



A semiparametric model for the systematic factors of portfolio credit risk premia[☆]

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ABSTRACT

The aim of this paper is to investigate the empirical relationship between daily fluctuations in the risk premium for holding a large diversified credit portfolio, which we approximate by a benchmark credit index, and some tradeable market factors which capture systematic risk. The analysis is based on an adaptive nonparametric modelling approach which allows for the data-driven estimation of the nonlinear dynamic relationship between portfolio credit risk premia and their hypothetical components. Our main finding is that the empirical weights of the systematic factors display sudden jumps during market crises and a less intense time-dependent behaviour during normal market conditions. In addition, we find that during market crises the directions of the empirical relationships are often inconsistent with ordinary economic intuition, as they are influenced by the specific circumstances of financial markets distress.

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1. Introduction

Identifying the systematic and idiosyncratic components of the fluctuations in the risk premium of a portfolio of credit-related products is particularly relevant for the construction of hedging strategies and for the effective diversification of risk. Furthermore, investigating the relationship between the overall risk of a credit portfolio and its systematic determinants is also significant for the development of credit risk management and basket credit derivatives pricing models. Indeed, in credit models the dependence structure of a portfolio is often modelled assuming the existence of some common systematic risk factors having a linear influence on the default risk of all the individual counterparties (see, for instance, McNeil et al. (2005) and Schönbucher (2003)).

Although their practical importance, the development of empirical credit risk models has been hindered by the limited availability of credit data. In fact, historical default data are insufficient and inadequate for the purpose of statistical modelling. As an alternative, information on credit risk can be inferred from financial market data, such as corporate bond credit spreads and credit default swap (CDS) spreads. In particular, the credit default swap market represents a more reliable source of credit data, as it is characterized by higher trading volume, liquidity, and informational efficiency than the corporate bond market (Blanco et al., 2005), where prices are often distorted by tax and liquidity issues. Furthermore, the credit default swap market provides forward-looking information, as it reflects investors' expectations on the evolution of default risk over future time periods. Additionally, the

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information on default risk is provided both at the firm-specific level, by means of single-name credit default swaps, and at the portfolio level, through CDS indices. Specifically, a single-name credit default swap is a financial product leading an investor to pay a periodic premium, referred to as CDS spreads, in return for coverage against the loss deriving from the default of a specific reference entity over a pre-determined time horizon; the entity whose default is being insured can be either a financial or non-financial company or a sovereign counterparty, while common default events covered by CDS contracts are bankruptcy, failure to make payments connected to debt obligations, and corporate restructuring. Nevertheless, market liquidity tends to be more concentrated on the recently launched credit indices, such as the ones of the iTraxx and CDX families, which are traded in higher volumes than the individual CDS products. Credit indices are standardized portfolios of single-name credit default swaps; hence, the observed price of a credit index, which is also referred to as spread, can be regarded as representative of investors' view on the aggregate default risk of a pre-specified credit portfolio over a given time period. It follows that from the point of view of empirical modelling, credit indices offer some advantages compared to single-name CDS products: firstly, their market is more liquid, therefore they are likely to be more reactive to the arrival of new information than the individual CDS products; secondly, credit indices provide an aggregate measure of the default risk associated to a portfolio; therefore, the cross correlations between the individual components are already implied in the observed market prices.

As a consequence, for the purpose of the analysis of this paper we approximate fluctuations in portfolio credit risk premia with the daily returns of the iTraxx Europe index, of which we aim to investigate the systematic risk factors. The choice of iTraxx Europe is due to the fact that, being a benchmark credit index including more than 100 credit default swaps on corporate entities operating in different industry sectors, its returns, intended as the first differences of the daily spreads, may be a good approximation of the fluctuations in the default risk of a large diversified portfolio of corporate credit exposures, as the one usually held by main financial institutions. However, while the empirical determinants of transaction prices of single-name credit default swaps were investigated by quite a few studies (see Cossin et al. (2002), Longstaff et al. (2003), Blanco et al. (2005), Ericsson et al. (2004), Norden and Weber (2009) and Das et al. (2008)), the components of daily spread changes of CDS indices were previously analysed only by Bystrom (2008) and Alexander and Kaeck (2008). Bystrom (2008) found a negative relationship between daily spread changes of iTraxx Europe sector indices, current stock returns and lagged stock returns. The same author also found a tendency of credit default swap spreads to widen when stock price volatility increases. Alexander and Kaeck (2008) estimated a Markov-switching model for iTraxx Europe sector indices considering two different regimes corresponding to a higher and a lower level of credit default spreads volatility. They found that interest rates, stock returns and stock volatility have a higher impact on credit default swap spreads in the high-volatility regime.

A common characteristic of earlier empirical studies is that the relationship between movements in CDS spreads and their hypothesized determinants is assumed to be described by a particular functional form, often specified as linear. However, the revealing information on the systematic risk factors is likely to affect the default risk of a credit portfolio, as for instance a credit index, in a nonlinear way, and no prior knowledge on the specific functional form of the relationship is available. As a consequence, in this paper we do not make any assumption on the structure of the relationship between the returns of the credit index and the considered risk factors, which we specify as movement in interest rates, stock index returns and changes in an equity volatility index, but we estimate the regression function nonparametrically. Furthermore, using an adaptive estimation method, we take into account the possibility that the impact of the systematic factors to the overall credit risk of the portfolio may be time-varying, reflecting either a smooth adjustment to the evolution of the credit and economic scenario, or sudden jumps corresponding to extreme and unexpected negative developments in credit markets. Additionally, we allow the volatility of daily credit index fluctuations to be time-varying, reflecting the different degrees of market's uncertainty on the evaluation of default risk.

Estimating the proposed heteroskedastic nonparametric regression model on daily data from November 2004 to January 2008, we find that the European credit market went through several different phases during the considered time period. In particular, the estimation results indicate the presence of prologued tranquil phases interrupted by shorter periods of unusual tensions associated to shocks to the perception of default risk at the systematic level, such as the downgrade of Ford and General Motors in 2005, the slowdown of the US housing market in 2006 and the credit crisis started in 2007. As a consequence, the estimated regression and volatility functions display pronounced time-varying behaviour and sudden discontinuities. In particular, while in normal market conditions the risk factors weights are relatively weak and their signs are coherent with economic intuition and with earlier empirical findings, during periods of market crisis the magnitudes of the estimated relations are significantly modified and their directions are not always consistent with ordinary economic insights, as they reflect the specific issues affecting financial markets during each crisis.

The proposed adaptive nonparametric model results particularly suitable for modelling the features of portfolio default risk premia and in terms of goodness of fit it outperforms its parametric counterpart. However, the resulting empirical evidence on the time-inhomogeneous behaviour of the weights of the systematic risk factors poses new issues for risk and portfolio management, in particular regarding the performance and the effectiveness of hedging and diversification strategies.

The remainder of the paper is organized as follows: Section 2 describes the adaptive nonparametric modelling methodology, while Section 3 presents the details regarding its application to the context of this paper and the criteria used to select the systematic risk factors. The employed dataset is described in Section 4 and the estimation results are presented in Section 5, while their detailed interpretation is discussed in Section 6. Section 7 examines the model performance, while Section 8 concludes the paper.

2. Adaptive nonparametric methodology

Adaptive nonparametric methods are particularly suitable to estimate economic relationships characterized by instability and sudden shifts as well as for modelling time-inhomogeneous properties of financial time series. The problem of adaptive

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