Inflation-Linked Bonds
Preserving Real Purchasing Power and Diversifying Risk
“Many people want the government to protect the consumer. A much more urgent problem is to protect the consumer from the government.”

—Milton Friedman

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The design of the illustrations for this brochure was provided by the agency SLAJ. The illustrations highlight the characteristics of paper money and the values, artists and monuments that have formed the respective nations. The image details were taken from the following banknotes: the British pound sterling (cover, pages 4, 8 and 36), the Japanese yen (pages 6 and 40), the Russian ruble (page 17), the euro (pages 18 and 28), the Macanese pataca (page 22) and the Indian rupee (page 27).
Foreword

Dear Reader

Inflation affects all of us, both as savers and investors. Inflation-linked bonds help to safeguard real purchasing power in periods of substantial inflation. These securities, which are still largely unknown to many investors, actually have a surprisingly long history. The first inflation-linked bond was issued in the USA way back in 1780. Since then, the market has grown steadily and now encompasses a variety of bonds issued by governments, as well as several corporate bonds. The derivatives market has also grown rapidly and today offers the opportunity to create synthetic inflation protection tailored to an individual investor’s needs.

Inflation-linked bonds are the only asset class to offer long-term protection against inflation. They thus enable investors to obtain a real yield that preserves purchasing power even when inflation is high. Since inflation-linked bonds have a low correlation with stocks and nominal (standard) bonds, they also help to increase the diversification of a traditional portfolio and thus improve the risk/return profile.

Why are inflation-linked bonds of interest right now? Given the rapid growth in the money supply in recent years, the latent risk of inflation has risen markedly. The reason why this has not led to an upsurge in inflation so far is, firstly, the rapid rise in international bank reserves and, secondly, the fact that the hoarding of money fostered by low nominal interest rates has boosted the demand for money. As soon as investor’s sentiment normalizes and nominal interest rates rise again, the demand for money will decline. This will significantly increase the risk of a rise in inflation.

The aim of this report is to explain inflation-linked bonds to interested investors in greater detail. We explain the features of inflation-linked bonds, describe how they work, and show several ways in which they can be used to protect investors from unpleasant inflation surprises. Other topics covered include the impact of inflation on the real economy, how to create synthetic inflation protection in countries without an inflation-linked bond market, and some specific themes for institutional investors such as liability-driven investing.

We strive to offer our clients the best investment solutions in the area of inflation-linked bonds. Our investment solutions range from funds, inflation swap overlays and liability-driven investing approaches to customized mandates with inflation protection.

We hope you will find this report stimulating reading.

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# Contents

**Executive Summary** 7

1. The Fundamentals of Inflation 9  
1.1 Inflation and Deflation – Theory and Practical Relevance 10  
1.2 Hyperinflation in Recent History 14

2. How Inflation Affects Private and Institutional Investors 19  
2.1 How Inflation Affects Private Investors 20  
2.2 How Inflation Affects Institutional Investors 20

3. Using Traditional Asset Classes to Protect against Inflation 23  
3.1 Correlation Analysis Findings 24  
3.2 Regression Analysis Findings 25

4. How Inflation-Linked Bonds Work 29  
4.1 How Inflation-Linked Bonds Work 30  
4.2 Evolution of the Market 31  
4.3 The Right Market Environment for Inflation-Linked Bonds 33  
4.4 Duration of Inflation-Linked Bonds 33  
4.5 The Deflation Floor 35  
4.6 Selecting the Right Benchmark 35

5. Protection for Countries without Inflation-Linked Bonds – an Example for Swiss Investors 37  
5.1 The Dynamic Modeling Approach 38  
5.2 How Good Is the Model? 39  
5.3 Practical Implementation 39

6. Portfolio Management with Inflation-Linked Bonds 41  
6.1 Wide Range of Investment Strategies 42  
6.2 Liability-Driven Investing 43

**Literature** 47
Executive Summary

This report contains six chapters, all of which can be read independently of one another. At the beginning of each chapter, a summary page highlights the main points in the chapter. Information boxes also provide easy-to-read summaries, while text boxes supply further material for readers who want to learn more about a particular topic.

1. The Fundamentals of Inflation
Although the developed industrialized countries have mostly exhibited low to moderate rates of inflation over the last 20 years, inflation risk has risen worldwide as a result of the expansion of central banks’ balance sheets. Inflation protection is therefore very much a live issue at the moment. What are the consequences of inflation and deflation? What role do investors’ expectations play? This chapter looks in detail at the impact of the current market environment and the outlook for the near future. It also highlights some of the common elements in the main hyperinflationary episodes in the recent past.

2. How Inflation Affects Private and Institutional Investors
What direct impact does inflation have on private and institutional investors? First of all, inflation erodes the purchasing power of money and has an adverse impact on most assets. The impact of the loss of purchasing power on a private or institutional investor’s financial situation depends primarily on the duration of the investor’s assets and liabilities.

3. Using Traditional Asset Classes to Protect against Inflation
Do investors really need inflation-linked bonds, or can traditional asset classes also provide long-term inflation protection? It is no surprise that nominal bonds do not offer protection against inflation. However, investments based on real assets such as stocks, real estate and commodities also offer only limited protection against inflation because their protective characteristics are overshadowed by the higher volatility of these asset classes.

4. How Inflation-Linked Bonds Work
Inflation-linked bonds differ in a number of ways from their nominal counterparts. These differences and the factors that determine the pricing of inflation-linked bonds are dealt with in this chapter. We also take a closer look at the market for inflation-linked bonds, which has grown rapidly over the last ten years, with the majority of bonds being issued by state borrowers.

5. Protection for Countries without Inflation-Linked Bonds – an Example for Swiss Investors
A modeling approach that dynamically weights investable international inflation indices can largely replicate Swiss inflation. Based on this investment strategy, we show how a nominal Swiss bond portfolio combined with an international inflation swap overlay can produce synthetic inflation protection for Switzerland-based investors. The approach presented here can be applied globally and can also be used, for example, to create inflation protection for emerging-market investments.

6. Portfolio Management with Inflation-Linked Bonds
Inflation-linked bonds not only have a low correlation with stocks and nominal bonds, but also offer a sustainable risk-adjusted real yield. These attributes can significantly improve the risk/return profile of a traditional portfolio. Furthermore, there are also interesting ways of actively managing inflation-linked bonds and thus generating additional alpha. In this context, we more closely examine the techniques of liability-driven investing, which looks at assets and liabilities collectively.
1. The Fundamentals of Inflation

Inflation is defined as a general rise in the prices of goods and services over time. It affects all of us, but not everyone is aware of its impact. Many of us suffer from “money illusion” and simply overlook the gradual loss of purchasing power caused by inflation, even though this effect can be very serious, particularly for pensioners.

Although inflation has been low in recent years, over the longer term we have been living in an almost unbroken period of rising prices since World War II. In some cases this inflation turned into hyperinflation, with disastrous consequences for individuals and society, for example in Brazil, Poland, Russia and, most recently, Zimbabwe.

In this chapter we explain some of the basic characteristics of inflation and investigate its historical evolution. We also explain the links between inflation, nominal and real interest rates, and economic developments. We round out the chapter with a number of interesting case studies of hyperinflationary episodes in recent times.
Inflation, which is derived from the Latin word inflare meaning “to bloat”, is defined as a general rise in the prices of goods and services over time. By the same token, inflation therefore also means that money gradually loses its purchasing power over time because a given amount buys an ever smaller quantity of goods.

Inflation is measured by calculating the change in the price of a predefined basket of goods and services. In most countries the figure is calculated monthly and published as an annual rate of inflation. The official baskets of goods and services vary from country to country. Figure 1 shows the current composition of the respective baskets of goods and services in Switzerland, the USA and the European Union (EU). The pie charts show that the housing, food and transportation components are the most important in all three consumer price indices, although with different weightings.

However, the official rate of inflation does not always match the public’s subjective perception of inflation. There are a number of possible reasons for this. Firstly, the composition of the basket is only revised at irregular intervals. Secondly, a number of goods whose prices are watched closely by many people are not included in the basket. Property prices are an obvious example because the housing category only includes rent costs.

Psychological factors additionally play a part in this effect. The official basket of goods and services also contains consumer durables such as cars, for example. If the prices of those durable goods rise more slowly than the prices of staple consumer goods such as food and clothing, this will reduce the official rate of inflation. However, people notice the rising prices of clothing and food far more, and so the official inflation rate is perceived as being too low. Furthermore, people tend to remember price increases longer than price cuts. Nonetheless, in spite of these shortcomings, the official inflation rate remains the best approximation for many investors for the actual change in purchasing power they experience.

Many people are unaware of the gradual erosion of their purchasing power through ongoing inflation. This is often referred to as the “money illusion.” For example, a wage increase of 10% when inflation is 15% is regarded as more appealing than a wage cut of 1% when inflation is 2% – even though there is a much greater loss of purchasing power in the first case (5%) than in the second (3%).

1.1 Inflation and Deflation – Theory and Practical Relevance

Since the outbreak of the financial crisis, many investors have become far more aware of the impact of economic developments and monetary policy. They are particularly concerned about two possible scenarios. Some fear a significant loss of purchasing power as a result of prolonged high inflation. Others, however, are more worried about possible deflation, i.e. gradually falling prices, with all the damaging effects on the economy this would entail.

In order to assess the probability of these scenarios and their impact, it is worth looking back over some longer data series. These do not exist for Switzerland, but are available for the USA. In order to be able to draw relevant conclusions from this data for Swiss investors, we begin by comparing inflation in the USA with inflation in Switzerland.
Figure 2: Inflation rates in the USA, the UK and Switzerland

Figure 2 tracks the inflation rates in Switzerland, the USA and the UK from January 1956 to July 2013. It shows that inflation in all three countries has mostly risen and fallen in unison. For example, inflation rose sharply in all three countries in the 1970s in the midst of the oil price shock. In the early 1980s, inflation fell back again rapidly after Paul Volcker was appointed chairman of the US Federal Reserve Board in 1979 and pledged to fight inflation tenaciously. Within a few years, the annual inflation rate in the USA fell from 14% to less than 4%. Inflation rates followed a similar path in the UK and Switzerland.1

The interdependence of inflation rates in different countries is not surprising. Only part of any country’s inflation rate is domestically generated. The rest is “imported inflation.” In open economies such as Switzerland, this is usually the weightier component. This transmission channel allows different national inflation indices to impact on each other.

As the chart shows, the inflation rates in all three countries were almost always positive during the analyzed period – except for the most recent past. There has been no period of prolonged deflation over the past 50 years. However, the picture changes if we include data going back much further. Figure 3 shows the inflation rate in the USA between 1666 and 2012. We can see that until World War II there were frequent periods of deflation that in some cases lasted for many years.

Figure 3: The inflation rate in the USA between 1666 and 2012

The low inflation rates in the 19th century were primarily attributable to the gold standard, which gave central banks less flexibility with regard to printing and minting money, particularly since it guaranteed a fixed rate of exchange between gold and money. The UK was the first country to introduce the gold standard and was soon followed by leading industrial nations such as France, Germany and the USA.

The gold standard minimized the currency risks between the member countries that had introduced it. Furthermore, all participating central banks used the same base interest rate, which was set by the Bank of England. However, the gold standard began to unravel when the differing economic growth trends in the various countries made it necessary for them to set their base interest rates individually. At the start of World War I the gold standard was therefore abandoned, which pushed up inflation significantly in some cases. In the USA, inflation rates leapt to over 15%, as illustrated in Figure 3. At the end of World War I there were efforts to reintroduce the gold standard. The result was steep deflation worldwide that worsened when the global economic crisis erupted in the late 1920s, leading to the collapse of the gold standard.

Sources:
- Bloomberg, FRED® database of the Federal Reserve Bank of St. Louis
- Period: January 31, 1956 to July 31, 2013

Sources: Credit Suisse, Oregon State University
- Period: 1666 to 2012

1 Over the entire period the correlation between Swiss and US inflation rates is \( \rho_{(CH, USA)} = 0.55 \) and the correlation between Swiss and UK inflation rates is \( \rho_{(CH, UK)} = 0.54 \).

Since the repeal of the gold standard at the beginning of World War I, US inflation rates have remained significantly higher than their historical average. Whereas inflation stood at 0.3% per year on average between 1666 and 1914, it averaged 3.3% between 1914 and 2012.
As Figure 3 shows, inflation was very volatile in the USA until well into the 19th century. For a long-term overview, it is therefore helpful to take a look at trend inflation. Figure 4 displays the seven-year moving average of the inflation rate.

Figure 4: Trend inflation in the USA from 1666 to 2012

Sources: Credit Suisse, Oregon State University
Period: 1666 to 2012

In a long-term comparison, it can be seen that the USA recorded its highest inflation rates in the years after World War II. Before that, there were repeated phases of very low or even negative inflation. However, the deflationary phases were not necessarily always followed by recessions like the one that occurred in the last such period in the 1930s.

A comparison of inflation with real interest rates reveals the following: the long-term average real interest rate in the USA stands at 3% per year; an inflation rate of -3% – in other words deflation – would thus result in a nominal interest rate of 0%. This level of deflation would comply with the Friedman rule, which was proposed in 1969 by the economist Milton Friedman as the guiding principle of an optimal monetary policy. Friedman argued that the opportunity cost of holding money (in the form of a loss of purchasing power over time) should equal the social cost of creating money. Since the production cost of printing paper money is close to zero, nominal interest rates should also be close to zero. Deflation of 2% to 3% would thus increase the welfare of an economy over the long term – at least according to model calculations.

In recent years, however, the consensus on optimal monetary policy has tended to move toward a slightly positive inflation rate, which is reflected in the inflation targets of 1% to 2% set by many central banks. One reason for this conviction is that very low nominal interest rates make it difficult for the financial sector to carry out its function of reallocating liquidity, which in turn would have a negative impact on economic development.²

Monetary equilibrium models show that low inflation or even slight deflation would increase the welfare of an economy over the long term. By contrast, high inflation leads to rising unemployment and a drop in overall economic activity.

So if deflation is more desirable according to the text books, what, conversely, are the effects of inflation? First of all, inflation erodes the purchasing power of money. When purchasing power diminishes, so does real consumption in an economy. This drop in consumption reduces corporate earnings and increases cost pressure, eventually leading to higher unemployment. The data should therefore reveal a positive correlation between higher inflation rates and higher unemployment. Similarly, higher inflation should go hand in hand with lower real consumption, lower real output and lower productivity.

This negative correlation is only faintly recognizable in the US data from 1955 to 2005. However, there was in fact a strong positive correlation between inflation and unemployment (correlation coefficient of 0.7).³

The Phillips Curve

The aforementioned positive correlation between inflation and unemployment contradicts the Phillips Curve theory, which states that higher inflation should lead to lower unemployment because real wages shrink and company profits rise, which favors job creation. However, this perspective masks the fact that inflation also hurts consumers’ purchasing power. This reduces corporate earnings and increases unemployment, as economic data from the USA confirms.

³ To calculate the correlation between unemployment and inflation, the trend rates were computed using a Hodrick-Prescott filter with λ = 1600 (since quarterly data was analyzed). Also, the inflation rates were represented by the Moody’s AAA index. This method was chosen because over the long term the Fisher equation holds and real interest rates are not particularly volatile – no major discrepancies should therefore be expected between the change in nominal interest rates and the change in inflation rates. Furthermore, this is the usual method applied in the literature, such as in Berentsen, Menzio and Wright (2011). The correlations between inflation and real consumption, real output and productivity were calculated using the trend growth rates. Here, the correlation between the respective trend growth rates and the trend growth rate of inflation is always approximately -0.15.

² See Berentsen, Camera and Waller (2007) or Berentsen, Huber and Marchesiani (2013) for a more detailed discussion.
This observation could lead one to believe that inflation merely has an impact on unemployment, but not on other aspects of the real economy such as consumption and productivity. This, however, is not so. The correlations become clearer if we take a closer look at periods when an abrupt jump in inflation was followed by a sustained decline. For the period from 1975 to 1985, for example, US data shows a correlation of 0.94 between inflation and unemployment and a correlation of -0.83 to -0.98 between inflation and real consumption, real output and productivity. This indicates that, historically, inflation does indeed have a significant negative impact on the real economy, but only when the rate of inflation has changed unusually sharply.

Would such an increase in inflation have the same effects today as it did in the 1970s? Economic studies tend to suggest that this would not be the case. The reason lies in the demand for money, which determines the effects of inflation on the real economy (see text box). Economic equilibrium models show that the higher and more elastic the demand for money, the more extensive these effects are.4

Money Demand

The quantity theory of money states that there is a direct relationship between money supply and price level. This relationship is described by the equation $M \times v = P \times Y$, where $M$ is the money supply, $v$ is the velocity of money, $P$ is the price level and $Y$ is real output. Money demand is given by $1 / v$; in other words, the higher the velocity of money, the lower the demand for money.

The demand for money has fallen sharply since the 1990s. The elasticity of money demand has also fallen in comparison with nominal interest rates. One possible explanation for this development is the improved supply of liquidity through financial intermediaries who offer the possibility to pay by credit card rather than cash, for example (see text box to the right).5

The lower demand for money means that an unexpected rise in inflation should have less impact on the real economy today than in the 1970s. However, money demand has risen again recently. This trend has primarily been driven by central-bank interventions around the world that have resulted in deep interest-rate cuts since the outbreak of the global economic and financial crisis. In turn, this has reduced the cost of holding money and has thus increased the demand for money.

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4 This is because a more elastic money demand function implies a lower aggregate risk aversion. It follows that the utility function of a typical household is less concave, so a rise in inflation results in a bigger loss of utility than would be the case if risk aversion were higher, i.e. if the money demand function were less elastic. This line of reasoning is based on the assumption that an isoelastic utility function is employed.

The rise in money demand is also the reason why the huge expansion in the money supply in recent years has so far not led to any significant increase in inflation. As Figure 6 shows, the relationship between nominal interest rates and the demand for money is currently weaker than previously. Nominal interest rates are at much the same level as in the 1950s, but money demand is only half as high. However, if nominal interest rates rise again and the expanded money supply is not reduced fast enough, the situation changes. The costs of holding money go up, money demand falls and the velocity of money increases. According to the quantity theory of money, higher inflation would be the result.

Figure 6: Money demand and nominal interest rates in the USA

Source: FRED® database of the Federal Reserve Bank of St. Louis
Period: 1st quarter of 1959 to 2nd quarter of 2013

1.2 Hyperinflation in Recent History
When people talk about currency devaluation, they soon mention hyperinflation, which is defined as an inflation rate of more than 50% per month and corresponds to annual inflation of about 13,000%. Hyperinflation amounts to a complete devaluation of paper money and normally does not end until the real value of the paper is higher than the real value of the banknote being printed. Hyperinflation has cropped up several times in the past. Although it has affected a wide variety of countries, its repercussions are always the same: rapid impoverishment of the population, rising unemployment, the abandonment of money as a means of payment and, as a result, a sharp reduction in the supply of goods and services.

Germany between 1914 and 1923
During and after World War I, Germany experienced the worst hyperinflation ever suffered by an industrialized nation. One of the main reasons was that Germany had gone off the gold standard in 1914 at the start of the war. This allowed the government to increase the money supply significantly by issuing war bonds to finance military expenditures. The bonds were considered to be a safe form of investment, so many people invested a large proportion of their assets in these certificates. After Germany lost the war, additional funds had to be raised in order to pay war reparations to the victors. The money supply was massively expanded once again. This eroded the real value of the money held by the public, ruining the national currency.

It soon became clear that even these funds would not be sufficient to pay the reparations. France and Belgium thereupon occupied the Ruhr region, which belonged to Germany. Years of German hyperinflation followed, during which time the exchange rate of 42 marks to the US dollar at the start of 1921 soared to 4.2 trillion marks to the dollar in 1923. Hyperinflation came to an end on November 15, 1923, when the German mark was replaced by the new rentenmark at a ratio of 1 trillion old marks per rentenmark.

The devaluation of the currency meant that the cost of the war and the reparations were ultimately imposed on the working population and anyone who held paper money. Germany’s middle class was in effect dispossessed and impoverished. Only a few major landowners were able to protect some of their wealth by investing in real assets.

Poland between 1989 and 1992
In 1988, the government of Poland decided to switch from a centrally planned economy to a market economy. However, this project turned out to be unexpectedly difficult, in part because central price controls were partially retained. Enterprises were therefore unable to rely on either the planned economy or the free market economy. In addition, labor movements gained huge support and were able to push through higher wage demands that bore no relation to the development of the real economy. This led to a shortage of many goods and triggered rapid price rises that — fueled by further price liberalization — developed into full-blown hyperinflation in 1989.

Poland’s government tried to bring the hyperinflation under control through radical structural reforms. It liberalized foreign trade, introduced a largely free market economy, devalued the national currency (the zloty) and cut state spending. It thus succeeded in cutting inflation significantly in the years after 1989. However, these radical measures also caused unemployment to climb and production to collapse. In 1993, inflation still stood at over 30% per year in Poland.

Whether it occurred in Germany, Poland, Brazil, Russia or Zimbabwe, the consequences of hyperinflation are almost always identical: a complete devaluation of paper money and the de facto expropriation of the population’s savings. The refusal to accept money as a means of payment leads to widespread unemployment and goods shortages.
Brazil between 1989 and 1994

Brazil was a military dictatorship until the mid-1980s. However, in the midst of a protracted deep recession following the 1979 oil price shock and the inflation this fueled, the ruling junta was having increasing difficulty ruling the country. Finally, in 1985, Brazil was transformed into a democracy. Tancredo Neves, the winner of the first presidential election, died of a stomach ulcer before taking office. Neves’ vice president, José Sarney, therefore became Brazil’s first president. Sarney faced major challenges. He not only had to instill democracy more deeply in the public mindset, but also had to clear away a huge mountain of debt and combat inflation. To this end he devised the Plano Cruzado economic program. This was intended to enable him to keep inflation within bounds by means of wage and price controls.

Sarney’s efforts were unsuccessful. By the end of his term of office in 1989, inflation had risen to around 2,000% per year. In 1990, the government of his successor, Fernando Collor de Mello, faced inflation rates of 6,000% per year. Collor de Mello, too, developed his own economic program. The Plano Collor enabled the government to freeze citizens’ savings for 18 months, starting in March 1990. At the same time, prices were frozen and interest rates on loans were raised. These measures thrust almost the entire population of Brazil into a bitter struggle for survival. Nevertheless, the program, which was extended in 1991, was a partial success. Inflation fell to around 400% per year.

In 1992, Collor de Mello was forced to stand down in the midst of a corruption scandal. He was succeeded by former vice president Itamar Franco. Under his leadership the government implemented a monetary reform that saw the previous currency, the cruzeiro, replaced by the Brazilian real. Even so, inflation rose further. In the 1994 election, Franco’s finance minister, Fernando Cardoso, was elected president. At that point, inflation was around 5,000% per year. Cardoso decided to peg the Brazilian currency to the US dollar at an exchange rate of 1 to 1, thus in a sense adopting the US Federal Reserve’s monetary policy. Over the next few years, this allowed inflation to return to normal rates of less than 10% per year. After a currency crisis in 1999, the real depreciated markedly (today one real is worth about USD 0.45). However, thanks to economic reforms and the creation of a stable political framework, Brazil’s inflation rate still remains in single digits today.

Russia between 1992 and 1999

After the Berlin Wall fell in Germany, in 1992 Russia as well ventured to shift from a centrally planned economy to a market economy. As a first step, the prices of most goods were liberalized and the population was permitted to accumulate private assets. Despite a relatively rapid process of privatization, investment funding remained in the hands of a state-owned bank. This bank approved almost all loan applications, of which there were many, because the privatized companies needed a large amount of additional funding in order to pay wages and modernize their plants. The result was a rapid expansion of credit. Yet it was not only private companies that were mainly financing themselves using borrowed money. The state, too, was opting for the easiest way of funding its high deficits. It just kept on increasing the money supply. This massive expansion pushed inflation up to 2,500% per year in 1992. The population was rapidly becoming poorer, so people tried to evade the depreciation of the ruble, as far as possible, by keeping their money in US dollars.

It took several years to remedy the situation and stabilize the currency. The problems were compounded by the fact that the banking sector was partially privatized and the new institutions offered forms of investment based on pyramid-type schemes, which financially ruined many citizens.

In 1996, Russia’s government finally succeeded in stabilizing the ruble exchange rate and largely put a stop to currency speculation. This brought inflation back down into double digits. However, a side effect of falling inflation was that many citizens and companies that had taken out loans with high fixed interest payments before 1995 (when inflation was still around 200% per year) became unable to service their debts. The resulting loss of confidence in the new monetary regime eventually led Russia to default in 1998. Inflation then rose to over 120% again in 1999. It was not until the beginning of the new millennium that Russia’s government was able to push inflation back down into the low double-digit percent range.

Inflation-Linked Bonds
Zimbabwe between 2007 and 2009

Zimbabwe was the first country to experience hyperinflation in the 21st century. The main person to blame for this is Robert Mugabe, who has ruled the country since it gained independence from the UK in 1980. Soon after Mugabe took power, it became evident that tax revenues were not sufficient to cover government spending, which could only be financed by constantly printing new money. This fueled inflation: when the Zimbabwean dollar (Z$) was first introduced in 1980, banknotes were issued in denominations of Z$2 to Z$20, whereas by 2005 they had gone up to between Z$50,000 and Z$100,000.

Rampant inflation and political turmoil in the country led to constant emigration, which further undermined the tax base. In order to meet Zimbabwe’s obligations toward the International Monetary Fund (IMF), one of country’s key creditors, the money supply was increased further and the new Zimbabwean dollar was introduced, with an exchange ratio of 1 to 1,000 of the previous currency.

The monthly rate of inflation then rose to over 50% in March 2007, and Zimbabwe found itself plunged into hyperinflation. The government issued banknotes denominated between Z$1 million and Z$10 million in the hope that this would tamp down inflation. Yet inflation went on rising. In July 2008 it hit 2,600% per month. In September 2008 the IMF estimated annual inflation at 489 trillion percent; other estimates were even higher. August 2008 saw the launch of the third Zimbabwean dollar, which continued to be issued in ever higher denominations over the following months. In January 2009 a Z$100 trillion banknote even came into circulation. In February 2009 the Mugabe government introduced the fourth Zimbabwean dollar. Soon, however, the currency – which no one trusted any longer – was abandoned in favor of the US dollar and the South African rand. Finally, in January 2010, the US dollar became the official currency, meaning that Zimbabwe effectively adopted the US Federal Reserve’s monetary policy. This led to an economic recovery and a decline in annual inflation into the single-digit percent range.

Nevertheless, hyperinflation had devastating consequences for Zimbabwe. Unemployment peaked at 94%, there were massive shortages of goods, and much of the population returned to bartering. In terms of per capita gross domestic product (GDP), the devaluation of the currency set the country back 50 years.
Inflation-Linked Bonds
2. How Inflation Affects Private and Institutional Investors

Inflation affects private and institutional investors alike. It is often particularly bad news for pensioners because their income tends not to be adjusted for inflation. In contrast, rising inflation can be beneficial for borrowers, because it decreases the real value of their debts.

The same is true for institutional investors: although inflation tends to diminish asset value, the net effect will be determined by the impact of inflation on liabilities.

This chapter undertakes an in-depth analysis of how inflation affects private and institutional investors, with a special focus on pension funds and insurance companies.
High inflation reduces the value of most traditional asset classes for both private and institutional investors. However, on closer examination, the effects do vary. Many private individuals may not be aware that their income will no longer be adjusted in line with inflation once they retire and that progressive inflation will thus erode their real income over time.

The impact on institutional investors, particularly pension funds and life insurance companies, is very much dependent on the duration of their liabilities. In some cases, higher inflation can actually benefit these institutions, though usually only temporarily.

2.1 How Inflation Affects Private Investors

Inflation can have a range of implications for private investors. The impact will vary from one person to the next, depending on how soon income and assets are adjusted for inflation. Pensioners tend to be more adversely affected by inflation than the working public because pensions are generally fixed at a nominal value while salaries are adjusted to inflation, albeit with a time lag. Statistically speaking, a pensioner might be expected to live for 20 years after retirement. If the annual inflation rate is 2%, then that pensioner’s real purchasing power will decline by approximately one-third over time. It is also important to bear in mind that pension income from defined contribution plans is determined by the amounts paid in. Consequently, the policyholder has no guaranteed protection against inflation either before or after retirement.

If you realize later in life that the purchasing power of your savings and pension will not be enough to maintain your desired standard of living in retirement, there is little scope for generating additional income. To combat the risk of poverty in old age, it is worth investing at least some of your assets in inflation-linked securities. In addition to providing some protection against inflation, this approach improves risk diversification within your portfolio.

2.2 How Inflation Affects Institutional Investors

Pension funds

First we need to distinguish between defined contribution and defined benefit plans. Nowadays, less than 10% of all pension funds offer defined benefit plans. Pension payments from defined benefit plans are calculated as a fixed percentage of final salary. Since salaries are adjusted in line with inflation, albeit with a time lag, pension funds have to guarantee inflation protection up to the policyholder’s retirement. Here it is important to consider whether the cost of the inflation protection is financed by the pension fund or the policyholder. If the contributions shortfall created by a salary increase is covered by the pension fund, then the fund pays for the inflation protection. Alternatively, the cost of the shortfall and thus the inflation protection is borne by the employee.

The situation is somewhat different for defined contribution plans. Here the pension fund has no statutory duty to protect policyholders against inflation prior to retirement. The pension payments are determined solely by the total contributions paid in. So what happens in the event of a substantial and sustained rise in inflation? Experience indicates that under inflationary conditions, pressure from policyholders eventually forces the fund to adjust long-term pension payments in line with inflation. Consequently, rising inflation results in higher pension payments to policyholders and has an adverse effect on the pension fund’s financial situation.

Inflation is therefore a major issue for both defined contribution and defined benefit plans.

Impact on assets

Higher inflation rates are bad news for the real value of most traditional asset classes, causing assets to lose value. The overall capital loss will vary according to the portfolio composition. As a general rule, around 40% of pension fund assets are invested in bonds, 30% in equities, 20% in real estate and the remaining 10% in cash and alternative assets.6

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The effects of higher inflation on bonds are the easiest to estimate. The prospect of higher inflation prompts higher nominal yields, causing bond prices to fall in tandem with the value of the pension fund assets. The longer the bond portfolio duration, the greater the loss. However, portfolio yields will adjust to the new interest rate levels over time as new bonds are issued with higher coupons to reflect higher market interest rates. The length of the recovery phase is determined by the bond portfolio duration.

The value of stocks also tends to fall in response to unexpected spikes in inflation. Higher inflation means increased borrowing costs for companies, which usually cannot be passed on to customers immediately in the form of higher prices. Inflation also curbs real consumption, which in turn further dents earnings. In the medium term, product prices can be adjusted to reflect the new situation, at which point profit margins will rise again. As a result, stocks tend to lose less value than bonds.

In the case of real estate, rental income is fixed at a nominal value for the short to medium term, so rent cannot be adjusted immediately to the new general price level. Marked inflation also increases borrowing costs, which will prevent a flight from cash to property and thus hinder real estate prices from rising. In view of this twofold effect, real estate offers limited protection against inflation. The same is true of commodities: declining corporate earnings reduce the demand for commodities, which in turn depresses prices. Furthermore, commodities do not deliver a steady income stream, unlike the dividend payments on stocks or coupon payments on bonds.

Pension funds can use a number of approaches to mitigate the effect of inflation on asset value. They can opt to invest in inflation-linked products, which provide protection against inflation and improve the risk/return profile of the total portfolio. Actively managing the nominal bond portfolio is another way of counteracting the effects of inflation.

Impact on liabilities
If the duration of liabilities to policyholders exceeds asset duration, as is usually the case for pension funds, higher inflation can improve the coverage ratio in real terms. However, the accounting coverage ratio may still decline because the technical interest rate is used to value future liabilities. If the pension fund’s board of trustees does not adjust the technical interest rate in line with the new interest rate level, inflation will inevitably reduce the coverage ratio.

However, this is only true if pension payments are fixed at a nominal rate, i.e. if the pension fund does not grant inflation protection on its liabilities. This solution is only viable in the short term because if inflation rises substantially in the long term, policyholders’ real purchasing power will steadily deteriorate, which could result in old-age poverty in the worst-case scenario. Pressure from policyholders would accordingly mount, forcing the pension fund to make an adjustment for inflation. The adjustment would increase the pension fund’s liabilities and have an adverse effect on its finances.

Insurance companies
In the insurance sector, inflation is an issue primarily for social security and life insurers. Most Swiss social security insurances are currently financed through a pay-as-you-go system. Ongoing revenues are used to cover outgoing payments. The impact of higher inflation on the finances of insurers operating under this model varies according to how rapidly revenues and expenses are adjusted to inflation. If revenues are adjusted sooner than expenses, the insurer’s finances could improve in the short term.

Life insurance policies operate along the same lines as defined contribution pension plans: the amount paid in determines the payout at the end of the policy term. However, many life insurance contracts guarantee a minimum nominal rate of return. Since life insurance policies tend to extend over several decades, there is a risk that the insurer will be unable to generate the promised nominal minimum return due to decreasing nominal interest rates. Many life insurance companies are facing this very problem at the moment. In the current zero-interest-rate environment, it is no longer possible to generate the minimum return that was promised so many years ago. Higher inflation would thus be good news for these companies: it would entail short-term capital losses on assets, but in the longer term interest rates, and therefore bond coupon payments, would increase, improving the company’s financial situation.

Insurance companies have far more room to maneuver than pension funds when it comes to valuing bond portfolios. If they hold a bond to maturity, the bond can be valued at amortized cost over the runtime rather than at market value. This means that the difference between the purchase price and the expected redemption value is amortized over the residual term. This valuation method offers greater financial stability in the event of an unexpected rise in inflation, albeit at the expense of limiting the scope for active bond portfolio management.
3. Using Traditional Asset Classes to Protect against Inflation

Is it possible to obtain sufficient inflation protection by investing in equities, real estate or gold? Quantitative analysis suggests that traditional asset classes do not offer sufficient protection against inflation.

In contrast, inflation-linked bonds are a reliable way of combating inflation within your portfolio – and mostly provide positive real yields.
How much inflation protection can be achieved by investing in equities, bonds with nominal coupons, money market instruments, real estate or commodities? The following analysis is based on US data, but has also been proven valid for the UK. We have selected these two countries for our assessment because both have a highly developed market for inflation-linked bonds. This enables us to take a closer look at this asset class’s suitability for hedging inflation risk and to compare it with the suitability of other types of investments.

We use two metrics devised by academics to assess potential for inflation protection: the correlation coefficient and the hedge ratio derived by Schotman and Schweitzer. Both indicators are calculated for a rolling four-year period to determine whether the asset class provides inflation protection over the medium term. Our analysis covers the period from December 2002 to July 2013.

**Figure 7: Real value of gold in Swiss francs between 1975 and 2013**

Sources: Credit Suisse, Bloomberg
Period: January 31, 1975 to July 31, 2013

The principle underpinning each method is simple: an asset class is deemed suitable for hedging if the asset value keeps pace with inflation. If inflation picks up, the asset value should also increase. Conversely, after adjustments for inflation, the prices of asset classes suitable for use as inflation protection should increase linearly. Figure 7 shows the evolution of the real value of gold between 1975 and 2013 in Swiss francs. The volatile graph indicates that gold did not offer good protection against inflation in Switzerland during the period analyzed.

3.1 Correlation Analysis Findings

The correlation coefficient indicates how close the relationship is between two time series – for inflation and the asset class return in the case at hand. By definition, the coefficient can be anywhere between -1 and +1. For the purposes of our analysis, a correlation coefficient close to +1 indicates that the asset class is suitable for hedging against inflation.

**The Correlation Coefficient**

The correlation coefficient is defined by the following formula:

$$\rho(\pi, x) = \frac{\text{Cov}(\pi, x)}{\sigma(\pi) \cdot \sigma(x)}$$

where Cov($\pi, x$) represents the covariance between the year-on-year percentage change in the Consumer Price Index (CPI) $\pi$ and asset class $x$. The standard deviation of the year-on-year percentage change for each time series is represented by $\sigma$.

Figure 8 shows the correlation coefficients for 2002 to 2013. Inflation-linked bonds obviously offered better inflation protection than real estate and equities during that period.

**Figure 8: Rolling correlation coefficients for different asset classes in the USA**

Sources: Credit Suisse, Bloomberg
Period: December 31, 2002 to July 31, 2013

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7 Indices used: S&P 500 for equities; JPM GBI US for nominal bonds; Citigroup USD 3-Month Euro Deposit Local Currency Index for money market instruments; FTSE NAREIT Composite TR Index for real estate; Thomson Reuters/Jefferies CRB Commodity Index for commodities; Barclays US Inflation-Linked Bonds TR Index for inflation-linked bonds.
During the financial crisis from 2007 to 2009, money market instruments offered the best hedge against inflation. However, their effectiveness has declined considerably in recent years. Regular bonds provided poor inflation protection throughout the entire observation period.

### 3.2 Regression Analysis Findings

The correlation coefficient provides an initial but imprecise picture of the hedging suitability of individual asset classes. The Schotman and Schweitzer hedge ratio gives a deeper level of detail. Calculated by means of regression analysis, it indicates how much an investor should ideally invest in each respective asset class in order to earn the highest possible risk-adjusted real return.

#### The Schotman and Schweitzer Hedge Ratio

The Schotman and Schweitzer hedge ratio is determined via the calculation of the following ordinary least-squares (OLS) regression equation:

\[ \text{CPI}_t \text{YoY}_t \sim \alpha + \beta_{SS} \cdot \text{asset class}_x \text{YoY}_t, \]

with CPI \( \text{YoY}_t \) referring to the year-on-year percentage change in the CPI at time \( t \) and asset class \( x \) \( \text{YoY}_t \) referring to the year-on-year percentage change in the value of asset class \( x \) at time \( t \). The Schotman and Schweitzer hedge ratio (\( \beta_{SS} \)) can be calculated as follows:

\[ \beta_{SS} = \frac{\text{Cov}(\pi, x)}{\sigma^2(x)}. \]

The above equation illustrates that \( \beta_{SS} \) is ultimately a scaled version of the correlation coefficient.

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While the protective properties of money market instruments are very volatile, equities, commodities and real estate provide only a relatively low level of inflation protection. The same applies to conventional bonds. Only inflation-linked bonds perform well in overall terms, exhibiting both good and stable hedging characteristics.

The analysis above clearly shows that although real assets offer a certain degree of potential long-term protection, the volatility of these asset classes over the short term outweighs their positive hedging characteristics. By definition, nominal bonds provide no protection against inflation. Only money market instruments adapt to ongoing interest-rate fluctuations quickly enough to offer a certain degree of partial protection against inflation. However, their protective properties are highly volatile and their potential returns quite limited. Inflation-linked bonds provide good protection against inflation over both the short and long term, with largely positive real returns and relatively low volatility.
Inflation Protection in the UK

The observation period for the UK also corresponds to the period between December 2002 and July 2013. Figure 10 shows the correlation coefficients for the individual asset classes during the analyzed period.

Figure 10: Rolling correlation coefficients for different asset classes in the UK

While the protective properties of money market instruments were very volatile during the observation period, equities, commodities and real estate provided only a relatively low level of protection. The same applies to conventional nominal bonds. Only inflation-linked bonds performed well in overall terms, exhibiting both good and stable hedging characteristics. The Schotman and Schweitzer hedge ratio confirms this impression, as Figure 11 illustrates.

Figure 11: Schotman and Schweitzer hedge ratios for different asset classes in the UK

Sources: Credit Suisse, Bloomberg
Period: December 31, 2002 to July 31, 2013

While the protective properties of money market instruments were very volatile during the observation period, equities, commodities and real estate provided only a relatively low level of protection. The same applies to conventional nominal bonds. Only inflation-linked bonds performed well in overall terms, exhibiting both good and stable hedging characteristics. The Schotman and Schweitzer hedge ratio confirms this impression, as Figure 11 illustrates.

Figure 11: Schotman and Schweitzer hedge ratios for different asset classes in the UK

Sources: Credit Suisse, Bloomberg
Period: December 31, 2002 to July 31, 2013

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8 Indices used: FTSE Index for equities; JPM GBI UK for nominal bonds; Citigroup GBP 3-month Euro Deposit Local Currency Index for money market instruments; FTSE EPRA/NAREIT Developed TR Index for real estate; Thomson Reuters/Jefferies CRB Commodity Index, unhedged, in British pounds sterling for commodities; Barclays UK Inflation-Linked Bonds TR Index for inflation-linked bonds.
4. How Inflation-Linked Bonds Work

Inflation-linked bonds differ from nominal bonds in a number of key regards. The following chapter specifies these distinctions as well as the reasons for yield differentials between the two types of bonds. It also examines alternative methods of implementing inflation protection.

This chapter also focuses on the market for inflation-linked bonds, which, dating back more than 230 years, is older than many people would imagine. The outstanding volume of inflation-linked bonds currently amounts to around USD 2.4 trillion, with the largest issuers being the USA, the UK and Brazil. This chapter explains why countries issue real debt whereas only a small number of companies do so.

The circumstances in which inflation-linked bonds offer particularly good returns on the one hand and less impressive returns on the other are also discussed. The duration of inflation-linked bonds and the issue of choosing the right benchmark for a corresponding portfolio round out the chapter.
4.1 How Inflation-Linked Bonds Work

Conventional bonds are issued with a fixed nominal coupon and a redemption payment amount agreed in advance. These conditions take account of inflation expectations at the time of issuance but are not subsequently adjusted.

Inflation-linked bonds, in contrast, guarantee a fixed real return irrespective of inflation. The inflation incurred after issuance can be offset in two different ways. The first possibility is that the coupons are adjusted in line with realized inflation, with the redemption value remaining constant (see Figure 12). Alternatively, the redemption value is continually indexed to incurred inflation and the real coupons are set as a percentage of this value. In practice, most issuers use the second method.

Figure 12: Comparison of nominal and inflation-linked bonds

Inflation-linked bonds do not incorporate inflation risk premiums because they are not subject to this risk. Their yield consequently tends to be slightly lower than that of conventional bonds.

Inflation-linked bonds provide the best possible protection against inflation. Unfortunately, though, even this protection is not perfect. To offer complete inflation protection, bond cash flows (via coupon and principal repayments) would have to be adjusted in line with realized inflation. However, this is not possible in practice because the length of time it takes to compile data and perform calculations means that inflation rates are always published after a delay of a few months. This is why there is a short period at the end of an inflation-linked bond’s term to maturity (referred to as the “indexation lag”) during which complete protection cannot be guaranteed. In compensation, however, investors receive retroactive inflation protection for a period of the same length prior to the bond being purchased.

The indexation lag is equivalent to three months in most markets. The shorter the bond’s term to maturity, the greater the indexation lag’s effect. In markets with volatile inflation rates, it is wise to take seasonal components into account. For example, inflation rates in France in January and July are lower on average than in other months due to retailer clearance sales. Inflation-linked bonds that expire in April or October (i.e. three months after January and July, respectively) therefore offer a worse deal than bonds that are redeemed during the rest of the year.

In theory, such seasonal effects should be perfectly priced into the forward interest rate curve, but this is frequently not the case in practice. By actively managing inflation-linked bonds, these and other inefficiencies can be deliberately exploited to earn extra returns.

Inflation-linked bonds adjust coupon payments in line with realized inflation — unlike conventional bonds, which pay nominal interest. Consequently, no inflation risk premium is incorporated, meaning that inflation-linked bond yields tend to be slightly lower, but also less risky.

Inflation-linked bonds are not the only means of hedging portfolios against inflation. Inflation swaps make it possible to obtain synthetic inflation protection even for conventional bonds. A swap generally involves two parties exchanging future cash flows. An inflation swap involves one party (the payer) making fixed payments over the duration of the transaction in line with his inflation expectations when the agreement was struck. The counterparty (the receiver) makes payments corresponding to the actual realized rates of inflation (see Figure 14). This means, for example, that if the expected rate of inflation was 2% when the agreement was struck, the payer must pay the receiver 2% of the agreed nominal value of the swap after one year. The receiver, on the other hand, pays the payer the actual realized rate of inflation as a percentage of the nominal value. If the actual realized inflation in this example were to exceed 2%, this would constitute an inflation surprise to the benefit of the payer. But if the realized rate of inflation turns out lower than 2%, the receiver profits from the swap.
Since a portfolio of nominal bonds prices in current inflation expectations, synthetic inflation protection is possible by combining such portfolios with inflation swaps. The investor makes payments to the counterparty in line with the inflation expectations for his bond portfolio while the counterparty makes payments determined by the actual realized inflation rate. The investor thus obtains inflation protection that is tantamount to a direct investment in inflation-linked bonds (see Figure 15).

**The Advantages of Synthetic Inflation Protection**

- The limited investment universe offered by inflation-linked bonds is enlarged to include the broad spectrum of nominal bonds.
- Protection is possible regardless of maturity and duration (real/nominal).
- Bid/ask spreads are tighter because liquidity is higher than on the market for inflation-linked bonds.

Inflation swaps offer a number of advantages over direct investments in inflation-linked bonds (see text box). One advantage is that they help to overcome the inherent limits of the inflation-linked bond investment universe. For example, the Barclays Capital Euro Government Inflation-Linked Bond (EGILB) Index consisted of just 18 bonds at the end of August 2013, with French securities accounting for 76% of the index composition and German bonds 24%. By way of comparison, its nominal counterpart, the Euro Aggregate Bond Index, comprised 3,016 bonds from 46 different countries at the end of August 2013. Synthetic inflation protection enables much broader diversification within bond portfolios, thereby reducing concentrated risks.

Although the first ever inflation-linked bond was issued back in 1780, the market has only been growing strongly over the past ten years. The total market value of all inflation-linked bonds issued currently amounts to around USD 2.4 trillion (see Figure 16).
In terms of the market value of issued paper, the USA leads the way, followed by the UK. Brazil is in third place, accounting for a market value of around USD 280 billion. The South American giant issued its first ever inflation-linked bond back in 1964. As recently as 2003, Brazil’s share of the global market was negligibly small. With a share of around 70%, it now dominates the market for inflation-linked bonds originating from emerging economies. France, Italy and Sweden, in contrast, have lost much of their importance on the inflation-linked bond market in recent years (see Figure 17).

**Figure 17: Evolution of market share for various countries**

Source: Barclays Capital  
Period: December 31, 1996 to July 31, 2013

Inflation-linked bonds thus enable countries to reduce their anticipated refinancing costs. However, the inflation risk premium has been extremely low over the last nine years, equating to around five basis points per year.9 Another reason for issuing inflation-linked bonds is that it is a good way to tap into new investor groups. Inflation-linked bonds also help to smooth out the duration structure of government debt. In addition, central banks use conventional and inflation-linked bond yields to calculate expected inflation and set monetary policy. Furthermore, issuing inflation-linked bonds also helps to bolster confidence because the state cannot inflate these debts away. This aspect is particularly important for emerging economies, some of which are only able to obtain refinancing by issuing inflation-linked bonds in their national currency.

Lower interest costs are the main reason why countries issue inflation-linked bonds. However, other motives include tapping into new investor groups, gauging inflation expectations and smoothing out the debt duration structure.

Only a very small number of inflation-linked corporate bonds are in circulation. Most people who invest in inflation-linked bonds are very risk averse and therefore shy away from bonds that have no government backing. Consequently, demand for inflation-linked corporate bonds is low. Moreover, most of the few such bonds that exist are very illiquid.

The only developed market for inflation-linked corporate bonds is in the UK, where there are two main groups of issuers. The first group consists of companies such as supermarket chains whose business performance is heavily dependent on inflation. Such companies use inflation-linked bonds to achieve better congruence between revenues and interest expenses. The second group consists of companies with long-term liabilities, for example utility companies such as Anglian Water, Scottish Power and Severn Trent. Since inflation-linked bonds are generally issued with longer-than-average terms to maturity, such companies can consequently achieve a better match between the duration of their assets and the duration of their liabilities. Furthermore, since the regulated prices for utility services such as electricity and water are linked to inflation, there is again a greater degree of harmony between interest expenses and revenues.

For the period from July 31, 2004 to July 31, 2013, the return on the Barclays World Inflation-Linked Bonds TR, hedged in US dollars, was 4.69% p.a., while the return on the nominal benchmark index, the Barclays World Breakeven Inflation-Linked Bonds TR, hedged in US dollars, amounted to 4.74% p.a. This equates to an average inflation risk premium of 0.05% p.a.
4.4 Duration of Inflation-Linked Bonds

Duration is a measure of the average time for which capital is tied up in a bond and also reflects how sensitive its value is to changes in interest rates. In general, inflation-linked bonds have a longer duration than comparable nominal bonds because the majority of the reimbursement for inflation for such bonds falls due when the nominal value is repaid on maturity. In addition, their duration is calculated with real coupons, while nominal coupons are used for nominal bonds. Therefore, it is not possible to compare durations like for like. To better understand the problem, it is helpful to look at the dual duration concept.

Since nominal bonds are sensitive to both changes in real interest rates and changes in inflation, their duration can be calculated as follows:

\[
\text{duration (nominal bond)} = \text{duration (real interest rate)} = \frac{\text{duration (inflation)}}{1 + \text{inflation beta}}
\]

However, inflation-linked bonds are not sensitive to changes in inflation, but only to changes in real interest rates:

\[
\text{duration (inflation-linked bond)} = \frac{\text{duration (real interest rate)}}{1 + \text{inflation beta}} = 0
\]

To take this difference into account, in practice the duration of inflation-linked bonds is often adjusted with the inflation beta (see text box on the next page). This measures the sensitivity between real and nominal yields. Figure 19 shows the evolution of the inflation beta for the USA and the UK.10

Figure 19: Inflation beta in the USA and the UK

As can be seen in Figure 19, the inflation beta is very unstable. For example, for a US inflation-linked bond with a real duration of 10 years, the nominal duration in 1997 was around \( \beta_{IL} \cdot \text{MD} = 0.2 \cdot 10 = 2 \) years, while for the same bond in 2005, it was around \( \beta_{IL} \cdot \text{MD} = 0.8 \cdot 10 = 8 \) years (see Figure 19). This means that over time, there is a considerable difference in the duration adjusted for the inflation beta.

Since an inflation-linked bond is not sensitive to changes in inflation, its duration cannot be compared one to one with the duration of a nominal bond. One way to improve comparability is the inflation beta. However, this is unstable over time. The key rate duration is a better way to more precisely manage the duration of a bond portfolio.

10 Indices used: USGG10YR for nominal yields on 10-year US government bonds; GUKG10 for nominal yields on 10-year UK government bonds; USGTT10Y for US real yields; GUKGIN10 for UK real yields. The inflation beta was calculated over a rolling window of six months.
**Duration of Nominal and Inflation-Linked Bonds – the Inflation Beta**

The present value of a nominal bond equals the sum of its discounted future cash flows:

\[ P_0 = \sum_{t=1}^{T} \frac{C_t}{(1 + r)^t} \]

where \( P_0 \) represents the present value, \( C_t \) the cash flow at time \( t \), and \( r \) the nominal interest rate. The derivative of the above formula with respect to the nominal interest rate \( \frac{\partial P_0}{\partial r} \) measures how much the present value changes when there is a slight change in the interest rate. The modified duration is defined as the derivative divided by the present value and is described by the following equation:

\[ MD = \frac{\frac{\partial P_0}{\partial r}}{P_0} = \frac{1}{P_0} \sum_{t=1}^{T} \frac{t \cdot C_t}{(1 + r)^{t+1}}. \]

The duration of inflation-linked bonds is represented by \( \beta_{IL} \cdot MD \), where \( \beta_{IL} \) is the inflation beta resulting from the estimation of the following regression:

\[ \ln \left( \frac{1 + Yield_{Real, t}}{1 + Yield_{Real, t-1}} \right) \sim \alpha + \beta_{IL} \cdot \ln \left( \frac{1 + Yield_{Nom, t}}{1 + Yield_{Nom, t-1}} \right) \]

where \( Yield_{Real, t} \) represents the real yield at time \( t \) and \( Yield_{Nom, t} \) the nominal yield at time \( t \).

A better tool for making investment decisions is the key rate duration. It describes the change in each individual cash flow when there is a change in the interest rate for the corresponding maturity along the yield curve. The key rate duration can be used to compare how sensitive the individual cash flows of the portfolio and benchmark are to changes in real interest rates.

Figure 20 shows the key rate duration (duration density) against the real yields generated by an inflation-linked portfolio and a nominal benchmark portfolio. Here the blue curve represents the key rate duration of the inflation-linked portfolio, while the gray line is that of the nominal benchmark portfolio. A key rate duration of 0.5 at the four-year mark means that the portfolio loses around 0.5 * 1% = 0.5% in value if the four-year real interest rate increases by 1%. In the same circumstances, the nominal benchmark portfolio falls 1.4% in value (key rate duration of 1.4 at the four-year mark).\(^{11}\)

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\(^{11}\) These calculations are based on the simplified assumption that all other interest rates along the real interest rate curve remain unchanged. The duration density is an analytical version of the key rate duration.
4.5 The Deflation Floor

In the event of a sustained period of deflation, it would be possible in principle for the redemption value of an inflation-linked bond at maturity to be less than its par value. A deflation floor guarantees that the capital repayment at maturity will always amount to at least the par value. The deflation floor thus serves to protect bond buyers. Nowadays, most countries that issue inflation-linked bonds offer a deflation floor. Key exceptions to this include the UK, Brazil, Japan, Canada and Mexico.

The deflation floor is a type of built-in capital protection and therefore costs investors a certain amount. The more likely a sustained period of deflation is, the higher this amount will be. This is why Japan, which has been in a deflationary environment since the turn of the millennium, does not offer a deflation floor. The premium charged for protection would simply be too high.

4.6 Selecting the Right Benchmark

The tightly defined investment universe of inflation-linked bonds poses a problem when it comes to compiling a meaningful index. One potential solution is to switch to a nominal benchmark. In doing so, however, investors must be aware that due to the lack of an inflation risk premium, long-term returns on inflation-linked bonds tend to be lower than those on a nominal benchmark, provided that inflation does not turn out higher than expected.

With the implementation of synthetic inflation protection (nominal bond portfolio combined with an inflation swap), the nominal underlying portfolio can invest in the same investment universe as the nominal benchmark. Differences in returns between the benchmark and the portfolio can then be explained as a result of changes in inflation expectations and inflation risk premiums because both are invested in the same real interest rate curve.
5. Protection for Countries without Inflation-Linked Bonds – an Example for Swiss Investors

Switzerland does not issue inflation-linked bonds. Can Swiss investors still protect themselves against inflation using inflation-linked bonds from other issuers? In this chapter, we introduce a model that uses inflation indices of the USA and the euro zone to replicate Swiss inflation – with satisfactory results. The concept presented here can be applied anywhere in the world and can be used, for example, to create inflation protection for investments in emerging markets. Such protection can be implemented practically using products offered by Credit Suisse.
The Swiss Confederation does not issue inflation-linked bonds. So how can Swiss investors protect themselves against inflation in Switzerland using inflation-linked bonds from other issuers? In this chapter we examine the relationship between inflation in Switzerland and inflation in the UK, the USA and Europe. There are inflation-linked bonds for these three markets in addition to a well developed derivatives market. The dynamic modeling approach presented below allows Swiss inflation to be closely replicated using a combination of inflation rates from the USA and the euro zone. The concept can be applied anywhere in the world and can be used, for example, to implement inflation protection for investments in emerging markets.

In 2003, Credit Suisse became the first financial institution to offer synthetic inflation protection for Swiss investors, which is based on the model presented here. In recent years, other financial institutions have launched similar products, which confirms the high quality of our methods.

5.1 The Dynamic Modeling Approach

Monthly data for the period between January 1998 and July 2013 is used for the quantitative analysis. Inflation time series usually are not stationary. Hence, examining just the raw data would deliver misleading estimates that could not be used to draw meaningful conclusions. For this reason, we do not look at the inflation rates themselves, but instead examine their rates of change (first log differences). The basic idea behind this model is simple. The combination of foreign inflation indices that best replicates Swiss inflation also provides the best basis for inflation protection for Swiss investors.

Figure 22 shows the correlation of the rates of inflation in the UK, the USA and the euro zone with the rate of inflation in Switzerland. Measurements are taken over a rolling window of seven years. It can be seen that the correlations fluctuate significantly in part. These considerable fluctuations over time mean that a dynamic modeling approach that can adapt to changing market conditions is the best option.

Figure 23: Evolution of regression coefficients for the USA and the euro zone

Since the correlations of the various inflation indices with the Swiss rate of inflation vary over time, a dynamic modeling approach is better able to adapt to changing market conditions.

During the financial crisis, the correlation between Swiss inflation and all three of the indices examined increased; nevertheless, the correlation with UK inflation is comparatively low. Furthermore, the relationship between inflation in Switzerland and in the UK is of little statistical significance when viewed across the period as a whole. Therefore, below we concentrate solely on the rates of inflation in the euro zone and the USA. Figure 23 shows how the regression coefficients $\beta_{\text{Euro}}$ and $\beta_{\text{US}}$ changed over the period between January 1998 and July 2013, with $\beta_{\text{Euro}}$ representing the regression coefficient of the log change in euro zone inflation and $\beta_{\text{US}}$ the corresponding coefficient for the USA.

It can be seen that both coefficients were largely stable throughout the period examined. The relevance of European inflation with respect to Swiss inflation tends to be greater than that of US inflation. In addition, we can see that $\beta_{\text{Euro}}$ and $\beta_{\text{US}}$ decreased considerably during the dot-com crisis at the turn of the millennium, before stabilizing again at a higher level. If the values $\beta_{\text{Euro}}$ and $\beta_{\text{US}}$ are interpreted as portfolio weightings and it is taken into account that current inflation rates appear with a delay of one month on average, an inflation time series implied by the model can be calculated for Switzerland. Figure 24 provides a comparison of the model-implied and actual inflation rates in Switzerland.

Figure 24: Comparison of model-implied and actual inflation rates in Switzerland

Sources: Credit Suisse, Bloomberg
Period: January 31, 1998 to July 31, 2013

It can be seen that both coefficients were largely stable throughout the period examined. The relevance of European inflation with respect to Swiss inflation tends to be greater than that of US inflation. In addition, we can see that $\beta_{\text{Euro}}$ and $\beta_{\text{US}}$ decreased considerably during the dot-com crisis at the turn of the millennium, before stabilizing again at a higher level. If the values $\beta_{\text{Euro}}$ and $\beta_{\text{US}}$ are interpreted as portfolio weightings and it is taken into account that current inflation rates appear with a delay of one month on average, an inflation time series implied by the model can be calculated for Switzerland. Figure 24 provides a comparison of the model-implied and actual inflation rates in Switzerland.
There are clear similarities between the rates of inflation implied by the model and actual inflation. The correlation between the two time series is $\rho = 0.61$, meaning it is relatively high. The higher mean of the model’s data series is not relevant here because only the rates of change are relevant with respect to the accuracy of the replication. This is so because inflation-linked bonds provide protection against unexpected changes in inflation and not the actual level of expected inflation, which is already priced into nominal interest rates.

In addition, Figure 24 shows that the model functioned very well during the financial crisis. Since then, the replication has tended to deliver a figure that is too high for Switzerland. This is because the euro and the US dollar depreciated significantly against the Swiss franc during this period, leading to lower prices for imported products. Most of Switzerland’s deflation was caused by this exchange-rate effect, which the model cannot reflect.

5.2 How Good Is the Model?

The correlation coefficient is a simple way of numerically expressing the hedging potential offered by our model. At $\rho = 0.61$, the correlation coefficient is relatively high. Another way to check this is the Schotman and Schweitzer hedge ratio (see Section 3.2), which estimates the realized inflation using the inflation implied by the model. We obtain a $\beta_{ss}$ of 0.71. This is a relatively high value, which implies a good level of inflation protection. Bear in mind, however, that the Schotman and Schweitzer hedge ratio is only a scaled version of the correlation coefficient and therefore does not provide much more information than the correlation coefficient itself.

Summing up, the model can be used to construct good inflation protection for Swiss investors.

5.3 Practical Implementation

The hedging strategy for Swiss investors can be implemented in two ways: physically, using a portfolio of foreign inflation-linked bonds, or synthetically, by combining inflation swaps with a portfolio of bonds denominated in Swiss francs.

At Credit Suisse, synthetic implementation is preferred for a number of reasons. Firstly, this ensures that the portfolio is always invested in Switzerland’s real interest rate curve and not in a foreign curve, as would be the case with physical implementation. Secondly, this enables the portfolio manager to invest in the much broader-based investment universe of nominal bonds, which in turn increases the diversification of the portfolio. Thirdly, the portfolio can be custom-adjusted to the investor’s wishes with regard to duration, credit rating allocation and market allocation. Fourthly, with a synthetic implementation, the foreign currency risk is limited to the cash flows of the inflation swaps and does not encompass the entire bond portfolio, as is the case with a physical implementation. This leads to lower currency hedging costs.

Since there are no inflation-linked Swiss bonds, it is difficult to find an ideal benchmark for such a product. With synthetically created inflation protection, a nominal benchmark presents an advantage in that it enables the portfolio to be invested in the same investment universe as the benchmark. Differences in returns between the benchmark and the portfolio can therefore be explained directly by changes in inflation expectations in the USA and Europe because the underlying real interest rate curve is identical.

However, investors must be aware that if there is no unexpected increase in inflation, the returns from such a product tend to be lower than the returns on the nominal benchmark over the long term due to the absence of an inflation risk premium.
6. Portfolio Management with Inflation-Linked Bonds

There are various methods for improving the risk and return of a traditional portfolio using inflation-linked investments. In this chapter, we present the most common methods, ranging from classical minimum variance optimization to the prediction of inflation rates and on to sophisticated techniques of liability-driven investing that are particularly well-suited for pension funds.
6.1 Wide Range of Investment Strategies

Inflation-linked bonds can be actively managed in a portfolio in different ways. The options range from the classical minimum variance approach to techniques of liability-driven investing (LDI). We will be taking a closer look at these strategies below. For purposes of illustration, we will be using US data since the USA offers a good data base and has a well developed market for inflation-linked-bonds.

Minimum variance optimization

Minimum variance optimization (MVO) seeks the same degree of protection against inflation risk that retrospectively would have minimized the variance, or risk, of a nominal portfolio. However, in this context it has to be taken into consideration that past performance is not necessarily a reliable indicator of future performance.

To illustrate the strategy, we have calculated the MVO of a portfolio of nominal US government bonds (represented by the JPM GBI US index) hedged with inflation swaps (represented by the Barclays US Inflation Swap ER index). Figure 25 shows the resulting curve in the risk/return spectrum. For the period reviewed (October 2006 to July 2013), a hedge ratio of 45% would have reduced annual volatility from 4.9% to 4.6% and additionally would have decreased the maximum loss in 2009 from 4.6% to 2.9%. Conversely, the Sharpe ratio of the portfolio (return per unit of risk) would have been the largest with a hedge ratio of 20%.

Figure 25: Inflation protection in the risk/return spectrum

In contrast to the MVO, which is based on past performance, the optimum hedge can also be derived from inflation forecasts. To this end, the portfolio management team refers to various influencing variables as part of a balanced scorecard approach. These include fundamental factors (such as monetary and fiscal data), technical factors (in particular from chart analysis), and quantitative and behavior-based factors. On this basis, the team decides whether it considers the market’s inflation expectations as being too high or too low.

In other words, rather than making an absolute forecast, a relative forecast is made. If the forecast diverges from market expectations, the portfolio allocation is modified accordingly. The team uses the same approach to determine its own expectations for real interest rates in comparison with those of the market. Based on the relative forecasts for inflation and real interest rates, the following four dimensions are actively managed in the portfolio:

- Market weightings: certain countries are actively over-weighted or underweighted.
- Real interest rate duration: if the team expects real interest rates to decline, the real interest rate duration is increased relative to the benchmark; in the opposite case it is reduced.
- Inflation duration: if the investment guidelines permit investments in nominal bonds, the portfolio inflation duration is increased in the event of declining inflation expectations.
- Positioning along the real interest rate curve: not only is the duration with respect to changes to real interest rates actively managed, but also the positioning along the real interest rate curve in relation to the benchmark.

In addition to these four dimensions, transaction costs and market liquidity are taken into consideration in the construction of the portfolio.

Fair value of breakeven inflation

Breakeven inflation is the value of the expected inflation rate at which nominal and inflation-linked bonds deliver equally good returns. If the portfolio manager expects this value to rise, he should increase the inflation hedge ratio; in the opposite case it would be appropriate to reduce it. In practice, making a reliable forecast is a difficult task, even on the basis of the balanced scorecard approach described above. Essentially, the wider the range of influencing factors considered, the more stable the forecast model. This is because future breakeven rates are influenced by many different factors such as producer sentiment (measured by purchasing managers’ indices such as the ISM Manufacturing PMI), 10-year nominal interest rates, the breakeven rates of the current and preceding month, the trade-weighted exchange rate of the reference currency, the slope of the interest rate curve and the price of oil.

This means that in the period between October 2006 and July 2013, a hedge ratio of approximately 45% would have improved the risk/return profile of a nominal government bond portfolio, though the return itself would have declined slightly (by about 40 basis points per year) due to the partial elimination of the inflation risk premium.
How strong the influence of all these factors is on the future break-even inflation rate can be examined by means of a multivariate regression analysis. Figure 26 shows the monthly break-even rate calculated on the basis of the illustrated factor model and compares it with the actual break-even rate. The underlying data are US data for the period between December 2002 and July 2013. Short-term fluctuations of the model results are smoothed with a time series filter. The blue band around the forecast value in the chart represents the confidence interval. The lower the volatility of the break-even rate implied by the model, the tighter the band. Inversely, this means that tighter confidence intervals are indicative of greater model forecast accuracy. However, the goal of the calculation is not a perfect match between projected and actual break-even rates. Instead the objective is to correctly estimate the magnitude of change. If the actual rate lies outside the confidence interval, it is assumed that the break-even rate will revert to a value justified according to the model. In the example, this happens in 59% of the cases.

Another interesting aspect of the calculation is that the importance of the various variables influencing the model is relatively stable (see Figure 27). Producer sentiment and the current break-even rate have a particularly constant influence. Conversely, the influence of the price of oil and the slope of the interest rate curve are relatively volatile.

However, no model is perfect. In practice, a quantitative approach should therefore always be just one of several methods used for setting strategy.

### 6.2 Liability-Driven Investing

While classic portfolio management approaches concentrate only on the assets side of an investor’s balance sheet, liability-driven investing also considers the liabilities side, or in other words financial obligations. Among other things, it makes it possible to bring the duration of assets in line with that of liabilities. When making investment decisions, it is also possible to take into consideration the elasticity of liabilities with respect to various risk factors such as changes in interest rates or inflation. LDI is therefore a sensible investment strategy particularly for pension funds.

Liability-driven investing is a portfolio management approach that views assets and liabilities collectively. Depending on conditions and requirements, there are several suitable methods for implementing an LDI strategy.

LDI poses a number of challenges for investors. The most difficult aspect is that each asset class is subject to mainly one specific risk factor (credit risk, for instance, in the case of investment-grade bonds) while at the same time additional factors (such as movements in exchange rates and interest rates) co-determine its performance. Traditional asset class diversification can therefore result in undesired and undetected risk concentrations with respect to certain factors. Such a misallocation can be counteracted through the use of derivatives. For instance, inflation swaps can be used to reconcile the sensitivity of the investment portfolio to changes in inflation with the corresponding sensitivity of liabilities.

There are three possibilities for implementing an LDI strategy. If the liabilities are more than 100% covered by assets, cash flow matching or present value matching can be implemented. However, if the coverage ratio is lower than 100%, the only available method is risk budgeting (see Figure 28).

Figure 28: Investment solutions under the LDI approach

<table>
<thead>
<tr>
<th>Coverage ratio ≥ 100%</th>
<th>Coverage ratio &lt; 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cash flow matching</td>
<td>• Risk budgeting</td>
</tr>
<tr>
<td>• Present value matching</td>
<td></td>
</tr>
</tbody>
</table>

Source: Credit Suisse
Cash Flow Matching

Cash flow matching completely eliminates the risk of the investor being unable to meet its current liabilities, but only if the coverage ratio exceeds 100%. In the case of a pension fund, for instance, it is thus possible to reallocate the portfolio so that the timing and amount of coupon payments and principal repayments match those of the pension payouts due. This enables the pension fund to meet all of its liabilities in any event. Any surplus revenues can be reinvested. Since cash flow matching does not take the elasticity of the risk factors (for instance with respect to interest rate changes) into consideration, liability shortfalls are possible over the course of the retention period. However, this does not adversely affect the capacity to meet pension obligations. Cash flow matching is particularly suitable for pension funds with known life times.

Present Value Matching

If the life time of a pension fund is unknown and its liabilities are more than 100% covered, present value matching is a sensible technique for constructing a portfolio. Under this approach, liabilities and assets are hedged equally against various risk factors to immunize their influence on the coverage ratio. To this end, various overlays are created using derivatives. An interest swap overlay, for instance, makes it possible to immunize the coverage ratio against changes in real interest rates. Figure 30 illustrates how the interest duration profile (duration density) of the portfolio (blue line) aligns with that of liabilities (gray line).

However, such an interest swap overlay influences the sensitivity of the coverage ratio to changes in inflation. The sensitivity of the portfolio and liabilities to changes in inflation can be reconciled with an inflation swap overlay (see Figure 31).

Similar overlays can be implemented for foreign-currency and credit risks. For the latter, a CDS overlay is employed that is based on the duration times spread (DTS) approach. The DTS density makes it possible to calculate the sensitivity of the individual durations to changes in the credit spread and to derive the necessary hedging positions from the sensitivities thus calculated.

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**Figure 29: Cash flow matching**

![Cash flow matching graph]

Source: Credit Suisse

**Figure 30: The effect of an interest swap overlay**

![Interest swap overlay graph]

Source: Credit Suisse

**Figure 31: The effect of an inflation swap overlay**

![Inflation swap overlay graph]

Source: Credit Suisse

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12 The duration density is an analytical form of the key rate duration, which is discussed in Section 4.4.
Risk Budgeting

Risk budgeting is based on the same principle as present value matching. It is used when liabilities are not fully covered by assets. In this case, the basic idea is to selectively take risks in order to raise the coverage ratio to 100% or more with a certain degree of probability.

This probability increases as risk tolerance rises. However, the potential loss rises at the same time (see Figure 32).

Figure 32: Relationship between risk and coverage ratio

![Figure 32: Relationship between risk and coverage ratio](source: Credit Suisse)

The composition of the selected risk is consciously controlled. Each asset class is subject to different risk factors. Since in addition the volatilities and correlations of the individual asset classes constantly change, a portfolio with rigid positions in these classes will have a risk profile that continually changes. This is why in risk budgeting the allocation decision and risk management are inseparably connected with each other.

The driving force is the risk composition of the portfolio. It is consciously selected rather than ascertained retroactively. Risk budgeting makes it possible to detect undesired risk concentrations and to change them using various overlays to maximize the probability of achieving a 100% coverage ratio (see Figure 33).

Figure 33: Example of risk composition before and after implementation of risk budgeting

![Figure 33: Example of risk composition before and after implementation of risk budgeting](source: Credit Suisse)
Literature


Popular Literature

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