 3.1 %. This yield is relatively low compared with historical values, but not dramatically so. The 10-year government bond yield is currently about 4.6 %, and the yield on index linked bond is about 1.6 %, implying a break even inflation of 3 %.

5.4.2 Estimating ERP using the dividend discount model

The expected long-term (equilibrium) ERP for the UK stock market should be at approximately the same level as for the US and European stock markets at 2.5 percentage points. The expected GDP growth is at the same rate as in Europe, but lower than in the US, confer our base scenario in chapter 1 above.

The estimated ERP for the UK market from table 5.1 above is at 3.3 %, after corrections for stock buybacks of 0.75 %. The main reason for the high ERP compared with the other markets is the higher current dividend yield and the low real yield on longer dated real government bonds. We believe that the latter is an anomaly caused by the huge demand for this kind of bonds from UK pension funds, as a response to changing regulations. Correcting for this by adding one percentage point to the bond yield (deducting one percentage point from break-even inflation) will bring the ERP in the UK close to the long term equilibrium level of 2.5 percentage points. We thus do not find convincing evidence that market pricing deviates significantly from the long term equilibrium.

5.5. The Japanese stock market

5.5.1 Recent market developments

The Japanese stock market, as measured by the FTSE World total return index, has rallied by more than 30 % over the last year (by end of July 2006), despite recent corrections. At the same time the dividend yield has fallen slightly, from 1.1 % to around 1.0 %. The 10-year government bond yield has increased to 1.9 %. Real yield on government bonds is in the range of 1%. This is low in an international comparison, but not in the light of the recent yield history in Japan.

5.5.2 Estimating ERP using the dividend discount model

We follow the same approach as for the other markets. The basic hypothesis is that expected long-term (equilibrium) ERP for the Japanese stock market is in the same range as in the other markets (2.5 %)[3].

Japan now appears to be emerging from a period of deflation and several recessions, and a higher future dividend growth than we have seen in recent history cannot be ruled out. We assume that the future real growth in dividends will be 1.2 %, which is lower than assumed for the UK, Europe and the US. The size of stock buyback correction is very uncertain. The buyback culture has reached Japan, and Japanese corporations are now reporting record buybacks. The correction could therefore be at the same level as in the UK or Europe. A correction of 0.75 percentage points brings the computed ERP to 2 %, fairly close to the long term equilibrium level.

The price-to-book ratio does not indicate gross overpricing of the Japanese stock market. The ratio is now 1.9. If we use the model of Société Generale (2006) (which, however, is calibrated to the US and UK stock markets), current valuations are consistent with an expected ERP of 2.5 % (and expected real bond yield of 1 %) provided expected real earnings-per-share growth is approximately 1 %, not an excessively high growth rate, and consistent with our assumption for the expected real dividend growth.

5.6. Asia/Pacific ex Japan

The equity benchmark of the Government Pension Fund – Global includes Australia, South Korea, Hong Kong, Taiwan, Singapore and New Zealand (in decreasing order of market capitalizations). We let the FTSE World Asia/Pacific-ex-Japan index represent an aggregate of these equity markets. According to this index, the total one-year return by the end of July 2006 was 15.5 % (measured in local currencies). Over the same one-year period dividend yield moved little, starting and ending at 3.1 %, a level seen for most of the last 12 years (apart from the time of the Asian crisis, when the dividend yield temporarily rose to more than 5 %).

[3] One could argue that higher volatility in the Japanese stock market warrants a higher long-term ERP. However, it is not clear that volatility in Japan will stay higher than in the US and Europe in the long run. Moreover, if co-variation is the priced risk factor (as in CAPM), the lower correlation of the Japanese stock market with other major stock markets should pull ERP in the opposite direction.

We will not analyse further the valuation of the equity markets in Asia/Pacific ex Japan. The equity markets of interest are diverse and at different stages of development, rendering an analysis more uncertain and challenging. Instead, it will be assumed that the expected real equity return is close to that of the US equity market. Correlations (e.g. rolling 10-year) between the two markets have shown an upward trend, and are now approaching 70 %.

5.7. Expected return in the deflation scenario

In the scenario with strong disinflation/deflation, where demand falls, all variables in the dividend discount model will gradually be affected. First, the real yield on government bonds will change (see chapter 4). Secondly, the real dividend growth (and earnings growth) will fall in line with lower economic growth. Third, the required equity risk premium (ERP) will likely rise, as investors perceive higher risks and, possibly, become more risk averse.

Gradual increases of ERP in combination with falling expected dividend growth will, according to the dividend discount model, affect stock prices negatively. Historically, deflation has been associated with low realized ERP. Figure 5.8 shows 5-year and 10-year rolling geometric average real returns, ERP and inflation rates, and zooms in on a period of very low inflation or deflation in the United States, the period from1900 up to WWII. Annualized ex post ERP is seen to reach as low as minus 6 % over the 10-year period ending in 1938.

The crash in the stock market starting in 1929 brought the economy into depression and deflation. In this particular case, it was the bursting of the stock market, in combination with the (mistaken) policy response that caused deflation. Reversely, it is reasonable to assume that deflation triggered by other demand-destroying factors (such as bursting of the property market or unwinding of major financial imbalances) will negatively affect the stock market (although causality may be different).

To get a handle on the effect of deflation on the equity risk premium, we perform a simple "back-of-the-envelope" calculation using the dividend discount model (although the simple static version is for constant expectations). We assume that the expected real bond yield falls gradually towards 1 % throughout a 15-year period characterized by disinflation and subsequent deflation (see chapter 4). We further assume that the expected inflation rate falls gradually and becomes negative some ten years ahead (see chapter 1); that the expected real dividend (or earning) growth rate falls gradually from the present value of roughly 2 % to 1 % as GDP growth slows down; and that the required risk premium increases steadily, from 2.5 % today to 3.5 % 15 years from now[4]. This simple example leads to an annualized expected real equity return of 1–2 %, and a *zero* equity risk premium over bond returns in the 15-year period.

Still, these low real returns and equity risk premia are well above the realized value in the early 1930's (annualized ERP of -6 % over a specific 10-year period; figure 5.8). One obvious explanation is that the stock market was then hit by many complex forces, both rational and irrational, that cannot be captured in the simple (rational) dividend discount model. Another

[4] The increase in required ERP is related to perceived increase in risk, such as volatility/covariance risk (CAPM), and/or macro-risk such as GDP and inflation volatility (JPMorgan 2005).

explanation is that the bond market performed well, decoupling from the stock market, and effectively "crowding out" the equity risk premium.

The above discussion shows that it is difficult to produce a point estimate of the expected real equity return and equity risk premium under the deflation scenario. What it also shows, however, is that the expected real equity return and equity risk premium must be low, of the order of 1 - 2 % and 0 %, respectively, even under mild assumptions. As always the uncertainty is large; the real equity return could fall much further (see figure 5.8). We assign an estimation uncertainty (standard deviation) of three percentage points to the estimate, skewed to the downside.

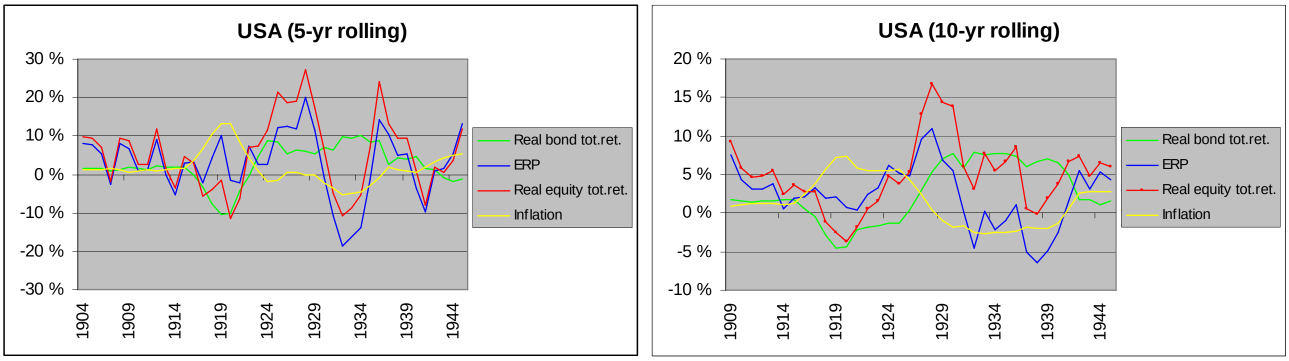

Figure 5.8: *5-year and 10-year rolling geometric averages of real bond return, (realized) equity risk premium over bonds, real equity total return and inflation rate in the United States from 1900 to 1945. Annual data from Dimson et al (2005).*

5.8. Expected return in the stagflation scenario

Periods of stagflation were seen in the United States in the 1970s and early 1980s, following the severe oil price shock in 1973-1974. The inflation rate rose sharply while the economy went into recession in 1973 Q4 – 1975 Q1, and 1980 Q1 – 1980 Q3. Also the United Kingdom experienced periods of stagflation in the 1970s and '80s. Extended periods of stagflation, lasting a decade or more, has not been experienced so far, however. Historical data are therefore of limited use when evaluating the stock market behaviour in such economic environment.

Figure 5.9 shows real bond and equity total returns, ERP and inflation rates in the US and UK from 1970-1985. The US stock market fell dramatically in 1973 and 1974, but rallied strongly in 1975 and zigzagged thereafter. A very similar pattern is seen in the UK, only more extreme in its swings. Figure 5.10 shows the corresponding 15-year rolling geometric averages of these returns and inflation rates. In the US, the annualized real equity return was below 3 % over 15-year periods ending between 1974 and 1984, while the annualized ex post equity risk premium was only 0.8 % over the 15-year period ending in 1974. In the UK the 15-year annualized ex post real equity return hovered around 2-3 % between 1975 and 1983, and was even negative in 1974. The combination of low economic growth and high inflation rates has, not surprisingly, been very negative for both stock and bond markets.

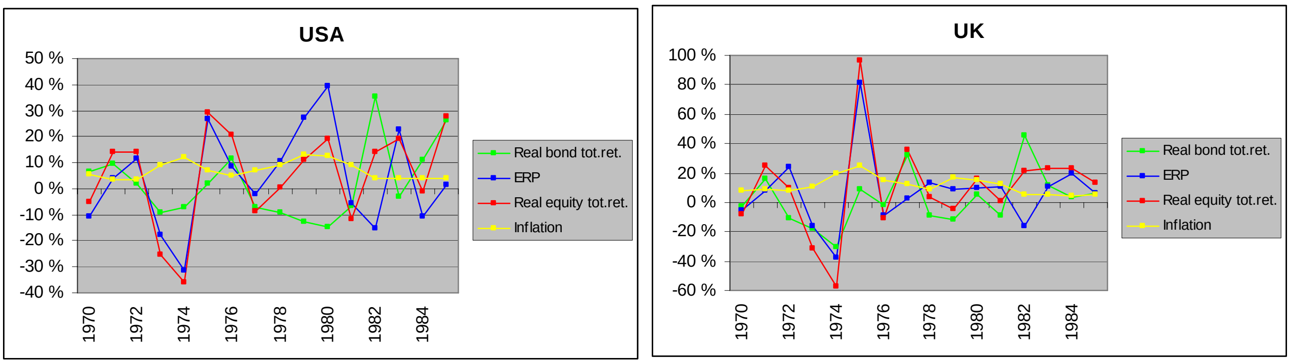

Figure 5.9: *Real bond returns, total equity returns, equity risk premia over bonds, and inflation rate in the US and UK over the period 1970-1985. Annual data from Dimson et al (2005).*

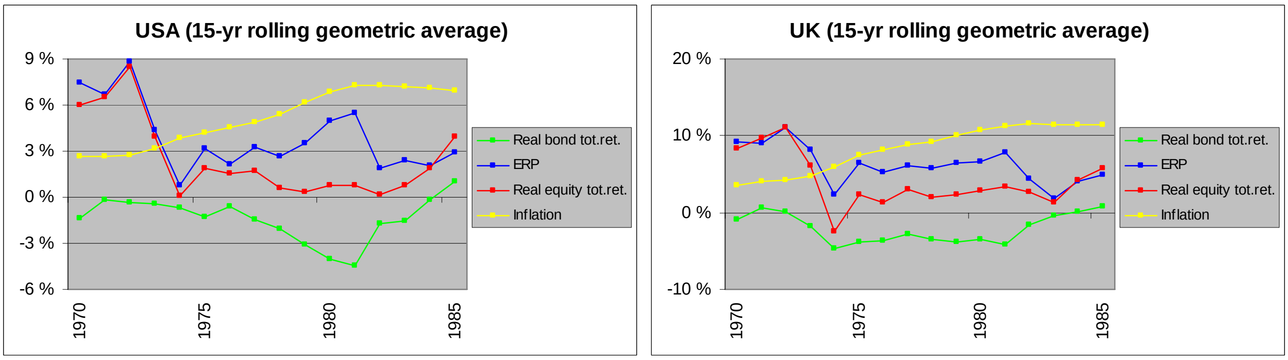

Figure 5.10: *15-year rolling geometric averages of real bond returns, (realized) equity risk premia over bonds, real equity total returns and inflation rates in the US and UK from 1970 to 1985. Annual data from Dimson et al (2005).*

Given the limited history of extended periods with stagflation, we choose to estimate the effect on the stock market by the static dividend discount model: We shall assume falling expected dividend (earnings) growth (due to falling GDP growth), rising required ERP (due to higher perceived risk and/or risk aversion), rising expected inflation rates (chapter 1), and virtually flat expected real bond yields (chapter 4). Specifically, we again assume that the expected real dividend (or earning) growth rate falls gradually from the present value of roughly 2 % to 1 % 15 years ahead, and that the required risk premium increases steadily, from 2.5 % today to 3.5 % 15 years from now. The annualized expected real equity return is then 0 – 2 % over the 15-year period, which implies an equity risk premium close to zero.

It seems intuitively reasonable that the expected real equity return is lower in the stagflation scenario than in the deflation scenario. From the above empirical and theoretical discussion, one may conclude that a rough estimate of the expected real equity return in the stagflation scenario is slightly positive % under moderate assumptions. The equity risk premium becomes close to zero. The estimation uncertainty is considerable, however, at least of the order of 2 percentage points. There is little basis for differentiating between regions.

Tables 5.2a-b below summarise our assumptions about the real and nominal expected returns on listed equity investments under our three scenarios:

	The US	Europe ex UK	UK	Asia ex Japan	Japan
Base scenario	4.1 %	3.6 %	5.4 %	4.1 %	3.6 %
Deflation scenario	1.7 %	1.2 %	2.7 %	1.7 %	2.0 %
Stagflation scenario	0.7 %	0.3 %	2.0 %	0.7 %	0.2 %

Table 5.2a: *Expected real equity returns under the three scenarios, when deflating with expected local inflation rates.*

	The US	Europe ex UK	UK	Asia ex Japan	Japan
Base scenario	6.6 %	5.7 %	7.6 %	6.6 %	4.7 %
Deflation scenario	2.4 %	1.6 %	3.1 %	2.4 %	1.4 %
Stagflation scenario	5.6 %	5.0 %	6.8 %	5.6 %	3.8 %

Table 5.2b: *Expected nominal equity returns under the three scenarios, when deflating with expected local inflation rates.*

5.9. The small cap segment

There are two reasons for considering inclusion of the small cap segment in the Fund's benchmark portfolio. One is the possibility to capture a "small cap premium" and the other is the potential to lower overall portfolio risk. The main pitfall of a small cap investment strategy is potentially high implementation costs. Small firms can be considerably less liquid than large firms and this might seriously hurt portfolio returns. Timing is another potential worry. Due to a high focus on the small cap premium in recent years, small caps may currently be overvalued.

The small cap premium
The small cap premium is an empirical regularity showing that small firms on average have earned a risk adjusted premium relative to larger firms. The premium was first documented for the US stock market over the period from 1936 to 1975 by Banz (1981). Following Banz's study, similar studies documented a small cap premium in 17 other countries. According to Dimson and March (1999), this makes the small cap premium the best documented stock market anomaly in the world.[5]

Measures of the small cap premium turn out to be quite sensitive to the choice of time period. Figure 5.11 shows the historical monthly small cap premium for some selected countries over three different time periods. The green bars show the size of the small cap premium found in the initial research papers. Note that the numbers are significant: a monthly premium of 0.5-1.0 percent translates into 6.0-12.0 percent annually. As first pointed out in Dimson and March (1999), the small cap premium seemed to disappear as soon as it was detected. This is illustrated by the blue bars in the figure showing negative small cap premiums for most

[5] Two survey articles on the small cap premium are Dimson and March (1988) and Hawawini and Keim (2000).

countries over the period 1980-2000. Finally, the yellow bars show the average difference in monthly returns between the large and small cap index of S&P/Citigroup from 2000 to March 2006. Over this much shorter time period, there have been large and positive (non-risk adjusted) small cap premiums in most countries.

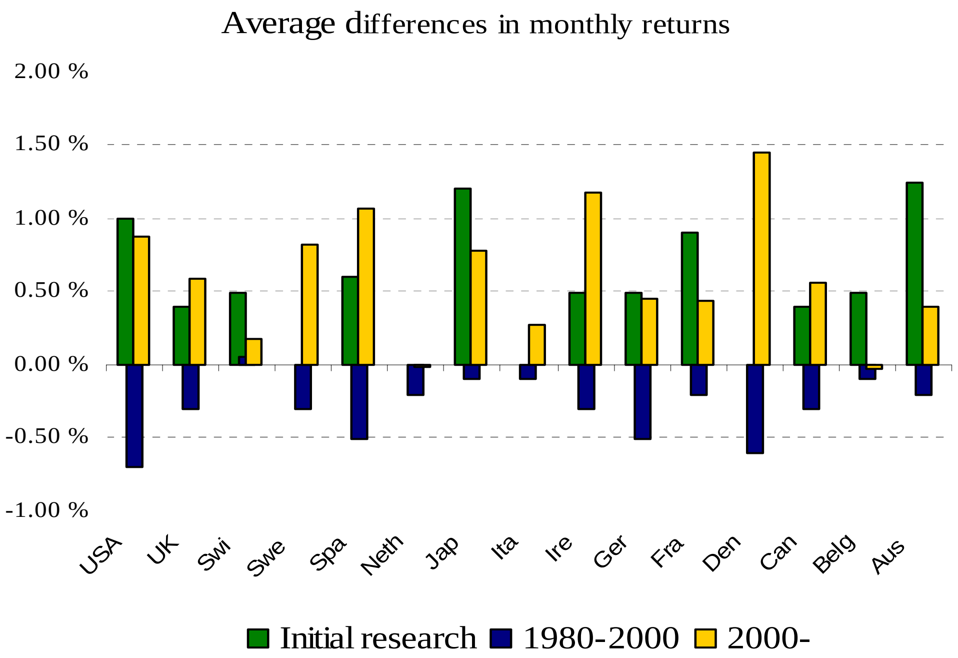

Figure 5.11: *Historical Small Cap Premium*

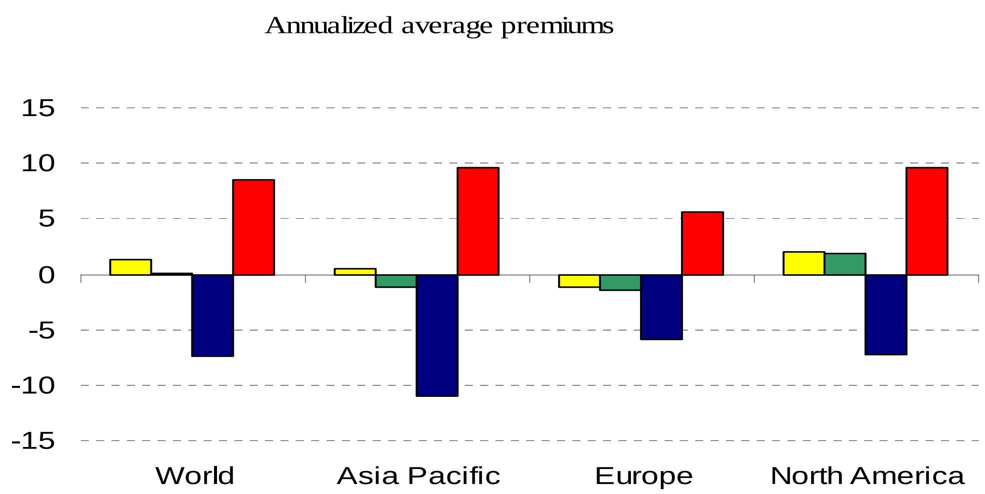

Figure 5.12: *Small Cap Premium last 15 years*

In Figure 5.12, we split the annualized (non risk adjusted) size premiums for a world index and three region indexes over the last 15 years into three 5-year sub-periods. Measured over the whole period, the average size effects are small. Over the period 1990-95, the average size effects are also quite small, but then over the next five years, average size effects are large and negative, and finally over the period 2000-05, they are large and positive.

Several theoretical explanations for the small cap premium have occurred over the years. According to Arbel and Strebel (1983), the small cap premium is explained by a neglected firm effect. While news about large firms results in big headlines, news about small firms is neglected by journalists as well as by analysts. As a result, too little information is available about small caps which make them problematic as investment objects. Maug and Naik (1995) suggest an explanation based on performance benchmarks. As long as performance benchmarks are oriented towards large firms, managers have low incentives to buy small caps. Both these explanations are based on agent theory.

In the US, the small cap premium can almost entirely be attributed to the month of January. This fact has naturally led to attempts to explain the premium with the standard January effect explanations such as year-end tax loss selling and window dressing. One problem with these explanations is that they do not fully explain the January effect, so one ends up explaining one puzzle with another puzzle. Another problem is that there is not found a similar connection between the small cap premium and seasonal return patterns in other countries.

A common problem for the explanations described above is that they cannot explain why the small cap premium suddenly turned negative.

Several authors have suggested that the small cap premium is a compensation for higher risk not reflected in the traditional price models. He and Ng (1994) and Fama and French (1995) focus on a risk factor related to distress. He and Ng argue that investors need compensation for the risk of small caps being de-listed, while Fama and French suggest that the premium is related to the risk of low earnings.

A final explanation is that size is a proxy for some other underlying factor which is the true source of the small cap premium, i.e. small firms have other characteristics than large firms, and these differences determine the premium. Dimson and March (1999) argue that "a bet on smaller companies is also a bet on relative sector performance". They find that as much as 50 percent of the negative small cap premium in the UK from 1989 through 1997 can be attributed to differences in sector exposure.

Based on the numbers in figures 5.11 and 5.12, it seems hard to make strong predictions about the size of the future small cap premium. However, as pointed out by Dimson and March (1999) is seems reasonable to think that a size effect exists in the sense that small caps perform differently from large caps. The fact that the premium was negative for most countries during the 1980's and late 90's favours explanations based on risk compensation and underlying differences in firm characteristics.

FTSE Global Small Cap Index Series

The natural way to include small caps would be to base the Fund's benchmark on FTSE's main product FTSE Global Equity Index Series (GEIS) which covers both large, mid, and small cap stocks. The FTSE Global Small Cap Index Series capture the bottom 10% of seven regional markets in the FTSE GEIS[6] and include around 4,600 small cap stocks across 48 countries.

To avoid illiquid stocks, FTSE performs liquidity screening. Firms with a full market cap of less than $100 mill are excluded from the index series. Firms that do not trade at least 15

[6] Asia Pacific ex Japan, Japan, North America, Latin America, Developed Europe, Emerging Europe, and Middle East and Africa

percent of their available shares in issue, in ten out of twelve months prior to a review, are also excluded. However, since the number of stocks in the index is high (together the mid- and small cap segment include around 2 700 stocks), a full replication could be both costly and complex.

	Large/mid cap			Small cap		
Region / Country	Market value (mill USD)	Number of stocks	Mean market value per stock	Market value (mill USD)	Number of stocks	Mean market value per stock
America / Africa						
Brazil	263 746	66	3 996	13 738	30	458
Canada	829 972	62	13 386	229 345	178	1288
Mexico	175 203	31	5 651	6 137	14	438
US	13 023 887	707	18 421	1 952 418	1730	1129
South Africa	229 288	82	2 796	9 589	37	259
Sum all developed	*13 853 859*	*769*	*18 015*	2 181 763	*1908*	*1143*
Sum all emerging	*668 237*	*179*	*3 733*	29 464	*81*	*364*
Sum	*14 522 096*	*948*	*15 318*	2 211 227	*1989*	*1112*
Europe						
Austria	47 357	8	5 919	25 472	18	1415
Belgium	124 017	16	7 751	23 157	32	724
Denmark	84 774	12	7 064	30 997	26	1192
Finland	147 772	11	13 433	41 525	36	1153
France	1 315 239	68	19 341	86 346	88	981
Germany	867 924	49	17 712	76 787	79	972
Greece	77 710	12	6 475	19 713	43	458
Ireland	91 783	8	11 472	23 764	17	1398
Italy	534 116	44	12 139	75 357	91	828
Netherlands	440 091	20	22 004	59 983	46	1304
Portugal	46 220	8	5 777	4 395	8	549
Spain	512 475	33	15 529	44 775	32	1399
Sweden	289 349	30	9 644	58 854	54	1090
Switzerland	823 814	32	25 744	85 616	86	996
UK	2 843 991	133	21 383	374 877	315	1190
Sum	*8 246 632*	*484*	17 038	*1 031 618*	*971*	*1062*
Asia / Oceania						
Australia	675 770	117	5 775	66 994	138	485
Hong Kong	354 786	107	3 315	31 294	109	287
Japan	2 786 834	484	5 757	314 527	854	368
Korea	419 965	99	4 242	56 259	142	396
New Zealand	17 904	15	1 193	2 487	13	191
Singapore	103 235	46	2 244	18 445	56	329
Taiwan	299 331	138	2 169	56 446	249	226
Sum all developed	*3 938 529*	*769*	5 121	*433 747*	*1 170*	*370*
Sum all emerging	*719 296*	*237*	3 035	*112 705*	*391*	*288*
Sum	*4 657 825*	*1 006*	4 630	*546 452*	*1 561*	*350*
Global sum	**27 426 553**	**2 438**	**11 249**	**3 789 297**	**4 521**	**838**

Table 5.3: *Stocks and market values in the large, mid and small cap segments of the FTSE Global Equity Index Series per August 2006.*

Table 5.3 presents a detailed decomposition of the part of the FTSE small cap index series which is relevant for the Fund and compare it to the current benchmark portfolio (FTSE All-world) per August 2006. The region allocation of the two index series is quite similar. The US stock market is the dominating market in both index series (52 percent of the total market value for small caps and 47 percent for large/mid caps). The next two largest countries are Japan and UK.

Since the small cap index series is constructed to capture the bottom 10 percent of each market, small cap stocks varies considerably in size across markets. Note that the average small cap firm in Austria, Ireland, Netherlands, and Spain is larger than the average large/mid cap firm in the current benchmark from New Zealand.

Figure 5.13 shows the industry allocation of FTSE's small cap index series on April 7. 2006. (For a more detailed sector allocation, see table in the Appendix.) The two largest industries are currently industrials (construction & materials, industrial goods & services) and financials (banks, insurance, financial services).

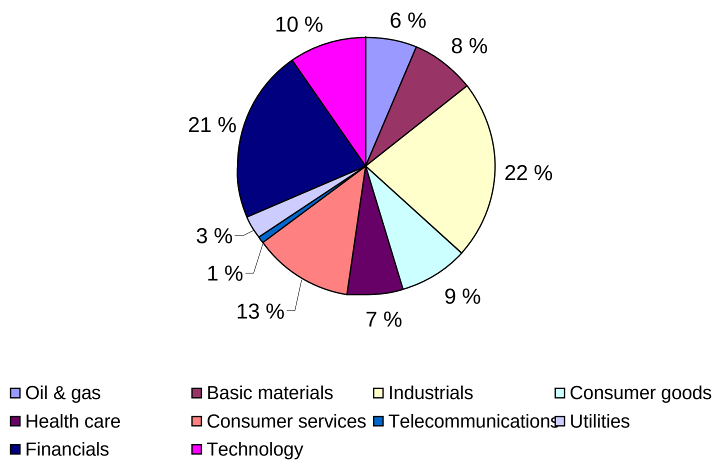

Figure 5.13: *FTSE Global Small Cap Index Series - Industry allocation*

Figure 5.14 shows the price/dividend ratio for FTSE's large, mid and small cap index series in the period from April 2001 to March 2006. Numbers for the small cap index series are not available before 2003. The numbers suggest that small caps currently are valued higher than large caps, especially in the US. However, the numbers are not corrected for buyback activity, which is probably most important for large caps in the US. The difference in valuation between small cap and mid cap stocks does not seem to be large.

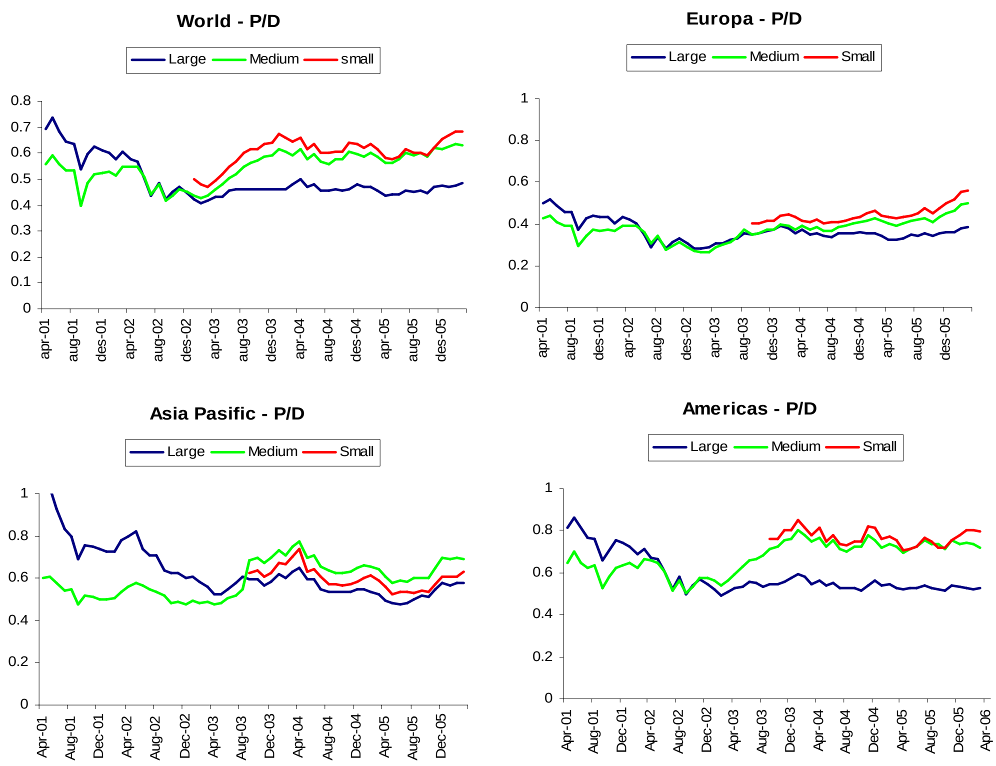

Figure 5.14: *FTSE large, mid and small cap index series. Price/dividend ratios*

The potential for diversification benefits

In order to evaluate the potential for diversification benefits from small cap investments, we need longer time series than the three-year series available for FTSE GEIS.

S&P/Citigroup has published monthly return series since July 1989 for a broad stock index (BMI), a large cap index (PMI), and a small cap index (EMI). BMI covers 52 different countries and over 9000 companies. The PMI and EMI segments are defined as respectively 80 and 20 percent of the BMI capitalization value. We also use returns series for the period 1975-1997 from Independence International Associates (IIA). The IIA database covers 19 countries and over 2500 companies. IIA define small caps as the bottom 30 percent by capitalization of their universe, and large caps as the top 70 percent. Note that both S&P/Citigroup and IIA define the small cap segment broader than FTSE does.

Table 5.4 shows annualized percentage volatilities for both data sets for three portfolios; a portfolio of large caps, a portfolio of small caps, and a portfolio of both large and small caps (total). The last column in the table shows the difference in volatility between the total portfolio and the large cap portfolio. Except for North America, all region portfolios experience diversification benefits from including small caps, but the benefits seem small. For a world portfolio in the period 1975-1997, including small caps did not have any discernable effect on volatility. This result is largely driven by the positive volatility difference for the North America region.

Jul 89-Mar 06	Total	Large cap	Small cap	Diff total/large
World	14.01	14.05	15.13	-0.04
World ex USA	16,03	16.12	16.67	-0.09
North America	14.19	14.17	16.51	0.02
Europe	15.35	15.51	15.81	-0.16
Asia/Pacific	21.44	21.59	22.55	-0.15

1975-1997	Total	Large cap	Small cap	Diff total/large
World	13,71	13,71	14,28	0,00
World ex USA	16,53	16,79	16,59	-0.26
North America	14,44	14,22	15,83	0,22
Europe	16,43	16,47	16,79	-0.04

Table 5.4: *Differences in volatility*

Calculated over the short period with available data from FTSE GEIS (2003-March 2006), the difference in volatility between the large cap and the small cap segment of the world index was 3.40 percent. One explanation for the much smaller differences in volatility between large and small caps for the longer time series may be the broader definition of small caps used here.

The two upper graphs in Figure 5.15 show the performance of large caps, small caps and a broad portfolio of both large and small caps for the world indexes published by IIA and S&P/Citigroup. Starting with the 22-year period 1975-97, $1 invested in large cap stocks would have grown in nominal terms to $20.45, an annualized return of 14.71 percent, while an equivalent investment in small cap stocks would have grown to $30.24, an annualized return of 16.76 percent. Thus, in spite of a very small difference in annualized volatility over this period, the small cap index beat the large cap index by over two percent annually. Over the nearly 16-year period from July 1989 to the present, the picture is much less clear-cut. A $1 investment in large caps during this period would have returned an annualized return of 9.05 percent, while an equivalent investment in small caps would have returned an annualized return of 10.25.

The two lower graphs of figure 5.15 show three years rolling differences in annualized returns and volatility between a broad world index (including small caps) and a world index of large caps only. The lilac curves and left hand axes show returns differences, while the blue curves and right hand axes show differences in volatility. Using the IIA data from 1975-1997, we find that the broad portfolio has had higher returns *and* lower risk over long periods of time. Using the more recent data set from S&P/Citigroup, a positive relationship seem to emerge between difference in returns and difference in volatility, i.e. lower risk seems to coincide with lower returns and vice versa. The volatility differences vary from -0.6 to 0.4 percent, while the return differences vary from -2.5 to 2 percent.

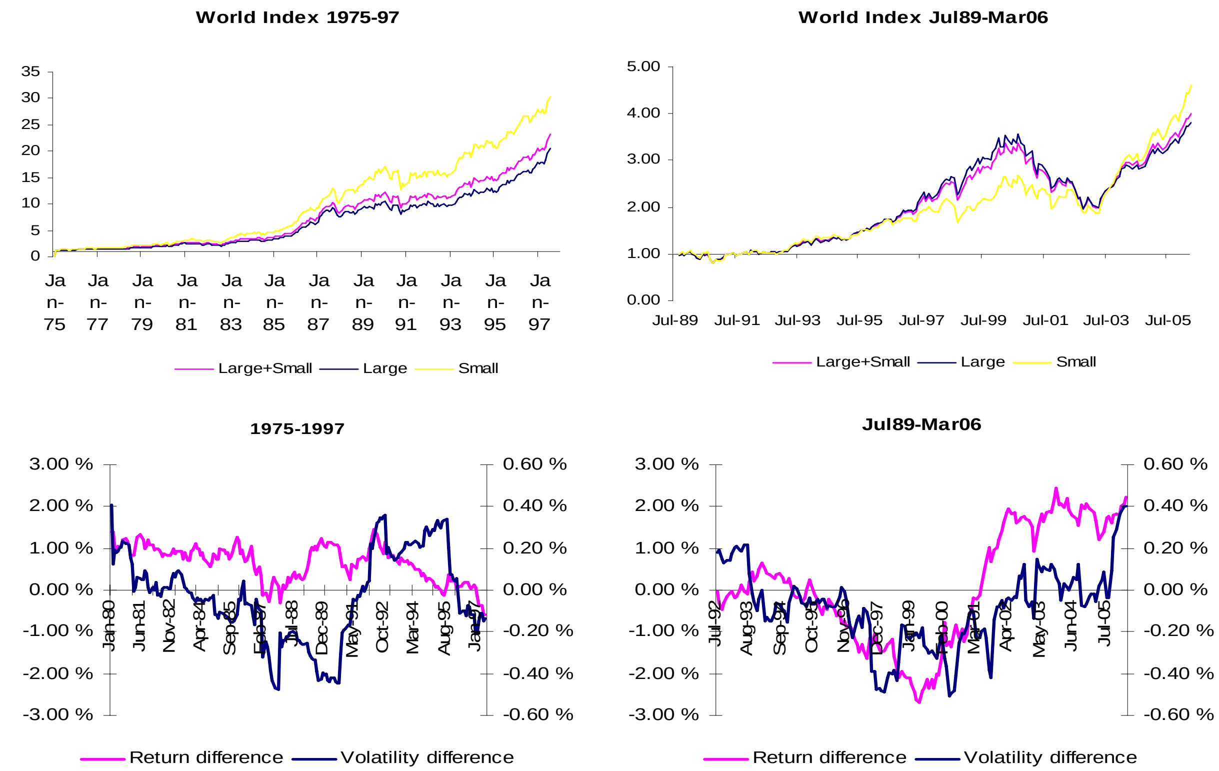

Figure 5.15: *Performance of small cap and large cap stocks and difference in annualized three years rolling returns and volatility between a broad index and a large cap index, IIA World Index (1975-1997) and S&P/Citigroup World Index (Jul89-Mar06)*

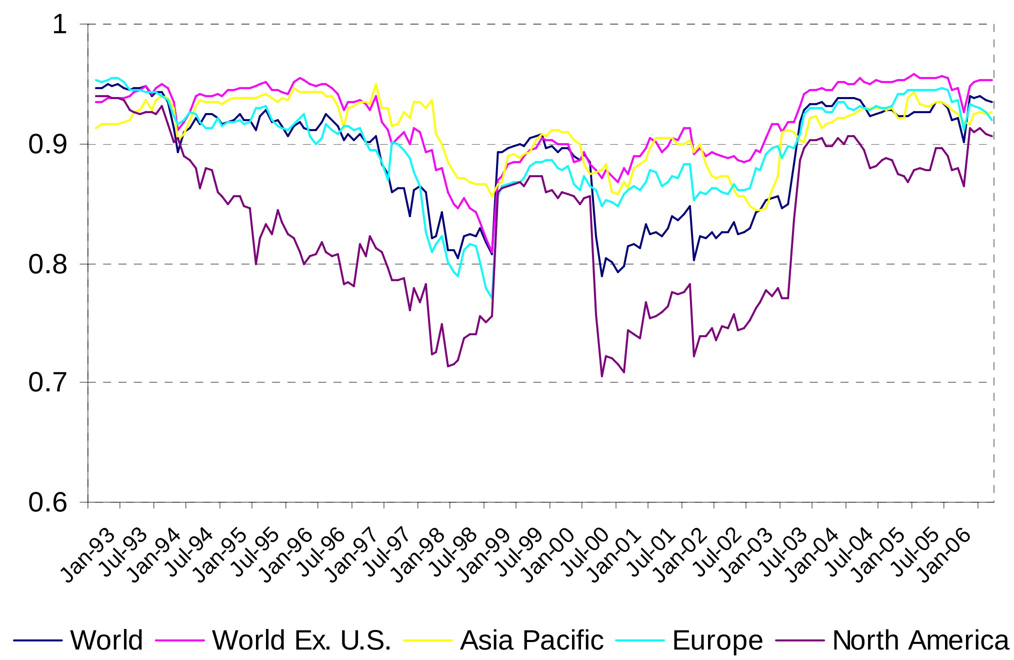

Figure 5.16: *Three years rolling correlation between large and small caps*

Another relevant issue is the size and stability of the correlation coefficient between returns on large and small caps. Figure 5.16 shows three years rolling correlation coefficients from the years 1989-2005 between large and small cap indexes published by S&P/Citigroup, for the world, the world ex US, North America and Europe. The correlation coefficients are high (above 0.7) and relatively stable around 0.8 – 0.9. For comparison the correlation coefficients between the large and small cap segment of FTSE GEIS world index was 0.83 over the period January 2003 - March 2006.

Implementation costs
A potential pitfall of a small cap investment strategy is that the costs of establishing and maintaining the portfolio can be quite large.

Based on data for the value of firms in the small cap segment of UK stocks in the period 1955-2001, Dimson et.al (2003) argue that even a passive investment strategy in UK small caps can cut annual returns by several percentages points. The main reason for the high implementation costs in this study is high turnover costs. Assuming an annual rebalancing scheme, the authors estimate that around 40 percent of the small cap portfolio had to be reinvested each year. The main component of the turnover costs is drop-outs (50 to 70 percent), while the residual costs are equally split between delisting and dividends.

FTSE reviews their small cap region indices once a year. Based on the last review for each region (June 2005 to March 2006), there were a total of 204 deletions from the small cap region. Deletion from an index is due to illiquidity (market values falling below $100 mill or free float falling below 15%) or promotion to the mid-cap index. 155 firms or 76 percent of the total number of deletions were drop-outs due to illiquidity. Using the minimum firm value of $100 mill as the lower bound and the average market value per August 2006 of $838 mill as the upper bound, the amount needed to be reinvested due to illiquid firms in this period lied somewhere in the range from $15 500 million to $129 890 million or between 0.4 and 3 percent of the market value of the total small cap index.

Table 5.5 shows the *total* portfolio turnover for FTSE Global Small Cap Index since its inception in September 2003, as well as the total portfolio turnover for the All-World Index and a combination of the two (All Cap). A first thing to note is that there are large variations over time in the turnover numbers. Hence, one should be careful to draw strong conclusions based on these data. The last reviews for each region (June 2005 to March 2006) have in total required transactions (buys plus sells) equivalent to 23 percent of total small cap market value. Thus, turnover seems quite high, but, in contrast to what Dimson et.al (2003) find, drop-outs of illiquid firms is not the main turnover component.

Inclusion of the small cap segment means going from a benchmark defined by the FTSE All-World (i.e. large and mid cap) index to a benchmark defined by the FTSE All Cap index. It is therefore most relevant to compare the turnover of these two indices, which are reported in the two last columns of table 5.5. Looking again at the last four quarters, the required indexing transactions increase from 1.93 percent to 5.32 percent of market value. Taking the average of all observations in the table gives higher turnover for both indexes, but does not significantly affect the difference between them.

Review	FTSE Global Small Cap Index	FTSE All-World Index	FTSE Global All Cap
March 2006	3.24	0.37	0.98
December 2005	10.67	0.19	1.81
September 2005	6.76	0.82	1.46
June 2005	2.24	0.55	1.07
March 2005	5.52	0.66	1.49
December 2004	23.89	5.01	3.34
September 2004	31.28	1.67	22.43
June 2004	2.12	0.69	1.16
March 2004	4.00	0.65	1.25
December 2003	1.59	0.17	0.73
September 2003	6.00	13.61	1.60

Table 5.5: *Portfolio turnover in the FTSE global equity indices*

According to NBIM, a large number of indexing transactions are taking place between the quarterly reviews, mainly because of IPOs or because of reinvestments of dividends. With the current large and mid cap equity benchmark, these transactions are fully 60 percent of the total indexing transactions, making for a total transaction requirement of 4.7 percent of market value. If we apply that same ratio to the small cap segment, the total transaction volume requirement of the All Cap Index is 13.0 percent.

A more reasonable assumption may be that transactions due to IPOs and reinvestment of dividends represent the same percentage of total market value in all market segments. With that more conservative assumption the transaction volume required to replicate the All Cap index will be 8 per cent of market value as compared to 5 per cent for the All-World Index.

In addition to higher turnover, the cost of transacting is likely to be higher in the small cap segment than in the mid- and large cap segments. Based on a sample of institutional investors in the US during the period 1991-1993, Keim and Madhavan (1997) find that transaction costs vary considerably with market cap and order size. For NYSE stocks, the average cost of buyer initiated orders varied from 0.31 percent for the smallest orders in the largest firms to 2.35 percent for the largest orders in the smallest firms.[7] On the other hand, StockFacts estimates the average trading cost associated with changes in the small cap index to be only 13 basis points higher than the corresponding average cost associated with changes in the large and mid cap indices (59 versus 46 basis points).

The exact costs for establishing a small cap portfolio will depend on market conditions and on the speed of implementation. The estimates of market impact in table 3.2 below are based on the StockFactsPRO model.

[7] Transaction costs are measured using the implementation shortfall approach and includes both explicit and implicit components of trading costs. Explicit costs are most notably broker commissions while implicit costs include spreads, price impact costs, opportunity costs, and costs related to adverse selection. The idea behind the measure is that total transaction costs equal the difference in value between (i) an imaginary portfolio where all assets are acquired without costs at the exact time the decisions to buy the assets were made and (ii) the actual portfolio.

	Buying small cap				Selling large and mid cap			
Implementation period	Com-missions	Taxes & charges	Impact cost	Total cost	Com-missions	Taxes & charges	Impact cost	Total cost
1 month	5.85	11.97	110.42	**128.23**	5.92	1.21	17.31	**24.43**
3 months	5.85	11.97	49.92	**67.74**	5.92	1.21	6.75	**13.87**
10 months	5.85	11.97	31.50	**49.32**	5.92	1.21	6.03	**13.16**

Table 5.6: *Initial implementation cost estimates (millions USD)*

If the entire small cap portfolio is bought within one month and paid for by selling large and mid cap stocks, the estimated total implementation costs are USD 153 millions. That number can be substantially reduced by stretching the implementation period. With a ten month implementation period the estimated total costs are USD 62 millions. Even that cost could be somewhat reduced by using inflows to the fund for buying the small cap stock rather than selling large and mid cap stocks.

Keim (1999) looks at the benefits from ensuring that investments in US small caps are done following flexible rules. Specifically, Keim looks at the difference in returns from investing directly in the CRSP 9-10 index rather than investing in a mutual fund known to use special investment rules and trading strategies in order to minimize transaction costs. By ruling out the most illiquid and low priced stocks, following a patient investment strategy, and providing liquidity in the upstairs market, the mutual fund beats the index by an annual 2.2 percent in the period 1982-1995. Hence, this study suggests that there are ways to manage high implementation costs in the small cap markets.

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Appendix

FTSE Global Small Cap Index – Sector allocation per 07.04.2006

Sector	No of stocks	Market cap (mill USD)	Share	Average market cap
Oil and gas				
Oil and gas producers	110	124 306	3.0%	1 397
Oil equipment, services & distribution	89	257 632	6.3%	1 295
Chemicals	181	109 905	2.7%	607
Basic resources				
Forestry & paper	45	23 320	0.6%	518
Industrial metals	121	113 438	2.8%	938
Mining	72	79 833	2.0%	1 109
Construction & materials	227	170 682	4.2%	752
Industrial goods & services				
Aerospace & defence	46	42 525	1.0%	924
General industrials	75	69 552	1.7%	927
Electronic & electrical equipment	238	154 252	3.8%	648
Industrial engineering	257	201 991	5.0%	786
Industrial transportation	133	92 983	2.3%	699
Support services	189	173 802	4.3%	920
Automobile & parts	108	52 379	1.3%	485
Food & beverage				
Beverages	38	18 213	0.4%	479
Food producers	146	82 058	2.0%	562
Personal & household goods				
Household goods	113	96 361	2.4%	853
Leisure goods	61	37 650	0.9%	617
Personal goods	124	65 875	1.6%	531
Tobacco	7	8 158	0.2%	1 165
Health care				
Health care equipment & services	155	141 922	3.5%	916
Pharmaceuticals & biotechnology	182	137 032	3.4%	753
Retail				
Food & drug retailers	54	40 630	1.0%	752
General retailers	261	200 776	4.9%	769
Media	146	103 726	2.5%	710
Travel & leisure	190	167 927	4.1%	884
Telecommunications				
Fixed line telecommunications	26	19 836	0.5%	763
Mobile telecommunications	16	14 253	0.3%	891
Utilities				
Electricity	59	66 890	1.6%	1 134
Gas, water, & multi-utilities	54	59 772	1.5%	1 107
Banks	276	218 275	5.4%	791
Insurance				
Non-life insurance	91	97 317	2.4%	1 069
Life insurance	23	31 216	0.8%	1 357
Financial services				
Real estate	328	305 783	7.5%	932
General financial	171	157 304	3.9%	920
Equity investment instruments	82	64 341	1.6%	785
Non-equity investment instruments				
Technology				
Software & computer services	205	147 496	3.6%	719
Technology hardware & equipment	320	252 583	6.2%	789

6. Private Equity

Private equity investments are unlisted equity investments in companies. The main motivations for private equity investments are either high growth potential in new businesses or high profit potential from restructuring of existing companies. These two sources of return are associated with venture capital investments and buy-out investments, respectively. Mezzanine debt financing[1] is a third and smaller fraction of the private equity investments universe.

Investments can be made directly into individual companies, or indirectly through private equity funds. Private equity funds are most often organized as limited partnerships with a lifetime of 7-10 years. The general partner provides a small amount of capital and is responsible for the operations of the fund, whereas the limited partners provide the bulk of the capital. Limited partners enjoy limited liability in exchange for very limited formal influence over the operations of the partnership. Over the last few years, funds of private equity funds have emerged as a popular alternative for investors seeking one-stop diversification of their private equity portfolios. Larger institutional investors tend to rely on investments in funds and, to a smaller extent, direct co-investments with general partners. For smaller institutions fund-of-funds might be the most cost-efficient way to get private equity exposure, as there are significant costs involved in building up necessary skills and data for performing extensive due diligence on potential investments.

Activity in the private equity markets have increased substantially since 2003 after a lull following the extreme levels of fundraising and investment during the late 1990s. Figure 6.1 shows the level of fundraising globally since 1996. Funds raised globally increased from $59 billion in 2002 to $187 billion in 2005.

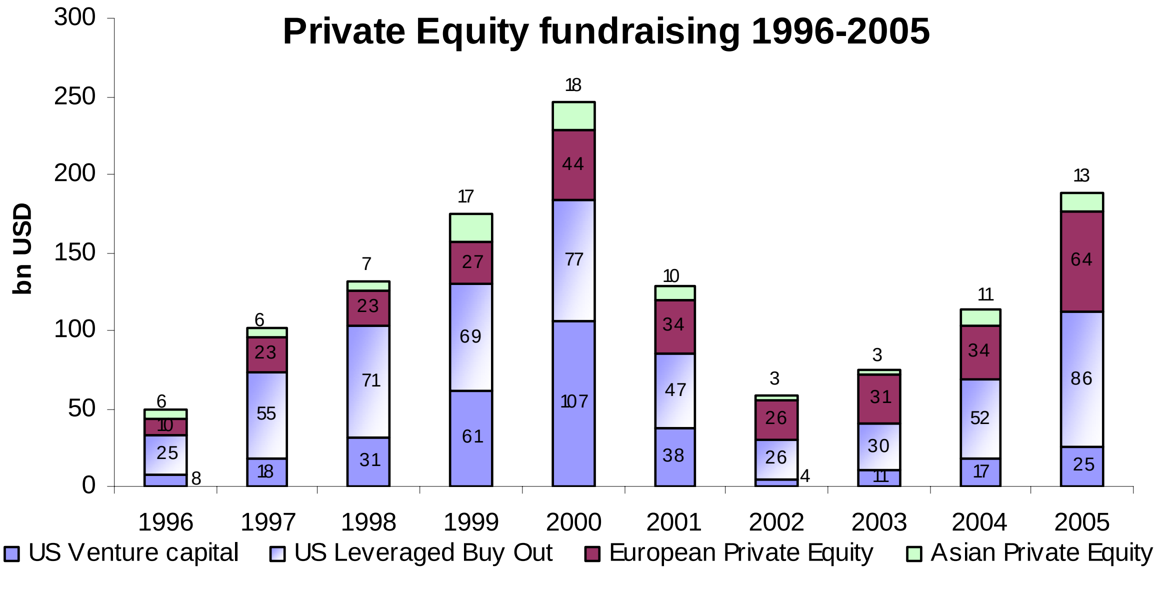


Figure 6.1. Funds raised globally 1996 - 2005. Source: Venture Economics/EVCA/Citigroup/Datastream

High levels of fundraising in recent years may lead to overhang, meaning that over the next few years, a large volume of capital already raised will be seeking profitable investment opportunities. The increased fundraising has not yet been accompanied by an increase in

[1] Debt that incorporates equity-based options, such as warrants, with a lower-priority debt.

investments. Investments in the U.S. buy-out market, which constitutes a large share of the total global private equity market, increased from $23.5 billion in 2002 to $42.9 billion in 2003, but then fell to $26.4 billion in 2004. Meanwhile, after the tech bubble years, investments in the US venture markets have been stable around $ 20 billion ($ 22.4 billion in 2005[2]) the last years.

A large share of the private equity capital is invested in U.S. portfolio companies, and the funds that undertake these investments are also primarily based in the US. During 1998-2003, on average 63 percent of funds were raised in North America, falling from 71 percent in 2000 to 54 percent in 2003. In terms of segments, buy-out has displaced venture capital as the largest sector in recent years. While buy-out comprised 38 percent of fundraising on average during 1998-2003, it amounted to 64 percent in 2003.[3]

6.1. A potential portfolio for the Government Pension Fund

As further detailed in the section on risk and return below, private equity investments are more accurately seen as return enhancers than as diversifiers. Thus, even a relatively small allocation of 2-3 percent could potentially be defended on grounds of superior return expectations, as long as the allocation is invested in above-average performing investment vehicles.

Annual investment volume

A 3 percent share of the Petroleum Fund can be expected to amount to about €11 billion within 2010, according to the Revised National Budget of 2006. Such a portfolio would make the fund a large player in private equity markets, probably the largest institutional private equity investor in Europe, and, also probably a sought-after limited partner with access to most of the high-quality private equity funds. Building the portfolio would require large volumes of commitments each year. The time-limited nature of private equity funds means that a large share of investments will be returned to the investor as fund distributions within a few years. According to Ljungqvist and Richardson (2003), the entire commitment is typically returned to the investor within 7 years.

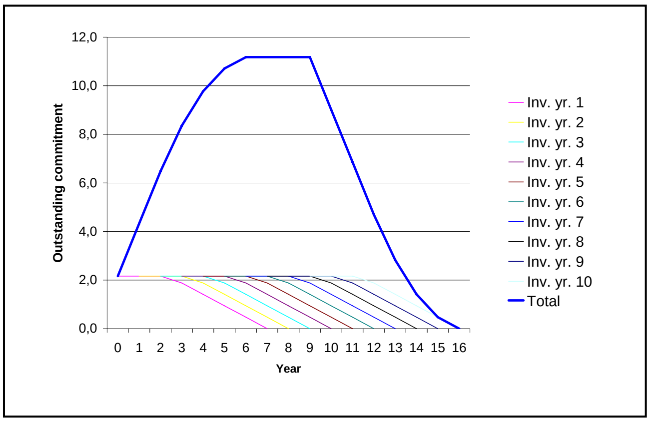


Figure 6.2: Indicated cash flow profile for a target portfolio of € 11 bn, based on a € 2.2 bn annual commitment in 10 years.

[2] Source: PWc/NVCA MoneyTree Report
[3] Source: PwC Global Private Equity 2004.

Taking into account the return of capital to investors, a rough estimate of the annual capital commitments required to reach and maintain a €11 billion invested portfolio is € 2.2 billion. Figure 6.2 illustrates the decline in outstanding committed capital invested each year, and the sum of outstanding commitments. Outstanding commitments are defined as initial commitments less distributions from the private equity funds. The figure is based on the distributions figures from Ljungqvist and Richardson (2003).

Global fundraising volumes over the last few years suggest that the private equity market is sufficiently large to accommodate the requisite annual commitment volume of approximately € 2 billion. The Pension Fund's annual commitment would amount to 1 percent of 2005 fundraising and to 2.1 percent of average annual fundraising from the low-point years of 2001 to 2004.

Nonetheless, the significant size of the Pension Fund's private equity portfolio would limit the possibility to target subsections of the private equity market. It is likely that a large share of the fund's portfolio will be in the buy-out segment, as the venture capital segment is more limited in size. This is consistent with available information on the composition of the private equity investments of other large investment funds. In addition, the share of the portfolio likely to be in US based funds with investments in the US will significantly overshoot the US share in the Pension Fund benchmark for its public investments. Figure 6.3 provides in panel A the regional and market segment split of global private equity investments in the period 2002-04[4]. Panel B shows the allocation of the €5.6 bn private equity portfolio invested by AlpInvest mainly on behalf of its founding partners, ABP and PGGM. These illustrations can serve as a rough indication of the expected diversification achieved by a large global private equity portfolio over a perennial investment period.

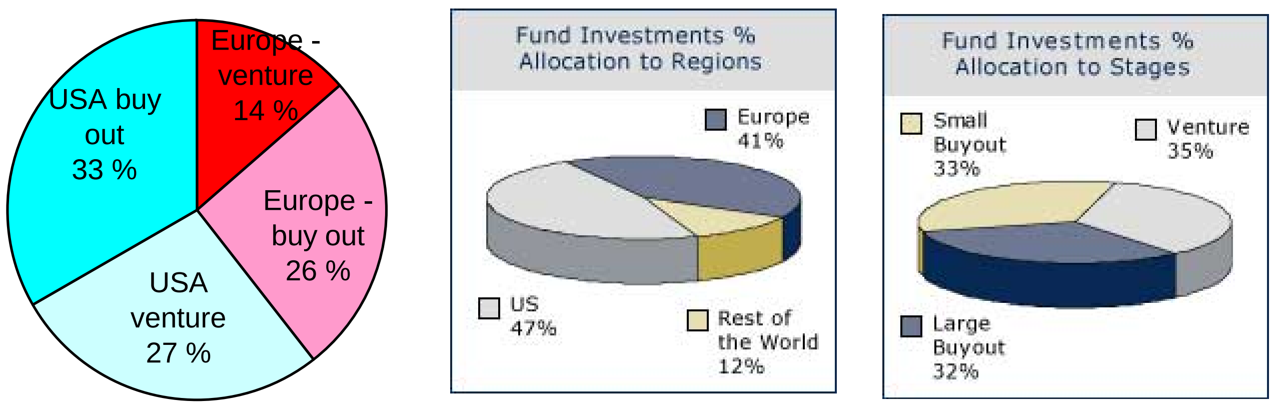


Figure 6.3 panel A: Regional distribution of global private equity investments 2000-2004. Sources: VentureEconomics/European Venture Capital Association. European investment amounts are converted to US dollar using average monthly exchange rate (WM Reuters closing rate)
Figure 6.3 panel B: Regional distribution and allocation to Private equity segments inAlpInvest Partners portfolio December 2005. Source: AlpInvest Partners

In the US, the average size of each venture fund was approximately $ 150 mill in 2005, while an average buy-out fund raised approximately $450 mill The average commitment per investor to each fund can, based on the figures above, be estimated to $10-20 mill in the

[4] Sources: VentureEconomics/European Venture Capital Association. European investment amounts are converted to US dollar using average monthly exchange rate (WM Reuters closing rate)

venture segment and $50-100 mill in the buy-out segment. This indicates that a € 11 bn fully invested portfolio with annual commitments at $ 2 bn may require a relationship with roughly 200 general partners, and investments in approximately 300 individual funds. In comparison, AlpInvest reports that their €5.6 bn portfolio is invested in almost 200 funds, and that a core relationship is maintained with close to 90 partner firms.

An alternative and more careful approach might be to start with a significant lower allocation target for a private equity portfolio at the preferred horizon, and consider an increase in the allocation when the fund has gained experience in committing and monitoring private equity investments.

Benefits of Discretion

The wide dispersion in return between successful and unsuccessful private equity funds warrants particular emphasis on fund selection, and thus, a bottom-up approach to allocation. The management of the Pension Fund's private equity portfolio is likely to be more successful if it allows for a high degree of discretion in picking the best funds at any time, rather than being bound by a variety of regional and other constraints on the portfolio. To maintain adequate risk control and good incentives, management discretion must be combined with process and documentation requirements. An incentive-based compensation system based on the long-term success of investments should be considered. Such compensation systems exist or are being developed at other investors, such as the private equity units of ATP and GIC.

Emphasizing discretion rather than specific allocation rules implies that the Government Pension Fund sets a high-level allocation to private equity, but refrains from establishing a norm portfolio for the allocation. As a result, the mandate will not include regional, segment or sector allocations. Rather, the relative shares of each region, sector and segment will be a result of the selection.

6.2. Risk and Return

Conceptually it is reasonable to assume that the drivers of return on unlisted stocks will be similar to those of listed stocks. Similar to listed companies, the earnings of private companies will be exposed both to general economic conditions and to sector developments. The ratio of fair value to earnings will likely also be correlated to the price-earnings ratio of listed stock markets, one reason being that IPO's is one important exit-strategy for private equity funds.

Expected Returns

Historical returns

Historical data on returns, volatilities and correlations of private equity has certain imperfections relative to their public market equivalents. First, neither private equity funds nor their portfolio companies are marked to market on a regular basis. Rather, portfolio companies are valued according to the most recent transaction value or some subjective estimate of fair value. Thus, the validity of the capital gains component of returns is highly uncertain and questionable. Second, there may be an element of self-selection (upward bias) in the reporting of returns to data providers, as reporting is done by the private equity funds themselves and is voluntary.

Despite of these issues, return indices such as those provided by US based Venture Economics, and Cambridge Associates, are widely used. Table 6.1 provides an overview of the historical returns on venture capital (VC) and buy-out investments (BO) in the US since the early 1980s, as well as public indices. VC investments are compared to the NASDAQ because of its prevalence of technology-related companies, whereas BO is compared to S&P500 because BO targets generally are mature companies, which feature heavily in that index.

	VC	NASDAQ	VC Less NASDAQ	BO	S&P500	BO Less S&P500
1981-1985	5,3 %	11,8 %	-6,5 %	…	14,7 %	…
1986-1990	5.2 %	14,6 %	-9,4 %	6,6%[5]	13,2 %	-5,6%
1991-1995	23,6 %	20,8 %	2,8 %	16,4 %	16.6 %	-0,2 %
1996-2000	62,4 %	23,5 %	38,9 %	20,8 %	18,3 %	2,5 %
2001-2005	-12,6 %	-1,3 %	-11,3 %	9,6 %	0,5 %	9,1 %
1981-2005	14,2 %	13,5 %	0,7 %	…	12,5 %	…
1986-2005	16,6 %	14,0 %	2,6 %	13,2 %	11,9 %	1,3 %

Table 6.1. Historical returns on venture capital and buyout investments. Source: Cambridge Associates, Datastream. The private equity returns are time-weighted returns from quarter to quarter, chained geometrically. Private equity returns are net of fees, whereas public sector returns are before fees.

The figures in Table 6.1 indicate that historically, private equity has outperformed public equity by a very narrow margin. However, the outperformance results entirely from the very strong private equity market in the nineties. In particular, according to this dataset, the outperformance of venture capital is explained by one single quarter in late 1999. If the fourth quarter of 1999 is eliminated from the series, venture capital underperforms NASDAQ by 0.2 percent annually in the period 1981 - 2005.

Table 6.2 compares private equity performance in Europe and the US since the mid-1990s. Over the 10-year period up to 2004, European VC investments were less profitable than those in the US, whereas the reverse was true for buy-out investments. During the last 5 years until 2004, venture capital investments have performed relatively poorly in both regions, although figures from the most recent years are less meaningful, due to the J-curve effect that is typical in private equity investments. The term J-curve describes the typical situation facing private equity investors, where returns are negative in the first years due to asset management fees and early write-offs, while turning strongly positive in later years.

	Western Europe		US	
	VC	BO	VC	BO
1999-2004	-10.2 %	17.9 %	-6.6 %	5.0 %
1995-2004	8.3 %	19.2 %	42.4 %	12.3 %

Table 6.2. Historical returns by region and segment. Source: Cambridge Associates.

The above tables display time-weighted returns, which are comparable to returns from public market equity indexes. But returns on private equity is frequently measured in terms of the internal rate of return (IRR), also called the dollar-weighted return. The IRR reflects the timing of investments and distributions, and thus measures not only a fund manager's ability to create value, but also his skill in timing investments and exits.

Tables 6.3 and 6.4 display IRR's by fund vintage year, i.e. the year when funds were established, calculated as of December 2005. The tables show both the average return and the return on the median fund and the upper quartile fund (i.e. best 25th percentile). IRR's are shown as 5-year arithmetic averages.

[5] Since second quarter 1986

United States	VC.			BO		
Vintage	Average	Median	Upper Quartile	Average	Median	Upper Quartile
1981-1985	9,6 %	8,6 %	13,1 %			
1986-1990	21,4 %	14,8 %	23,7 %	16,8 %	13,9 %	19,9 %
1991-1995	51,6 %	29,6 %	49,6 %	20,0 %	17,4 %	26,9 %
1996-2000	35,7 %	4,4 %	30,3 %	10,1 %	8,8 %	15,3 %

Table 6.3. Returns by vintage years in the U.S. Source: Cambridge Associates[6].

Western Europe	VC			BO		
Vintage	Average	Median	Upper Quartile	Average	Median	Upper Quartile
1986-1989	12 %	12 %				
1987-1989				15 %	14 %	
1990-1994	14 %	16 %		17 %	17 %	
1995-1999	10 %	9 %	13 % [a]	14 %	13 %	18 % [c]

Table 6.4. Returns by vintage years in Western Europe. Source: Cambridge Associates. [a] 1997-99 [b] 2000-01 [c] 1996-99

Average returns by vintage in the US shows that the 1990s were a particularly good period for VC investments, supported by the very strong IPO-market in the late nineties. BO investments performed well in the 1980s and into the early 1990s. The significant performance difference between the pooled mean and the median venture fund returns indicates that a limited number of relative larger venture funds have created superior returns in this period. In Europe, the figures confirm good performance by BO investments, but only modest returns on VC in comparison with the US.

There is wide dispersion between funds, both in the US and Europe. In the US, the outperformance of upper quartile funds relative to average funds is 4-13 percent for VC and 5-10 percent for BO. European data on upper quartile funds is less complete, but during 1997-2001, upper quartile outperformance was 12 percent for VC and 11 percent for BO (not shown in the table).

Academic studies

The conclusions from the historical data presented above are mostly confirmed by academic studies.

- Kaplan and Schoar (2005) study returns between 1980 and 2001 on 750 funds, most of which were established before 1995, thus avoiding the J-curve issue. Their main result is that BO returns were slightly below the S&P500 return, whereas VCs were slightly higher. They also find that funds raised during "boom" periods on average performs more poorly than funds raised under normal market conditions, a finding which they attribute the emergence of less qualified managers during booms.
- Jones and Rhodes-Kropf (2003) analyze returns on VC and BO funds formed in the period 1980 – 1999. Their main conclusion is that alpha increases with the amount of

[6] CA publishes also vintage year returns for the years after 2000, However, only a very limited part of fund investments these years will be realised. A dominant part of the reported fund returns will be based on appraisals of current investments in the fund portfolios, or affected by the first years J-curve effect. These returns will very likely be changed significantly once the funds exit their investments.

idiosyncratic risk. However, the aggregate value weighted venture capital and buy-out portfolios have alphas that are indistinguishable from zero.

- Ljunqvist and Richardson (2005) analyse detailed cash flow data from *one* large US institutional investor. Up to 85 percent of the institution's private equity investment capital was deployed to BO funds. The private equity investments of this particular investor strongly outperformed public markets, with an IRR 5.9 percent higher than S&P500 and 2.6 percent higher than NASDAQ.[7] Using an industry-group based approach to assigning betas to each fund in their sample; they find that both BO and VC funds have a beta close to 1.1, which they use to derive values for alpha. Cumulative alpha over the life of the funds is 15 percent for VC and 27 percent for BO, which roughly translates into annual alphas of 1.8 percent and 3 percent, respectively, if the average fund life is 8 years.
- Cochrane (2005) looks specifically at venture capital investments and studies individual private companies receiving private equity fund backing. A main result is that the geometric average return on VC investments is slightly below that of S&P500. However, both arithmetic average return and alpha is very high, 59 percent and 32 percent respectively, a fact that Cochrane attributes to high volatility. Beta for VC investments is 1.9, driven largely by returns on IPOs.
- Woodward (2004) reports a negative alpha of 30 bp per quarter when Cambridge Associates quarterly return premium on US venture funds in the period 1990 – 2003 are regressed on the return premium for the Wilshire 5000 public index, contemporaneous return plus five lagging quarters (using the three month bill as the risk free return). The sum of betas rises from 0.59 to 2.06 when lagged values of the public market index are introduced as explanatory variables in the regression. Woodward also makes use of an alternative index – the Sand Hill index - when estimating the relative performance of venture capital versus public equity. This index is based on company level data rather than fund level data. The author finds an alpha of 3 bp per month, equivalent to 36 bp per year when the return premium of this index is regressed against the contemporaneous and 18 months lagged Wilshire return premiums in the period 1990-2003. The beta is 2.0. Woodward concludes that the reward is not quite sufficient to cover the systematic risk, much less leave a further premium for illiquidity risk, as the Sand Hill index return is reported gross of fees[8]. Woodward reports an alpha of 50 bp per quarter when the return premium on Venture Economics Buy Out universe is regressed against the Wilshire premium, lagged 1-5 quarters in the period 1990 – 2003. However, the standard deviation of this alpha is even higher than the alpha itself.
- Phalippou and Zollo (2005) report negative performance figures on the VC and BO industry in general. They conclude that the return of private equity funds raised between 1980 and 1996 lags as much as 3.3 % (per annum) on the S&P return. They use the same dataset as Kaplan and Scohar (2005), and complement this material with three correction mechanisms. The first correction adjusts the original dataset for a potential sample-selection bias by including data on 1400 additional funds[9]. Second,

[7] Returns on public equities are comparable IRR-figures.

[8] A normal compensation scheme (2 % annual compensation to GPs on committed capital and 20 % carried interest) will roughly reduce a LP's return from a fund with 4 % on an annual basis, assuming a fund with 10 year life time.

[9] The original dataset included data on funds that either were officially liquidated or had no reported cash flow during the last two years of the sample. The authors complement this universe with data on funds that were excluded from the original dataset, but still had made at least four investments and one exit.

they compute the performance by aggregating cash flow streams across all funds instead of aggregating individual fund performance by committed capital[10]. Finally, they write completely off reported residual values on liquidated or "quasi liquidated" funds, as they argue that this might be closer to the true state than the values reported by the funds. Even after these corrections, the authors argue that the "true" expected PE performance estimates should be revised even more downwards.

- Kaserer and Diller (2004) have done the most extensive study on European Private Equity fund data. Based on Venture Economics data on 777 funds raising and investing capital in European private equity in the period 1980 – 2003, the authors draw a sample consisting of funds that either was liquidated or having only a small residual value relative to the present value of distributed cash flows at the end of the period[11]. When assuming that distributed cash flows during the period have been reinvested in a public equity benchmark, Kaserer & Diller find that private equity investments on average have performed very similar to public markets, The Sharpe ratio of the aggregated private equity market is either marginally higher or marginally lower than the Sharpe ratio of the public equity market, depending on where the limit on residual value relative to distributed cash flows as requirement for inclusion in the sample is set. On an absolute return basis, the relative performance varies from + 55 bp to – 62 bp for the alternative samples of funds. However, when restricting the included funds to funds raised after 1989, the study finds a significantly higher performance in the private equity market (+ 2.2 percentage points) as well as improved Sharpe ratio. The latter result shows that the 90'ties were a very attractive period for investors in private equity in Europe.

Factors determining success

While there is little evidence that private equity investments on average have offered investors a long term risk premium relative to listed equities, there is no doubt that a subset of investors have generated returns far above alternative rewards in public markets. As tables 6.3-4 above shows, the spread between the median and upper quartile performing BO funds has been 6-8 % over time, considering matured vintage year funds only. This spread is significantly higher within the venture capital universe.

Moreover, past returns seem to be a stronger predictor of future returns in private equity investments than what generally tends to be the case in public markets. This is true whether one considers general partner investments or classes of limited partners. Figure 6.4 show the proportion of follow-up funds receiving upper-quartile or second quartile performance in US, dependant on relative performance vs. peers in the first fund. Figure 6.4 demonstrates the link between past and current performance on general partner level. Academic studies confirm the same picture. Kaplan and Schoar (2005) find persistence in performance in successive funds by the same manager. 1 percentage point outperformance in a prior VC fund results on average in 0.7 percentage point outperformance in the subsequent VC fund, whereas the equivalent for BO funds is 0.3 percentage point.

[10] The effect of this correction is to reduce the weight of recently raised funds in the universe.

[11] At the end of 2003, 95 of the 777 funds in the database was liquidated. 200 funds had a residual value of less than 10 % of distributed cash flows, and 262 funds had a residual value of less than 20 % of distributed cash flows.

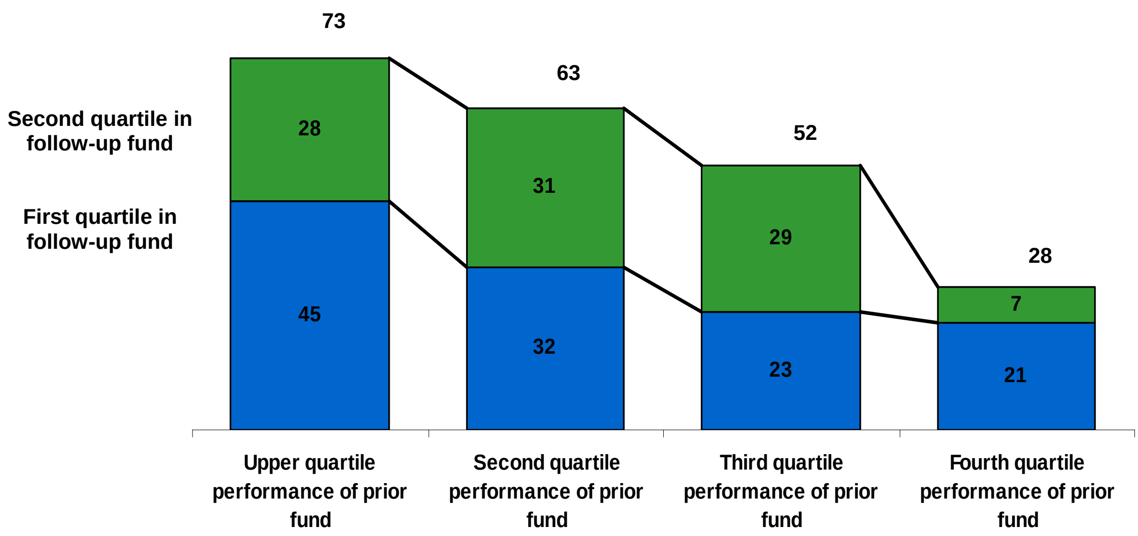


Figure 6.4: Persistence of returns between first fund and follow-up funds, USA. Source: CS private Equity/McKinsey

The persistence of outperformance also seems to be valid among different investor classes. Lerner, Schoar and Wong (2005) analyse investments done by different investor segments in US private equity funds established prior to 1999. They find that US endowments on average have an annual return which is 14 % higher than other investor classes. While some of this can be attributed to the fact that the endowments are "early entries" in the industry and achieved access to certain superior venture funds which are closed for later entrants, endowments also outperform other investor classes when considering younger partnerships only. Funds in which endowments decided to reinvest also show higher performance than those where they decided not to invest.

Potential side interests among certain investors are offered as explanation why some investors have persistently achieved higher returns. Some argues that certain LPs (limited partners) do not invest in private equity only to obtain the highest risk-adjusted returns, but also to establish a relationship between the fund and the LP's corporate parent. Revenues arising from consulting work (for M&A's), underwriting or lending, might more than offset the cost incurred by a negative expected alpha on the fund investment. Other (politically motivated) investors might also invest in PE in order to stimulate the local economy.

Lerner, Schoar and Wong (2005), on the other hand, attribute most of the proved return differences to differences in skills among investors.

A key condition for developing and maintaining skills in a private equity investment organisation is to avoid high turnover among the senior investment professionals. The alignment of interest between the organisation itself and its senior investment professionals through financial motivation, such as compensation schemes or co-partnership, as well as non-pecuniary benefits, is probably important for the expected turnover.

Given the persistence of superior returns among GPs (general partners), the LPs challenge is not only to identify likely out-performers, but also to get access to them. In a situation where GPs can choose the LPs they want, LPs offering long term relationships and a stable source to financing might have an advantage above others.

Finally, as the fee structure heavily impacts net performance of a fund, many investors might not fully realize the impact of complicated - and to a certain extent non-salient – fee structures on performance.

Summary on Expected Returns

The widespread view that private equity as an asset class offers a clear risk-adjusted return premium relative to public markets seems to be premature. Most recent research tend to conclude that the average investor in this asset class has received a risk adjusted return either in line with, or worse than returns offered by public markets.

However, as opposed to traditional asset classes, it is not possible to estimate expected return in private equity independent of manager selection. The dispersion of returns between upper quartile and median investors is significantly higher in private equity than in public equity markets. Moreover, the persistence of superior performance among certain investors seems to be stronger in private markets than in public markets. Hence, there are reasons to believe that a subset of investors can achieve a long term return on private equity in excess of risk adjusted public market returns, where the excess return is attributed to skill.

6.3. Volatility and Correlations

A comparison of quarterly performance figures in private versus public markets might lead to the conclusion that private equity offer low volatility as well as low correlation with public markets.

However, such time series analysis will significantly underestimate the risks associated with private equity and overestimate the diversification benefits versus public market investing. Stale pricing creates the most obvious problem. Private equity investments are not marked to market the way (liquid) bonds and public equities are. Rather, the general partner's valuation of the portfolio companies might be based on the last round of financing (common for venture investments) or on an infrequent valuation executed by the partner himself (common for buy-out investments). This creates serial correlation between the valuation estimates, and results in artificially low volatility and correlation figures.

One alternative to overcome the problem with stale pricing could be to aggregate return figures over longer periods, for example using 1 or 3 years non-overlapping returns data. The short period private equity has existed as an asset class commonly in use by institutional investors introduces limitations to this approach.

Another approach has been to construct market return data over shorter time intervals based on reported company valuations. Hwang, Quigley and Woodward (2005) estimate an index for venture capital in US, based on information about pricing events (IPO's, acquisitions, private funding, cessation of operations) in the universe of US venture firms in the period 1987 – 2003. The index is constructed through a hybrid version of the repeated-sales technique, and is corrected for selection bias. The index measures the return on direct investment, not the limited partners' return from fund investment. Hwang, Quigley and Woodward report a quarterly volatility of real returns on the venture index at 13.2 %. Table 6.5 summarises the correlations on quarterly real returns between the venture index and other markets as calculated by the authors.

Correlation between	S&P 500	NASDAQ	Govt. bond index
Hybrid venture index	0,39	0,47	-0,14

Table 6.5: Correlation between hybrid venture index and public markets, USA 1987 - 2003 Source: Hwang, Quigley and Woodward (2005)

Budhraja and Figueredo (2005) suggest a new method where public market data and aggregated private market index data are used to generate "true" private equity return series, where the problem with serial correlation is avoided. They attribute the measurement error of published private equity returns to systematic and random components, and estimate three systematic components of the error term; serial correlation, public market effects and private markets effects. The authors estimate the "true" time series pattern of the private market returns through a two-stage regression analysis where listed market returns and serial correlated adjusted private market returns are input variables.

When implementing the model on US data from January 1988 through September 2003, the authors find that volatilities in private equity markets and correlation with public markets increase substantially. Table 6.6 compares annual volatilities and correlations before and after use of the suggested correction mechanisms of Budhraja and Figueredo.

	Annual volatility		Correlation with S&P 500	
	Before correction	After correction[12]	Before correction	After correction
Venture capital	17,4 %	43,3 %	0,45	0,55
Leveraged buy out	11,0 %	20,4 %	0,51	0,75[13]

Table 6.6: Correlations between private equity and US stocks, Budhraja/Figueredo, Journal of Portfolio Management Winter 2005

This study does not report correlation between the private equity markets and other listed markets. In table 6.7 below are volatilities and correlations estimated by the use of the Budhraja/Figueredo methodology applied on a slightly different and extended dataset[14].

The results here are broadly in line with the figures in the Budhraja/Figueredo original work, and support the general hypothesis that venture capital and buy-out are highly correlated with the public equity markets. The true volatility of venture capital is above the volatility of the listed market. In comparison, the Post Venture Capital Index – an index measuring the performance of former venture capital firms 10 years after listing, has had a volatility of 34 % in the same period. This comparison indicates however that the volatility of venture markets as calculated above is too pessimistic for this asset class.

The volatility of buy-out investments seems to be fairly in line with its public market equivalent. The latter result should be challenged by the fact that LBO companies tend to be more leveraged than listed companies, and also by alternative studies indicating a higher beta on LBO funds.

[12] The volatility of the serial correlation adjusted time series are set by increasing the volatility of the serial correlation adjusted time series with the observed standard deviation on the estimation error in the regression. This represents a conservative estimate of true volatility.

[13] The modelled quarterly market returns in private markets are correlated against quarterly S&P 500 returns. The adjusted correlation figures also include a correction for "model overfit".

[14] Data from 1987-2005. Private equity markets are represented by the quarterly Cambridge Associates indices CA US Venture Capital Index and CA US Private Equity Index.

Asset class	Annual volatility		Correlation With S&P 500		Correlation with Nasdaq		Correlation with US govt. bonds	
	Before correction	After correction	Before correction	After correction	Before correction	After correction	Before correction	After correction
Venture capital	18,2 %	50,4 %	0,42	0,63	0,51	0,78	-0,06	-0,14
LBO	8,8 %	16,5 %	0,62	0,74	0,62	0,74	-0,03	-0,15
S&P 500	16,3 %				0,84		-0,15	
Nasdaq	25,4 %						-0,17	
Govt. bonds	2,4 %							

Table 6.7: Volatility and correlations between Private Equity and public markets in USA, 1987 – 2005. Sources: Cambridge Associates for PE index data. Norges Bank calculations.

Summary of risk and volatilities

As volatilities of reported private equity returns are heavily impacted by stale pricing, the direct use of reported short term returns in calculating volatilities and correlation with listed equity markets will lead to a significant exaggeration of diversification benefits. While there is no industry standard for constructing time series data comparable to returns in listed markets, different empirical tests support the idea that short term returns in unlisted markets should be highly correlated with market returns on listed stocks in similar market segments. There are also reasons to believe that the volatility of private equity investments exceeds the volatility of public stock market indices in the same segment and region. Venture investments are characterized by high uncertainty and fat tails on the distribution of returns of individual investments. Portfolio companies in LBO funds will typically be more leveraged than the average listed company, also resulting in higher expected volatility.

The volatility and correlation estimates in table 6.6 and table 6.7 above seems to be a fair estimate of true risk in these markets, perhaps with a slight upward revision of the volatility estimate of buy out investments.

6.4. Indices and Risk Control

A limited number of index providers publish regular reports on the overall performance of the different segments of the private equity market. As mentioned above, Venture Economics (VE) and Cambridge Associates (CA) are the two most commonly used sources to the short term and long term overall performance of the PE industry. None of the index providers claim to show a perfect picture of historical performance, as they rely on voluntary submission of performance figures from the different funds. Nevertheless, both vendors have a large penetration in the industry. Venture Economics currently monitors the performance of more than 2000 private equity funds globally and follows the investment costs and values on 1200 funds. Cambridge Associates claims to cover approx. 80 % of all capital raised by US venture funds in the period 1981-2005, and nearly 70 % of capital raised by US buy-out funds between 1986 and 2005. Both companies offer a variety of analytical tools based on the maintained data bases.

While the VE and CA indices merely report the valuations done by the general partners, a third index provider, Sand Hill, tries to build an index that is comparable to the indices in use in public markets. The challenge of correcting short term performance data from general partners for intermittent pricing and valuation biases are met through the use of statistical tools. The Sand Hill index reports continuous returns from 1989 and onwards on US venture companies. However, in contrast to the VE and CA indices, the SH index will show returns on the PE company level, not the returns received by limited partners.

The fund and company information and analysis offered by the index providers give valuable information to private equity managers in the short term as well as in the long term. However, they can not act as a neutral benchmark for a plan sponsor's assessment of a particular fund's short term performance.

6.5. Other institutional investors

Large institutional investors generally invest a limited portion of their assets in private equity, with a long term target to achieve returns superior to returns offered by public equities, or at least risk adjusted returns similar to public markets while realizing diversification benefits in the overall portfolio. This is further illustrated in table 6.9

The US pension fund CalPERS is the largest private equity investor among the funds referred to in table 6.9. The $ 10 billion invested portfolio understate the overall size of the program, as the fund had committed $ 26,4 billion to close to 480 different private equity vehicles by the end of September 2005. All private equity investments are organised under the alternative investment program, which has a separate allocation of capital at the asset allocation level in the fund. CalPERS invests mainly indirect through partnerships, but participates also in direct deals either as sole investor or through co-investments with a general partner. The internal private equity team is an integrated part of the investment management organisation. However, CalPERS relies not entirely on internal resources when sourcing investment alternatives and performing due diligence. External strategic relationships with a limited number of specialist firms engaged in deal sourcing and screening/due diligence on investment alternatives is an important element of the total alternative investment program.

Ontario Teachers' has also retained the private equity team as a part of the internal management organisation, although it is organised as a separate profit unit – the Teachers' Private Capital. This unit is responsible for all private equity investing (benchmarked against the Canadian listed equity market) as well as infrastructure investing (benchmarked against the Canadian CPI + 4 %). Teachers' Private Capital invests either indirectly being a limited partner in a private equity fund or directly through co-investments with financial partners.

The two largest European pension funds, ABP and PGGM, have chosen an external route for the implementation of the funds' private equity investment strategies. The asset allocation decision is retained in the funds themselves, while the capital once it is allocated is invested by the ABP/PGGM joint venture AlpInvest Partners, employing 55 investment professionals. The capital allocated from ABP and PGGM constitute the dominant part of AlpInvest Partners' funding, but other external investors have also contributed to the € 30 billion commitments received by AlpInvest by the end of 2005. AlpInvest splits its commitments between 80 % fund investments (primary and secondary) and 20 % co-investments/direct investments.

Fund	Country	Net invested in PE	% of total net assets	Benchmark
CalPERS	USA	$ 10 bn	5,1 %	Long term: 300 bp over Wilshire 2500 Short term: At least median performance among PE universe on a per vintage year basis
New York State Com. Ret. Fund	USA	$ 8 bn	6,3 %	Long term: Higher return than public equities
CalSTRS	USA	$ 7,5 bn	5,4 %	Russell 3000 + 5 % + 90 days T-bill return (lagged 1 quarter)
Michigan Bureau of Invest.	USA	$ 6 bn	12,0 %	Higher return than S&P 500 on a 1, 3 and 5 year basis. Comparions on shorter horizons also done versus peer universe
Yale Endowment Fund	USA	$ 1,8 bn	14,5 %	Long term: University inflation + 10 %. Short term: Higher than CA composite
Harvard Management Company	USA	$ 2,4 bn	8,0 %	Not stated
Ontario Teachers	Canada	C$ 6,0 bn	6,2 %	Higher return than Canadian listed equity market
Canada Pension Plan	Canada	C$ 3,5 bn	3,8 %	Long term: 8 % real return
Caisse de dépôt et placement du Québec	Canada	C$ 5,1 bn	5,0 %	Long term: Higher return than S&P 600 (small cap index) Short term: expected return on govt.bonds + 250 bp equity premium + 500 bp
ABP	The Netherlands	€ 5,6 bn[15]	3 % (approx.)	Not stated
PGGM	The Netherlands	€ 3,5 bn	4,7 %	Long term: Public equities + 200 bp
ATP	Denmark	DKK 5,4 bn	4,1 %	Not stated
AP6	Sweden	SEK 8,5 bn	Not applicable	Short rate + equity premium + liquidity premium over a 5 year rolling horizon (not stated in numbers)

Table 6.9: Private equity allocations and return targets for large institutional investors. Sources: Latest available annual reports

[15] This amount represents our own estimate, based on publicly available information. The ABP 2005 annual report values private equity holdings and commodity holdings to € 9,4 billion. According to ABPs web site, the target allocation to private equity is 6 % of the variable-yield allocation (54 %), while the commodity allocation is 4 %.

7. Real Estate and infrastructure

7.1. The real estate and infrastructure markets

7.1.1 Real estate – size of the market

Only uncertain estimates can be given of the size of the global investable real estate market. European Public Real Estate Association (EPRA) estimates the global commercial real estate market to $ 14.5 trillion, using 2004 data[1]. That analysis was based on a calculation formula developed by Liang and Gordon (2003) in Prudential Investors. The total comprises 40 % in USA and other American countries (3 % in Latin America), 38 % in Europe and 22 % in Asia/Pacific. South Africa and other African countries are not included in this study.

Figures for the share of the investable market owned by investors, termed invested real estate, vary considerably among different sources. Conservative estimates indicate that the invested share is between a quarter and a third of the overall investable real estate markets[2]. Other sources, like Jones Lang LaSalle, value the invested market significantly higher, particularly in the US. Approximately $220 billion in total real estate assets in the US is controlled by tax-exempted investors[3], which is less than 10 % of the total invested real estate market here according to JLLS figures. Owner-occupant real estate contributes significantly to the difference between investable and invested real estate.

Region/ Country	Investable	Invested	Listed	Unlisted
America	5840	3170	440	2730
U.S.	5000	2840	420	2400
Europe	5530	1460	450	1010
U.K.	1040	510	100	410
France	790	160	30	130
Germany	1080	230	190*	40*
Asia Pacific	3160	1680	300	1380
Japan	1970	1290	90	1200
Total	**14530**	**6310**	**1180**	**5130**

* The division between gross asset values of listed and unlisted real estate vehicles in Germany is misleading. Possible reasons might be a conservative estimate of the invested market and/or full inclusion of companies with revenues from more than control over real estate in the listed index**.**

Table 7.1. Approximate breakdown of the gross asset values in global investable real estate market. Sources: EPRA, LaSalle Investment Management, GPR.

* The **division between gross asset values of listed and unlisted real estate vehicles in Germany is misleading. Possible reasons might be a conservative estimate of the**

[1] EPRA/Hughes & Arissen September 2005: “Global Real Estate Securities - Where do they fit in the broader market ?”

[2] Sources: Roulac (2003): “Corporate owned real estate represents a substantial investment universe”, Journal of Portfolio Management vol.9 no. 2 2003. Hess/Liang (2003): Sizing up the US Real Estate Market, Prudential Real estate Investors Research 2003

[3] According to the Tax-exempt Real Estate 2006 Survey executed by IREI and Kingsley Associates, the $ 97,5 bn in real estate assets covered in this survey constitutes 43,5 % of total real estate investments by US tax-exempted investors. The target allocation to international real estate among the survey participants was 3 %.

invested market and/or full inclusion of companies with revenues from more than control over real estate in the listed index.

Table 7.1 gives an overview of the size of the investable and invested real estate markets globally. The invested real estate market figures are based on estimates by LaSalle Investment Management. The figures for listed real estate are based on equity market capitalization as of year end 2005 and leverage ratios varying from 20 % in Asia/Pacific to 45 % in Continental-Europe.

7.1.2 Real Estate Indices

There are several global indices for listed real estate. The four most commonly used indices are:

- S&P Citigroup BMI Property Index: This index has the most extensive market coverage, given that its inclusion criteria, including minimum size and liquidity, are less strict that those of other indices. In august 2006, this index covered 463 property stocks in 21 developed markets and 13 emerging markets, with a total market capitalisation of $ 807 bn.
- FTSE EPRA/NAREIT Global Property Index: Having higher standards for liquidity and size, this index contains a somewhat lower share of the total market. As of August 2006, it contained 319 companies in 21 countries with value of $ 769 billion.
- Global Property Research 250 (GPR 250) covers 248 of the most liquid real estate companies, as measured by 12 month trailing trading volume. The companies in the index were based in 22 countries and had a market value of $661 billion as of 31 August 2006. The Global Property General Index covering 29 markets and also less liquid stocks had at the same time a total market value of $ 968 bn.
- UBS Warburg Global Real Estate Investor Index is a subset of the FTSE-EPRA/NAREIT index. The purpose is to identify and cover companies that are typical real estate investors, as opposed to typical developers. The selection of companies is based on the share of future revenues that is expected to be from rental activities. As of March 2006, 231 companies with a market capitalization of $ 553 billion qualified for inclusion in the index.

All of these indices are market cap weighted and use free float adjustment for market capitalization. Both REIT-style instruments and “ordinary” real estate companies are included.

Table 7.2 analyses the difference between the real estate segment of the FTSE all-world index and the two “pure” real estate indices FTSE EPRA/NAREIT and GPR 250 in more detail. These two indices are chosen as they are considered to be a broad, but still investable representation of the global listed real estate universe.

In North America and Europe the pure real estate indices cover a broader set of the universe, mainly because of the inclusion of the small cap real estate stocks. Within the large and medium cap segment the indices are virtually overlapping. This is also the case in Japan. As the Australian listed property companies tend to be medium sized companies (with a broad international exposure), the differences between the indices are only minor in this country. Hong Kong is a different case, as the FTSE All-World has a bigger market cap and also includes several stocks which are not a part of the GPR 250 (and probably not of the FTSE EPRA/NAREIT index either)[4]. A higher percentage of revenues must come from real estate

[4] This is also the case for Singapore, not shown in the table because of its smaller market size.

related activities to be included in the real estate indices than what is needed to be assigned to this industry category in the FTSE-All-World index series[5].

Region and country	**FTSE AW Real Estate**		**FTSE EPRA/ NAREIT**		**GPR 250**		**Comparison FTSE AW Real Estate – GPR 250**		
	Market cap 30.06.06 (mill $)	**Number of stocks 30.06.06**	**Market cap 30.06.06 (mill $)**	**Number of stocks 31.12.05**	**Market cap 30.06.06 (mill $)**	**Number of stocks 30.06.06**	**Number of stocks in both indices**	**Number of stocks in FTSE AW only**	**Number of stocks in GPR 250 only**
North America	*222253*	*30*	*343187*	*146*	*277826*	*118*	*21*	*9*	*97*
USA	201128	28	318165	127	261931	104	*21*	*7*	83
Canada	21126	2	25022	19	15895	14	0	2	14
Europe	*78354*	*12*	*151129*	*91*	*123967*	*63*	*11*	*1*	*52*
UK	45729	5	71196	38	56287	24	5	0	19
Germany	0	0	5717	3	4834	3	0	0	3
France	12293	3	17219	6	11230	3	2	1	1
Netherlands	10771	2	17131	8	13152	7	2	0	5
Asia/Pacific	*221780*	*69*	*225843*	*70*	*138310*	*45*	*36*	*33*	*11*
Japan	63044	8	82689	21	87510	25	5	3	20
Australia	69843	16	73857	25	64704	17	14	2	3
Hong Kong	76433	18	56394	13	40294	12	8	10	4

Table 7.2: Comparison of real estate segments in FTSE AW and pure real estate indices. Sources: FTSE, EPRA, Global Property Research

Table 7.2 shows that on average a pure real estate index will give a better representation of the real estate universe than the FTSE All-World index, but mainly because of the exclusion of small cap companies from the equity index. A comparison of the real estate segment of the full FTSE global equity index with the pure real estate indices will probably show small differences.

For unlisted real estate, the most important indices are the NCREIF-index, which covers the US, and the IPD-indices, which cover most countries in Western Europe as well as Canada, Japan and South Africa. There is also an Australian index maintained by the consulting firm Mercer. Capital gains reported in these indices are mostly based on appraisals. Reporting frequencies vary from monthly for the UK IPD index to annually for most of the other IPD indices. NCREIF reports quarterly. None of these indices have full market coverage, but IPD covers approximately 40 percent of the European unlisted market, estimated by IPD at € 1 070 bn (gross asset value) in markets with an IPD index by the end of 2004. NCREIF covers a much smaller share of the US market (less than 5 % according to Marcato/Key, 2005).It is

[5] The assignment of companies to industry categories in FTSE aw is based on the Industry Classification Benchmark, jointly developed by FTSE and Dow Jones. A company will be assigned to the industry which is the most important source for revenues, based on last published reports. A company will be defined as a real estate company and eligible for inclusion in the FTSE/Epra/Nareit index if 75 % of EBITDA (60 % in Asia) can be assigned to real estate activities. To be qualified for inclusion in the GPR-indices, 75 % of operational turnover must come from real estate.

nonetheless quite common to use the NCREIF index as an indication of market developments and as a performance benchmark in the US market.

There is no global index for unlisted real estate, but a European index has been developed and is published annually by IPD.

7.1.3 Defining the infrastructure market

Infrastructure is a broad term for a range of economic and social assets which are used to satisfy general community, social and economic needs. While public funding has been, and will continue to be, an important capital source for infrastructure projects, private capital has grown in importance as a source of capital. Private capital investments in infrastructure can be done through a direct or indirect equity stake in a business that typically owns and/or operates an infrastructure asset. Exposure can also be achieved through debt financing of owner or operating companies.

There is a clear distinction between infrastructure development investments and investments in infrastructure assets in operation. The definition above does not explicitly exclude development investing. However, the return and risk profile of an infrastructure investment change significantly from the development and establishing phase to the operation phase, as described in the risk and return section below. These phases must be analysed separately. The remaining part of this chapter implicitly assumes investments in infrastructure assets under operation, as this is the investment category long term institutional investors typically will consider as a part of their core holdings.

Because of the importance of infrastructure assets to community and their role as natural monopolies in many cases, the revenue streams of the operator will be regulated by governments companies to a smaller or greater extent, depending on the type of infrastructure. This introduces an upside as well as downside cap on associated earnings and risks. An allowed rate of return on investments and legally binding agreements on pricing mechanisms within long term concession periods are examples of such regulations. Within social infrastructure (as defined below) the responsibility for providing service normally remains with the government, and the government provides the income stream directly. The variability of returns will be low, and the investor should expect a return between government bonds and equities. However, use of significant leverage in the financing structure, which is typically the case in financing social infrastructure, can enhance expected equity return as well as risk. On the other side, investments in for instance airport operating companies give the investor a higher degree of freedom to adopt active business strategies to yield higher returns, at the cost of reduced income certainty.

Infrastructure (equity) investments are generally characterised by:

- *A long duration:* Underlying assets and contracts with the relevant public authority will typically have a lifetime of at least 10 years – and often for a period longer than 30 years.
- *Relatively high income yields*: When an infrastructure project is through the construction phase and has entered into the operational phase, it will typically have predictable and regular capital inflows, either true user payment or true public contractual transfers.
- *Big scale investments*: It is common for infrastructure assets to be valued at well over $ 1 bn, requiring either very large investors or a collaborative approach from a group of investors.

Infrastructure investments can be split into two categories: economic infrastructure and social infrastructure. Economic infrastructure consists of services for which the user is prepared to pay. Toll roads and other transport related infrastructure assets are typical examples. Social infrastructure is composed by assets necessary for provision of services granted by the government, where private sector builds, owns, operates and maintains the facilities. Schools, hospitals and prisons typically belong to this category. Private capital contributions to such projects are generally organised under a PFI (Private funding initiative) or PPP (public private partnership) umbrella. Figure 7.1 provides a further decomposition of infrastructure investments.

Economic infrastructure			Social infrastructure
Transport	Energy & Utility	Communications	
Toll roads Bridges Tunnels Sea Ports Airports Rail Ferries	Gas distribution -and/or - storage Electricity distribution – and/or - generation Water treatment – and/or - distribution	Cable networks Satellite systems	Healthcare facilities Education facilities Housing Judicial and Correctional facilities

Figure 7.1: Infrastructure sectors. Source: RREEF Infrastructure

7.1.4 Size and composition of markets

In 2005 a new global index was created by Macquarie Bank in cooperation with FTSE, tracking all companies with a significant part of their revenues arising from the control of infrastructure assets. The total value of all listed vehicles in the index (utilities and operational companies) is $1.4 trillion in the investable index, and $1.8 trillion in the full index[6], equivalent to approx. 4% of the FTSE Global Equity All Cap Index. The listed universe is dominated by utilities operating electricity and/or gas distribution systems in the US, Europe or Japan, although other sectors such as airport operating companies also are represented in the index.

This listed universe can only serve as a weak indication of the overall market size. First, a lot of the companies in this index will have revenues from other activities than those which can be directly related to the control over infrastructure assets. Second, investments by unlisted private investors/companies should be included together with the public company investments.

We are not aware of any studies estimating the global size of the unlisted infrastructure market. However the Deutsche Bank affiliated investment management firm RREEF has

[6] The companies must have a minimum full market capitalisation of USD 250 million to be included in the index. All companies are drawn from the FTSE Global Equity Index series. Data as of January 2006.

recently performed a rough calculation of the European market size based on two different approaches. In a bottom up analysis they assign an economic value to a key variable in each infrastructure sector (for example the number of passengers at an airport), based on market values and debt levels of listed companies in this sector, together with traffic (in a broad sense) information. Using public information on overall traffic in each sector and each country, whether the owner/operating company is a public entity or a private company, RREEF obtains a rough indication of the gross asset value of all infrastructure. In a top down analysis RREEF compares the size of the listed market transport and utilities and compare it with the bottom-up estimated size of the overall infrastructure market in the same sectors. By imposing the average listed/total ratio in these two sectors on the total size of a listed infrastructure index, an overall estimate of the total infrastructure market can be built.

The two methods arrive at rather different results, with range from $ 3 trillion (bottom up) to $ 8 trillion (top-down). While the calculations done in the bottom-up approach excludes some of the infrastructure sectors and hence likely underestimate the true market size, the top-down approach will likely overstate the same market, as several of the companies have revenues from non-infrastructure activities and own assets outside of Europe. A best estimate of the European Market according to RREEF is therefore $ 4 – 6 trillion.

Extrapolating this European estimate to the global market using regional GDP-weights gives an estimate of the global infrastructure market gross asset value of $ 17 – 23 trillion. This indicates that the total value of infrastructure assets globally is not significantly different from the total value of commercial real estate assets. However, significant parts of this will be funded by public budgets. Within the private capital funded universe, debt financing will be the dominant source of capital.

The total market capitalisation can be further decomposed into individual sectors. Figure 7.2 shows a decomposition of the market based on two alternative sources – and for the European market only. Panel (a) shows the total value of all infrastructure transactions in European OECD countries in the period 2000-02 divided by sectors, while (b) shows the distribution between sectors of the bottom-up calculation performed by RREEF as explained above. Hence, the first estimate is transaction based, while the second estimate is holding based.

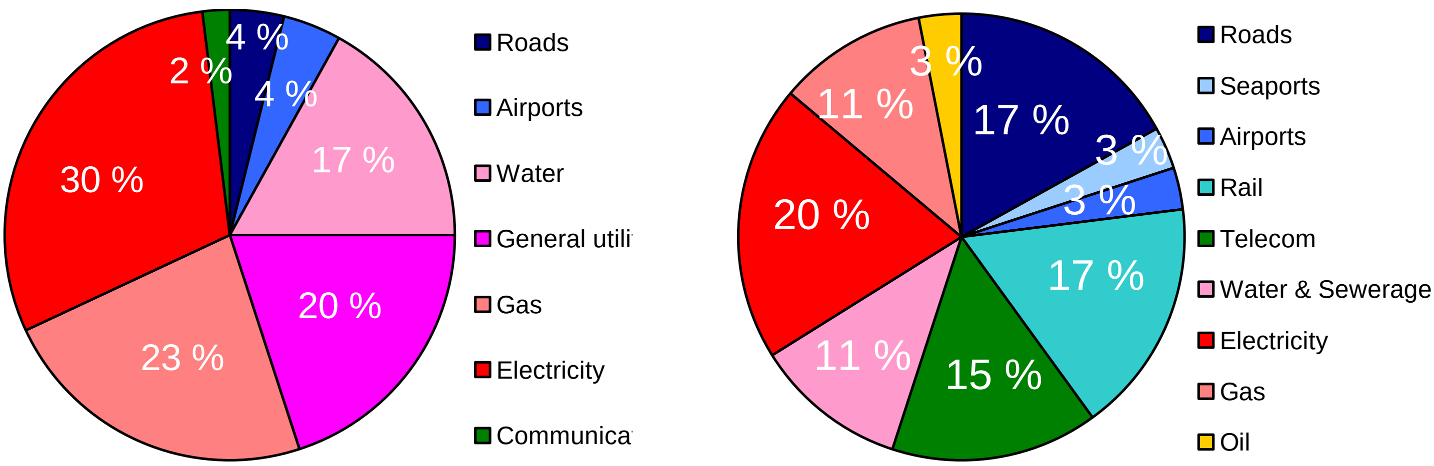


Figure 7.2: (a) Infrastructure transactions (debt + equity) European OECD countries jan 2000 – jan 2003. Source: Thomson Financial and Macquarie estimates. Total transaction value estimate: € 140 bn.

(b) RREEF estimate total value of European Infrastructure Market (2005/06), Total value estimate: $ 1,2 trillion.

The demand for infrastructure assets is generally expected to be stable and growing over time, stimulated by increasing wealth and income levels. At the same time public authorities face constraints on budget financing due to weak fiscal balances. Figure 7.3 provides an overview of the current economic growth potential and government fiscal balance in developed as well as emerging markets.

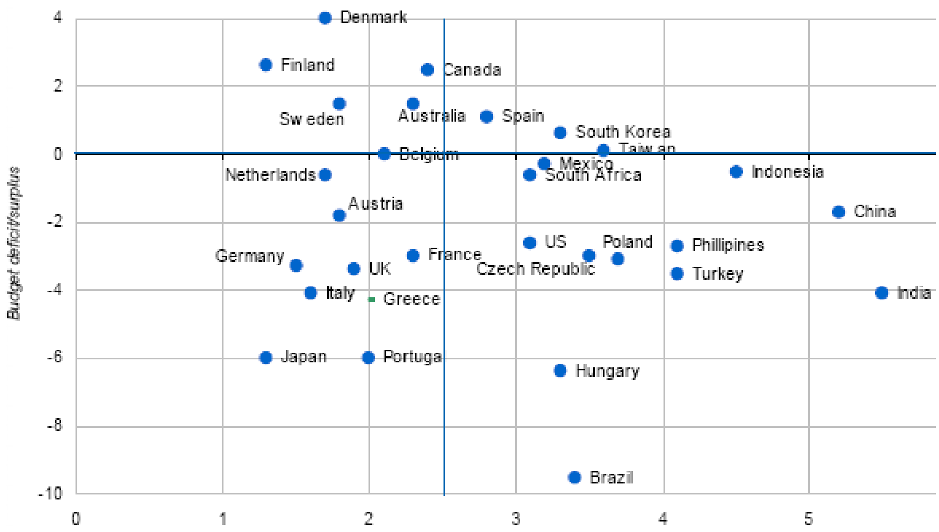


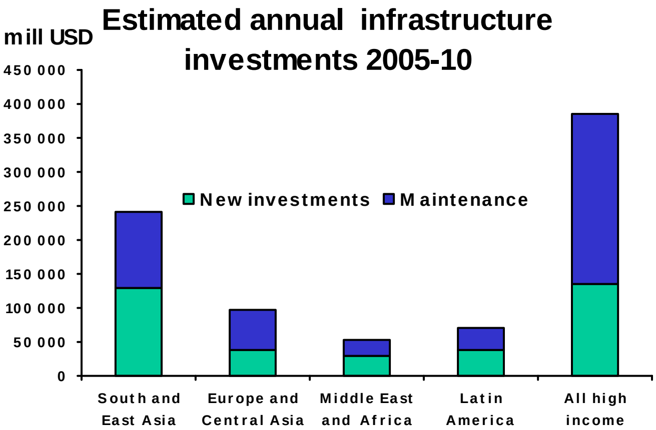
Figure 7.3: Budget deficits and long term real GDP growth in individual countries. Source: RREEF/Deutsche Bank research

The figure illustrates that several large emerging market economies (in particular China and India) are facing a rapid growth combined with pressure on public spending. But also large developed economies growing at a modest pace have internal budget pressures to transfer some of the financing need for infrastructure from public budgets to private investors.

The World Bank infrastructure Vice Presidency has tried to estimate the need for investments in infrastructure globally in order to satisfy consumer and producer demand based on predicted GDP growth, the sector composition, and the technology level of the individual economies[7]. The study estimates that new investment needs will be approximately $ 370 billion every year in the period 2005 – 2010, amounting to nearly 1 % of worldwide GDP. Another $ 480 billion is estimated as a minimum level for maintenance of current infrastructure stock in order to avoid threats to the current network's functionality. Figure 7.4 provides a breakdown of the estimated annual new investments and maintenance needs by geography and sector.

It may be noticed that the estimated annual new investments in developing Asia (mainly China and India) roughly equals the estimated new infrastructure investments in all high income countries aggregated. It may also be noticed that road investments are estimated to be even higher than investments in electricity generation. However, as the figure show, investments in gas utilities and transport segments such as airports and ports have not been estimated in the World Bank study.

[7] Fay/Yepes (2003): Investing in infrastructure, what is needed from 2000 to 2010?, World Bank Policy Research Paper wps 3102



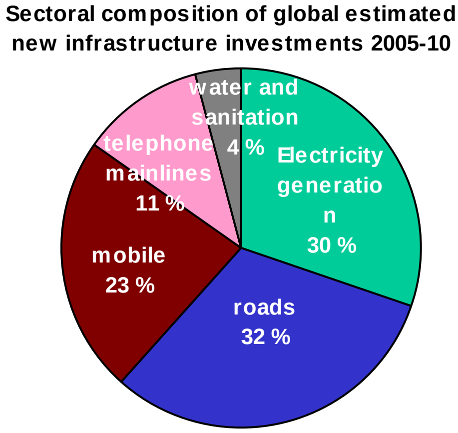


Figure 7.4: Estimated annual investments in infrastructure 2005-10 by geography and sector

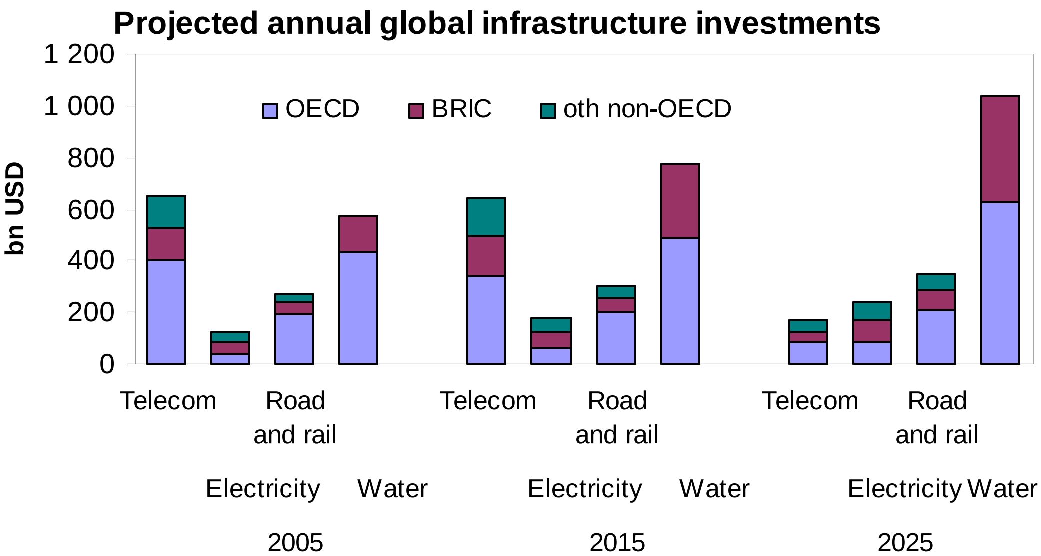


Figure 7.5: Projected infrastructure investment requirements 2005 – 2030. Source: OECD

An alternative study estimating future infrastructure investment requirements globally for a long term is recently published by OECD[8]. The authors emphasises strongly that any such long term projections can only provide an indication of the orders of magnitude of the infrastructure investment requirements, and that needs (derived from a set of variables where GDP growth is the most important) for many reasons may not translate into effective demand. Figure 7.5 provide key numbers from this study, where the investment requirements are illustrated for 2005 (average 2003-2010 or actual 2005-figures), 2015 (average 2011-2020) and 2025 (average 2021-2030). The amounts are aggregated for the OECD countries, the

[8] OECD General Economics & Future Studies (2006), vol. 2006, no. 2: Infrastructure to 2030: Telecom, Land Transport, Water and Electricity

BRIC-countries (Brazil, Russia, India and China) and all remaining non-OECD countries, and separated between the telecom, electricity, transport and water sectors[9].

The report estimates a growth in global infrastructure investments in these sectors only marginally weaker than the assumed global gdp growth from 2005 until 2015. After 2015/2020 is the overall infrastructure requirement expected to fall somewhat, explained by a reduction in expected telecom investments. However, it is important to bear in mind that water infrastructure investments in non-OECD countries outside of the BRIC-universe are not modelled in the report. Water infrastructure investments are the main reason why the BRIC-share increases over time, and similar investment requirements should prove to be significant also in other non-OECD countries over time.

7.2. A potential portfolio for the Government Pension Fund

7.2.1 Real estate

Size

Building a real estate portfolio for the Government Pension Fund will take several years, and the challenge will be compounded by the expected growth of the Fund over the same period. The remainder of this chapter makes the assumption that an allocation of at least 5 percent is necessary for real estate to make a significant contribution to the risk-return properties of the Fund. A 5-10 percent allocation will be equivalent to €17-34 billion in 2010, according to projections for the future growth of the Fund made in the National Budget 2006.[10] Below, these figures are compared to the current rather than the future size of investment markets, given the difficulty of projecting the future developments.

Investment instruments

The size of the Pension Fund will pose a challenge for achieving a meaningful exposure to real estate, at least within the context of the current investment guidelines. An allocation of 5 percent will require the use of both listed and unlisted real estate. It will prove extremely challenging to build such a large portfolio while limiting investments to small minority positions in listed stocks or unlisted funds, as a continued pursuit of the current investment strategy in public markets would suggest. An allocation of this size will also require large investments through segregated account managers, joint ventures, or other vehicles suited for large scale investments in real estate.

A real estate portfolio invested solely in listed instruments would come to comprise a large share of the total market. The total investment universe of listed instruments, measured by the market capitalisation of the FTSE-EPRA/NAREIT indices and adjusted for free float, was € 606 billion ($ 733 billion) as of 31 March 2006. A €17-34 billion investment as indicated

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[9] The authors do not provide separate estimates for BRICs and other non-OECD countries for the telecom sector. The division in figure 7.5 is based on comments in the report on the relative size of India and China up to 2020/2025 in the non-OECD countries group (page 108). The authors provide only investment requirement estimates for the four BRIC-countries outside the OECD universe as far as water infrastructure investments are concerned.

[10] A 5-10 percent share will equal at least €10-20 billion at the end of 2006. Interviews with large pension funds indicate that 5-10 years may be needed to invest these amounts. In 4 years, i.e., at the end of 2010, the fund will have grown further and a 5-10 percent allocation is forecasted to correspond to €17-34 billion. The figures are in terms of current euros.

above is equivalent to owning 3-6 percent of all companies in the index, given current market size.

It is likely that the size of the listed market will increase over the next few years. The introduction of REITs has been proposed in both the UK and Germany. These proposals could lead to a significant increase in the size of the European listed market, in particular if these initiatives lead to investor-friendly structures to replace some of the current unlisted vehicles and to move real estate assets in Germany from open-ended fund structures into structures more suitable for institutional investors. However, even a doubling of the European market will only boost the total global market by 15-20 percent, given the limited size of the listed sector in Europe today.

The regional distribution of the Pension Fund's real estate investments will have important implications for the construction of the portfolio. A distribution based on import weights, resulting in a weight of at least 50 percent in Europe, would make the Fund's share of the total market particularly large in this region. The current market size is about €100 billion, according to the FTSE/EPRA/NAREIT Europe index, meaning that a 5-10 % allocation in 2010 with 50 % in European listed real estate securities would be equivalent to owning on average 8 -16 percent of current market. Such high ownership shares would be inconsistent with the Fund's objective of being solely a financial investor.

A regional distribution that deviates from the import weights or from the policy weights in the listed stocks and bond portfolios would give the fund the option of investing a larger amount in North-America, which has a large and liquid listed market. The regional distribution of the FTSE-EPRA/NAREIT index as of December 2005 was around 20 percent Europe, 50 percent North America, and 30 percent Asia-Pacific.[11] In the following chapter, a portfolio composition is illustrated with a somewhat lower European weight of 40 %, an equal target allocation of 40 % to America and 20 % allocated to Asia/Pacific.

Indicative composition of a real estate portfolio

Figure 7.6 illustrates the probable size limitations which even a 5 % allocation target will face if the Fund should be limited to diversified minority positions in listed real estate companies and unlisted general real estate funds. The total regional allocation requirements are set by the overall predicted size of the Pension Fund in 2010 as stated in the National Budget 2006, an assumed real estate allocation of 5 % and the 40/40/20 regional weightings as stated above.

The maximum allocation to listed securities is set to 2 % of the current market capitalisation (December 2005) of the FTSE-EPRA/NAREIT indices in each region. The maximum allocation to unlisted funds in Europe is roughly estimated based on funds actually raised in Europe the last years. A capacity limit of € 300 mill is assumed for annual equity commitments to real estate funds in this region[12]. The amounts in North America and

[11] The sector distribution was around 26 percent offices, 25 percent retail, 13 percent apartments, 23 percent diversified, and the balance in industrial and hotels. The sector distribution is according to UBS Global Real Estate Sector Index 31.12.05, which classifies the FTSE-EPRA/NAREIT index by sector and is reported on the EPRA website. In Asia-Pacific, companies classified by UBS as developers (as opposed to investors) comprised 45 percent of the listed market, whereas this share was small in Europe and North-America.

[12] The average GAV on funds in the INREV database excluding German Open Ended Funds by February 2006 is approximately € 450 mill. With an assumed leverage of 40 % this is equivalent to equity holdings of € 270 million. With the exception of 2004, INREV reports 35-45 new fund launches every year in the period 2000-2005. € 300 million is equivalent to 2,8 % of the aggregated equity capital of 40 funds raising on average € 270 million. Further, it is assumed that the commited capital will be invested over the subsequent three year period after launch year with 50 % invested in the first year after launch, and that no capital will be returned in the first five years.

Asia/Pacific are based on the estimated constraint in Europe and adjusted upwards according to the relative size of the total unlisted real estate market as reported in table 7.1.

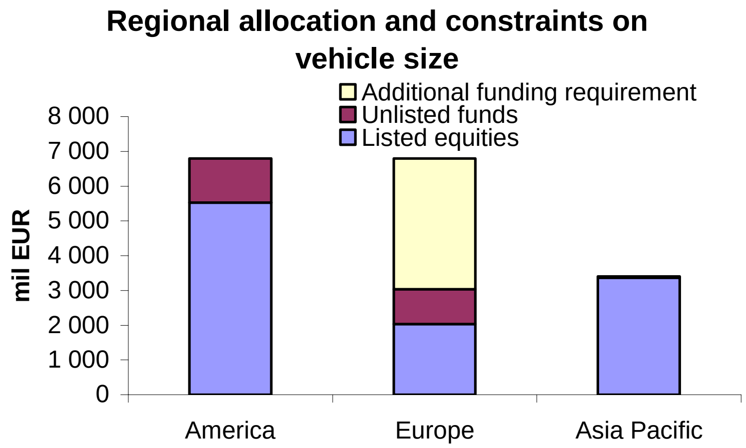

Figure 7.6: Regional allocation targets for a 5 % real estate allocation in 2010 and capacity constraints in listed securities and unlisted real estate funds. Sources: FTSE/EPRA/NAREIT, INREV, National Budget 2006, Norges Bank/SSK estimates.

Any calculation of size constraints for a diversified real estate investment strategy will be very rough and uncertain. The future market development is unknown. The estimated maximum market share (2-3 % of total market or annual fund raising in these calculations) is a critical assumption. While it can be argued that a diversified strategy without any very large (strategic) holdings can be implemented with higher average market shares, a careful approach would favour the selected limits.

With these reservations, figure 7.6 indicates that a potential real estate portfolio will have to be established using a combination of listed securities, unlisted funds and strategic interests in property vehicles, the latter in particular in Europe. Three main arguments can be quoted in favour of this strategy:

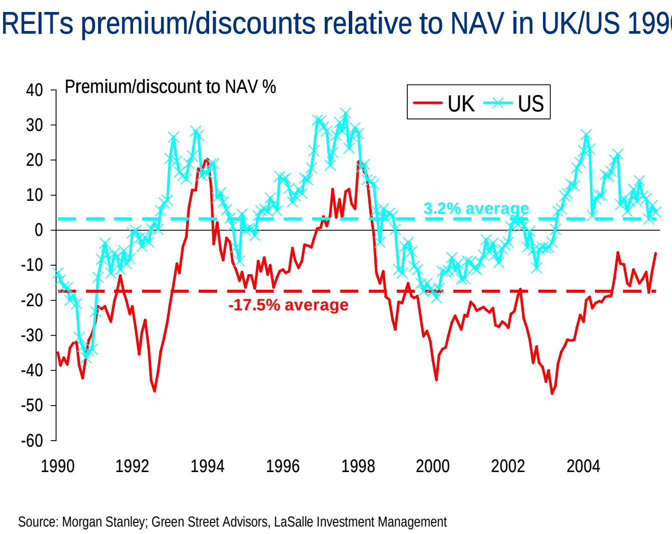

Figure 7.7: REIT P/NAV ratios in US and UK 1990 - 2005. Source: LaSalle Investment Management

(a): It is highly doubtful whether the accumulated listed real estate markets and fundraising by unlisted vehicles are large enough to absorb a 5 % (or higher) real estate allocation by the Fund, implemented over a limited number of years, if the Fund is limited to being a small investor in any single security or fund.

(b): The Fund should maintain flexibility and be able to choose investment vehicles based on an updated evaluation of the different alternatives. For example, the ratio between the stock price of listed real estate securities and the underlying net asset values (the REIT premium) will be relevant for the choice between listed and unlisted vehicles at any time. Figure 7.7 shows the volatility of the average REIT premium/discount in the US and UK the last 15 years. The average premium/discount has varied substantially over time, indicating that valuation of public versus private market should play a role in a real estate implementation strategy.

(c): The real estate funds represented in the INREV database (and in the market) have vastly different return objectives and risk profiles. The most aggressive (opportunistic) funds might be suited for active strategies relative to a real estate benchmark, but less suited for automatic inclusion in a large real estate implementation program.

7.2.2 Infrastructure

The listed equity infrastructure universe constitutes approximately 4 % of the global listed equity universe. Utility stocks are a larger share of the FTSE All World index in Europe than in other world regions. Consequently, the Pension Fund benchmark has a higher percentage invested in utility stocks than the world market weight, 4.6 % by the end of March 2006. This means that the total percentage of the equity portfolio invested in companies defined as infrastructure companies by index vendors will be somewhat higher than this. Given a specific allocation to infrastructure investments, there are however at least three reasons to build a portfolio of unlisted infrastructure equity as a supplement to the listed portfolio:

(1) Existence of liquidity risk premium

It is commonly assumed that if an investor compares two investment alternatives that are equal in all other respects than the degree of liquidity, an additional return must be offered by the illiquid investment if the investor should be indifferent between the alternatives. In other words; liquidity is a priced risk factor in the market, at least in the long term. If liquidity is less important for the Pension Fund than for the average investor, one should expect the Fund to own more illiquid assets than the average investor, and collect the priced risk premium in the market. Unlisted infrastructure (and other unlisted assets) provides an opportunity to collect an expected liquidity premium.

(2) Broadening the investment universe

As far as we know there are no data available on the size of the market for unlisted institutional equity investments in infrastructure. However, it is common knowledge that significant deal flows have been and will be transacted by other investors than public companies. A broader opportunity set for investments is advantageous for the Fund.

(3) Non-infrastructure exposure in public companies.

As described above, infrastructure investments are characterised by long-lasting and predictable cash flows in mature projects. Public companies controlling infrastructure assets have exposure to such income flows, but they may also have exposure to other more income volatile projects, for example projects in a development phase. The volatility of the equity return on such companies might therefore not only reflect the short term volatility of the mature infrastructure market. Private investments in infrastructure provide possibilities for a more tailor-made infrastructure exposure with lower volatility of underlying income streams than the listed universe of utility companies offer.

Extending the possible investment universe to private equity alternatives means that unlisted infrastructure funds and direct equity investments together with financial partners can be utilised.

The market for unlisted infrastructure funds is growing, but the funding level is still only modest. In 2005 was the Macquarie European Infrastructure Fund closed after reaching its target level of € 1.5 bn. A similar fund targeting North American infrastructure was closed in 2004 with C$460 million in commitments from institutional investors, mainly in Canada. These two funds have been the best known unlisted funds with a regional mandate in recent years, indicating the still modest overall size of this market segment.

It is roughly assumed that over the period 2006-2007, various infrastructure funds will target a capital base of € 10 billion globally[13]. Assuming that this is correct and that a maximum limit on a prudent commitment policy is 2-3 % of this amount, a potential allocation to infrastructure through funds can roughly be estimated to € 100 – 150 million on an annual basis. However, as this market is rapidly increasing in size, this amount can probably be revised upwards in the future. By doubling the estimate and extrapolating it over a 5-6 year period, total commitments to infrastructure funds over such a period at € 1.5 – 2 billion can probably be defended while maintaining a prudent commitment policy. Given the size of the Government Pension Fund, it is unlikely that any prudent investment in unlisted infrastructure funds can reach a full percentage point of the total asset base in the next 5 years. In addition it should be considered whether accessing the infrastructure market through funds yields higher net returns (after fees) than a direct strategy.

The only way to achieve significant exposure to infrastructure assets (defined as 3 % of the fund’s net assets or more) outside listed equity markets will most likely be through investing equity capital in infrastructure operating companies, preferably in joint ventures with other large investors.

Hence, a set of larger strategic equity investments in infrastructure operating companies should be expected to be core investments in a potential unlisted infrastructure portfolio. Fund investments should be expected to supplement these core investments.

As long as infrastructure is not considered as a separate sector in the FTSE AW / FTSE GEIS series, the utility sector of this index remains as the best proxy for infrastructure stocks. Figure 7.8 provides a rough picture of a possible composition of a potential global infrastructure portfolio 5-6 years ahead, given projections of the total size of the Pension Fund, current size of the listed equity markets, a maximum limit on 2 % of the listed market and the estimates on maximum allocations to infrastructure funds as argued for above. A regional division similar to the existing weights in the strategic benchmark is further assumed. The composition is shown for alternative allocation targets of 5 % and 10 %.

[13] Source: a large investor in meetings with Norges Bank

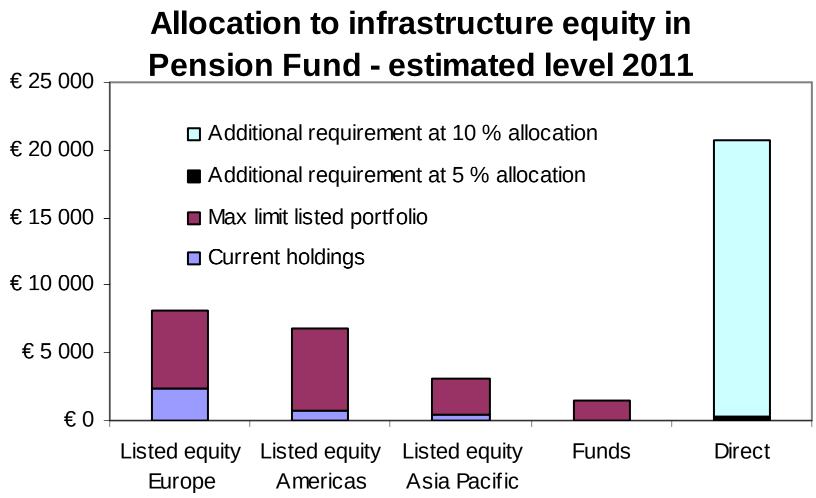

Figure 7.8: Potential composition of an infrastructure portfolio, assuming the projected Pension Fund level in 2011, and alternative allocations of 5 and 10 % to infrastructure and public market data as of March 2006.

The figure shows that only a small increase from today in the size of the global public utility equity market will support a 5 % allocation to infrastructure in 2011 entirely invested through public markets. At this allocation level, unlisted markets are interesting primarily as a potential return enhancer at a given risk level relative to public equities. With a higher allocation target, size limitations make unlisted vehicles necessary in the implementation of the strategy.

An alternative implementation strategy for a given allocation target might be to build a private portfolio through direct investments and fund investments, and fund the remaining investment need by increasing the public equity utility portfolio. The main argument for such a strategy would be a better representation of non-utility infrastructure investments and potential higher risk-adjusted returns. Advantages of scale might also reduce the cost of managing an unlisted infrastructure portfolio as the portfolio grows. However, due to lack of data any theory about differences in return on a risk adjusted basis between listed and unlisted investments will be very challenging to prove empirically.

7.3. Risk and Return

7.3.1 Expected returns on real estate

Historical returns

In the five countries where time series of return data for unlisted real estate is available for periods longer than 20 years, average real returns have been between 5.8 and 7.4 percent, with a simple average of 6.7 percent across countries. Extending the sample to the longest possible data period in each country, average real returns have varied between 5.1 percent and 7.4 percent.

Three of the countries saw higher returns in listed than in unlisted real estate, while in the other two the opposite was the case. Studies comparing historical returns of listed and unlisted real estate in the US have concluded that most of the difference can be attributed to leverage in listed real estate and differences in sector mix.

	Unlisted[14]					Listed[15]					
	US 78-05	UK 71-05	Nether-lands 77-05	Can-ada 85-05	France 86-05	US 86-05	UK 86-05	Nether-lands 86-05	Can-ada 86-05	France 86-05	Global 86-05
Historical average	12.0	12.4	9.1	9.0	8.1						
Inflation	4.3	6.9	2.8	2.7	2.1						
Real return	7.4	5.1	6.1	6.1	5.9						
Risk premium vs. bonds	2.4	1.1	0.5	-2.4	-2.7						
Average since 1986	10.2	11.3	9.6	8.9	8.1	11.9	12.0	7.8	-3.9	9.5	8.7
Inflation	3.0	3.6	2.0	2.7	2.1	3.0	3.6	2.0	2.7	2.1	
Real return	7.0	7.4	7.4	6.0	5.8	8.6	8.1	5.7	-6.4	7.3	
Risk premium vs. bonds	0.5	0.7	1.5	-1.9	-2.7	2.2	1.4	-0.3	-14.7	-1.3	

Table 7.3: Historical local returns on listed and unlisted real estate and premium/discount versus bonds

The table also shows that the realised return relative to bonds in this period varies between countries. In only one of the five countries, Netherlands, has unlisted and not leveraged real estate earned a premium higher than the expected additional management costs in this asset class. However, this has been a period where inflation has fallen more than markets expected. In such an environment, one should expect bonds to outperform. The realised premiums might not correctly represent the ex-ante (expected) risk premiums in the capital markets.

Ex-ante required returns on real estate and the corresponding real estate risk premium are unobservable, but some simplistic assumptions may give useful indications of how these variables have evolved over time. Figure 7.9 illustrates the development over time of the ex-ante long-term risk premium on non-leveraged real estate in the UK and US from 1978. The expected return on real estate is constructed using a simple Gordon growth model, where the expected return is equal to the current income return yield (initial yield in UK, NCREIF cap rate in the US) plus an estimate of a constant future rental growth rate. This rate is at any time equal to half of the past three year’s inflation in the US and ¾ of the same in the UK. Historically, the negative margin between inflation and rental growth has been bigger in the US than in UK and Europe. The expected return on bonds is equal to the 10-year government bond yield at any time.

In the early eighties inflation fell quickly, while nominal bond yields were maintained at high levels. Figure 7.9 assumes that the falling inflation rate was immediately passed through as reduced rental growth estimates. This might overstate the market reactions as well as the reduction in the risk premium, as the high nominal bond yields may have reflected a slow pass-through of the current inflation reduction into inflation expectations. The increased risk premiums estimated around 1990 reflect the bursting of the real estate bubble at that time. The average estimated ex-ante risk premium in the two countries over this period is in the range 2.0 – 2.5 percentage points.

[14] Source: NCREIF (USA), Hordijk (2004) Netherlands 1977-94, IPD (other markets and periods)
[15] Source: Global Property Research

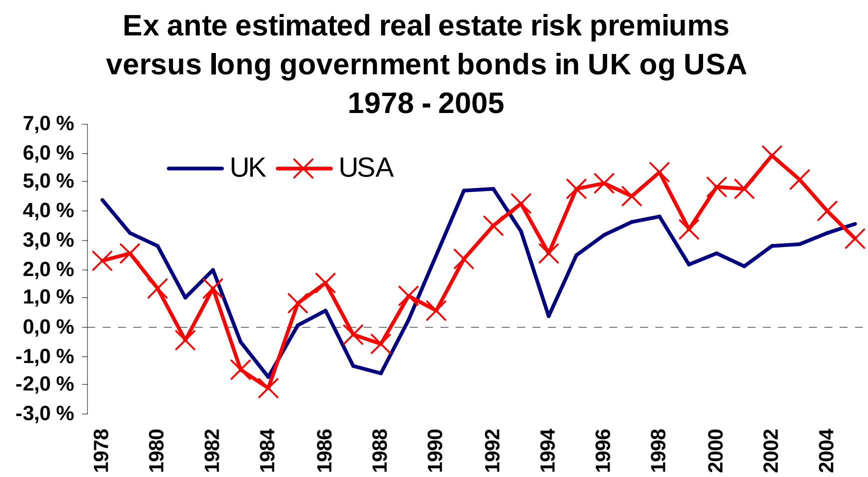

Figure 7.9: Ex ante estimated risk premiums on real estate, UK and US 1978 – 2005

The organisation for indirect real estate investors in Europe, INREV, also produces a return index for unlisted property funds in Europe, calculated by IPD. There are return figures available for the years 2001-2005. In figure 7.10, the time weighted annual returns in this period for the all-European index is compared with the IPD Pan European index for the same period. While the IPD index mirrors the property market in general, the INREV index measures the fund performance. The use of leverage should in this period result in higher fund performance relative to the direct property market return. Differences in country and sector allocations between the indices will also create deviations. On average, the funds in the INREV database have outperformed the IPD index with only 60 bp annually in this period, and in 3 of 5 years.

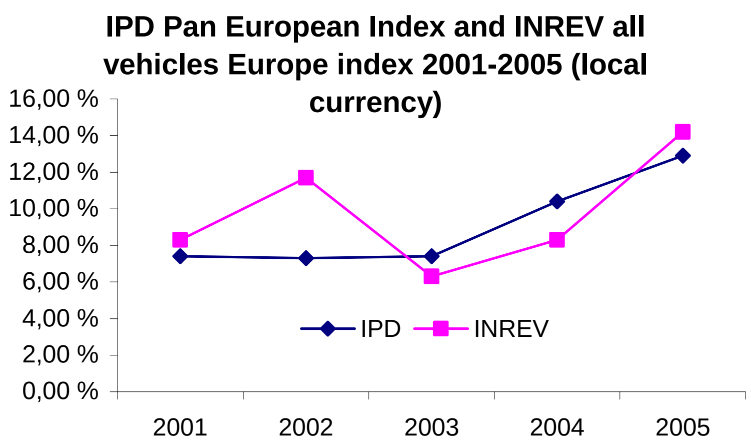

Figure 7.10: INREV fund performance and IPD property market performance, Pan European Market 2001-05 (local currency.

Expected return and risk premiums in 2006.

Figure 7.9 above assumes that the relationship between income return and price is constant over time. In the current situation, given the extremely strong real estate markets in recent years, this might be too simplistic.

A commonly used valuation indicator for real estate investments is the so-called capitalization rate, or cap rate. The cap rate is calculated by dividing net operating income (NOI)[16] by market price (or appraisal value). A reduction in the cap rate may be caused by either a decrease of rental income or an increase in prices. The cap rate is closely related to the concept of price-earnings ratio in the stock markets, although it is the reciprocal of the P/E.

The low cap rate currently observed must be viewed in light of the capital market conditions. There are at least three reasons why cap rates have fallen in recent years. First, interest rates have decreased, despite some reversal in recent months. Second, the cap rate itself does not give a complete picture of the expected returns on real estate investments, as capital expenditure and tenant improvements does not affect the NOI. Third, the required risk premium on real estate has probably declined.

Thus, falling cap rates may reflect expectations of a rebound in rental income, which would boost the total return on real estate even if cap rates remain at their currently low levels. Since about 2002 cap rates have fallen much more rapidly than real interest rates, reducing the difference between the two with 1-2 percentage points in the major markets (see figure 7.11).

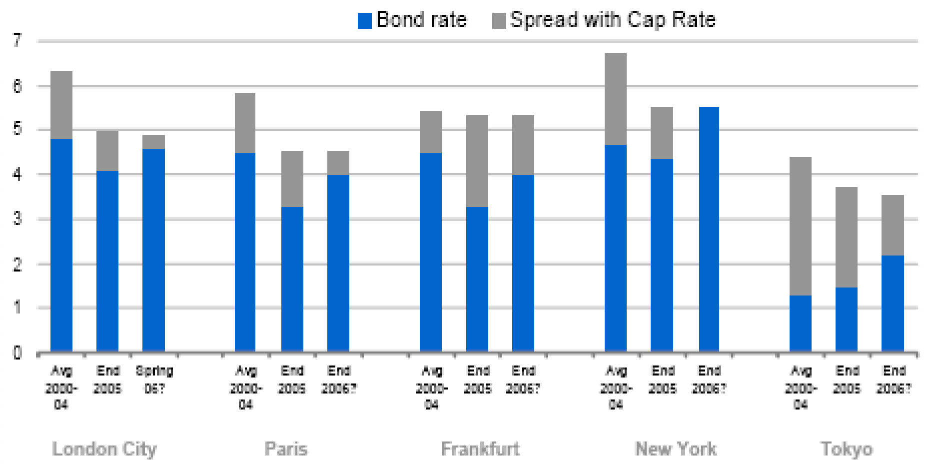

Figure 7.11: Bond rate and cap rate spread reductions in major cities, 2000-06. Source: RREEF

The recent rapid fall in cap rates can at least partially be attributed to lower rental income, as a consequence of the global and US slowdown in economic activity and subsequent fall in rent levels in many locations and sectors. An analysis by Prudential Real Estate investors of cap rates between 2000 and mid-2004 attributed 80 percent of the change in cap rates to falling income, and only 20 percent to increasing prices. Falling vacancy rates and the apparent lack of excessive new construction suggests that positive growth in rents will return in the relatively near future.

An analysis of expected returns for a long-term investor like the Government Pension Fund may start by dividing the 15 year investment horizon (from end 2006 to end 2021), into two periods. During the first period, which we somewhat arbitrarily assume to last for six years, cap rates may be expected to increase to an equilibrium level, whereas during the second period, the cap rate may be expected to stay constant.

Table 7.4 below summarizes expectations for returns on non-leveraged real estate investments over the next six years and the following nine years. These numbers are based on present cap

[16] NOI is most commonly defined as rent less operating and maintenance expenses, but before interest payments, taxes, and capital improvements. The latter can be expected to increase the value of the property, which is consistent with NCREIF practice in calculating index returns.

rates and a few fairly conservative assumptions of cap rate and rental growth development, as follows:

- For the next six years it is assumed that a reversion of last years rapid price increases in real estate will bring cap rates in North America and Europe back towards historical average levels. Such a development will be aided by a slight increase in interest rates during the same period, and moderate growth in supply of new real estate stock. A reversion is also assumed in developed and quasi-developed Asia-Pacific (Japan, Singapore, Hong Kong, Korea, Taiwan and Austral-Asia), albeit somewhat less than in the two other main regions. During the follow-on nine-year period, cap rates are assumed to stay constant in all three main regions.
- Due to the very strong growth forecasts, the current cap rates are assumed to be constant in emerging Asia-Pacific (China and India) also in the first period.
- The rental growth is assumed to be half of an expected annual inflation of 2 % in North America (US), and 25 bp below a similar inflation target in Europe. The rental growth in developed and emerging Asia is somewhat lower and somewhat higher, respectively, than the European forecast, due to different growth and inflation scenarios for the two Asian market segments.

Region	Cap rate 2006 (e)	Annual rental growth (e)	Cap rate 2011 (e)	Cap rate 2021 (e)	Estimated IRR – sum of the two periods
North America	6.25 %	1 %	7.5 %	7.5 %	7.1 %
Europe	5.25 %	1.75 %	6.5 %	6.5 %	6.6 %
Developed Asia	4.5 %	1.5 %	5.5 %	5.5 %	5.5 %
Emerging Asia	9.0 %	2 %	9.0 %	9.0 %	11.2 %

Table 7.4: Expected returns on unleveraged real estate, before taxes and costs.

Any long term estimate on returns will obviously be very uncertain.

On the other hand, the most important risk factors to the base case are rapid growth of supply, and partly related, a failure of rental growth to materialize as expected. Lower than expected rental growth might lead investors to question real estate allocation levels and thus could negatively affect demand. At this point, the risk of excessive supply generally appears subdued, with one possible exception being the US apartment sector.

Based on the assumptions outlined, expected return on unleveraged real estate over the next 15 years is estimated at approximately 7 % in US and North America, 6.5 % in Europe, 5.5 % in developed Asia and 11 % in emerging Asia.

Adjustments for leverage, taxes and costs

The estimates above must be adjusted to account for taxes and management costs.

Taxes may, according to a large European institutional investor, be roughly 10 % of before-tax returns. Management costs will vary between listed and unlisted real estate. The cost of managing listed real estate may reasonably be around 15 basis points, according to surveys from the consulting firm CEM and given a 50/50 split between external and internal management. The costs of managing unlisted real estate will be significantly higher, most likely around 100 – 150 basis points, assuming mainly external management. However, one should not conclude that listed real estate will yield higher returns after costs. Since significant parts of the management costs will accrue independently of whether the owner is a listed company or a fund, the cost difference is likely to be neutralised by an opposite difference in returns before costs.

Table 7.5 is based on the expected pre-cost IRR's in table 7.5 and simply adjusts these numbers for tax and estimated management costs. One would expect a relationship between the maturity and depth of the market and management costs. Hence, the management cost estimate in table 7.5 is lowest in North America (approx. 75 bp) and highest in emerging Asia (150 bp). Europe and developed Asia is expected to have a cost level of 100 and 125 basis points respectively.

Region	Estimated IRR	Taxes and management costs	Risk premium before taxes and management costs	Risk premium after taxes and management costs
North America	7.1 %	150 bp	250 bp	100 bp
Europe	6.6 %	175 bp	325 bp	125 bp
Developed Asia	5.5 %	175 bp	325 bp	125 bp
Emerging Asia	11.2 %	250 bp	375 bp	125 bp

Table 7.5: Estimated long-term risk premiums on real estate versus long government bonds in 2006. Reference bonds: long bond yields in USA (North America), UK, Germany, France (Europe) Japan, Australia (developed Asia) and India (emerging Asia)

The use of leverage will increase the expected return on real estate. The premiums quoted above do not represent the expected return difference between bonds and indirect real estate vehicles as they are normally constructed.

7.3.2 Real estate returns under various inflation scenarios

The supposed attractive inflation hedging characteristics of holding real estate have traditionally been an important motivation for institutional investors in this asset class. Long term leases with CPI-adjustment clauses protect investors from inflation surprises. If this relationship was stable, one would expect the nominal return to increase in a high-inflation environment, and decrease in low-inflation environment. The real returns should be expected to be less affected by inflation. However, there are several reasons why this relationship might not hold in the short and medium term, and also vary from market to market:

- The lease structures vary between markets.
- The real estate returns is also affected by demand and supply forces which at least temporarily might be out of sync with the cycles of the economy.
- The presence of CPI-adjustments in lease contracts is not globally unanimous.

In table 7.6 is the time series of real estate returns in UK and US split into two time intervals: the “high inflation” years of 1978-81 (from 1971 in UK) and 1987-90 and the “normal/low inflation years” of 1982-86 and 1991-05.

	UK		USA	
	High inflation	Low inflation	High inflation	Low inflation
Average CPI	11,9%	3,3%	7,9%	2,8%
Average aritm. nominal return	16,6%	10,1%	10,7%	9,5%
Average aritm. real return	6,8%	6,8%	2,8%	4,7%
Average annual volatility of nominal returns	13,5%	6,1%	8,4%	8,5%
Average annual volatility of real returns	16,7%	6,6%	6,4%	8,4%

Table 7.6: Real estate returns and volatilities in high-inflation and low-inflation years in the US and the UK 1978(71)-2005. Unsmoothed NCREIF returns in the US.

In the UK, real returns have on average been the same in high-inflation periods as in low-inflation periods, while the latter environment has produced on average close to 2 % higher return in the US. However, it is obvious that the very strong real estate markets the last years affect these numbers, and the number of years in both sub-periods are still too few to draw strong conclusions. The volatility of nominal and real returns has not been materially different in low-inflation periods in these two markets, in line with what one should expect. In the high inflation period one should expect the volatility of nominal returns to be significantly higher than the real return volatility, but one notice that the opposite has in fact been true in the UK. This is heavily affected by the very volatile market related to the OPEC-embargo in 73/74 and the real estate crash in the late 80’s. Once again, this demonstrates that short term real estate cycles might dominate the return and risk pattern and disrupt the expected inflation hedge characteristics of this asset class.

During the OPEC crisis in 1974-75 and in the beginning of the 80’s, the UK as well as the US economy experienced shorter periods with stagflation (negative real growth and high inflation). The performance of the real estate markets in these two periods was dramatically different. The surprising inflation shock of 74 and 75 eroded the real values of real estate significantly (close to – 50 % real return in UK in this period), while the real return was positive in the early 80’s, as the general belief in the inflation hedging capability of real estate would suggest.

The only large market to experience several years with deflation the last 30 years, Japan, has seen negative price changes every year from 1999 to 2005. Unfortunately there are no total return figures for commercial real estate markets available for this period, but changes in urban land indices and commercial rent indices indicate that the deflation years have been weak years also for real estate. However, the real estate market developments in Japan the last 10-15 years are clearly affected by the long term effects of the burst of the real estate land price bubble in late 80’s and early 90’s.

The perceived inflation hedge capabilities of real estate have been tested in several research papers, giving somewhat contradictory results. Based on a study of real estate securities and common stocks returns in seven countries, Liu, Hartzell and Hoesli (1997)[17] conclude that real estate securities have hedged inflation more poorly than common stocks in some countries, while the inflation hedging capability has been equal to common stocks in other countries. Other studies conclude that real estate act as a good inflation hedge, in particular against expected inflation. Literature reviews in Benjamin, Sirmans and Zietz (2001)[18] and Chen and Sing (2006)[19] show that the relationship between real estate returns and inflation depends on the methodology, periods, type of real estate and countries utilised in the different studies.

7.3.3 Real estate volatility

While the unlisted real estate fund indices and the listed real estate equity indices clearly have different volatilities, most of this difference can be attributed to appraisal smoothing of index levels in unlisted real estate, particularly in the US, and the use of leverage by listed companies.

Table 7.7 compares the volatility in the three countries with longest index series for unlisted real estate with the volatilities in the listed marked, and shows how the volatility difference is dramatically narrowed when taking appraisal smoothing and leverage into consideration.

	USA	**UK**	**Netherlands**
Direct real estate volatility – raw data series	3.3 % (from 1978)	8.8 % (from 1976)	5.3 % (from 1977)
Appraisal smoothing correction[20]	+ 5.1 % (7.0%)		
Leverage correction[21]	+4.1 %	+ 6.7 %	+5.0 %
Direct real estate volatility after corrections	12.5 %	15.5 %	10.3 %
Listed real estate volatility (from 1983)	18.0 %	25.2 %	15.0 %
Listed real estate volatility (from 1994)	17.0 %	20.1 %	13.2 %

Table 7.7: Comparison and correction of volatilities in unlisted and listed real estate markets in US, UK and Netherlands from mid-seventies

When comparing volatilities on an equal basis, it seems that the volatility of listed markets can be used as an upper limit also for volatility estimates of the direct market, leveraged up to

[17] Liu, Hartzell and Hoesli (1997): International Evidence on Real Estate Securities as an Inflation Hedge, Real Estate Economics, Volume 25, Issue 2 1997
[18] Benjamin, Sirmans and Zietz (2001): Returns and Risk on Real Estate and other Investments, Journal of Real Estate Portfolio Management, Volume 7, number 3 2001
[19] Chen and Sing (2006): Common Structural Time Series Components, Journal of Real Estate Portfolio Management, Volume 12, number 1, 2006
[20] It is assumed that the index follows an auto regressive price process. The unsmoothed return series is constructed using a standard filter using NCREIF lagged 1 quarter as predictor (independent variable) of the current index level. The number in parentheses represents the volatility mark-up when using NCREIF lagged two quarters as independent variable
[21] It is assumed that the average debt/equity ratios in each market have been representative for the full period

the same level as the listed market. It has been argued that the volatility in listed markets from the early nineties on is a better predictor of future volatility than longer series, given the lack of market depth and turnover before this period.

7.3.4 Real estate correlations versus fixed income and equities

Similar to volatility, the correlation properties of listed real estate is used to proxy for unlisted real estate.

Listed and unlisted real estate has a different short-term relationship with the stock market. Historically, the correlation between unlisted real estate and stocks is close to zero. Such low correlation also applies for medium-term periods up to three years, according to US and UK data. However, correlation figures based on appraised values, as is the case for unlisted property indices, are not sound estimates for true correlations. The actual correlation between unlisted real estate and stocks may be higher than what is indicated by real estate indices. Given persuasive evidence of the long-term relationship between listed and unlisted real estate, the correlation between listed real estate and stocks may be viewed as an upper limit for the correlation between unlisted real estate and stocks. Correlation between listed real estate and stocks is in the range 0.2-0.8, depending on the region. The correlation between bonds and unlisted real estate is also low.

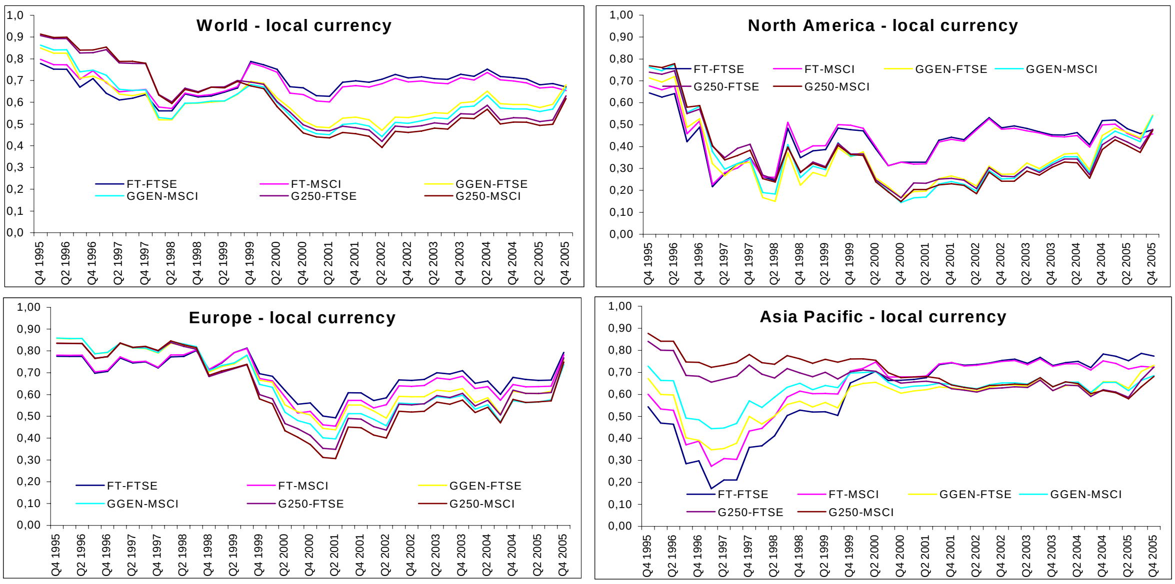

Figure 7.12: Rolling 5-year quarterly correlations between stocks and listed real estate, based on quarterly data 1990 - 2005. Three real estate indices (FTSE/EPRA/NAREIT, GPR General and GPR 250) are correlated against two broad equity indices (FTSE World and MSCI world) in each region as well as in the aggregate world.

Correlations between stocks and real estate have varied over time, as shown in figure 7.12. Correlations peaked in the late 1990s, after which a period of declining correlations followed. Only lately have correlations increased again. Similarly shifting correlations can be found when examining bonds and real estate.[22]. The correlation estimate is also to a certain extent dependant on choice of real estate and broad equity indices to be used in the calculations.

7.3.5 Infrastructure returns

The risk and return profile on infrastructure investments depends heavily on the stage of development of the underlying projects. In the development phase the equity owners face a substantial construction risk and – unless there is a guarantee provision in the contract with the authorities – uncertainty about the demand for the new services developed and offered by the operating company. In the early stage of a project, capital accumulation should be expected to constitute an important part of total return. When the development stage is finished and the business operations have reached a normal level, the income yields will normally replace capital accumulation as the dominant source for return. This will obviously affect return as well as risk expectations. While investments in mature infrastructure projects should offer an expected return and risk broadly in line with core real estate strategies, development phase infrastructure investments are more comparable with value added real estate investments, typically targeting 3-5 % higher expected return at significant higher risk.

The best proxy for infrastructure return and risk data in the listed equity markets are the global utilities sector indices. Given the size of the utility companies they will dominate any listed infrastructure index which is based on market capitalisation[23] .

Table 7.8 shows the return on infrastructure equities compared with real estate equities and the total equity market from 1993.

	Utilities		Real Estate		Total equities	
	Annual geom. Return	Annualised volatility (quarterly data)	Annual geom. Return	Annualised volatility (quarterly data)	Annual geom. Return	Annualised volatility (quarterly data)
1993-2005	7.4%	13.0 %	9.8 %	18.0 %	8.4 %	16.2 %
1993-99	5.9%	10.2%	5.5%	19.4%	17.2 %	14.5 %
2000-05	9.0 %	15.5 %	14.3 %	16.7 %	0.3 %	17.1 %

Table 7.8: Geometrical return and annualised volatility on global listed utilities (FTSE World Utilities), real estate (FTSE/EPRA/NAREIT global index) and total equities (FTSE World), 1993-2005. Local currency indices.

Compared with real estate and total equities, utilities have had a more stable return pattern throughout the period, with a lower volatility. The modest capital return during the last six

[22] Data for making a good estimate of the correlation between an unlisted index adjusted for appraisal smoothing and other asset classes is not available. An accurate analysis requires a distinction between capital gains and rental income. By simplistically assuming stable rental income of 7.5 percent per year since 1965, Geltner-style unsmoothing results in a stock-real estate correlation of -0.05 and a bond-real estate correlation of -0.33. The correlation between the smoothed and unsmoothed real estate indices is 0.76 (all based on annual returns).
[23] At publication time of the Maquarie Global Infrastructure Index June 2005, utilities composed 87 % of the index. The 20 largest companies in the index were all utilities based in the US, Europe or Japan.

years as compared to real estate equities might also indicate that the risk of a reversal of cap rates are less severe for utility stocks than what appears to be the case for real estate securities.

Figure 7.13 shows the five year rolling correlations between utilities, real estate and general equities in the same period in the three main regions as well as globally.

There has been a clear trend towards higher correlations between higher income yielding equity sectors as real estate and utilities on the one hand and total equities on the other. But there is no evidence of higher correlations between utilities and real estate than between those sectors and equities in general.

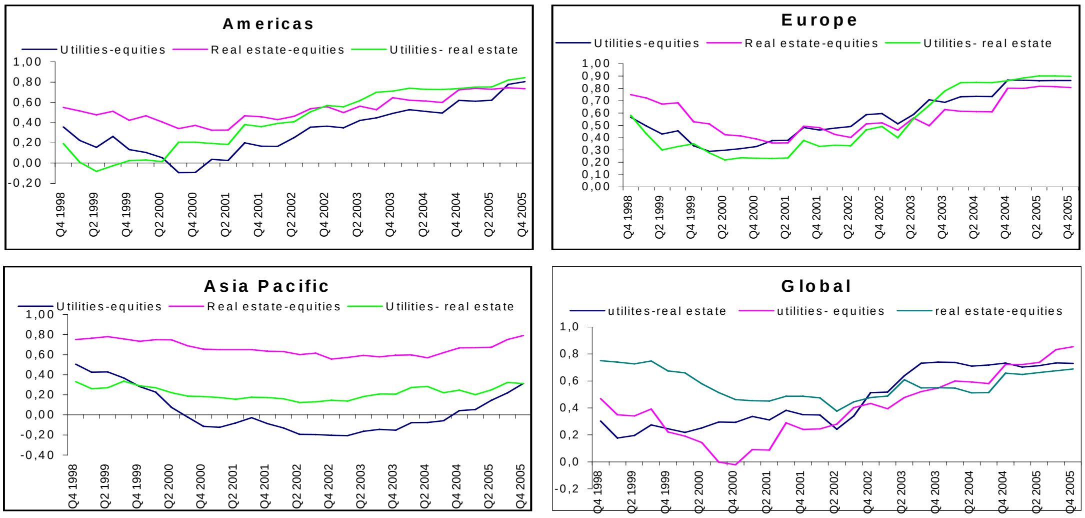

Figure 7.13: Five year rolling correlations between utilities, real estate and total equities in Americas, Europe, Asia/Pacific and globally (local currency correlation). Sources: FTSE (utilities and total equities), GPR (real estate).

Long return data time series for investments in unlisted infrastructure funds are not available. Any analysis done on return data based on the fund manager's valuation of assets, as opposed to transaction data or listed market prices, will suffer from well known weaknesses such as stale pricing, smoothing of return figures and artificially low variance and covariance with listed markets. Differences in long term risk between listed and unlisted infrastructure equity investments could arise from structural differences in the use of leverage or from significant differences in type of underlying infrastructure assets operated or owned by listed utilities or infrastructure companies versus unlisted funds. Given the lack of evidence of such differences, the best guess on expected return and risk from investing in infrastructure in general will be equal to what we can extract from listed market investments data.

There is a time series for unlisted Australian infrastructure funds dating back to 1997, showing that these funds have on average outperformed the Australian stock market at a lower risk, and have had a return broadly in line with real estate, also at a lower risk. The correlation figures against all other asset classes are in the band 0.1-0.3. However, given the short time period and the limited geographical representation, these numbers can not be used as estimates for future return and risk properties.

Expected return and risk - summary

In the absence of long time series of returns, any estimate on return and risk must be based on qualitative judgement. As the income component should be a more important return source for investments in infrastructure companies, one should expect the volatility of returns to be lower than what is normally expected in the equity markets in general. However, the use of leverage in established infrastructure projects limits this difference. The volatility of listed utilities in the period such data are available (10-13 %) serves as a best guess. It can also be argued that private investments in regulated infrastructure sectors on average might be somewhat less volatile than public equities issued by utility companies, since many public utility companies have a certain proportion of income arising from sources not related to infrastructure. Assuming that the Sharpe ratio is not materially different between the different equity sectors, it follows that the expected return should lie between equities and bonds. Arguments in favour of a slightly higher Sharpe ratio in unlisted infrastructure relative to public equities in general, might however be an existence of a value stock premium (a heavily discussed topic in academia) and a liquidity premium. This return/risk profile seems similar to what one should expect core real estate investments to yield.

Due to the income profile of infrastructure investments, one should also expect this asset class to offer some diversification benefits relative to bonds and equities in general. However, any interval given with a high degree of confidence will be wide. The short history of data referred to in this chapter suggests that a best estimate of correlation between infrastructure equity and equity markets in general might be in the band 0,4 – 0,7, also not very different from what one would expect in the case of core real estate.

7.4. Other Institutional Investors

7.4.1 Real estate

Table 7.9 gives an overview of the real estate investment portfolios of selected large international and Nordic pension funds.

ABP divides its real estate investments into two main parts, a liquid portfolio and a strategic portfolio. The strategic portfolio is mainly composed of strategic holdings in real estate funds, whose origin was the pension fund’s former directly owned real estate holdings. This part of the portfolio is benchmarked internally against the IPD Netherlands direct real estate benchmark. The liquid portfolio is more geographically diversified, and is mainly composed by listed securities in all three main global regions. The listed portfolio is benchmarked internally against a listed real estate index. However, for the purpose of public reporting, ABP compares its overall real estate returns against the WM Netherlands real estate return. This is the composite real estate return of all Dutch pension funds excluding ABP and PGGM. The ABP real estate portfolio is managed by a staff of approximately 20 people located in Amsterdam (Schiphol) and New York, managing all real estate securities and unlisted fund investments. The three property companies where ABP is either a dominant or sole investor (Vesteda, Corio and KFN) employ in total approximately 600 people.

Investor	Value of real estate portfolio	Components	Geographic distribution	Sectors
ABP (Netherlands)	€18 billion (11 %)	65 % ”liquid” (listed) 35 % ”strategic”	Europe 50 % America 40 % Asia Pacific 10 %	Office 37 % Retail 37 % Apartments 20 %
PGGM (Netherlands)	€8.2 billion (11 %)	Listed 40 %. unlisted 60 % (approx)	Europe 67 % America 26 % Asia Pacific 7 %	Office 29 % Retail 41 % Apartments 26 %
ATP (Denmark)	€1.9 billion (5 %)	Direct 70 % Unlisted funds 30 %	Denmark 70 % Europe x Denmark 30 %	Office 67 % Retail 13 % Apartments 0 %
Alecta (Sweden)	€2.5 billion (7 %)	Direct 100 %	Sweden 45 % UK+Netherlands 32 % US 21 %	Office 43 % Retail 25 % Apartments 7 %
National Pension Reserve Fund (Ireland)	€ 124 million (0.8%). target 8 % by 2009	100 % indirect. primarily unlisted funds	45 % Europe 41 % North America 14 % Asia	Not stated
CalPERS (US)	$ 9.3 billion (7.3 %)	Listed 10 % Unlisted 90 % (of which mostly joint ventures)	US ca. 95 %	Office 21 % Retail 19 % Industrial 24 % Apartments 10 %
Ontario Teachers (Canada)	C$ 12.5 billion (13%)	100 % owned or managed by subsidiary Cadillac Fairwiew	Not stated	Not stated

Table 7.9: Real estate portfolios of selected institutional investors.

PGGM splits its real estate holdings into strategic, tactical and opportunistic investments. Strategic investments are held for at least five years, and consist mainly of unlisted fund investments. Quoted funds valued at net asset value (not stock price) can also enter the strategic portfolio. Tactical investments are more short term oriented investments, entirely done in listed stocks because of their higher liquidity. Opportunistic investments are medium term investments with high return potential as well as a higher perceived risk. Similar to ABP practice, all PGGM listed real estate securities are managed by the internal real estate team, as a part of the real estate portfolio. Also similar to ABP, the former directly owned real estate portfolio (pre 1995) has been externalized, and parts of this can be found as real estate controlled by the companies where PGGM has a strategic ownership position. As a result, the PGGM’s real estate team is limited in size. PGGM benchmarks its real estate investments against the direct Dutch real estate market (IPD Netherlands), but is currently considering replacing this with a real return target.

CalPERS benchmark the real estate portfolio return before costs against the direct US real estate market return (NCREIF), but the fund also requires a long term real return of 5 % after costs. There is a division between core investments in the various real estate segments and a diversified set of alternative non-core real estate programs. Direct as well as indirect investments are allowed, and the use of instruments spans from 100 % equity in direct investments to hybrid debt instruments. There are defined portfolio limits on core versus non core holdings, on the percentages invested in each main real estate segment, on geographical distribution within the US, on the use of public securities, on use of leverage, and on the relative size of international holdings in the portfolio. An extensive use of external manager organizations (10 external core managers and 30 non-core managers by November 2005) has been the key strategy in order to limit the size of the internal management organization.

Ontario Teachers acquired 100 % of the shares in the property company Cadillac Fairview in December 1999, and has delegated all real estate investment responsibilities to this organization. The official benchmark for CF/OTPP's real estate investments is Canadian CPI + 4 %, i.e. a real return of 4 %. The portfolio is concentrated in retail and office premises, primarily in Canada (50 – 100% ownership) and in the US (49 % ownership being the norm), but fund investments and minority equity investments in property companies overseas are also represented in the portfolio. Cadillac Fairview employs approximately 1500 people, but the vast majority of this number will be engaged in property management, and not in the allocation and investment decisions taken by the company at management level.

7.4.2 Infrastructure

Australia is the only national market where institutional investors have traditionally invested significant amounts in infrastructure assets. In this country up to 70 % of all investments are economic infrastructure rather than social. Parts of these investments are in listed vehicles and tend to be reported as a part of the superannuation funds' equity exposures. In 2002 it was estimated that 2 % of total superannuation fund investments were in infrastructure, but there are reasons to believe that this underestimates the true figure[24].

Several large Canadian pension funds and reserve funds have in recent years increased their allocations to infrastructure or intend to do so in the near future. According to fund information, further increases are scheduled to come.

- Ontario Teachers had C$ 4.8 bn invested in infrastructure and timber by the end of 2005, equivalent to 5 % of all net assets. The infrastructure portfolio has grown from virtually nothing to this amount over a period of less than four years. Infrastructure constituted together with real estate, inflation linked bonds and commodities the 32 % allocation to inflation sensitive assets at this time. The allocation includes strategic ownership shares in publicly listed companies, private equity shares as well as senior and subordinated debt. Ontario Teachers have recently reduced its fund investments and increased its direct investments, aside with a build-up of an internal infrastructure team.
- The pension plan for municipality employees in Ontario, OMERS, had C$ 2.4 bn (5.7%) allocated to infrastructure by the end of 2004. This fund has established a long term target of 15 % invested in this asset class, a target it plans to reach by the end of 2010. OMERS' investments in this asset class are organised through its subsidiary Borealis Infrastructure. As opposed to Ontario Teachers, OMERS/Borealis concentrate their investments in domestic projects in the transportation, energy, buildings (social infrastructure) and pipeline sectors.
- Canada Pension Plan had a minor 0.4 % (C$335 mill) of its total net assets invested in infrastructure by the end of December 2005. CPP intends to increase this over time, but the fund has not established a specific target. CPP opens for investments in funds, public securities, co-investments with general partners and joint venture/consortia with strategic partners, and it targets investments in North America as well as Europe.

[24] Source: Leslie Nielson: Research Note no. 42 2004–05: Superannuation investments in infrastructure , Parliament of Australia, Parliamentary Library

The two large Dutch funds ABP and PGGM have also started up with modest investments in infrastructure. None of them have specified a particular allocation in their policy mix. However, it is publicly known that they have participated in private equity infrastructure funds led by Macquarie Bank (2004 – ABP only) and ABN AMRO Bank (2006 – both funds). By the end of 2005, the ABP commitments to infrastructure funds totalled approximately 1 % of the fund's net assets, a percentage that is expected to rise over time. ABP focuses on fund investments and co-investments with other investors, and has so far excluded direct investments where the fund is the sole investor in infrastructure projects. PGGM considers infrastructure as a part of the fund's real estate allocation, and has not established a (publicly stated) target for their infrastructure holdings share of net assets.

Long-term market outlook

Staff Memo 2006/7