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Early default risk and surrender risk: Impacts on participating life insurance policies☆

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ABSTRACT

We study the risk-neutral valuation of participating life insurance policies with surrender guarantees when an early default mechanism, forcing an insurance company to be liquidated once a solvency threshold is reached, is imposed by a regulator. The early default regulation affects the policies' value not only directly via changing the policies' payment stream but also indirectly via influencing policyholder's surrender. In this paper, we endogenize surrender risk by assuming a representative policyholder's surrender intensity bounded from below and from above and uncover the impact of the regulation on the policyholder's surrender decision making. A partial differential equation is derived to characterize the price of a participating policy and solved with the finite difference method. We discuss the impacts of the early default regulation and insurance company's reaction to the regulation in terms of its investment strategy on the policyholder's surrender as well as on the contract value, which depend on the policyholder's rationality level.

1. Introduction

A typical participating life insurance policy provides policyholders with a minimum interest rate guarantee and bonus payments upon death and upon survival which are linked to the performance of the insurance company. Usually, additional options are embedded in the policies to increase their attractiveness to the policyholders, among which the most popular one is a surrender option. A surrender option entitles the policyholders to terminate their contract prematurely and to obtain the surrender benefits promised by the insurance company.

The policyholders may not necessarily receive the payments specified in their contract even if they hold it until maturity. If the insurance company does not have enough reserves to pay back its liabilities at the maturity date, the policyholders cannot get more than what remains in the company. To protect the policyholders from collecting too few benefits as the insurance company declares bankruptcy at maturity, regulatory authorities impose early default mechanisms to monitor insurance companies' financial status and close them before it is too late. For example, under Solvency II, the supervisory authority withdraws the authorization of an insurance company when its capital falls below the minimum capital requirement and does not recover within a short period of time, see Solvency II Directive (2009/138/EC). Also, an insurance company supervised by the Swiss Financial Market Supervisory Authority (FINMA) can lose its license when its risk-based capital drops below the lowest threshold specified in the Swiss Solvency Test (SST), see FINMA Circ. 08/44 SST, FINMA (2008). Proceeds from liquidated assets are then paid to stakeholders. Hence, the policyholders also face early default risk of the insurance company accompanied with the early default regulatory intervention.

Both surrender and early default intervention definitely have direct impacts on the fair valuation of participating life insurance

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policies since they change the policies' payment stream. In the existing literature, most studies focus on only one of these two aspects. For example, Andreatta and Corradin (2003), Bacinello (2003), Bauer et al. (2006), Grosen and Jørgensen (2000), and Zaglauer and Bauer (2008) study the fair value of participating life insurance policies with an embedded surrender option but have not considered early default risk triggered by the bad performance of the insurance company, while Bernard et al. (2005), Chen and Suchanecki (2007), Grosen and Jørgensen (2002), and Jørgensen (2001) take into account regulatory intervention in valuing participating policies, but leave out surrender risk. The only work, as far as we are aware, that treats early default risk and surrender risk at the same time is Le Courtois and Nakagawa (2013). In their paper, surrender risk is modeled through a Cox process with an intensity that is correlated to the financial market but is independent of the company's liquidation threshold. However, since the early termination of the insurance company imposed by the regulator reforms the contracts' payment structure for the policyholders, which we consider as the direct impact on the contracts' value, as a response the policyholders may change their surrender behavior. Such an influence of enforced early bankruptcy on policyholders' surrender behavior can be considered as a "by-product" of the regulatory intervention, which in turn affects the contracts' payment stream and correspondingly, the contracts' value. Hence, modeling policyholders' surrender being independent of the regulator's early default intervention is oversimplistic.

The present paper incorporates this by-product effect of the regulatory intervention on policyholders' surrender behavior into analyzing the impact of the early default risk on the fair value of participating life insurance policies. We specify a model which endogenizes policyholders' surrender to value participating policies from the perspective of the insurance company which is monitored by an external regulator. Most literature assumes that policyholders are fully rational, which means that they can terminate their contract at the optimal time so that the surrender option is priced as a pure American-style option, see e.g., Andreatta and Corradin (2003), Bacinello (2005, 2003), and Grosen and Jørgensen (2000, 1997). However, since there is not an active market to monitor the contract values, and if policyholders are not capable of valuing their contract correctly, the surrender option is hardly exercised at the right time. Also due to the lack of an active policy trading market, policyholders, when in urgent liquidity needs, have to surrender their contract at the insurance company and collect the surrender guarantees, which are usually lower than the fair contract value. Empirical evidence which confirms the so called emergency fund hypothesis is found e.g. in Kiesenbauer (2011) and Kuo et al. (2003). Given the limitations, it is more reasonable to consider policyholders as partially rational from a purely financial point of view, which also corresponds to the spirit of Solvency II: While valuing options written in the contracts, realistic assumptions concerning the likelihood that policyholders exercise the options should be used, see Solvency II Directive (2009/138/EC), European Parliament (2015). The approach of modeling policyholders' partial rationality in Li and Szimayer (2014) is adopted in our model. Policyholders' surrender is considered as a randomized event and arrival of the event is assumed to follow a Poisson process with an intensity bounded from below and from above. The lower and upper bounds refer to the minimum surrender rate due to exogenous reasons and the maximum surrender rate due to limited financial rationality, respectively.

Following a safe-side equivalence principle in the actuarial practice, participating life insurance policies are priced at the maximum market-consistent value in our paper, which is derived by choosing surrender intensities within the two bounds in the safe-side scenarios.[1] In contrast to the first-order premium calculation based on deterministic safe-side scenarios, see Christiansen and Steffensen (2013), the safe-side scenarios adopted for pricing in our model are determined throughout the contract term dynamically, taking into account the by-protect effect of the regulator's solvency intervention on policyholders' surrender. In addition to incorporating real surrender practice into valuing contracts as required by Solvency II and treating the surrender risk differently for different policyholders in determining solvency capital as emphasized by CEIOPS,[2] we are able to distinguish the effects of regulator's early default intervention on different policyholders' surrender and their contracts' fair value by assuming different surrender intensity bounds. Moreover, when the regulatory rule changes, the insurance company may react to it by adopting a different investment strategy, which again affects the contracts' value directly and indirectly through its influence on policyholders' surrender behavior. Hence, in the present paper, we also study how the insurance company chooses its investment strategy in face of different regulatory rules, and the impacts of the insurance company's investment strategy on policyholders' surrender and their contract value.

Table 1
Insurance company's balance sheet at t_0.

Assets	Liabilities & Equity
A_0	$L_0 \equiv \alpha A_0$ $E_0 \equiv (1-\alpha)A_0$

The remainder of the paper is organized as follows: In Section 2 we model the insurance company and introduce the payoff structure of a participating life insurance policy. The early default regulatory framework is specified as well. Besides, both the financial market and the insurance market are modeled with respect to the stochastic processes of the underlying asset, the mortality risk intensity and the surrender risk intensity. In Section 3 we derive the partial differential equation for the price of the participating policy. In Section 4 we analyze the effects of the regulatory framework and the investment strategy on the policyholder's surrender and contract value. Section 5 concludes.

2. Model framework

2.1. Company overview

Inspired by the model framework in Briys and de Varenne (1994), we consider a life insurance company which acquires an asset portfolio with initial value A_0 at time $t_0 = 0$ financed by two agents, i.e., a policyholder and an equity holder. The policyholder pays a premium to acquire the initial liability $L_0 = \alpha A_0$ with $\alpha \in (0, 1)$. The rest is levied from the equity holder who acquires $E_0 \equiv (1-\alpha)A_0$ with limited liability. The insurance company's balance sheet at time t_0 is shown in Table 1. The parameter α is called the wealth distribution coefficient in Grosen and Jørgensen (2002).

It is assumed that the insurance company operates in an arbitrage-free and complete financial market over a time interval $[0, T]$, where the time T corresponds to the maturity date of the insurance contract. As the insurance contract matures at T, the insurance company closes and its assets are liquidated and distributed to the stakeholders.[3]

[1] The same scenarios, however, are named as worst-case scenarios in Li and Szimayer (2014), which are conceptually equivalent from a mathematical point of view.

[2] CEIOPS refers to the Committee of European Insurance and Occupational Pensions Supervisors, which was replaced by the European Insurance and Occupational Pensions Authority (EIOPA) since 2011. CEIOPS has pointed out that policyholders' surrender behavior poses a significant risk to insurance companies and the surrender risk should be treated differently for different policyholders. For example, if the policyholders are institutional investors, since they tend to be better informed and react more quickly, the surrender risk can be substantially higher, see CEIOPS (2009).

[3] For simplicity, we assume that the company closes when the contract ends. It is not a strict assumption because it can be considered that assets raised from the