Insurance: Mathematics and Economics 66 (2016) 86–96

Contents lists available at ScienceDirect

Insurance: Mathematics and Economics

journal homepage: www.elsevier.com/locate/ime

Assessing inflation risk in non-life insurance

Alexander Bohnert *, Nadine Gatzert, Andreas Kolb

Friedrich-Alexander University Erlangen-Nürnberg (FAU), Department of Insurance Economics and Risk Management, Lange Gasse 20, 90403 Nuremberg, Germany

ARTICLE INFO

Article history:
Received February 2015
Received in revised form
October 2015
Accepted 1 November 2015
Available online 17 November 2015

JEL classification:
C53
E31
G22
G32

Keywords:
Separation method
Claims inflation
Regression analysis
Simulation
Vasicek

ABSTRACT

Inflation risk is of high relevance in non-life insurers' long-tail business and can have a major impact on claims reserving. In this paper, we empirically study claims inflation with focus on automobile liability insurance based on a data set provided by a large German non-life insurance company. The aim is to obtain empirical insight regarding the drivers of claims inflation risk and its impact on reserving. Toward this end, we use stepwise multiple regression analysis to identify relevant drivers based on economic indices related to health costs and consumer prices, amongst others. We further study the impact of (implicitly and explicitly) predicting calendar year inflation effects on claims reserves using stochastic inflation models. Our results show that drivers for claims inflation can considerably vary for different lines of business and emphasize the importance of explicitly dealing with (stochastic) claims inflation when calculating reserves.

1. Introduction

For non-life insurers, inflation associated with long-term liabilities represents one major risk source and can considerably impact the adequate estimation of technical provisions, thus directly influencing future earnings (see, e.g., Wüthrich, 2010; Ahlgrim and D'Arcy, 2012a; D'Arcy et al., 2009). Furthermore, in the context of new risk-based capital requirements for insurers as imposed by Solvency II, all material risks have to be considered in the calculation of solvency capital requirements and the Own Risk and Solvency Assessment (ORSA), implying that inflation risk should at least be taken into consideration within an internal model of an insurance company. The aim of this paper is to empirically study claims inflation in non-life insurance based on automobile liability insurance, fully comprehensive car insurance, and third party liability insurance data provided by a large non-life insurance company in Germany. Toward this end, we first focus on claims inflation by determining the main driving factors for inflation risk based on economic indices for different lines of business of the considered non-life insurer. Second, we model claims inflation based on the calendar year effects and assess its impact on claims reserving for the case of automobile liability insurance, which is of special relevance in the presence of superimposed inflation.

In general, inflation is measured as the percentage change in the overall level of prices measured by a price index such as the consumer price index (CPI). However, insurers are likely to be exposed to specific components of the CPI such as medical inflation rather than the overall level of price changes (see, e.g., Cummins and Derrig, 1993; Ahlgrim and D'Arcy, 2012a). In this context, Masterson (1968), for instance, measures the impact of inflation on insurers by isolating components of the CPI that are related to specific lines of business. Morrow and Conrad (2010) identify economic indicators, which best measure the inflation inherent in claims costs. In addition, Ahlgrim and D'Arcy (2012a) investigate the effects of inflation or deflation on the insurance industry in general, thereby indicating that property liability insurers are impacted by inflation in several ways, e.g. by means of costs of future claims on current policies and calculation of loss reserves. Regarding loss reserves, D'Arcy and Au (2008) and D'Arcy et al. (2009) point out that loss reserves are commonly calculated based on the assumption that the inflation rate experienced in the recent past will continue until these claims are closed, which, however, can take decades. Thus, if inflation increases, costs will be more than expected, which in particular affects long-term liabilities. In this context, Verbeek (1972)

* Corresponding author.
E-mail addresses: alexander.bohnert@fau.de (A. Bohnert), nadine.gatzert@fau.de (N. Gatzert), andreas.kolb@fau.de (A. Kolb).

http://dx.doi.org/10.1016/j.insmatheco.2015.11.003
0167-6687/

and Taylor (1977) separate the impact of inflation from the run-off triangle, which allows incorporating a different inflation rate in the calculation of reserves. Moreover, inflation also affects asset returns (see, e.g., Fama and Schwert, 1977) and thus the asset side of an insurer. While this may offset or magnify reserving risks in the presence of inflation, in this paper we specifically focus on the liability side of the insurance company.

In this context, claims inflation can be defined as the general inflation plus all other relevant influencing factors, whereby these other factors are also referred to as "superimposed inflation". The average motor insurance claim, for instance, is not only affected by general inflation, but also by the wages of the people repairing vehicles, medical costs for those injured in vehicle accidents, and litigation costs (see Swiss Re, 2010). Moreover, as pointed out by Swiss Re (2010), for instance, the term "inflation" may be misleading as it refers to quality-adjusted price increases, which is why they suggest the term "change in claims severity" as an alternative, which refers to changes in the average value per claim. However, to be consistent with the academic literature, in what follows we use the term "claims inflation".

With respect to non-life insurance claim costs, Cummins and Powell (1980) compare two different approaches to forecast claim costs for automobile insurance. They show that econometric models (univariate and multivariate models), which take into account economic indices (e.g. price and wage indices) to forecast insurance claim costs, are more accurate than exponential trend models. They also point out that inflation plays an important role in this context. Cummins and Griepentrog (1985) further compare econometric models with ARIMA models, which do not require forecasts for the underlying economic indices, and find that econometric models do better in forecasting automobile insurance claim costs. In addition, Cummins and Derrig (1993) first review different approaches in the previous literature on forecasting insurance claim costs and then use fuzzy set theory in order to combine forecasts from alternative models in order to derive a good (improved) forecast of insurance claim costs.

In the academic literature on the modeling of calendar year effects (diagonal effects) and claims inflation, Clark (2006) and D'Arcy et al. (2009) model claims inflation using a mean-reverting time series model, while Barnett and Zehnwirth (2000) study calendar year effects within a probabilistic trend family, de Jong (2006) uses a calendar-correlation-model, and de Jong (2012) develops and implements a model for dependences between loss triangles using Gaussian copulas. In addition, Wüthrich (2010) studies a Bayesian chain ladder model that allows for calendar year effects and, using a gamma–gamma model, shows that calendar year effects substantially impact the uncertainty of prediction of the claims reserves. Moreover, Shi et al., 2012, Salzmann and Wüthrich (2012), and Merz et al. (2013), also study calendar year effects in a Bayesian inference approach using Markov chain Monte Carlo simulation methods, while Saluz and Gisler (2014) analyze the difference between the best estimate predictions of the ultimate claim in two successive calendar years. In addition, Jessen and Rietdorf (2011) present two different approaches in order to include diagonal effects in claims reserving, and Björkwall et al. (2010) introduce a bootstrapping procedure for the separation method in claims reserving. Thus, while these papers analyze claims reserving, they do not specifically focus on the (stochastic) modeling of claims inflation in claims reserving or the identification of driving factors of claims inflation.

In this paper, we analyze claims inflation in non-life insurance on the basis of empirical data for automobile liability insurance, fully comprehensive car insurance, and third party liability insurance provided by a large German non-life insurance company. We thereby contribute to the literature in two main ways. First, we identify the main driving factors for claims inflation with focus on automobile liability insurance based on a real and representative data set for the non-life insurance market in Germany and thus provide unique empirical insights into the market. More specifically, we first empirically extract calendar year effects by means of the separation method, and then determine main driving factors (economic indices) that influence the observed inflation risk in automobile liability insurance, fully comprehensive car insurance, and third party liability insurance by using stepwise multiple linear regressions. This allows central insights in regard to main drivers of the respective claims inflation as, e.g., the progress in medical technology may considerably exceed the standard inflation as reflected by the consumer price index. Thus, an increase in prices for certain therapies may influence the costs for bodily injuries in, e.g., accident insurance, but may not affect the costs for other lines of business such as fully comprehensive car insurance. We show that inflation risk strongly depends on the line of business and that its major influencing factors may differ considerably.

Second, we introduce and present a modeling approach that comprises several steps of dealing with claims inflation in non-life insurance in regard to controlling and arriving at a final claims reserve. This approach is applied to the comprehensive data set of a large German non-life insurer consisting of the run-off triangle for the claims payments of the business line automobile liability insurance. Hence, we further contribute to the literature by studying the impact of the empirically observed superimposed inflation (addressed in the first step) on claims reserving for the considered business line. Toward this end, we use the bootstrapping procedure of the separation method presented in Björkwall et al. (2010), where the incremental claims are assumed to be gamma distributed, to obtain the predictive distribution of the claims reserves, while we account for an extrapolation of future claims inflation based on key economic indices. In addition, to explicitly account for calendar year effects, we model and calibrate claims inflation using a multiple linear regression model and the Vasicek (1977) model and thus extend the model by Björkwall et al. (2010). Our findings indicate that inflation risk can be substantial, thus being of high relevance in regard to the calculation of claims reserves.

The remainder of the paper is structured as follows. Section 2 illustrates the empirical extraction and analysis of the claims inflation using the separation method. Section 3 presents the modeling and calibration of the insurer's claims inflation using multiple linear regression and the Vasicek (1977) model, whereas the modeling of the claims reserves is presented in Section 4. The empirical analysis of claims inflation risk in the case of the automobile liability insurance of the German non-life insurer is presented in Section 5, and Section 6 concludes.

2. Empirical derivation and analysis of claims inflation

2.1. Empirical derivation of the claims inflation

To empirically derive the historical claims inflation[1] from the available claims data by the non-life insurer, we apply the separation method, which was first introduced by Verbeek (1972), who applied the model in the reinsurance context to the projection of the number of reported claims. Taylor (1977) further generalized this method in order to apply it to claim amounts rather than claim numbers.

Let $i \in \{0, \ldots, n\}$ denote the rows corresponding to the accident year in the triangle, and $k \in \{0, \ldots, n\}$ denote the columns

[1] Here, claims inflation is defined as the sum of the general inflation and the superimposed inflation (see Swiss Re, 2010).