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Decision Support

# Cure events in default prediction ☆

Marcus Wolter [a,*], Daniel Rösch [b]

[a] Leibniz Universität Hannover, Institute of Banking and Finance, Königsworther Platz 1, D-30167 Hannover, Germany
[b] Department of Statistics and Risk Management, Faculty of Economics, University of Regensburg, D-93040 Regensburg, Germany

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ABSTRACT

This paper evaluates the resurrection event regarding defaulted firms and incorporates observable cure events in the default prediction of SME. Due to the additional cure-related observable data, a completely new information set is applied to predict individual default and cure events. This is a new approach in credit risk that, to our knowledge, has not been followed yet. Different firm-specific and macroeconomic default and cure-event-influencing risk drivers are identified. The significant variables allow a firm-specific default risk evaluation combined with an individual risk reducing cure probability. The identification and incorporation of cure-relevant factors in the default risk framework enable lenders to support the complete resurrection of a firm in the case of its default and hence reduce the default risk itself. The estimations are developed with a database that contains 5930 mostly small and medium-sized German firms and a total of more than 23000 financial statements over a time horizon from January 2002 to December 2007. Due to the significant influence on the default risk probability as well as the bank's possible profit prospects concerning a cured firm, it seems essential for risk management to incorporate the additional cure information into credit risk evaluation.



## 1. Introduction

### 1.1. Motivation

In credit risk evaluation the influence of cure events is gaining more and more attention. Recent literature stated that survival models, which incorporate cure events, are used to improve the prediction of default events. In these models a fraction of cured or immune borrowers is identified in order to deal with heavy censoring due to rare default events. With this approach, one cannot only predict when a borrower defaults but also if he defaults at all. This is a big benefit to the existing ordinary survival analysis. These methods were, for example, used by Mo and Yau (2010) and Tong, Mues, and Thomas (2012) to predict defaults among personal loan portfolios. Cure models are also used to predict the default of corporate bonds or the bankruptcy of the firms itself, see (Topaloglu & Yildirim, 2009; Yildirim, 2008). One significant element in these models is that the cure events are unobserved and thus depend on different definitions of long-term survivorship. Differing definitions of cure events might reduce the comparability of these models and the findings most likely depend on the number of cure events created on the basis of these definitions.

An alternative way to evaluate the cure event occurrence is the use of observable cure events. Those events are observed among credit defaults when a default is triggered which does not generate a loss for a lender due to a successful resurrection. The use of observable cure events in the default prediction is a new approach in credit risk that, to our knowledge, has not been followed yet.

Usually observable cure events are treated indirectly as a 100% recovery, see (Calabrese & Zenga, 2010). Nevertheless, there are several reasons to evaluate observable cure events separately and introduce them in the default prediction rather than in the recovery estimation: an observable cure event has a significant impact on the defaulted firms in a credit portfolio because cured firms are no longer defaulted and are treated as "living" firms. Hence, the influence of this cure event is essential within the evaluation of default risk and is consequently an event that, if identified, should rather be explicitly incorporated in the default prediction than only indirectly measured by the estimation of the recovery rate. Default prediction models that incorporate the cure event are not only capable of predicting when a borrower defaults, but also if he defaults. If a fraction of defaultable firms in a bank's credit portfolio can be linked with a high cure probability this should reduce the equity costs of the expected portfolio loss.

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* Corresponding author. Tel.: +49 (0)177/854 44 97; fax: +49 (0)511/762 46 70.
*E-mail addresses:* m.a.wolter@gmx.de (M. Wolter), Daniel.Roesch@wiwi.uni-regensburg.de (D. Rösch).

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If one could identify the risk drivers concerning the default and the resurrection of a firm, it could be possible to identify the probability of a firm being cured. If we know a firm's cure probability as well as its default probability it is possible to estimate the probability of the firm of being "immune" for a certain time period. With this additional information, it might be possible to make more accurate loss predictions. Important information concerning the default and cure events could be recognized by these models, which might lead to lower costs or reveal, so far unseen, risk potentials.

To reach the event of being cured, a firm has to face the event of default first. The resurrection of a firm is an observable and loss-influencing but nevertheless mostly unevaluated event. Data concerning cure events is rare and predominantly only known to banks. Nevertheless, a cure event might contain a lot of borrower-specific and risk-specific information and a separate evaluation of a firm's resurrection through a cure probability model might cover this information. Our study can make use of bank-internal information regarding 1243 default events and 333 cure events among the defaulted firms.

### 1.2. Literature review

Earlier credit-risk-related scientific literature was written in the mid-1960s and focused on the default risk of single borrowers. Basic work was done by Beaver (1966, 1968a, 1968b). At the end of the 1960s (Altman, 1968) defined a scoring model evaluating credit risk on the basis of financial data: the Z-Score. A later generation of scoring models is the O-Score, evaluated by Ohlson (1980) based on logistic regression. An overview of the credit risk modeling on single loan basis can be found in Altman and Saunders (1997).

In the following years scientific work turned its focus from the single loan to the evaluation of credit risk regarding loan portfolios. Two main approaches in the credit risk literature are used as the basis for the evaluation of credit portfolio models: the structural model approach and the intensity model approach.

The pioneers of the structural models were (Black & Scholes, 1973; Merton, 1974, 1977). In their option-pricing approach, a firm's assets follow a geometric Brownian motion and the default probability is only driven by the firm's distance-to-default. The portfolio model used in Basel II as well as the Portfolio Manager™ model from Moodys and the Credit Metrics™ from JP Morgan Chase are examples of the use of the structural model approach. The intensity or reduced form models are based on the individual default intensity process of a borrower. Conditional on the realization of the intensity the number of defaults up to time $t$ are independent Poisson-distributed events. Basic work is done by Jarrow and Turnbull (1995), Jarrow, Lando, and Turnbull (1997), Lando (1998) and Hillegeist, Keating, Cram, and Lundstedt (2004). The portfolio model Credit Risk+™ from Credit Suisse Financial Products uses this approach. Hybrid models that use a combination of both approaches can be found in Duffie and Lando (2001) and Madan and Unal (2000). On overview concerning the intensity model approach can be found in Jarrow and Turnbull (2000) and Bluhm, Overbeck, and Wagner (2003).[1]

Regarding bank loan portfolios it is also appropriate to distinguish between bank-internal portfolio risk assessment and external risk evaluation through rating agencies, see (Lützenkirchen, Rösch, & Scheule, 2014). Bank-internal consumer loan specific risk evaluation is done, for example, by Crook, Edelman, and Thomas (2007) with a credit risk model based on logistic regression, by Bellotti and Crook (2008) with a survival analysis model or by Malik and Thomas (2009) trough a cox proportional hazard model. Chan and Kroese (2010) evaluates credit portfolios consisting of bonds and other financial assets and focuses on large portfolio losses. Regarding external risk evaluation through rating agencies see, for example, Altman and Rijken (2004), who evaluate the behavior of rating agencies regarding credit risk measuring or (Jobst & Zenios, 2005). They evaluate models based on the structural model as well as models based on the reduced form model regarding the influence of credit spreads and interest rates concerning large credit portfolios.

A quite new development in literature is the multi-period prediction with credit risk models, see (Duffie, Eckner, Horel, & Saita, 2009; Duffie, Saita, & Wang, 2007).

Besides the multi-period prediction the recent credit risk literature pays more and more attention to the cure event in default prediction. Due to the fact that a default event is a rare event, the applied survival analysis for default evaluation faces a high amount of censored observations which can distort the findings. The problem of heavy censoring among the observed subjects is well known in medicine and is routinely solved by the use of mixture cure models, where the patients are considered cured if they are immune concerning the evaluated disease, see (Farewell, 1982; Hughes, 1999; Kuk & Chen, 1992). Mixture cure models are widely used among clinical trials and separate the data generally into a cure fraction and a fraction of not-cured subjects, see (Corbière & Joly, 2007; Lai & Yau, 2009; Peng & Dear, 2000; Sy & Taylor, 2000). It is common to model both groups, the immune subjects in the cure fraction as well as the fraction of not-immune subjects, conditional on some covariate vectors in order to explain the two distributions. The covariate vectors can consist of the same covariates, but not necessarily. Some covariates may affect the possibility of being cured but may not have any influence on the timing of the event of interest and vice versa, see (Yu & Peng, 2008; Zhang & Peng, 2009). The use of mixture cure models is a quite new aspect in the credit-default-related literature. However, the cure event takes part in a wide range of credit default risk evaluation models. In several credit scoring models this approach is used in combination with personal loan data recently, see, for example, Beran and Djaidja (2007), Mo and Yau (2010) and Tong et al. (2012). In general default events are rare concerning large listed firms, but regarding the SME segment defaults are observed more often, which relieves the analysis.

Yildirim (2008) used the mixture cure model approach with random effects to model long-term survivorship concerning the default estimation of commercial mortgage backed securities. He considered that a reasonable contingent of the observed securities will never default during the duration and thus distorts the results of the survival analysis without cure fraction. The correlation between the securities is captured through the introduction of three independent random effects concerning region, property type and loan level. Topaloglu and Yildirim (2009) used a mixture cure model in order to predict the default of publicly traded US firms.

### 1.3. Main contributions

The introduction of cure events in credit risk modeling generates a wide range of additional options for superior models. The latest work in the credit literature, e.g., (Tong et al., 2012), used mixture cure models to enhance the performance of survival analysis concerning default risk modeling. This approach uses the unobserved cure event to deal with heavy censoring in the default data. We follow an alternative way to evaluate the cure event with the utilization of observable cure events. The idea that a cure event can be reached after the default is observed can be found in Ambrose and Capone (1996) where different foreclosure alte

[1] Cp. (Bluhm et al., 2003, p. 55–164.).