The Effect of Deflation or High Inflation on the Insurance Industry

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Prepared by
Kevin C. Ahlgrim
Illinois State University

Stephen P. D'Arcy
University of Illinois at Urbana-Champaign
California State University Fullerton
D'Arcy Risk Consulting, Inc.

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Introduction

Despite the relatively benign behavior of the general inflation rate in many countries for the past two decades, developments since the financial crisis of 2008 have created the potential for decreased price stability. One the one hand, the risk of a recession induced period of deflation is real and the fear of this scenario has led the U. S. Federal Reserve, and the central banks of other countries, to use both traditional and innovative policy tools to prevent deflation from taking hold. Conversely, in large part due to the expansionary fiscal policies adopted in response to the financial crisis, the risk of a significant increase in the inflation rate has grown. These forces illustrate that using the recent past to project future developments is not adequate to cope with the financial uncertainty that exists currently. This paper consists of six sections. The first section provides some background on inflation, describes some problems in measuring inflation, and explains some of its effects on an economy. The second section reviews historical inflation rates. The third section examines the effect of inflation or deflation on the property-liability and life insurance industries. The fourth section proposes risk mitigation strategies for insurers to cope with either deflation or high inflation rates. The fifth section describes a publicly available model that can be used to develop inflation/deflation projections under a regime switching format that can readily be adjusted to reflect current financial uncertainty. The final section provides conclusions.

Section 1 – Inflation Background

The rate of inflation typically refers to changes in the overall level of prices within an economy, which consequently leads to the erosion of the domestic currency.

1.1 Causes of inflation

Sowell (2004) provides a basic introduction to inflation by focusing on two major drivers: the real economy (focused on the supply and demand for production output in the economy) and the monetary aggregates (supply of money). Prior to fiat currency, most transactions were tied to physical commodities such as gold which naturally had a limited supply. In these economies with limited money supplies, there are two common explanations for increasing prices: (1) *demand-pull* inflation and (2) *cost-push* inflation (see Baghestani and AbuAl-Foul, 2010). First, in growing economies, increases in consumer demand may outpace available aggregate supply. This excess demand pulls prices higher as consumers part with wages given their confidence in the labor market due to economic expansion. This is one of the underlying arguments used as the basis for the Phillips (1958) curve illustrating an inverse relationship between inflation and unemployment: as more workers earn a wage, the additional demand created by consumption leads to demand-pull inflation.

In cost-push inflation, exogenous shocks to supply affect the factors of production, including raw materials, commodities, and labor. The elevated prices get passed on to consumers, especially if no immediate substitutes exist for produced goods. Thus, for example, higher oil prices get passed on to air passengers in the form of higher ticket prices and fuel surcharges.

Foreign exchange can often indirectly affect inflation. As the domestic currency weakens, this can exacerbate inflation since foreign goods become more expensive which can compound demand-push inflation during expansionary periods as consumers satisfy growing demand with imports. When foreign inputs are used for domestic products, this can accelerate cost-push inflation.

Finally, there may be elements of inflation persistence or inertia (Sheedy, 2010) where future inflation (and future expectations) is highly correlated with the recent history, especially during periods of past price increases. Central bankers may have an effect on the severity of persistence if inflation targeting is among its top objectives (see Levin, Natalucci, and Piger (2004)).

Monetary economists (such as Nobel Laureate Milton Friedman) argue that it is the supply of money that leads to inflation. Given the breakdown of the gold standard, money supply is no longer fixed in supply. Thus, if governments decide to increase the money supply, if there is no corresponding increase in output, then the increase in money leads to a devalued currency. Thus, monetarists focus on the growth of money supply as the key link to long-term price pressures and point to examples of hyperinflation as evidence of this link (see section 1.3 below). However, not all economists agree with this theory and argue that a greater supply of money does not automatically lead to inflation (Harvey, 2011). In this view, money supply affects interest rates, but not necessarily prices.

1.2 Measuring inflation

The most common methodology for estimating inflation calculates the percentage change in the overall level of prices over a 12-month period as measured by a price index, such as the Consumer Price Index (CPI). The traditional method for creating the CPI involves tracking the relative price of a basket of representative goods over time. In the U.S., there are approximately 80,000 goods in 200 categories that are tracked each month (see the methodology published by the Bureau of Labor Statistics (2007)). The Bureau of Labor Statistics (or BLS) has argued that inflation based on a CPI using a static basket of goods is an upwardly biased measure of price increases. Concerned that Social Security payments were inflated by the potential bias in a "cost of *goods* index," the U.S. Senate appointed a special commission to investigate price increases actually incurred by consumers based on a "cost of *living* index." The Boskin (1996) report finds that, in fact, the CPI has overstated inflation by 1.1%. The report states:

> "There are several categories or types of potential bias in using changes in the CPI as a measure of the change in the cost of living. 1) Substitution bias occurs because a fixed market basket fails to reflect the fact that consumers substitute relatively less (expensive) for more expensive goods when relative prices change. 2) Outlet substitution bias occurs when shifts to lower price outlets are not

> properly handled. 3) Quality change bias occurs when improvements in the quality of products, such as greater energy efficiency or less need for repair, are measured inaccurately or not at all. 4) New product bias occurs when new products are not introduced in the market basket, or included only with a long lag."

The Boskin report argues that measuring inflation from a static basket of goods is not a useful measure of price changes if consumers' choice of specific goods is constantly fluctuating. There are several reasons for changes in the makeup of consumers' purchases and each is mentioned in the Boskin Committee's work. Some of these biases stem from growing economies which are likely to see dramatic changes in available goods as new products are created to either replace old products which are no longer consumed or to marginally improve upon existing products. (Gordon (2006) evaluates the Boskin report and its criticisms including a breakdown of the four adjustments that led to the Committee's conclusion that inflation is upwardly biased by 1.1%.)

The substitution bias suggests that the CPI should be adjusted to reflect the changing demands of consumers. Two types of substitution bias were noted including upper level and lower level substitution. Consumers may buy more apples as opposed to oranges (deemed upper level substitution) because the price of oranges is increasing. A lower level substitution is when consumers switch from Granny Smith apples to Red Delicious apples. In each of these cases, the BLS argues that there needs to be adjustments to CPI to reflect consumer preferences, though critics would argue that substitutions in purchasing behavior is actual *evidence* of inflation as buyers move to similar goods that are now relatively cheaper when faced with the higher prices of previous spending patterns.

A separate additional issue related to substitution and inflation measures is that monetary policy often focuses on so-called "core" inflation which excludes food and energy given the potential short-term volatility in these items. But since these items take up approximately 23% of the expenditures of American consumers (Bureau of Labor Statistics), any sharp increase in the prices of these items may lead to consumers scrambling to make ends meet in difficult times. While core inflation would not capture the higher food and gas prices, subsequent substitution adjustments to CPI may further temper publicly available inflation measures.

When measuring prices, the BLS makes no distinction about the specific stores of shoppers. The Boskin report argues that an outlet substitution bias is embedded in the CPI since consumers are likely to choose discount stores that have lower prices and purchase items in higher volumes at those outlets. The effect of the outlet substitution bias is to weight lower prices more than in the past.

There may be times when one of the products from the basket of goods was included in a previous period that becomes unavailable in the future. In these cases, it is required to find a comparable substitute product for pricing the basket of goods. When substitutions are made, hedonic adjustments for differences in quality are made. Hedonic adjustments are differences in quality as measured by the perceived utility of consumers resulting from the introduction of the new product. Conrad, et. al. (1993) discuss the systems used to assist in ensuring comparability of substitute products based on different product features, called specifications. Thus, as higher

quality products replace older ones, consumers are likely to be more satisfied and would presumably be willing to pay a higher price for that satisfaction, leading to the quality change bias mentioned in the Boskin report.

Another problem is that new products, especially new technology, only get included in the CPI when they reach mass appeal, years after they are introduced to consumers. However, the widespread acceptance of the new technology is likely *because* the price has fallen to the point to make it more accessible to a mass market. The new product bias of the Boskin report essentially adjusts the CPI for these past price declines due to the quality improvement of new technology.

Based on all the changes implemented after the Boskin report, some critics argue that the reported rate of inflation understates the true effects of inflation on consumers. They go on to say that politicians ignored the criticisms of the Boskin report since it helps lower future obligations that are tied to CPI (such as Social Security payments) and simply help the U.S. government lower the value of those future promises.

The Bureau of Labor Statistics provides a detailed discussion of the adjustments made in the CPI calculation since 1999 to move it closer to a cost-of-living measure than a price index by recognizing the substitution effect that occurs when prices change (BLS 2011). In addition, a multiple regression approach is now used to determine the value of each component of various items, particularly clothing, books, appliances and electronics to remove the effect of hedonic quality changes in products. Insurers' claim costs are based on prices that do not reflect these adjustments, so insurance costs increases are likely to exceed the rate of inflation measured by the CPI.

1.3 Inflation and Insurer Costs

While the general rate of inflation as measured by the Bureau of Labor Statistics and reported as a percentage change in CPI is one indicator of price increases, the effects on insurers may be dramatically different. In effect, increases in retail prices are separated (through a hedonic regression) into pure price effects and additional manufacturing costs as a result of product improvement, often brought about by technological advances. When measuring inflation, the reported CPI strips out the extra costs embedded in new products that reflect product upgrades. As an example, the retail prices of automobiles may have increased 25% over the last decade, but the component of the CPI related to automobiles may indicate a much lower increase since modern cars have much more advanced technology than one produced previously. The BLS argues that if we want a measure of a truly static basket of goods, this year's cars are not the same as those manufactured earlier.

However, payments from insurers do not reflect these hedonic corrections. Auto insurers do not reduce payments for car repairs to adjust for differences in quality. Insurance reimbursements for medical care are especially prone to advancing technology. Increasing costs for insurers are affected by the continuous improvements in modern medical technology, not because the same outdated procedures of years ago are more expensive today. If a new generation of prosthetics provides significant benefits over older devices, any increase in cost would likely be fully

reflected in insurance claims, yet only part of the increase would be captured under the reported CPI.

Second, insurers are likely to be exposed to specific components of the CPI rather than the overall level of price changes. Masterson (1968) measures the impact of inflation on insurers by isolating those components that are related to separate lines of business.

Finally, inflation does not have an isolated impact on insurer performance. While high inflation by itself may increase claims of insurers, the interaction with other economic and financial variables may lead to a more complex risk assessment. For example, the traditional Phillips (1958) curve indicates that demand-pull inflation may be accompanied by low unemployment. Thus, at a time when an insurer may be experiencing higher claims caused by inflation, these effects may be offset by lower unemployment which might influence disability and workers compensation claims. Low unemployment may also improve insurer sales and retention. Also, low unemployment may lead to positive effects in the stock market, further cushioning the higher claim inflation exposure of insurers.

Another disparity between the CPI and insurance costs relates to the manner housing costs are reflected in the CPI. The CPI measures the cost of the Owners Equivalent Rent of the primary residence (OER), which measures the value of renting a residence and does not consider the selling price of the home. Based on the CPI approach, the cost of a residence reflects two elements, a consumption portion and an investment portion. The consumption portion is measured by the OER; the investment portion, or price appreciation in the value of the home, is ignored (Poole et al, 2005). Thus, the CPI did not incorporate the rapid increase in housing prices during the 2000-2006, nor the drop in prices that occurred subsequently. As the cost of claims for homeowners losses covers the full cost of the home, both the consumption and the investment portions, this discrepancy further removes the CPI from an appropriate measure of insurance costs.

1.4 Extreme inflation scenarios

The U.S. has observed relatively tame inflation over the recent past. However, in the current environment, there are conditions that appear to provide fertile ground with historical examples of both a deflationary environment and persistent inflation. In fact, while inflation surveys of economists generally forecast a continuation of low inflation in the near term, outliers do predict opposite extremes as well. Economist Nouriel Roubini has been concerned with long-term deflationary pressures in the global economy while John Williams has been discussing the onset of hyperinflation.

Deflation is a decline in the general level of prices in the economy. While there may be instances of prices declining in specific sectors, deflation is most concerned with a more general trend in the level of prices in the economy. Deflation is the result of the lack of aggregate demand in the economy, forcing suppliers to cut prices to attract customers. While specific incidents of deflation may have various causes, they often result from a drop in the aggregate supply of money in the economy brought on by dramatic reduction in credit. The concern about deflation is that if it takes root in the economy, it can be difficult to break the descending spiral

of lower prices, falling profitability, and ultimately increased unemployment. As a result, central banks make considerable effort to offset the path of an economy that begins to exhibit deflationary risks.

Ahearne, et.al. (2002) review the experience of the Japanese economy during the late 1980s through the mid-1990s which began to experience falling prices. They admit that the deflationary environment was difficult to predict and in fact, both policymakers and financial markets discounted this distinct possibility. Failure to act proactively can seriously impair the ability of central bankers to reverse the trend. Even if interest rates are set to zero, it is difficult to entice consumers to borrow to purchase new goods today if prices are declining.

At the other inflationary extreme is hyperinflation. Cagan (1956) used a strict measure to define hyperinflation as price increases in excess of 50% per month. Modern definitions apply lower thresholds, as the International Accounting Standards Board defines hyperinflation as 100% increase in prices over a three year period. Others simply define the term to mean a situation where increases in price levels are so rampant that annual inflation has little meaning given significant daily price increases.

The typical cause of hyperinflation is a large increase in a money supply relative to demand. Often this occurs in an economy where the central bank assists the government in a budget crisis by monetizing the debt created through significant deficits. Historically, these deficits commonly stem from one of two causes. First, the deficits are often created quickly, sometimes as a result of required rebuilding in the aftermath of a war. The needed funds may initially be borrowed, but if economic growth lags, the government may have difficulty repaying loans or rolling over debt as the maturity approaches. This situation can be intensified if sellers lose faith in the country's currency and raise prices as a premium for payment.

Several countries in Europe experienced hyperinflation soon after World War I, including Germany, Austria, Hungary, and Poland. In Germany, during the peak of inflation at the end of the year 1923, prices doubled every other day (see Bresciani-Turroni (1937) for an in depth examination of German hyperinflation during this period).

Another cause of government deficits may be due to economic strains that follow a shock to tax revenue which reduces funds available to build required infrastructure in rapidly growing economies. Cardoso (1989) discusses some of the causes of the experience of several Latin American countries in the late 1970s and the 1980s, especially Argentina, Brazil, Nicaragua, and Peru. The seeds of hyperinflation in these countries were planted in the 1960s as these growing economies borrowed heavily, especially from international investors, to build the necessary infrastructure of an increasingly industrialized nation. The global recession of the early 1980s reduced the demand for many Latin American exports reducing tax revenue and the ability to repay outstanding debt.

Inflation in Mexico followed a similar pattern. From 1974 through 2010, inflation averaged 29.5%, hitting a high of 179.7% in February 1988 (Source: TradingEconomics.com).

1.5 Effects of inflation

While increasing prices may sound negative, the final effects of inflation on different individuals vary and depend on whether the observed inflation was anticipated or a surprise. If inflation is expected, then investors can adjust required returns to compensate them for loss of purchasing power over the investment period. Employees may also negotiate more significant raises when faced with increased inflation expectations.

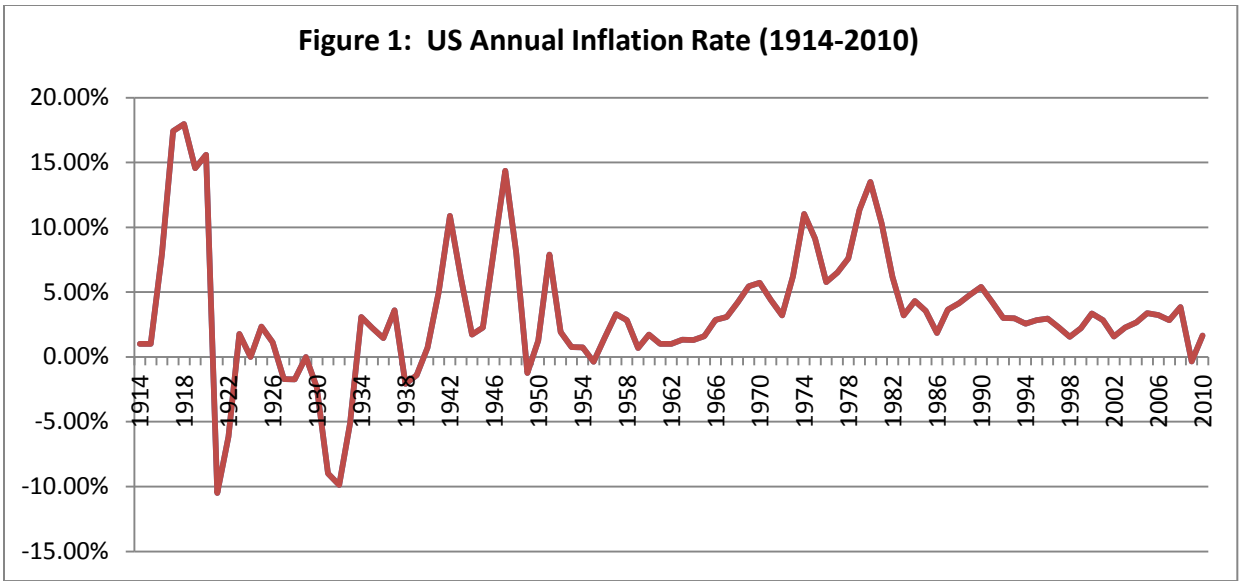
Unanticipated inflation can have several effects on the economy. First, unanticipated inflation creates significant uncertainty in an economy. If consumers become concerned about the increase in uncertainty, long-term real economic growth may become depressed, especially if unanticipated inflation exceeds wage growth leading to declining real earnings. Debtors tend to benefit at the detriment to lenders if inflation was unanticipated since funds are paid when prices are lower, similar to getting a reduced interest rate loan.

Inflation often leads to redistributions of income (Blanchard, 1997). The substitution effect mentioned earlier illustrates that as inflation affects certain sectors of the economy, consumers shift spending to competing industries. This is not necessarily a negative consequence, but it may affect the relative distribution of incomes quickly if inflation is not evenly distributed across all goods and services. Other redistribution effects result from inflation too. If retiree income is not adjusted for prices, the purchasing power of retirees declines relative to current workers who may be able to demand raises. Tax revenues may also be affected as earned income increases and the income brackets on tax tables are not adjusted appropriately.

In both deflationary and hyperinflation environments, it can be difficult to impede existing price pressures. Hyperinflation often compounds as consumers avoid a diminishing currency and exchange money for real goods. The opposite occurs in deflationary environments where prices are decreasing and consumers may simply hold on to cash instead of consuming since future prices will be lower than current prices. This aggravates aggregate demand further and sustains deflationary pressures.

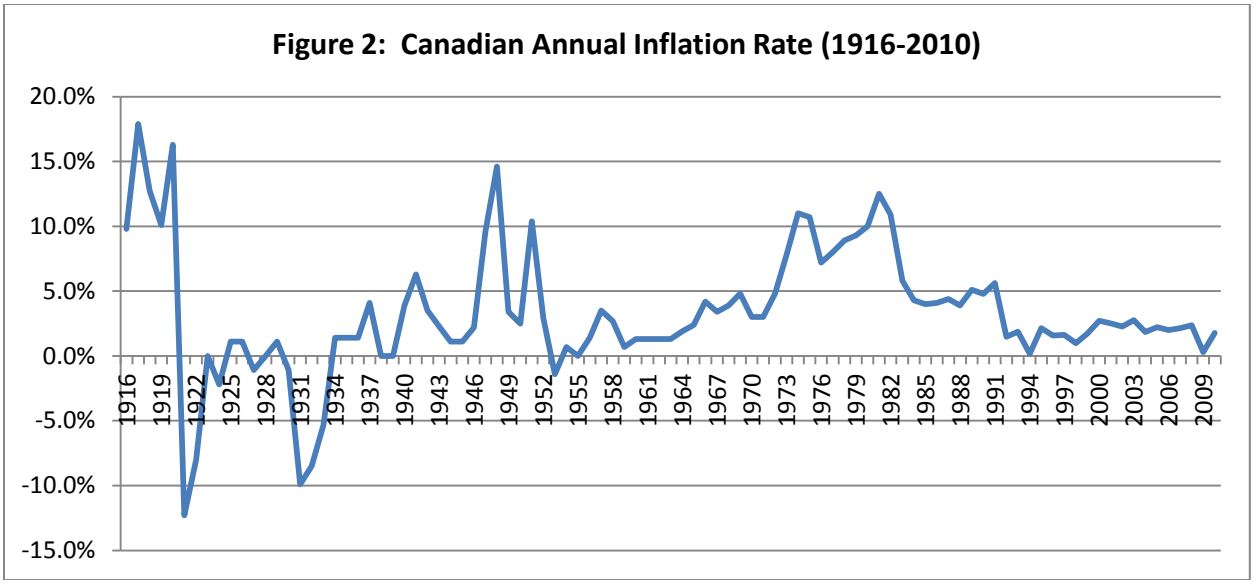
Section 2 – Historical Inflation Rates

Inflation rates, as measured by the change in the average US Consumer Price Index (Urban) each year compared to the prior year's average, are shown in Figure 1.



Periods of high inflation, moderate inflation and deflation can be observed in these data. The three periods of high inflation, 1917-1920, 1942-1947 and 1973-1982, all correspond with major wars or their aftermaths. Deflationary periods occurred from 1927-1933 and from 1938-39, although this may be considered one long deflationary period.

Figure 2 illustrates the inflation rates for Canada from 1916-2010. Similar patterns of high inflation, moderate inflation and deflation can also be observed in these data.



The historical statistics below break apart the data to illustrate three regimes: deflation, normal inflation (which is grouped between 0 and 6%), and high inflation rate (above 6%). The frequency and average values for each of these levels of inflation are shown in Table 1 for both the U. S. and Canada.

Table 1: Proposed Regimes for Inflation Model

	US 1914-2010 (97 years)		Canadian 1916-2010 (95 years)	
	Frequency	Mean	Frequency	Mean
All Years		3.4%		3.3%
Negative	13.4%	-4.0%	9.5%	-5.5%
0 to 6%	66.0%	2.6%	70.5%	2.3%
>6%	20.6%	10.5%	20.0%	10.7%

While the future cannot be predicted, it is clear that any model of future inflation rates should not be parameterized based solely on the levels of inflation experienced in the United States over the last few decades. A longer time horizon that would include the deflation of the 1930s and the high inflation of the 1910s, 1940s and 1970s, as well as consideration of developments in other countries that have faced similar economic conditions, needs to be reflected in any inflation model. Understanding historical inflation is useful, but Stock and Watson (2007) discuss how changing economic conditions have made it more difficult to accurately predict inflation.

Later in this paper we propose an inflation model that has three regimes. One interpretation of these inflationary regimes is that when the US economy is experiencing "normal" economic times, the average inflation rate is considered moderate. But two other economic regimes are possible in the future. First, expansionary fiscal policy combined with accommodative monetary policy may lead to sustained inflationary pressures. In this "high" inflation regime, there is a significantly higher average level of inflation than indicated from recent history. It seems plausible that in this high inflation regime, volatility may also be higher. A second alternate regime is that of continued worldwide economic stagnation despite government spending and central bank easing. The third regime incorporated in the inflation model reflects the possibility of these deflationary pressures. In this regime, the average level of inflation and the volatility are low.

Although overall inflation rates have recently been modest, commodity prices have increased significantly. *The Economist* Commodity Price Index as of May 24, 2011, was up 42 percent and the price of gold was up 28 percent over the prior year (The Economist, May 26, 2011). These values certainly provide a warning that the general inflation could soon increase significantly. Alternatively, the continued slump in housing prices and the stubborn high rates of unemployment in many countries warn of deflation risks. Currently, some economic forecasters are predicting a rapid increase in inflation, while others are warning of deflation. Therefore, this is not the time to rely on recent history to forecast future inflation rates.

Section 3 - The Effect of Inflation or Deflation on the Insurance Industry

3.1 Property-Liability Insurers

Several studies have documented the impact of inflation on the property-liability insurance industry. D'Arcy (1982) finds that both the underwriting profit margin and insurance investment

returns were negatively correlated with the inflation rate during the period 1951-1976. Krivo (2009) determines that although inflation and the underwriting profit margin were not significantly correlated over the subsequent period 1977-2006, investment returns and the year-to-year change in underwriting profit margin were both significantly negatively correlated with inflation over that period. Lowe and Warren (2010) describe the negative impact of inflation on property-liability insurers' claim costs, loss reserves and asset portfolios. They express concern that most current actuaries, underwriters and claim staff have never experienced a bout of severe inflation, so could be slow to adapt to any change in the economic environment. Recently, Martin Sullivan, former CEO of AIG and current deputy chairman of Willis Group Holdings, termed inflation a bigger risk to insurers than earthquakes, tsunamis or Europe's sovereign debt crisis (Crowley, 2011).

The Masterson Claim Cost Index has long indicated that claim cost inflation exceeds the general inflation rate (Pecora and Roe, 2003). By analyzing various public sources of information, including the CPI, Office of Business Economics and Bureau of Labor Statistics data on personal income and a various construction cost indices, Masterson determined that insurance claim costs generally exceeded the overall inflation rate (Masterson, 1968). This was especially notable for medical costs. Masterson derived his medical claim cost index from the components of the CPI that measure hospital charges and physician fees. Currently medical care is one of the major elements of the CPI and is measured by Medical Care Commodities (MCC) and Medical Care Services (MCS).

Property-liability insurers are impacted by inflation in several ways. The clearest impact is the cost of future claims on current policies. Workers compensation indemnity claims are based on wages at the time of a loss; wages tend to increase during inflationary periods, but not directly in line with on the CPI. For property policies, the values of the insured property are based on the cost to repair or replace the item at the time of loss in almost all cases. Very few contracts provide a pre-specified, fixed value. Thus, as inflation increases the value of the property, the cost of claims increases. During the last bout of high inflation, automobile manufacturers tried to minimize price increases on new vehicles, but made up the lost profits by increasing the cost of replacement parts for items frequently damaged in an accident at a level well above the inflation rate. Since most of these repairs are covered by insurance, then the effect on consumers was indirect. The insurance industry and automobile manufacturers engaged in many disputes over the need to use original manufacturer's replacement parts when repairing a car involved in an accident. That issue is not completely settled. Therefore, the insurance industry can expect collision damage repair costs to increase more rapidly than the general inflation rate if inflation were to increase significantly.

Another major component of property-liability claims is for medical services, either under workers' compensation, for medical payments under an automobile insurance, homeowners or other policy, or as a component of a liability claim. In general, medical cost inflation for property-liability insurers tends to exceed the general inflation rate. A significant portion of medical expenses in the U. S. are covered by government programs that impose constraints on reimbursements to medical providers. In addition, many major health insurance plans are in a position to negotiate arrangements with providers prior to the provision of medical services. Both of these arrangements can serve to control medical reimbursements for those parties below

the rate of medical inflation. (However, the Milliman Medical Index shows that the healthcare costs for workers and their health insurance companies have still increased at a rate significantly in excess of the rate of inflation (Mayne et al, 2011). These arrangements, though, have the effect of exacerbating the impact of medical cost inflation on insurers and other parties that do not have the power to dictate reimbursement rates or negotiate costs prior to services.

A third major component of claim costs for property-liability insurers is for liability claims for damage to property or injury to a person caused by an insured. In these cases, the claimant has little incentive to control costs when they will be paid by the responsible party's insurer. In fact, there is the perverse incentive to increase the cost of such items as medical care or loss of wages in order to generate a larger settlement for non-economic losses such as pain-and-suffering. As noted by Lowe and Warren (2010), the last time inflation spiked in the 1980s, a full-blown liability insurance crisis erupted, with claims costs increasing well in excess of the general inflation rate.

In addition to the impact of inflation on the cost of future claims on current policies, property-liability insurers are also likely to experience adverse development on loss reserves if inflation increases. As explained in D'Arcy, Au and Zhang (2009) and D'Arcy and Au (2011), loss reserves are commonly set based on the inherent assumption that the inflation rate experienced in the recent past will continue until these claims are closed. For some liability insurance lines, it can take decades for these losses to close. However, if inflation increases it will cost more than expected to settle these claims and the loss reserves will prove inadequate. As this trend is noted, insurers will be forced to increase these liabilities for losses that have already occurred. Any increase in liabilities directly reduces the policyholders surplus.

Another negative impact of inflation is on the investment portfolio. As noted long ago by Irving Fisher (1930) interest rates (or "new money rates" in insurance terminology) and inflation are closely related, as investors expect a real return, over the inflation rate, as compensation for foregoing current consumption. An increase in interest rates reduces the value of long term fixed income holdings, which make up a significant proportion of investments for property-liability insurers. Although statutory accounting does not require insurers to value bonds that are expected to be held to maturity at this reduced market value, the economic value has indeed decreased. Insurance investment returns were significantly negatively correlated with inflation during the period 1933-1981 (D'Arcy, 1982) and 1977-2006 (Krivo, 2009). In addition, stock returns were significantly negatively correlated with inflation during the period 1933-1981 (D'Arcy, 1982), although not during the period 1977-2006 (Krivo, 2009). This discrepancy may be due to the level of inflation and whether it was expected. A return to a high level of inflation could reduce the value of stocks held in insurers' portfolios.

If inflation rates were to increase sharply, the impact on property-liability insurers would be significant. Earnings from both underwriting and investments will be reduced and policyholder surplus will decrease as a result of both increased liabilities and reduced asset values. Preparing for this potential development is essential if insurers do not want to risk impairment or insolvency from an inflationary shock.

If inflation is bad for property-liability insurers, is deflation good? While there are fewer instances of a sustained deflationary environment in the U. S. to answer this question, Japan has experienced deflation recently and could provide some clues. Unfortunately, data on the long term performance of the Japanese insurance industry were not available to provide any meaningful conclusions. During the Depression, 1930-1939, the U. S. experience a deflation rate in six of the ten years. At the same time, the property-liability insurance industry experienced underwriting losses in two of those years, but relatively high underwriting profits during the remainder. However, premium volume declined, with net written premiums for insurance company groups dropping 33% from 1929 to 1935. (See Appendix A for premium levels by year during this era.) In addition, investment returns were low, and stock returns extremely volatile, during most of the Depression. The risk of default on bonds was high, creating a challenging investment environment for insurers.

Prior studies have examined the relationship between inflation and other variables, underwriting profit margins, investment income, equity returns and interest rates, over an entire time period. What is important under a regime switching environment is the relationship within each regime, not across all regimes. Thus, we need to break the historical data into the different regimes. Unfortunately, it is not possible to clearly identify particular regimes, even in retrospect. A deflation rate could be the result of a deflation regime or an outlier value experienced during a normal, or even high inflation regime. Alternatively, an inflation rate in the normal range could occur even though the economy is experiencing a deflation or high inflation regime. Thus, the classification of historical time periods into regimes presents a challenge.

This first analysis will treat classify all inflation levels according to the associated regime, with all deflation rates classified as the deflation regime, all inflation rates above 6.0% classified as high inflation regimes and the rest classified as moderate inflation regimes. Table 2 shows the average inflation rates, underwriting profit margins and net investment income of the property-liability insurance industry, based on Best's Aggregates and Averages, from 1914-2009, as well as stock returns measured by the change in the S&P 500 Index and the average unemployment rate.

Table 2: Historical Relationship between U. S. Inflation and Other Factors by Regime 1914-2009

Regime	Average Inflation	Average UPM	Corr. Inf & UPM	Average NII	Corr. Inf & NII	Average Stock Return	Corr. Inf & Stock	Average Unemployment	Corr. Inf & Unemp
Deflation	-4.0%	1.2%	0.49	3.4%	-0.69	9.7%	0.45	11.9%	-0.42
Moderate Inflation	2.6%	-1.7%	-0.26	3.8%	0.37	8.1%	-0.18	6.3%	0.03
High Inflation	10.5%	0.6%	-0.04	4.3%	-0.02	2.0%	-0.19	5.6%	-0.02
Total	3.4%	-0.8%	0.01	3.9%	0.22	7.0%	-0.11	7.0%	-0.38

Based on these data, the insurance industry has the lowest underwriting profit margin during periods of moderate inflation, and during that regime, inflation and underwriting profits are negatively correlated. The underwriting profit margins were somewhat higher during the periods of high inflation, but once in a high inflation regime the level of inflation was not highly

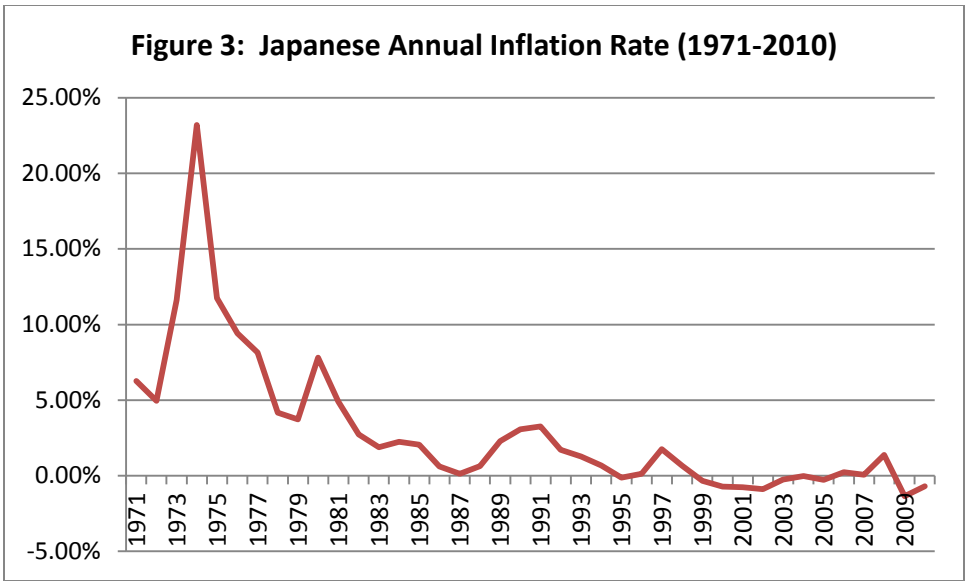
correlated with the inflation rate. In the deflation regime underwriting profits margins were the highest and the inflation rate and the underwriting profit margin were positively correlated. This means that for low absolute levels of deflation the industry was more profitable than when the absolute deflation rate was high. One obvious caveat of this analysis is the different mix of business written by insurers over the different regime classifications. Most of the deflation observations occurred between the years 1921-1949, when property lines predominated insurance writings. Only 1955 and 2009 experienced deflation during the era when liability insurance lines, with their lower underwriting profit margins, represented the majority of property-liability insurance writings.

Net investment income as a percent of mean assets did not vary much, but was highest during periods of high inflation and lowest during deflation. The net investment income value includes interest, dividends and rents, minus all investment expenses. Capital gains are not included. Assets are carried at statutory values, which for bonds are amortized, rather than market, values. Thus, this metric represents a portfolio average of historical interest rates, not the current market rate. This metric is negatively correlated with inflation during deflation, but positively correlated during moderate inflation.

Average stock returns were positive in all regimes, but highest during deflation and lowest during high inflation. This is surprising, as the common conception is that the stock market dropped precipitously during the Depression of the 1930s, a period of sustained deflation. Although the stock market fell sharply in 1930, 1931 and 1932, it increased just as sharply in the deflation years of 1922, 1927, 1928, 1933, 1938, 1955 and 2009. Over the entire period, inflation and stock returns were modestly negatively correlated, but there was a high positive correlation (0.45) within the deflation regime.

Unemployment was highest during deflation, and lowest during high levels of inflation. The negative correlation over the entire period, confirming the Phillips curve that posits an inverse relationship between inflation and unemployment, is driven by data from deflation regimes. Thus, high inflation might not be associated with a reduction in the unemployment rate, but deflation would increase unemployment and the higher the absolute level of deflation, the higher the unemployment rate.

The Japanese insurance market can provide a more recent example of the impact of deflation on the property-liability insurance industry, as the country has experience deflation in 10 of the last 16 years. The inflation rates for Japan from 1971 to 2010 are shown in Figure 3.



3.2 Life insurers

Unlike property-liability insurers, life insurers are less affected by claims inflation since many products have policy payouts that are fixed in amount. While there is anecdotal evidence linking the economy to changes in life expectancy (see Barrett (2000)), no impact has been seen in the U.S. during times of economic distress. Though inflation-indexed life insurance products are available, Brown, Mitchell, and Poterba (2000) point out that sales of these products have not been very large in the US. Instead, life insurers has promoted variable products (both life insurance and annuities) to tie values of stock market performance for policyholders who are concerned about the erosion of value due to inflation (Rejda (2011)). It is typically advertised that the correlation between stock market returns and inflation will allow these variable products to provide a reasonable hedge against higher prices (see the discussion of the empirical evidence of the effectiveness of this hedge below).

Life insurers are more likely to be indirectly affected by the impact of inflation for several reasons. High inflation erodes the current value of fixed future payments creating a disincentive for life insurance purchases and an increase in lapse rates. Li, et. al. (2007) provides empirical evidence for the negative impact of inflation on life insurance demand and sales. In an economy with high inflation, the value of money makes it difficult to justify current expenditures on future fixed payments that are rapidly decreasing in value. In addition, the guaranteed rate of return offered under older policies will be inadequate during sustained inflationary environments. It is therefore likely that there will be an increase in policy lapses and loan activity as policyholders try to capitalize on the higher rates of return of competing products. Significant disintermediation is likely to reduce profitability and require significant liquidity of life insurers.

While medical policies may be subject to significant inflation, the short-term nature of most contracts period significantly reduces risk exposure. But life and health insurers that sell significant amounts of long-term care and disability insurance may be highly affected since these

products have longer payouts and claim inflation that has potential to magnify general measures of inflation.

The life insurance industry may be more affected by sustained deflationary pressures. Since many products provide for a minimum rate of return guarantee, any scenario that leads to deflation or sustained periods of very low inflation, may pose challenges to life insurers to earn promised rate guarantees.

Finally, any significant change in inflation will likely have a dramatic effect on the company's balance sheets. Browne, Carson, and Hoyt (2001) show that the financial performance measures such as Return on Equity (ROE) and Return on Assets (ROA) are significantly negatively affected by unanticipated inflation, likely driven by the significant leverage of life insurers. Unlike property-liability insurers, the liabilities of life insurers commonly reflect the present value of future obligations. When recognizing liabilities on the balance sheet, higher inflation may lead to increased liabilities for casualty companies. However, the present value of life insurers' obligations, which are fixed in amount, may decline if interest rates increase as a result of inflation.

On the asset side of the balance sheet, an important question in understanding and insurers exposure to inflation risk requires some understanding of the relationship between inflation and asset returns. The Fisher hypothesis suggests a direct link between nominal asset returns and expected inflation. There have been various studies that tested this link often with contradictory results (for a summary of this research see Titman and Warga (1989) and Stock and Watson (2003)). In many cases, the key to understanding many of the differences in the study revolve around the investment horizon and the type of investment.

The relationship between inflation and investment returns is of concern to investors and is the subject of a long line of research. The starting point for tests typically revolves around the Fisher effect, which suggests that nominal rates of return (R_i) on investments should include a real rate of return (r_i) and a component that compensates investors for the effects of inflation (q). If returns are continuously compounded, then for security i:

$$R_i = r_i + q$$

Fisher assumed that the real and monetary sectors of the economy were independent, early tests simply measure the one-to-one relationship suggested above between R_i and q. Fama (1975) tested the Fisher hypothesis using U.S. Treasury bills. He finds that fluctuations in short-term nominal interest rates appear to be explained by variations in future inflation and concludes that real rates of interest are approximately stable.

Fama and Schwert (1977) expand the assets under consideration and find that real estate provides the best hedge against inflation, though government bonds and bills also move positively with inflation. Somewhat surprisingly, they find that stocks and inflation are negatively related. Their results are confirmed by Guelton (1983) when looking more broadly across 26 countries. Swiss Re (2010) also reports the correlation of inflation and annual returns in various asset classes. They report that there is high correlation for real estate (based on appraisal data), commodities, and Treasury bills, while the correlation between inflation and longer-term bonds

is predictably negative. They find no statistical significance between equities and inflation using recent data. Due to the role of the real estate in the financial crisis of 2008, which is now recognized as a real estate bubble, the relationship found by Fama and Schwertand others might not hold in the future.

Boudoukh and Richardson (1993) extend the short-term results of Fama and Schwert (1977) and find that while stock returns are slightly uncorrelated (or perhaps zero) with inflation in the short-term, at longer horizons the expected Fisher relationship is stronger. Solnik and Solnik (1997) confirm the link between inflation and stock returns over longer horizons using eight countries and Schotman and Schweitzer (2000) find that the effectiveness of stocks as an inflation hedge depends on the investment horizon.

It had been believed that since stocks are claims on real assets, monetary policy should not affect stock returns. Subsequent research looked more explicitly at linking inflation to the real economy. Fama (1981) argues that the surprising results indicating a negative relationship in the short-term between inflation and stock prices are not causal, but instead are a proxy for the more significant and positive relationship between stock returns and real activity. Empirically, negative shocks to the real economy are reflected in lower stock prices. This in turn may trigger looser monetary policy actions which may affect future inflation and explain the negative correlation with stock prices in the short-term (see Fama (1981) and Lee (1992)).

Exhibit B illustrates the bivariate correlation matrix for several classes of assets. It should be noted that when the investment horizon exceeds one year, the correlations are based on overlapping periods which may bias correlations. The results are consistent with previous studies mentioned above. For example, the short-term correlation between inflation and stock returns is slightly negative, but over longer periods the correlation is increasingly positive. There is a high correlation between Treasury bills and inflation, but for longer-term interest rate dependent securities, as yields on bonds rise with inflation, prices move in the opposite direction to generate the negative correlation illustrated over short horizons.

Bekaert and Wang (2010) report that hedging inflation risk is difficult when using securities such as stocks and bonds. They also consider and expanded set of potential hedges including real estate and commodities with similar disappointing results. Bekaert and Wang (2010) argue that the lack of a good inflation hedge highlights the importance of inflation indexed securities such as Treasury Inflation Protected Securities (or TIPS).

Section 4 - Insurer Risk Mitigation Strategies for Deflation or High Inflation

The moderate inflation levels from 1983 to 2010 in the United States and Canada have produced an entire generation of employees who have never experienced a high inflation environment, or, except for the blip in the US in 2009, deflation. Contingency planning for deflation or high inflation has proven to be unnecessary. In North America, only Mexico has faced sustained inflation over this period. Similar to a long period without a natural disaster, the lack of extreme inflation scenarios may lead to complacency about managing risks. Thus, the first risk

mitigation strategy for insurers is to prepare staff to be ready to deal with deflation or high inflation. Effective contingency planning that recognizes the negative impact that deflation or high inflation would have on insurance companies is an essential first step. This will allow companies to respond quickly when (not if) economic conditions change. Specific risk mitigation steps can be considered in three different areas: actuarial, operational and investments. These will be expanded below.

4.1 Actuarial aspects of risk mitigation

During the last bout of high inflation, insurers found it necessary to reduce policy terms and adjust rates frequently to keep up with increasing costs. At a company where one of the authors worked, there appeared to be a maximum rate level increase that could be made without significantly increasing the lapse rate. Keeping rate adjustments below this level required semiannual rate adjustments. Performing rate analyses and filings, if necessary, every six months for each state and each line could require substantially more staff than is currently allocated to pricing areas. When inflation increases, trend factors should be able to accommodate higher forecasted inflation rates than the rates that occurred during the experience period. Studies of the relationship between rate increases and policy retention are needed to allow the company to optimize profits in an inflationary environment.

For property-liability insurers, loss reserves will be significantly affected by a change in the inflation rate. Most loss reserve calculations do not specifically consider inflation as a factor in setting reserves, which means that average inflation rates imbedded in the experience are projected to continue. This works when inflation is stable, but not when it is volatile. Taylor (1977) and D'Arcy and Gorvett (2000) propose loss reserve methods that separate out the impact of inflation from experience and then allow the actuary to incorporate a different inflation rate in the reserve calculations. Several of the methods available in most loss reserving software allow discretion in the inflation rate used for establishing reserves. Those responsible for loss reserving should become familiar with the methods that handle inflation separately so they are able to make any necessary reserve adjustments if we move to a high inflation or deflation regime.

For life insurers, many policy forms have incorporated features which lessen the chance for arbitrage opportunities in products. Instead of providing policy loans at fixed rates, whole life policies often link loan rates to a floating index which is likely to be correlated with inflation and reduce repeated episodes of disintermediation. While policyholders are likely to be skeptical about eliminating any guaranteed rates of return commonly embedded in policies, developing triggers that are linked to the risk of deflation may alleviate the concern that investment returns may fall short of the minimum guarantee.

The high inflation rates experienced in Mexico led to several policy design recommendations for life insurers. Real interest rates, rather than nominal rates, should be used for guarantees and investment rates. Premiums, face value and expenses should be indexed either to inflation or wages to prevent the loss of value that led to consumer dissatisfaction with their life insurance policies (Asociación Mexicana de Actuarios, 2011).

Policies that index benefits for inflation, such as inflation adjusted annuities, need to have a cap in order to avoid significant unexpected exposure in the event of sustained high inflation. Hyperinflation, although considered a remote possibility by many, is a risk that does need to be addressed. As properly pricing a policy that fully indexes inflation could be cost prohibitive if the risk of hyperinflation is reflected, this risk could be viewed as a social problem, and not one that can be handled through insurance. Policy design issues, though, need to be addressed now, and not after inflation begins to increase.

4.2 Operational aspects of risk mitigation

During periods of high inflation, reducing the policy term to be able to implement premium increases quickly is important. Some lines of business have partially inflation sensitive exposure bases that somewhat mitigate the impact of inflation on premium adequacy. However, monitoring these exposure bases by auditing payroll or sales for commercial policies and adjusting replacement costs for homeowners policies becomes a more critical aspect of operations under a high inflation environment. Also, if unemployment persists at high levels even during a high inflation regime it is possible that some exposures bases will not reflect overall inflation. Companies need to be prepared to devote the resources needed to critical areas when inflation increases. It would be foolish, and possibly fatal, for a company to adhere to a pre-established staffing budget that prevents a company from maintaining adequate rates.

Analysis of the Mexican inflation led the recommendation to establish a maximum level of coverage based on the original face value of a policy and a maximum inflation adjustment. Also, variable deductibles were recommended to keep the policyholder's share of a loss proportional to the total value, rather than a fixed level (Asociación Mexicana de Actuarios, 2011).

In the 1970s, reinsurers writing excess policies indexed retentions to the CPI in order to limit the effect of inflation on their costs. Inflation was pushing claims that were initially below the retention over the level as well as increasing claims already hitting retention levels, so reinsurers were experiencing a much higher level of claim cost inflation than primary insurers were. Indexing retentions was one way to mitigate this effect. Insurers should be prepared to incorporate similar steps to reduce the effect of inflation on their claim costs by indexing coverage levels and deductibles when inflation begins to increase.

Deflation creates its own set of risks for insurers, as deflation is a common sign of deteriorating economic conditions. An increase in the unemployment rate that tends to accompany deflation can lead to more policy lapses. The creditworthiness of all counterparties is a more serious concern. For policyholders, unpaid balances on existing policies, either from installment payments or premium adjustments, may become harder to collect. Agents' balances are more likely to become uncollectible. Reinsurance recoveries may not be paid. In addition, bonds and other debt instruments will have higher default rates. Contract terms need careful consideration during deflation. Whereas longer terms will slow the premium level decline, they may be harder to sell or to collect the premiums in difficult economic times. Shorter policy terms may prove necessary during deflation regimes. Rate adjustments, even though leading to lower rates, may be needed for competitive reasons to retain business that will be drawn away if rate reductions are not matched.

4.3 Investments to mitigate risk

While inflation-indexed products are not a great majority of a life insurer's product portfolio, as baby boomers retire and begin to worry about the erosion of purchasing power during retirement, the demand for inflation-indexed products may increase. Life insurers may be able to hedge some of this exposure through the purchase of inflation-indexed bonds or over-the-counter derivatives such as inflation swaps or caps and floors (or interest rate caps/floors). As long as the index of the insurer's liability corresponds with the index in the acquired asset the basis risk may be negligible. But if increased demand of inflation-indexed products leads to more life insurers scrambling to hedge their risks, the limited availability of inflation linked securities in the market could make direct hedges more expensive and if these costs are passed on to policyholders, demand for cash value life products. The use of imperfect hedges, including equities or real assets such as real estate and commodities, increases basis risk.

Long term fixed income bonds, the type most commonly held by insurers, decline significantly in value when interest rates increase. Given the recognized relationship between inflation rates and interest rates, a spike in inflation is likely to be accompanied by an equally sharp increase in interest rates (see the discussion in Section 3 for references to studies). Even though insurers can avoid recognizing the loss in market value of these bonds under statutory accounting rules, the drag on income of the lower interest rates earned on these investments and the inability to sell these assets without recognizing the loss creates financial problems. In a high inflation environment, stocks have also performed poorly (Table 2). Short term bonds, however, allow insurers to reinvest the proceeds more quickly, reducing the impact of an interest rate increase on asset values and earnings. Thus, one risk mitigation strategy is to invest in short term bonds. Based on data from 1951-1981, the inflation immunized investment portfolio involved shifting 43 percent of investable assets to Treasury bills, with the remaining 57 percent invested based on historical asset allocations (D'Arcy, 1982). On average this will reduce investment earnings, as short term bonds normally have lower interest rates than longer term bonds. However, this allocation reduces the impact of inflation on earnings.

An alternative investment strategy would be to invest in commodities which are considered to be effective inflation hedges. For example, Northwestern Mutual invested $400 million in gold bullion in May 2009. Even though inflation has not increased significantly since then, concerns over inflation and economic stability both domestic and international pushed the price of gold up almost 60 percent in the two subsequent years. For property-liability insurers, investing in timber, steel and other components of replacement costs on claims could be an effective inflation hedge.

Section 5 - A Model of Inflation

This section describes a publicly accessible model that simulates inflation over the next 50 years. See Ahlgrim and D'Arcy (2011) for a complete discussion on its use. A Users Manual describing inputs, outputs and other key components of the model accompanies this paper.

5.1 A regime switching model

There are many possible formulations of an inflation model. Actuaries are familiar with a simple first-order autoregressive (AR(1)) model of inflation as a starting point for incorporating uncertainty in future prices. For example, Wilkie (1986) uses an AR(1) model when he puts inflation as the engine for his stochastic investment model. Actuaries often use discrete time simulations when performing cash flow testing or dynamic financial analysis (DFA) and the discrete time equivalent of an autoregressive time series model is:

$$q_{t+1} = [(1-k)q_t + k\theta] + \sigma\varepsilon_t \quad (1)$$

The first term (in square brackets) in equation (1) determines the expected future inflation as an average of two values: the current level of inflation (q_t) and the mean reversion level θ. The parameter k determines the relative weight attached to current environment and a long-term average. If mean reversion speed is high (k is near 1.0), then recent history is not weighted heavily and inflation quickly reverts to θ. The second term in (1) adds random shocks through a draw of a normalized distribution (ε_t), which is scaled by a constant volatility parameter σ which adjusts the amount of uncertainty in the inflation process.

When selecting parameters for this process, users might choose values that yield a model that mimics historical inflation. In fact, history is often used as a metric of model performance. But often when applying a model to the data, there exist subperiods that occur during structural transitions in the economy or during financial crises and the historical fit of models that attempt to mimic historical movements of financial variables may be lacking.

Consider term structure models which aim to mimic interest rate movements. When measuring the relative performance of several models (such as in Chan, Karolyi, Longstaff, and Sanders (1992)), most popular models fail to capture the interest rate dynamics exhibited during the early 1980s. But the higher levels of interest rates and the increase in volatility of this period may be caused by a shift in the policies of the Federal Reserve to target money growth. In situations where there are distinct episodes where the behavior of time series appears markedly different, modelers may consider a change in regime. Hamilton (1989) provides a general discussion of regime switching and Ang and Bekaert (2002) describe an application to term structure models.

As another example of regime switching models, Hardy (2001) discusses a regime switching model for stock returns as a way to capture the fatter tails exhibited in historical returns. In normal economic times, equity returns may be (approximately) normal with a constant variance, but during times of severe economic uncertainty and recession observed returns from a normal distribution might appear statistically improbable. To handle these outliers, a second regime is introduced which incorporates increased uncertainty. To keep models tractable, regimes are defined somewhat broadly so that the number of changes in a given period remains relatively low. For example, Hardy (2001) uses only two regimes and she finds that extending the stock return model to three regimes yields only a marginal improvement in fit for US data.

The core concept of regimes switching is that at any point in time, economic variables may be modeled by the dynamics within that regime. However, changes in the economy may build such

that the assumed process for financial variables is no longer appropriate. In these cases, the economy is said to switch regimes. In an alternate regime, the dynamics of financial models differ from those assumed under a normal economic environment.

In the inflation model, at any point in time, the rate of inflation is an autoregressive process as in (1). But the dynamics of the inflation process (the parameters) are dictated by the prevailing regime. Changes in regime are based on transition (or switching) probabilities. Selecting transition probabilities is an important but difficult task given the inability to pinpoint specific regimes from the past. It is important to note that we cannot directly observe changes in regimes but instead must imply changes in regimes based on consistency with historical data. For example, even when the level of inflation is observed to be "low" relative to historical standards, this does not mean that the economy has entered the deflationary regime period. An alternative explanation is that the normal regime has just experienced an outlier. Single outliers are temporary, but regimes tend to persist for longer periods.

5.2 Model extensions

There are a significant number of studies that extend the autoregressive model of inflation by incorporating the term structure spread, stock returns, exchange rates, and other variables (for a summary of this research see Stock and Watson (2003) and Wright (2009)).

Models that predict inflation are typically of three types: models based on real activity in the economy, projections based off financial market data, or time series models such as the one described in the previous section. Using the time series model as a starting point, users may wish to extend the model and incorporate aspects of the real economy or financial variables.

Since demand-pull inflation requires demand to exceed supply, it is useful to model a variable that is closely related to the amount of slack in an economy, also known as the output gap. One example of using the output gap as part of an inflation forecast is the Phillips curve indicating the relationship between inflation and unemployment. However, other variables, including housing starts or capacity utilization, have been used in lieu of unemployment to help improve the forecasting ability in the Phillips curve (see Stock and Watson (1999)).

Another approach to extending the model is to use publicly available variables constructed from financial market data such as yield curve information. Fama (1975) finds that movements in short-term nominal interest rates appear to predict subsequent short-term inflation levels. Others have used the yield spread as based on the difference between yields of long-term government bonds over short-term bills. The economic rationale for using the slope of the yield curve as a predictor for future inflation is presented in Kozicki (1997). While she argues that short-term rates tend to be tethered to monetary policy, Estrella and Mishkin (1997) contend that long-term rates are more reflective of expectations of monetary policy over the long-term and that this effect is magnified if there is increased credibility in the central bank. Kozicki (1997) finds some weak evidence for predicting inflation using the yield curve spread, but also finds that the level of the yield curve provides significantly more explanatory power than the spread, which

appears to reject Estrella and Mishkin's (1997) use of the spread in assessing the effects of monetary policy on future inflation.

There is evidence that suggest that predicting inflation using information from asset prices, such as using term structure models, is inferior to forecasts based on relationships to real activity such as the Phillips curve (see Stock and Watson (1999) and Ang, Bekaert, and Wei (2007)). Ang, Bekaert, and Wei (2007) go further and compare inflation forecasts using a variety of methods including surveys, term structure models, time series models, or by forecasting from projections of real activity. They find that survey data outperforms other forecasts.

Section 6 - Conclusions

Deflation and high inflation each present significant risks to insurers. Although inflation rates have been moderate for several decades, the possibility of a regime switch to deflation or high inflation needs to be considered given the current unsettled financial conditions. These risks can be managed by insurers, but inflation risk management requires advance planning. Few insurers seem to be currently prepared for a drastic change in economic conditions.

The regime switching inflation model described in this paper provides a tool that can be used to generate inflation forecasts that vary more widely than those produced by most other economic scenario generators (ESG). The parameters in this model can be easily adjusted to reflect a variety of views of future inflation possibilities. This model was not developed to be completely consistent with other ESGs, but to encourage practitioners to examine inflation risk more closely and to develop approaches that will help insurers cope with deflation or high inflation risk.

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Appendix A - Net Written Premiums 1927-1940					
Insurance Company Groups					
(000 omitted)					
Year	Net Written Premiums				
1927	851590				
1928	884046				
1929	912945				
1930	822466				
1931	726717				
1932	614350				
1933	546660				
1934	595439				
1935	607939				
1936	644036				
1937	704431				
1938	662880				
1939	727575				
1940	842696				
Source	Best's Aggregates and Averages, 1941, p. 5				
	Fire Company Members Only				

EXHIBIT B
PEARSON CORRELATION COEFFICIENT MATRIX
Data Source: Stocks, Bonds, Bills, and Inflation

ONE YEAR HORIZON

	Stock	*LT Bond*	*Tbill*	*Inflation*
Stock	1.000			
LT Bond	0.028	1.000		
Tbill	-0.012	0.225	1.000	
Inflation	-0.002	-0.148	0.405	1.000

TWO YEAR HORIZON[a]

	Stock	*LT Bond*	*Tbill*	*Inflation*
Stock	1.000			
LT Bond	0.111	1.000		
Tbill	0.079	0.293	1.000	
Inflation	0.153	-0.104	0.431	1.000

THREE YEAR HORIZON[a]

	Stock	*LT Bond*	*Tbill*	*Inflation*
Stock	1.000			
LT Bond	0.117	1.000		
Tbill	0.111	0.359	1.000	
Inflation	0.228	-0.045	0.449	1.000

FOUR YEAR HORIZON[a]

	Stock	*LT Bond*	*Tbill*	*Inflation*
Stock	1.000			
LT Bond	0.124	1.000		
Tbill	0.137	0.414	1.000	
Inflation	0.284	0.016	0.470	1.000

FIVE YEAR HORIZON[a]

	Stock	*LT Bond*	*Tbill*	*Inflation*
Stock	1.000			
LT Bond	0.140	1.000		
Tbill	0.159	0.456	1.000	
Inflation	0.301	0.049	0.487	1.000

a. NOTE: Multi-period correlations use overlapping data.