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Portfolio Benefits of Adding Corporate Credit Default Swap Indices: Evidence from North America and Europe*

Benjamin Hippert † André Uhde ‡ Sascha Tobias Wengerek §

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Abstract

Employing main and sector-specific CDS indices from the North American and European CDS market and performing mean-variance out-of-sample analyses for conservative and aggressive investors over the period from 2006 to 2014, this paper analyzes portfolio benefits of adding corporate CDS indices to a traditional financial portfolio consisting of stock and sovereign bond indices. As a baseline result, we initially find an increase in portfolio (downside) risk-diversification when adding CDS indices, which is observed irrespective of both CDS markets, investor-types and different sub-periods including the global financial crisis and European sovereign debt crisis. In addition, the analysis reveals higher portfolio excess returns and performance in CDS index portfolios, however, these effects clearly differ between markets, investor-types and sub-periods. Overall, portfolio benefits of adding CDS indices mainly result from the fact that institutional investors replace sovereign bond indices rather than stock indices by CDS indices due to better risk-return characteristics. Our baseline findings remain robust under a variety of robustness checks. Results from sensitivity analyses provide further important implications for institutional investors with a strategic focus on a long-term conservative portfolio management.

Keywords: corporate credit default swap indices, mean-variance asset allocation, out-of-sample portfolio optimization, portfolio risk-diversification, portfolio performance evaluation.

JEL Classification: C61, G01, G11, G15, G23.

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1 Introduction

The ongoing globalization and integration of financial markets has increased the cross-border co-movement of financial asset returns and has decreased cross-border and cross-asset risk-diversification at the same time (Solnik et al., 1996; Hunter and Simon, 2005; Wu et al., 2005; Cappiello et al., 2006; Eun and Lee, 2010; Daskalaki and Skiadopoulos, 2011; Christoffersen et al., 2012; Silvennoinen and Thorp, 2013). Additionally, the last decade is characterized by a higher degree of volatility transmission (Mensi et al., 2013; Bekaert et al., 2014) resulting in a more distinctive vulnerability of globalized financial markets caused by shocks, e.g. the collapse of Lehman Brothers or the Greece bailout (Belke and Gokus, 2011; Diebold and Yilmaz, 2012).

Under such difficult conditions, investors face a stronger challenge to build up financial portfolios, which exhibit reasonable risk-return structures despite the threat of stronger risk co-movements and in particular, stronger downside losses. Typically, investors seek for liquid safe-haven investments exhibiting a weak downside risk affinity, which is true for long-term sovereign bonds. In fact, a "*flight to liquidity and quality*" was especially observed during the financial crisis in 2007 and 2008 when investors heavily restructured their financial portfolios by replacing shares of stock indices by shares of sovereign bond indices (Beber et al., 2009; Baur and Lucey, 2009; Goyenko and Ukhov, 2009; Hameed et al., 2010). However, since even sovereign bonds and individual alternative investments (esp. commodities) have been affected by liquidity constraints (Nissanke, 2012; Calice et al., 2013) and an increasing return-volatility (Meng et al., 2009; Belke and Gokus, 2011; Hui et al., 2013; Mensi et al., 2013) during the global financial crisis (GFC) and the European sovereign debt crisis (ESDC), the scope for portfolio risk-diversification has become tight. Taking this into account, recent studies suggest single-name and multi-name credit default swaps (CDSs) as a suitable asset class for portfolio risk-reduction strategies (Liu et al., 2017). These studies provide evidence that CDS markets were liquid and that CDSs exhibit a moderate risk exposure even during crisis periods (Blanco et al., 2005; Bühler and Trapp, 2009; Díaz et al., 2013), (Berndt and Obreja, 2010; Junge and Trolle, 2015).

The paper at hand is the first that empirically investigates portfolio benefits which result from adding corporate CDS indices to a traditional financial portfolio consisting of stock and sovereign bond indices. Employing CDS indices in a portfolio context, our analysis contributes to the body of related studies documenting portfolio gains and portfolio risk-diversification effects from implementing different asset classes next to stock and sovereign bond indices (Black and Litterman, 1992; Abanomey and Mathur, 1999; Anson, 1999; Cheung and Miu, 2010; Consiglio et al., 2016; Füss et al., 2016). As regards our empirical methodology employed, the most related papers are provided by Daskalaki and Skiadopoulos (2011) as well as Bessler and Wolff (2015) who focus on portfolio benefits of adding individual commodity classes to a traditional financial benchmark portfolio.

Employing individual North American and European corporate CDS indices for different sub-periods between 2006 and 2014, this study provides empirical evidence for an increase in portfolio (downside) risk-diversification when adding CDS indices to a benchmark portfolio consisting of stock and sovereign bond indices. The risk-reduction effect exist irrespective of both CDS markets and investor-types, and is observed for every sub-period, i.e. even during the GFC and ESDC period. We find the highest risk-diversification gains and the most portfolio benefits for conservative investors. In addition, the analysis reveals an enhancement of portfolio excess returns and performance when adding CDS indices, however, these effects clearly differ between markets, investor-types and sub-periods. Overall, CDS index portfolio benefits mainly result from the fact that institutional investors replace sovereign bond indices rather than stock indices by CDS indices due to better risk-return characteristics. These baseline findings remain robust under a variety of robustness checks. Results from sensitivity analyses further reveal that (i) stock index-corporate CDS index portfolios exhibit stronger benefits than traditional stock index-sovereign bond index portfolios, (ii) portfolio benefits of adding corporate CDS indices are higher than benefits of adding corporate bond indices and (iii) global investors pursue cross-border risk-diversification strategies by means of corporate CDS indices.

The remainder of the paper is organized as follows. Section 2 introduces the main characteristics of CDS indices and discusses returns from CDS indices. Section 3 presents our empirical methodology, includes a description of the data and a method to calculate CDS index excess returns. Baseline empirical findings as well as results from further robustness checks and sensitivity analyses are presented and discussed in Section 4. Finally, Section 5 summarizes and concludes.

2 CDS indices and CDS index returns

In contrast to research studies analyzing single-name CDSs, the number of studies focusing on CDS indices (multi-name CDSs) is still scarce. Therefore, this section briefly introduces the main characteristics of CDS indices and discusses the link between CDS index spreads and CDS index returns.

CDS indices are standardized over-the-counter (OTC) products and include a fixed or varying basket of selected single-name CDS. Each CDS index contract involves a pre-determined maturity, pre-defined credit events, a fixed coupon and floating upfront payments.

From an institutional investor's point of view, buying or selling a CDS index is an expression of his sentiment towards credit quality as an asset class. Hence, CDS indices allow to express bullish or bearish views on the development of credit market quality by trading one single instrument that can be liquidated at any point of time.

Figure 1 illustrates that the trading volume of CDS indices has evolved remarkably since its beginning in 2005, which is due to the fact that trading costs have decreased while market liquidity, operational efficiency and transparency have increased at the same time. The trading volume of CDS indices has reached its peak in the second half of 2007 but has noticeably decreased in the aftermath of the GFC. Since 2009, the total volume of CDS index trades exhibits almost constant values until the end of our sample period in the second half of 2014. Corresponding to the development of the market for CDS indices, industry support has also grown, with banks and institutional investors playing the dominant role on the sell-and-buy side of the CDS market. While institutional investors primarily hedge their open positions by means of CDS indices, banks have CDS indices in their banking and trading books, engage in product development and, as licensed dealers, provide the necessary liquidity for their (private) clients. Moreover, the International Swaps and Derivatives Association (*ISDA*) has created globally approved legal documentations for CDS indices and many third parties have integrating CDS indices into their trading platforms.

The Markit Group Limited (Markit) owns and operates CDS indices and thus, is the leading provider of consistent and comprehensive data on CDS indices. The Markit *CDX* family covers North America and emerging markets (Latin America, partly Asia, EEMEA), whereas Markit *iTraxx* indices include European, Asian and emerging markets (CEEMEA). Markit launches semi-annually new series of CDS indices, so-called 'on-the-run' series, since the *regular index-roll process* is carried out every March and September. During this process the previous index becomes 'off-the-run' and continues to trade until maturity, while liquidity is shifted to the new introduced on-the-run series.

Typically, a regular index roll-over is processed if an entity's credit rating shifts outside the pre-determined investment-grade range, or if the entity's liquidity is substantially deteriorated (O'Kane, 2008; Markit, 2014). Next to the regular index-roll process, roll-overs are also triggered by the default of one or more reference entities. The default of a reference entity is defined as a credit event, such as bankruptcy, while the recovery rate of a defaulted entity is settled via auctions.[1] In case of a credit event, the defaulted reference entity is immediately removed from the index and a new index version is established. Hence,

[1]The final recovery rate is a fundamental part of the CDS index return calculation (Equation 10 in Section 3.4). Using two-stage auctions to settle CDS contracts ensures transparency and leads to a standardized recovery rate of the underlying debt of the defaulting reference entity. We refer to Helwege et al. (2009) for further detailed information on the auction process of CDS contracts.

the number of reference entities in the new index version is reduced by the number of defaulted entities. As a consequence, several versions of the same index series may be traded simultaneously. Furthermore, since each reference entity is equally-weighted by "one divided by the actual number of entities in the index", the individual weight of each remaining entity increases (Markit, 2014; Junge and Trolle, 2015).

Depending on the position in a CDS index contract, long or short, the investor in a CDS index pays or earns *fixed coupon payments* on an appointed notional on a quarterly basis. Additionally, *accrued interest* is taken into account up to the trade date. Coupon and accrued interest payments flow from the protection buyer to the protection seller. The seller of a CDS index (the protection buyer) is insured against probable defaults of the index' reference entities, whereas the buyer of a CDS index (protection seller) is exposed to these defaults (Markit, 2014).

In addition, the investor in a CDS index pays or earns an *upfront payment* at the initiation and at the close date of a CDS index contract. The difference in upfront payments between these two points in time simply reflects the change in the *price of a CDS index*. Changes in upfront payments (changes in CDS index prices) are determined by changes in the reference entities' credit quality which is measured by the *CDS index spreads* during the contract period. Assuming that the CDS index spread decreases, i.e. the credit risk exposure of the index decreases and the CDS index price increases, the upfront payment is lower at the closing date than it has been at the initiation date. Given this, the index buyer (protection seller, long position) earns a positive return from holding the CDS index, whereas the index seller (protection buyer, short position) suffers from the decrease in the underlying entities' credit quality. In sum, CDS index spreads and CDS index prices as well as *CDS index returns* are inversely related. A lower level of the reference entities' credit risk exposures is associated with higher CDS index prices and CDS index returns for a long position in the CDS index contract, given there is no default among the index entities which would affect the investor's return (Markit, 2014).

3 Empirical framework and data

3.1 Out-of-sample estimation approach

In order to empirically investigate portfolio benefits of adding corporate CDS indices to a traditional financial portfolio consisting of stock and sovereign bond indices, we employ an out-of-sample estimation procedure following DeMiguel et al. (2009), Daskalaki and Skiadopoulos (2011) as well as Bessler and Wolff (2015).[2]

We utilize a 12-months rolling window approach to calculate the portfolio weights on every first trading day of month t.[3] Subsequently, the out-of-sample performance is calculated by using the estimated weights from month t to compute the realized portfolio risk and return during the following month $t+1$. The 12-months rolling windows are used to estimate both, the portfolio returns and the covariance matrix. By rolling the window one month forward, the portfolio performance of month $t+2$ can be calculated, based on the information available from $t+1$ while dropping the earliest return. This procedure is repeated until we obtain the out-of-sample risk and return profile for our entire observation period spreading from January 2006 to December 2014.

3.2 Asset allocation model

Depending on different allocation strategies pursued by asset managers in practice, a variety of asset allocation models exist. We employ a mean-variance portfolio optimization strategy (Markowitz, 1952) as our asset allocation model of first choice. The reason is, that the mean-variance out-of-sample approach is widely spread within the related literature (DeMiguel et al., 2009; Daskalaki and Skiadopoulos, 2011; Bessler and Wolff, 2015; Bessler et al., 2017). Thus, our results may be compared with results from related studies that analyze portfolio benefits of adding assets beyond CDS indices to a traditional financial benchmark portfolio.[4]

The mean-variance analysis is the process of weighing portfolio risk against the expected portfolio return. The optimization problem is defined as the following objective function:

$$\max_{\omega} U = \omega'\mu - \frac{\delta}{2}\omega'\Sigma\omega, \qquad (1)$$

where U is the utility function of an investor, ω is the vector of portfolio weights, μ is a vector of expected excess returns, δ is the risk aversion coefficient and Σ is the covariance matrix of asset excess returns. We assume an aggressive and a conservative investor. The risk aversion

[2]We additionally perform an in-sample procedure. However, this approach is based on the less realistic assumption that the investor is able to perfectly forecast future portfolio returns, return volatilities and return correlations, i.e. estimations errors are not considered. As a consequence, we observe overestimated portfolio benefits of adding CDS indices when employing the in-sample procedure, which is in line with empirical findings provided by Bessler and Wolff (2015) and Bessler et al. (2017). Therefore, we do not report empirical results from the in-sample procedure in this paper but provide them on request.

[3]Note that a variation of the rolling windows as a robustness check is less meaningful for our analysis since we investigate portfolio benefits during three different time periods. Thus, varying the length of the rolling windows would shift these sub-periods and would provoke biased estimation results.

[4]Note that we repeat the out-of-sample estimations by employing the Black-Litterman model as an alternative asset allocation model in a robustness check in Section 4.2.

coefficient δ is set to 2 for the aggressive investor and it is set to 10 for the conservative investor following Fletcher and Hillier (2005), Daskalaki and Skiadopoulos (2011) and Bessler and Wolff (2015). The sample mean $\widehat{\mu}$ and the sample covariance $\widehat{\Sigma}$ are computed by employing the rolling windows approach as described in Section 3.1.

Since this is the first comprehensive study analyzing CDS indices in a portfolio context, we initially abstract from transaction costs and set short sale constraints in order to obtain the "direct" impact on a portfolio's risk, excess return and performance of adding CDS indices to the benchmark portfolio.[5] Furthermore, two realistic investment constraints are implemented, i.e. budget restrictions and volatility bounds. Setting a budget restriction provides that the portfolio weights ω sum to the value of 1:

$$\sum_{i=1}^{N} \omega_i = 1, \tag{2}$$

where N denotes the number of assets.

Setting short sale constraints ensures that the investor exceptionally invests in long positions:

$$\forall i \in 1, \ldots, N : \omega_i \geq 0. \tag{3}$$

Implementing short sale constraints is a reasonable strategy since even most institutional investors are restricted to hold long positions.

Finally, an upper volatility bound σ^* is implemented to distinguish between the two types of investors:

$$\sqrt{\omega' \Sigma \omega} \leq \sigma^*. \tag{4}$$

The upper bounds are set to 5% p.a. for the conservative investor and 15% p.a. for the aggressive investor.[6] Note, that the upper volatility bound may not be interpreted as a target volatility that may set an incentive for the investor to invest in risky assets during bear markets and thus, is more likely to cause negative returns. Rather, the upper volatility bound here forces the asset allocation model to shift investment capital from risky to low-risk portfolio assets during times of financial turmoil and hence, protects from portfolio losses (Bessler et al., 2017). Furthermore, implementing the volatility bound is equivalent to

[5]We present a comprehensive analysis of varying transaction costs and allow for short sales during later robustness checks in Section 4.2.

[6]The upper volatility bound is calculated by employing the MSCI World Index and the Barclays Global Government Bond index as independent benchmark indices with a proportion of 80% (0%) stocks and 20% (100%) bonds for the aggressive (conservative) investor.

shrinking the input parameters, which enhances the out-of-sample performance and prevents from extreme portfolio allocations which may arise under the mean-variance approach (Frost and Savarino, 1988; Jagannathan and Ma, 2003; Bessler et al., 2017).

3.3 Portfolio measures

Next to analyzing changes in a portfolio's excess returns and standard deviations (SDs) of excess returns when adding CDS indices, we additionally investigate the impact on portfolio downside risk, performance and the extent of portfolio rebalancing by employing five different portfolio measures.

First, we implement the widely used Value-at-Risk (VaR) in order to measure a portfolio's downside risk. However, since returns usually are not normally distributed, we include higher moments of the distribution (see also Boudt et al., 2008 who apply the Cornish-Fisher expansion (Cornish and Fisher, 1938) to VaRs). In this manner, the VaR is described as the lower α-percentile of a random variable X that quantifies the loss (Linsmeier and Pearson, 2000):[7]

$$VaR_{1-\alpha}(X_i) = F_{X_i}^{-1}(\alpha) = \inf(z|P(X_i \leq z) \geq \alpha). \quad (5)$$

We measure the sample $\widehat{VaR}_{1-\alpha}$ by employing the sample returns $\widehat{\mu}_i$ and setting the confidence level $1 - \alpha$ to 99%. A higher VaR indicates a higher downside risk.

Second, the Sharpe Ratio (SR, Sharpe, 1966) for portfolio i is calculated using the corresponding sample excess return $\widehat{\mu}_i$ divided by the sample standard deviation $\widehat{\sigma}_i$:

$$\widehat{SR}_i = \frac{\widehat{\mu}_i}{\widehat{\sigma}_i}. \quad (6)$$

A higher SR indicates a higher risk-adjusted portfolio performance.

Third, since an investor is usually more concerned about the lower tail of the return distribution, we additionally employ the Sortino Ratio (SoR) which is introduced by Sortino and Price (1994) in order to rank different portfolios by exceptionally focusing on the portfolios' downside risk. The SoR is based on the SR but includes the downside deviation (DD) instead of the standard deviation (SD) as denominator. In contrast to the SD, which measures upper and lower risk, the DD measures the lower tail of the distribution. We employ the risk-free interest rate as the minimum return required by an investor and compute the sample SoR by using excess returns as:

[7] Since we define the VaR as "loss", the sign of the computed VaR is positive.

$$\widehat{SoR}_i = \frac{\widehat{\mu}_i}{\widehat{DD}_i}, \tag{7}$$

where

$$\widehat{DD}_i = \sqrt{\frac{1}{T}\sum_{i=1}^{T}\min(\widehat{\mu}_i, 0)^2}.$$

Like the SR, a higher SoR suggests a higher downside risk-adjusted portfolio performance.

Fourth, the gain-loss or *Omega Ratio* (OR) is computed. According to Keating and Shadwick (2002) this ratio can be expressed as the probability-weighted ratio of gains and losses relative to any given return threshold r (here: the risk-free interest rate). Unlike the SR, the OR does not require any assumption on the distribution of returns and hence, all higher moments are included. The OR of an asset i is than expressed as:

$$OR_i(r) = \frac{\frac{1}{T}\sum_{t=1}^{T}\max(0, r_{t,i} - r)}{\frac{1}{T}\sum_{t=1}^{T}\max(0, r - r_{t,i})}, \tag{8}$$

where $r_{t,i}$ represents the return of an asset i at time t and r is the minimum required return, i.e. the risk-free interest rate. Portfolios exhibiting a higher OR have a better return-based portfolio performance and should be preferred by investors.

Finally, we compute the portfolio turnover (PT) following related studies provided by DeMiguel et al. (2009), Daskalaki and Skiadopoulos (2011) and Bessler et al. (2017). The PT is the average absolute change in the weights ω of portfolio composition c over the T rebalancing points over time and across N assets. More common, PT is the average percentage of the portfolio value that has to be reallocated and is calculated as:

$$PT_c = \frac{1}{T}\sum_{t=1}^{T}\sum_{j=1}^{N}\omega_{c,j,t+1} - \omega_{c,j,t_+}, \tag{9}$$

where $\omega_{c,j,t}$ is the optimal portfolio weight computed at time t and ω_{c,j,t_+} is the weight before rebalancing at time $t+1$.[8]

3.4 Data

Performing out-of-sample estimations as presented above requires data on benchmark and test assets. *Benchmark assets* describe the current investment opportunity set of an investor (the benchmark portfolio). We employ stock and sovereign bond indices as benchmark assets and thus, provide comparability with related studies (Daskalaki and Skiadopoulos,

[8]Note that ω_{c,j,t_+} differs from $\omega_{c,j,t}$ due to asset price changes during time t and $t+1$.

2011; Bessler and Wolff, 2015). We construct two corresponding benchmark portfolios which differ in terms of their benchmark assets and risk-free interest rates. We assume that the North American investor holds the S&P500 representing the North American equity market and the Barclays US Aggregate Government Bond index (NA SBI) as a proxy for the North American debt market. In contrast, the European investor's benchmark portfolio includes the EuroStoxx50 and the Barclays Europe Aggregate Government Bond (EUR SBI) reflecting the European equity and sovereign bond market, respectively. All asset prices are denominated in US-Dollar.

In order to account for an investor's opportunity costs, we perform out-of-sample estimations with excess returns, which are defined as returns over the risk-free rate for stock and bond indices. CDS index excess returns are calculated following the method provided by Junge and Trolle (2015):

$$r_{i,t,t'} = -\Big(UF_{i,t'}(C) - UF_{i,t}(C)\Big) + \frac{I_t}{I} C \frac{t'-t}{360} - \frac{1}{I}(L_{i,t'} - L_{i,t}). \tag{10}$$

As mentioned in Section 2, the CDS index is traded with a fixed coupon C and date-t upfront payment $UF_{i,t}(C)$. $L_{i,t}$ is the cumulative loss due to credit events among the index' underlying entities on date t, I_t defines the number of entities in the index at time t, and I is the original number of entities in the index. Upfront payments are calculated following the CDS Standard Model provided by the ISDA. The risk-free interest rate is given by the 3M-TBill for the North American investor and by the 3M-EURIBOR for the European investor. Data on monthly prices of stock and bond indices as well as the history of the risk-free interest rates are retrieved from *Thomson Reuters Datastream* and *EIKON*.

Test assets describe further asset classes which are added to the benchmark portfolio. We implement corporate CDS indices as test assets in our study. Due to data availability reasons, we focus on the largest markets for CDS indices, i.e. the North American and the European market.[9] We retrieve data on CDS indices from *Markit*[10]. We employ the CDX.NA.IG (CDXN), CDX.NA.IG.NonFin (CDXNF), CDX.NA.IG.Fin (CDXF) and CDX.NA.IG.HiVol

[9]Corporate CDS indices as employed in our analysis approximately cover 73 percent of the outstanding gross notional of multi-name CDS for the corporate sector. The coverage (ratio) is calculated by means of the Depository Trust & Clearing Corporation (*DTCC*) database.

[10]Two defaults, Fannie Mae and Freddie Mac, affected the CDXN and CDXF during our sample period. Therefore, supplementary data is retrieved from *Creditex*, which provides cash settlement values for credit derivative trades, data of credit event auctions and final prices with regard to ISDA settlement protocols and in cooperation with Markit (`www.creditfixings.com`).

(CDXHV) from the North American CDX.NA.IG family[11], and we include the iTraxx Europe (iTrE), iTraxx Europe Non-Financial (iTrNF), iTraxx Europe Financial (iTrF) and iTraxx Europe HiVol (iTrHV) from the European iTraxx family.[12] Sector-independent CDS main indices are employed since they are the most diversified indices of this asset class. Financial and non-financial CDS indices are implemented in order to disentangle portfolio benefits during these different sub-indices, especially during the GFC and ESDC period. Finally, high-volatility indices are used in order to examine portfolio benefits of adding the "most risky" (volatile) CDS indices to the benchmark portfolio. Basically, members of the North American CDX.NA.IG family and the European iTraxx family are corresponding counterparts. However, while the European iTrF includes a fixed number of financial entities, the number of members in the North American CDX.NA.IG.Fin fluctuates moderately.

We use data on five-year CDS index contracts since these contracts are the most liquid contracts within the group of multi-name CDSs. We do not include time series of CDS indices (and stock and bond indices) if they exhibit an insufficient trading frequency, i.e. we observe missing observations of CDS index prices for at least three consecutive trading days. Our entire sample of CDS index excess returns (as well as stock and bond index excess returns) covers the period from January 2005 to December 2014 for the North American and European market, respectively. Due to the fact that we employ 12-months rolling windows under the mean-variance out-of-sample approach, the observation period runs from January 2006 to December 2014. In order to investigate portfolio benefits during crisis and non-crisis periods separately, we additionally split the entire period into three sub-periods. Following Dungey et al. (2015)[13] the pre-GFC period runs from January 2006 to June 2007, the GFC period comprises the period from July 2007 to May 2009 and the post-GFC/ESDC period runs from June 2009 to December 2014.

As shown in Table 1, we observe a strong variation in the risk-, return- and performance-characteristics of single asset classes during the entire period and across the three sub-periods. Similarly, Table 2 reports that pairwise inter-asset correlation coefficients of monthly excess

[11] The CDXN includes the 125 most liquid North American entities with an investment-grade rating and comprises various segments, e.g. Consumer Cyclical, Energy, Financials, Industrial and Telecom, and Media and Technology. The CDXNF includes sub-sector indices as listed before, except for the financial sector. This sector is separately included in the CDXF. The CDXHV contains 30 entities of the main index with the highest 5-year CDS spreads average over the last 90 days prior to the initiation date of the high volatility index composition (Markit, 2015).

[12] The iTrE includes 30 Autos & Industrials, 30 Consumers, 20 Energy, 20 Technology, Media, and Telecom, and 25 Financials. The iTrNF comprises the sub-sectors as listed before, except for the 25 entities from the financial sector, which are included in the iTrF. The iTrHV contains 30 entities of the main index with the highest 5-year CDS spread average over the last 90 days prior to the initiation date of the high volatility index composition (Markit, 2015).

[13] Coupling smooth transition functions with structural GARCH, Dungey et al. (2015) develop an empirical method to identify the transition dates between crisis and non-crisis phases endogenously.

returns vary with respect to the different asset classes, across continents and with regard to different sub-periods. We refer to the descriptive statistics and correlation matrix in more detail during the interpretation of our empirical results in Section 4.

4 Empirical results

4.1 Mean-variance out-of-sample analysis

Results from the mean-variance out-of-sample estimations are presented in Table 3a. Portfolio benefits, which result from adding corporate CDS indices to respective benchmark portfolios, are marked in bold. Corresponding means of portfolio weights are reported in Table 3b while time-varying portfolio weights are plotted in Figures 3a and 3b.

Entire period

As initially shown in Table 3a, portfolio turnover rates generally increase in CDS index portfolios in each sub-period, which is due to the fact that portfolio restructuring opportunities rise when the investor is allowed to invest in one more asset class. Furthermore, the European conservative investor's benchmark portfolio violates the pre-determined volatility bound of 5% which is due to the fact that benchmark assets in Europe exhibit a remarkably higher risk-level as compared to their North American counterparts (Table 1). However, adding CDS indices to the benchmark portfolio reduces the portfolio risk under the required threshold of 5%.[14]

Table 3a additionally reports that the risk-return structure (as measured by excess returns, the standard deviation (SD) and the Value-at-Risk (VaR)) as well as the portfolio performance (as proxied by the Sharpe Ratio (SR), the Sortino Ratio (SoR) and the Omega Ratio (OR)) improve for both North American investors and the European conservative investor when adding CDS indices to respective benchmark portfolios during the entire period. This finding suggests that CDS indices may be a suitable long-term investment for these investor-types. In contrast, portfolio effects are mixed for the European aggressive investor. Although the CDS index portfolios' (downside) risk decreases, excess returns decrease as well. In addition, the (downside) risk-adjusted measures SoR and SR signal an increase in portfolio performance in most cases, whereas the return-based OR indicates a decrease in performance.

[14] We observe a violation of the volatility constraint and a recovery through adding CDS indices to the European conservative investor's benchmark portfolio in every sub-period.

Analyzing portfolio weights as reported in Table 3b and illustrated in Figures 3a and 3b provides further important insights. In particular, it is shown to what extent and during which period of time benchmark assets are substituted by CDS indices. In addition, it is revealed if portfolio weights are statistically and economically relevant. As reported by Table 3b and Figures 3a and 3b, both conservative investors hold higher proportions of the sovereign bond index in benchmark portfolios than their aggressive counterparts. This finding was expected since conservative investors may stronger invest in low-risk sovereign bond indices. Furthermore, benchmark portfolios from both European investors exhibit higher shares of the sovereign bond index than portfolios from the North American counterparts.

Introducing CDS indices, however, it is shown, that *each* investor replaces sovereign bond indices rather than stock indices by individual CDS indices. This is due to the fact that corporate CDS indices in our sample generally exhibit better risk-return-performance properties and a higher (downside) risk-reduction potential than sovereign bond indices (and stock indices) over the entire period (Table 1 and 3b). Our analysis further reveals that both European investors stronger invest into CDS indices than their North American counterparts since the North American benchmark portfolio is much better diversified than the European basket during the entire period (Table 2). Referring to the time-varying portfolio weights, Figure 3b illustrates that the European conservative investor *continuously* holds shares of CDS indices. Taking this finding and results from the out-of-sample estimations into account, we provide evidence that CDS indices provoke portfolio benefits for institutional investors and that European CDS indices may be suitable stand-alone investments for European conservative investors during the entire period.

Pre-GFC period (January 2006 - June 2007)

The *pre-GFC* period is characterized by increasing stock index prices and rising short-term interest rates (Figure 2). Both are expected to have a positive impact on CDS index returns (Longstaff and Schwartz, 1995; Duffee, 1998; Collin-Dufresne et al., 2001; Blanco et al., 2005; Driessen, 2005; Feldhütter and Lando, 2008; Greatrex, 2009; Norden and Weber, 2009; Stanton and Wallace, 2011; Calice et al., 2013). In addition, benchmark and test assets from our study exhibit the lowest (downside) risk during the pre-GFC period as compared to all other sub-periods (Table 1) while the level of volatility of stock index prices (Figure 2) and volatility transmission between the stock, bond and CDS markets is also low during this period (see also Belke and Gokus, 2011; Schreiber et al., 2012). Finally, bubbles in the European and North American CDS market suggest the willingness of investors to accept lower CDS premiums than predicted by theoretical asset pricing models (Meine et al., 2012).

As reported by Table 3a, reducing portfolio (downside) risk is a dominating effect when adding CDS indices to benchmark portfolios during the pre-GFC period although benchmark assets already exhibit the lowest risk exposure during this sub-period. The risk-diversification effect through CDS indices is observed irrespective of both CDS markets, different types of investors and individual CDS index sub-groups while we find the strongest risk-reduction effect for both conservative investors. As regards portfolio returns, however, empirical results reveal a decrease in excess returns for most of the CDS index portfolios and across all CDS index sub-groups indicating that portfolio risk-reduction is at the expense of portfolio returns. An enhancement of portfolio excess returns together with a diversification of portfolio risk is observed for the European conservative investor only.

Results concerning changes in portfolio performance correspond to previous findings from risk-return characteristics. While values of the (downside) risk-adjusted SR and SoR suggest, that the (downside) risk-reduction effect outweighs the decrease of excess returns in CDS index portfolios in most cases, we observe an increase in the return-based OR for portfolios of the European conservative investor only. Overall, the European conservative investor realizes the strongest portfolio benefits through adding CDS indices. This is the only investor who remarkably increases shares of the EuroStoxx50 and profits temporarily from the stock index' high level of excess returns while the stock index' higher risk exposure is compensated by CDS indices.

Referring to portfolio weights, Table 3b as well as Figures 3a and 3b show that benchmark portfolios from both aggressive investors exceptionally comprise stock indices. This may be due to the very poor performance of both sovereign bond indices and a moderate risk exposure of both stock indices during the pre-GFC period (Table 1). In contrast, both conservative investors follow a two-asset strategy holding stock and bond indices in their benchmark portfolios. However, since the NA SBI performs weaker than the EUR SBI during the pre-GFC period, the North American conservative investor holds a smaller share of the bond index.

Introducing CDS indices, our analysis initially reveals that both North American investors stronger engage in CDS indices than their European counterparts. Furthermore, we find that CDS indices exhibit the highest weights among all asset classes in both conservative portfolios. The European conservative investor follows a three-asset strategy but clearly reduces shares of the EUR SBI. In contrast, the North American conservative investor completely replaces the bond index (and proportions of the stock index) by CDS indices. Thus, taking results from the out-of-sample estimations and the analysis of portfolio weights into account, we provide clear evidence that sovereign bond indices are replaced by CDS indices serving as alternative instruments for portfolio risk-diversification strategies during the pre-GFC period. Our finding corresponds to results from related studies analyzing single-name CDSs during non-crisis periods in a non-portfolio context (e.g., Blanco et al., 2005; Greatrex, 2009; Jacoby et al., 2010).

GFC period (July 2007 - May 2009)

The *GFC*, which has originated in the US subprime mortgage segment, has quickly spread to the global financial market. Thus, as shown in Figure 2, we observe sharply decreasing stock index prices and short-term interest rates in North America and Europe during the crisis period. In addition, Figure 2 reports high-volatile stock markets on both continents. Due to a growing commonality between traditional financial assets (Table 2), volatility shocks were transmitted in an unpredictable high level on globalized financial markets (Eun and Lee, 2010; Belke and Gokus, 2011; Schreiber et al., 2012; Eichengreen et al., 2012; Kotkatvuori-Örnberg et al., 2013; Jung and Maderitsch, 2014). Almost all asset classes in our study (except for the EUR SBI) were negatively affected by the GFC which is reflected by a strong decline of excess returns and a strong increase in (downside) risk (Table 1). In addition, as survival probabilities of banks were underestimated during the GFC period, bank-CDS spread levels rose strongly (Raunig and Scheicher, 2009; Meine et al., 2012). However, as shown in Table 2, the correlation between individual CDS indices (especially the CDXF and iTrF) and stock indices in North America and Europe rises only moderately or even decreases during the GFC period. In addition, correlations between CDS indices and both sovereign bond indices slightly decrease.

Table 3a reports negative portfolio excess returns and a general decline in portfolio performance for each benchmark portfolio irrespective of both CDS markets and investor-types during the GFC period. In addition and related to the pre-GFC period, we observe an increase in portfolio risk for benchmark portfolios from both European investors.

Turning to CDS index portfolios, our analysis reveals that (downside) portfolio risk-reduction is a major benefit of adding CDS indices to benchmark portfolios for both European investors and, in large parts, for both North American investors. However and as expected, due to the onset of the GFC in the US, the North American CDXF and CDXHV do not or sparsely contribute to a reduction of portfolio risk during the crisis period. In contrast, benefits from European CDS index portfolios do not remarkably differ among the individual CDS index sub-groups. In fact, we observe the strongest positive effects for the European iTrF.

As regards the CDS index portfolio performance, the analysis provides ambiguous empirical results. While the *SoR* indicates an increase in portfolio performance for both European investors, the *SR* and *OR* do not. Furthermore, we observe the strongest enhancement in portfolio performance for CDXN- and CDXNF-portfolios from both North American investors, whereas the increase in performance of CDXF- and CDXHV-portfolios is weak. Rather, we find the lowest portfolio turnover rates for CDXF- and CDXHV-portfolios suggesting that both CDS indices have played a minor role in a portfolio context during the GFC period in the US.

Analyzing portfolio weights from benchmark portfolios (Table 3b as well as Figures 3a and 3b) initially reveals, that each investor follows a two-asset strategy during the GFC period. In this context, we observe a "*flight to safety*" (Baur and Lucey, 2009; Goyenko and Ukhov, 2009; Hameed et al., 2010; Chudik and Fratzscher, 2012) at the peak of the crisis in 2008. Hence, *each* investor stronger invests in sovereign bond indices as related to the pre-GFC period, and even both aggressive investors completely substitute stock indices by respective bond indices due to better risk-return-performance properties (Table 1).

Introducing CDS index portfolios, we find that both North American investors still seek the sovereign bond index as a low-risk investment, i.e. they stronger invest in the NA SBI than in individual CDS indices. In contrast, both European investors hold higher shares of CDS indices than shares of the EUR SBI since the end of 2008. Nevertheless, as it is generally shown that sovereign bond indices rather than stock indices are replaced by CDS indices in large parts and irrespective of different investor-types, we provide evidence that CDS indices serve as alternative instruments to reduce portfolio (downside) risk even during the GFC period. Our finding may be explained by the fact that CDS markets were more liquid (Bühler and Trapp, 2009; Bongaerts et al., 2011; Díaz et al., 2013; Coudert and Gex, 2013) and more information-efficient during the GFC period (Delatte et al., 2012; Das et al., 2014). However, focusing on individual CDS sub-indices, our analysis also reveals that the CDXF and CDXHV do not play a role in North American portfolios. This finding was expected since the US financial sector has served as a catalyst of the financial crisis and thus, risk exposures of most North American banks were overestimated by investors a (Belke and Gokus, 2011; Bongaerts et al., 2011).

Post-GFC/ESDC period (June 2009 - December 2014)

The *post-GFC/ESDC* period is characterized by two different economic developments. On the one hand, financial markets have begun to recover from the GFC, as shown by increasing stock index prices, decreasing stock index price volatility and slightly increasing short-term interest rates on average (Figure 2). On the other hand, especially European financial markets have been heavily affected by individual sovereign debt crises, starting with the Greek debt crisis in October 2009 and reaching a peak in 2012. Due to the vulnerability of the European sovereign bond market, investors have shifted their investment capital from stressed to non-stressed European countries (Beck et al., 2016). As a consequence, cross-border financial contagion has gradually become an important factor for (European) investors (Table 2) when rebalancing their financial portfolios (Fry-McKibbin et al., 2014). Moreover, financial markets in the US and Europe are influenced by Quantitative Easing programs and interest-rate policies conducted by the Federal Reserve Bank (Fed) and the European Central Bank (ECB) during the post-GFC period. These programs and policies have had a positive impact on the North American equity market but most European stocks have poorly performed and sovereign bond yields have even turned to be negative (Table 1; Gagnon et al., 2011; Martin and Milas, 2012; Delatte et al., 2012).

As reported by Table 3a, we observe positive excess returns for benchmark portfolios in North America, whereas excess returns are negative for European benchmark portfolios during the post-GFC/ESDC period. In addition, the portfolio (downside) risk-level is higher in European benchmark portfolios than in North American portfolios. Both findings primarily result from a very bad performance of the European sovereign bond index (Table 1), and they clearly indicate that the European financial market has been strongly affected by the ESDC.

Turning to CDS index portfolios, it is initially revealed that the risk-return structure enhances, and that the portfolio performance increases when adding CDS indices to benchmark portfolios from both North American investors. More important, similar effects are observed for CDS index portfolios from the European conservative investor suggesting that implementing CDS indices to a large extent mitigates the unfavorable risk-return structure and poor performance of the benchmark portfolio. As regards the European conservative investor, adding CDS indices also provokes a reduction of portfolio (downside) risk and an increase in portfolio performance, however, the impact on portfolio excess returns and on the return-based OR is ambiguous. Finally, investigating individual CDS sub-indices, portfolios including the CDXF and iTrF exhibit higher excess returns but a higher (downside) risk as compared to CDXNF- and iTrNF-portfolios.

Referring to portfolio weights, Table 3b as well as Figures 3a and 3b report that shares of stock indices are higher in North American than European benchmark portfolios, which might be due to the fact that stocks have much better recovered than sovereign bonds under the North American "Quantitative Easing" programs (Martin and Milas, 2012; Table 1). However, as shown, each investor "allocates more cautiously" during the post-GFC/ESDC period as related to the pre-GFC crisis period. As a consequence, benchmark portfolios exhibit higher proportions of sovereign bond indices in general.

Introducing CDS indices, the analysis reveals that each investor employs CDS indices to rebalance respective benchmark portfolios. However and as expected, both European investors heavily replace the sovereign bond index by individual CDS sub-indices. In addition, the European conservative investor continuously holds CDS indices during the post-GFC/ESDC period while CDS indices exhibit the largest portfolio share. Results from the analysis of portfolio weights reconfirm that a strong rebalancing of European benchmark portfolios through CDS indices is due to the fact that the EUR SBI's risk-return structure and performance noticeably suffered during the ESDC period. In contrast, both the industrial and financial sector have benefited from the ECB's excessive monetary policy strategy over time (Gagnon et al., 2011; Martin and Milas, 2012; Delatte et al., 2012) resulting in a better risk-return structure and higher performance of European CDS indices (Table 1).

Summarizing results from mean-variance out-of-sample estimations and portfolio weights analyses across all sub-periods, we provide empirical evidence for an increase in portfolio (downside) risk-diversification when adding CDS indices to a stock index-sovereign bond index benchmark portfolio. This effect exists irrespective of both CDS markets and investor-types, and it is observed for every sub-period, i.e. especially during the GFC and ESDC. We find the highest risk-diversification gains and the most portfolio benefits for conservative investors. Furthermore, our analysis reveals an enhancement of portfolio excess returns and performance through CDS indices, however, these effects clearly differ between markets, investor-types and sub-periods. Overall, portfolio benefits of adding CDS indices are triggered by the fact that investors replace sovereign bond indices rather than stock indices by CDS indices due to better risk-return properties. Our findings clearly suggest that CDS indices have the highest potential for increasing portfolio benefits during the post-GFC/ESDC period and thus, can be described as appropriate stand-alone investments during this period.

4.2 Robustness checks

Results from the following robustness checks are reported in Tables 4a-6b and Figures 4a-6b.

Introducing transaction costs

Since this is the first study to investigate portfolio benefits of adding CDS indices, we have abstracted from transaction costs so far in order to carve out the direct impact on portfolio (downside) risk, excess returns and performance. In this section, we allow for transaction costs and investigate the robustness of our baseline findings.[15]

[15] We additionally consider transaction costs during the further robustness checks (relaxation of short sale constraints and Black-Litterman asset allocation model). However, since results do not remarkably differ from respective versions without transaction costs, we do not report them in this paper but provide them on request.

Transaction costs result from shifting portfolio structures and, ceteris paribus, have a negative impact on portfolio excess returns and performance. Consequently, a passive portfolio management suggesting a buy-and-hold strategy may be more rational. However, pursuing an active portfolio management strategy by frequently rebalancing portfolios aims at increasing portfolio excess returns and performance while keeping portfolio risk at an acceptable level. Hence, taking the trade-off between both portfolio allocation strategies into account and considering that transaction costs decrease the variance in portfolio shares, diminish the portfolio turnover and change the portfolio structure as compared to our baseline model, the impact of transaction costs on portfolio benefits is not predictable.

To address transaction costs we use an extension provided by Bessler et al. (2017) and modify the objective function in Equation 1 as:

$$\max_{\omega} U = \omega'\mu - \Delta'\varphi - \frac{\delta}{2}\omega'\Sigma\omega, \tag{11}$$

where Δ is the vector of the portfolio changes required to rebalance the portfolio at the monthly rebalancing points and φ is the vector of transaction costs.

We perform a two-step procedure to investigate if our baseline results are robust under transaction costs. In a first step, we gradually increase transaction costs by 10 bps. Subsequently, we compare portfolio benefits from the transaction cost analysis with portfolio benefits from our baseline analysis for every single transaction cost level. The changes in portfolio benefits are given in percent and are aggregated over all portfolio measures, all time-periods and both investor-types in a condensed analysis.

As reported by Table 4a, changes in portfolio benefits are moderate when implementing transaction costs. We observe the highest (lowest) changes at an unusual transaction cost level of 100 bps (10 bps). Moreover, we find more negative changes (less portfolio benefits) than positive changes (additional portfolio benefits). However, the difference between negative and positive changes becomes smaller and the relation between negative and positive changes reverses in Europe for transaction cost levels higher than 40 bps.

In addition to this condensed analysis, we chose a realistic transaction cost level of 40 bps and repeat the out-of-sample estimations from Section 4.1 to retrieve more detailed results. Again, we present mean-variance out-of-sample results, mean portfolio weights and time-varying portfolio weights for every sub-period and investor-type in Tables 4b and 4c as well as Figures 4a and 4b.

To be upfront with it, our baseline results are generally reiterated even when introducing transaction costs. As shown by Table 4b, transaction costs do not affect benefits from European CDS index portfolios as observed during the baseline analysis. As regards CDS index portfolios from both North American investors, transaction costs provoke fewer portfolio benefits in terms of excess returns and performance during the GFC period but the risk-diversification potential of CDS indices is completely unaffected.

Corresponding to a general decrease in portfolio turnover rates as shown in Table 4b, the analysis of portfolio weights confirms that transaction costs make it less attractive for investors to frequently shift portfolio structures (Table 4c as well as Figures 4a and 4b). This impact is reflected by the North American conservative investor who replaces shares of the NA SBI by the CDXN and CDXNF during the GFC period, and who holds large parts of both CDS sub-indices until the end of our observation period in 2014. In addition, introducing transaction costs incentivizes investors to hold higher shares of CDS indices during the pre-GFC period, while we observe the strongest increase in CDS index shares for portfolios from both North American investors.

Relaxation of short sale constraints

As a further robustness check we relax the assumption of short sale constraints. Since it is less realistic to disproportionately lever one asset by shorting others, we only allow for a 100% leverage of one asset and describe corresponding portfolio weight constraints as:

$$\forall i \in 1, \ldots, N : -1 \leq \omega_i \leq 2. \tag{12}$$

Table 5a reports that our baseline findings are reiterated even when partly allowing for short sale transactions. Additionally, we find that portfolio turnover rates increase under short sales, which was expected since investment opportunities become larger. Related to the baseline analysis, the number of CDS index portfolio benefits rises when relaxing short sale constraints, which is especially true for CDS index portfolio excess returns and performance. Our finding is due to the fact that short sales help the investor to exploit the volatility bounds more efficiently when investing in CDS indices and following a three-asset strategy.

Referring to portfolio weights, Table 5b as well as Figures 5a and 5b report that investors (heavily) shorten poorly performing benchmark assets during specific sub-periods. Thus, they shorten both sovereign bond indices during the pre-GFC and mainly the post-GFC/ESDC period, both stock indices during the GFC period and the EUR SBI during the post-GFC/ESDC period. Our analysis further reveals that, in general, North American investors more strongly shorten assets than their European counterparts, whereas we do not observe any negative CDS index portfolio weights for the European conservative investor. Finally, as compared to our baseline results, shortening benchmark assets leads to higher CDS index portfolio weights in almost all cases, which is due to the fact that CDS indices exhibit a better risk-return performance structure than corresponding stock and bond indices. Among the the group of CDS indices we find an average negative portfolio weight during the GFC period for the CDXF only.

Black-Litterman asset allocation model

Related studies suggest that the mean-variance approach is susceptible to corner solutions, extreme portfolio reallocations and turnover rates (e.g. Black and Litterman, 1992; Satchell and Scowcroft, 2000; Bessler et al., 2017). Although some of these shortcomings may already be mitigated as we implement volatility bounds as well as constraints on portfolio weights and short-selling, we repeat the out-of-sample estimations by employing the Black-Litterman (BL) model as an alternative asset allocation model (e.g. Black and Litterman, 1992; Satchell and Scowcroft, 2000; Bessler et al., 2017). The Black-Litterman procedure is expected to diminish the disadvantages of the mean-variance approach as it reacts more directly to economic changes and hence, adjusts the asset allocation more quickly. Furthermore, it generates stronger diversification across asset classes resulting in less extreme asset allocations and lower portfolio turnover rates (Bessler et al., 2017).

The Black-Litterman model combines two different sources of information (Black and Litterman, 1992), i.e. "*implied excess returns*" and "*investors views*". *Implied excess returns* are derived from a naïve 1/N benchmark portfolio[16] and are computed as:

$$\Pi = \delta \Sigma \omega^*, \tag{13}$$

where Π is the vector of *implied excess returns*, δ is the risk-aversion coefficient, Σ is the covariance matrix of excess returns and ω^* are the portfolio weights being derived from the benchmark or market model.

Investors' views describe the investors' subjective excess return estimates which may be based on mere assumptions or even valid estimates. Combining both sources of information, the Black-Litterman returns are the weighted average of implied excess returns and investors' views and can be written as:

$$\hat{\mu}_{BL} = ((\tau\Sigma)^{-1} + P'\Omega^{-1}P)^{-1}((\tau\Sigma)^{-1}\Pi + P'\Omega^{-1}Q), \tag{14}$$

[16]Note that further asset allocation models, such as strategic weights or minimum-variance, could be implemented as alternative Black-Litterman benchmark portfolios. However, employing strategic weights is challenging for our analysis since reliable data on strategic weights of CDS indices in an investor's portfolio is not yet available. As regards minimum-variance, we perform Black-Litterman out-of-sample estimations employing this asset allocation model. However and as expected, since each CDS index in our sample exhibits a lower risk exposure than respective North American and European stock and sovereign bond indices, we observe a much stronger risk-diversification effect as compared to the 1/N-Black-Litterman and the mean-variance approach. We provide results on request.

where P is a binary pick matrix for an asset with a subjective excess return. The weighing factors of the combined returns are the matrix Ω that contains information about the reliability of the views Q as well as the parameter τ that calibrates the tracking error to the benchmark portfolio. Following related studies, we set the parameter τ to 0.05 (Black and Litterman, 1992; He and Litterman, 1999; Drobetz, 2001; Idzorek, 2005; Bessler et al., 2017).[17]

Modelling the posterior covariance matrix as

$$\Sigma_{BL} = \Sigma + ((\tau\Sigma)^{-1} + P'\Omega^{-1}P)^{-1}. \tag{15}$$

Black-Litterman returns and covariances are used to maximize the investor's mean-variance utility function as described in Equation (1). We implement the same risk-aversion coefficients and constraints as used for our baseline approach. Corresponding to our baseline analysis, we perform a sample-based procedure of the Black-Litterman model as proposed by Bessler et al. (2017). The investors' views Q are provided by the historical sample excess returns derived from the rolling windows. The reliability of the views Ω is measured as the variance of the historical forecast errors. Accordingly, the pick matrix P equals the identity matrix since we have subjective excess return estimates for every asset under investigation.

Table 6a presents the results from the 1/N-Black-Litterman out-of-sample estimations. As shown, our baseline findings are robust even when employing this alternative asset allocation model suggesting that our baseline results are not biased by possible shortcomings of the mean-variance approach. As expected, we observe an increase in portfolio gains (especially higher excess returns and performance) for most of the CDS index portfolios due to a more efficient asset allocation. In addition, CDS index shares slightly increase in North American portfolios and they slightly decrease in European portfolios in most sub-periods. In this context, Table 6b as well as Figures 6a and 6b reveal that the number of corner solutions remarkably decreases which is due to the 1/N benchmark portfolio within the Black-Litterman asset allocation strategy. Under this framework investors are stronger "forced" to invest into a three-asset strategy.

[17] We vary this parameter in a sensitivity analysis. Corresponding to results provided by Bessler et al. (2017), results from the 1/N-Black-Litterman model converge to results from our baseline mean-variance approach for larger values of τ, and they converge to the 1/N benchmark portfolio for very small values of τ.

4.3 Sensitivity analyses

Results from the following sensitivity analyses are reported in Tables 7a-9b. For the sake of brevity, we do not report the time-varying portfolio weights for each sensitivity analysis, but provide them on request.

Two-asset allocation strategy

As revealed by the baseline analysis, most portfolio benefits, and especially risk-diversification effects, result from the fact that investors replace sovereign bond indices by CDS indices in different intensities. Taking this into account, we construct a portfolio consisting of stock indices and CDS indices in order to investigate portfolio benefits more directly from a two-asset allocation strategy.

Table 7a reports that stock index-CDS index portfolios generally provoke stronger benefits for investors than traditional stock index-sovereign bond index portfolios. In particular, we observe an enhancement of excess returns and performance as well as stronger risk-diversification effects for most stock index-CDS index portfolios. This finding confirms our baseline result that CDS indices are an appropriate investment to achieve portfolio benefits. As regards Europe, the analysis reveals a greater number of portfolio benefits, which are observed irrespective of investor-types and individual CDS sub-indices. Even the iTrHV index is found to reduce portfolio (downside) risk (and enhance excess return and performance) more strongly than the EUR SBI. Referring to the North American market, we find that the CDXF and the CDXHV provoke the weakest (downside) risk-diversification effects in North American portfolios during the GFC period, whereas portfolio excess returns increase in most cases. These findings are in line with results from the baseline analysis.

Referring to mean portfolio weights, Table 7b reports that North American stock index-CDS index portfolios exhibit higher shares of individual CDS sub-indices as compared to shares of the NA SBI in the traditional stock index-sovereign bond index benchmark portfolio throughout all sub-periods. Higher shares of CDS indices may be explained by the fact that most North American CDS indices perform better than the North American sovereign bond index over time (Table 1). In contrast, we observe smaller shares of the European CDS sub-indices in stock index-CDS index portfolios as compared to shares of the EUR SBI in the traditional stock index-sovereign bond index benchmark portfolio. Our finding is due to the fact, that European investors temporarily increase shares of the EuroStoxx50 in order to profit from the stock index' high level of excess returns, while the stock index' higher risk exposure is compensated by CDS indices.

Conventional corporate credit risk investment

In a next sensitivity analysis we employ corporate bond indices (CBIs) instead of CDS indices as an alternative proxy for corporate credit risk. CBIs are conventional instruments for portfolio managers to proxy corporate credit risk over a long time period. Several studies, e.g. Levy and Lerman (1988) as well as Liu (2016), highlight the diversification potential of corporate bonds in a portfolio context. However, since the corporate bond market has faced several turbulences over time, such as credit deteriorations, high levels of illiquidity and volatility during the last couple of years (Bao et al., 2011; Friewald et al., 2012; Aussenegg et al., 2015), portfolio benefits of adding CBIs instead of CDS indices are not distinct. Due to data availability reasons, we restrict the sensitivity analysis to the Barclays US Agg Corp AAA (NA CBI), the Barclays Euro Agg Corp (EUR CBI) and the CDS main indices CDXN and iTrE. Corresponding to our CDS main indices, both corporate bond indices are sector-independent and diversified.

Table 8a reports the results from the mean-variance out-of-sample estimations including CBIs and compares these results with results from our baseline findings. As shown, portfolio benefits of adding CBIs are very limited and, in most cases, smaller in value as compared to portfolio benefits from including respective CDS main indices. Hence, Table 8b reports that investors generally hold (remarkably) higher shares of the CDS main indices than shares of the respective CBIs. The dominance of CDS indices is due to several reasons. First, several studies provide evidence for a liquidity transmission from the corporate bond to the CDS market especially during crisis periods (e.g. Amihud et al., 2005; Bühler and Trapp, 2009; Bongaerts et al., 2011; Díaz et al., 2013). Second, the single-asset descriptive statistics (Table 1) show that both CBIs exhibit a higher level of (downside) risk as compared to SBIs and CDS indices in every sub-period. In addition, CDS index performance measures exhibit higher values in most periods. Finally, both CBIs are much stronger positively correlated with respective SBIs as compared to both main CDS indices (Table 2). As a result, the risk-diversification potential of both CBIs is limited, especially in terms of (downside) risk-reduction.

Global investment opportunities

So far, we have analyzed portfolio benefits of adding individual CDS indices to respective benchmark portfolios for the North American and the European CDS market separately. In practice, institutional investors do not face such investment borders, i.e. European investors may also invest in North American CDS indices whereas North American investors may hold shares of European CDS indices. Thus, in a final sensitivity analysis we investigate portfolio benefits from a global investor's point of view. We modify the benchmark portfolio by including the *MSCI World index* and the *Barclays Global Aggregate Sovereign bond index* (*Global SBI*) as respective proxies of the global equity and sovereign bond market. Modifying the benchmark portfolio in this way additionally allows to control if our baseline results are benchmark-sensitive.

As reported by Table 9a, we observe a reduction of portfolio (downside) risk through adding CDS indices even under a global framework. This finding is generally irrespective of individual CDS sub-indices and different sub-periods. However, we do not observe a risk-reduction effect through CDS indices for the global aggressive investor's portfolio during the pre-GFC period. The reason is, that the MSCI World exhibits outstanding risk-return properties during this sub-period resulting in zero mean portfolio weights for the global SBI and nearly all CDS indices (Table 1 and 9b). Finally and in line with our baseline results, the analysis reveals a stronger increase in portfolio excess returns and performance for portfolios from the global conservative investor throughout all sub-periods.

Analyzing mean portfolio weights provides further important insights (Table 9b). Corresponding to our baseline findings, even the global SBI is (heavily) replaced by main CDS indices due to better risk-return properties (Table 1). Furthermore and supporting our baseline results, the global conservative investor holds higher proportions of CDS indices than the global aggressive investor. Finally and most important, Table 9b reveals that both global investors hold larger shares of European than North American CDS indices during the GFC period, and they hold larger proportions of North American than European CDS indices during the post-GFC/ESDC period. Taking this into account, we provide evidence that both CDS main indices are employed for a cross-border risk-diversification strategy.

5 Summary and conclusion

Employing different main and sector-specific CDS indices from the North American and European market and performing mean-variance out-of-sample analyses for conservative and aggressive investors during specific sub-periods between 2006 and 2014, this paper analyzes portfolio benefits of adding corporate CDS indices to a traditional financial portfolio consisting of stock and sovereign bond indices.

As a baseline result, we find an increase in portfolio (downside) risk-diversification when adding CDS indices which exists irrespective of different CDS markets, investor-types and sub-periods (crisis and non-crisis periods). We find the highest risk-diversification gains and the most portfolio benefits for conservative investors. In addition, our analysis reveals an enhancement of portfolio excess returns and performance when adding CDS index portfolios, however, these effects clearly differ between markets, investor-types and sub-periods. Overall, portfolio benefits of adding CDS indices mainly result from the fact that CDS indices replace sovereign bond indices rather than stock indices due to better risk-return properties. Our baseline findings remain robust under a variety of robustness checks. Results from sensitivity analyses additionally reveal that (i) stock index-CDS index portfolios exhibit stronger benefits than traditional stock index-sovereign bond index portfolios, (ii) portfolio benefits of adding CDS indices are stronger than benefits of adding corporate bond indices and (iii) global investors pursue cross-border risk-diversification strategies by means of CDS indices.

In contrast to single-name CDS, a multi-name CDS index is a highly diversified credit risk investment, which is much less sensitive to potential defaults. Even under a policy of low interest rates and even on fragile financial markets, CDS indices provide a sufficient return over the risk-free rate along with a high risk-reduction potential in a portfolio context. Therefore, and against the background of our empirical results we suggest that CDS indices are a beneficial instrument for institutional investors, such as life insurance companies and banks, who have a strategic focus on a long-term conservative portfolio management.

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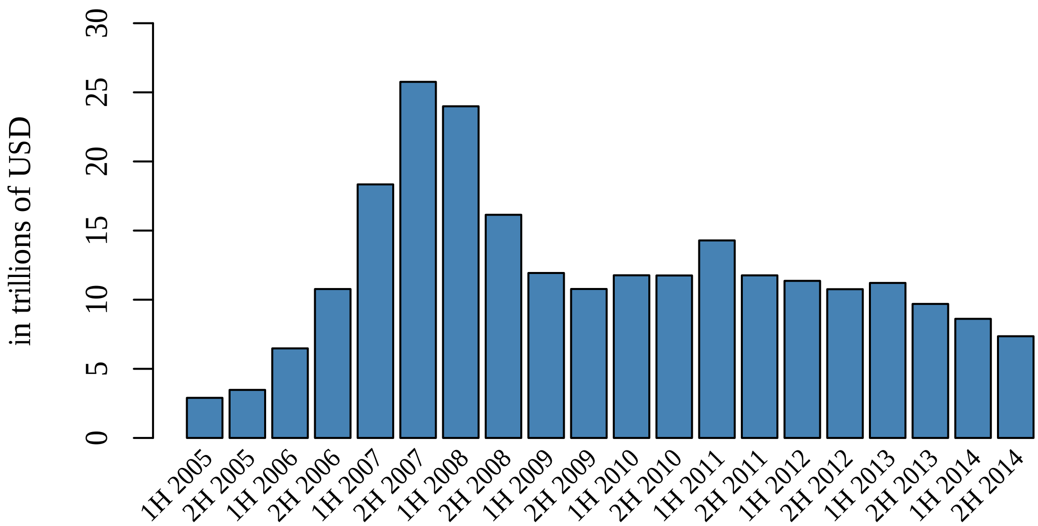
Appendix

Figure 1: Outstanding notional of multi-name credit default swaps



Notes: This figure shows the outstanding notional of multi-name credit default swaps from the first half of 2005 until the second half of 2014 in trillions of US-Dollar. The data is retrieved from the Bank for International Settlements (BIS).

Table 1: Descriptive statistics

	Return (%)	SD (%)	$VaR_{99\%}$ (%)	SR	SoR	OR
Entire period						
S&P500	5.64	16.09	13.33	0.35	0.50	1.31
EuroStoxx50	0.30	24.86	19.15	0.01	0.02	1.01
MSCI World	3.84	17.08	14.88	0.22	0.31	1.20
NA SBI	-2.08	3.65	2.73	-0.57	-0.72	0.65
EUR SBI	-0.72	10.82	9.25	-0.07	-0.09	0.95
Global SBI	-1.65	5.21	6.42	-0.32	-0.38	0.77
NA CBI	-0.08	7.88	8.14	-0.01	0.20	0.99
EUR CBI	-0.12	11.88	10.17	-0.01	-0.01	0.99
CDXN	0.86	2.60	2.27	0.33	0.48	1.33
CDXNF	1.11	2.35	2.36	0.47	0.69	1.51
CDXF	0.00	5.12	6.43	0.00	0.00	1.00
CDXHV	1.63	5.10	3.93	0.32	0.49	1.32
iTrE	1.01	2.49	1.80	0.40	0.62	1.40
iTrNF	1.01	2.47	2.19	0.41	0.60	1.42
iTrF	1.01	3.42	2.24	0.29	0.45	1.27
iTrHV	1.84	4.48	4.05	0.41	0.61	1.43
Pre-GFC period						
S&P500	6.08	7.19	4.27	0.85	1.38	1.78
EuroStoxx50	19.54	9.57	4.27	2.04	5.34	4.58
MSCI World	9.47	7.57	4.64	1.25	2.20	2.34
NA SBI	-6.76	2.51	2.05	-2.69	-2.25	0.15
EUR SBI	-0.69	6.55	3.94	-0.10	-0.15	0.93
Global SBI	-8.42	2.92	2.53	-2.88	-2.32	0.13
NA CBI	-6.13	2.85	2.10	-2.15	-0.57	0.23
EUR CBI	0.62	6.51	3.53	0.10	-0.15	1.07
CDXN	0.68	0.50	0.32	1.36	2.16	2.53
CDXNF	0.79	0.53	0.34	1.49	2.49	2.78
CDXF	0.21	0.52	0.37	0.41	0.57	1.36
CDXHV	0.93	1.18	0.83	0.79	1.13	1.77
iTrE	0.75	0.45	0.19	1.66	4.17	3.57
iTrNF	0.85	0.54	0.22	1.59	4.03	3.37
iTrF	0.31	0.19	0.10	1.64	3.46	3.38
iTrHV	1.53	0.92	0.40	1.66	4.04	3.70
GFC period						
S&P500	-20.30	24.40	16.65	-0.83	-1.02	0.52
EuroStoxx50	-16.84	35.68	24.78	-0.47	-0.61	0.69
MSCI World	-18.02	26.45	19.20	-0.68	-0.84	0.59
NA SBI	-2.04	5.29	3.22	-0.39	-0.54	0.73
EUR SBI	2.33	15.50	11.55	0.15	0.21	1.13
Global SBI	-2.71	7.65	8.21	-0.35	-0.41	0.72
NA CBI	-1.67	14.07	8.70	-0.12	-0.05	0.89
EUR CBI	0.67	17.25	12.86	0.04	0.05	1.03
CDXN	-2.07	4.65	2.82	-0.44	-0.60	0.72
CDXNF	-0.43	4.24	2.99	-0.10	-0.14	0.92
CDXF	-8.66	9.54	7.72	-0.91	-1.07	0.50
CDXHV	-3.92	9.19	4.55	-0.43	-0.61	0.73
iTrE	-0.69	3.74	2.11	-0.19	-0.27	0.87
iTrNF	-0.84	4.11	2.71	-0.20	-0.28	0.85
iTrF	-0.10	3.85	1.95	-0.03	-0.04	0.98
iTrHV	-0.80	7.30	4.97	-0.11	-0.16	0.91
Post-GFC/ESDC period						
S&P500	14.43	13.49	9.10	1.07	1.84	2.19
EuroStoxx50	1.02	23.16	15.27	0.04	0.06	1.03
MSCI World	9.82	14.40	10.03	0.68	1.09	1.67
NA SBI	-0.84	3.17	2.31	-0.27	-0.35	0.82
EUR SBI	-1.77	9.92	8.00	-0.18	-0.23	0.87
Global SBI	0.54	4.55	3.61	0.12	0.16	1.10
NA CBI	2.08	5.60	3.86	0.37	0.17	1.32
EUR CBI	-0.59	10.88	8.60	-0.05	-0.07	0.96
CDXN	1.91	1.83	1.08	1.04	1.93	2.28
CDXNF	1.72	1.68	0.94	1.03	1.91	2.20
CDXF	2.92	3.03	2.22	0.96	1.66	2.22
CDXHV	3.72	3.51	2.27	1.06	1.87	2.30
iTrE	1.66	2.28	1.59	0.73	1.17	1.73
iTrNF	1.68	2.02	1.51	0.83	1.33	1.89
iTrF	1.58	3.73	2.47	0.42	0.65	1.38
iTrHV	2.83	3.78	2.71	0.75	1.21	1.78

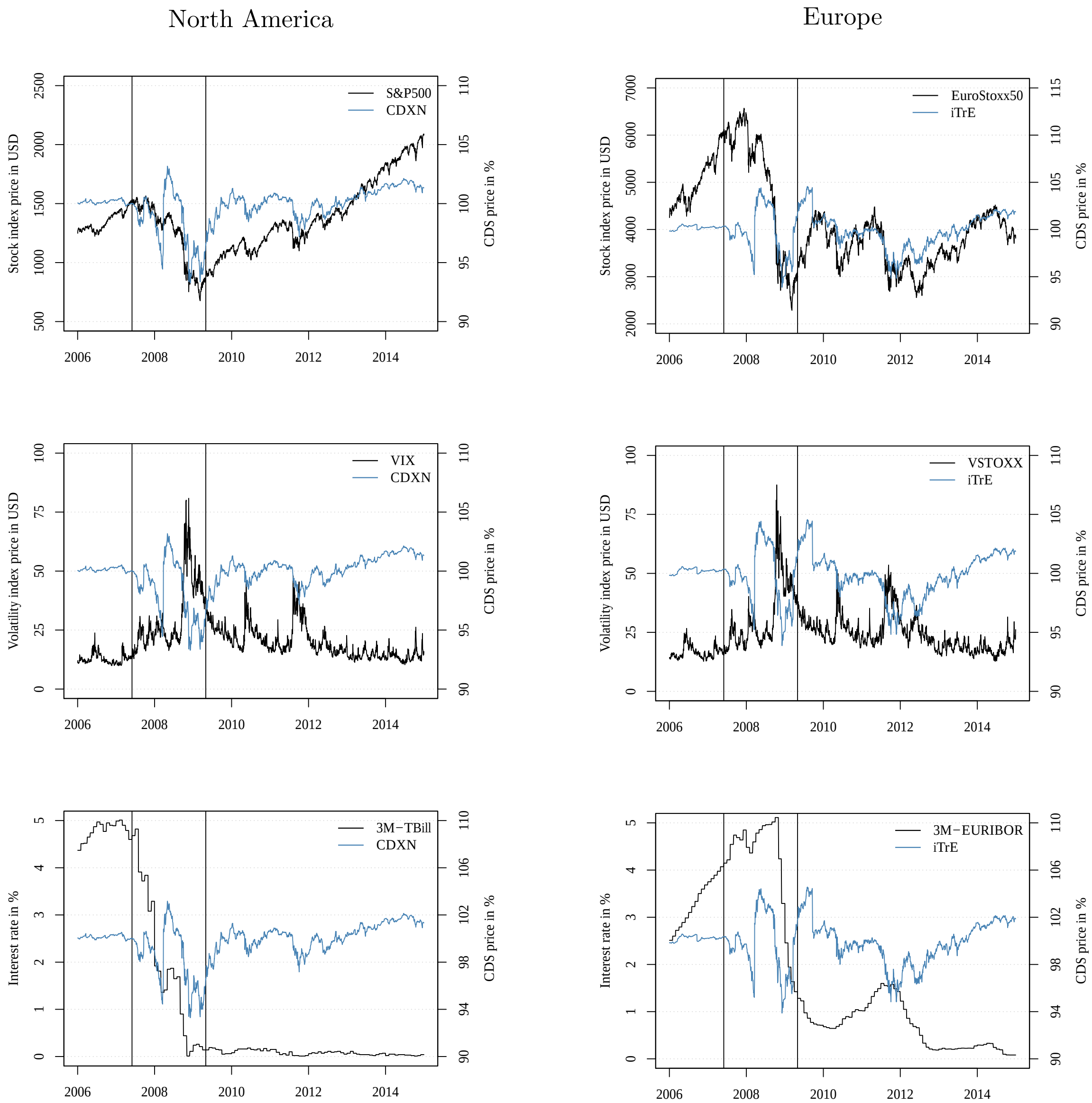
Notes: This table provides sample moments and performance measures of all stock indices, sovereign bond indices, credit default swap indices and corporate bond indices as used in the analysis for the entire period from January 2006 to December 2014 and all analyzed sub-periods. 'Return' denotes the annualized time-series mean of monthly excess returns while 'SD' denotes the corresponding annualized standard deviation of excess returns. '$VaR_{99\%}$' shows the non-parametric 99% Value-at-Risk for the respective asset classes. 'SR' is the annualized Sharpe Ratio and 'SoR' is the corresponding annualized Sortino Ratio. Finally, 'OR' is the annualized Omega Ratio.

Table 2: Correlation matrix

	S&P500	EuroStoxx50	MSCI World	NA SBI	EUR SBI	Global SBI	NA CBI	EUR CBI	CDXN	CDXNF	CDXF	CDXHV	iTrE	iTrNF	iTrF	iTrHV
Entire period																
S&P500	1.00	0.88***	0.97***	−0.19*	0.54***	0.48***	0.19**	0.64***	0.77***	0.71***	0.70***	0.77***	0.61***	0.60***	0.48***	0.60***
EuroStoxx50		1.00	0.94***	−0.19*	0.72***	0.46***	0.13	0.77***	0.70***	0.64***	0.64***	0.69***	0.61***	0.57***	0.57***	0.59***
MSCI World			1.00	−0.21**	0.63***	0.51***	0.17*	0.73***	0.79***	0.72***	0.73***	0.79***	0.65***	0.63***	0.53***	0.64***
NA SBI				1.00	0.26***	0.44***	0.67***	0.10	−0.38***	−0.41***	−0.20**	−0.30***	−0.51***	−0.51***	−0.35***	−0.51***
EUR SBI					1.00	0.56***	0.31***	0.93***	0.35***	0.29***	0.37***	0.35***	0.26***	0.21**	0.33***	0.25***
Global SBI						1.00***	0.46***	0.60***	0.42***	0.36***	0.41***	0.43***	0.31***	0.32***	0.21**	0.33***
NA CBI							1.00	0.25***	−0.03	−0.14	0.18*	0.03	−0.25**	−0.27***	−0.11	−0.25***
EUR CBI								1.00	0.50***	0.41***	0.54***	0.50***	0.43***	0.38***	0.44***	0.42***
CDXN									1.00	0.96***	0.82***	0.95***	0.86***	0.86***	0.63***	0.86***
CDXNF										1.00	0.62***	0.86***	0.86***	0.88***	0.57***	0.89***
CDXF											1.00	0.88***	0.63***	0.58***	0.59***	0.57***
CDXHV												1.00	0.78***	0.76***	0.63***	0.76***
iTrE													1.00	0.98***	0.81***	0.96***
iTrNF														1.00	0.67***	0.98***
iTrF															1.00	0.68***
iTrHV																1.00
Pre-GFC period																
S&P500	1.00	0.82***	0.93***	−0.21	−0.07	0.00	−0.01	0.03	0.59***	0.52**	0.72***	0.55**	0.52**	0.51**	0.41*	0.49**
EuroStoxx50		1.00	0.93***	−0.18	0.17	−0.03	−0.04	0.24	0.42*	0.38	0.45*	0.42*	0.49**	0.49**	0.24*	0.52***
MSCI World			1.00	−0.25	0.06	−0.08	−0.08	0.15	0.60***	0.56**	0.56**	0.59**	0.63***	0.62***	0.39	0.62***
NA SBI				1.00	0.51**	0.91***	0.96***	0.41*	−0.04	−0.01	−0.09	−0.09	−0.25	−0.28	0.20	−0.30
EUR SBI					1.00	0.36	0.47*	0.97***	0.08	0.12	−0.08	0.08	0.04	0.03	0.03	−0.02
Global SBI						1.00	0.94	0.29	0.04	0.03	0.10	−0.03	−0.16	−0.20	0.43*	−0.23
NA CBI							1.00	0.41*	0.11	0.12	0.07	0.05	−0.15	−0.19	0.32	−0.21
EUR CBI								1.00	0.12	0.15	−0.02	0.10	0.11	0.11	0.04	0.04
CDXN									1.00	0.99***	0.75***	0.98***	0.79***	0.77***	0.63***	0.77***
CDXNF										1.00	0.63***	0.97***	0.79***	0.78***	0.61***	0.78***
CDXF											1.00	0.68***	0.53**	0.50**	0.54**	0.49**
CDXHV												1.00	0.82***	0.81***	0.59**	0.80***
iTrE													1.00	1.00***	0.59***	0.96***
iTrNF														1.00	0.53**	0.97***
iTrF															1.00	0.46*
iTrHV																1.00
GFC period																
S&P500	1.00	0.95***	0.98***	0.08	0.67***	0.70***	0.56***	0.71***	0.75***	0.67***	0.66***	0.75***	0.44**	0.44**	0.24	0.48**
EuroStoxx50		1.00	0.98***	0.09	0.77***	0.69***	0.53***	0.82***	0.72***	0.64***	0.66***	0.71***	0.39*	0.40*	0.21	0.44**
MSCI World			1.00	0.01	0.71***	0.71***	0.51**	0.79***	0.77***	0.68***	0.70***	0.76***	0.47**	0.48**	0.25	0.51**
NA SBI				1.00	0.50**	0.39*	0.56***	0.32	−0.38*	−0.44**	−0.12	−0.25	−0.64***	−0.61***	−0.50**	−0.64***
EUR SBI					1.00	0.72***	0.60***	0.95***	0.33	0.23	0.42**	0.33	−0.08	−0.05	−0.20	−0.03
Global SBI						1.00	0.44**	0.76***	0.47**	0.39*	0.48**	0.49**	0.21	0.29	−0.22	0.27
NA CBI							1.00	0.55***	0.08	−0.08	0.34	0.16	−0.24	−0.26	−0.06	−0.25
EUR CBI								1.00	0.47**	0.33	0.59***	0.47**	0.11	0.13	−0.06	0.15
CDXN									1.00	0.95***	0.78***	0.94***	0.89***	0.87***	0.60***	0.87***
CDXNF										1.00	0.54***	0.83***	0.89***	0.90***	0.46**	0.92***
CDXF											1.00	0.86***	0.58***	0.50**	0.67***	0.48**
CDXHV												1.00	0.78***	0.73***	0.66***	0.74***
iTrE													1.00	0.98***	0.65***	0.96***
iTrNF														1.00	0.51**	0.98***
iTrF															1.00	0.50**
iTrHV																1.00
Post-GFC/ESDC period																
S&P500	1.00	0.86***	0.97***	−0.49***	0.54***	0.32***	−0.35***	0.66***	0.83***	0.81***	0.81***	0.84***	0.78***	0.79***	0.67***	0.75***
EuroStoxx50		1.00	0.93***	−0.42***	0.73***	0.35***	−0.33***	0.78***	0.75***	0.72***	0.75***	0.76***	0.80***	0.76***	0.79***	0.75***
MSCI World			1.00	−0.45***	0.65***	0.38***	−0.33***	0.77***	0.86***	0.83***	0.84***	0.86***	0.83***	0.83***	0.75***	0.80***
NA SBI				1.00	0.03	0.39***	0.81***	−0.11	−0.49***	−0.48***	−0.45***	−0.46***	−0.45***	−0.48***	−0.33***	−0.44***
EUR SBI					1.00	0.47***	−0.04	0.92***	0.45***	0.43***	0.46***	0.46***	0.57***	0.51***	0.65***	0.57***
Global SBI						1.00	0.45***	0.51***	0.39***	0.37***	0.39***	0.39***	0.43***	0.39***	0.46***	0.42***
NA CBI							1.00	−0.13	−0.29**	−0.29**	−0.25**	−0.28**	−0.29**	−0.33***	−0.18	−0.29**
EUR CBI								1.00	0.62***	0.58***	0.65***	0.64***	0.72***	0.67***	0.74***	0.72***
CDXN									1.00	0.99***	0.91***	0.96***	0.87***	0.87***	0.78***	0.86***
CDXNF										1.00	0.84***	0.92***	0.86***	0.86***	0.77***	0.85***
CDXF											1.00	0.94***	0.79***	0.78***	0.72***	0.78***
CDXHV												1.00	0.83***	0.83***	0.75***	0.83***
iTrE													1.00	0.98***	0.93***	0.97***
iTrNF														1.00	0.85***	0.98***
iTrF															1.00	0.87***
iTrHV																1.00

Notes: This table provides pairwise inter-asset correlation coefficients of monthly excess returns with respect to the different asset classes for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Figure 2: Economic environment



Notes: These figures show the development of stock index prices, volatilities of stock index prices, the short-term risk-free interest rates and respective prices of the North American and European main CDS index (CDXN, iTrE) between January 2006 and December 2014. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Table 3a: Mean-variance out-of-sample results (baseline analysis)

	North American investor										European investor									
	BM	CDXN	CDXNF	CDXF	CDXHV	BM	CDXN	CDXNF	CDXF	CDXHV	BM	iTrE	iTrNF	iTrF	iTrHV	BM	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	2.77	**3.22**	**3.43**	2.56	**2.89**	0.55	**1.25**	**1.56**	**0.95**	**1.48**	1.39	-1.03	-1.34	0.36	-0.05	-0.61	**0.32**	**0.23**	**0.87**	**1.78**
SD (%)	9.37	**8.75**	**8.72**	**8.86**	**9.18**	4.76	**4.18**	**4.15**	**4.27**	**4.30**	12.66	**8.53**	**8.53**	**8.97**	**9.34**	*10.04*	**4.15**	**4.12**	**4.62**	*5.02*
$VaR_{99\%}$ (%)	5.11	**4.77**	**4.78**	**4.85**	**4.95**	2.58	**2.24**	**2.25**	**2.30**	**2.30**	7.73	**4.68**	**4.73**	**4.93**	**5.23**	6.46	**2.23**	**2.28**	**2.44**	**2.87**
SR	0.11	**0.31**	**0.33**	**0.25**	**0.18**	0.13	**0.37**	**0.34**	**0.36**	**0.38**	0.13	**0.18**	0.08	**0.32**	0.05	-0.11	**0.14**	**0.11**	**0.27**	**0.22**
SoR	0.42	**0.51**	**0.52**	**0.60**	**0.50**	0.12	**2.88**	**0.66**	**0.81**	**0.53**	0.40	**0.64**	**0.68**	**0.54**	**0.80**	0.15	**0.82**	**0.85**	**0.71**	**0.99**
OR	1.25	**1.32**	**1.34**	1.24	**1.27**	1.09	**1.23**	**1.29**	**1.18**	**1.28**	1.08	0.92	0.90	1.03	1.00	0.96	**1.05**	**1.04**	**1.14**	**1.26**
PT (%)	15.36	30.91	30.51	29.12	28.16	10.94	29.87	31.96	29.59	30.56	11.59	37.02	37.32	35.48	35.78	4.87	20.37	20.61	15.47	16.17
Pre-GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	6.08	2.24	2.26	2.13	2.45	1.85	1.11	1.08	1.06	1.40	19.54	16.13	16.14	16.11	16.17	4.20	**8.07**	**8.10**	**7.97**	**8.21**
SD (%)	6.97	**4.49**	**4.58**	**4.24**	**5.08**	4.96	**2.89**	**2.93**	**2.77**	**3.19**	9.57	**9.02**	**9.03**	**9.00**	**9.06**	*5.75*	**4.70**	**4.71**	**4.66**	**4.75**
$VaR_{99\%}$ (%)	3.66	**2.46**	**2.51**	**2.31**	**2.77**	2.69	**1.61**	**1.64**	**1.53**	**1.84**	5.00	**4.69**	**4.69**	**4.67**	**4.71**	2.84	**2.41**	**2.42**	**2.37**	**2.49**
SR	0.81	**0.97**	**0.86**	**1.20**	0.70	0.41	**1.02**	**0.96**	**1.22**	**0.70**	2.02	1.81	1.80	1.88	1.77	0.81	**1.76**	**1.75**	**1.82**	**1.73**
SoR	0.21	**0.48**	**0.44**	**1.16**	**0.38**	0.00	**0.62**	**0.57**	**2.10**	**0.47**	0.99	**1.00**	**1.00**	**1.04**	**1.00**	0.24	**1.15**	**1.07**	**1.79**	**0.99**
OR	1.78	1.36	1.37	1.35	1.40	1.29	1.25	1.24	1.23	**1.31**	4.58	3.96	3.96	3.95	3.96	1.64	**3.61**	**3.62**	**3.58**	**3.70**
PT (%)	5.56	59.95	56.80	54.85	42.90	13.27	47.99	49.30	41.31	52.87	5.56	16.67	16.67	16.67	16.67	21.38	25.03	24.87	25.61	24.55
GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	-6.75	**-3.50**	**-2.33**	-6.77	-6.78	-5.01	**-3.18**	**-1.59**	**-4.66**	**-3.21**	-5.27	-9.96	-11.29	-5.91	-12.99	-0.89	-4.80	-5.14	-3.90	-3.19
SD (%)	5.61	**5.23**	**5.12**	5.62	5.62	4.50	**3.92**	**3.71**	**4.35**	**4.27**	11.23	**7.24**	**7.51**	**7.01**	**8.42**	*9.80*	**4.60**	**4.77**	**4.64**	*5.48*
$VaR_{99\%}$ (%)	3.21	**3.07**	**3.07**	3.21	3.21	2.55	**2.34**	**2.30**	**2.43**	**2.42**	6.36	**3.53**	**3.81**	**3.26**	**4.54**	5.71	**2.36**	**2.62**	**2.25**	**3.39**
SR	-1.27	**-0.87**	**-0.68**	-1.28	-1.28	-1.00	**-0.97**	-1.00	-1.05	**-0.78**	-0.85	-1.22	-1.41	**-0.46**	-1.81	-0.31	-1.09	-1.26	-0.71	-1.24
SoR	0.02	0.01	**0.04**	0.02	0.02	-0.06	**-0.05**	**-0.01**	-0.06	-0.06	0.68	**0.69**	**0.69**	**0.74**	**0.69**	0.29	**0.34**	**0.35**	**0.36**	**0.35**
OR	0.43	**0.64**	**0.76**	0.43	0.43	0.49	**0.61**	**0.80**	0.48	**0.61**	0.79	0.50	0.47	0.65	0.48	0.95	0.57	0.56	0.64	0.78
PT (%)	12.94	31.60	32.11	12.94	12.94	12.08	27.28	39.68	19.57	16.96	13.06	32.13	34.97	23.46	36.80	8.78	23.47	23.85	23.05	23.66
Post-GFC/ESDC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	5.15	**5.80**	**5.71**	**5.88**	**6.33**	2.10	**2.82**	**2.78**	**2.84**	**3.11**	-1.20	-2.57	-2.62	-1.72	**0.03**	-1.81	**-0.01**	**-0.04**	**0.61**	**1.76**
SD (%)	11.31	**11.10**	**11.08**	**11.22**	11.51	4.80	**4.61**	**4.63**	**4.64**	**4.60**	13.97	**8.84**	**8.75**	**9.64**	**9.74**	*11.28*	**3.84**	**3.74**	**4.60**	**4.94**
$VaR_{99\%}$ (%)	6.15	**5.97**	**5.98**	**6.09**	**6.13**	2.57	**2.37**	**2.39**	**2.47**	**2.38**	8.93	**5.07**	**5.06**	**5.58**	**5.61**	7.68	**2.14**	**2.13**	**2.53**	**2.79**
SR	0.39	**0.54**	**0.53**	**0.52**	**0.55**	0.45	**0.66**	**0.63**	**0.62**	**0.69**	-0.05	**0.22**	**0.14**	**0.18**	**0.23**	-0.29	**0.13**	**0.13**	**0.19**	**0.31**
SoR	0.61	**0.69**	**0.71**	**0.66**	**0.69**	0.21	**4.49**	**0.92**	**0.77**	**0.75**	0.14	**0.53**	**0.59**	**0.34**	**0.79**	0.07	**0.89**	**0.96**	**0.53**	**1.21**
OR	1.44	**1.51**	**1.50**	**1.52**	**1.55**	1.42	**1.60**	**1.58**	**1.65**	**1.71**	0.93	0.80	0.79	0.87	**1.00**	0.87	**1.00**	**0.99**	**1.10**	**1.33**
PT (%)	21.81	25.86	25.88	30.75	29.53	12.79	28.36	27.50	32.64	31.96	15.70	47.16	46.66	47.64	43.54	2.06	21.01	21.30	13.10	14.24

Notes: This table shows the results of the mean-variance out-of-sample optimized benchmark (BM) portfolios consisting of stock and sovereign bond indices and the respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

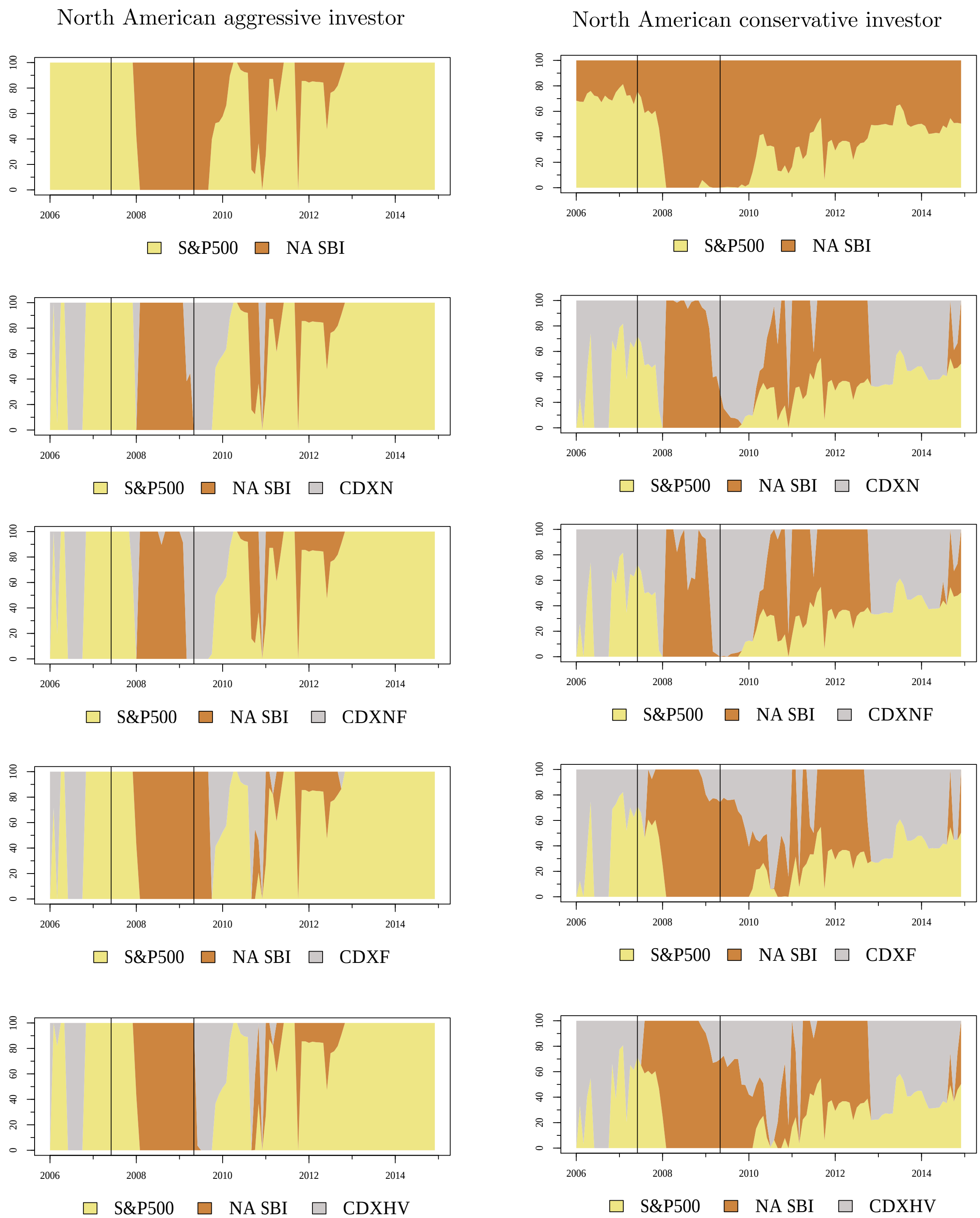
Table 3b: Mean-variance out-of-sample portfolio weights (baseline analysis)

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index
aggressive													
BM	Mean (%)	70.89***	29.11***		100.00***	0.00		27.91***	72.09***		77.83***	22.17***	
	SD (%)	40.47	40.47		0.00	0.00		44.64	44.64		32.67	32.67	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
CDXN	Mean (%)	63.65***	19.70***	16.65***	61.40***	0.00	38.60***	26.09***	60.13***	13.78**	77.15***	11.12***	11.73***
	SD (%)	43.92	35.37	35.35	49.80	0.00	49.80	44.90	47.82	31.97	33.74	22.70	29.80
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CDXNF	Mean (%)	63.50***	18.76***	17.74***	62.19***	0.00	37.81***	24.42***	55.69***	19.89**	77.26***	11.12***	11.62***
	SD (%)	43.57	34.95	36.29	48.97	0.00	48.97	42.69	50.02	38.47	33.58	22.70	29.57
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
CDXF	Mean (%)	62.91***	24.11***	12.98***	59.55***	0.00	40.45***	27.93***	72.07***	0.00	75.81***	14.13***	10.06***
	SD (%)	43.90	39.54	30.39	49.31	0.00	49.31	44.65	44.65	0.00	35.14	28.44	24.46
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00
CDXHV	Mean (%)	63.95***	20.91***	15.14***	65.66***	0.00	34.34***	27.95***	72.05***	0.00	75.84***	8.97***	15.19***
	SD (%)	43.58	37.02	33.40	47.96	0.00	47.96	44.65	44.65	0.00	35.00	19.53	32.19
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	37.11***	62.89***		71.98***	28.02***		16.98***	83.02***		34.65***	65.35***	
	SD (%)	25.27	25.27		4.27	4.27		26.44	26.44		17.85	17.85	
	Max. (%)	81.37	100.00		81.37	34.47		71.08	100.00		65.43	99.94	
CDXN	Mean (%)	28.15***	31.54***	40.31***	37.30***	0.00	62.70***	12.04***	59.28***	28.68***	31.22***	30.49***	38.29***
	SD (%)	22.78	37.16	35.14	33.70	0.00	33.70	22.34	45.14	32.31	16.11	31.92	34.26
	Max. (%)	81.79	100.00	100.00	81.79	0.00	100.00	67.02	100.00	100.00	61.31	93.94	97.22
CDXNF	Mean (%)	28.38***	29.46***	42.16***	37.08***	0.00	62.92***	11.81**	47.62***	40.57***	31.72***	31.14***	37.14***
	SD (%)	22.74	35.88	36.10	33.43	0.00	33.43	22.66	44.63	36.46	15.86	32.68	35.18
	Max. (%)	81.69	100.00	100.00	81.69	0.00	100.00	67.27	100.00	100.00	61.37	93.93	99.87
CDXF	Mean (%)	26.93***	36.32***	36.75***	37.94***	0.00	62.06***	15.69***	74.84***	9.47***	27.83***	32.86***	39.31***
	SD (%)	23.88	36.93	32.29	35.05	0.00	35.05	25.31	31.88	14.75	17.80	31.37	29.34
	Max. (%)	82.21	100.00	100.00	82.21	0.00	100.00	66.00	100.00	53.72	60.78	93.94	94.01
CDXHV	Mean (%)	25.40***	37.12***	37.48***	34.04***	0.00	65.96***	16.27***	76.55***	7.18***	26.21***	33.55***	40.24***
	SD (%)	22.73	36.36	33.76	31.43	0.00	31.43	26.16	28.45	12.76	17.46	30.70	31.47
	Max. (%)	80.70	100.00	100.00	80.70	0.00	100.00	65.08	100.00	34.92	58.27	93.94	99.22

European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index
aggressive													
BM	Mean (%)	41.49***	58.51***		100.00***	0.00		30.42***	69.58***		29.57***	70.43***	
	SD (%)	45.16	45.16		0.00	0.00		47.05	47.05		38.05	38.05	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
iTrE	Mean (%)	42.15***	13.76***	44.07***	94.44***	0.00	5.56	30.43***	37.38***	32.19***	32.13***	9.35***	58.52***
	SD (%)	45.06	32.11	44.77	23.57	0.00	23.57	47.05	48.35	46.61	38.93	25.02	41.44
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrNF	Mean (%)	42.39***	13.51***	44.10***	94.44***	0.00	5.56	30.43***	38.09***	31.48***	32.52***	8.70***	58.78***
	SD (%)	45.09	32.32	44.95	23.57	0.00	23.57	47.05	48.82	46.61	39.08	24.81	41.57
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrF	Mean (%)	41.15***	15.55***	43.30***	94.44***	0.00	5.56	30.43***	35.21***	34.36***	30.52***	12.98***	56.50***
	SD (%)	45.09	34.28	45.00	23.57	0.00	23.57	47.05	48.42	48.14	38.54	30.28	42.12
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrHV	Mean (%)	41.26***	15.19***	43.55***	94.44***	0.00	5.56	30.43***	40.62***	28.95***	30.69***	10.54***	58.77***
	SD (%)	45.00	33.46	44.31	23.57	0.00	23.57	47.05	48.51	44.51	38.43	26.84	40.95
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	7.81***	92.19***		29.01***	70.99***		13.79***	86.21***		0.06	99.94***	
	SD (%)	12.65	12.65		7.93	7.93		11.85	11.85		0.73	0.73	
	Max. (%)	41.14	100.00		41.14	87.90		33.90	99.99		5.23	100.00	
iTrE	Mean (%)	15.48***	9.83***	74.70***	47.70***	1.86*	50.44***	14.49***	26.88***	58.63***	7.16***	6.11***	86.73***
	SD (%)	19.93	22.61	26.58	13.43	4.54	14.94	20.84	35.55	32.36	9.95	16.43	18.48
	Max. (%)	59.73	91.47	100.00	59.73	15.99	100.00	54.56	79.23	100.00	29.33	91.47	100.00
iTrNF	Mean (%)	15.64***	10.14***	74.22***	47.45***	1.87**	50.68***	14.47***	27.01***	58.52***	7.50***	6.57***	85.93***
	SD (%)	19.90	23.42	26.93	13.32	4.60	14.85	20.83	35.67	32.39	10.39	18.14	19.84
	Max. (%)	59.36	98.48	100.00	59.36	16.41	100.00	54.42	79.41	100.00	30.42	98.48	100.00
iTrF	Mean (%)	14.43***	8.14***	77.43***	48.61***	1.87***	49.52***	14.47***	26.75***	58.78***	5.23***	3.44***	91.33***
	SD (%)	20.22	19.59	25.46	13.81	4.45	15.30	20.80	34.84	31.94	8.06	7.66	10.98
	Max. (%)	61.07	78.43	100.00	61.07	14.76	100.00	55.08	78.43	100.00	25.43	30.97	100.00
iTrHV	Mean (%)	13.94***	10.11***	75.95***	45.71***	1.92***	52.37***	13.87***	32.34***	53.79***	5.43***	4.67***	89.90***
	SD (%)	19.38	20.41	24.46	13.09	4.66	14.72	20.10	32.92	26.72	9.01	9.39	12.48
	Max. (%)	57.63	80.55	100.00	57.63	16.94	100.00	53.64	80.55	93.01	27.20	42.23	100.00

Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Figure 3a: Time-varying mean-variance out-of-sample portfolio weights (baseline analysis)



Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both North American investors for the entire period from January 2006 to December 2014 and all sub-periods. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Figure 3b: Time-varying mean-variance out-of-sample portfolio weights (baseline analysis)

Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both European investors for the entire period from January 2006 to December 2014 and all sub-periods. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Table 4a: Changes in CDS index portfolio benefits due to transaction costs

	Total			North America			Europe		
TC level in bps	Changes from baseline in %	Negative changes in %	Positive changes in %	Changes from baseline in %	Negative changes in %	Positive changes in %	Changes from baseline in %	Negative changes in %	Positive changes in %
10	4.69	2.87	1.82	8.33	4.69	3.64	1.04	1.04	0.00
20	12.50	12.24	0.26	23.44	22.92	0.52	1.56	1.56	0.00
30	16.15	14.59	1.56	26.04	25.52	0.52	6.25	3.65	2.60
40	12.50	10.68	1.82	18.75	18.23	0.52	6.25	3.13	3.12
50	16.41	9.38	7.04	22.92	16.67	6.25	9.90	2.08	7.82
60	17.19	9.90	7.30	22.92	17.19	5.73	11.46	2.60	8.86
70	18.49	10.68	7.81	23.44	17.19	6.25	13.54	4.17	9.37
80	17.45	9.90	7.56	21.88	14.06	7.82	13.02	5.73	7.29
90	16.15	9.12	7.03	21.35	13.02	8.33	10.94	5.21	5.73
100	21.35	9.64	11.72	21.35	12.50	8.85	21.35	6.77	14.58

Notes: This table shows the changes in CDS index portfolio benefits due to transaction costs (TC). Changes (in %) are aggregated over all portfolio measures, all time-periods and both investor-types (aggressive and conservative) for different transaction cost levels.

Table 4b: Mean-variance out-of-sample results (40 bps transaction costs)

North American investor	BM	CDXN	CDXNF	CDXF	CDXHV	BM	CDXN	CDXNF	CDXF	CDXHV
Entire period	*aggressive*					*conservative*				
Return (%)	5.50	4.46	4.48	4.36	4.43	1.54	**1.72**	**1.96**	1.05	1.43
SD (%)	10.02	**9.01**	**9.03**	**8.98**	**9.11**	4.89	**3.71**	**3.67**	**3.94**	**4.04**
$VaR_{99\%}$ (%)	5.51	**4.97**	**4.98**	**4.97**	**5.04**	2.65	**2.15**	**2.13**	**2.24**	**2.32**
SR	0.31	**0.34**	**0.34**	0.28	0.28	0.28	**0.32**	**0.38**	0.16	0.17
SoR	0.41	**0.56**	**0.55**	**0.96**	**0.51**	0.11	**4.02**	**0.77**	**1.00**	**0.52**
OR	1.48	1.43	1.43	1.42	1.43	1.25	**1.36**	**1.44**	1.19	**1.27**
PT (%)	6.08	8.77	8.75	8.86	9.81	6.68	6.19	6.11	7.75	7.59
Pre-GFC period	*aggressive*					*conservative*				
Return (%)	6.08	-0.88	-0.78	-1.29	-0.35	1.82	-0.02	0.09	-0.55	0.46
SD (%)	6.97	**0.95**	**1.03**	**0.71**	**1.74**	4.92	**0.75**	**0.82**	**0.54**	**1.51**
$VaR_{99\%}$ (%)	3.66	**0.56**	**0.62**	**0.38**	**1.09**	2.71	**0.43**	**0.48**	**0.29**	**0.92**
SR	0.81	**1.00**	**0.98**	0.66	0.57	0.38	**0.98**	**0.96**	**0.65**	**0.50**
SoR	0.21	**0.89**	**0.81**	**3.44**	**0.58**	0.02	**0.93**	**0.86**	**3.37**	**0.59**
OR	1.78	0.56	0.61	0.39	0.86	1.28	0.98	1.08	0.59	1.27
PT (%)	5.56	16.67	16.67	16.67	16.67	11.40	10.56	10.53	11.21	9.67
GFC period	*aggressive*					*conservative*				
Return (%)	-9.78	-9.81	-9.78	-9.83	-9.80	-6.81	**-5.16**	**-4.10**	-7.69	-6.87
SD (%)	5.81	**5.80**	**5.80**	5.81	5.81	4.51	**3.05**	**2.88**	**3.98**	**3.93**
$VaR_{99\%}$ (%)	3.34	**3.33**	**3.33**	3.34	3.34	2.72	**2.29**	**2.23**	**2.61**	**2.69**
SR	-1.65	-1.66	-1.65	-1.66	-1.65	-1.50	-2.03	-1.68	-2.39	-2.30
SoR	0.02	0.02	0.02	0.02	0.02	-0.10	-0.20	-0.14	-0.19	-0.17
OR	0.34	0.34	0.34	0.34	0.34	0.41	0.39	**0.43**	0.38	0.39
PT (%)	13.03	13.06	13.04	13.03	13.03	11.27	9.98	10.00	15.27	15.14
Post-GFC/ESDC period	*aggressive*					*conservative*				
Return (%)	10.60	**10.80**	**10.78**	**10.74**	10.60	4.34	**4.56**	**4.54**	**4.49**	**4.54**
SD (%)	12.29	**12.28**	12.29	12.29	**12.23**	*5.01*	**4.73**	**4.71**	**4.85**	**4.76**
$VaR_{99\%}$ (%)	6.76	**6.72**	**6.72**	6.77	**6.68**	2.61	**2.56**	**2.53**	2.63	**2.58**
SR	0.84	**0.86**	**0.85**	**0.85**	**0.86**	0.87	**0.94**	**0.93**	**0.90**	**0.94**
SoR	0.60	**0.65**	**0.66**	**0.62**	**0.65**	0.20	**6.30**	**1.06**	**0.77**	**0.75**
OR	1.95	**1.97**	**1.97**	**1.97**	**1.98**	1.97	**2.03**	**2.02**	**2.05**	**2.08**
PT (%)	6.83	6.85	6.85	8.33	6.85	6.71	6.58	6.48	7.04	7.16

European investor	BM	iTrE	iTrNF	iTrF	iTrHV	BM	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*					*conservative*				
Return (%)	1.53	-0.96	-0.82	-1.44	1.16	-0.62	**0.38**	**0.35**	**0.29**	**1.75**
SD (%)	12.95	**7.89**	**7.84**	**8.46**	**8.88**	*10.04*	**3.92**	**3.89**	**4.53**	**4.93**
$VaR_{99\%}$ (%)	7.97	**4.31**	**4.34**	**4.65**	**5.01**	6.45	**2.07**	**2.12**	**2.37**	**2.81**
SR	0.07	**0.14**	**0.14**	0.04	**0.23**	-0.12	**0.19**	**0.17**	**0.16**	**0.22**
SoR	0.39	**0.63**	**0.67**	**0.53**	**0.76**	0.15	**0.81**	**0.84**	**0.71**	**0.97**
OR	1.09	0.93	0.93	0.90	1.09	0.96	**1.06**	**1.06**	**1.04**	**1.25**
PT (%)	7.07	12.62	12.51	13.00	11.75	4.76	7.74	7.90	7.73	8.95
Pre-GFC period	*aggressive*					*conservative*				
Return (%)	19.54	13.34	13.41	13.04	13.88	4.20	**7.03**	**7.09**	**6.88**	**7.54**
SD (%)	9.57	**7.32**	**7.34**	**7.25**	**7.48**	*5.75*	**4.00**	**4.02**	**3.92**	**4.14**
$VaR_{99\%}$ (%)	5.00	**3.74**	**3.75**	**3.69**	**3.84**	2.84	**2.03**	**2.04**	**1.97**	**2.16**
SR	2.02	**2.12**	**2.11**	1.91	**2.12**	0.81	**2.08**	**2.07**	**1.90**	**2.07**
SoR	0.99	**1.00**	0.99	**1.16**	0.98	0.24	**1.16**	**1.07**	**1.87**	**0.99**
OR	4.58	3.59	3.59	3.52	3.70	1.64	**3.35**	**3.37**	**3.29**	**3.59**
PT (%)	5.56	16.67	16.67	16.67	16.67	21.38	17.35	17.22	17.43	16.30
GFC period	*aggressive*					*conservative*				
Return (%)	-6.74	-12.12	-11.94	-12.84	-7.40	-0.89	-7.42	-7.54	-7.08	-4.91
SD (%)	11.83	**7.80**	**7.97**	**7.87**	**9.82**	*9.80*	**4.55**	**4.73**	**4.69**	*5.49*
$VaR_{99\%}$ (%)	6.95	**4.09**	**4.33**	**4.04**	**5.83**	5.71	**2.32**	**2.56**	**2.26**	**3.39**
SR	-1.14	-1.30	-1.31	-1.45	**-0.94**	-0.31	-1.46	-1.51	-1.38	-1.37
SoR	0.64	0.64	0.64	**0.70**	**0.65**	0.29	**0.31**	**0.32**	**0.34**	**0.33**
OR	0.74	0.44	0.45	0.42	0.70	0.95	0.46	0.47	0.47	0.68
PT (%)	13.10	21.78	21.78	21.78	21.87	8.78	19.67	19.72	19.50	22.58
Post-GFC/ESDC period	*aggressive*					*conservative*				
Return (%)	-0.47	-0.97	-0.82	-1.41	**0.68**	-1.82	**1.27**	**1.24**	**1.05**	**2.47**
SD (%)	14.24	**8.07**	**7.94**	**8.99**	**8.94**	*11.27*	**3.68**	**3.56**	**4.63**	**4.95**
$VaR_{99\%}$ (%)	9.13	**4.54**	**4.50**	**5.11**	**5.04**	7.68	**1.99**	**1.98**	**2.51**	**2.78**
SR	-0.04	**0.10**	**0.11**	**0.05**	**0.12**	-0.30	**0.25**	**0.24**	**0.22**	**0.28**
SoR	0.14	**0.52**	**0.59**	**0.30**	**0.74**	0.07	**0.89**	**0.96**	**0.52**	**1.18**
OR	0.97	0.92	0.93	0.89	**1.06**	0.87	**1.29**	**1.30**	**1.18**	**1.49**
PT (%)	8.39	11.38	11.20	11.97	9.93	1.89	4.10	4.30	4.04	5.27

Notes: This table shows the results of the mean-variance out-of-sample optimized benchmark (BM) portfolios consisting of stock and sovereign bond indices and the respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods while implementing a transaction cost level of 40 bps. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

Table 4c: Mean-variance out-of-sample portfolio weights (40 bps transaction costs)

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index
aggressive													
BM	Mean (%)	75.77***	24.23***		100.00***	0.00		31.48***	68.52***		84.46***	15.54***	
	SD (%)	38.13	38.13		0.00	0.00		46.61	46.61		26.70	26.70	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
CDXN	Mean (%)	60.02***	22.99***	16.99***	5.56	0.00	94.44***	31.60***	68.40***	0.00	84.41***	13.58***	2.01***
	SD (%)	44.92	38.21	36.69	23.57	0.00	23.57	46.54	46.54	0.00	26.68	26.31	8.65
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	99.99	45.17
CDXNF	Mean (%)	60.05***	22.99***	16.96***	5.56	0.00	94.44***	31.53***	68.47***	0.00	84.47***	13.55***	1.98**
	SD (%)	44.94	38.24	36.67	23.57	0.00	23.57	46.56	46.56	0.00	26.64	26.31	8.46
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.01	100.00	99.99	44.05
CDXF	Mean (%)	59.87***	23.18***	16.95***	5.56	0.00	94.44***	31.57***	68.43***	0.00	84.18***	13.88***	1.94**
	SD (%)	44.95	38.17	36.68	23.57	0.00	23.57	46.59	46.59	0.00	26.94	26.28	8.48
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	47.41
CDXHV	Mean (%)	59.07***	21.72***	19.21***	5.56	0.00	94.44***	31.51***	68.49***	0.00	82.91***	11.50***	5.59**
	SD (%)	45.29	37.52	38.54	23.57	0.00	23.57	46.60	46.60	0.00	28.91	23.69	20.11
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	39.00***	61.00***		71.38***	28.62***		20.14***	79.86***		36.77***	63.23***	
	SD (%)	23.84	23.84		3.74	3.74		27.22	27.22		16.00	16.00	
	Max. (%)	78.47	100.00		78.47	34.47		71.08	100.00		65.43	99.93	
CDXN	Mean (%)	20.32***	11.92***	67.76***	2.51	0.00	97.49***	13.53***	29.57***	56.90***	27.44***	9.07***	63.49***
	SD (%)	18.18	16.15	16.10	10.62	0.00	10.62	20.83	20.02	1.33	14.43	11.55	9.48
	Max. (%)	58.15	44.60	100.00	45.05	0.00	100.00	44.92	44.60	58.85	58.15	42.59	90.55
CDXNF	Mean (%)	20.90***	11.55***	67.55***	2.49	0.00	97.51***	13.54***	28.40***	58.06***	28.37***	8.86***	62.77***
	SD (%)	18.20	15.39	15.91	10.55	0.00	10.55	20.56	19.23	1.54	14.13	10.86	9.04
	Max. (%)	58.32	42.59	100.00	44.77	0.00	100.00	44.55	42.59	60.61	58.32	39.52	88.74
CDXF	Mean (%)	19.69***	25.08***	55.23***	2.83	0.00	97.17***	14.10***	50.95***	34.95***	26.13***	22.94***	50.93***
	SD (%)	18.56	27.69	22.99	11.99	0.00	11.99	21.61	34.71	17.70	15.35	20.78	8.56
	Max. (%)	57.00	100.00	100.00	50.88	0.00	100.00	50.09	100.00	51.82	57.00	77.84	62.21
CDXHV	Mean (%)	16.85***	24.87***	58.28***	2.06	0.00	97.94***	11.22***	53.58***	35.20***	22.75***	21.69***	55.56***
	SD (%)	16.36	28.61	23.40	8.72	0.00	8.72	17.33	38.24	22.49	14.43	19.34	8.80
	Max. (%)	56.11	96.49	100.00	37.00	0.00	100.00	37.40	96.49	64.40	56.11	72.55	68.94

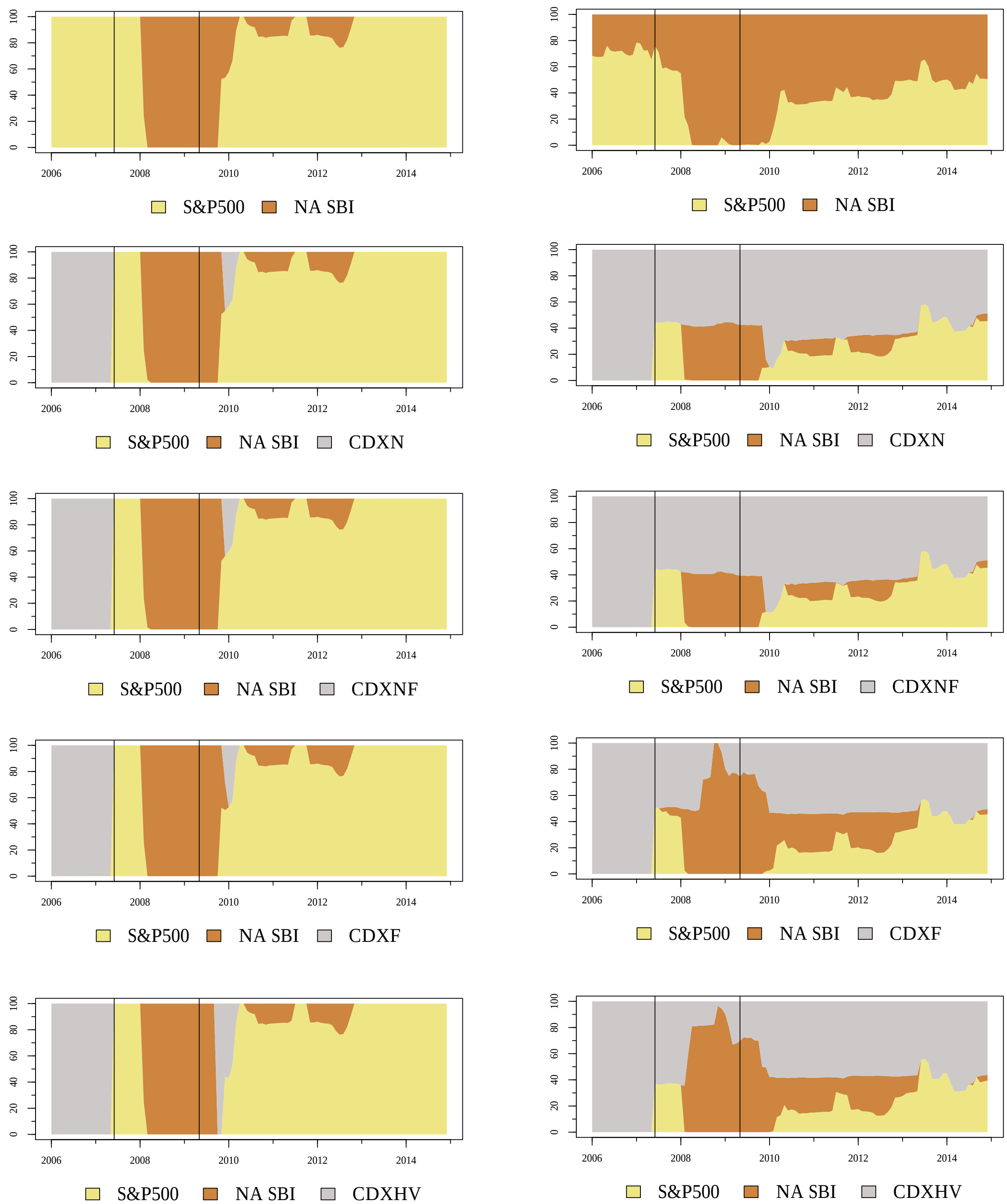
European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index
aggressive													
BM	Mean (%)	44.23***	55.77***		100.00***	0.00		37.71***	62.29***		31.49***	68.51***	
	SD (%)	43.50	43.50		0.00	0.00		47.35	47.35		35.95	35.95	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
iTrE	Mean (%)	41.08***	9.37***	49.55***	77.78***	0.00	22.22**	37.72***	31.85***	30.43***	32.37***	4.18***	63.46***
	SD (%)	44.82	24.76	43.97	42.78	0.00	42.78	47.35	45.33	47.05	39.88	9.01	37.38
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	24.28	100.00
iTrNF	Mean (%)	41.20***	9.09***	49.71***	77.78***	0.00	22.22**	37.72***	31.84***	30.44***	32.56***	3.72***	63.72***
	SD (%)	44.79	24.61	44.09	42.78	0.00	42.78	47.35	45.33	47.05	39.86	8.03	37.52
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	21.91	100.00
iTrF	Mean (%)	40.69***	10.41***	48.90***	77.78***	0.00	22.22**	37.73***	31.83***	30.44***	31.74***	5.85***	62.41***
	SD (%)	44.54	25.45	43.22	42.78	0.00	42.78	47.34	45.31	47.05	39.22	12.47	36.34
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	33.28	100.00
iTrHV	Mean (%)	39.99***	11.65***	48.36***	77.78***	0.00	22.22**	37.71***	45.97***	16.32**	30.61***	3.00***	66.39***
	SD (%)	45.12	28.36	44.58	42.78	0.00	42.78	47.35	47.09	35.52	40.01	6.47	38.16
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	17.55	100.00
conservative													
BM	Mean (%)	7.79***	92.21***		29.01***	70.99***		13.79***	86.21***		0.09	99.91***	
	SD (%)	12.65	12.65		7.93	7.93		11.86	11.86		0.64	0.64	
	Max. (%)	41.15	100.00		41.15	87.90		33.91	99.99		5.23	100.00	
iTrE	Mean (%)	15.32***	5.54***	79.14***	40.84***	1.18**	57.98***	15.86***	24.46***	59.68***	8.27***	0.21*	91.52***
	SD (%)	19.60	17.90	24.63	22.81	2.43	23.52	20.21	32.77	30.26	11.16	1.17	11.24
	Max. (%)	59.73	78.09	100.00	59.73	7.40	100.00	54.56	78.09	100.00	28.85	7.06	100.00
iTrNF	Mean (%)	15.56***	5.70***	78.74***	40.58***	1.17**	58.25***	15.96***	24.76***	59.28***	8.70***	0.37**	90.93***
	SD (%)	19.62	18.06	24.63	22.66	2.45	23.37	20.35	33.07	30.52	11.63	1.28	11.61
	Max. (%)	58.92	78.36	100.00	58.92	7.59	100.00	54.42	78.36	100.00	29.65	7.62	100.00
iTrF	Mean (%)	14.36***	5.95***	79.69***	41.73***	0.99**	57.28***	16.25***	24.97***	58.78***	6.36***	0.75***	92.89***
	SD (%)	19.66	17.97	24.95	23.28	2.34	23.87	20.39	32.74	30.70	8.81	2.13	9.06
	Max. (%)	61.07	76.89	100.00	61.07	6.94	100.00	55.08	76.89	100.00	25.31	9.13	100.00
iTrHV	Mean (%)	13.65***	8.37***	77.98***	39.00***	0.57**	60.43***	15.22***	30.56***	54.22***	6.31***	2.85***	90.84***
	SD (%)	18.92	19.06	23.62	21.81	1.30	22.14	19.54	31.20	25.63	10.00	6.68	10.54
	Max. (%)	55.73	79.16	100.00	55.73	4.08	100.00	53.64	79.16	93.01	27.20	27.31	100.00

Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods while implementing a transaction cost level of 40 bps. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Figure 4a: Time-varying mean-variance out-of-sample portfolio weights (40 bps transaction costs)

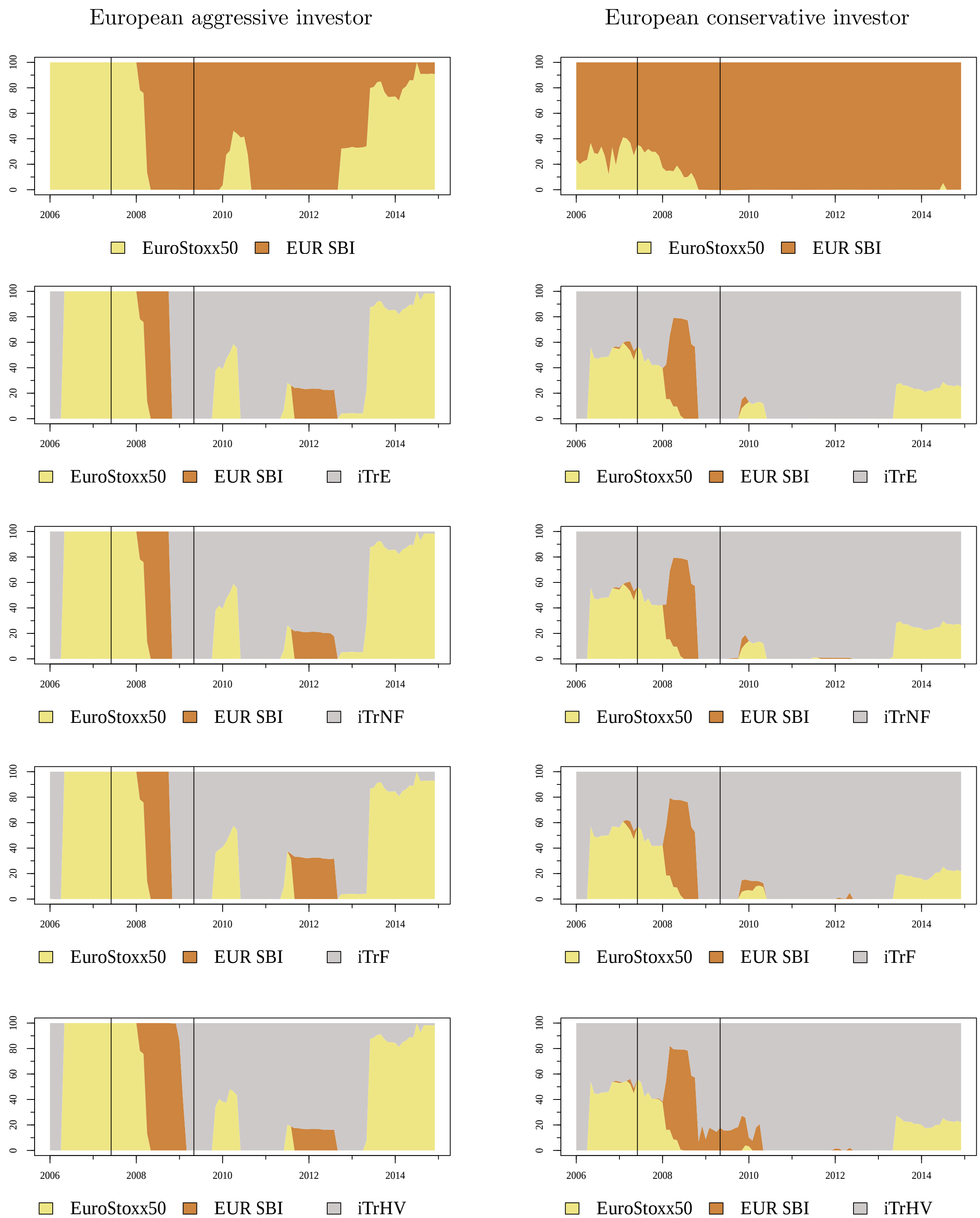
North American aggressive investor

North American conservative investor



Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both North American investors for the entire period from January 2006 to December 2014 and all sub-periods while implementing a transaction cost level of 40 bps. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Figure 4b: Time-varying mean-variance out-of-sample portfolio weights (40 bps transaction costs)



Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both European investors for the entire period from January 2006 to December 2014 and all sub-periods while implementing a transaction cost level of 40 bps. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Table 5a: Mean-variance out-of-sample results (relaxation of short sale constraints)

North American investor	BM	CDXN	CDXNF	CDXF	CDXHV	BM	CDXN	CDXNF	CDXF	CDXHV
Entire period	*aggressive*					*conservative*				
Return (%)	6.74	**7.55**	**7.47**	6.15	**8.39**	1.19	**3.82**	**4.42**	**2.52**	**3.96**
SD (%)	14.01	**13.40**	**13.23**	**13.26**	**13.46**	4.88	**4.72**	**4.75**	**4.69**	**4.80**
$VaR_{99\%}$ (%)	7.27	**6.86**	**6.69**	**6.71**	**6.72**	2.63	**2.32**	**2.31**	**2.21**	**2.27**
SR	0.40	**0.53**	**0.57**	**0.48**	**0.59**	0.28	**0.81**	**0.93**	**0.57**	**0.82**
SoR	0.79	**3.31**	**1.25**	**1.50**	**1.23**	0.12	**10.38**	**1.62**	**1.98**	**1.26**
OR	1.37	**1.45**	**1.45**	1.36	**1.53**	1.19	**1.68**	**1.86**	**1.46**	**1.77**
PT (%)	34.99	85.06	89.58	97.71	102.49	11.77	59.23	57.09	61.80	60.22
Pre-GFC period	*aggressive*					*conservative*				
Return (%)	18.24	11.26	11.16	10.99	11.09	1.85	**8.78**	**8.93**	**8.10**	**8.48**
SD (%)	14.26	**9.68**	**9.74**	**9.24**	**10.32**	4.96	**4.21**	**4.26**	**4.08**	**4.66**
$VaR_{99\%}$ (%)	7.29	**5.02**	**5.05**	**4.75**	**5.32**	2.69	**1.96**	**1.99**	**1.85**	**2.30**
SR	1.24	**1.33**	**1.31**	**1.33**	1.15	0.41	**2.06**	**2.07**	**1.98**	**1.83**
SoR	0.98	**1.54**	**1.46**	**3.19**	**1.36**	0.00	**2.14**	**2.02**	**6.44**	**1.61**
OR	2.25	1.95	1.93	1.93	1.92	1.29	**3.31**	**3.39**	**3.04**	**3.25**
PT (%)	27.00	119.97	126.41	104.52	135.89	13.27	45.70	46.58	43.42	43.65
GFC period	*aggressive*					*conservative*				
Return (%)	5.32	**8.29**	**8.43**	2.76	**11.46**	-2.00	**1.61**	**4.66**	-3.87	**-0.24**
SD (%)	14.42	**14.30**	**13.41**	14.50	**14.22**	*5.07*	**4.79**	**4.83**	*5.01*	**4.98**
$VaR_{99\%}$ (%)	6.77	6.93	**6.34**	**6.63**	**6.64**	2.76	**2.56**	**2.47**	**2.36**	**2.42**
SR	0.16	**0.25**	**0.46**	0.09	**0.68**	-0.32	**0.12**	**0.80**	-0.77	**-0.05**
SoR	0.37	0.33	**0.38**	**0.42**	*0.38*	-0.04	**-0.02**	**0.08**	**0.04**	**0.03**
OR	1.22	**1.35**	**1.39**	1.10	**1.53**	0.78	**1.16**	**1.58**	0.66	**0.98**
PT (%)	50.50	96.73	112.16	92.01	96.63	15.99	74.90	69.83	69.89	68.76
Post-GFC/ESDC period	*aggressive*					*conservative*				
Return (%)	4.14	**6.30**	**6.15**	**6.01**	**6.61**	2.10	**3.25**	**3.12**	**3.22**	**4.18**
SD (%)	13.80	14.08	14.11	13.91	14.04	4.80	4.83	4.85	**4.75**	**4.78**
$VaR_{99\%}$ (%)	7.44	**7.32**	**7.25**	**7.26**	**7.12**	2.57	**2.34**	**2.34**	**2.25**	**2.21**
SR	0.25	**0.42**	**0.41**	**0.39**	**0.41**	0.45	**0.71**	**0.67**	**0.65**	**0.85**
SoR	0.87	**4.81**	**1.50**	**1.41**	**1.49**	0.21	**16.16**	**2.04**	**1.46**	**1.58**
OR	1.24	**1.40**	**1.39**	**1.40**	**1.44**	1.42	**1.73**	**1.69**	**1.84**	**2.16**
PT (%)	38.14	79.29	80.05	102.93	102.15	12.79	63.84	61.84	69.93	68.07

European investor	BM	iTrE	iTrNF	iTrF	iTrHV	BM	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*					*conservative*				
Return (%)	2.40	0.78	0.70	2.29	**2.95**	-1.92	**0.62**	**0.48**	**1.47**	**1.76**
SD (%)	14.50	**13.91**	**13.95**	**13.82**	**13.84**	*8.90*	**4.85**	**4.85**	**4.91**	**4.92**
$VaR_{99\%}$ (%)	8.05	**6.99**	**6.99**	**6.97**	**6.67**	5.76	**2.22**	**2.20**	**2.38**	**2.24**
SR	0.21	-0.04	-0.03	0.09	0.17	-0.20	**0.15**	**0.14**	**0.27**	**0.37**
SoR	0.61	**1.32**	**1.40**	**1.06**	**1.69**	0.13	**1.14**	**1.16**	**1.03**	**1.32**
OR	1.12	1.03	1.03	1.10	**1.14**	0.86	**1.08**	**1.06**	**1.20**	**1.24**
PT (%)	42.84	105.08	104.38	104.28	100.04	13.83	48.35	48.19	44.54	43.36
Pre-GFC period	*aggressive*					*conservative*				
Return (%)	29.75	21.44	21.52	21.07	21.76	4.20	**5.96**	**6.01**	**5.75**	**6.22**
SD (%)	15.00	**14.54**	**14.55**	**14.52**	**14.59**	*5.75*	**5.00**	**5.00**	**5.00**	**5.00**
$VaR_{99\%}$ (%)	8.54	**7.89**	**7.89**	**7.87**	**7.91**	2.84	**2.56**	**2.56**	**2.52**	**2.57**
SR	1.98	1.36	1.37	1.32	1.40	0.81	**1.19**	**1.20**	**1.15**	**1.24**
SoR	1.68	**1.72**	**1.72**	**1.78**	**1.76**	0.24	**1.60**	**1.46**	**2.65**	**1.30**
OR	3.97	2.94	2.94	2.91	2.98	1.64	**2.32**	**2.35**	**2.21**	**2.46**
PT (%)	34.39	99.72	99.49	100.43	101.63	21.38	50.92	50.57	52.23	49.45
GFC period	*aggressive*					*conservative*				
Return (%)	-2.89	**-2.58**	-4.05	3.98	-4.53	-3.55	**-0.72**	**-1.21**	**2.24**	**-0.22**
SD (%)	14.87	14.91	14.92	14.88	14.97	*9.00*	**5.00**	**5.00**	**5.00**	**5.00**
$VaR_{99\%}$ (%)	6.15	**5.76**	**5.79**	**5.57**	**5.79**	4.73	**2.05**	**2.03**	**1.98**	**2.15**
SR	-0.15	-0.15	-0.25	**0.29**	-0.29	-0.44	**-0.14**	**-0.24**	**0.45**	**-0.04**
SoR	1.14	**1.34**	**1.33**	**1.42**	**1.30**	0.31	**0.37**	**0.38**	**0.38**	**0.38**
OR	0.90	**0.93**	0.88	**1.12**	0.86	0.83	**0.93**	**0.89**	**1.23**	**0.98**
PT (%)	44.01	89.23	89.63	88.41	90.79	18.34	34.09	34.86	33.58	34.89
Post-GFC/ESDC period	*aggressive*					*conservative*				
Return (%)	-3.13	-3.62	-3.27	-3.33	**0.46**	-3.00	**-0.36**	**-0.42**	**0.06**	**1.25**
SD (%)	14.24	**13.40**	**13.46**	**13.27**	**13.25**	*9.71*	**4.75**	**4.76**	**4.85**	**4.87**
$VaR_{99\%}$ (%)	8.58	**7.17**	**7.16**	**7.21**	**6.63**	6.90	**2.18**	**2.16**	**2.48**	**2.18**
SR	-0.15	-0.37	-0.33	-0.32	**0.00**	-0.38	**-0.02**	**-0.02**	**-0.04**	**0.27**
SoR	0.15	**1.21**	**1.33**	**0.75**	**1.80**	0.04	**1.28**	**1.34**	**0.83**	**1.64**
OR	0.85	0.84	0.85	0.85	**1.02**	0.78	**0.95**	**0.95**	**1.01**	**1.18**
PT (%)	50.41	117.44	116.19	116.47	108.82	14.27	56.60	56.16	50.34	48.93

Notes: This table shows the results of the mean-variance out-of-sample optimized benchmark (BM) portfolios consisting of stock and sovereign bond indices and the respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods while allowing for short sales. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

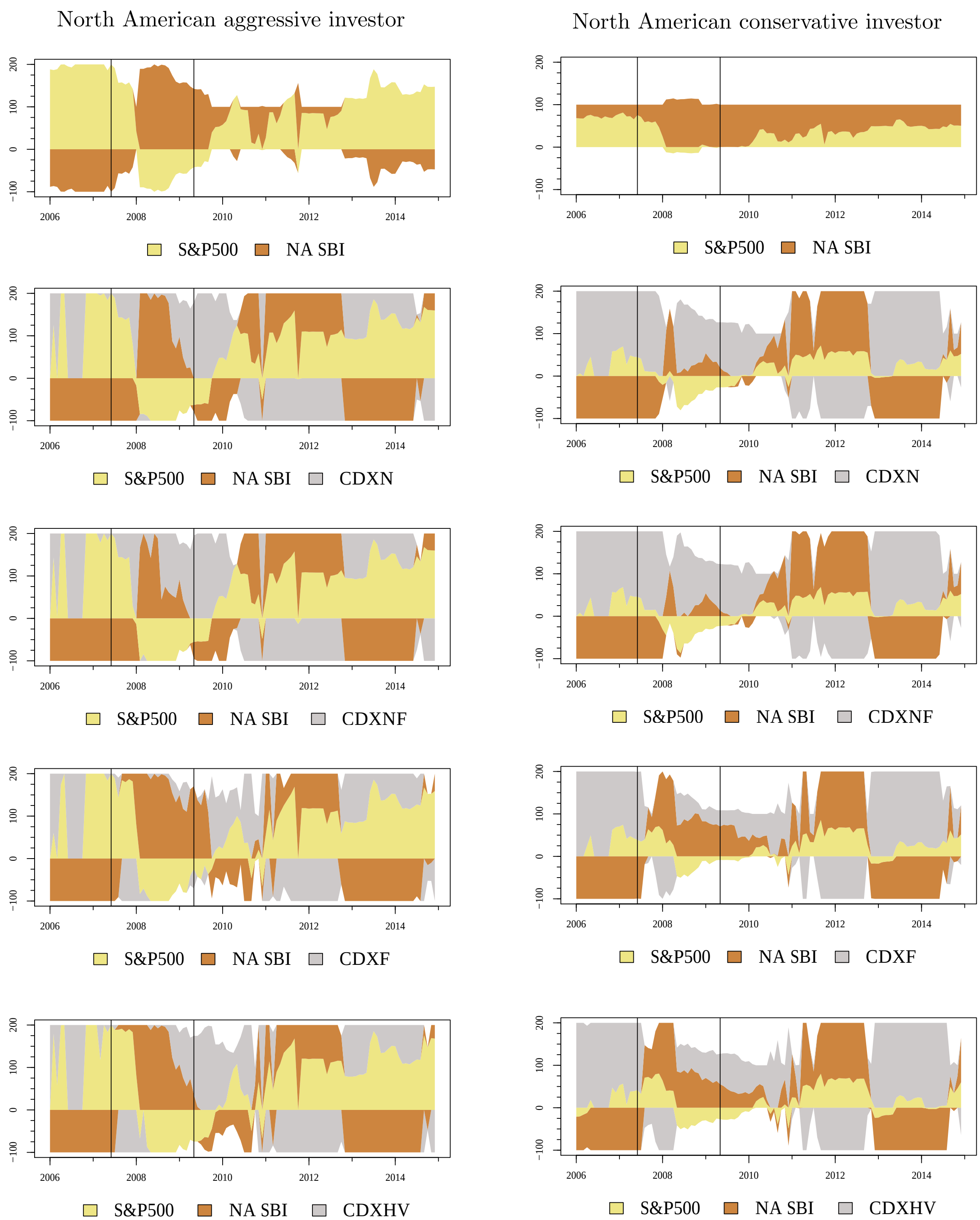
Table 5b: Mean-variance out-of-sample portfolio weights (relaxation of short sale constraints)

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index
aggressive													
	Mean (%)	87.95***	12.05		196.52***	−96.52***		−10.56***	110.56***		92.60***	7.40	
BM	*SD* (%)	91.55	91.55		5.38	5.38		107.96	107.96		55.47	55.47	
	Max. (%)	200.00	200.00		200.00	−86.11		191.27	200.00		188.49	156.18	
	Mean (%)	72.59***	−2.78	30.19***	116.92***	−100.00***	83.08***	−26.29	60.74**	65.55***	94.62***	1.53	3.85
CDXN	*SD* (%)	92.77	105.79	104.72	97.48	0.00	97.48	103.74	125.37	67.60	59.00	94.35	109.11
	Max. (%)	200.00	200.00	200.00	200.00	−100.00	200.00	189.26	200.00	200.00	186.20	200.00	200.00
	Mean (%)	72.45***	−7.42	34.97***	117.27***	−100.00***	82.73***	−28.22	34.17	94.05***	94.96***	3.18	1.86
CDXNF	*SD* (%)	92.50	99.65	107.37	96.64	0.00	96.64	102.53	109.78	67.65	58.04	95.02	108.66
	Max. (%)	200.00	200.00	200.00	200.00	−100.00	200.00	189.34	200.00	200.00	186.22	200.00	200.00
	Mean (%)	71.99***	2.51	25.50***	112.13***	−100.00***	87.87***	−6.20	119.78***	−13.58***	88.05***	−10.20	22.15*
CDXF	*SD* (%)	92.12	107.75	94.33	97.45	0.00	97.45	118.25	93.89	54.11	61.79	89.79	96.95
	Max. (%)	200.00	200.00	200.00	200.00	−100.00	200.00	188.91	200.00	70.40	186.05	200.00	200.00
	Mean (%)	71.18***	−3.95	32.77***	118.78***	−100.00***	81.22***	−7.08	104.67***	2.41	85.25***	−15.44	30.19**
CDXHV	*SD* (%)	96.32	100.66	104.18	93.60	0.00	93.60	125.03	87.49	84.24	67.98	84.34	109.57
	Max. (%)	200.00	200.00	200.00	200.00	−100.00	200.00	191.12	200.00	140.22	185.49	200.00	200.00
conservative													
	Mean (%)	35.85***	64.15***		71.98***	28.02***		11.04***	88.96***		34.65***	65.35***	
BM	*SD* (%)	27.36	27.36		4.27	4.27		30.91	30.91		17.85	17.85	
	Max. (%)	81.37	114.76		81.37	34.47		71.08	114.76		65.43	99.94	
	Mean (%)	16.47***	−0.91	84.44***	27.70***	−100.00***	172.30***	−26.53***	4.62	121.91***	28.21***	23.82**	47.97***
CDXN	*SD* (%)	35.35	94.68	107.88	26.92	0.00	26.92	32.42	72.06	66.47	25.88	97.43	115.17
	Max. (%)	72.11	162.06	200.00	69.67	−100.00	200.00	41.03	147.03	189.99	72.11	162.06	200.00
	Mean (%)	16.35***	−2.25	85.90***	27.05***	−100.00***	172.95***	−28.10***	−8.02	136.12***	28.73***	25.99**	45.28***
CDXNF	*SD* (%)	34.97	94.13	107.57	26.38	0.00	26.38	32.23	63.56	52.03	24.13	97.93	114.27
	Max. (%)	68.88	162.35	200.00	68.44	−100.00	200.00	42.38	107.56	200.00	68.88	162.35	200.00
	Mean (%)	21.52***	11.47	67.01***	28.99***	−99.96***	170.97***	5.90	79.54***	14.56	24.88***	18.04	57.08***
CDXF	*SD* (%)	33.40	92.93	103.59	29.14	0.15	29.16	42.20	55.06	67.50	29.74	89.14	107.95
	Max. (%)	86.02	153.98	200.00	74.39	−99.37	200.00	71.21	153.98	164.96	86.02	153.60	200.00
	Mean (%)	15.53***	12.24	72.23***	14.86**	−95.74***	180.88***	4.19	83.70***	12.11	19.61***	16.72	63.67***
CDXHV	*SD* (%)	37.32	92.06	110.03	26.49	8.25	21.82	50.74	51.70	79.37	34.02	88.62	113.37
	Max. (%)	80.58	160.32	200.00	56.60	−78.74	200.00	80.58	160.32	167.30	80.17	151.23	200.00

European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index
aggressive													
	Mean (%)	32.38***	67.62***		159.86***	−59.86***		9.44	90.56***		6.01	93.99***	
BM	*SD* (%)	86.68	86.68		15.60	15.60		93.36	93.36		62.38	62.38	
	Max. (%)	186.01	200.00		186.01	−37.51		167.14	162.35		108.68	200.00	
	Mean (%)	39.24***	−9.57	70.33***	149.27***	−63.32***	14.05	10.21	80.58***	9.21	19.64**	−26.07**	106.43***
iTrE	*SD* (%)	88.19	98.27	92.84	41.26	51.89	75.84	95.86	93.57	82.70	71.57	90.26	82.01
	Max. (%)	184.74	200.00	200.00	184.74	33.39	200.00	165.25	200.00	157.35	146.99	200.00	200.00
	Mean (%)	39.75***	−9.31	69.56***	149.25***	−63.12***	13.87	9.88	79.92***	10.20	20.58**	−25.48**	104.90***
iTrNF	*SD* (%)	88.00	98.40	92.49	41.39	51.74	76.11	96.08	94.28	82.53	71.28	90.64	82.25
	Max. (%)	184.65	200.00	200.00	184.65	32.47	200.00	165.21	200.00	154.01	147.26	200.00	200.00
	Mean (%)	37.43***	−9.66	72.23***	149.40***	−63.27***	13.87	11.23	84.53***	4.24	16.34*	−27.59**	111.25***
iTrF	*SD* (%)	88.86	96.25	90.94	40.83	52.41	74.91	95.02	90.61	82.13	72.46	85.86	75.03
	Max. (%)	185.08	200.00	200.00	185.08	37.01	199.97	165.43	200.00	170.36	145.56	200.00	200.00
	Mean (%)	36.08***	−12.13	76.05***	148.31***	−64.29***	15.98	8.42	84.72***	6.86	15.43*	−31.37***	115.94***
iTrHV	*SD* (%)	90.02	96.53	91.07	42.08	50.77	76.87	98.20	92.99	76.68	73.03	84.70	75.46
	Max. (%)	183.90	200.00	200.00	183.90	31.90	200.00	164.72	200.00	138.29	146.04	190.96	200.00
conservative													
	Mean (%)	−11.73***	111.73***		29.01***	70.99***		3.45	96.55***		−27.89***	127.89***	
BM	*SD* (%)	28.80	28.80		7.93	7.93		28.16	28.16		16.33	16.33	
	Max. (%)	41.14	154.54		41.14	87.90		33.90	154.54		5.23	153.60	
	Mean (%)	10.54***	−13.16***	102.62***	43.33***	−30.10***	86.77***	0.10	36.06***	63.84***	5.32*	−25.51***	120.19***
iTrE	*SD* (%)	29.93	52.12	44.94	16.72	28.08	42.20	32.70	34.09	28.70	25.79	52.32	40.43
	Max. (%)	62.59	91.22	189.19	58.39	15.99	172.33	53.91	78.38	110.52	62.59	91.22	189.19
	Mean (%)	10.91***	−11.44**	100.53***	42.87***	−29.56***	86.69***	0.02	36.08***	63.90***	6.06*	−22.89***	116.83***
iTrNF	*SD* (%)	29.71	51.69	44.11	16.78	27.68	41.84	32.71	34.34	28.92	25.66	52.26	40.44
	Max. (%)	60.59	104.30	183.13	57.83	16.38	171.53	53.68	78.56	111.80	60.59	104.30	183.13
	Mean (%)	8.20***	−13.94***	105.74***	45.15***	−31.54***	86.39***	1.65	36.39***	61.96***	0.52	−26.49***	125.97***
iTrF	*SD* (%)	29.71	50.52	44.80	16.36	29.65	43.49	31.39	32.84	26.70	24.23	49.24	36.66
	Max. (%)	62.49	77.58	200.00	60.53	14.76	174.77	54.83	77.58	116.65	62.49	72.85	200.00
	Mean (%)	6.12**	−10.83**	104.71***	39.48***	−26.04***	86.56***	−1.60	41.70***	59.90***	−0.18	−24.78***	124.96***
iTrHV	*SD* (%)	30.09	52.38	45.87	17.99	24.54	39.92	32.83	34.96	25.51	25.69	51.61	39.72
	Max. (%)	59.32	80.73	200.00	55.00	16.94	168.19	52.34	80.73	106.81	59.32	58.53	200.00

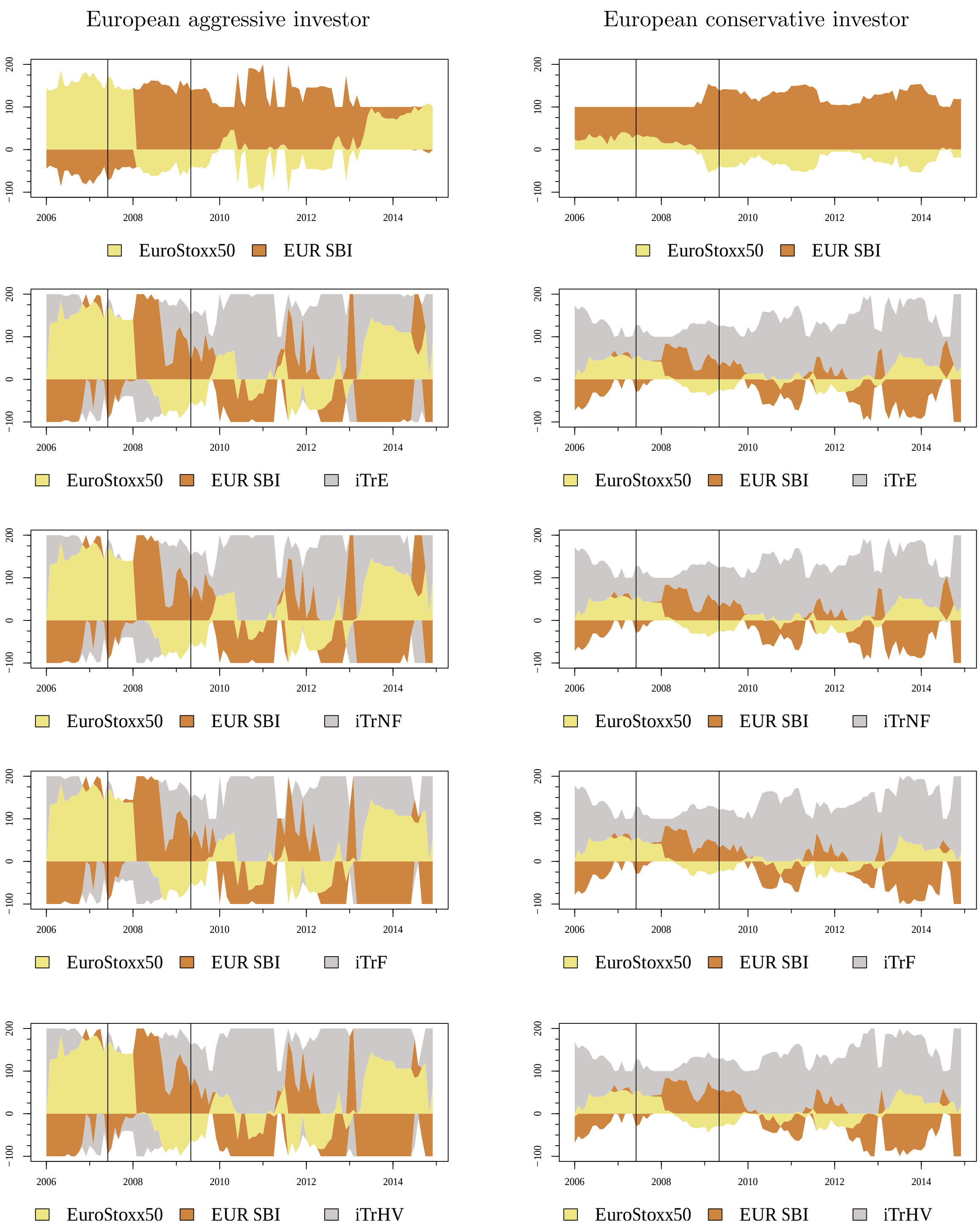
Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods while allowing for short sales. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Figure 5a: Time-varying mean-variance out-of-sample portfolio weights (relaxation of short sale constraints)



Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both North American investors for the entire period from January 2006 to December 2014 and all sub-periods while allowing for short sales. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Figure 5b: Time-varying mean-variance out-of-sample portfolio weights (relaxation of short sale constraints)



Notes: This figure shows the monthly mean-variance out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both European investors for the entire period from January 2006 to December 2014 and all sub-periods while allowing for short sales. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Table 6a: 1/N-Black-Litterman out-of-sample results

	North American investor										European investor									
	BM	CDXN	CDXNF	CDXF	CDXHV	BM	CDXN	CDXNF	CDXF	CDXHV	BM	iTrE	iTrNF	iTrF	iTrHV	BM	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	3.44	**4.16**	**4.09**	**3.91**	**4.54**	-0.45	**1.51**	**1.56**	**0.39**	**1.06**	-0.70	**0.14**	**0.10**	**0.27**	**0.43**	-0.61	**0.50**	**0.39**	**0.82**	**1.37**
SD (%)	8.09	**7.39**	**7.30**	**7.76**	**7.72**	4.85	**4.25**	**4.23**	**4.39**	**4.39**	13.02	**10.55**	**10.56**	**10.56**	**10.75**	*10.27*	**4.93**	**4.93**	***5.01***	***5.36***
$VaR_{99\%}$	4.45	**3.98**	**3.94**	**4.25**	**4.21**	2.67	**2.41**	**2.41**	**2.46**	**2.51**	7.75	**5.88**	**5.92**	**5.78**	**6.06**	6.45	**2.72**	**2.77**	**2.60**	**2.99**
SR	0.24	**0.46**	**0.44**	**0.41**	**0.49**	-0.14	**0.18**	**0.20**	**-0.01**	**0.10**	-0.02	**0.07**	**0.04**	**0.15**	**0.04**	-0.11	**0.15**	**0.13**	**0.20**	**0.18**
SoR	0.32	**0.46**	**0.48**	**0.50**	**0.46**	0.07	**2.86**	**0.58**	**0.68**	**0.43**	0.31	**0.51**	**0.55**	**0.42**	**0.64**	0.15	**0.65**	**0.67**	**0.53**	**0.79**
OR	1.37	**1.53**	**1.52**	**1.47**	**1.56**	0.94	**1.27**	**1.28**	**1.06**	**1.18**	0.96	**1.01**	**1.01**	**1.02**	**1.03**	0.96	**1.07**	**1.05**	**1.11**	**1.18**
PT	14.98	25.89	24.93	24.05	24.71	6.71	12.61	11.67	12.94	11.85	14.03	23.89	23.85	23.19	24.34	4.51	7.53	7.92	8.26	9.12
Pre-GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	2.02	**2.14**	1.97	**2.29**	1.66	-0.31	**1.76**	**1.77**	**1.53**	**1.55**	13.00	12.79	12.25	**14.08**	12.52	4.23	**7.10**	**7.05**	**7.37**	**7.17**
SD (%)	6.00	**5.30**	**5.13**	**5.72**	**4.66**	3.96	**2.84**	**2.81**	**2.89**	**2.92**	7.87	**7.84**	**7.64**	8.30	**7.58**	*5.88*	**4.66**	**4.64**	**4.70**	**4.68**
$VaR_{99\%}$	3.15	**2.80**	**2.72**	**2.94**	**2.56**	2.18	**1.52**	**1.52**	**1.49**	**1.67**	3.60	3.86	3.75	4.14	3.77	2.85	**1.95**	**1.94**	**1.99**	**2.02**
SR	0.59	**0.83**	**0.84**	**0.80**	**0.82**	-0.02	**0.79**	**0.78**	**0.72**	**0.67**	1.81	**1.93**	**1.91**	**1.93**	**1.94**	0.80	**1.67**	**1.67**	**1.69**	**1.67**
SoR	0.12	**0.34**	**0.34**	**0.70**	**0.34**	-0.13	**0.61**	**0.56**	**2.10**	**0.42**	0.79	**0.96**	**0.94**	**1.08**	**0.95**	0.23	**0.83**	**0.77**	**1.28**	**0.73**
OR	1.25	**1.30**	**1.28**	**1.30**	**1.26**	0.94	**1.51**	**1.53**	**1.42**	**1.46**	3.43	3.43	3.31	**3.69**	3.42	1.64	**3.22**	**3.21**	**3.39**	**3.23**
PT	24.55	35.48	35.73	33.11	37.47	10.93	15.07	14.92	15.75	13.84	21.06	30.59	31.64	23.09	32.13	19.82	15.51	15.55	14.58	15.49
GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	-7.31	**-3.41**	**-3.42**	**-6.01**	**-3.16**	-13.75	**-6.99**	**-6.62**	**-11.73**	**-9.47**	-9.17	**-5.44**	**-5.80**	**-4.23**	**-5.81**	-0.90	-4.63	-5.01	-3.27	-3.90
SD (%)	5.97	**4.10**	**4.11**	**4.63**	**4.72**	4.76	**3.58**	**3.60**	**3.95**	**3.98**	11.46	**8.08**	**8.14**	**7.94**	**8.46**	*10.03*	**4.96**	**4.96**	**4.94**	***5.56***
$VaR_{99\%}$	3.91	**2.47**	**2.60**	**2.70**	**2.80**	3.10	**2.69**	**2.76**	**2.69**	**2.89**	6.54	**4.12**	**4.25**	**3.76**	**4.54**	5.71	**2.77**	**2.88**	**2.43**	**3.29**
SR	-2.11	**-1.23**	**-1.30**	**-1.39**	**-1.03**	-3.08	**-2.61**	**-2.51**	-3.29	**-2.86**	-1.27	**-1.17**	-1.32	**-0.68**	-1.40	-0.30	-0.88	-0.95	-0.59	-1.08
SoR	-0.07	-0.07	**-0.04**	-0.08	**-0.06**	-0.14	-0.19	-0.14	-0.20	-0.20	0.47	**0.48**	**0.49**	**0.48**	**0.49**	0.29	0.16	0.17	0.17	0.17
OR	0.52	**0.60**	**0.62**	0.44	**0.68**	0.23	**0.39**	**0.42**	0.21	**0.28**	0.67	**0.72**	**0.70**	**0.78**	**0.72**	0.95	0.64	0.61	0.74	0.74
PT	17.05	39.21	34.30	31.86	31.09	9.56	14.65	13.52	15.54	14.35	12.79	27.59	27.73	27.92	27.84	8.78	11.46	12.02	10.88	15.80
Post-GFC/ESDC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	7.51	7.31	7.24	**7.75**	**7.96**	4.08	**4.36**	**4.31**	**4.25**	**4.54**	-1.48	**-1.34**	**-1.13**	-1.89	**-0.67**	-1.80	**0.49**	**0.45**	**0.46**	**1.63**
SD (%)	9.38	**9.08**	**8.97**	**9.37**	9.58	*5.12*	**4.85**	**4.83**	**4.94**	**4.93**	14.94	**12.13**	**12.18**	**12.07**	**12.39**	*11.53*	**5.00**	**5.00**	***5.12***	***5.47***
$VaR_{99\%}$	4.98	**4.81**	**4.73**	5.13	5.14	2.65	**2.55**	**2.53**	**2.63**	**2.61**	9.29	**7.03**	**7.08**	**6.91**	**7.20**	7.68	**2.90**	**2.95**	**2.82**	**3.15**
SR	0.95	0.93	0.93	0.92	0.92	0.84	**0.97**	**0.97**	**0.92**	**0.96**	-0.09	**-0.01**	**0.00**	**-0.04**	**0.03**	-0.29	**0.10**	**0.09**	**0.08**	**0.22**
SoR	0.51	**0.68**	**0.70**	**0.64**	**0.67**	0.20	**4.51**	**0.84**	**0.61**	**0.65**	0.12	**0.40**	**0.47**	**0.22**	**0.60**	0.07	**0.77**	**0.82**	**0.46**	**1.03**
OR	1.96	1.93	1.94	**2.00**	**1.99**	1.89	**2.06**	**2.04**	**2.02**	**2.10**	0.92	0.91	0.92	0.88	**0.96**	0.87	**1.08**	**1.07**	**1.07**	**1.27**
PT	14.62	21.58	21.69	21.64	21.90	7.54	13.95	12.88	14.04	13.15	15.48	23.77	23.39	24.45	23.98	1.91	6.89	7.32	8.43	8.00

Notes: This table shows the results of the 1/N-Black-Litterman out-of-sample optimized benchmark (BM) consisting of stock and sovereign bond indices and the respective CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods. The parameter τ, which calibrates the tracking error is set to 0.05. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

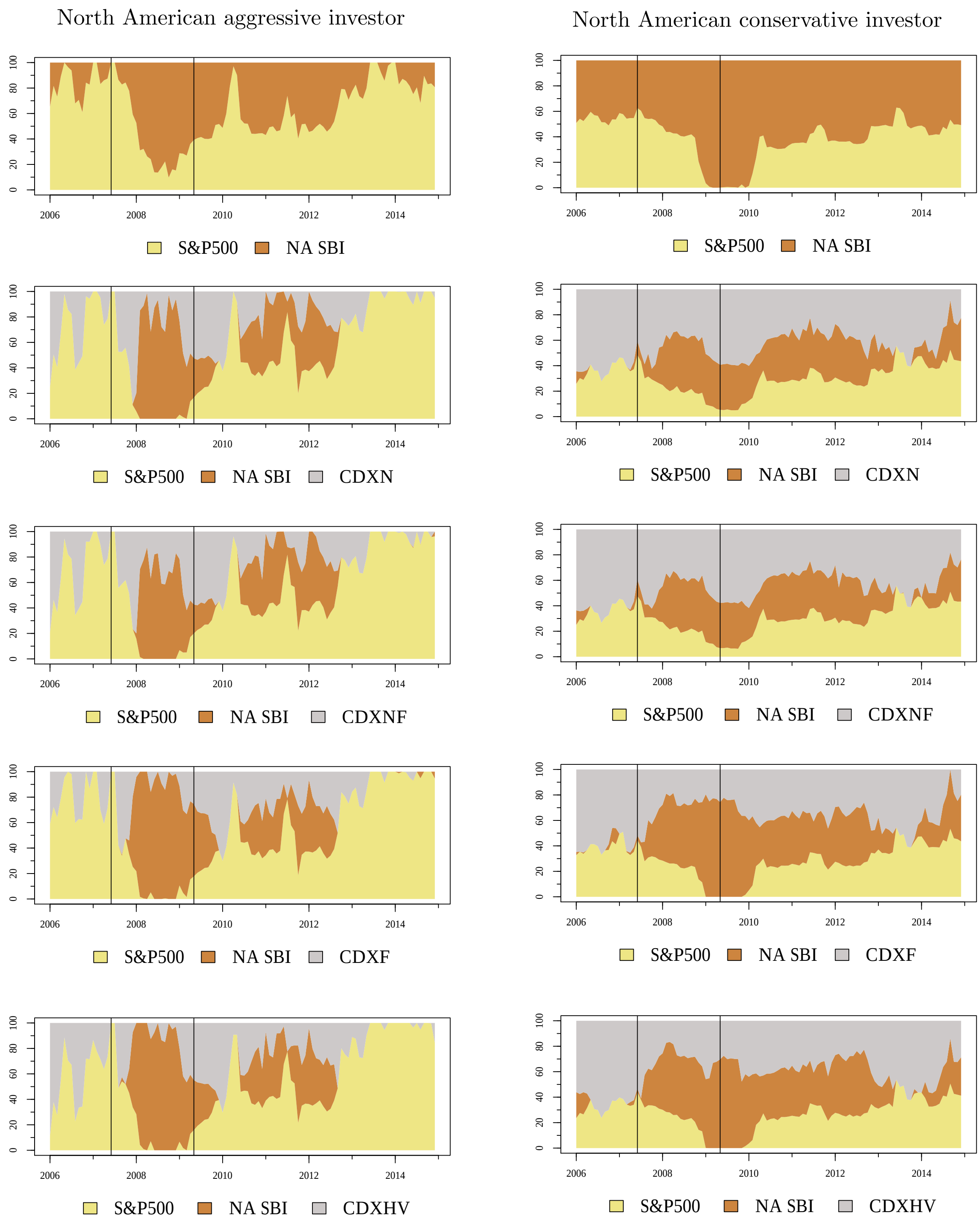
Table 6b: 1/N-Black-Litterman out-of-sample portfolio weights

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC period*		
		S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index
aggressive													
BM	Mean (%)	63.33***	36.67***		84.61***	15.39***		40.23***	59.77***		65.54***	34.46***	
	SD (%)	24.83	24.83		12.69	12.69		27.66	27.66		19.71	19.71	
	Max. (%)	100.00	90.30		100.00	38.97		100.00	90.30		100.00	60.02	
CDXN	Mean (%)	54.92***	22.12***	22.96***	73.30***	0.00	26.70***	15.38***	51.63***	32.99***	63.56***	17.93***	18.51***
	SD (%)	34.16	29.09	21.89	25.54	0.00	25.54	26.57	38.29	25.34	27.86	20.70	18.33
	Max. (%)	100.00	98.77	88.22	100.00	0.00	75.19	100.00	98.77	88.22	100.00	62.59	62.37
CDXNF	Mean (%)	54.73***	20.42***	24.85***	70.38***	0.00	29.62***	18.38***	43.73***	37.89***	63.01***	17.90***	19.09***
	SD (%)	33.11	26.35	21.59	26.52	0.00	26.52	27.69	33.64	20.00	27.26	20.94	18.50
	Max. (%)	100.00	87.69	79.94	100.00	0.01	79.28	100.00	87.69	79.94	100.00	62.89	62.25
CDXF	Mean (%)	55.23***	24.14***	20.63***	79.98***	0.00	20.02***	15.84***	65.60***	18.56***	62.10***	16.40***	21.50***
	SD (%)	33.82	31.62	18.02	17.14	0.00	17.14	23.86	37.12	20.92	28.86	18.52	17.39
	Max. (%)	100.00	100.00	70.02	100.00	0.01	41.10	100.00	100.00	65.09	100.00	56.36	70.02
CDXHV	Mean (%)	52.51***	23.47***	24.02***	59.21***	0.00	40.79***	17.90***	63.16***	18.94***	62.60***	16.15***	21.25***
	SD (%)	32.94	31.08	21.23	25.29	0.00	25.29	26.23	36.59	19.63	28.84	19.12	18.55
	Max. (%)	100.00	100.00	88.64	100.00	0.00	88.64	99.86	100.00	51.23	100.00	60.58	70.29
conservative													
BM	Mean (%)	39.13***	60.87***		54.88***	45.12***		34.20***	65.80***		36.58***	63.42***	
	SD (%)	17.20	17.20		3.41	3.41		20.74	20.74		15.84	15.83	
	Max. (%)	62.91	100.00		62.61	51.06		60.37	100.00		62.91	100.00	
CDXN	Mean (%)	29.83***	24.20***	45.97***	36.84***	2.31***	60.85***	20.54***	33.70***	45.76***	31.13***	26.82***	42.05***
	SD (%)	11.84	15.06	12.30	6.67	3.66	7.03	9.06	12.86	9.72	11.97	11.84	11.18
	Max. (%)	55.80	45.02	72.25	48.53	10.96	72.25	43.28	45.02	62.43	55.80	42.04	60.80
CDXNF	Mean (%)	30.15***	23.56***	46.29***	36.02***	2.81***	61.17***	21.80***	32.20***	46.00***	31.44***	26.17***	42.39***
	SD (%)	11.18	14.70	11.88	6.67	4.34	7.30	8.78	13.05	9.37	11.40	11.76	10.49
	Max. (%)	55.97	44.66	73.35	47.67	12.99	73.35	43.66	44.66	62.21	55.97	41.24	61.77
CDXF	Mean (%)	28.76***	32.21***	39.03***	38.93***	2.28***	58.79***	20.20***	50.21***	29.59***	28.97***	34.07***	36.96***
	SD (%)	13.64	22.87	13.56	5.54	3.71	7.02	12.23	20.06	10.63	13.79	18.70	10.30
	Max. (%)	54.63	80.48	66.93	51.02	12.67	66.93	39.17	80.48	57.17	54.63	77.82	61.39
CDXHV	Mean (%)	27.10***	30.99***	41.91***	32.66***	4.07**	63.27***	20.81***	46.85***	32.34***	27.77***	32.77***	39.46***
	SD (%)	12.56	21.28	13.92	5.70	6.85	6.25	12.64	15.43	9.99	13.09	18.82	10.42
	Max. (%)	53.78	72.52	76.35	43.92	20.35	76.35	37.88	69.73	60.91	53.78	72.52	62.36

European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index
aggressive													
BM	Mean (%)	42.31***	57.69***		76.51***	23.49***		40.31***	59.69***		33.81***	66.19***	
	SD (%)	29.05	29.05		10.32	10.32		30.26	30.26		25.34	25.34	
	Max. (%)	100.00	100.00		100.00	36.39		97.75	100.00		98.94	100.00	
iTrE	Mean (%)	43.95***	25.72***	30.33***	80.20***	6.11***	13.69**	32.44***	44.71***	22.85***	38.17***	24.46***	37.37***
	SD (%)	28.12	19.78	26.57	20.96	8.08	22.65	27.78	24.01	27.43	21.75	13.88	24.82
	Max. (%)	100.00	81.40	80.08	100.00	23.35	66.59	100.00	81.40	73.36	99.03	60.21	80.08
iTrNF	Mean (%)	44.15***	25.37***	30.48***	77.97***	6.93***	15.10***	32.77***	44.15***	23.08***	38.98***	23.87***	37.15***
	SD (%)	27.51	19.84	26.24	21.71	8.46	23.76	28.22	24.17	27.81	21.35	14.39	24.18
	Max. (%)	100.00	80.96	78.17	100.00	22.95	68.32	100.00	80.96	76.65	99.02	63.55	78.17
iTrF	Mean (%)	43.19***	25.19***	31.62***	85.23***	3.68***	11.09***	31.76***	44.69***	23.55***	35.82***	24.27***	39.91***
	SD (%)	28.90	19.62	26.42	16.05	7.79	16.50	23.90	24.10	27.23	22.68	12.45	24.63
	Max. (%)	100.00	81.91	79.87	100.00	22.06	50.91	98.06	81.91	68.98	99.03	68.79	79.87
iTrHV	Mean (%)	42.56***	25.92***	31.52***	76.79***	5.06***	18.15***	32.91***	45.72***	21.37***	36.67***	24.73***	38.60***
	SD (%)	28.86	21.13	26.61	23.03	8.18	24.79	30.18	23.74	25.12	22.87	16.18	25.37
	Max. (%)	100.00	78.65	89.12	100.00	22.23	72.05	100.00	78.65	72.88	99.03	68.34	89.12
conservative													
BM	Mean (%)	7.72***	92.28***		28.63***	71.37***		13.79***	86.21***		0.02	99.98***	
	SD (%)	12.54	12.54		7.87	7.87		11.86	11.86		0.51	0.51	
	Max. (%)	41.14	100.00		41.14	87.88		33.92	99.99		3.90	100.00	
iTrE	Mean (%)	16.59***	19.97***	63.44***	40.70***	25.88***	33.42***	18.92***	29.43***	51.65***	9.31***	15.14***	75.55***
	SD (%)	14.41	8.50	20.40	5.28	5.20	9.37	14.36	6.90	18.59	6.83	5.47	9.67
	Max. (%)	47.89	40.50	94.87	47.89	33.83	52.88	45.53	40.50	80.83	24.94	27.39	94.87
iTrNF	Mean (%)	16.96***	19.78***	63.26***	40.17***	25.99***	33.84***	18.95***	28.17***	52.88***	10.05***	15.23***	74.72***
	SD (%)	14.08	8.56	20.46	5.34	5.06	9.29	14.63	8.69	20.71	6.79	5.58	10.33
	Max. (%)	46.91	40.62	95.69	46.91	34.33	52.92	45.58	40.62	87.58	25.49	28.40	95.69
iTrF	Mean (%)	14.32***	18.14***	67.54***	42.21***	24.14***	33.65***	18.54***	30.88***	50.58***	5.37***	12.16***	82.47***
	SD (%)	16.05	10.48	23.37	4.30	4.83	7.85	13.60	5.08	15.94	7.17	7.78	12.03
	Max. (%)	50.55	39.95	100.00	50.55	32.19	50.48	44.46	39.95	74.69	22.79	26.88	100.00
iTrHV	Mean (%)	13.86***	18.54***	67.60***	39.76***	25.35***	34.89***	17.78***	27.84***	54.38***	5.56***	13.52***	80.92***
	SD (%)	15.62	10.99	23.35	5.77	4.43	8.70	14.81	10.66	21.88	7.44	9.19	13.12
	Max. (%)	48.00	42.15	100.00	48.00	32.57	52.70	46.23	42.15	92.96	23.11	34.14	100.00

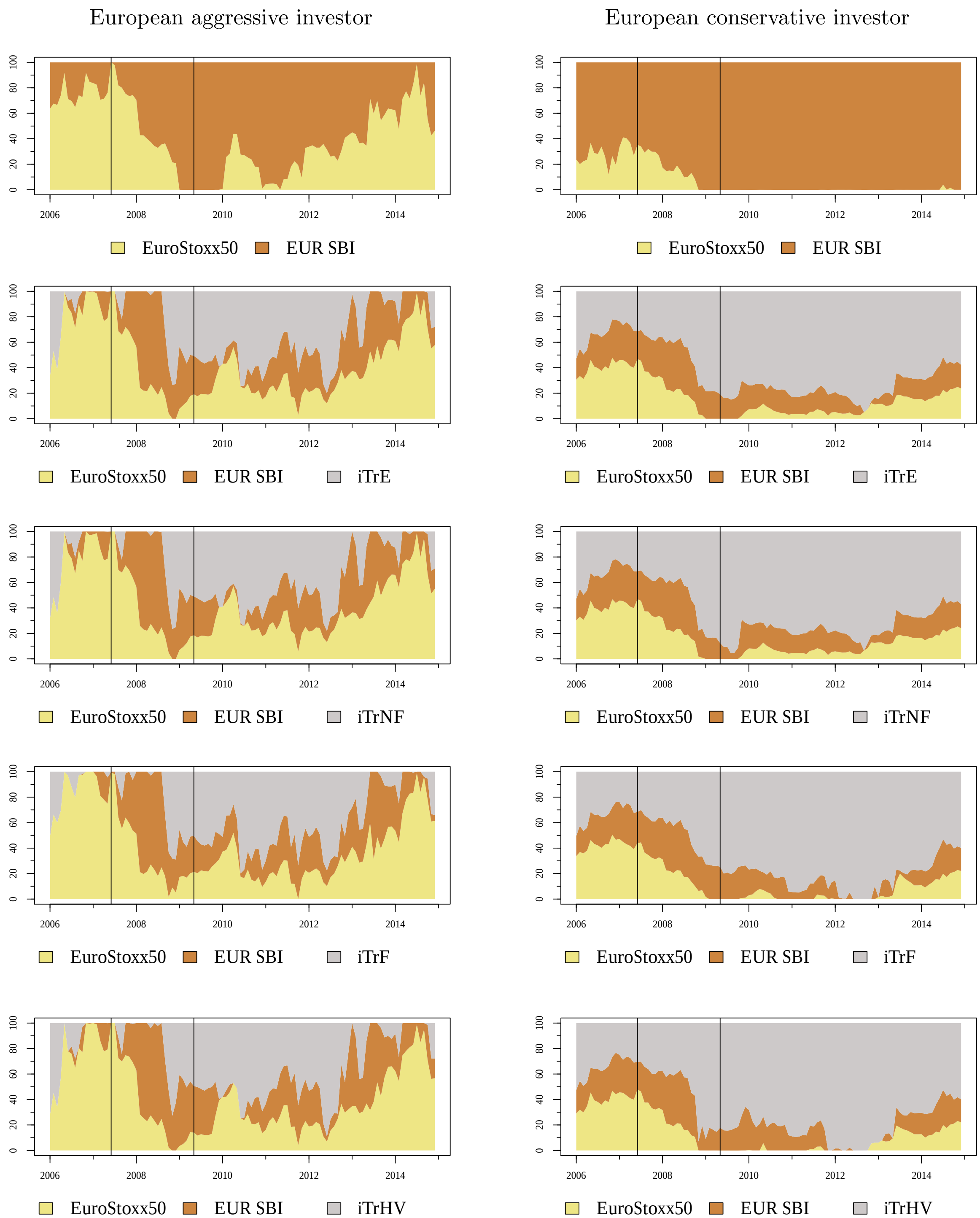
Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative investor of a 1/N-Black-Litterman investor for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Figure 6a: Time-varying 1/N-Black-Litterman out-of-sample portfolio weights



Notes: This figure shows the monthly 1/N-Black-Litterman out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both North American investors for the entire period from January 2006 to December 2014 and all sub-periods. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Figure 6b: Time-varying 1/N-Black-Litterman out-of-sample portfolio weights



Notes: This figure shows the monthly 1/N-Black-Litterman out-of-sample portfolio compositions (in %) for benchmark and CDS index portfolios of both European investors for the entire period from January 2006 to December 2014 and all sub-periods. The two vertical black lines indicate the borders of sub-periods as analyzed in this study.

Table 7a: Mean-variance out-of-sample results (stock index-SBI investor vs. stock index-CDS index investor)

	North American investor										European investor									
	SBI	CDXN	CDXNF	CDXF	CDXHV	SBI	CDXN	CDXNF	CDXF	CDXHV	SBI	iTrE	iTrNF	iTrF	iTrHV	SBI	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	2.77	**4.02**	**4.28**	**2.78**	**4.01**	0.55	**1.60**	**1.78**	**0.99**	**2.19**	1.39	1.29	1.29	1.23	**2.61**	-0.61	**1.73**	**1.69**	**1.94**	**2.68**
SD (%)	9.37	**8.88**	**8.83**	9.72	9.76	4.76	**4.22**	**4.14**	*5.36*	*5.38*	12.66	**8.30**	**8.28**	**8.78**	**9.14**	*10.04*	**3.96**	**3.93**	**4.50**	***5.09***
$VaR_{99\%}$ (%)	5.11	**4.94**	**4.95**	5.74	5.42	2.58	**2.40**	**2.38**	3.38	3.06	7.73	**4.62**	**4.67**	**4.84**	**5.21**	6.46	**2.18**	**2.23**	**2.43**	**2.92**
SR	0.11	**0.42**	**0.47**	**0.33**	**0.41**	0.13	**0.42**	**0.47**	**0.35**	**0.42**	0.13	**0.30**	**0.27**	**0.32**	**0.22**	-0.11	**0.37**	**0.34**	**0.44**	**0.37**
SoR	0.42	**0.47**	**0.49**	**0.55**	**0.44**	0.12	**2.89**	**0.69**	**0.83**	**0.56**	0.40	**0.57**	**0.61**	**0.46**	**0.46**	0.15	**0.77**	**0.80**	**0.66**	**0.66**
OR	1.25	**1.40**	**1.44**	1.23	**1.34**	1.09	**1.29**	**1.34**	**1.13**	**1.32**	1.08	**1.12**	**1.12**	**1.11**	**1.24**	0.96	**1.35**	**1.35**	**1.34**	**1.45**
PT (%)	15.36	24.06	23.39	21.88	20.47	10.94	15.58	16.10	12.45	14.21	11.59	18.88	18.94	18.52	19.05	4.87	8.47	8.58	7.68	7.56
Pre-GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	6.08	2.24	2.26	2.13	2.45	1.85	1.12	1.07	1.06	1.41	19.54	16.13	16.14	16.11	16.17	4.20	**8.44**	**8.46**	**8.31**	**8.60**
SD (%)	6.97	**4.49**	**4.58**	**4.24**	**5.08**	4.96	**2.90**	**2.93**	**2.77**	**3.19**	9.57	**9.02**	**9.03**	**9.00**	**9.06**	*5.75*	**4.70**	**4.71**	**4.66**	**4.75**
$VaR_{99\%}$ (%)	3.66	**2.46**	**2.51**	**2.31**	**2.77**	2.69	**1.61**	**1.64**	**1.53**	**1.84**	5.00	**4.69**	**4.69**	**4.67**	**4.71**	2.84	**2.45**	**2.46**	**2.41**	**2.52**
SR	0.81	**0.97**	**0.86**	**1.20**	0.70	0.41	**1.02**	**0.96**	**1.22**	**0.70**	2.02	1.81	1.80	1.88	1.77	0.81	**1.83**	**1.82**	**1.89**	**1.81**
SoR	0.21	**0.48**	**0.44**	**1.16**	**0.38**	0.00	**0.62**	**0.57**	**2.10**	**0.47**	0.99	**1.00**	**1.00**	**1.04**	**1.04**	0.24	**1.17**	**1.09**	**1.84**	**1.90**
OR	1.78	1.36	1.37	1.35	1.40	1.29	1.25	1.24	1.23	**1.31**	4.58	3.96	3.96	3.95	3.96	1.64	**3.73**	**3.74**	**3.70**	**3.83**
PT (%)	5.56	60.00	56.78	54.76	42.88	13.27	47.90	49.27	41.33	52.81	5.56	16.67	16.67	16.67	16.67	21.38	20.22	20.01	20.95	19.70
GFC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	-6.75	**-3.32**	**-1.94**	-11.20	**-6.17**	-5.01	**-2.92**	**-1.43**	-9.90	-5.06	-5.27	**-2.08**	**-2.24**	**-1.44**	**-1.75**	-0.89	-1.38	-1.54	**-0.73**	-1.40
SD (%)	5.61	**5.04**	**4.67**	7.99	7.57	4.50	**3.93**	**3.67**	*6.80*	*6.40*	11.23	**7.15**	**7.30**	**7.29**	**8.54**	*9.80*	**4.05**	**4.20**	**4.21**	**5.53**
$VaR_{99\%}$ (%)	3.21	3.27	**3.18**	5.92	4.77	2.55	2.62	2.59	5.22	4.22	6.36	**4.11**	**4.34**	**4.07**	**5.37**	5.71	**2.33**	**2.56**	**2.30**	**3.69**
SR	-1.27	-1.29	**-0.95**	-1.85	**-1.15**	-1.00	-1.35	**-0.97**	-2.03	-1.34	-0.85	**-0.33**	**-0.46**	**-0.07**	**-0.57**	-0.31	-0.40	-0.53	**-0.13**	-0.77
SoR	0.02	-0.20	-0.11	-0.24	-0.23	-0.06	-0.25	-0.15	-0.34	-0.32	0.68	0.36	0.36	0.42	0.42	0.29	0.07	0.08	0.09	0.08
OR	0.43	**0.68**	**0.77**	**0.47**	**0.66**	0.49	**0.68**	**0.81**	0.48	**0.69**	0.79	**0.83**	**0.82**	**0.89**	**0.89**	0.95	0.83	0.82	0.91	0.88
PT (%)	12.94	13.04	12.93	13.04	13.04	12.08	10.70	10.75	10.36	10.78	13.06	13.39	13.18	13.40	13.44	8.78	11.05	11.04	11.02	10.33
Post-GFC/ESDC period	*aggressive*					*conservative*					*aggressive*					*conservative*				
Return (%)	5.15	**7.01**	**6.97**	**7.76**	**7.92**	2.10	**3.28**	**3.07**	**4.70**	**4.89**	-1.20	-1.55	-1.49	-1.85	**0.46**	-1.81	**1.00**	**0.98**	**1.14**	**2.49**
SD (%)	11.31	11.37	11.40	11.79	11.77	4.80	**4.68**	**4.63**	*5.56*	*5.61*	13.97	**8.51**	**8.42**	**9.23**	**9.36**	*11.28*	**3.73**	**3.63**	**4.55**	***5.02***
$VaR_{99\%}$ (%)	6.15	6.18	6.21	6.61	6.36	2.57	**2.54**	**2.51**	3.25	2.99	8.93	**4.77**	**4.78**	**5.15**	**5.29**	7.68	**2.05**	**2.05**	**2.47**	**2.75**
SR	0.39	**0.86**	**0.86**	**0.84**	**0.86**	0.45	**0.87**	**0.84**	**0.94**	**0.95**	-0.05	**0.11**	**0.12**	**0.03**	**0.08**	-0.29	**0.24**	**0.23**	**0.25**	**0.37**
SoR	0.61	**0.69**	**0.71**	**0.65**	**0.69**	0.21	**4.58**	**1.01**	**0.89**	**0.89**	0.14	**0.52**	**0.59**	**0.32**	**0.33**	0.07	**0.90**	**0.97**	**0.53**	**0.54**
OR	1.44	**1.63**	**1.63**	**1.70**	**1.71**	1.42	**1.72**	**1.65**	**2.13**	**2.12**	0.93	0.87	0.87	0.86	**1.04**	0.87	**1.23**	**1.24**	**1.21**	**1.52**
PT (%)	21.81	21.17	21.00	19.07	19.98	12.79	11.43	11.89	8.26	7.82	15.70	24.35	24.52	23.76	24.60	2.06	7.37	7.61	5.91	6.28

Notes: This table shows the results of the mean-variance out-of-sample optimized index portfolios of a North American and European aggressive and conservative stock index-SBI and stock index-CDS index investor for the entire period from January 2006 to December 2014 and all sub-periods. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

Table 7b: Mean-variance out-of-sample portfolio weights (stock index-SBI investor vs. stock index-CDS index investor)

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index	S&P500	NA SBI	CDS index
aggressive													
BM	Mean (%)	70.89***	29.11***		100.00***	0.00		27.91***	72.09***		77.83***	22.17***	
	SD (%)	40.47	40.47		0.00	0.00		44.64	44.64		32.67	32.67	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
CDXN	Mean (%)	63.47***		36.53***	61.39***		38.61***	26.09***		73.91***	76.87***		23.13***
	SD (%)	43.63		43.63	49.82		49.82	44.90		44.90	33.23		33.23
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
CDXNF	Mean (%)	63.63***		36.37***	62.19***		37.81***	24.43***		75.57***	77.48***		22.52***
	SD (%)	43.09		43.09	48.96		48.96	42.70		42.70	32.47		32.47
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
CDXF	Mean (%)	62.67***		37.33***	59.52***		40.48***	30.43***		69.57***	74.57***		25.43***
	SD (%)	43.96		43.96	49.30		49.30	47.05		47.05	35.51		35.51
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
CDXHV	Mean (%)	63.57***		36.43***	65.67***		34.33***	30.43***		69.57***	74.39***		25.61***
	SD (%)	43.59		43.59	47.96		47.96	47.05		47.05	35.31		35.31
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
conservative													
BM	Mean (%)	37.11***	62.89***		71.98***	28.02***		16.98***	83.02***		34.65***	65.35***	
	SD (%)	25.27	25.27		4.27	4.27		26.44	26.44		17.85	17.85	
	Max. (%)	81.37	100.00		81.37	34.47		71.08	100.00		65.43	99.94	
CDXN	Mean (%)	23.85***		76.15***	37.33***		62.67***	12.04***		87.96***	24.28***		75.72***
	SD (%)	23.05		23.05	33.73		33.73	22.34		22.34	17.44		17.44
	Max. (%)	81.79		100.00	81.79		100.00	67.02		100.00	61.31		100.00
CDXNF	Mean (%)	24.31***		75.69***	37.06***		62.94***	11.82***		88.18***	25.17***		74.83***
	SD (%)	22.91		22.91	33.42		33.42	22.66		22.66	17.10		17.10
	Max. (%)	81.69		100.00	81.69		100.00	67.27		100.00	61.37		100.00
CDXF	Mean (%)	21.02***		78.98***	37.95***		62.05***	14.06***		85.94***	18.85***		81.15***
	SD (%)	24.48		24.47	35.04		35.04	22.28		22.27	19.73		19.73
	Max. (%)	82.21		100.00	82.21		100.00	66.00		100.00	60.78		100.00
CDXHV	Mean (%)	18.48***		81.52***	34.02***		65.98***	12.88***		87.12***	16.23***		83.77***
	SD (%)	22.46		22.46	31.42		31.42	20.62		20.61	18.44		18.44
	Max. (%)	80.70		100.00	80.70		100.00	65.08		100.00	58.27		100.00

European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index	EuroStoxx50	EUR SBI	CDS index
aggressive													
BM	Mean (%)	41.49***	58.51***		100.00***	0.00		30.42***	69.58***		29.57***	70.43***	
	SD (%)	45.16	45.16		0.00	0.00		47.05	47.05		38.05	38.05	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
iTrE	Mean (%)	45.59***		54.41***	94.44***		5.56	41.13		58.87	34.00		66.00
	SD (%)	44.51		44.51	23.57		23.57	48.27		48.27	38.70		38.70
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
iTrNF	Mean (%)	45.73***		54.27***	94.44***		5.56	41.08***		58.92***	34.23***		65.77***
	SD (%)	44.55		44.55	23.57		23.57	48.22		48.22	38.87		38.87
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
iTrF	Mean (%)	44.95***		55.05***	94.44***		5.56	41.12***		58.88***	32.96***		67.04***
	SD (%)	44.42		44.42	23.57		23.57	48.27		48.27	38.22		38.22
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
iTrHV	Mean (%)	44.19***		55.81***	94.44***		5.56	41.00***		59.00***	31.78***		68.22***
	SD (%)	44.67		44.67	23.57		23.57	48.16		48.16	38.34		38.34
	Max. (%)	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00
conservative													
BM	Mean (%)	7.81***	92.19***		29.01***	70.99***		13.79***	86.21***		0.06	99.94***	
	SD (%)	12.65	12.65		7.93	7.93		11.85	11.85		0.73	0.73	
	Max. (%)	41.14	100.00		41.14	87.90		33.90	99.99		5.23	100.00	
iTrE	Mean (%)	16.43***		83.57***	47.92***		52.08***	15.51***		84.49***	8.28***		91.72***
	SD (%)	19.88		19.88	13.53		13.53	20.69		20.69	10.61		10.61
	Max. (%)	59.73		100.00	59.73		100.00	54.56		100.00	29.63		100.00
iTrNF	Mean (%)	16.67***		83.33***	47.66***		52.34***	15.47***		84.53***	8.76***		91.24***
	SD (%)	19.83		19.83	13.42		13.42	20.67		20.67	11.09		11.09
	Max. (%)	59.36		100.00	59.36		100.00	54.42		100.00	30.42		100.00
iTrF	Mean (%)	15.04***		84.96***	48.85***		51.15***	15.65***		84.35***	5.74***		94.26***
	SD (%)	20.18		20.18	13.92		13.92	20.71		20.71	8.23		8.23
	Max. (%)	61.07		100.00	61.07		100.00	55.08		100.00	25.43		100.00
iTrHV	Mean (%)	14.34***		85.66***	45.86***		54.14***	14.76***		85.24***	5.73***		94.27***
	SD (%)	19.38		19.38	13.17		13.17	19.91		19.91	9.27		9.27
	Max. (%)	57.63		100.00	57.63		100.00	53.64		100.00	27.20		100.00

Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative stock index-SBI investor and a stock index-CDS index investor for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Table 8a: Mean-variance out-of-sample results (stock index-SBI-CBI investor vs. stock index-SBI-CDS index investor)

	North American investor						European investor					
	BM	NA CBI	CDXN	BM	NA CBI	CDXN	BM	EUR CBI	iTrE	BM	EUR CBI	iTrE
Entire period	*aggressive*			*conservative*			*aggressive*			*conservative*		
Return (%)	2.77	2.22	**3.22**	0.55	**1.11**	**1.25**	1.39	**1.59**	-1.03	-0.61	-1.06	**0.32**
SD (%)	9.37	**9.27**	**8.75**	4.76	4.83	**4.18**	12.66	12.74	**8.53**	*10.04*	***9.82***	**4.15**
$VaR_{99\%}$ (%)	5.11	**4.88**	**4.77**	2.58	**2.50**	**2.24**	7.73	**7.71**	**4.68**	6.46	**6.29**	**2.23**
SR	0.11	0.05	**0.31**	0.13	**0.26**	**0.37**	0.13	0.10	**0.18**	-0.11	-0.19	**0.14**
SoR	0.42	**0.50**	**0.51**	0.12	**0.24**	**2.88**	0.40	**0.44**	**0.64**	0.15	0.15	**0.82**
OR	1.25	1.21	**1.32**	1.09	**1.18**	**1.23**	1.08	**1.09**	0.92	0.96	0.93	**1.05**
PT (%)	15.36	23.45	30.91	10.94	19.37	29.87	11.59	24.81	37.02	4.87	19.73	20.37
Pre-GFC period	*aggressive*			*conservative*			*aggressive*			*conservative*		
Return (%)	6.08	6.08	2.24	1.85	1.84	1.11	19.54	19.54	16.13	4.20	**4.45**	**8.07**
SD (%)	6.97	6.97	**4.49**	4.96	**4.94**	**2.89**	9.57	9.57	**9.02**	*5.75*	***5.73***	**4.70**
$VaR_{99\%}$ (%)	3.66	3.66	**2.46**	2.69	**2.67**	**1.61**	5.00	5.00	**4.69**	2.84	**2.82**	**2.41**
SR	0.81	0.81	**0.97**	0.41	**0.42**	**1.02**	2.02	2.02	1.81	0.81	**0.85**	**1.76**
SoR	0.21	0.21	**0.48**	0.00	**0.01**	**0.62**	0.99	0.99	**1.00**	0.24	0.23	**1.15**
OR	1.78	1.78	1.36	1.29	1.29	1.25	4.58	4.58	3.96	1.64	**1.70**	**3.61**
PT (%)	5.56	5.56	59.95	13.27	24.53	47.99	5.56	5.56	16.67	21.38	29.89	25.03
GFC period	*aggressive*			*conservative*			*aggressive*			*conservative*		
Return (%)	-6.75	**-6.61**	**-3.50**	-5.01	-5.08	**-3.18**	-5.27	-5.27	-9.96	-0.89	-2.79	-4.80
SD (%)	5.61	6.16	**5.23**	4.50	4.50	**3.92**	11.23	11.23	**7.24**	*9.80*	***9.56***	**4.60**
$VaR_{99\%}$ (%)	3.21	3.45	**3.07**	2.55	2.55	**2.34**	6.36	6.36	**3.53**	5.71	**5.61**	**2.36**
SR	-1.27	**-1.12**	**-0.87**	-1.00	-1.02	**-0.97**	-0.85	-0.85	-1.22	-0.31	-0.68	-1.09
SoR	0.02	**0.03**	0.01	-0.06	-0.06	**-0.05**	0.68	0.68	**0.69**	0.29	0.26	**0.34**
OR	0.43	0.43	**0.64**	0.49	0.48	**0.61**	0.79	0.79	0.50	0.95	0.87	0.57
PT (%)	12.94	18.29	31.60	12.08	14.60	27.28	13.06	13.06	32.13	8.78	24.35	23.47
Post-GFC/ESDC period	*aggressive*			*conservative*			*aggressive*			*conservative*		
Return (%)	5.15	4.22	**5.80**	2.10	**3.03**	**2.82**	-1.20	**-0.89**	-2.57	-1.81	-1.95	**-0.01**
SD (%)	11.31	**10.96**	**11.10**	4.80	4.91	**4.61**	13.97	14.11	**8.84**	*11.28*	***11.01***	**3.84**
$VaR_{99\%}$ (%)	6.15	**5.70**	**5.97**	2.57	**2.44**	**2.37**	8.93	**8.90**	**5.07**	7.68	**7.45**	**2.14**
SR	0.39	0.25	**0.54**	0.45	**0.66**	**0.66**	-0.05	-0.09	**0.22**	-0.29	-0.29	**0.13**
SoR	0.61	**0.74**	**0.69**	0.21	**0.40**	**4.49**	0.14	**0.22**	**0.53**	0.07	**0.09**	**0.89**
OR	1.44	1.38	**1.51**	1.42	**1.60**	**1.60**	0.93	**0.95**	0.80	0.87	0.86	**1.00**
PT (%)	21.81	32.75	25.86	12.79	22.47	28.36	15.70	37.01	47.16	2.06	18.38	21.01

Notes: This table shows the results of the mean-variance out-of-sample optimized benchmark (BM) portfolios consisting of stock and sovereign bond indices and the respective CBI and CDS index portfolios of a North American and European aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods. 'Return' denotes the annualized mean excess return of a portfolio in percent while 'SD' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). 'SR' indicates the annualized mean Sharpe Ratio, 'SoR' is the annualized mean Sortino Ratio and 'OR' indicates the annualized Omega Ratio. 'PT' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

Table 8b: Mean-variance out-of-sample portfolio weights (stock index-SBI-CBI investor vs. stock index-SBI-CDS index investor)

North American investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		S&P500	NA SBI	NA CBI/CDXN	S&P500	NA SBI	NA CBI/CDXN	S&P500	NA SBI	NA CBI/CDXN	S&P500	NA SBI	NA CBI/CDXN
aggressive													
BM	Mean (%)	70.89***	29.11***		100.00***	0.00		27.91***	72.09***		77.83***	22.17***	
	SD (%)	40.47	40.47		0.00	0.00		44.64	44.64		32.67	32.67	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
NA CBI	Mean (%)	65.71***	17.93***	16.36***	100.00***	0.00	0.00	27.93***	67.28***	4.79*	69.46***	5.81***	24.73***
	SD (%)	42.92	35.21	29.74	0.00	0.00	0.00	44.65	44.38	15.99	38.60	16.36	34.03
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	61.41	100.00	100.00	100.00
CDXN	Mean (%)	63.65***	19.70***	16.65***	61.40***	0.00	38.60***	26.09***	60.14***	13.77**	77.15***	11.12***	11.73***
	SD (%)	43.92	35.37	35.35	49.80	0.00	49.80	44.90	47.82	31.97	33.74	22.70	29.80
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	37.11***	62.89***		71.98***	28.02***		16.98***	83.02***		34.65***	65.35***	
	SD (%)	25.27	25.27		4.27	4.27		26.44	26.44		17.85	17.85	
	Max. (%)	81.37	100.00		81.37	34.47		71.08	100.00		65.43	99.94	
NA CBI	Mean (%)	36.52***	35.84***	27.64***	70.99***	6.33**	22.68***	16.94***	81.76***	1.30	33.98***	28.00***	38.02***
	SD (%)	25.18	40.90	30.34	4.54	12.39	11.97	26.36	29.62	6.21	18.09	36.68	32.93
	Max. (%)	80.38	100.00	88.21	80.38	32.56	37.49	70.23	100.00	29.77	65.43	99.94	88.21
CDXN	Mean (%)	28.15***	31.54***	40.31***	37.30***	0.00	62.70***	12.04***	59.28***	28.68***	31.22***	30.49***	38.29***
	SD (%)	22.78	37.16	35.14	33.70	0.00	33.70	22.34	45.14	32.31	16.11	31.92	34.26
	Max. (%)	81.79	100.00	100.00	81.79	0.00	100.00	67.02	100.00	100.00	61.31	93.94	97.22

European investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		EuroStoxx50	EUR SBI	EUR CBI/iTrE	EuroStoxx50	EUR SBI	EUR CBI/iTrE	EuroStoxx50	EUR SBI	EUR CBI/iTrE	EuroStoxx50	EUR SBI	EUR CBI/iTrE
aggressive													
BM	Mean (%)	41.49***	58.51***		100.00***	0.00		30.42***	69.58***		29.57***	70.43***	
	SD (%)	45.16	45.16		0.00	0.00		47.05	47.05		38.06	38.05	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
EUR CBI	Mean (%)	39.72***	31.09***	29.19***	100.00***	0.00	0.00	30.42***	69.58***	0.00	26.71***	26.24***	47.05***
	SD (%)	46.32	43.26	41.12	0.00	0.00	0.00	47.05	47.05	0.00	39.33	38.64	43.45
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	0.00	100.00	100.00	100.00
iTrE	Mean (%)	42.15***	13.76***	44.09***	94.44***	0.00	5.56	30.43***	37.38***	32.19***	32.13***	9.35***	58.52***
	SD (%)	45.06	32.11	44.77	23.57	0.00	23.57	47.05	48.35	46.61	38.93	25.02	41.44
	Max. (%)	100.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	7.81***	92.19***		29.01***	70.99***		13.79***	86.21***		0.06	99.94***	
	SD (%)	12.65	12.65		7.93	7.93		11.85	11.85		0.73	0.73	
	Max. (%)	41.14	100.00		41.14	87.90		33.90	99.99		5.23	100.00	
EUR CBI	Mean (%)	6.84***	65.25***	27.91***	28.71***	62.87***	8.42*	9.48***	36.06***	54.46***	0.06	75.91***	24.03***
	SD (%)	11.93	42.47	40.93	7.83	24.46	23.10	10.22	47.62	42.72	0.74	40.01	40.08
	Max. (%)	41.14	100.00	100.00	41.14	87.90	74.91	30.49	99.99	98.11	5.23	100.00	100.00
iTrE	Mean (%)	15.48***	9.83***	74.69***	47.70***	1.86*	50.44***	14.49***	26.88***	58.63***	7.16***	6.11***	86.73***
	SD (%)	19.93	22.61	26.58	13.43	4.54	14.94	20.84	35.55	32.36	9.95	16.43	18.48
	Max. (%)	59.73	91.47	100.00	59.73	15.99	100.00	54.56	79.23	100.00	29.33	91.47	100.00

Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a North American and European aggressive and conservative stock index-SBI-CBI investor and a stock index-SBI-CDS index investor for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.

Table 9a: Mean-variance out-of-sample results (global investor)

	BM	CDXN	CDXNF	CDXF	CDXHV	iTrE	iTrNF	iTrF	iTrHV	BM	CDXN	CDXNF	CDXF	CDXHV	iTrE	iTrNF	iTrF	iTrHV
Entire period	*aggressive*									*conservative*								
Return (%)	1.15	0.19	0.78	0.99	**1.48**	1.03	0.93	**1.24**	0.75	-0.70	**-0.09**	**0.47**	**0.64**	**1.25**	**0.81**	**0.76**	**0.80**	**0.65**
SD (%)	9.16	**8.36**	**8.24**	**8.86**	**8.85**	**8.39**	**8.42**	**8.46**	**8.96**	*5.39*	**4.34**	**4.25**	**4.94**	**4.97**	**4.36**	**4.37**	**4.46**	**4.83**
$VaR_{99\%}$ (%)	5.64	**4.83**	**4.76**	**5.44**	**5.23**	**4.81**	**4.89**	**4.82**	**5.27**	3.75	**2.46**	**2.44**	**3.00**	**3.02**	**2.49**	**2.54**	**2.55**	**2.96**
SR	-0.08	**-0.02**	**0.03**	**0.00**	**0.03**	**0.02**	**-0.02**	**0.01**	-0.23	-0.37	**0.01**	**0.10**	**0.03**	**0.10**	**0.12**	**0.11**	**0.05**	**-0.15**
SoR	0.48	**0.51**	**0.53**	**0.50**	**0.51**	**0.55**	**0.57**	**0.52**	**0.62**	0.21	**2.96**	**0.76**	**0.81**	**0.63**	**0.75**	**0.76**	**0.70**	**0.88**
OR	1.10	1.02	1.07	1.09	**1.13**	1.09	1.09	**1.11**	1.06	0.91	**0.99**	**1.07**	**1.09**	**1.18**	**1.13**	**1.12**	**1.12**	**1.09**
PT (%)	21.13	40.54	38.63	38.64	31.66	33.34	36.66	31.87	37.44	11.05	34.23	36.12	32.37	28.29	33.85	32.35	29.90	33.28
Pre-GFC period	*aggressive*									*conservative*								
Return (%)	9.47	9.47	9.47	8.30	9.47	9.47	9.47	9.47	9.23	2.53	**3.62**	**3.77**	**3.01**	**4.20**	**3.59**	**3.62**	**3.56**	**3.33**
SD (%)	7.58	7.58	7.58	**7.40**	7.58	7.58	7.58	7.58	**7.51**	5.00	**4.62**	**4.65**	**4.50**	**4.73**	**4.60**	**4.61**	**4.60**	**4.53**
$VaR_{99\%}$ (%)	4.54	4.54	4.54	**4.45**	4.54	4.54	4.54	4.54	**4.50**	3.30	**2.78**	**2.80**	**2.68**	**2.89**	**2.74**	**2.74**	**2.74**	**2.71**
SR	1.11	1.11	1.11	1.10	1.11	1.11	1.11	1.11	1.11	0.51	**1.07**	**1.07**	**1.00**	**1.06**	**1.12**	**1.11**	**1.13**	**1.01**
SoR	0.51	0.51	0.51	**0.54**	0.51	0.51	0.51	0.51	0.51	0.16	**0.67**	**0.64**	**1.50**	**0.54**	**0.84**	**0.77**	**1.39**	**0.71**
OR	2.34	2.34	2.34	2.18	2.34	2.34	2.34	2.34	2.31	1.45	**1.71**	**1.74**	**1.57**	**1.84**	**1.69**	**1.70**	**1.69**	**1.66**
PT (%)	5.56	5.56	5.56	10.55	5.56	5.56	5.56	5.56	8.98	16.54	30.41	29.89	33.37	29.36	29.81	29.91	29.08	33.04
GFC period	*aggressive*									*conservative*								
Return (%)	-8.28	-11.07	**-7.95**	-8.28	**-7.29**	**-7.93**	-8.59	**-6.71**	-10.43	-6.12	-8.80	**-5.78**	-7.31	**-5.86**	**-4.94**	**-5.15**	**-5.51**	-7.44
SD (%)	6.69	**5.39**	**4.93**	6.69	**6.48**	**4.70**	**4.90**	**4.79**	**6.23**	*5.80*	**4.17**	**3.92**	*5.43*	*5.21*	**3.57**	**3.73**	**3.71**	**4.64**
$VaR_{99\%}$ (%)	4.97	**3.39**	**3.10**	4.97	**4.68**	**2.76**	**3.08**	**2.72**	**4.22**	4.51	**2.64**	**2.60**	**3.87**	**3.62**	**2.19**	**2.44**	**2.17**	**3.45**
SR	-2.06	-2.39	-2.15	-2.06	**-1.93**	**-1.98**	-2.18	**-1.72**	-2.85	-2.00	-2.56	-2.11	-2.17	**-1.96**	**-1.78**	**-1.88**	-2.10	-2.92
SoR	0.03	0.01	**0.04**	0.03	0.02	**0.04**	**0.04**	**0.09**	**0.05**	-0.10	-0.10	**-0.04**	-0.12	-0.13	**-0.04**	**-0.03**	**0.00**	**-0.03**
OR	0.51	0.39	0.47	0.51	**0.58**	0.44	0.40	0.51	0.48	0.56	0.41	0.50	0.50	**0.60**	0.51	0.51	0.46	0.50
PT (%)	13.04	56.52	47.83	13.04	21.73	53.01	61.59	47.54	65.22	12.28	38.70	48.87	21.16	23.44	41.44	42.22	40.91	41.98
Post-GFC/ESDC period	*aggressive*									*conservative*								
Return (%)	2.16	1.56	1.44	**2.21**	**2.35**	1.84	1.90	1.75	**2.31**	0.29	**1.91**	**1.73**	**2.74**	**2.89**	**2.04**	**2.01**	**2.22**	**2.71**
SD (%)	10.43	**9.58**	**9.55**	**10.00**	**10.00**	**9.87**	**9.85**	**9.95**	**10.28**	*5.35*	**4.32**	**4.26**	**4.89**	**4.95**	**4.57**	**4.53**	**4.69**	**4.98**
$VaR_{99\%}$ (%)	6.16	**5.39**	**5.39**	**5.86**	**5.59**	**5.59**	**5.60**	**5.61**	**5.84**	3.60	**2.31**	**2.29**	**2.78**	**2.85**	**2.52**	**2.52**	**2.63**	**2.86**
SR	0.28	**0.49**	**0.49**	**0.41**	**0.41**	**0.41**	**0.42**	**0.31**	**0.30**	-0.04	**0.61**	**0.60**	**0.52**	**0.54**	**0.51**	**0.53**	**0.49**	**0.49**
SoR	0.63	**0.68**	**0.71**	**0.66**	**0.68**	**0.74**	**0.76**	**0.68**	**0.84**	0.34	**4.63**	**1.06**	**0.94**	**0.90**	**0.99**	**1.04**	**0.76**	**1.25**
OR	1.20	1.14	1.13	1.20	**1.21**	1.17	1.18	1.16	**1.21**	1.04	**1.39**	**1.35**	**1.58**	**1.57**	**1.39**	**1.39**	**1.40**	**1.50**
PT (%)	31.08	47.43	47.34	57.95	42.53	37.04	39.45	36.55	38.54	12.04	36.62	36.31	38.42	32.15	35.23	32.51	29.23	33.22

Notes: This table shows the results of the mean-variance out-of-sample optimized benchmark (BM) portfolios consisting of the MSCI World index and the Global SBI as well as the respective CDS index portfolios of a global aggressive and conservative investor for the entire period from January 2006 to December 2014 and all sub-periods. 'Return' denotes the annualized mean excess return of a portfolio in percent while '*SD*' is the annualized mean standard deviation of excess returns in percent. The downside risk of the portfolios is measured by the non-parametric mean sample Value-at-Risk at the 99%-level ('$VaR_{99\%}$'). '*SR*' indicates the annualized mean Sharpe Ratio, '*SoR*' is the annualized mean Sortino Ratio and '*OR*' indicates the annualized Omega Ratio. '*PT*' is the portfolio turnover of each portfolio in percent. Numbers printed in bold indicate an improvement in CDS index portfolios as compared to the respective benchmark portfolios except for the portfolio turnover rates. Numbers printed in italic indicate a violation of the volatility bounds.

Table 9b: Mean-variance out-of-sample portfolio weights (global investor)

Global investor		*Entire period*			*Pre-GFC period*			*GFC period*			*Post-GFC/ESDC period*		
		MSCI World	Global SBI	CDS index	MSCI World	Global SBI	CDS index	MSCI World	Global SBI	CDS index	MSCI World	Global SBI	CDS index
aggressive													
BM	Mean (%)	62.16***	37.84***		100.00***	0.00		30.43***	69.57***		62.88***	37.12***	
	SD (%)	44.63	44.63		0.00	0.00		47.05	47.05		41.83	41.83	
	Max. (%)	100.00	100.00		100.00	0.00		100.00	100.00		100.00	100.00	
CDXN	Mean (%)	60.81***	19.88***	19.31***	100.00***	0.00	0.00	30.43***	39.13***	30.44***	60.71***	18.62***	20.67***
	SD (%)	45.22	37.51	37.25	0.00	0.00	0.00	47.05	49.90	47.05	42.85	34.82	36.95
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
CDXNF	Mean (%)	60.94***	17.01***	22.05***	100.00***	0.00	0.00	30.43***	26.09***	43.48***	60.92***	18.46***	20.62***
	SD (%)	45.11	35.06	39.26	0.00	0.00	0.00	47.05	44.90	50.69	42.68	34.80	36.71
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
CDXF	Mean (%)	59.60***	28.78***	11.62***	97.51***	0.00	2.49	30.43***	69.57***	0.00	59.43***	22.52***	18.05***
	SD (%)	45.65	43.34	28.67	10.55	0.00	10.55	47.05	47.05	0.00	43.87	38.23	34.52
	Max. (%)	100.00	100.00	100.00	100.00	0.00	44.75	100.00	100.00	0.00	100.00	100.00	100.00
CDXHV	Mean (%)	59.28***	24.76***	15.96***	100.00***	0.00	0.00	30.43***	63.78***	5.79**	58.25***	18.01***	23.74***
	SD (%)	46.10	41.08	32.85	0.00	0.00	0.00	47.05	45.42	14.76	44.32	36.11	38.86
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	56.52	100.00	100.00	100.00
iTrE	Mean (%)	61.90***	20.63***	17.47***	100.00***	0.00	0.00	30.43***	24.44***	45.13***	62.47***	24.86***	12.67***
	SD (%)	44.56	37.33	35.56	0.00	0.00	0.00	47.05	42.42	49.58	41.71	39.00	29.28
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrNF	Mean (%)	61.76***	19.65***	18.59***	100.00***	0.00	0.00	30.43***	24.98***	44.59***	62.25***	23.10***	14.65***
	SD (%)	44.58	36.29	35.10	0.00	0.00	0.00	47.05	40.52	47.60	41.75	38.22	29.95
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrF	Mean (%)	62.15***	22.98***	14.87***	100.00***	0.00	0.00	30.43***	24.09***	45.48***	62.87***	28.77***	8.36***
	SD (%)	44.63	37.75	34.62	0.00	0.00	0.00	47.05	42.09	49.52	41.82	39.26	26.38
	Max. (%)	100.00	100.00	100.00	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
iTrHV	Mean (%)	61.57***	23.53***	14.90***	99.14***	0.00	0.86	30.43***	39.13***	30.44***	62.17***	24.50***	13.33***
	SD (%)	44.83	40.23	33.15	3.62	0.00	3.62	47.05	49.90	47.05	42.36	39.46	30.00
	Max. (%)	100.00	100.00	100.00	100.00	0.00	15.37	100.00	100.00	100.00	100.00	100.00	100.00
conservative													
BM	Mean (%)	21.59***	78.41***		64.87***	35.13***		19.50***	80.50***		10.68***	89.32***	
	SD (%)	26.26	26.26		7.60	7.60		30.44	30.43		12.69	12.69	
	Max. (%)	83.38	100.00		83.38	44.35		79.69	100.00		49.36	100.00	
CDXN	Mean (%)	25.50***	22.83***	51.67***	59.03***	0.00	40.97***	17.95***	34.17***	47.88***	19.08***	25.07***	55.85***
	SD (%)	25.82	37.39	33.04	15.51	0.00	15.51	28.18	46.23	40.61	19.63	36.90	33.23
	Max. (%)	81.99	100.00	100.00	81.99	0.00	78.08	78.50	100.00	100.00	62.97	100.00	100.00
CDXNF	Mean (%)	25.73***	21.02***	53.25***	59.02***	0.00	40.98***	18.04***	23.21***	58.75***	19.42***	25.91***	54.67***
	SD (%)	25.71	35.75	32.86	14.92	0.00	14.92	28.35	39.58	38.66	19.57	37.45	33.78
	Max. (%)	82.13	100.00	100.00	82.13	0.00	77.98	78.68	100.00	100.00	63.08	100.00	100.00
CDXF	Mean (%)	24.34***	30.42***	45.24***	58.79***	0.00	41.21***	18.23***	61.18***	20.59***	17.18***	28.03***	54.79***
	SD (%)	26.54	37.59	29.68	18.14	0.00	18.14	28.56	36.67	21.93	19.92	35.42	29.57
	Max. (%)	81.40	100.00	100.00	81.40	0.00	92.71	77.77	100.00	50.18	62.20	100.00	100.00
CDXHV	Mean (%)	22.87***	31.53***	45.60***	56.83***	0.00	43.17***	18.68***	58.54***	22.78***	15.18***	30.72***	54.10***
	SD (%)	25.51	38.71	31.57	14.29	0.00	14.29	29.15	35.34	28.53	18.40	38.57	32.17
	Max. (%)	81.82	100.00	100.00	81.82	0.00	81.35	77.24	100.00	67.67	60.15	100.00	100.00
iTrE	Mean (%)	26.08***	25.44***	48.48***	59.38***	0.00	40.62***	17.91***	17.25***	64.84***	19.93***	35.09***	44.98***
	SD (%)	25.68	38.05	32.34	16.02	0.00	16.02	28.23	29.94	32.36	19.33	41.88	34.02
	Max. (%)	81.87	100.00	100.00	81.87	0.00	81.09	78.49	89.34	100.00	63.65	100.00	100.00
iTrNF	Mean (%)	26.18***	22.96***	50.86***	59.08***	0.00	40.92***	17.80***	16.93**	65.27***	20.21***	31.20***	48.59***
	SD (%)	25.71	36.87	31.71	16.06	0.00	16.06	28.11	29.00	31.63	19.64	41.21	33.55
	Max. (%)	81.76	100.00	100.00	81.76	0.00	81.18	78.33	89.74	100.00	63.85	100.00	100.00
iTrF	Mean (%)	25.25***	35.67***	39.08***	60.65***	0.00	39.35***	18.32***	21.40***	60.28***	18.12***	50.16***	31.72***
	SD (%)	25.56	41.99	34.00	15.53	0.00	15.53	28.73	33.69	33.77	17.65	43.00	34.94
	Max. (%)	82.28	100.00	100.00	82.28	0.00	79.52	79.07	92.45	100.00	61.80	100.00	100.00
iTrHV	Mean (%)	23.81***	34.34***	41.85***	55.49***	0.00	44.51***	17.01***	40.63***	42.36***	17.64***	41.41***	40.95***
	SD (%)	24.87	38.95	28.70	19.13	0.00	19.13	27.13	40.34	30.30	18.29	39.13	30.52
	Max. (%)	81.29	100.00	100.00	81.29	0.00	91.19	77.65	100.00	92.64	60.44	100.00	100.00

Notes: This table shows the mean out-of-sample portfolio weights ('Mean' (%)), their standard deviations ('*SD*' (%)) and the maximum portfolio shares ('Max' (%)) of each asset class in individual benchmark (BM) and respective CDS index portfolios of a global investor for the entire period from January 2006 to December 2014 and all sub-periods. *, ** and *** indicates significance at the 10%, 5% and 1% level, respectively.