ARE RANGE BASED MODELS GOOD ENOUGH? EVIDENCE FROM SEVEN STOCK MARKETS

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Abstract

We study the performance of range-based models over varying market conditions and compare their performance against a set of alterative risk measurement models, including the more widely used techniques in practice for measuring the Value-at-Risk (VaR) of seven financial market indices. In particular, we focus on model accuracy in estimated VaRs over quiet and volatile moments utilizing loss functions and likelihood ratio tests for coverage probability. The empirical estimates based on these two criteria find that the range based-model of Yang and Zhang (2000) shows some success in estimated VaR risk measure, especially during quiet periods, than is the case for the other range based models considered. Also, we find that the EWMA and RiskMetrics models have an inconsistent marginal edge over the widely used GARCH and historical simulation specifications and that there is validity in the use of the EWMA and RiskMetrics models over range-based approaches as both capture and thus provide more accurate estimated VaR risk measure of market risk.

Keywords: Range Based Models, Value-at-Risk, Market Risk, Financial Markets, Risk Measurement

1. INTRODUCTION

Today risk measurement models are universal with financial firms situating value-at-risk (VaR) methods at the fulcrum of their risk management process for the management and reporting of market risk. Essentially, VaR is defined as the maximum expected loss of a portfolio for a given confidence level α and a specified time horizon. Its wide use in risk management owes much to its conceptual simplicity for VaR summarizes the market risk associated with any portfolio to just a single number. For example, the VaR at level α at the 1-day horizon is the nominal 1-day loss that will not be exceeded. Expressed differently, VaR at level α would indicate that over a specified horizon the potential maximum loss for an asset will not exceed VaR at a confidence level of $(1-\alpha)$. Although the literature in this area has grown considerably, partly motivated by the risk-adjusted measures of capital adequacy enforced by the Basil committee which, in turn, spawned the development of increasingly sophisticated risk measurement techniques, such as the equally weighted moving average (EWMA), RiskMetrics, the historical simulation approach to econometric procedures based on autoregressive moving average (ARIMA) models, extensions of the generalized autoregressive conditional heteroscedasticity (GARCH) family of statistical processes, and the application of extreme value theory in an effort to shed light on the forecasting ability of these approaches, the overwhelming evidence have been mixed; see for examples Schlueter and Deuschle (2010), Aloui et al. (2011), Berger (2013), Gerlach et al. (2013), Del Brio et al. (2014), Bams, et al. (2017), and Zhang et al. (2017). Of these studies Schlueter and Deuschle (2010) compare VaR estimates based on ARIMA approaches and report mixed statistical evidence for the predictive ability of wavelet-based forecasts, while Berger (2016) presents a copula-based wavelet approach in order to derive better predictive performance and, in an attempt to improve the forecasting ability for daily S&P 500 returns, Zhang et al. (2017) offers a wavelet-based

ARIMA approaches. What is apparent from these and other studies is that there remains no universally accepted method that yields accurate estimates of VaR for an asset or a portfolio and or what can be considered as the best risk measurement model; see for a discussion Kuester et al. (2006), Perignon and Smith (2010), Berkowitz et al. (2011), and Koch-Medina and Munari (2016). Mindful of this, and in light of the frequency of crisis events in financial markets, practitioners have become increasingly fastidious and so want to know when deliberating the choice of risk measurement models which of the available methods are conducive to delivering consistent and accurate estimated VaRs over varying market conditions. For if a particular model is not of a suitable fit it may prove to be costly as a consequence of inaccurate estimates of market risk. This concern about what an inaccurate estimate of market risk might mean for financial firms has been highlighted by the demise of a number of financial firms which incurred large financial losses at the height of the financial crisis that appears to challenge existing approaches to risk measurement and the management of financial risk more specifically. Together, these events are providing the catalyst for a host of regulatory proposals and for calls for risk measurement models to keep pace with the market environment, both of which are directed toward appraising appropriate models for accurate estimates of VaR.

There are several reasons to why it is important to evaluate the performance of risk measurement models over varying market conditions. First, financial firms need to know how well risk measurement models perform in quiet as well as at volatile times in relation to each other in order to compare model accuracy, which is tantamount to stress testing. Thus, in principle, the credibility of a risk measurement model will depend on the exactness of the estimates of market risk it delivers. Second, risk measurement models are vehicles for decision making; that is, they are important for risk managers whose primary objective is to maintain the level of risk exposure within defined limits and for regulators whose main task are to ensure the stability of the financial system, and so require accurate measurement and reporting of VaR numbers to be able to take an informed view about the level of risk-taking at a financial firm, as well as to track their market risk exposure over time. Thus, the present study could be of interest to financial firms and their regulatory authorities.

The data used throughout this paper is the daily index of seven countries drawn from Europe, North America, Asia, and Latin America, as it offers insights of the risks faced by financial firms in these market over a time period marked by the reactions of market participant to news associated with deteriorating economic conditions, market volatility, the bursting of stock market bubbles, the Asian financial crisis, the Russian and Brazilian crisis, the deflation of the financial bubble centred on the dot-com companies, the catastrophic events of 9/11, and other shocks that impacted the world's stock markets over the sample period. The empirical analysis is confined to the period January 1992 to December 2002, a period which, as just mentioned, witnessed a number of shocks to global markets.

In accordance with the regulatory framework, the accuracy of estimated VaRs is assessed with respect to their one-step-ahead forecasts and 99 percent coverage levels. The methods are then back-tested using two evaluation measures – Lopez (1999) loss function approach which is defined to produce higher values when exceptions occur, and Christoffersen's (1988) likelihood ratio tests for coverage probability, which is independent of the model process producing the estimated VaR and captures whether a particular procedure shows correct conditional coverage. The paper is organized into five sections. Section 2 outlines the range based approaches used to estimate VaR, including a class of alternative approaches, and the evaluation methodology used to assess their statistical accuracy. Section 3 presents the data. Section 4 presents and discusses the empirical results of the model's evaluation of estimated VaRs. Section 5 contains a summary of our findings and concluding remarks.

2. THE VAR SPECIFICATIONS CONSIDERED

As earlier noted, value at risk (VaR) is a widely used statistical framework for estimating the market risk of economic losses in financial markets. By employing VaR in daily risk management, banks and other financial firms can discern the minimum amount, in monetary terms; they might expect to lose with a small probability α over a stated time horizon, usually 1-day or 10-days.

Mathematically, we commence by considering the return series $\{R_t\}_1^T$ of a financial asset, such that $\{R_t\}_1^T$ follows a stochastic process:

$$y_t = \mu_t + \varepsilon_t \tag{1}$$

Where, $E(\varepsilon_t | \Theta_{t-1}) = 0$ and $E(\mathcal{E}_t^2 | \Theta_{t-1}) = \sigma_t^2$.[1] Let $z_t \equiv \varepsilon_t/\sigma_t$ have the conditional distribution Φ_t with zero conditional mean and unit conditional variance defined by $z_t | \Theta_{t-1} \sim \Phi_t(0,1)$. Since our approach in this paper is to consider stock indices drawn from a number of capital markets, in preference to the construction of portfolios, we do not consider covariances. Thus the approach we follow is a variance method whereby the *Var(a)* can be estimated as follows:

$$VaR_t(\alpha) = \mu + \Phi_t^{-t}(\alpha)\sigma_{t.} \tag{2}$$

In many applications, researchers assume the expected return μ equals 0, and we make this assumption.[2] Thus Eq. (2) becomes:

$$VaR_t(\alpha) = \Phi_t^{-t}(\alpha)\sigma_{t.} \tag{3}$$

From Eq. (3) the estimation of VaR entails estimating $\Phi_t(\cdot)$ and σ_t. In regard to the models examined in this paper, we assume a parametric distribution (e.g., normal distribution) for $\Phi_t(\cdot)$. The conditional distribution, $\Phi_t(\cdot)$, is assumed to be constant over time or assumed to be Gaussian

[1] Specifically, Θ_{t-1} is the time t-1 information set (σ-field).
[2] This assumption is based on the conjecture that the magnitude of μ is substantially smaller than the magnitude of the standard deviation σ and can thus be ignored

N(0, 1), while conditional variance σ_t^2 is estimated using different methods of volatility models. The approaches followed for the estimation of VaR (i.e., the estimation and modelling of σ_i) includes the widely used parametric and non-parametric approaches and the less representative range-based method which are presented next.

2.1. Range based models

Since volatility is recognized as time varying, it is imperative to use the most recent price observations to construct an estimate of volatility. Here, volatility estimates using additional information such as high, low, open prices to achieve better accuracy — in addition to the closing price used by the conventional estimators, have been considered in the literature. For example, the theoretical and empirical studies include Parkinson (1980), Garman and Klass (1980), Rogers and Satchell (1991), and Yang and Zhang (2000). For the purpose of this study, we subject these extreme based models to empirical testing to see how well they estimate VaR.

Following Garman and Klass (1980), the price in each period of length T starts at the closing price of the previous period, with each period divided into two intervals with fractions θ and $1-\theta$. Since trading is closed during the first interval of length, θT, the price movement in this interval (before opening) is unobservable. The high and low prices in a data set are those observed from the second interval of length$(1-\theta)T$ (i.e., the trading interval)[3]. Parkinson (1980) demonstrates that expectation of the high minus the low squared is proportional to variance and constructs an estimate based on the high minus the low expressed as:

$$\hat{\sigma}_p = \frac{1}{4n\ln 2}\sum_{i=1}^{n}(u_i - d_i)^2 \quad (4)$$

However, this estimator is only valid when there are no opening jumps and no drift. In contrast, Rogers and Satchell (1991) variance estimator is defined by:

$$\hat{\sigma}_{rs} = \frac{1}{n}\sum_{i=1}^{n}\left[u_i\left(u_i - c_i\right) + d_i\left(d_i - c_i\right)\right] \quad (5)$$

The variance estimator, $\hat{\sigma}_{rs}$, of expression (5) is, according to Yang and Zhang (2000) a much better estimator than expression (4) since it is independent of the drift and is equal to zero when the security price makes a one-direction move of either *u=c* and *d=0* for a straight-up move or *d=c* and *u=0* for a straight-down move.[4] Garman and Klass (1980) variance estimator (derived under the assumption of no drift) is calculated as follows[5]:

$$\hat{\sigma}_{gk} = \sigma_0^{'} - 0.383\sigma_C^{'} + 1.364\hat{\sigma}_p + 0.019\hat{\sigma}_{rs} \quad (6)$$

where

$$\sigma_0^{'} = \frac{1}{n}\sum_{i=1}^{n} o_i^2$$

$$\sigma_c^{'} = \frac{1}{n}\sum_{i=1}^{n} c_i^2$$

The estimators just discussed are only valid under the assumptions of either no drift or no opening jumps. Thus, Yang and Zhang (2000) point out that although the no drift assumption is reasonable for daily financial data, we can often see that "the price of a security goes through a "trendy" phase, in which the drift could be large compared to the volatility". Since estimators $\hat{\sigma}_p$ and $\hat{\sigma}_{gk}$ will underestimate volatility, they further note that the assumption of no opening jumps is not realistic, since opening jumps do occur in reality and, in such cases estimators $\hat{\sigma}_p$ and $\hat{\sigma}_{rs}$ will underestimate the volatility. To overcome this, Yang and Zhang (2000) suggests estimating the variance of the underlying security during these periods based on the following:

$$\hat{\sigma}_{yz} = \hat{\sigma}_0 + k\hat{\sigma}_c + \left(1-k\right)\hat{\sigma}_{rs} \quad (7)$$

where $\hat{\sigma}_{rs}$ is given in expression (6) and $\hat{\sigma}_0$ and $\hat{\sigma}_c$ are defined as follows:

$$\hat{\sigma}_0 = \frac{1}{n-1}\sum_{i=1}^{n}\left(o_i - \bar{o}\right)^2 \quad (8)$$

$$\hat{\sigma}_c = \frac{1}{n-1}\sum_{i=1}^{n}\left(c_i - \bar{c}\right)^2 \quad (9)$$

with

$$\bar{o} = \frac{1}{n}\sum_{i=1}^{n} o_i \quad (10)$$

$$\bar{c} = \frac{1}{n}\sum_{i=1}^{n} c_i \quad (11)$$

In the empirical part of this paper, the constant k was chosen to minimize the variance of the estimator $\hat{\sigma}_{yz}$ and was set equal to:

$$k = \frac{0.34}{1.34 + \frac{n+1}{n-1}} \quad (12)$$

The above minimum-variance estimator is an unbiased estimator, which is independent of both the drift and opening jumps of the underlying price movement. For Yang and Zhang (2000), expression (12) is more accurate than the estimator based only on closing prices.

[3] θT, is an effective time period that models the opening jump as an unobservable continuous price movement. The fraction θ, measures the relative size of the opening jump. The case $\theta=0$ means that there is no opening jump, and the case $\theta \to 1$ implies that the price movement in the period is dominated by the opening jump.

[4] This is because the price movements in such situations can be explained by the drift term alone (zero variance).

[5] This formula was not explicitly given in Garman and Klass (1980). We adopt it from Yang and Zhang (2000).

2.2. The equally weighted moving average model

The equally weighted moving average (EWMA) method assumes variances are constant over the forecasting period. For calculating VaR, we estimate the volatility of asset return by a historical moving average variance process. Assuming that returns, R_t, are observable over m days, the equally weighted sample variance is expressed as:

$$\sigma_t^2 = \frac{1}{m-1}\sum_{j=1}^{m}(R_{t-1})^2 \qquad (13)$$

where the choice of window width m is critical. The choice of short windows would suffer from inferior statistical efficiency, though they are likely to do better in capturing the dynamics of short-term volatility. Once σ_t^2 is estimated, VaR is estimated under the assumption returns are normally distributed.

2.3. RiskMetrics method

Perhaps the most practicable volatility models used in the application of risk management has been the RiskMetrics (RM) model of J.P. Morgan (1996), also known as the exponentially weighted moving average, which deals with the insensitivity of the Equally Weighted method to recent innovations and assigns exponentially weights to more distant observations. The RM model expresses the variance as:

$$\sigma_t^2 = \lambda\sigma_{t-1}^2 + (1-\lambda)y_{t-1}^{\ \ 2} \qquad (14)$$

Specifically, $\lambda \epsilon [0,1]$ is the decay factor reflecting how the impact of past observations decays while forecasting one-day-ahead σ_t^2. The most recent observations have the largest impact and the impact decays exponentially as the observations move towards the past. With a low value of λ, the weight attached to historical returns decays rapidly as we go further into the past. A high λ leads to a much lower decay of weights. But once σ_t^2 is estimated VaR is estimated under the assumption that returns are normally distributed.

2.4. Garch models

While the EWMA model captures volatility clustering, Bollerslev's (1986) Generalized Autoregressive Conditional Hetroscedasticity (GARCH) model allows for both autoregressive and moving average behaviour in variance and covariance. Thus we consider the Exponential GARCH (EGARCH) and the standard GARCH (1, 1) models. The latter is given by:

$$\sigma_t^2 = \phi + \beta\sigma_{t-1}^2 + \alpha\varepsilon_{t-1}^2 \qquad (15)$$

where σ_t^2 the time-varying conditional variance is modelled as a stochastic process. For a well-defined GARCH(1, 1) the restrictions $\varphi > 0$, $\beta \geq 0$, $|\alpha| < 1$ and $1-\beta-\alpha > 0$ are imposed to ensure the conditional variance is positive. β measures the extent to which a volatility shock today feeds through into next period's volatility, while $(\beta+\alpha)$ measures the rate at which this effect dies out over time. The EGARCH model of Nelson (1991) is used to forecast volatility as given by:

$$\ln\sigma_t^2 = \omega + \left(1+\sum_{i=1}^{q}a_i L^i\right)\left(1-\sum_{i=1}^{p}\beta_j L^i\right)^{-1}\left\{\theta z_{t-1} + \gamma\left[|z_{t-1}| - E|z_{t-1}|\right]\right\} \qquad (16)$$

where θ and γ are the parameters of asymmetry, and L^i is the lag operator. Eq. (16) is capable of capturing any asymmetric impact of shocks on volatility and allows good and bad news to affect volatility in a different way — e.g. small positive shocks will have a greater impact on conditional volatility than small negative shocks, while large negative shocks will have a greater impact on conditional volatility than large positive shocks.

2.5. Historical simulation models

The Historical simulation (HS) approach is widely used in the financial industry owing to its flexibility and ease of application. The model constructs the distribution of portfolio value changes, $\triangle P$, from historical data without imposing distribution assumptions and estimating parameters, and further assumes that trends of past price changes will continue in the future. Thus, the hypothetical future prices for time $t+s$ are obtained by applying historical price movements to current (log) prices as follows:

$$P_{i,t+s}^* = P_{i,t+s-1}^* + \Delta P_{i,t+s-k} \qquad (17)$$

Where t is the current time, $s=1,2,...,k$, k, is the horizon length of going back in time, $P_{i,t+s}^*$ is the hypothetical (log) price of the i-th asset at time $t+s$, $P_{i,t}^* = P_{i,t}$, $\triangle P_{i,t+s-k} = P_{i,t+s-k} - P_{i,t+s-1-k}$, $P_{i,t}$ is the historical (log) price of the i-th asset at time t. Assuming a time horizon $\tau = 1$, the portfolio returns at time $t+s$ is defined as:

$$R_{p,t+s}^* = P_{p,t+s}^* - P_{p,t} \qquad (18)$$

where $P_{p,t}$ is the current portfolio (log) price. The VaR is obtained from the density function of the computed hypothetical returns. Thus VaR(α) = $VaR_{t,\tau}$ is estimated by the negative of the $(1-\alpha)th$ quantile, VaR^*; specifically, $F_{k\triangle P}(-VaR) = F_{k\triangle P}(VaR^*) = 1-\alpha$, where $F_{k\triangle P}(x)$ is the empirical cumulative distribution function:

$$F_{k,\Delta P}(x) = \frac{1}{k}\sum_{s=1}^{k}1\left\{R_{p,t+s}^* \leq x\right\}, \quad x \in \text{Ÿ} \qquad 19$$

A particular advantage of this approach is the no distributional assumptions, meaning that deviation from normality is not an issue. The model is also risk-free in that parameter estimation and correlation effects between various assets are modelled implicitly since profits are paired against losses for the entire position (Khindanova and Rachev, 2000; Linsmeier and Pearson, 1999).

2.6. Kernel method

As regards the Kernel method, Kernel estimation makes use of non-parametric methods of weighting the historical data when estimating volatility as:[6]

$$\sigma_t = \sqrt{\sum_{t=1}^{T} w_i R_t^2} \quad (20)$$

The weights are then estimated using a non-parametric kernel method defined by:

$$w_t = \frac{\hat{f}(x_t)}{\sum_{t=1}^{T} \hat{f}(x_t)} \quad (21)$$

where $\hat{f}x$ is the kernel density estimator, which at point x has the form:

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{T} K\left(\frac{x_i - x}{h}\right) \quad (22)$$

where *K( )* is the kernel function, which may take a variety of functions provided it holds certain regularity properties. A commonly used kernel is the Gaussian kernel defined by:

$$K(u) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}u^2\right) \quad (23)$$

The unknown factor, *h*, in Eq. (23) is the window width, otherwise termed the bandwidth. In choosing the bandwidth there is a trade-off between variance and bias. The larger the bandwidth the smaller will be the variance but the greater the bias and vice versa. A number of methods are available for choosing the bandwidth from simple cross-validation to various "plug-in" methods (Sheather and Jones, 1991). In this study, the bandwidth is defined by:

$$h = Std(X)1.06T^{-1/5} \quad (24)$$

since it can be shown to the optimal choice if data are assumed to be normally distributed and the Gaussian Kernel is used (Silverman, 1986).

2.7. Back testing the methods: Model evaluation

Back testing is a common procedure in risk management which enables risk managers, at a glance, to validate the statistical accuracy of economic VaR models. In this respect, the present article will consider two alternatives: (i) a test for accuracy of VaR estimates suggested by Lopez (1999) and (ii) a likelihood ratio tests for coverage probability proposed by Christoffersen (1988). The utility of the testing framework is that it roots in regulatory requirements and thereby allows for an evaluation of the statistical precision of out-of-sample VaR estimates; see Kuester et al. (2006) and Halbleib and Pohlmeier (2012).

According to the framework of Lopez (1999), the accuracy of estimated VaRs can be gauged by how well they minimize a loss function representing the concerns of risk managers. Loss functions reflecting such concerns are specified in a negative direction by assigning higher scores when failures occur and the VaR models are then assessed by comparing the expected value of the loss function. A model that minimizes expected losses is preferred to ones that do not reduce losses. The loss function at time t has the form:

$$L_t = \begin{cases} f(R_t, VaR_{t|t-1}) & \text{if } R_t < VaR_{t|t-1} \\ g(R_t, VaR_{t|t-1}) & \text{if } R_t \geq VaR_{t|t-1} \end{cases} \quad (25)$$

where $f()$ and $g()$ are functions that satisfy $f() \geq g()$ and R_t the realized return or loss. For the purpose of this exercise we consider three loss functions: a binary loss function which takes account of whether any given days return is greater or smaller than estimated VaR; a quadratic loss function which takes account of the size of the negative returns that exceed estimated VaR, and a firm's loss function suggested by Sarma et al. (2000) to resolve a possible conflict between the goals of safety and profit resulting from a firm's use of VaR in internal risk management.

The binary loss function treats any negative return smaller than estimated VaR as a violation. Thus we are concerned with the number of violations rather than the magnitude of such violations. Each loss exceeding the VaR is assigned an equal weight of unity, while all other returns have a zero weight, that is.

$$L_t^b = \begin{cases} 1 & \text{if } R_t < VaR_{t|t-1} \\ 0 & \text{if } R_t \geq VaR_{t|t-1} \end{cases} \quad (26)$$

It follows that if the VaR model discussed above provides the correct level of coverage, as defined by its confidence level, then the average binary loss function over the sample will equate 0.05 for the 95 percent confidence level and 0.01 for the 99 percent confidence level. The quadratic loss function reflects the magnitude of the exception, but as well as taking this into account the application of its functional form penalizes large exceptions more severely than would be the case with a linear or binary measure. The quadratic loss function is defined by:

$$L_t^Q = \begin{cases} 1 + \left(R_t - VaR_{t|t-1}\right)^2 & \text{if } R_t < VaR_{t|t-1} \\ 0 & \text{if } R_t \geq VaR_{t|t-1} \end{cases} \quad (27)$$

Sarma et al. (2000) term the above the regulatory loss function since it more readily

[6] A similar method was followed by Pagan & Schwert (1989) and was used by Engel & Gizycki (1999a) to estimate VaR

reflects the goals of the financial regulator. The implication in this area is that a VaR estimator reporting too high values is likely to persuade a financial firm to hold too much capital, thus imposing the opportunity cost of capital upon them. To solve this Sarma et al. suggest modelling a firm's loss function in a manner that penalizes failures as well as imposing a penalty reflecting the cost of capital suffered on other days as follows:

$$L_t^F = \begin{cases} \left(R_t - VaR_{t|t-1}\right) & \text{if } R_t < VaR_{t|t-1} \\ aVaR_{t|t-1} & \text{if } R \geq VaR_{t|t-1} \end{cases} \quad (28)$$

where α is a measure of the opportunity cost of capital. The first component in Eq. (28) reflects the penalty due to the failure of a model, while the second component signifies the opportunity cost for the risk manager due to risk management.

In contrast, test of unconditional coverage consists of examining if the realized (ex-post) coverage rate equilibrates the theoretical coverage rate, which is equivalent to testing if the indicator variable I_t, which takes a value of 1 if the loss is greater than the estimated VaR (referred to as a violation) and 0 otherwise, follows an independent and identically distributed (i.i.d) process with parameter p; where p equals VaR's theoretical coverage rate α. The likelihood ratio (LR) test statistic for the unconditional coverage test follows a x^2distribution with one degree of freedom. The test is calculated as follows:

$$LR_{uc} = -2\ln\left[\frac{(1-p)^{T-N}\, p^N}{\left[1-(N/T)\right]^{T-N}(N/T)^N}\right] \xrightarrow{d} \chi^2(1) \quad (29)$$

where p is the desired significance level, i.e. one minus the VaR confidence level, N is the number of violations, and T is the number of VaR estimates. LR_{uc} is asymptotically distributed chi-squared with one-degree of freedom under the null hypothesis that p is the true probability. Although the test can be used to penalize financial firms, it does not capture asymmetries or leverage effects which will affect the accuracy of any forecasts. An improvement of the unconditional back-testing framework is the test for conditional coverage which requires correct unconditional coverage and simultaneously ensures that the violating series is i.i.d. through a test for independence. Christoffersen's (1988) LR test for independence thus test the hypothesis that the failure process is independently distributed against the alternative that the process follows a first order Markov process as defined by:

$$LR_{ind} = -2\ln\left[\frac{(1-\pi)^{(T_{00}+T_{10})}\,\pi^{(T_{01}+T_{11})}}{(1-\pi_0)^{T_{00}}\,\pi_0^{T_{01}}\,(1-\pi_1)^{T_{10}}\,\pi_1^{T_{11}}}\right] \xrightarrow{d} \chi^2(1) \quad (30)$$

where T_{ij} $i,j = 0,1$ is the number of observations with a j following an i in the I_t sequence, and $\pi_{0,1} = T_{0,1}/(T_{00} + T_{o,1})$. Since both the unconditional coverage and the independence properties should be satisfied for an accurate VaR model, Christoffersen's (1988) proposed the following statistic:

$$LR_{cc} = LR_{uc} + LR_{ind} \xrightarrow{d} \chi^2(2) \quad (30)$$

which is asymptotically a χ^2 distribution with two degrees of freedom. For an insight into the statistical back-testing framework over and above the regulatory back-testing approach see Engle and Manganielli (2004) and Ziggel et al. (2014).

3. DATA DESCRIPTION AND SUMMARY STATISTICS

The data used in this study consists of daily stock index closing prices, which includes 2870 observations for each series over the period January 1992 to December 2002 for a range of international stock indexes including: the U.S.A, Dow Jones Industrial Index (DJI), Canada, TSX Index (TSX), Germany, DAX30 Index (DAX), Netherlands, AEX Index (AEX), Japan, Nikkei 225 Index (NIKKEI 225), Thailand, Bangkok SET Index (SET), and Brazil, BOVESPA Index (IBOV), for which we calculate the daily VaR. These data were obtained from Data stream. The selection of the time period of 11 years was motivated by the appropriate time span for estimation and testing that this set of daily returns offer as it includes periods marked by events that triggered large price swings in the capital markets considered.[7] Daily market Open, High, Low and Close prices were used which is consistent with normal practice and reflect the view that these four prices have a much higher informational content than other intraday prices.[8] Returns, r, are calculated as the percentage logarithmic differences between the price time t and t_{-1}, $r_t = 100^* (log\ P_t - logp_{t-1})$. Table 1 displays summary statistics for the data.

7 The period was chosen to cover both volatile periods and periods of relative tranquility in financial markets. For example, it covers the "controlled" devaluation of the Mexican peso in December 1994 that resulted in a spill over of the "peso-crisis" to the rest of Latin America, Asia, and the more developed financial markets. The flotation of the Thai baht and its subsequent 17% decline against the US dollar on the 2nd of July 1997, that resulted in significant global financial market volatility, as well as the devaluation of the Russian rouble; the fiscal deficit problems in Brazil that resulted in global financial market volatility in 1998, the financial distress of Barings Bank and Long Term Capital Management, the stock market crisis that commenced with the terrorist attack in the U.S in 2001, and was intensified in 2002 with the corporate governance scandals of Enron and WorldCom, resulting in significant financial market volatility, especially in the U.S and Europe.

8 Open and Close refer to the price at the opening and closing of the market, while High and Low prices corresponds to the two extremes – the highest and lowest prices recorded from the day's trading

Table 1. Preliminary statistics on stock market returns

	Countries						
Summary	***U.S.***	***Canada***	***Germany***	***Netherlands***	***Japan***	***Thailand***	***Brazil***
Statistics	(DJI)	(TSX)	(DAX)	(AEX)	(NIKKEI)	(SET)	(BOVESPA)
Mean	0.0337	0.0221	0.0211	0.0328	-0.0343	-0.02241	0.3423
S.D	1.03320	0.93610	1.44420	1.31550	1.47348	1.78500	3.06999
Skewness	0.296418	-0.721448	-0.302624	-0.253861	0.1737	0.443055	0.423815
Kurtosis	8.193869	10.309260	6.638475	7.615715	5.3761	7.564559	9.027373
JB	3267.941	6637.731	1626.910	2578.528	2578.528	2585.4	4430.288
PP-LC	-1.49399	-1.44921	-1.46105	-1.72784	-0.67851	-0.70626	-7.73829
PP-R	-53.35509	-48.76776	-53.65794	-52.31525	-56.18333	-7.58750	-50.09319
Q(5)	6.10	29.65	7.67	19.04	10.33	48.72	15.84
Q(10)	11.97	33.81	21.00	40.75	15.63	72.73	57.23
Q(20)	25.89	55.09	45.90	64.30	22.97	93.76	105.93
Q2(5)	385.63	259.69	1003.30	1366.00	190.46	440.53	376.69
$Q^2(10)$	636.16	468.22	1908.30	2616.30	315.52	658.86	536.18
$Q^2(20)$	877.21	742.31	2981.40	4392.90	452.29	802.29	715.05
Max	6.1547	4.6835	7.5527	7.4526	7.6605	11.3495	28.8176
Min	-7.4549	-8.4652	-8.87447	-7.5310	-7.2340	-10.0280	-17.2292

Note: JB is the Jarque-Bera statistics, which is distributed asymptotically as a chi-square under the null hypothesis of normality. Q(5), Q(10), Q(20) and $Q(5)^2$, $Q(10)^2$, $Q(20)^2$ are the Ljung-Box statistics of up to order 20 of the return and squared return series, respectively.

The reported results indicate that the mean daily returns from investing in a fund representative of the selected developed markets' range between -0.03 percent (Japan) and 0.03 percent (U.S.), while for a fund representative of emerging market stock indices between -0.02 percent (Thailand) and 0.34 percent (Brazil). Meanwhile, the standard deviations, which may be taken as a direct measure of volatility and the asset's risk for developed markets range between 0.9361 percent (Canada) and 1.4734 percent (Japan). While for emerging markets this range between 1.7850 percent (Thailand) and 3.0699 percent (Brazil). For the stock markets sampled, the markets of Thailand (11.3) and Brazil (28.8) displayed the largest daily price movement The skewness statistics suggest that all return series are either negatively or positively skewed. The kurtosis statistics suggest departure from normality and all series are highly leptokurtic. From the respective Jarque-Bera statistics, we can reject the normality assumption for return series, while the Ljung-Box statistic values suggest that they exhibit a high degree of autocorrelation in squares, but not in levels for some of the markets. The results of the unit root test, based on Phillips (1987) and Phillips-Perron (1988), (the critical values for rejection of hypothesis of a unit root are –3.4357, -2.8631 and –2.5676 for 1, 5 and 10 percent respectively) for the logarithmic of close prices (PP-LC) and logarithmic returns (PP-R) indicate that all of the return series are stationary. Figure 1(see Appendix) displays the dynamics of the logarithmic of close prices of the market indexes over the past eleven years. The patterns indicate that the markets experienced significant market falls associated with the South East Asian crisis of 1997, Brazil's debt problem of 1998, the dot-com bubble in 2000, the 9/11 terrorist attacks in 2001 and the pressure of selling more generally

In addition, Figure 2 (see Appendix) shows that the return series are more volatile over specific time periods. We can clearly observe that there are phases with different degrees of volatility. The USA stock market index (DJI) is seen to have a very high degree of volatility especially in 2001 which coincided with bad news. The volatility levels were very similar in other markets, except for the Canadian and Brazilian market, mainly due in part to the bad news coming from the USA which resulted in a succession of large positive and negative returns within a very short time horizon, indicating therefore that stock price risk management is warranted. Volatility clustering is manifestly apparent for all stock index return series indicating the presence of heteroscedasticity.

Figure 3 (see Appendix) displays the monthly volatilities of the return series. Interestingly the data shows the standard pattern of volatility across all markets. Although volatility increased in all markets, the industrialized markets seem to exhibit more market jitters than the emerging markets sampled. In particular, there are turbulent months which are then followed by further turbulent months, while relatively calm months tend to bunch together.

4. ESTIMATION AND RESULTS

In this section, we apply the parametric and nonparametric models outlined in section 2 to the data for the seven stock markets. The VaR estimates for the financial markets in this study are calculated for a one-day holding period at the 95% and 99% confidence levels in order to evaluate whether model performance changes for different VaR levels. For VaR estimation, we employ estimation window size ranging from 50 to 1250 past observations and a one-day moving average procedure to push the estimation period through time. For the GARCH and EGARCH methods we apply the algorithm advanced by Bernt et al. (1974) to maximise the log-likelihood, while the parameters are estimated using 1250 observations and a one day ahead sample forecasts of volatility is estimated using a rolling window dynamic re-parameterization approach which requires estimating each model, and then using the parameters to create a one-day-ahead forecast of volatility for each market index.

We first analyze the performance of the models by using the method advanced by Lopez (1999) to evaluate VaR estimates using regulatory loss functions. The results for the evaluation of model accuracy are presented in Tables 2 to 8 (95% VaR) and (99% VaR), where the Lopez B, Lopez Q, and Lopez F denote the binary, quadratic, and the firm's loss function respectively. The first column lists the name of the models. The second and third column reports the estimated Lopez B statistic for the

95%and 99% confidence levels for period 1 (volatile moments). The fourth and fifth column reports the estimated statistics for the Lopez Q test for both confidence levels, while the sixth and seventh column shows the estimated statistics for the Lopez F statistics. The remaining columns presents the results for the second period (quiet times) and the third period (volatile moments). Tables 9 to 15 are assembled in the same manner and report Christoffersen's likelihood ratio test results for unconditional coverage (or probability failures, LR_{uc}), serial independence of exceptions (LR_{ind}), and conditional coverage (LR_{cc}), to determine which model is more accurate.

Considering first, period 1, designated 'volatile' moments – due to the instability set in motion by the Asian (1997 and 1998), Russian (1998) and Brazilian (1999) crisis. A first observation that emerges from Table 2 to 8 using the Lopez (1999) loss functions, as given by the binary and quadratic loss functions, is that according to their performance in each statistical loss function, no particular model produced sufficiently accurate and consistent estimated VaRs for the 95% and 99% level VaR for developed and emerging markets, although the range based and kernel methods are identified as the least accurate in VaR risk measure. To further illustrate model performance, we examined closely the results for the European markets which are perhaps less prone to market trembles than the emerging markets in our sample. Tables 2 and 3 (see Appendix) show that for the AEX and DAX returns, the Lopez-B statistic ranges from 5.046 (AEX - RM 50.90) to 28.440 (DAX - RS 1250) for the 95% confidence level and from 1.376 (AEX - GK 50) to 22.477 (DAX RS 1250). For these markets the range based and kernel models are again identified as the least recommendable as they provided the least accurate estimated VaRs, though the Historical Simulation (HS) model which, as earlier noted, is one of the most widely used models in practice evidenced poor values, with the Lopez-B statistics ranging from 7.339 (DAX HS 50) to 15.367 (AEX HS 1250) for the 95% confidence level, and (DAX HS 250) 2.064 to 5.275 (AEX HS 1250). More specifically, we see from the values of the firm's loss function (Lopez F) that during volatile moments all the models, for all returns, become relatively more expensive, and especially in the case of the SET and BOVESPA returns for the estimation period.

Comparable levels of performance in the accuracy of estimated VaRs were also observed for period three as a result of the terrorist attack on the Pentagon and the World Trade Centre on September 11th 2001, coupled with the financial shocks linked to the financial collapse of Enron and WorldCom which affected most markets. The estimates in Tables 2 to 8 for the Lopez-B and Lopez-Q statistics indicate that no particular model stood out in terms of delivering sufficiently accurate estimated VaRs for the 95% and 91% level VaR. For the same period the estimates indicate that for the DJI return, the Lopez-B statistic ranges from 4.323 RiskMetrics (RM-100.94) to 19.885 Kernel (KS 1250) for the 95% confidence level, and from 1.153 (EGARCH) to 11.239 (KS 1250) for the 99% confidence level. More strikingly, the loss function values fail to identify a dominant VaR model, suggesting that the results are open to interpretation taking into full consideration the loss functions used and the chosen horizon. On this basis, the kernel, range based, and HS models appear to be the least recommendable for their ability in delivering accurate estimated VaRs across all markets and confidence intervals.

Tables 9 to 15 (see Appendix) report the LR statistics for the different coverage levels at 95% and 99% level VaR. As can be seen, the accuracy performance of the models in estimated VaRs are broadly similar, though most noticeably the performance of the range-based models are considerably poor in confidence levels for all markets than is the case for the more widely used risk measurement models. Similar conclusions are attained here, comparable with their performance in each statistical loss function. One encouraging result was that in the case of the AEX and DJI returns in period 1 and 3, although there were a large number of violations, the violations did not arrive in clusters as would otherwise have been expected. Interestingly, the poor performance of the models during volatile moments — i.e., the Asian financial crisis, the catastrophic events of September 11, 2001, and the fears surrounding the financial distress of Enron is generally in line with results furnished by Danielsson (2002) who investigated similar models over the same time span, albeit with larger window lengths (300, 1000 and 1250 observations), but only for the regulatory 99% level VaR, which produced inferior accuracy results to smaller confidence levels.

We find that when we analyzed the models during volatile moments, due to the Asian crisis which followed a period of relative calm in global financial markets, the smaller sample windows were not only able to fully capture the short-term dynamics of the markets but also furnished better model performance in estimated VaRs. For example, the performance of the EWMA procedure for the SET return, displayed in Table 7, where the performance difference as measured by the binary loss function for the largest and smallest sample window size was between 8.486 for the 95% level VaR and 2.293 for the 99% level VaR. Besides, the conditional coverage LR statistic improved by a factor of 48.3 for the 95% level VaR and 19.93 for the 99% level VaR. The improved performance of the VaR models using smaller sampling windows were further confirmed during the catastrophic events of 9/11 2001 (period 3), especially for European and North American markets that were widely affected.

Discernibly, model performance in estimated VaR risk measure improved when the largest window size was examined. The results here permit to conclude that the models were able to better capture the extreme returns from the first period, thereby delivering larger estimated VaRs. Thus the performance difference between the two volatile moments, for both the smallest and largest window size, reduced significantly. An examination of results in Table 3 for the DAX return shows that the difference of the binary loss function statistic for the EWMA procedure with 50 and 1250 observations during the first period were 5.275 and 4.358 for the 95% and 99% level VaR respectively, while for the third period this was 4.611 and 4.611. In the second period, quiet times, denoting the absence of any market perturbation or financial distress, the variation in window size had more of a varied influence on model performance in the accuracy of estimated VaR risk measure.

We also observe that model accuracy generally improved as the size of sampling windows increased. This was expected since, as earlier remarked, larger size windows were able to fully capture the extreme returns from the first period, thereby generating larger estimated VaRs. This was also confirmed by the results which identified the largest window size (1250) as performing worse than the second (500) and third (250) windows in estimated VaR risk measure. The explanation for this can probably be found in the windows which contained observations that take in the period 1992 to 1997, which was a quieter time for financial markets.

The results summarizing Christoffersen's test for this period were quite low, indicating that the majority of VaR models were providing unconditional and conditional coverage, independent of the confidence level for the markets considered. From the estimates, one can discern a clear and significant reduction in the LR statistic in comparison with the first period. For instance, for the AEX return, it can be seen that the LR_{cc} statistic for the GARCH model displayed in Table 11 decreased from 2.21 to 0.05 for the 95% level VaR, and 5.87 to 1.47 for the 99% level VaR. Similar reductions were obtained for some of the VaR models applied to AEX returns for this period.

In contrast, the range-based models provide the least accurate estimated VaR risk measure in relation to their counterparts. Among these models, estimated values of the various loss functions (in terms of accuracy performance and conditional coverage) for the model of Yang and Zhang (2000) are identified as the most accurate, with the model of Garmon and Klass (1980) the second best performing model for both developed and emerging markets. In particular, the estimated VaRs of the model of Yang and Zhang and Garmon and Klass were especially biased during the first period for as Tables 2 to 10 show, the best binary loss function statistics[9] for the 95% level VaR ranged from 5.963 (DJI) to 17.890 (DAX) for the model of Parkinson (1980); 6.193 (DJI) to 15.826 (TSX) for the model of Rogers and Satchell's (1991); 5.275 (DJI) to 11.009 (SET) for the model of Garmon and Klass (1980), and 5.505 (NIKKEI 225) to 7.798 (BOVESPA) for the model of Yang and Zhang (2000)[10]. Specifically, the relative performance of these models improved during the second period, but deteriorated during the third period, especially for European and North American markets for reasons earlier noted. The statistics indicate that the only accurate and acceptable estimated VaR risk measure delivered y these models were for the SET return during the second and third period. But even for the SET all the models, the kernel aside, are identified as providing similar or even better accuracy performance in estimated VaR risk measure. One explanation for the poor performance of the range-based models may be due to the restrictive assumptions in the models structure such as the drift, the opening jump and the distribution of returns, which is perhaps why the model of Yang and Zhang (2000) with its less restrictive assumptions than the other range based models performed better.

The figure also shows that the most biased estimated VaRs were those of the kernel method, the results of which are in line with those obtained by Engle and Gizycki (1999a) who employed three different bandwidths. One explanation for the poor performance of the kernel specification over the three estimation periods may be as a result of our choice of bandwidth, but in light of the kernel and range based models underestimation of VaR, the results also show that both models delivered lower estimated values in the firm's loss function. This, we suspect, may be due to the large data requirements of the range-based models, the larger estimation time, and complexity of decision regarding the bandwidth of the kernel procedure, all of which suggests that one would be reluctant to recommend the use of such models to manage market risk.

On the basis of the magnitude of the statistics presented in Tables 2-8 and the results of Christoffersen's test reported in Tables 9-15, at the 95% and 99% VaR levels, it is clear that the GARCH and EGARCH models do not outperform the widely used VaR models for we could not correlate the performance of the models with the return series for any market or indeed to any confidence levels. In a similar way to the alternative models, the GARCH and EGARCH models also produced biased estimated VaRs during the Asian crisis, though the null hypothesis of independence of violations could not be rejected at 95% and 99% confidence levels. Even so, it must be highlighted that in the case of the DJI, TSX and BOVESPA returns, the accuracy performance of the models improved during the second and third period – particularly since the volatility persistence characteristic of stock returns included in the structure of the models' improved estimated VaR risk measure. The figures indicate that during the third period there was a slight decrease in model performance, though, for the majority of markets, the null hypothesis of conditional coverage could not be rejected.

It is apparent from the results that estimated VaRs from the GARCH and EGARCH specifications are very similar. A possible explanation for this is that for a large number of estimations of the EGARCH specification, the leverage effect was statistically insignificant, thus producing volatility estimates approaching the ones produced by the basic GARCH. This particular observation contrast with results of Sarma et al. (2000) and Berkowitz and O'Brien (2002) who considered modifying the basic GARCH based on the conditional normal distribution, which can be improved once the time variation in volatility is suitably modelled. Analogous conclusions can be drawn for the EWMA model which showed similar estimates and, in some cases, better accuracy performance, as well as providing better conditional coverage than the parametric models, which is consistent with results obtained by Sarma et al. (2000).

During the first period — in uniform with range based models – the use of small window sizes improved model performance accuracy significantly for the 95% and 99% VaR levels for all markets, except for the DJI return for which the results show the binary and quadratic loss function values above the critical values, while the firm's loss function values were relatively high with the two smallest window size of 50 and 100 providing conditional coverage for the 95% or 99% level VaR. A close look at the values of the statistics for both types of tests indicate that model performance improved during the second period (which was a notable improvement on the first period), though results over sampling window size varied, principally because the larger size windows were able to manifest more extreme returns from the first period.

[9] Comparing the statistics across windows for each country.
[10] The smallest values are for the 50 observations, while the largest values are for the 1250 observations. The reason of this difference has already been explained.

Over the period that encapsulate the catastrophic events of 9/11 (period 3), the performance accuracy of the models were very similar to the first period, with the smallest size windows delivering better performance than larger size windows. In particular high values of LR_{cc} were observed for European markets. Yet despite these end results, the null hypothesis of independence of violations was not rejected for the smallest window size at the 99% level VaR. The performance of the EWMA method across all estimation periods shows that although the volatility forecast of the model can be improved with the aid of smaller or larger window size, the unconditional normality assumption is inadequate in modelling the empirical distribution of daily returns, even during quieter moments. Estimates for the first and third periods also show that the EWMA method delivered better VaRs than the GARCH models. But as far as identifying a model that is resilient to the inconstancy of financial markets, the estimates from both types of tests identify the RiskMetrics (RM) procedure as delivering better performance during volatile moments. Specifically, during the first period, the model produced the most accurate VaRs for the 95% and 99% confidence level for the AEX, NIKKEI 225, and SET returns. Specifically, the LR_{cc}identify the RM model as providing conditional coverage for all markets for the 95% and 99% level VaRs in both volatile moments. The LR_{cc} indicate that during the first period the model delivered better estimated VaRs for European and North American markets than for the representative markets of Asia and South American. That is, the latter markets reacted markedly to the fallout from the Asian crisis and from the ramifications of perceived market uncertainty. But although model performance was reversed in the third period for European markets, the RM model was the only VaR model that provided conditional coverage for these markets.

On the other hand, the Lopez B and Q statistics show that for all markets, the RM model performed poorly during quiet periods, even though it provides conditional coverage. This is more pronounced in all markets during quiet periods and during the third period, particularly for the SET and BOVESPA returns. The result here seems to suggest that the choice of the decay factor is important for the performance of the RM model, especially over the shorter window size, though it does not alter considerably the performance of the model for larger size windows. Clearly, since the sampling windows for most of the returns include observations from a relatively quiet period, we would expect an increase in the value of the decay factor to improve model performance, as more recent observations would be expected to have a larger bearing on volatility estimation.

Likewise, during quiet periods, we would also expect VaR models to provide more accurate estimated VaRs with lower decay factors since more value is given to more extreme events from the first period. The results here, although indecisive, suggest the accuracy of estimated VaRs for the RM model depends on the harmony between the sampling window size and the value of the decay factor. In respect to this, estimates identify the smallest window size as delivering the poorest performance for all three decay factors, confidence levels, and markets during volatile moments (1997/1998), while in the third-period model accuracy improved as a result of increasing the window size and the decay factor.

Overall, and in a similar way to the EWMA model, the RM model generally produced higher values of the firm's loss function than the GARCH, suggesting that financial firms allocating risk capital based on RM estimates would incur higher capital costs.

Considering further the specification search for model accuracy in VaR risk measure, and accounting for the performance of the Historical Simulation (HS) method during the first volatile period; looking closely at Tables 2-8, the Lopez-B statistic ranges from 5.505 (NIKKEI 225 – HS 250) to 15.138 (SET – HS 1250) for the 95 percent confidence level, and from 1.606 (TSX – HS 250) to 2.982 (SET – HS 1250). The performance of the model in VaRs for the markets was particularly poor at higher confidence level in both periods of highly volatile moments, as well as failing to furnish conditional coverage for both confidence levels. The results further show that over this period the use of longer data window size produced mixed results, with the two largest window size (the 500 and 1250) producing inferior performance at 95% and 99% VaR levels. The reason for this is that both windows include observations from a time when markets evinced far less volatility, suggesting that the empirical distribution of past returns are inappropriate to model the extreme returns over volatile moments. The most notable exception here is the BOVESPA, which is understandable since in both Fig 1 and 3 we can see that the large sample windows comprise observations from a period when asset prices on the stock market were somewhat volatile. We should stress here, also, that the model significantly improved in quiet times, which accords with results obtained by Engel and Gizycki (1999a), Hendricks (1996), Jackson et al. (1997), and Mahoney (1996), yielding less biased estimated VaRs for the higher confidence level in the case of the DAX, DJI, TSX, and BOVESPA returns. When examined over period three, the results show that model performance was inferior to parametric specifications, especially for the DAX, AEX and DJI returns. The results here are consistent with Kupiec (1995) and Sarma et al. (2000), who found that the HS model did not provide superior performance to the EWMA, RM, and GARCH models in volatile moments and for all data window size.

In summary, the results illustrate that when estimating VaR over varying market conditions that, in general, the kernel, range-based and historical simulation procedure are the least among the models considered to deliver accurate estimated VaR risk measure. The study further suggests that the use of GARCH based specifications is not a reliable way for financial firms to estimate VaR and to manage their market risk, and despite previous studies conclusion that GARCH models can provide better estimates. Observedly, the EWMA model has shown some success in delivering VaR risk measures by altering the window size. The same finding is also applicable for the RiskMetrics procedure, though the model marginally delivers better performance in estimated VaR risk measure, and especially during volatile moments. Nonetheless, it worth noting that these risk measurement models have their own advantages and disadvantages; see for a discussion Emmer et al. (2015). The limitation of the present study is that it does not consider a portfolio of mixed securities or portfolios consisting of the stocks of individual companies comprising the indexes of the markets used to estimate the daily VaR.

5. CONCLUSION AND IMPLICATIONS

We studied the accuracy performance of various classes of risk measurement models, including the most widely used specifications in practice, and alternative models which have not frequently appeared in the literature in VaR risk measure. The empirical analysis places particular emphasis on model performance in the accuracy of estimated VaR over three distinct estimation periods – one quiet and two volatile – as well as across developed and emerging markets from different geographical regions. To verify and thus evaluate model accuracy and performance, the models are compared using Lopez regulatory loss functions and Christofferson likelihood ratio tests for coverage probability (or the number of violations).

In our analysis, it is shown that the EWMA and RiskMetric procedure delivered more accurate estimated VaR risk measure than did any of the alternative risk measurement procedures, though performance varies with the 95% and 99% confidence levels. In particular, the RiskMetric procedure performs reasonably well during volatile periods, while the EWMA do better in the quiet period. Furthermore, the evidence suggests that the resulting VaR numbers might differ considerably for identical portfolios that include stocks drawn from the seven markets indices considered. The results presented here are consistent with the conjecture that procedures tend to underestimate VaR during periods of financial stress, while they imply higher opportunity cost of capital. The results also indicate that procedures such as the EWMA can provide more accurate estimated VaRs than the GARCH and HS models by changing the estimation horizon, while the Kernel, Range-based and HS models are identified as the least accurate in estimated VaR risk measure in both confidence levels, across financial markets and all periods. The results thus fit a pattern that is similar to that found by Danielsson (2002) as it provides further evidence on the relation between the performance of alternative VaR models over periods of financial stresses and strains. It also has interesting implications for practitioners and regulators alike, since our application implements back-testing techniques to evaluate the performance of VaR models over stable and volatile moments which may help to mitigate investors, portfolio managers, and regulators concern over the efficacy of risk measurement models to yield accurate and consistent VaR estimates over varying market conditions. Overall, the conclusion reached here speaks in support of the RiskMetric and EWMA procedure as the best performing models, though it may be more interesting to compare them and the other models considered in this study in terms of portfolio management performance using portfolios that are the components of the stock market indexes included in this study.

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APPENDIX

Figure 1. Time series dynamic of USA, Dow Jones (DJI), Canada, Toronto (TSX), Germany (DAX), Netherlands (AEX), Japan (Nikkei 225), Thailand (SET), Brazil (IBOV)

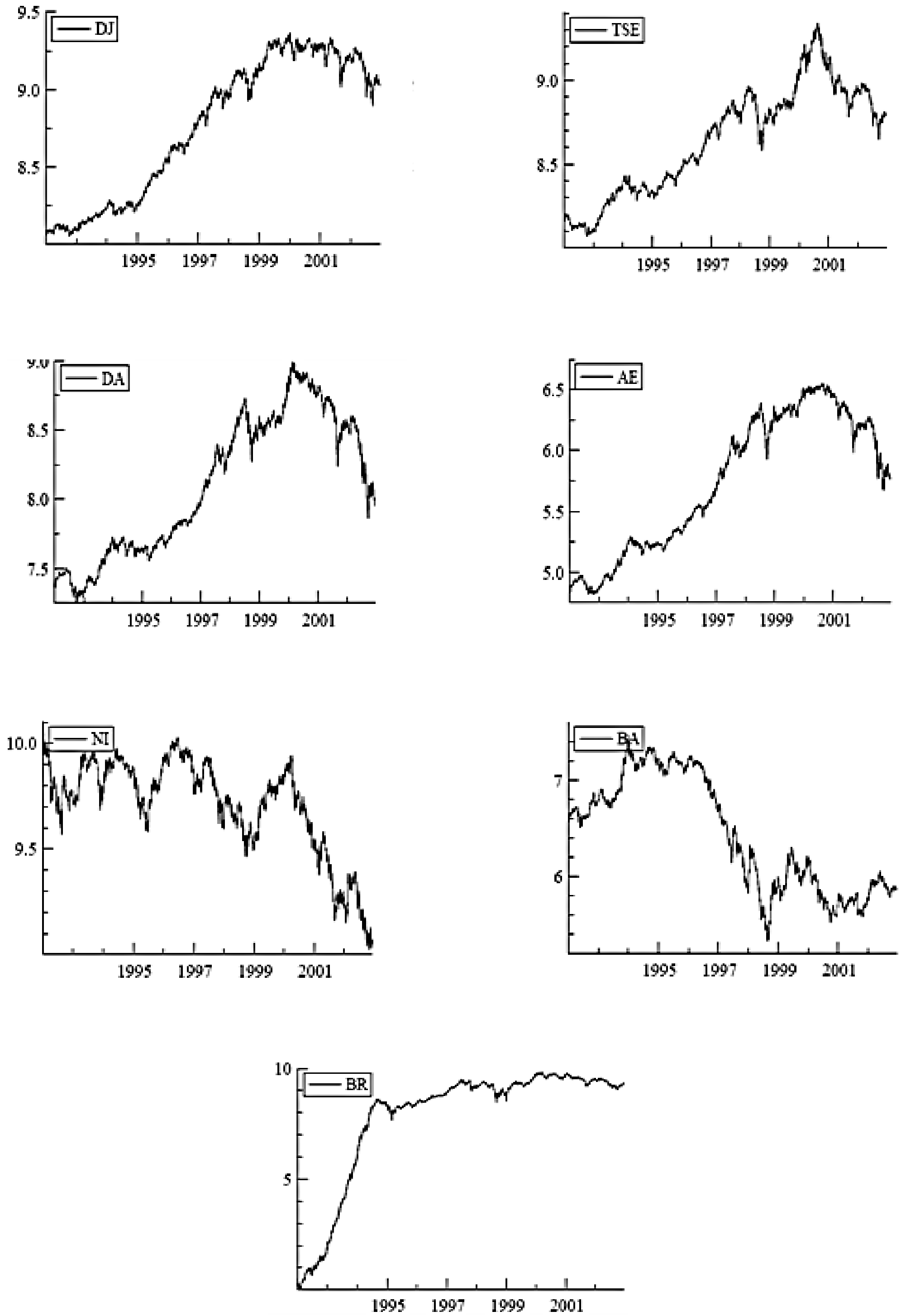

Figure 2. Daily returns of market indexes (DJI, TSX, DAX, AEX, Nikkei 225, SET, IBOV)

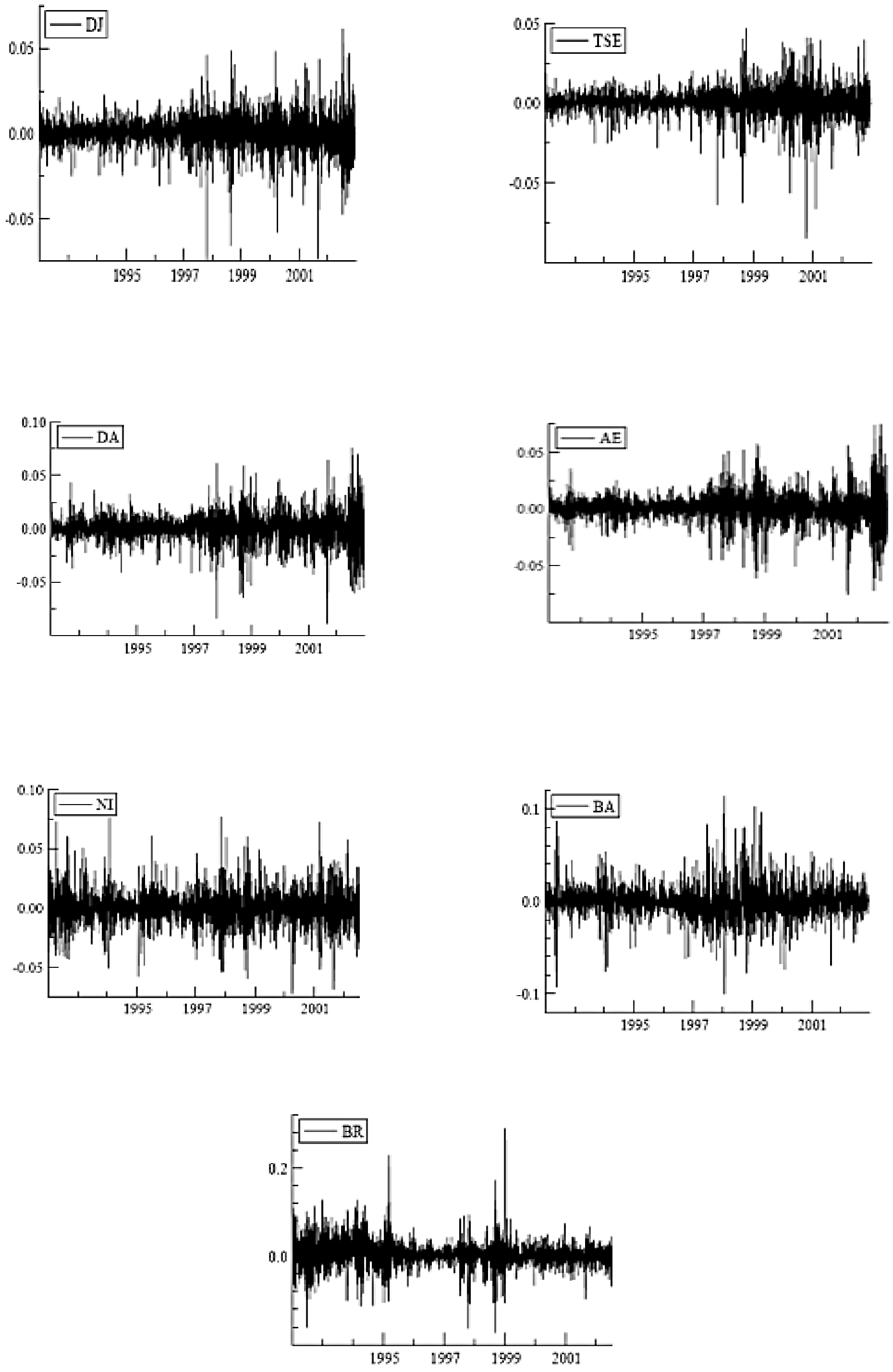

Figure 3. Monthly volatilities (DJI, TSX, DAX, AEX, Nikkei 225, SET, IBOV)

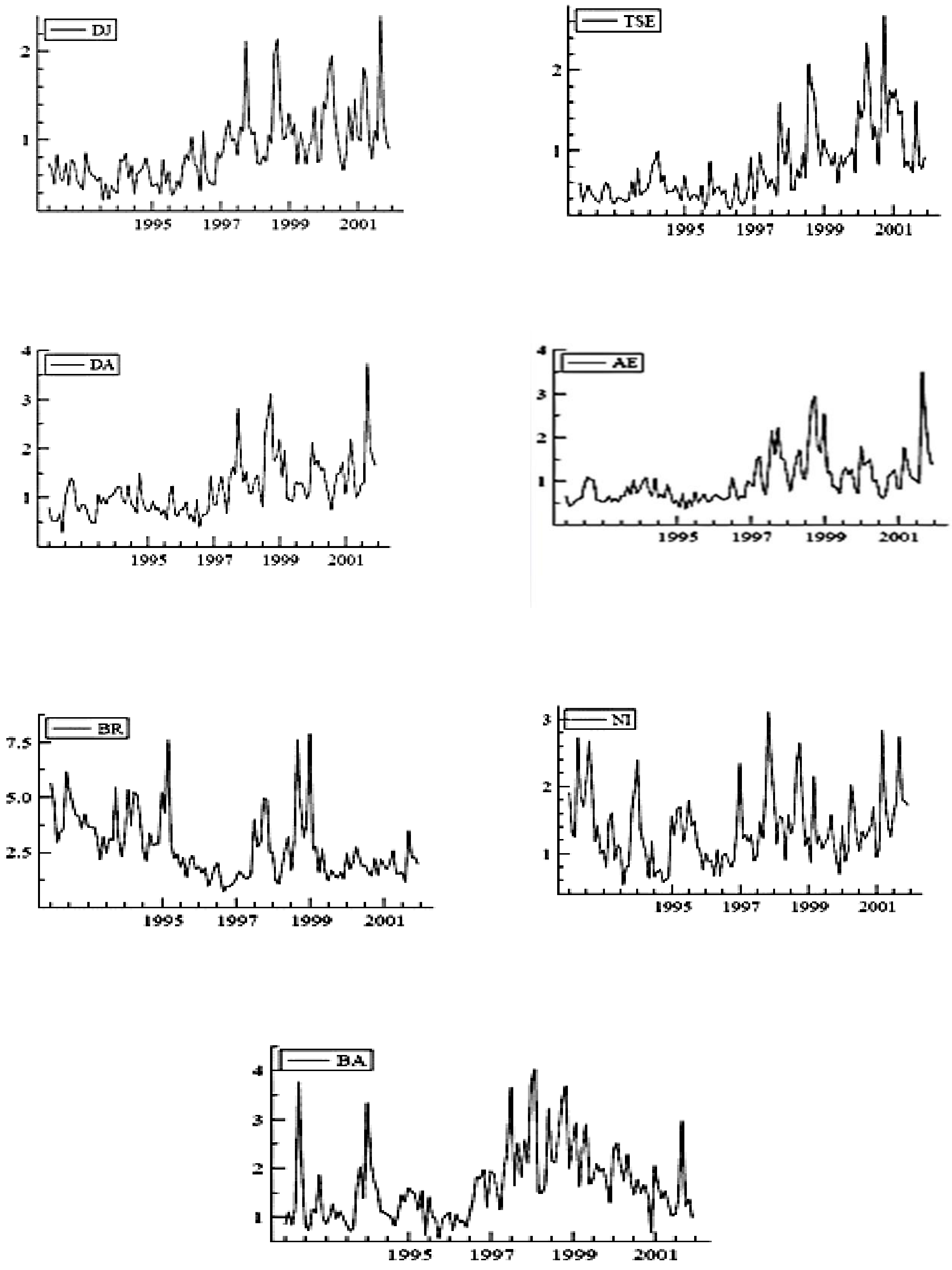

Table 2. Netherlands (AEX) loss function statistics (part 1)

	Period 1						***Period 2***						***Period 3***					
	Lopez B		***Lopez Q***		***Lopez F***		***Lopez B***		***Lopez Q***		***Lopez F***		***Lopez B***		***Lopez Q***		***Lopez F***	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	5,963	1,376	5,964	1,377	0,076	0,112	5,747	1,724	5,748	1,724	0,056	0,082	7,781	3,170	7,784	3,171	0,101	0,147
MA Z 100	5,963	2,294	5,965	2,294	0,074	0,107	5,172	1,580	5,173	1,581	0,059	0,086	8,934	5,476	8,937	5,477	0,098	0,140
MA Z 250	7,569	3,440	7,570	3,441	0,067	0,097	4,023	1,293	4,024	1,293	0,065	0,093	8,934	4,899	8,938	4,901	0,086	0,123
MA Z 500	8,716	4,817	8,718	4,817	0,057	0,081	3,017	1,006	3,018	1,006	0,070	0,100	11,527	7,205	11,533	7,207	0,073	0,103
MA Z 1250	12,615	8,028	12,618	8,029	0,044	0,063	3,736	1,006	3,736	1,006	0,062	0,090	13,545	7,205	13,262	7,207	0,071	0,101
RM 50 .90	5,046	2,294	5,047	2,294	0,075	0,108	7,615	1,580	7,615	1,581	0,053	0,079	7,205	1,153	6,918	1,153	0,099	0,146
RM 100 .90	5,046	2,064	5,047	2,064	0,075	0,108	7,471	1,580	7,472	1,581	0,053	0,079	7,205	1,153	6,918	1,153	0,099	0,147
RM 250 .90	5,046	2,064	5,047	2,064	0,075	0,108	7,471	1,580	7,472	1,581	0,053	0,079	7,205	1,153	6,918	1,153	0,099	0,147
RM 500 .90	5,046	2,064	5,047	2,064	0,075	0,108	7,471	1,580	7,472	1,581	0,053	0,079	7,205	1,153	6,918	1,153	0,099	0,147
RM 1250 .90	5,046	2,064	5,047	2,064	0,075	0,108	7,471	1,580	7,472	1,581	0,053	0,079	7,205	1,153	6,918	1,153	0,099	0,147
RM 50 .94	5,963	2,064	5,964	2,065	0,073	0,107	7,328	1,724	7,328	1,724	0,053	0,078	8,069	1,729	8,071	1,730	0,097	0,144
RM 100 .94	5,505	1,835	5,506	1,835	0,075	0,109	6,322	1,580	6,322	1,581	0,055	0,080	6,916	1,441	6,918	1,442	0,101	0,147
RM 250 .94	5,505	1,835	5,506	1,835	0,075	0,109	6,322	1,580	6,322	1,581	0,055	0,080	6,916	1,441	6,918	1,442	0,101	0,148
RM 500 .94	5,505	1,835	5,506	1,835	0,075	0,109	6,322	1,580	6,322	1,581	0,055	0,080	6,916	1,441	6,918	1,442	0,101	0,148
RM 1250 .94	5,505	1,835	5,506	1,835	0,075	0,109	6,322	1,580	6,322	1,581	0,055	0,080	6,916	1,441	6,918	1,442	0,101	0,148
RM 50 .97	6,881	2,294	6,882	2,294	0,066	0,097	8,764	2,443	8,765	2,443	0,048	0,071	10,086	3,458	10,089	3,459	0,087	0,129
RM 100 .97	6,193	1,376	6,194	1,377	0,073	0,108	5,891	1,437	5,891	1,437	0,055	0,081	7,781	3,170	8,072	3,171	0,098	0,142
RM 250 .97	5,505	1,376	5,506	1,377	0,075	0,110	5,172	1,149	5,173	1,150	0,057	0,084	6,628	2,594	6,631	2,595	0,101	0,145
RM 500 .97	5,505	1,376	5,506	1,377	0,075	0,110	5,172	1,149	5,173	1,150	0,057	0,084	6,628	2,594	6,631	2,595	0,101	0,145
RM 1250 .97	5,505	1,376	5,506	1,377	0,075	0,110	5,172	1,149	5,173	1,150	0,057	0,084	6,628	2,594	6,631	2,595	0,101	0,145
KS 50	10,092	4,817	10,094	4,817	0,054	0,079	11,063	4,598	11,064	4,598	0,040	0,059	12,680	7,493	12,685	7,495	0,077	0,109
KS 100	11,697	6,651	11,700	6,653	0,049	0,071	10,920	5,029	10,921	5,029	0,040	0,059	15,274	9,222	15,569	9,227	0,069	0,097
KS 250	13,991	8,486	13,995	8,488	0,042	0,060	10,920	4,454	10,921	4,455	0,041	0,060	21,037	12,392	21,047	12,397	0,051	0,071
KS 500	19,954	10,780	19,959	10,783	0,033	0,048	9,770	4,023	9,771	4,024	0,042	0,062	25,072	17,003	25,083	16,722	0,044	0,058
KS 1250	21,771	17,661	24,777	17,665	0,026	0,036	14,368	7,471	14,370	7,472	0,033	0,048	24,784	16,427	24,796	24,795	0,044	0,060
GK 50	6,193	1,376	6,194	1,376	0,075	0,111	5,029	1,437	5,029	1,437	0,058	0,084	8,357	3,458	8,360	3,459	0,094	0,136
GK 100	6,193	2,523	6,194	2,523	0,074	0,108	4,598	1,437	4,598	1,437	0,061	0,089	9,510	5,476	9,514	5,477	0,092	0,132
GK 250	7,339	3,211	7,341	3,212	0,068	0,098	3,736	1,293	3,736	1,293	0,067	0,096	9,510	5,187	9,514	5,189	0,083	0,118
GK 500	8,486	4,587	8,488	4,588	0,058	0,084	2,730	1,006	2,730	1,006	0,071	0,102	12,104	7,205	12,109	7,207	0,072	0,102
GK 1250	12,615	8,028	12,618	8,029	0,044	0,063	3,305	1,006	3,305	1,006	0,064	0,092	13,545	7,205	13,262	7,207	0,071	0,102
RS 50	12,156	5,734	12,158	5,735	0,051	0,075	8,477	2,586	8,478	2,587	0,046	0,068	12,392	6,340	12,396	6,342	0,078	0,113
RS 100	12,884	6,422	12,847	6,423	0,050	0,072	7,615	2,730	7,616	2,730	0,048	0,071	12,392	7,781	12,398	7,784	0,079	0,110
RS 250	12,156	7,110	12,159	7,112	0,047	0,067	6,466	2,874	6,466	2,874	0,051	0,074	13,256	7,781	13,262	7,784	0,070	0,100
RS 500	14,679	8,486	14,683	8,488	0,041	0,058	5,747	1,724	5,748	1,725	0,053	0,077	16,715	8,934	16,433	8,937	0,060	0,086
RS 1250	20,413	12,385	20,418	12,389	0,032	0,045	8,477	3,017	8,478	3,018	0,045	0,067	17,579	10,375	17,229	10,379	0,057	0,080
P 50	11,009	5,275	11,011	5,276	0,053	0,078	8,764	2,730	8,765	2,730	0,046	0,069	12,104	5,764	12,396	5,766	0,079	0,116
P 100	11,468	5,275	11,471	5,277	0,052	0,076	8,046	2,874	8,047	2,874	0,049	0,071	12,104	7,205	12,397	7,207	0,080	0,113
P 250	11,468	7,110	11,471	7,112	0,049	0,070	6,322	2,874	6,323	2,874	0,052	0,075	12,968	7,493	12,974	7,496	0,071	0,101
P 500	13,991	8,486	13,994	8,488	0,042	0,060	6,034	1,724	6,035	1,724	0,054	0,078	16,427	8,934	16,433	8,937	0,061	0,087
P 1250	12,385	11,468	19,730	11,471	0,033	0,047	7,902	2,874	7,903	2,874	0,046	0,068	17,579	9,510	17,299	9,514	0,058	0,081
YZ 50	6,193	1,376	6,194	1,376	0,076	0,111	5,029	1,293	5,029	1,293	0,058	0,085	8,069	3,458	8,072	3,459	0,095	0,137
YZ 100	5,963	2,523	5,965	2,523	0,075	0,108	4,598	1,580	4,598	1,581	0,062	0,089	9,510	5,476	9,514	5,477	0,093	0,133
YZ 250	7,110	3,440	7,112	3,441	0,069	0,099	3,736	1,149	3,736	1,150	0,067	0,096	9,510	5,187	9,514	5,189	0,083	0,119
YZ 500	8,257	4,587	8,259	4,588	0,059	0,084	2,730	1,006	2,730	1,006	0,072	0,102	16,427	7,205	12,109	7,207	0,072	0,102

Table 2. Netherlands (AEX) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
YZ 1250	12,385	8,028	12,389	8,029	0,045	0,063	3,305	1,006	3,305	1,006	0,064	0,092	13,256	6,916	12,974	6,919	0,072	0,103
GARCH	6,193	2,294	6,194	2,294	0,071	0,103	5,172	1,437	5,173	1,437	0,056	0,082	6,628	1,441	6,341	1,441	0,096	0,141
EGARCH	5,734	2,523	5,735	2,523	0,069	0,100	4,023	1,293	4,024	1,293	0,059	0,085	7,781	1,441	7,782	1,441	0,090	0,135
HS 50	8,028	2,752	8,029	2,753	0,069	0,103	7,184	1,437	7,185	1,437	0,054	0,078	9,222	3,746	9,513	3,747	0,097	0,130
HS 100	7,569	2,294	7,571	2,294	0,070	0,113	5,316	1,724	5,317	1,724	0,058	0,088	8,646	4,611	8,649	4,613	0,095	0,150
HS 250	7,798	2,064	7,800	2,065	0,066	0,113	4,023	1,293	4,024	1,293	0,063	0,104	10,086	2,017	10,090	2,019	0,082	0,158
HS 500	9,404	3,211	9,406	3,212	0,053	0,098	3,305	0,718	3,305	0,718	0,067	0,122	12,104	4,035	12,109	4,036	0,072	0,129
HS 1250	15,367	5,275	15,371	5,276	0,039	0,077	4,454	0,718	4,455	0,718	0,057	0,117	13,883	3,458	13,550	3,459	0,068	0,135

Table 3. Germany (DAX) loss function statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	7,569	2,523	7,571	2,524	0,078	0,113	6,034	1,293	6,035	1,293	0,067	0,098	7,493	2,305	7,495	2,306	0,107	0,157
MA Z 100	7,339	2,064	7,342	2,065	0,075	0,110	5,172	1,149	5,173	1,149	0,070	0,102	8,357	4,035	8,361	4,036	0,102	0,148
MA Z 250	7,798	3,670	7,801	3,671	0,069	0,099	4,741	1,580	4,742	1,580	0,073	0,106	8,934	4,035	8,937	4,036	0,091	0,132
MA Z 500	9,862	5,275	9,866	5,277	0,059	0,084	3,592	0,862	3,592	0,862	0,076	0,110	10,951	6,340	10,955	6,054	0,081	0,116
MA Z 1250	12,844	6,881	12,849	6,883	0,050	0,071	6,609	1,293	6,610	1,293	0,065	0,096	12,104	6,916	12,108	6,630	0,077	0,110
RM 50 .90	5,963	2,294	5,965	2,294	0,077	0,110	7,328	1,580	7,328	1,580	0,064	0,095	7,493	1,153	7,494	0,865	0,105	0,157
RM 100 .90	5,963	2,294	5,965	2,294	0,077	0,111	7,328	1,580	7,328	1,580	0,064	0,095	7,205	1,153	7,206	0,865	0,106	0,157
RM 250 .90	5,963	2,294	5,965	2,294	0,077	0,111	7,328	1,580	7,328	1,580	0,064	0,095	7,205	1,153	7,206	0,865	0,106	0,157
RM 500 .90	5,963	2,294	5,965	2,294	0,077	0,111	7,328	1,580	7,328	1,580	0,064	0,095	7,205	1,153	7,206	0,865	0,106	0,157
RM 1250 .90	5,963	2,294	5,965	2,294	0,077	0,111	7,328	1,580	7,328	1,580	0,064	0,095	7,205	1,153	7,206	0,865	0,106	0,157
RM 50 .94	6,651	2,523	6,653	2,524	0,076	0,109	7,328	1,724	7,328	1,724	0,063	0,093	8,069	1,153	8,071	0,865	0,103	0,154
RM 100 .94	6,193	2,523	6,194	2,523	0,077	0,111	6,897	1,293	6,897	1,293	0,065	0,096	7,781	0,865	7,782	0,865	0,105	0,157
RM 250 .94	5,963	2,523	5,965	2,523	0,078	0,111	6,753	1,293	6,753	1,293	0,065	0,096	7,781	0,865	7,782	0,865	0,105	0,157
RM 500 .94	5,963	2,523	5,965	2,523	0,078	0,111	6,753	1,293	6,753	1,293	0,065	0,096	7,781	0,865	7,782	0,865	0,105	0,157
RM 1250 .94	5,963	2,523	5,965	2,523	0,078	0,111	6,753	1,293	6,753	1,293	0,065	0,096	7,781	0,865	7,782	0,865	0,105	0,157
RM 50 .97	8,716	3,899	8,718	3,900	0,068	0,098	8,477	2,730	8,478	2,730	0,057	0,084	10,663	3,458	10,665	3,459	0,092	0,137
RM 100 .97	7,339	2,523	7,341	2,524	0,075	0,109	6,753	1,580	6,753	1,580	0,065	0,096	8,069	2,017	8,071	2,018	0,102	0,151
RM 250 .97	6,422	2,294	6,424	2,294	0,077	0,111	6,178	1,149	6,178	1,149	0,067	0,099	7,493	2,017	7,495	2,018	0,104	0,154
RM 500 .97	6,422	2,294	6,424	2,294	0,077	0,111	6,178	1,149	6,178	1,149	0,067	0,099	7,205	2,017	7,207	2,018	0,104	0,154
RM 1250 .97	6,422	2,294	6,424	2,294	0,077	0,111	6,178	1,149	6,178	1,149	0,067	0,099	7,205	2,017	7,207	2,018	0,104	0,154
KS 50	10,092	7,110	10,095	7,112	0,058	0,081	13,218	5,316	13,219	5,316	0,046	0,070	12,392	6,052	12,396	6,054	0,082	0,120
KS 100	11,697	7,339	11,702	7,342	0,054	0,075	12,213	5,172	12,214	5,173	0,047	0,070	14,986	8,069	14,992	8,361	0,074	0,106
KS 250	13,991	8,716	13,996	8,719	0,046	0,064	12,356	5,172	12,358	5,173	0,046	0,069	18,156	10,086	18,163	10,090	0,059	0,084
KS 500	18,119	12,156	18,126	12,160	0,037	0,051	12,356	5,747	12,358	5,748	0,046	0,068	21,037	13,833	21,047	13,838	0,053	0,073
KS 1250	21,789	15,826	21,796	15,831	0,032	0,043	17,098	9,914	17,100	9,915	0,035	0,052	23,055	15,562	23,065	15,568	0,050	0,068
GK 50	10,550	4,587	10,553	4,588	0,062	0,090	6,753	2,011	6,753	2,012	0,063	0,093	8,934	3,170	8,936	3,171	0,097	0,142
GK 100	10,321	5,505	10,325	5,506	0,061	0,086	6,034	1,868	6,035	1,868	0,065	0,096	8,934	4,611	8,937	4,613	0,095	0,137
GK 250	10,550	5,963	10,554	5,965	0,055	0,079	5,460	1,437	5,460	1,437	0,068	0,100	9,510	4,611	9,514	4,324	0,087	0,127
GK 500	13,761	8,257	13,766	8,260	0,047	0,066	5,603	1,006	5,604	1,006	0,068	0,100	12,104	6,628	12,109	6,342	0,076	0,109
GK 1250	16,284	9,174	16,290	9,178	0,042	0,059	9,339	2,730	9,340	2,730	0,055	0,082	14,697	8,069	14,703	7,783	0,070	0,101
RS 50	19,266	14,679	19,272	14,682	0,039	0,052	7,615	2,155	7,616	2,155	0,058	0,087	10,663	2,882	10,665	2,883	0,095	0,141

Table 3. Germany (DAX) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RS 100	19,954	14,679	19,960	14,683	0,037	0,049	7,184	2,155	7,184	2,155	0,060	0,089	9,222	4,323	9,226	4,324	0,095	0,137
RS 250	23,624	15,596	23,631	15,602	0,031	0,042	7,759	1,868	7,759	1,868	0,060	0,090	9,798	5,187	9,802	4,901	0,086	0,124
RS 500	27,294	18,807	27,302	18,814	0,027	0,036	8,908	3,161	8,909	3,161	0,056	0,084	12,392	6,916	12,397	6,630	0,075	0,109
RS 1250	28,440	22,477	28,450	22,484	0,026	0,032	14,080	7,902	14,082	7,903	0,041	0,060	16,715	9,510	16,722	9,513	0,063	0,090
P 50	17,890	12,615	17,895	12,618	0,042	0,057	6,897	2,155	6,897	2,155	0,060	0,088	9,510	3,170	9,513	3,171	0,098	0,144
P 100	17,890	13,532	17,896	13,536	0,039	0,053	6,753	2,155	6,753	2,155	0,062	0,091	9,222	4,611	9,226	4,613	0,096	0,138
P 250	20,413	14,679	20,420	14,684	0,034	0,046	7,471	1,724	7,472	1,724	0,062	0,093	9,798	5,187	9,802	4,901	0,086	0,124
P 500	25,459	16,972	25,467	16,978	0,028	0,039	8,477	2,011	8,478	2,012	0,059	0,088	12,392	6,628	12,397	6,342	0,076	0,110
P 1250	27,294	19,954	27,302	19,961	0,027	0,035	12,931	7,184	12,932	7,184	0,043	0,063	16,138	8,934	16,145	8,649	0,064	0,092
YZ 50	10,321	4,817	10,324	4,818	0,062	0,090	6,609	1,868	6,610	1,868	0,064	0,094	8,646	2,882	8,648	2,883	0,098	0,145
YZ 100	10,550	5,734	10,554	5,736	0,061	0,086	5,891	1,724	5,891	1,724	0,066	0,097	8,357	4,323	8,361	4,324	0,097	0,139
YZ 250	11,009	5,963	11,013	5,965	0,055	0,078	5,460	1,580	5,460	1,581	0,069	0,101	9,798	4,899	9,802	4,612	0,087	0,126
YZ 500	13,761	8,257	13,766	8,260	0,047	0,066	5,460	0,862	5,460	0,862	0,069	0,101	12,104	6,628	12,108	6,342	0,077	0,111
YZ 1250	16,284	9,174	16,290	9,178	0,042	0,059	9,195	2,586	9,196	2,586	0,055	0,083	14,121	8,069	14,127	7,783	0,071	0,102
GARCH	6,422	3,899	6,424	3,900	0,071	0,100	6,322	1,293	6,322	1,293	0,066	0,097	8,069	1,153	8,070	0,865	0,100	0,151
EGARCH	7,110	4,587	7,112	4,588	0,068	0,095	5,747	1,149	5,747	1,149	0,066	0,098	8,357	0,865	8,359	0,577	0,094	0,144
HS 50	7,339	3,211	7,341	3,212	0,076	0,113	7,615	3,017	7,616	3,017	0,063	0,086	8,646	4,611	8,648	4,612	0,100	0,130
HS 100	8,028	2,752	8,030	2,753	0,075	0,114	5,891	2,299	5,891	2,299	0,071	0,098	8,357	3,746	8,360	4,036	0,099	0,143
HS 250	8,716	2,064	8,718	2,065	0,066	0,123	4,454	1,149	4,454	1,149	0,075	0,117	8,646	2,017	8,649	2,018	0,090	0,152
HS 500	11,468	2,752	11,472	2,753	0,054	0,110	4,310	0,718	4,311	0,718	0,073	0,131	12,104	4,035	12,108	4,036	0,079	0,124
HS 1250	13,991	4,587	13,996	4,589	0,047	0,087	7,184	0,287	7,184	0,287	0,062	0,119	12,968	3,746	12,973	3,459	0,074	0,133

Table 4. Canada (TSX) loss function statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	5,734	2,523	5,735	2,524	0,049	0,071	4,598	1,437	4,599	1,437	0,061	0,088	4,899	2,305	4,900	2,306	0,048	0,069
MA Z 100	6,193	2,294	6,194	2,295	0,048	0,069	4,310	1,580	4,311	1,581	0,063	0,090	5,476	2,594	5,476	2,594	0,047	0,067
MA Z 250	7,110	2,752	7,112	2,753	0,042	0,060	4,741	1,724	4,743	1,725	0,063	0,091	5,764	2,017	5,764	2,017	0,050	0,073
MA Z 500	8,945	4,817	8,947	4,818	0,036	0,051	6,322	1,724	6,323	1,725	0,058	0,085	3,170	0,576	3,170	0,576	0,063	0,091
MA Z 1250	10,780	6,881	10,782	6,882	0,031	0,044	8,477	4,023	8,479	4,024	0,046	0,066	2,882	0,865	2,882	0,865	0,059	0,084
RM 50 .90	5,505	2,752	5,506	2,753	0,047	0,068	5,316	2,443	5,317	2,443	0,059	0,084	7,205	1,441	7,205	1,441	0,046	0,068
RM 100 .90	5,505	2,752	5,506	2,753	0,047	0,068	5,316	2,443	5,317	2,443	0,059	0,085	6,916	1,441	6,917	1,441	0,046	0,069
RM 250 .90	5,505	2,752	5,506	2,753	0,047	0,068	5,316	2,443	5,317	2,443	0,059	0,085	6,916	1,441	6,917	1,441	0,046	0,069
RM 500 .90	5,505	2,752	5,506	2,753	0,047	0,068	5,316	2,443	5,317	2,443	0,059	0,085	6,916	1,441	6,917	1,441	0,046	0,069
RM 1250 .90	5,505	2,752	5,506	2,753	0,047	0,068	5,316	2,443	5,317	2,443	0,059	0,085	6,916	1,441	6,917	1,441	0,046	0,069
RM 50 .94	5,505	2,523	5,506	2,524	0,047	0,067	5,603	2,155	5,605	2,156	0,058	0,084	6,916	2,017	6,917	2,017	0,045	0,067
RM 100 .94	4,817	2,523	4,818	2,524	0,048	0,069	5,316	1,724	5,317	1,725	0,060	0,086	6,340	2,017	6,341	2,017	0,047	0,068
RM 250 .94	4,817	2,523	4,818	2,524	0,049	0,069	5,172	1,724	5,174	1,725	0,060	0,086	6,340	2,017	6,341	2,017	0,047	0,069
RM 500 .94	4,817	2,523	4,818	2,524	0,049	0,069	5,172	1,724	5,174	1,725	0,060	0,086	6,340	2,017	6,341	2,017	0,047	0,069
RM 1250 .94	4,817	2,523	4,818	2,524	0,049	0,069	5,172	1,724	5,174	1,725	0,060	0,086	6,340	2,017	6,341	2,017	0,047	0,069
RM 50 .97	7,339	3,440	7,341	3,441	0,042	0,061	6,609	2,874	6,611	2,874	0,053	0,076	8,069	3,170	8,358	3,170	0,041	0,060
RM 100 .97	5,734	2,523	5,735	2,524	0,047	0,068	5,029	1,868	5,030	1,868	0,059	0,085	6,340	2,305	6,341	2,306	0,046	0,067
RM 250 .97	5,734	2,523	5,735	2,524	0,048	0,069	4,598	1,868	4,599	1,868	0,061	0,088	5,764	2,017	5,764	2,017	0,047	0,069
RM 500 .97	5,734	2,523	5,735	2,524	0,048	0,069	4,454	1,868	4,455	1,868	0,061	0,088	5,764	2,017	5,764	2,017	0,047	0,069

Table 4. Canada (TSX) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RM 1250 .97	5,734	2,523	5,735	2,524	0,048	0,069	4,454	1,868	4,455	1,868	0,061	0,088	5,764	2,017	5,764	2,017	0,047	0,069
KS 50	11,927	6,422	11,929	6,424	0,032	0,046	11,207	4,741	11,209	4,743	0,041	0,060	11,239	5,187	11,528	5,188	0,033	0,049
KS 100	12,615	8,028	12,618	8,030	0,029	0,041	11,351	5,316	11,353	5,317	0,040	0,058	13,256	6,628	13,834	6,629	0,030	0,045
KS 250	14,908	9,404	14,911	9,406	0,025	0,035	10,201	6,322	10,203	6,323	0,038	0,055	13,256	7,205	13,258	7,205	0,030	0,044
KS 500	17,431	11,697	17,435	11,700	0,021	0,029	12,213	8,190	12,215	8,191	0,034	0,048	10,086	5,476	10,087	5,476	0,035	0,051
KS 1250	19,266	14,450	19,270	14,453	0,018	0,025	22,270	12,931	22,274	12,934	0,023	0,034	11,816	6,052	12,105	6,052	0,031	0,046
GK 50	8,257	4,128	8,259	4,130	0,040	0,057	7,759	2,299	7,760	2,300	0,052	0,076	8,357	3,458	8,934	3,459	0,040	0,058
GK 100	8,716	4,817	8,718	4,818	0,039	0,055	6,753	2,011	6,754	2,012	0,054	0,079	9,222	3,746	9,223	3,747	0,039	0,057
GK 250	9,174	5,505	9,176	5,506	0,034	0,048	7,184	2,730	7,185	2,731	0,054	0,079	7,781	2,882	7,781	2,882	0,045	0,066
GK 500	11,009	6,881	11,012	6,882	0,030	0,042	7,615	3,305	7,617	3,306	0,050	0,072	4,323	0,865	4,323	0,865	0,056	0,082
GK 1250	15,138	9,174	15,141	9,176	0,025	0,035	10,345	6,753	10,347	6,754	0,039	0,055	4,323	1,729	4,323	1,729	0,051	0,073
RS 50	16,055	9,862	16,058	9,865	0,024	0,034	17,098	9,483	17,100	9,484	0,032	0,046	13,833	7,205	14,410	7,782	0,030	0,044
RS 100	15,826	11,009	15,829	11,012	0,024	0,033	15,517	8,621	15,520	8,622	0,033	0,048	14,986	6,916	15,563	6,917	0,028	0,043
RS 250	18,349	11,927	18,352	11,929	0,020	0,029	12,644	7,471	12,646	7,473	0,035	0,050	14,697	7,781	14,699	7,782	0,028	0,041
RS 500	19,725	14,679	19,728	14,682	0,019	0,025	14,511	8,477	14,514	8,479	0,032	0,046	10,375	5,187	10,376	5,188	0,034	0,051
RS 1250	20,413	15,826	20,417	15,829	0,017	0,023	21,408	12,069	21,412	12,072	0,024	0,035	11,816	6,052	12,105	6,052	0,031	0,046
P 50	11,927	7,110	11,929	7,112	0,030	0,043	13,649	6,609	13,651	6,610	0,036	0,054	11,239	5,187	11,817	5,188	0,033	0,049
P 100	12,156	7,339	12,159	7,341	0,030	0,042	12,356	6,034	12,358	6,036	0,038	0,056	11,239	5,187	11,817	5,188	0,032	0,048
P 250	13,761	8,486	13,764	8,488	0,027	0,038	10,345	5,603	10,347	5,605	0,040	0,057	12,392	5,764	12,393	5,764	0,032	0,048
P 500	15,596	9,404	15,599	9,406	0,023	0,033	10,489	7,184	10,491	7,185	0,037	0,053	8,357	4,035	8,358	4,035	0,039	0,057
P 1250	17,890	11,927	17,893	11,929	0,020	0,028	16,523	9,339	16,526	9,341	0,029	0,042	9,510	4,323	9,511	4,323	0,036	0,053
YZ 50	7,569	3,899	7,571	3,900	0,041	0,059	7,471	2,155	7,473	2,156	0,052	0,077	8,357	3,170	8,934	3,170	0,041	0,060
YZ 100	8,028	4,587	8,030	4,589	0,040	0,057	6,322	2,011	6,323	2,012	0,055	0,080	8,934	3,746	8,934	3,747	0,040	0,058
YZ 250	8,945	4,587	8,947	4,589	0,035	0,051	6,466	2,730	6,467	2,731	0,055	0,080	7,781	3,170	7,781	3,170	0,044	0,065
YZ 500	10,321	6,651	10,324	6,653	0,031	0,044	7,328	2,874	7,329	2,875	0,051	0,074	3,746	0,865	3,747	0,865	0,057	0,083
YZ 1250	14,450	8,716	14,452	8,718	0,026	0,036	9,914	6,609	9,916	6,611	0,040	0,056	4,323	1,729	4,323	1,729	0,052	0,075
GARCH	6,881	2,752	6,882	2,753	0,044	0,064	4,598	2,011	4,599	2,012	0,062	0,089	4,323	1,153	4,323	1,153	0,051	0,075
EGARCH	8,486	3,670	8,488	3,671	0,038	0,056	5,747	2,011	5,748	2,012	0,058	0,084	2,305	0,288	2,306	0,288	0,055	0,079
HS 50	6,881	3,211	6,882	3,212	0,046	0,077	6,897	2,155	6,898	2,156	0,053	0,087	7,493	4,035	7,493	4,035	0,047	0,062
HS 100	8,028	2,982	8,029	2,983	0,046	0,074	6,322	1,724	6,323	1,725	0,057	0,089	6,628	2,882	6,629	2,882	0,044	0,069
HS 250	8,945	1,606	8,947	1,606	0,037	0,071	5,747	1,724	5,748	1,725	0,060	0,095	6,340	0,865	6,340	0,865	0,049	0,085
HS 500	11,697	2,294	11,700	2,295	0,030	0,064	6,466	1,149	6,467	1,150	0,058	0,099	2,882	0,576	2,882	0,576	0,065	0,099
HS 1250	13,073	3,899	13,076	3,900	0,027	0,057	9,052	1,580	9,054	1,581	0,043	0,088	2,882	0,288	2,882	0,288	0,059	0,100

Table 5. US (DJI) loss function statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	4,358	2,064	4,359	2,065	0,059	0,083	6,609	1,580	6,610	1,581	0,054	0,079	5,187	1,729	5,477	1,730	0,072	0,104
MA Z 100	4,817	1,835	4,818	1,836	0,058	0,083	5,603	1,580	5,604	1,581	0,056	0,081	5,187	1,729	5,477	1,730	0,069	0,100
MA Z 250	5,734	2,294	5,736	2,295	0,053	0,076	4,885	1,580	4,886	1,581	0,057	0,083	6,340	1,729	6,342	1,730	0,064	0,094
MA Z 500	7,569	3,440	7,571	3,442	0,047	0,067	4,741	1,293	4,742	1,293	0,057	0,083	7,493	2,305	7,494	2,306	0,061	0,090
MA Z 1250	9,633	5,046	9,635	5,048	0,037	0,054	6,466	1,868	6,466	1,868	0,049	0,072	8,069	2,594	8,071	2,595	0,058	0,085
RM 50 .90	5,046	3,211	5,047	3,212	0,056	0,079	6,609	2,011	6,610	2,012	0,052	0,077	4,899	1,729	4,900	1,730	0,070	0,101
RM 100 .90	5,046	3,211	5,047	3,212	0,056	0,079	6,609	2,011	6,610	2,012	0,053	0,077	4,611	1,729	4,612	1,730	0,070	0,101

Table 5. US (DJI) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RM 250 .90	5,046	3,211	5,047	3,212	0,056	0,079	6,609	2,011	6,610	2,012	0,053	0,077	4,611	1,729	4,612	1,730	0,070	0,101
RM 500 .90	5,046	3,211	5,047	3,212	0,056	0,079	6,609	2,011	6,610	2,012	0,053	0,077	4,611	1,729	4,612	1,730	0,070	0,101
RM 1250 .90	5,046	3,211	5,047	3,212	0,056	0,079	6,609	2,011	6,610	2,012	0,053	0,077	4,611	1,729	4,612	1,730	0,070	0,101
RM 50 .94	4,817	3,211	4,818	3,212	0,056	0,079	6,753	1,724	6,753	1,724	0,052	0,076	4,899	1,441	5,189	1,442	0,069	0,100
RM 100 .94	4,358	2,752	4,359	2,753	0,057	0,081	6,322	1,724	6,322	1,724	0,053	0,078	4,323	1,153	4,324	1,154	0,071	0,103
RM 250 .94	4,358	2,752	4,359	2,753	0,057	0,081	6,322	1,724	6,322	1,724	0,053	0,078	4,323	1,153	4,324	1,154	0,071	0,103
RM 500 .94	4,358	2,752	4,359	2,753	0,057	0,081	6,322	1,724	6,322	1,724	0,053	0,078	4,323	1,153	4,324	1,154	0,071	0,103
RM 1250 .94	4,358	2,752	4,359	2,753	0,057	0,081	6,322	1,724	6,322	1,724	0,053	0,078	4,323	1,153	4,324	1,154	0,071	0,103
RM 50 .97	6,193	3,211	6,194	3,212	0,051	0,072	8,190	3,305	8,190	3,305	0,047	0,068	6,340	3,458	6,630	3,459	0,062	0,090
RM 100 .97	4,817	2,294	4,818	2,295	0,057	0,080	6,322	1,580	6,322	1,581	0,053	0,077	5,187	1,729	5,477	1,730	0,069	0,100
RM 250 .97	4,587	2,294	4,589	2,295	0,058	0,082	5,891	1,437	5,891	1,437	0,054	0,080	4,899	1,441	4,900	1,442	0,071	0,102
RM 500 .97	4,587	2,294	4,589	2,295	0,058	0,082	5,891	1,437	5,891	1,437	0,054	0,080	4,899	1,441	4,900	1,442	0,071	0,102
RM 1250 .97	4,587	2,294	4,589	2,295	0,058	0,082	5,891	1,437	5,891	1,437	0,054	0,080	4,899	1,441	4,900	1,442	0,071	0,102
KS 50	11,239	5,734	11,241	5,736	0,037	0,053	12,500	6,466	12,501	6,466	0,037	0,054	9,510	5,187	10,089	5,189	0,050	0,072
KS 100	11,468	6,651	11,471	6,653	0,035	0,050	11,925	6,322	11,927	6,322	0,036	0,052	14,121	6,628	14,700	6,918	0,044	0,065
KS 250	11,697	8,028	11,700	8,030	0,032	0,045	11,925	5,747	11,927	5,748	0,034	0,050	16,715	8,934	17,006	8,936	0,037	0,055
KS 500	14,450	9,174	14,453	9,177	0,028	0,040	13,075	6,034	13,076	6,035	0,033	0,049	17,867	10,375	18,159	10,377	0,035	0,052
KS 1250	19,954	12,615	19,958	12,618	0,022	0,030	16,667	9,770	16,668	9,771	0,027	0,039	19,885	11,239	20,177	11,530	0,033	0,048
GK 50	5,275	2,294	5,277	2,295	0,052	0,075	7,759	2,586	7,759	2,586	0,047	0,069	7,493	2,882	7,783	2,883	0,059	0,086
GK 100	5,505	2,752	5,506	2,753	0,052	0,074	6,753	2,874	6,754	2,874	0,049	0,071	8,934	3,458	9,224	3,459	0,057	0,083
GK 250	6,651	2,752	6,653	2,753	0,049	0,071	5,747	2,299	5,748	2,299	0,050	0,072	8,934	2,882	9,224	2,883	0,054	0,081
GK 500	8,257	3,670	8,259	3,671	0,044	0,064	5,603	1,868	5,604	1,868	0,050	0,073	10,375	3,458	10,377	3,459	0,051	0,076
GK 1250	10,321	5,505	10,324	5,506	0,036	0,052	7,471	3,305	7,472	3,305	0,044	0,065	10,951	4,035	10,953	4,036	0,050	0,074
RS 50	6,193	2,523	6,194	2,524	0,050	0,072	8,046	2,874	8,047	2,874	0,045	0,066	7,781	3,170	8,071	3,171	0,057	0,083
RS 100	6,651	2,982	6,653	2,983	0,049	0,070	6,897	3,017	6,897	3,018	0,047	0,068	9,510	3,746	9,800	3,747	0,055	0,081
RS 250	8,257	3,670	8,259	3,671	0,045	0,065	6,178	2,586	6,179	2,587	0,049	0,071	10,086	3,458	10,377	3,459	0,052	0,077
RS 500	8,486	4,128	8,488	4,130	0,042	0,060	6,466	2,299	6,466	2,299	0,048	0,071	10,951	4,035	11,241	4,036	0,050	0,074
RS 1250	10,550	5,734	10,553	5,736	0,036	0,051	8,046	3,592	8,047	3,592	0,043	0,063	11,239	4,323	11,530	4,324	0,048	0,071
P 50	5,963	2,523	5,965	2,524	0,051	0,074	7,471	2,443	7,472	2,443	0,048	0,071	6,340	2,594	6,630	2,595	0,061	0,089
P 100	5,963	2,752	5,965	2,754	0,051	0,073	6,753	2,443	6,754	2,443	0,050	0,073	7,781	3,458	8,071	3,459	0,059	0,085
P 250	7,339	3,670	7,341	3,671	0,047	0,067	5,603	2,011	5,604	2,012	0,051	0,075	9,222	2,594	9,224	2,595	0,055	0,081
P 500	8,716	4,128	8,718	4,130	0,042	0,061	5,316	1,580	5,317	1,581	0,051	0,075	10,375	3,170	10,377	3,171	0,053	0,078
P 1250	10,550	6,193	10,553	6,194	0,035	0,050	7,471	3,305	7,472	3,305	0,044	0,065	10,663	4,035	10,665	4,036	0,051	0,075
YZ 50	5,046	2,064	5,048	2,065	0,053	0,077	7,471	2,443	7,472	2,443	0,048	0,070	6,628	2,594	6,918	2,595	0,061	0,089
YZ 100	5,275	2,294	5,277	2,295	0,053	0,076	6,753	2,299	6,754	2,299	0,050	0,073	7,781	2,882	8,071	2,883	0,059	0,087
YZ 250	6,651	2,752	6,653	2,753	0,049	0,071	5,603	1,868	5,604	1,868	0,051	0,075	8,646	2,594	8,647	2,595	0,056	0,082
YZ 500	8,257	3,670	8,259	3,671	0,045	0,065	5,316	1,580	5,317	1,581	0,051	0,075	10,375	3,170	10,377	3,171	0,053	0,079
YZ 1250	9,633	4,817	9,635	4,818	0,037	0,054	7,040	2,874	7,041	2,874	0,046	0,067	10,663	3,746	10,665	3,747	0,051	0,076
GARCH	5,734	2,982	5,736	2,983	0,053	0,076	6,178	1,149	6,179	1,150	0,054	0,079	4,899	1,441	4,900	1,442	0,068	0,099
EGARCH	7,110	2,523	7,112	2,524	0,047	0,068	5,747	1,293	5,748	1,293	0,054	0,079	5,187	1,153	5,188	1,153	0,066	0,097
HS 50	6,193	2,752	6,194	2,753	0,053	0,086	7,471	2,443	7,472	2,443	0,050	0,074	6,340	2,882	6,630	2,883	0,062	0,097
HS 100	5,963	2,523	5,965	2,524	0,052	0,083	5,891	2,155	5,891	2,155	0,054	0,078	7,493	2,305	7,783	2,307	0,058	0,102
HS 250	6,881	1,835	6,883	1,836	0,048	0,081	5,029	1,293	5,029	1,293	0,056	0,089	8,357	1,729	8,359	1,730	0,058	0,100
HS 500	8,028	2,294	8,030	2,295	0,043	0,074	5,316	0,862	5,317	0,862	0,054	0,089	7,781	2,017	7,783	2,018	0,059	0,101
HS 1250	11,239	3,440	11,241	3,442	0,034	0,063	6,897	1,293	6,897	1,293	0,046	0,081	10,086	2,017	10,088	2,018	0,055	0,094

Table 6. Japan (NIKKEI) loss function statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	6,651	2,752	6,652	2,753	0,077	0,112	5,316	2,299	5,317	2,299	0,066	0,095	5,476	1,153	5,476	1,153	0,082	0,119
MA Z 100	5,734	2,523	5,735	2,523	0,078	0,111	4,454	2,011	4,455	2,012	0,068	0,098	4,323	1,153	4,324	1,153	0,082	0,119
MA Z 250	5,734	1,835	5,735	1,835	0,075	0,109	4,741	1,580	4,742	1,581	0,068	0,099	4,323	1,153	4,324	1,153	0,083	0,120
MA Z 500	7,798	3,211	7,800	3,212	0,066	0,095	4,741	1,437	4,742	1,437	0,071	0,103	4,899	0,865	4,900	0,865	0,078	0,114
MA Z 1250	10,321	3,440	10,323	3,441	0,060	0,089	4,310	1,437	4,311	1,437	0,068	0,099	6,052	1,153	6,053	1,153	0,074	0,109
RM 50 .90	7,339	1,606	7,340	1,606	0,074	0,111	5,891	2,299	5,892	2,299	0,064	0,093	7,781	1,441	7,782	1,441	0,077	0,115
RM 100 .90	7,339	1,606	7,340	1,606	0,075	0,111	5,891	2,299	5,892	2,299	0,064	0,093	7,781	1,441	7,782	1,441	0,077	0,115
RM 250 .90	7,339	1,606	7,340	1,606	0,075	0,111	5,891	2,299	5,892	2,299	0,064	0,093	7,781	1,441	7,782	1,441	0,077	0,115
RM 500 .90	7,339	1,606	7,340	1,606	0,075	0,111	5,891	2,299	5,892	2,299	0,064	0,093	7,781	1,441	7,782	1,441	0,077	0,115
RM 1250 .90	7,339	1,606	7,340	1,606	0,075	0,111	5,891	2,299	5,892	2,299	0,064	0,093	7,781	1,441	7,782	1,441	0,077	0,115
RM 50 .94	6,881	2,064	6,881	2,064	0,074	0,108	5,603	2,155	5,604	2,156	0,063	0,092	7,493	1,153	7,494	1,153	0,076	0,114
RM 100 .94	6,651	2,064	6,652	2,064	0,076	0,111	5,460	2,011	5,461	2,012	0,065	0,095	6,628	1,153	6,629	1,153	0,079	0,116
RM 250 .94	6,651	1,835	6,652	1,835	0,076	0,111	5,460	2,011	5,461	2,012	0,065	0,095	6,628	1,153	6,629	1,153	0,079	0,117
RM 500 .94	6,651	1,835	6,652	1,835	0,076	0,111	5,460	2,011	5,461	2,012	0,065	0,095	6,628	1,153	6,629	1,153	0,079	0,117
RM 1250 .94	6,651	1,835	6,652	1,835	0,076	0,111	5,460	2,011	5,461	2,012	0,065	0,095	6,628	1,153	6,629	1,153	0,079	0,117
RM 50 .97	8,945	3,670	8,946	3,670	0,066	0,097	6,322	3,017	6,323	3,018	0,057	0,083	8,646	1,729	8,647	1,729	0,069	0,103
RM 100 .97	6,193	2,523	6,194	2,523	0,075	0,109	5,460	2,299	5,461	2,299	0,064	0,093	6,340	1,441	6,341	1,441	0,078	0,115
RM 250 .97	5,734	2,523	5,735	2,523	0,077	0,111	5,029	2,155	5,030	2,156	0,066	0,096	5,476	1,153	5,476	1,153	0,080	0,118
RM 500 .97	5,734	2,523	5,735	2,523	0,077	0,111	5,029	2,155	5,030	2,156	0,066	0,096	5,476	1,153	5,476	1,153	0,080	0,118
RM 1250 .97	5,734	2,523	5,735	2,523	0,077	0,111	5,029	2,155	5,030	2,156	0,066	0,096	5,476	1,153	5,476	1,153	0,080	0,118
KS 50	12,615	7,339	12,617	7,341	0,052	0,075	12,644	5,747	12,646	5,748	0,041	0,061	12,104	4,323	12,105	4,323	0,057	0,085
KS 100	14,908	7,339	14,911	7,341	0,048	0,071	14,080	6,609	14,083	6,610	0,040	0,059	13,256	5,187	13,835	5,188	0,054	0,082
KS 250	16,514	8,486	16,517	8,488	0,043	0,063	14,511	6,753	14,514	6,754	0,039	0,058	14,697	5,187	15,276	5,188	0,050	0,076
KS 500	20,413	12,844	20,417	12,847	0,036	0,052	14,080	7,615	14,083	7,616	0,040	0,058	17,291	8,357	17,870	8,647	0,044	0,066
KS 1250	23,394	14,908	23,400	14,911	0,032	0,046	15,805	8,046	15,807	8,047	0,036	0,053	21,037	10,086	21,329	10,376	0,039	0,059
GK 50	9,633	3,899	9,635	3,900	0,061	0,089	7,615	3,305	7,616	3,305	0,055	0,080	10,086	2,882	10,376	2,882	0,063	0,094
GK 100	9,862	3,670	9,864	3,671	0,061	0,090	7,328	2,874	7,329	2,874	0,056	0,082	8,934	2,882	9,223	2,882	0,063	0,093
GK 250	10,092	3,899	10,094	3,900	0,059	0,087	7,040	2,730	7,041	2,730	0,057	0,082	8,357	3,170	8,359	3,171	0,063	0,092
GK 500	12,844	5,275	12,847	5,276	0,052	0,077	7,040	2,586	7,041	2,587	0,058	0,085	9,510	4,035	9,800	4,035	0,060	0,089
GK 1250	13,991	6,422	13,994	6,423	0,048	0,071	7,328	3,017	7,329	3,018	0,055	0,081	10,375	3,746	10,376	3,747	0,059	0,087
RS 50	11,239	4,817	11,241	4,817	0,055	0,081	9,195	3,592	9,197	3,593	0,051	0,074	13,256	5,476	13,835	5,476	0,053	0,080
RS 100	11,468	5,046	11,470	5,047	0,056	0,082	8,333	3,448	8,335	3,449	0,052	0,076	13,833	4,899	14,411	4,900	0,052	0,079
RS 250	11,697	4,817	11,699	4,817	0,054	0,080	8,621	3,448	8,622	3,449	0,052	0,076	13,833	4,323	14,123	4,324	0,053	0,081
RS 500	13,991	5,963	13,994	5,965	0,049	0,072	8,621	3,017	8,622	3,018	0,053	0,078	13,256	4,611	13,835	4,612	0,053	0,080
RS 1250	14,908	7,798	14,911	7,800	0,045	0,066	8,908	3,305	8,909	3,305	0,051	0,075	14,121	4,611	14,411	4,612	0,051	0,079
P 50	9,862	4,128	9,864	4,129	0,061	0,089	8,621	3,879	8,622	3,880	0,053	0,077	12,392	4,899	12,682	4,900	0,056	0,084
P 100	10,092	4,128	10,094	4,129	0,061	0,089	7,902	3,017	7,904	3,018	0,055	0,080	12,680	3,746	13,258	3,747	0,055	0,084
P 250	10,092	3,899	10,094	3,900	0,059	0,088	7,759	2,730	7,760	2,730	0,055	0,081	11,239	3,746	11,529	3,747	0,057	0,086
P 500	12,844	5,275	12,847	5,276	0,052	0,078	7,328	2,730	7,329	2,730	0,057	0,084	12,680	4,035	12,970	4,035	0,055	0,084
P 1250	13,991	5,963	13,994	5,965	0,049	0,073	7,615	3,161	7,616	3,161	0,055	0,080	12,104	3,746	12,394	3,747	0,056	0,085
YZ 50	9,404	3,899	9,405	3,900	0,063	0,092	7,328	3,017	7,329	3,018	0,057	0,083	9,222	2,594	9,512	2,594	0,065	0,096
YZ 100	9,633	3,440	9,635	3,441	0,063	0,092	6,178	2,874	6,179	2,874	0,059	0,085	8,357	2,305	8,359	2,306	0,065	0,096

Table 6. Japan (NIKKEI) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
YZ 250	8,945	3,670	8,947	3,670	0,061	0,090	6,609	2,299	6,610	2,299	0,059	0,085	8,069	2,594	8,070	2,594	0,065	0,096
YZ 500	12,844	5,275	12,846	5,276	0,053	0,080	6,322	2,299	6,323	2,299	0,060	0,088	9,222	3,170	9,512	3,171	0,062	0,092
YZ 1250	13,991	5,505	13,994	5,506	0,049	0,074	6,897	2,730	6,898	2,730	0,057	0,083	9,798	3,458	9,800	3,459	0,060	0,090
GARCH	7,110	2,064	7,111	2,064	0,072	0,106	5,603	2,155	5,604	2,155	0,066	0,095	6,340	0,865	6,341	0,865	0,077	0,114
EGARCH	6,193	2,064	6,193	2,064	0,075	0,109	4,741	2,011	4,742	2,012	0,066	0,095	6,052	0,288	6,052	0,288	0,078	0,117
HS 50	6,422	3,899	6,423	3,899	0,074	0,103	6,466	2,586	6,467	2,587	0,063	0,092	6,916	2,594	6,917	2,594	0,076	0,106
HS 100	5,963	2,982	5,965	2,982	0,075	0,113	5,603	2,299	5,605	2,299	0,063	0,101	6,340	2,017	6,341	2,018	0,076	0,113
HS 250	5,505	1,835	5,506	1,835	0,074	0,126	5,891	1,149	5,892	1,150	0,064	0,103	5,764	1,153	5,765	1,153	0,077	0,118
HS 500	8,716	1,835	8,717	1,835	0,065	0,115	5,029	1,149	5,030	1,150	0,069	0,111	5,764	1,153	5,765	1,153	0,073	0,115
HS 1250	10,092	1,835	10,094	1,835	0,060	0,103	4,454	1,006	4,455	1,006	0,068	0,106	6,052	1,153	6,053	1,153	0,072	0,118

Table 7. Thailand (SET) loss function statistics (part 1)

	Period 1								*Period 2*				*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	5,505	1,606	5,506	1,606	0,124	0,179	3,161	0,718	3,162	0,719	0,092	0,132	4,035	2,594	4,036	2,595	0,069	0,097
MA Z 100	3,670	1,147	3,671	1,147	0,123	0,176	3,448	0,862	3,449	0,862	0,095	0,137	4,035	2,305	4,037	2,307	0,071	0,100
MA Z 250	5,275	1,376	5,277	1,377	0,114	0,165	2,730	0,431	2,730	0,431	0,102	0,147	3,458	1,441	3,460	1,442	0,073	0,103
MA Z 500	9,174	3,670	9,177	3,671	0,095	0,138	1,868	0,287	1,868	0,287	0,111	0,159	3,170	1,729	3,172	1,730	0,078	0,110
MA Z 1250	13,991	3,899	13,995	3,901	0,075	0,114	3,448	0,718	3,449	0,719	0,101	0,146	1,729	0,865	1,730	0,865	0,104	0,147
RM 50 .90	6,881	2,064	6,882	2,064	0,120	0,175	3,879	1,149	3,880	1,150	0,087	0,125	5,187	2,594	5,189	2,594	0,064	0,092
RM 100 .90	6,881	1,835	6,882	1,835	0,121	0,176	3,736	1,006	3,737	1,006	0,087	0,126	5,187	2,594	5,189	2,594	0,065	0,092
RM 250 .90	6,881	1,835	6,882	1,835	0,121	0,176	3,736	1,006	3,737	1,006	0,087	0,126	5,187	2,594	5,189	2,594	0,065	0,092
RM 500 .90	6,881	1,835	6,882	1,835	0,121	0,176	3,736	1,006	3,737	1,006	0,087	0,126	5,187	2,594	5,189	2,594	0,065	0,092
RM 1250 .90	6,881	1,835	6,882	1,835	0,121	0,176	3,736	1,006	3,737	1,006	0,087	0,126	5,187	2,594	5,189	2,594	0,065	0,092
RM 50 .94	6,422	1,835	6,423	1,835	0,119	0,173	3,592	1,437	3,593	1,437	0,087	0,124	4,899	2,882	4,901	2,882	0,065	0,092
RM 100 .94	5,963	1,606	5,964	1,606	0,122	0,178	3,305	1,006	3,305	1,006	0,089	0,128	4,035	2,882	4,036	2,882	0,067	0,094
RM 250 .94	5,963	1,606	5,964	1,606	0,122	0,178	3,305	1,006	3,305	1,006	0,089	0,128	4,035	2,882	4,036	2,882	0,067	0,094
RM 500 .94	5,963	1,606	5,964	1,606	0,122	0,178	3,305	1,006	3,305	1,006	0,089	0,128	4,035	2,882	4,036	2,882	0,067	0,094
RM 1250 .94	5,963	1,606	5,964	1,606	0,122	0,178	3,305	1,006	3,305	1,006	0,089	0,128	4,035	2,882	4,036	2,882	0,067	0,094
RM 50 .97	8,028	2,982	8,029	2,982	0,107	0,156	5,603	1,868	5,605	1,868	0,078	0,113	5,187	2,882	5,478	2,883	0,060	0,084
RM 100 .97	5,275	1,376	5,277	1,376	0,120	0,174	3,736	1,149	3,736	1,150	0,089	0,128	4,035	2,594	4,036	2,594	0,067	0,095
RM 250 .97	4,817	1,376	4,818	1,376	0,123	0,177	3,448	1,006	3,449	1,006	0,092	0,132	4,035	2,305	4,036	2,306	0,069	0,097
RM 500 .97	4,817	1,376	4,818	1,376	0,123	0,177	3,448	0,862	3,449	0,862	0,092	0,133	4,035	2,305	4,036	2,306	0,069	0,097
RM 1250 .97	4,817	1,376	4,818	1,376	0,123	0,177	3,448	0,862	3,449	0,862	0,092	0,133	4,035	2,305	4,036	2,306	0,069	0,097
KS 50	14,220	6,422	14,224	6,424	0,079	0,116	11,063	4,454	11,065	4,455	0,058	0,086	9,222	3,746	9,513	4,037	0,046	0,066
KS 100	16,055	6,651	16,060	6,654	0,071	0,106	10,920	4,167	10,922	4,168	0,058	0,086	10,663	4,899	10,955	5,190	0,043	0,062
KS 250	18,119	9,174	18,125	9,177	0,064	0,093	9,770	4,023	9,772	4,024	0,060	0,088	10,663	5,187	10,954	5,190	0,042	0,061
KS 500	23,853	16,284	23,862	16,289	0,052	0,072	8,764	4,023	8,766	4,024	0,062	0,091	9,222	4,899	9,513	4,901	0,045	0,065
KS 1250	30,963	22,706	30,975	22,714	0,040	0,053	14,511	6,322	14,515	6,323	0,050	0,074	6,340	3,170	6,343	3,171	0,056	0,079
GK 50	11,009	2,752	11,012	2,754	0,097	0,144	5,460	1,293	5,461	1,294	0,078	0,114	4,611	3,170	4,613	3,171	0,064	0,089
GK 100	10,550	2,752	10,553	2,753	0,092	0,137	4,310	1,580	4,311	1,581	0,085	0,122	4,899	2,882	4,902	2,883	0,066	0,093
GK 250	12,156	3,899	12,160	3,901	0,081	0,121	4,023	1,293	4,024	1,293	0,093	0,135	4,611	1,729	4,613	1,730	0,066	0,094
GK 500	16,743	6,651	16,748	6,653	0,070	0,106	2,874	0,431	2,874	0,431	0,098	0,141	3,458	1,729	3,460	1,730	0,071	0,101
GK 1250	19,495	9,633	19,501	9,636	0,060	0,088	4,598	1,149	4,599	1,150	0,085	0,124	2,017	1,153	2,018	1,153	0,091	0,129

Table 7. Thailand (SET) loss function statistics (part 2)

	Period 1								*Period 2*				*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RS 50	17,431	7,339	17,436	7,342	0,069	0,103	11,063	4,023	11,065	4,024	0,058	0,086	10,951	4,899	11,242	4,901	0,043	0,063
RS 100	15,826	5,734	15,830	5,736	0,069	0,104	10,632	3,736	10,634	3,737	0,059	0,088	10,375	4,323	10,666	4,325	0,045	0,065
RS 250	16,972	6,651	16,977	6,654	0,066	0,100	9,195	3,448	9,197	3,449	0,063	0,092	8,646	4,035	8,937	4,036	0,048	0,068
RS 500	19,266	11,239	19,272	11,242	0,060	0,086	7,328	3,017	7,329	3,018	0,067	0,098	7,205	3,170	7,496	3,172	0,051	0,073
RS 1250	24,083	14,908	24,090	14,913	0,051	0,072	8,908	4,310	8,910	4,311	0,063	0,091	4,323	1,729	4,325	1,730	0,065	0,093
P 50	12,385	4,587	12,389	4,589	0,084	0,124	7,902	2,730	7,904	2,731	0,067	0,099	8,934	3,746	9,225	3,748	0,049	0,070
P 100	12,385	2,982	12,389	2,983	0,081	0,123	6,753	2,730	6,754	2,731	0,070	0,102	8,069	3,746	8,072	3,748	0,051	0,072
P 250	12,844	3,670	12,848	3,671	0,078	0,118	6,178	2,299	6,179	2,299	0,074	0,108	6,340	3,170	6,343	3,171	0,054	0,077
P 500	17,661	7,110	17,666	7,112	0,067	0,101	5,172	1,580	5,173	1,581	0,079	0,115	6,340	3,170	6,342	3,171	0,058	0,083
P 1250	21,101	11,239	21,108	11,242	0,056	0,082	5,891	3,305	5,892	3,305	0,073	0,105	3,170	1,729	3,172	1,730	0,075	0,107
YZ 50	9,862	2,523	9,865	2,524	0,103	0,152	5,316	1,293	5,317	1,294	0,080	0,117	4,323	3,170	4,325	3,171	0,069	0,096
YZ 100	8,945	2,064	8,947	2,065	0,099	0,147	4,167	1,580	4,168	1,581	0,087	0,125	4,899	2,882	4,901	2,883	0,072	0,101
YZ 250	10,092	3,211	10,095	3,212	0,090	0,132	3,448	1,006	3,449	1,006	0,096	0,138	3,458	1,729	3,460	1,730	0,071	0,100
YZ 500	15,596	5,275	15,600	5,277	0,074	0,112	2,299	0,287	2,299	0,287	0,103	0,148	3,458	1,729	3,460	1,730	0,073	0,104
YZ 1250	18,119	9,174	18,125	9,177	0,063	0,092	4,454	1,006	4,455	1,006	0,090	0,131	1,729	0,865	1,730	0,865	0,096	0,135
GARCH	8,486	2,064	8,488	2,064	0,114	0,168	2,730	0,862	2,731	0,862	0,097	0,138	2,882	0,865	2,883	0,865	0,082	0,118
EGARCH	7,339	1,606	7,341	1,606	0,112	0,164	3,017	1,293	3,018	1,293	0,096	0,138	2,882	1,153	2,883	1,153	0,083	0,118
HS 50	7,110	2,982	7,113	2,983	0,101	0,149	6,322	1,868	6,323	1,868	0,077	0,114	5,476	2,305	5,766	2,306	0,067	0,100
HS 100	6,422	2,523	6,424	2,524	0,102	0,151	4,885	1,580	4,886	1,581	0,084	0,126	6,052	2,017	6,343	2,018	0,061	0,124
HS 250	6,193	2,064	6,195	2,065	0,099	0,153	3,448	0,862	3,449	0,862	0,094	0,139	5,187	1,153	5,190	1,154	0,062	0,137
HS 500	11,239	3,211	11,242	3,212	0,086	0,140	3,017	0,431	3,018	0,431	0,099	0,150	3,746	1,441	3,748	1,441	0,070	0,120
HS 1250	15,138	2,982	15,142	2,983	0,072	0,129	4,023	0,862	4,024	0,862	0,094	0,146	1,729	0,865	1,730	0,865	0,096	0,150

Table 8. Brazil (BOVESPA) loss function statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	6,881	3,670	6,892	3,676	0,156	0,216	4,454	1,293	4,455	1,293	0,106	0,153	6,052	2,305	6,055	2,307	0,103	0,148
MA Z 100	7,798	4,128	7,810	4,135	0,150	0,209	3,592	0,718	3,593	0,719	0,114	0,164	5,476	2,882	5,479	2,884	0,101	0,144
MA Z 250	8,028	5,046	8,042	5,054	0,137	0,188	4,167	1,149	4,168	1,150	0,127	0,183	5,476	1,729	5,478	1,730	0,098	0,142
MA Z 500	10,321	6,193	10,338	6,203	0,119	0,161	2,299	0,718	2,300	0,719	0,143	0,203	5,476	2,017	5,478	2,019	0,097	0,139
MA Z 1250	5,963	2,752	5,974	2,758	0,156	0,218	1,724	0,431	1,725	0,431	0,137	0,196	2,882	0,865	2,883	0,865	0,131	0,188
RM 50 .90	7,110	3,211	7,119	3,216	0,149	0,211	5,891	1,580	5,892	1,581	0,099	0,144	7,205	2,594	7,207	2,595	0,099	0,144
RM 100 .90	7,110	3,211	7,119	3,216	0,150	0,211	5,891	1,580	5,892	1,581	0,099	0,145	7,205	2,594	7,207	2,595	0,099	0,144
RM 250 .90	7,110	3,211	7,119	3,216	0,150	0,211	5,891	1,580	5,892	1,581	0,099	0,145	7,205	2,594	7,207	2,595	0,099	0,144
RM 500 .90	7,110	3,211	7,119	3,216	0,150	0,211	5,891	1,580	5,892	1,581	0,099	0,145	7,205	2,594	7,207	2,595	0,099	0,144
RM 1250 .90	7,110	3,211	7,119	3,216	0,150	0,211	5,891	1,580	5,892	1,581	0,099	0,145	7,205	2,594	7,207	2,595	0,099	0,144
RM 50 .94	7,110	3,440	7,120	3,446	0,149	0,209	5,891	1,868	5,892	1,868	0,099	0,143	7,493	2,594	7,496	2,595	0,098	0,142
RM 100 .94	6,651	3,440	6,661	3,445	0,153	0,214	5,172	1,724	5,173	1,724	0,102	0,148	6,628	2,305	6,631	2,307	0,100	0,145
RM 250 .94	6,651	3,211	6,661	3,216	0,153	0,214	5,172	1,580	5,173	1,581	0,102	0,149	6,628	2,305	6,631	2,307	0,100	0,145
RM 500 .94	6,651	3,211	6,661	3,216	0,153	0,214	5,172	1,580	5,173	1,581	0,102	0,149	6,628	2,305	6,631	2,307	0,100	0,145
RM 1250 .94	6,651	3,211	6,661	3,216	0,153	0,214	5,172	1,580	5,173	1,581	0,102	0,149	6,628	2,305	6,631	2,307	0,100	0,145
RM 50 .97	8,486	4,817	8,499	4,824	0,137	0,190	7,040	2,443	7,042	2,443	0,090	0,131	8,069	3,170	8,073	3,172	0,089	0,129
RM 100 .97	7,569	3,440	7,580	3,446	0,150	0,210	4,741	1,293	4,742	1,293	0,104	0,151	6,628	2,594	6,631	2,595	0,099	0,142
RM 250 .97	7,110	3,440	7,121	3,446	0,153	0,214	4,167	1,293	4,168	1,293	0,108	0,156	6,052	2,594	6,055	2,595	0,101	0,145

Table 8. Brazil (BOVESPA) loss function statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	Lopez B		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*		*Lopez B*		*Lopez Q*		*Lopez F*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RM 500 .97	7,110	3,440	7,121	3,446	0,153	0,214	4,167	1,293	4,168	1,293	0,108	0,157	6,052	2,594	6,055	2,595	0,101	0,145
RM 1250 .97	7,110	3,440	7,121	3,446	0,153	0,214	4,167	1,293	4,168	1,293	0,108	0,157	6,052	2,594	6,055	2,595	0,101	0,145
KS 50	12,615	8,257	12,635	8,270	0,109	0,145	9,483	4,167	9,485	4,168	0,072	0,104	11,239	6,052	11,244	6,055	0,072	0,103
KS 100	16,514	10,321	16,536	10,336	0,097	0,128	8,908	3,879	8,910	3,880	0,073	0,106	12,968	6,628	12,974	6,631	0,068	0,098
KS 250	19,495	13,303	19,524	13,323	0,085	0,108	9,914	4,454	9,917	4,455	0,074	0,107	13,256	7,205	13,262	7,208	0,063	0,090
KS 500	23,165	16,743	23,198	16,767	0,077	0,092	8,190	4,023	8,193	4,024	0,074	0,107	14,121	7,205	14,127	7,208	0,062	0,090
KS 1250	18,578	12,385	18,604	12,403	0,090	0,115	11,351	5,172	11,354	5,174	0,063	0,092	12,392	5,476	12,397	5,478	0,067	0,097
GK 50	9,862	5,505	9,877	5,513	0,128	0,176	7,328	2,299	7,329	2,299	0,086	0,125	9,222	4,035	9,226	4,037	0,082	0,118
GK 100	10,780	6,193	10,795	6,202	0,125	0,171	6,034	2,155	6,036	2,155	0,092	0,133	10,375	3,746	10,379	3,749	0,081	0,118
GK 250	10,092	6,651	10,109	6,662	0,118	0,159	5,460	1,868	5,461	1,868	0,102	0,147	9,510	4,035	9,514	4,036	0,080	0,117
GK 500	13,991	8,028	14,012	8,041	0,102	0,137	3,879	1,149	3,881	1,150	0,115	0,165	10,086	4,035	10,090	4,036	0,079	0,115
GK 1250	9,633	4,817	9,648	4,825	0,126	0,174	3,448	0,862	3,449	0,862	0,111	0,159	4,323	1,441	4,325	1,442	0,107	0,154
RS 50	11,239	6,881	11,254	6,889	0,122	0,166	7,615	2,586	7,617	2,587	0,082	0,120	10,663	4,611	10,667	4,614	0,077	0,112
RS 100	11,468	6,881	11,485	6,890	0,121	0,164	6,322	2,299	6,323	2,299	0,087	0,127	11,239	4,035	11,244	4,037	0,076	0,112
RS 250	12,385	7,569	12,404	7,581	0,111	0,150	6,034	2,011	6,036	2,012	0,098	0,141	11,239	4,323	11,243	4,325	0,075	0,110
RS 500	15,138	8,257	15,160	8,271	0,098	0,132	4,310	1,293	4,312	1,294	0,108	0,156	11,527	4,323	11,532	4,325	0,075	0,110
RS 1250	11,927	5,734	11,944	5,744	0,117	0,161	4,023	1,006	4,024	1,006	0,104	0,151	4,899	1,441	4,901	1,442	0,101	0,146
P 50	9,862	5,734	9,876	5,742	0,132	0,181	6,609	2,443	6,611	2,443	0,090	0,131	7,781	3,458	7,785	3,460	0,087	0,124
P 100	10,780	5,963	10,795	5,972	0,129	0,177	4,885	2,011	4,886	2,012	0,097	0,139	9,510	2,882	9,514	2,884	0,085	0,124
P 250	9,633	6,651	9,650	6,662	0,120	0,161	5,172	1,868	5,174	1,868	0,108	0,156	9,222	3,746	9,225	3,748	0,083	0,121
P 500	13,532	8,028	13,552	8,041	0,104	0,140	3,305	1,149	3,306	1,150	0,121	0,173	9,222	3,746	9,225	3,748	0,082	0,119
P 1250	8,945	4,587	8,960	4,595	0,131	0,180	2,874	0,575	2,875	0,575	0,116	0,166	4,323	1,153	4,325	1,153	0,111	0,161
YZ 50	9,404	5,505	9,418	5,512	0,132	0,181	6,897	2,299	6,898	2,299	0,089	0,129	8,934	3,746	8,938	3,749	0,084	0,122
YZ 100	9,633	5,963	9,648	5,972	0,129	0,177	5,172	2,011	5,174	2,012	0,095	0,137	10,086	3,458	10,091	3,460	0,083	0,122
YZ 250	10,092	7,110	10,109	7,121	0,119	0,160	5,172	1,724	5,174	1,724	0,106	0,153	9,222	3,746	9,226	3,748	0,082	0,119
YZ 500	13,303	7,798	13,323	7,811	0,105	0,141	3,592	1,149	3,593	1,150	0,118	0,170	9,222	3,746	9,226	3,748	0,081	0,118
YZ 1250	9,404	4,587	9,418	4,595	0,129	0,179	3,017	0,575	3,018	0,575	0,114	0,164	4,323	1,153	4,325	1,153	0,110	0,158
GARCH	6,193	3,211	6,201	3,215	0,155	0,218	4,454	1,149	4,455	1,150	0,107	0,155	4,323	1,441	4,325	1,442	0,109	0,157
EGARCH	6,193	2,982	6,201	2,986	0,152	0,214	4,167	0,575	4,167	0,575	0,106	0,155	5,187	1,153	5,189	1,153	0,109	0,159
HS 50	8,716	3,440	8,727	3,445	0,151	0,227	6,034	2,586	6,036	2,587	0,089	0,129	7,205	2,305	7,208	2,307	0,098	0,150
HS 100	8,028	3,670	8,039	3,674	0,147	0,230	4,741	1,437	4,742	1,437	0,097	0,150	6,340	2,305	6,343	2,307	0,100	0,162
HS 250	8,257	3,440	8,272	3,445	0,137	0,241	4,885	0,862	4,886	0,862	0,110	0,187	5,764	1,441	5,766	1,442	0,098	0,151
HS 500	11,927	3,670	11,945	3,676	0,112	0,212	3,017	0,575	3,018	0,575	0,126	0,233	5,187	1,729	5,190	1,730	0,097	0,146
HS 1250	7,798	2,294	7,812	2,297	0,134	0,251	2,443	0,144	2,443	0,144	0,123	0,246	3,746	0,288	3,748	0,288	0,117	0,229

Table 9. Holland (AEX) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	0,80	0,56	0,13	0,17	0,94	0,73	0,78	3,03	0,05	0,42	0,83	3,45	4,87	10,49	6,11	0,88	10,98	11,37
MA Z 100	0,80	5,40	3,19	0,47	4,00	5,87	0,04	2,01	0,01	0,35	0,05	2,37	9,26	34,26	5,89	5,90	15,15	40,16
MA Z 250	5,27	16,05	2,36	0,39	7,63	16,44	1,49	0,55	0,61	0,24	2,10	0,79	9,26	27,51	5,89	3,96	15,15	31,47
MA Z 500	10,47	33,40	6,10	0,85	16,57	34,24	6,67	0,00	2,05	0,14	8,72	0,14	23,12	57,05	2,73	2,42	25,84	59,47
MA Z 1250	38,13	86,75	7,82	3,39	45,96	90,14	2,56	0,00	2,02	0,14	4,58	0,14	37,13	57,05	1,65	7,69	38,77	64,75
RM 50 .90	0,00	5,40	0,01	0,47	0,01	5,87	8,70	2,01	0,25	0,35	8,95	2,37	3,14	0,08	0,35	0,09	3,49	0,17

Table 9. Holland (AEX) Christoffersen test statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RM 100 .90	0,00	3,82	0,01	0,38	0,01	4,20	7,82	2,01	0,34	0,35	8,16	2,37	3,14	0,08	0,35	0,09	3,49	0,17
RM 250 .90	0,00	3,82	0,01	0,38	0,01	4,20	7,82	2,01	0,34	0,35	8,16	2,37	3,14	0,08	0,35	0,09	3,49	0,17
RM 500 .90	0,00	3,82	0,01	0,38	0,01	4,20	7,82	2,01	0,34	0,35	8,16	2,37	3,14	0,08	0,35	0,09	3,49	0,17
RM 1250 .90	0,00	3,82	0,01	0,38	0,01	4,20	7,82	2,01	0,34	0,35	8,16	2,37	3,14	0,08	0,35	0,09	3,49	0,17
RM 50 .94	0,80	3,82	0,13	0,38	0,94	4,20	6,99	3,03	0,45	0,42	7,44	3,45	5,85	1,53	0,26	3,02	6,11	4,55
RM 100 .94	0,23	2,46	2,80	0,30	3,03	2,76	2,37	2,01	0,02	0,35	2,39	2,37	2,41	0,60	1,03	0,15	3,44	0,75
RM 250 .94	0,23	2,46	2,80	0,30	3,03	2,76	2,37	2,01	0,02	0,35	2,39	2,37	2,41	0,60	1,03	0,15	3,44	0,75
RM 500 .94	0,23	2,46	2,80	0,30	3,03	2,76	2,37	2,01	0,02	0,35	2,39	2,37	2,41	0,60	1,03	0,15	3,44	0,75
RM 1250 .94	0,23	2,46	2,80	0,30	3,03	2,76	2,37	2,01	0,02	0,35	2,39	2,37	2,41	0,60	1,03	0,15	3,44	0,75
RM 50 .97	2,92	5,40	0,43	0,47	3,35	5,87	17,13	10,43	0,56	0,85	17,69	11,28	14,79	12,93	1,83	0,65	16,61	13,58
RM 100 .97	1,22	0,56	0,99	0,17	2,21	0,73	1,10	1,18	0,15	0,29	1,25	1,47	4,87	10,49	3,07	0,88	7,94	11,37
RM 250 .97	0,23	0,56	0,34	0,17	0,57	0,73	0,04	0,15	0,01	0,19	0,05	0,34	1,76	6,18	6,13	1,51	7,90	7,70
RM 500 .97	0,23	0,56	0,34	0,17	0,57	0,73	0,04	0,15	0,01	0,19	0,05	0,34	1,76	6,18	6,13	1,51	7,90	7,70
RM 1250 .97	0,23	0,56	0,34	0,17	0,57	0,73	0,04	0,15	0,01	0,19	0,05	0,34	1,76	6,18	6,13	1,51	7,90	7,70
KS 50	18,61	33,40	4,72	2,13	23,34	35,53	40,66	48,48	2,65	0,19	43,30	48,66	30,81	61,18	7,92	4,14	38,73	65,32
KS 100	30,40	62,05	8,61	2,02	39,01	64,07	38,95	58,14	4,27	0,03	43,22	58,17	51,07	87,56	4,61	7,78	55,69	95,34
KS 250	50,97	95,50	9,56	4,44	60,53	99,94	38,95	45,38	0,41	0,27	39,36	45,65	108,46	142,14	0,26	4,50	108,72	146,64
KS 500	121,26	142,58	6,17	9,36	127,43	151,94	26,40	36,52	0,32	0,61	26,72	37,13	157,12	232,78	0,78	0,24	157,90	233,02
KS 1250	192,58	309,88	5,34	6,88	197,92	316,76	87,36	122,08	1,89	1,17	89,25	123,26	153,44	220,83	1,72	0,56	155,16	221,39
GK 50	1,22	0,56	2,77	0,17	3,98	0,73	0,00	1,18	0,03	0,29	0,04	1,47	6,91	12,93	2,61	0,86	9,52	13,79
GK 100	1,22	7,18	5,23	0,57	6,44	7,75	0,24	1,18	0,19	0,29	0,43	1,47	11,89	34,26	6,97	2,88	18,86	37,14
GK 250	4,42	13,60	2,75	0,54	7,17	14,14	2,56	0,55	0,00	0,24	2,56	0,79	11,89	30,83	4,58	3,39	16,47	34,22
GK 500	9,31	30,22	4,44	1,07	13,75	31,30	8,98	0,00	0,37	0,14	9,35	0,14	26,85	57,05	3,34	2,42	30,19	59,47
GK 1250	38,13	86,75	7,82	3,39	45,96	90,14	4,76	0,00	1,57	0,14	6,33	0,14	37,13	57,05	1,65	7,69	38,77	64,75
RS 50	34,18	47,04	5,25	0,22	39,43	47,27	14,79	12,30	0,00	0,96	14,79	13,26	28,80	45,22	4,50	3,91	33,31	49,13
RS 100	40,17	58,18	9,21	4,65	49,38	62,83	8,70	14,29	0,00	0,37	8,70	14,67	28,80	65,38	6,48	9,17	35,29	74,55
RS 250	34,18	70,01	9,34	3,17	43,52	73,18	2,89	16,39	0,42	1,19	3,31	17,58	34,97	65,38	4,49	3,58	39,46	68,97
RS 500	57,91	95,50	9,24	4,44	67,15	99,94	0,78	3,03	0,05	0,42	0,83	3,45	63,93	82,98	0,99	5,89	64,91	88,87
RS 1250	127,54	178,44	6,25	8,56	133,79	187,01	14,79	18,59	1,86	1,31	16,65	19,90	72,14	106,56	0,35	4,87	72,49	111,43
P 50	25,07	40,04	2,84	0,48	27,90	40,52	17,13	14,29	0,09	1,07	17,22	15,36	26,85	37,81	4,50	5,17	31,36	42,99
P 100	28,58	40,04	9,39	2,16	37,97	42,19	11,57	16,39	0,07	0,27	11,64	16,67	26,85	57,05	4,50	11,19	31,36	68,24
P 250	28,58	70,01	11,91	3,17	40,49	73,18	2,37	16,39	1,67	1,19	4,04	17,58	32,86	61,18	5,11	4,14	37,97	65,32
P 500	50,97	95,50	9,56	4,44	60,53	99,94	1,48	3,03	0,09	0,42	1,57	3,45	61,27	82,98	0,99	5,89	62,26	88,87
P 1250	118,17	157,68	6,83	9,39	125,00	167,07	10,57	16,39	0,67	1,19	11,24	17,58	72,14	92,21	0,35	4,58	72,49	96,79
YZ 50	1,22	0,56	2,77	0,17	3,98	0,73	0,00	0,55	0,03	0,24	0,04	0,79	5,85	12,93	3,07	0,86	8,92	13,79
YZ 100	0,80	7,18	3,19	0,57	4,00	7,75	0,24	2,01	0,19	0,35	0,43	2,37	11,89	34,26	6,97	2,88	18,86	37,14
YZ 250	3,63	16,05	3,17	0,39	6,80	16,44	2,56	0,15	0,00	0,19	2,56	0,34	11,89	30,83	4,58	3,39	16,47	34,22
YZ 500	8,21	30,22	2,95	1,07	11,16	31,30	8,98	0,00	0,37	0,14	9,35	0,14	26,85	57,05	3,34	2,42	30,19	59,47
YZ 1250	36,13	86,75	8,56	3,39	44,70	90,14	4,76	0,00	1,57	0,14	6,33	0,14	34,97	53,02	2,01	2,87	36,98	55,89
GARCH	1,22	5,40	0,99	0,47	2,21	5,87	0,04	1,18	0,01	0,29	0,05	1,47	1,76	0,60	0,26	0,15	2,03	0,75
EGARCH	0,47	7,18	0,22	0,57	0,70	7,75	1,49	0,55	0,02	0,24	1,51	0,79	4,87	0,60	0,40	0,15	5,27	0,75
HS 50	7,17	9,15	0,53	0,68	7,70	9,84	6,19	1,18	1,60	0,29	7,79	1,47	10,54	15,55	2,63	3,00	13,17	18,55
HS 100	5,27	5,40	2,36	0,47	7,63	5,87	0,14	3,03	0,64	0,42	0,78	3,45	8,05	24,31	6,62	8,52	14,67	32,83
HS 250	6,19	3,82	3,86	0,38	10,04	4,20	1,49	0,55	0,02	0,24	1,51	0,79	14,79	2,80	3,46	0,29	18,24	3,09
HS 500	14,30	13,60	9,00	0,93	23,30	14,53	4,76	0,62	1,53	0,07	6,29	0,69	26,85	18,32	3,34	2,50	30,19	20,83
HS 1250	65,18	40,04	8,88	0,48	74,06	40,52	0,45	0,62	0,27	0,07	0,72	0,69	39,33	12,93	1,32	0,65	40,65	13,58

Table 10. German (DAX) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	5,27	7,18	6,85	5,04	12,12	12,22	1,48	0,55	0,14	0,24	1,61	0,79	3,96	4,36	4,14	0,38	8,11	4,74
MA Z 100	4,42	3,82	1,14	6,68	5,56	10,50	0,04	0,15	0,01	0,19	0,05	0,34	6,91	18,32	2,61	10,73	9,52	29,06
MA Z 250	6,19	18,64	3,86	2,34	10,04	20,98	0,10	2,01	0,12	0,35	0,22	2,37	9,26	18,32	5,89	2,50	15,15	20,83
MA Z 500	17,12	40,04	0,81	0,48	17,93	40,52	3,21	0,14	0,01	0,10	3,22	0,24	19,60	45,22	5,71	2,01	25,32	47,23
MA Z 1250	40,17	66,00	2,36	1,70	42,53	67,69	3,46	0,55	0,32	0,24	3,78	0,79	26,85	53,02	5,12	1,32	31,98	54,33
RM 50 .90	0,80	5,40	3,19	0,47	4,00	5,87	6,99	2,01	8,09	0,35	15,07	2,37	3,96	0,08	0,00	0,05	3,96	0,13
RM 100 .90	0,80	5,40	3,19	0,47	4,00	5,87	6,99	2,01	8,09	0,35	15,07	2,37	3,14	0,08	0,02	0,05	3,17	0,13
RM 250 .90	0,80	5,40	3,19	0,47	4,00	5,87	6,99	2,01	8,09	0,35	15,07	2,37	3,14	0,08	0,02	0,05	3,17	0,13
RM 500 .90	0,80	5,40	3,19	0,47	4,00	5,87	6,99	2,01	8,09	0,35	15,07	2,37	3,14	0,08	0,02	0,05	3,17	0,13
RM 1250 .90	0,80	5,40	3,19	0,47	4,00	5,87	6,99	2,01	8,09	0,35	15,07	2,37	3,14	0,08	0,02	0,05	3,17	0,13
RM 50 .94	2,28	7,18	4,12	1,22	6,39	8,40	6,99	3,03	1,11	0,42	8,10	3,45	5,85	0,08	0,26	0,05	6,11	0,13
RM 100 .94	1,22	7,18	2,77	1,22	3,98	8,40	4,74	0,55	0,69	0,24	5,43	0,79	4,87	0,07	0,40	0,05	5,27	0,12
RM 250 .94	0,80	7,18	3,19	1,22	4,00	8,40	4,08	0,55	0,57	0,24	4,65	0,79	4,87	0,07	0,40	0,05	5,27	0,12
RM 500 .94	0,80	7,18	3,19	1,22	4,00	8,40	4,08	0,55	0,57	0,24	4,65	0,79	4,87	0,07	0,40	0,05	5,27	0,12
RM 1250 .94	0,80	7,18	3,19	1,22	4,00	8,40	4,08	0,55	0,57	0,24	4,65	0,79	4,87	0,07	0,40	0,05	5,27	0,12
RM 50 .97	10,47	21,36	2,19	1,97	12,66	23,33	14,79	14,29	1,10	1,07	15,89	15,36	17,94	12,93	0,00	0,65	17,94	13,58
RM 100 .97	4,42	7,18	2,75	5,04	7,17	12,22	4,08	2,01	0,57	0,35	4,65	2,37	5,85	2,80	1,33	0,29	7,18	3,09
RM 250 .97	1,71	5,40	0,78	5,80	2,49	11,20	1,90	0,15	0,20	0,19	2,10	0,34	3,96	2,80	2,01	0,29	5,98	3,09
RM 500 .97	1,71	5,40	0,78	5,80	2,49	11,20	1,90	0,15	0,20	0,19	2,10	0,34	3,14	2,80	2,42	0,29	5,56	3,09
RM 1250 .97	1,71	5,40	0,78	5,80	2,49	11,20	1,90	0,15	0,20	0,19	2,10	0,34	3,14	2,80	2,42	0,29	5,56	3,09
KS 50	18,61	70,01	4,72	3,17	23,34	73,18	69,58	64,88	0,07	0,00	69,65	64,88	28,80	41,47	0,10	7,77	28,91	49,23
KS 100	30,40	74,10	4,61	1,14	35,01	75,24	55,33	61,48	0,31	0,01	55,64	61,49	48,63	69,67	0,24	2,61	48,87	72,28
KS 250	50,97	99,96	1,73	2,19	52,70	102,15	57,28	61,48	0,05	0,01	57,34	61,49	77,82	101,71	0,04	8,00	77,85	109,71
KS 500	97,32	173,19	7,09	2,25	104,41	175,44	57,28	75,43	0,34	0,05	57,63	75,47	108,46	169,18	0,04	3,38	108,49	172,55
KS 1250	147,05	262,03	7,75	3,03	154,80	265,06	135,43	198,24	0,01	0,67	135,44	198,91	131,99	203,21	0,56	1,96	132,55	205,17
GK 50	21,74	30,22	3,71	3,42	25,46	33,64	4,08	5,56	0,57	1,17	4,65	6,73	9,26	10,49	1,81	4,22	11,07	14,71
GK 100	20,15	43,50	6,17	0,34	26,32	43,84	1,48	4,22	0,09	0,50	1,57	4,71	9,26	24,31	1,81	8,52	11,07	32,83
GK 250	21,74	50,68	0,31	0,13	22,06	50,81	0,30	1,18	0,00	0,29	0,30	1,47	11,89	24,31	6,97	5,31	18,86	29,62
GK 500	48,73	91,09	3,25	2,95	51,98	94,05	0,51	0,00	0,02	0,14	0,53	0,14	26,85	49,07	3,34	1,64	30,19	50,71
GK 1250	75,36	109,06	4,60	4,91	79,96	113,97	22,22	14,29	0,25	1,07	22,47	15,36	46,24	69,67	2,03	3,58	48,27	73,25
RS 50	112,06	233,23	4,07	4,08	116,13	237,31	8,70	7,05	1,44	0,97	10,14	8,02	17,94	8,23	0,32	4,97	18,26	13,20
RS 100	121,26	233,23	7,63	4,08	128,90	237,31	6,19	7,05	0,12	0,97	6,31	8,02	10,54	21,25	1,47	9,57	12,01	30,82
RS 250	174,56	256,20	7,51	6,38	182,06	262,57	9,61	4,22	1,63	0,50	11,24	4,71	13,30	30,83	8,86	7,56	22,17	38,39
RS 500	234,38	340,82	4,04	8,15	238,41	348,97	18,35	20,89	0,06	1,44	18,41	22,33	28,80	53,02	2,85	3,36	31,66	56,38
RS 1250	254,31	444,74	4,04	11,71	258,35	456,45	82,77	134,74	0,00	0,03	82,77	134,77	63,93	92,21	0,74	6,97	64,66	99,18
P 50	94,46	183,74	4,81	1,60	99,27	185,34	4,74	7,05	0,69	0,97	5,43	8,02	11,89	10,49	1,17	4,22	13,06	14,71
P 100	94,46	205,35	4,81	1,39	99,27	206,74	4,08	7,05	0,01	0,66	4,09	7,71	10,54	24,31	1,47	8,52	12,01	32,83
P 250	127,54	233,23	12,92	5,59	140,46	238,82	7,82	3,03	1,27	0,42	9,09	3,45	13,30	30,83	8,86	3,96	22,17	34,79
P 500	203,69	291,69	6,95	4,34	210,64	296,03	14,79	5,56	0,00	0,58	14,79	6,14	28,80	49,07	2,85	1,64	31,66	50,71
P 1250	234,38	372,52	4,04	7,63	238,41	380,15	65,38	113,85	0,01	0,05	65,39	113,90	58,66	82,98	1,27	6,62	59,93	89,60
YZ 50	20,15	33,40	2,58	2,96	22,73	36,35	3,46	4,22	0,46	1,41	3,92	5,62	8,05	8,23	2,19	4,97	10,24	13,20
YZ 100	21,74	47,04	5,56	0,22	27,30	47,27	1,10	3,03	0,15	0,42	1,25	3,45	6,91	21,25	2,61	9,57	9,52	30,82
YZ 250	25,07	50,68	1,56	0,13	26,63	50,81	0,30	2,01	0,00	0,35	0,30	2,37	13,30	27,51	8,86	4,60	22,17	32,11
YZ 500	48,73	91,09	3,25	2,95	51,98	94,05	0,30	0,14	0,76	0,10	1,06	0,24	26,85	49,07	3,34	1,64	30,19	50,71
YZ 1250	75,36	109,06	4,60	4,91	79,96	113,97	20,89	12,30	0,17	0,96	21,07	13,26	41,59	69,67	2,89	3,58	44,48	73,25

Table 10. German (DAX) Christoffersen test statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
GARCH	1,71	21,36	2,37	5,09	4,08	26,45	2,37	0,55	0,02	0,24	2,39	0,79	5,85	0,08	0,26	0,05	6,11	0,13
EGARCH	3,63	30,22	1,40	3,42	5,04	33,64	0,78	0,15	0,22	3,17	1,00	3,32	6,91	0,07	0,15	0,02	7,06	0,09
HS 50	4,42	13,60	2,75	0,54	7,17	14,14	8,70	18,59	1,44	1,31	10,14	19,90	8,05	24,31	2,19	0,09	10,24	24,40
HS 100	7,17	9,15	1,69	0,95	8,86	10,11	1,10	8,68	0,15	0,79	1,25	9,46	6,91	15,55	2,61	2,50	9,52	18,05
HS 250	10,47	3,82	2,19	6,68	12,66	10,50	0,45	0,15	0,27	0,19	0,72	0,34	8,05	2,80	4,15	0,29	12,20	3,09
HS 500	28,58	9,15	1,03	4,37	29,61	13,52	0,73	0,62	0,08	0,07	0,81	0,69	26,85	18,32	3,34	2,50	30,19	20,83
HS 1250	50,97	30,22	4,17	1,07	55,13	31,30	6,19	4,97	0,05	0,01	6,24	4,98	32,86	15,55	3,40	3,57	36,26	19,12

Table 11. Canada (TSX) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	0,47	7,18	3,66	1,22	4,13	8,40	0,24	1,18	0,19	0,29	0,43	1,47	0,01	4,36	3,96	6,82	3,97	11,18
MA Z 100	1,22	5,40	2,77	0,47	3,98	5,87	0,73	2,01	0,36	0,35	1,09	2,37	0,16	6,18	2,88	11,76	3,04	17,94
MA Z 250	3,63	9,15	3,17	0,68	6,80	9,84	0,10	3,03	0,12	0,42	0,22	3,45	0,41	2,80	0,58	8,00	0,99	10,80
MA Z 500	11,69	33,40	5,49	0,00	17,18	33,40	2,37	3,03	0,02	0,42	2,39	3,45	2,80	0,74	4,22	0,02	7,02	0,77
MA Z 1250	23,38	66,00	9,36	1,70	32,74	67,69	14,79	36,52	0,86	0,02	15,65	36,54	3,84	0,07	10,32	0,05	14,16	0,12
RM 50 .90	0,23	9,15	1,82	0,95	2,04	10,11	0,14	10,43	0,53	0,85	0,67	11,28	3,14	0,60	0,02	0,15	3,17	0,75
RM 100 .90	0,23	9,15	1,82	0,95	2,04	10,11	0,14	10,43	0,53	0,85	0,67	11,28	2,41	0,60	0,07	0,15	2,48	0,75
RM 250 .90	0,23	9,15	1,82	0,95	2,04	10,11	0,14	10,43	0,53	0,85	0,67	11,28	2,41	0,60	0,07	0,15	2,48	0,75
RM 500 .90	0,23	9,15	1,82	0,95	2,04	10,11	0,14	10,43	0,53	0,85	0,67	11,28	2,41	0,60	0,07	0,15	2,48	0,75
RM 1250 .90	0,23	9,15	1,82	0,95	2,04	10,11	0,14	10,43	0,53	0,85	0,67	11,28	2,41	0,60	0,07	0,15	2,48	0,75
RM 50 .94	0,23	7,18	4,17	1,22	4,40	8,40	0,51	7,05	0,31	0,66	0,82	7,71	2,41	2,80	1,03	8,00	3,44	10,80
RM 100 .94	0,03	7,18	5,97	1,22	6,00	8,40	0,14	3,03	0,53	0,42	0,67	3,45	1,21	2,80	1,64	8,00	2,85	10,80
RM 250 .94	0,03	7,18	5,97	1,22	6,00	8,40	0,04	3,03	0,66	0,42	0,70	3,45	1,21	2,80	1,64	8,00	2,85	10,80
RM 500 .94	0,03	7,18	5,97	1,22	6,00	8,40	0,04	3,03	0,66	0,42	0,70	3,45	1,21	2,80	1,64	8,00	2,85	10,80
RM 1250 .94	0,03	7,18	5,97	1,22	6,00	8,40	0,04	3,03	0,66	0,42	0,70	3,45	1,21	2,80	1,64	8,00	2,85	10,80
RM 50 .97	4,42	16,05	2,75	0,39	7,17	16,44	3,46	16,39	0,32	1,19	3,78	17,58	5,85	10,49	1,18	4,22	7,03	14,71
RM 100 .97	0,47	7,18	1,51	0,57	1,98	7,75	0,00	4,22	0,03	0,50	0,04	4,71	1,21	4,36	1,64	6,82	2,85	11,18
RM 250 .97	0,47	7,18	1,51	0,57	1,98	7,75	0,24	4,22	0,19	0,50	0,43	4,71	0,41	2,80	2,42	8,00	2,82	10,80
RM 500 .97	0,47	7,18	1,51	0,57	1,98	7,75	0,45	4,22	0,27	0,50	0,72	4,71	0,41	2,80	2,42	8,00	2,82	10,80
RM 1250 .97	0,47	7,18	1,51	0,57	1,98	7,75	0,45	4,22	0,27	0,50	0,72	4,71	0,41	2,80	2,42	8,00	2,82	10,80
KS 50	32,27	58,18	7,87	2,37	40,14	60,56	42,39	51,63	2,35	0,26	44,75	51,89	21,33	30,83	0,07	3,39	21,40	34,22
KS 100	38,13	86,75	12,46	11,19	50,59	97,94	44,16	64,88	0,55	0,00	44,70	64,88	34,97	49,07	2,25	1,32	37,22	50,39
KS 250	60,29	113,69	12,74	6,51	73,03	120,20	30,87	90,22	0,09	0,02	30,97	90,24	34,97	57,05	1,65	2,42	36,62	59,47
KS 500	88,84	162,81	9,33	11,01	98,17	173,82	55,33	143,37	0,80	0,42	56,13	143,79	14,79	34,26	5,52	2,88	20,31	37,14
KS 1250	112,06	227,58	11,85	10,05	123,91	237,63	245,99	305,09	5,97	0,60	251,96	305,68	24,96	41,47	2,10	2,01	27,05	43,47
GK 50	8,21	24,20	1,40	1,63	9,61	25,83	9,61	8,68	0,82	0,75	10,44	9,43	6,91	12,93	2,00	7,95	8,91	20,89
GK 100	10,47	33,40	6,10	0,00	16,57	33,40	4,08	5,56	0,01	0,58	4,09	6,14	10,54	15,55	0,41	6,97	10,95	22,52
GK 250	12,97	43,50	7,18	0,34	20,15	43,84	6,19	14,29	0,58	0,37	6,77	14,67	4,87	8,23	3,58	4,97	8,45	13,20
GK 500	25,07	66,00	11,07	3,62	36,14	69,62	8,70	23,28	0,99	1,57	9,69	24,86	0,35	0,07	5,31	0,05	5,66	0,12
GK 1250	62,72	109,06	9,67	7,18	72,39	116,24	32,43	101,83	0,05	0,01	32,48	101,84	0,35	1,53	5,31	9,42	5,66	10,95
RS 50	72,76	123,12	8,48	5,28	81,24	128,40	135,43	184,06	2,15	0,10	137,58	184,16	39,33	57,05	0,16	3,86	39,49	60,91
RS 100	70,20	147,57	11,29	11,07	81,49	158,64	106,64	156,61	3,01	0,34	109,65	156,96	48,63	53,02	0,01	2,87	48,65	55,89

Table 11. Canada (TSX) Christoffersen test statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RS 250	100,21	167,98	9,72	7,87	109,93	175,84	61,28	122,08	0,39	0,34	61,67	122,42	46,24	65,38	0,39	0,40	46,62	65,78
RS 500	118,17	233,23	11,92	7,31	130,09	240,54	89,69	152,16	1,64	0,86	91,33	153,02	16,33	30,83	4,87	3,39	21,20	34,22
RS 1250	127,54	262,03	9,30	9,25	136,84	271,28	225,96	273,30	5,89	0,09	231,85	273,39	24,96	41,47	2,10	2,01	27,05	43,47
P 50	32,27	70,01	10,16	3,17	42,42	73,18	76,06	97,91	2,40	0,46	78,47	98,37	21,33	30,83	1,25	3,39	22,58	34,22
P 100	34,18	74,10	7,17	2,75	41,35	76,84	57,28	82,72	2,13	0,09	59,42	82,81	21,33	30,83	0,02	3,39	21,35	34,22
P 250	48,73	95,50	10,38	4,44	59,11	99,94	32,43	71,86	3,02	0,02	35,45	71,88	28,80	37,81	2,85	2,42	31,66	40,23
P 500	67,67	113,69	10,07	6,51	77,74	120,20	34,01	113,85	0,28	0,58	34,29	114,43	6,91	18,32	4,75	2,50	11,66	20,83
P 1250	94,46	167,98	11,45	15,48	105,91	183,46	124,67	179,40	2,54	0,16	127,21	179,56	11,89	21,25	2,63	5,31	14,52	26,56
YZ 50	5,27	21,36	2,36	1,97	7,63	23,33	7,82	7,05	1,17	0,66	9,00	7,71	6,91	10,49	2,00	9,06	8,91	19,55
YZ 100	7,17	30,22	5,57	0,01	12,73	30,23	2,37	5,56	0,02	0,58	2,39	6,14	9,26	15,55	0,59	6,97	9,84	22,52
YZ 250	11,69	30,22	5,49	0,01	17,18	30,23	2,89	14,29	1,45	0,37	4,34	14,67	4,87	10,49	3,58	4,22	8,45	14,71
YZ 500	20,15	62,05	11,04	2,02	31,20	64,07	6,99	16,39	0,45	1,19	7,44	17,58	1,25	0,07	3,00	0,05	4,26	0,12
YZ 1250	55,56	99,96	10,05	8,65	65,61	108,61	27,86	97,91	0,00	0,00	27,86	97,91	0,35	1,53	5,31	9,42	5,66	10,95
GARCH	2,92	9,15	12,59	0,95	15,51	10,11	0,24	5,56	1,37	0,58	1,62	6,14	0,35	0,08	2,06	13,53	2,41	13,61
EGARCH	9,31	18,64	9,45	0,26	18,76	18,90	0,78	5,56	0,22	0,58	1,00	6,14	6,58	2,47	6,82	0,01	13,40	2,48
HS 50	2,92	13,60	0,00	0,54	2,92	14,14	4,74	7,05	0,87	0,66	5,61	7,71	3,96	18,32	2,01	2,50	5,98	20,83
HS 100	7,17	11,30	1,69	0,80	8,86	12,10	2,37	3,03	0,02	0,42	2,39	3,45	1,76	8,23	1,32	4,97	3,08	13,20
HS 250	11,69	1,36	1,85	0,23	13,55	1,59	0,78	3,03	0,22	0,42	1,00	3,45	1,21	0,07	0,26	0,05	1,48	0,12
HS 500	30,40	5,40	8,61	0,47	39,01	5,87	2,89	0,15	0,42	0,19	3,31	0,34	3,84	0,74	4,97	0,02	8,81	0,77
HS 1250	42,25	21,36	10,66	0,16	52,91	21,52	19,60	2,01	0,33	0,35	19,94	2,37	3,84	2,47	10,32	0,01	14,16	2,48

Table 12. US (DJI) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	0,39	3,82	1,74	0,38	2,13	4,20	3,46	2,01	0,00	0,35	3,46	2,37	0,03	1,53	0,80	0,21	0,82	1,74
MA Z 100	0,03	2,46	0,00	0,30	0,03	2,76	0,51	2,01	1,39	0,35	1,90	2,37	0,03	1,53	2,88	0,21	2,90	1,74
MA Z 250	0,47	5,40	1,51	0,47	1,98	5,87	0,02	2,01	2,70	0,35	2,72	2,37	1,21	1,53	0,14	0,21	1,36	1,74
MA Z 500	5,27	16,05	0,91	1,07	6,18	17,12	0,10	0,55	0,12	0,24	0,22	0,79	3,96	4,36	0,58	1,92	4,54	6,29
MA Z 1250	15,69	36,67	1,03	2,54	16,71	39,21	2,89	4,22	1,45	0,50	4,34	4,71	5,85	6,18	1,33	1,51	7,18	7,70
RM 50 .90	0,00	13,60	2,34	0,93	2,35	14,53	3,46	5,56	0,00	0,58	3,46	6,14	0,01	1,53	0,03	0,21	0,04	1,74
RM 100 .90	0,00	13,60	2,34	0,93	2,35	14,53	3,46	5,56	0,00	0,58	3,46	6,14	0,11	1,53	0,09	0,21	0,20	1,74
RM 250 .90	0,00	13,60	2,34	0,93	2,35	14,53	3,46	5,56	0,00	0,58	3,46	6,14	0,11	1,53	0,09	0,21	0,20	1,74
RM 500 .90	0,00	13,60	2,34	0,93	2,35	14,53	3,46	5,56	0,00	0,58	3,46	6,14	0,11	1,53	0,09	0,21	0,20	1,74
RM 1250 .90	0,00	13,60	2,34	0,93	2,35	14,53	3,46	5,56	0,00	0,58	3,46	6,14	0,11	1,53	0,09	0,21	0,20	1,74
RM 50 .94	0,03	13,60	2,13	0,93	2,16	14,53	4,08	3,03	0,23	0,42	4,30	3,45	0,01	0,60	0,00	0,15	0,01	0,75
RM 100 .94	0,39	9,15	1,74	0,68	2,13	9,84	2,37	3,03	0,28	0,42	2,65	3,45	0,35	0,08	0,18	0,09	0,53	0,17
RM 250 .94	0,39	9,15	1,74	0,68	2,13	9,84	2,37	3,03	0,28	0,42	2,65	3,45	0,35	0,08	0,18	0,09	0,53	0,17
RM 500 .94	0,39	9,15	1,74	0,68	2,13	9,84	2,37	3,03	0,28	0,42	2,65	3,45	0,35	0,08	0,18	0,09	0,53	0,17
RM 1250 .94	0,39	9,15	1,74	0,68	2,13	9,84	2,37	3,03	0,28	0,42	2,65	3,45	0,35	0,08	0,18	0,09	0,53	0,17
RM 50 .97	1,22	13,60	0,07	0,93	1,29	14,53	12,61	23,28	1,22	0,07	13,83	23,35	1,21	12,93	1,32	0,86	2,53	13,79
RM 100 .97	0,03	5,40	0,85	0,47	0,88	5,87	2,37	2,01	0,02	0,35	2,39	2,37	0,03	1,53	0,80	0,21	0,82	1,74
RM 250 .97	0,16	5,40	1,93	0,47	2,09	5,87	1,10	1,18	0,15	0,29	1,25	1,47	0,01	0,60	1,34	0,15	1,35	0,75

Table 12. US (DJI) Christoffersen test statistics (part 2)

RM 500 .97	0,16	5,40	1,93	0,47	2,09	5,87	1,10	1,18	0,15	0,29	1,25	1,47	0,01	0,60	1,34	0,15	1,35	0,75
RM 1250 .97	0,16	5,40	1,93	0,47	2,09	5,87	1,10	1,18	0,15	0,29	1,25	1,47	0,01	0,60	1,34	0,15	1,35	0,75
KS 50	26,80	47,04	1,28	3,05	28,08	50,09	59,27	94,04	5,34	0,00	64,60	94,05	11,89	30,83	5,87	1,05	17,76	31,87
KS 100	28,58	62,05	3,47	2,02	32,05	64,07	51,49	90,22	1,99	0,54	53,48	90,76	41,59	49,07	1,20	8,58	42,79	57,65
KS 250	30,40	86,75	0,81	0,53	31,21	87,28	51,49	75,43	0,54	2,77	52,03	78,19	63,93	82,98	0,13	1,81	64,05	84,79
KS 500	55,56	109,06	2,07	0,03	57,63	109,09	67,46	82,72	1,00	2,18	68,46	84,90	74,96	106,56	1,71	0,48	76,68	107,04
KS 1250	121,26	183,74	2,89	2,75	124,15	186,49	127,33	193,48	0,95	0,94	128,28	194,42	95,76	121,46	0,12	0,49	95,88	121,95
GK 50	0,07	5,40	0,05	0,47	0,11	5,87	9,61	12,30	0,01	0,49	9,63	12,80	3,96	8,23	0,40	0,60	4,36	8,83
GK 100	0,23	9,15	0,34	0,68	0,57	9,84	4,08	16,39	0,23	0,27	4,30	16,67	9,26	12,93	3,09	0,65	12,35	13,58
GK 250	2,28	9,15	2,02	0,68	4,30	9,84	0,78	8,68	1,18	0,79	1,97	9,46	9,26	8,23	1,47	1,17	10,73	9,40
GK 500	8,21	18,64	0,38	0,26	8,59	18,90	0,51	4,22	3,09	1,41	3,61	5,62	16,33	12,93	0,48	0,65	16,81	13,58
GK 1250	20,15	43,50	1,32	4,17	21,47	47,66	7,82	23,28	0,34	0,07	8,16	23,35	19,60	18,32	0,20	0,30	19,80	18,62
RS 50	1,22	7,18	0,36	0,57	1,57	7,75	11,57	16,39	0,06	0,27	11,63	16,67	4,87	10,49	0,26	0,72	5,13	11,21
RS 100	2,28	11,30	2,02	0,80	4,30	12,10	4,74	18,59	0,15	0,19	4,89	18,78	11,89	15,55	3,99	0,45	15,88	16,00
RS 250	8,21	18,64	0,38	0,26	8,59	18,90	1,90	12,30	1,92	0,49	3,81	12,80	14,79	12,93	0,48	0,65	15,27	13,58
RS 500	9,31	24,20	0,26	0,09	9,57	24,29	2,89	8,68	1,45	0,79	4,34	9,46	19,60	18,32	0,10	0,30	19,71	18,62
RS 1250	21,74	47,04	2,21	3,66	23,95	50,70	11,57	28,33	0,06	0,01	11,63	28,34	21,33	21,25	0,49	0,18	21,82	21,43
P 50	0,80	7,18	0,13	0,57	0,94	7,75	7,82	10,43	0,00	0,85	7,82	11,28	1,21	6,18	1,32	0,48	2,53	6,67
P 100	0,80	9,15	1,23	0,68	2,04	9,84	4,08	10,43	0,23	0,85	4,30	11,28	4,87	12,93	3,07	0,65	7,94	13,58
P 250	4,42	18,64	1,14	0,26	5,56	18,90	0,51	5,56	3,09	0,58	3,61	6,14	10,54	6,18	1,47	1,51	12,01	7,70
P 500	10,47	24,20	0,16	0,09	10,63	24,29	0,14	2,01	1,85	0,35	2,00	2,37	16,33	10,49	0,48	0,88	16,81	11,37
P 1250	21,74	54,39	2,21	2,77	23,95	57,16	7,82	23,28	0,34	0,07	8,16	23,35	17,94	18,32	0,32	0,30	18,26	18,62
YZ 50	0,00	3,82	0,01	0,38	0,01	4,20	7,82	10,43	0,00	0,63	7,82	11,06	1,76	6,18	1,03	0,48	2,80	6,67
YZ 100	0,07	5,40	0,48	0,47	0,55	5,87	4,08	8,68	0,23	0,75	4,30	9,43	4,87	8,23	1,33	1,17	6,19	9,40
YZ 250	2,28	9,15	2,02	0,95	4,30	10,11	0,51	4,22	3,09	0,50	3,61	4,71	8,05	6,18	2,19	1,51	10,24	7,70
YZ 500	8,21	18,64	0,38	0,26	8,59	18,90	0,14	2,01	1,85	0,35	2,00	2,37	16,33	10,49	0,48	0,88	16,81	11,37
YZ 1250	15,69	33,40	1,03	0,85	16,71	34,24	5,44	16,39	0,72	1,19	6,16	17,58	17,94	15,55	0,32	0,45	18,26	16,00
GARCH	0,47	11,30	0,22	0,80	0,70	12,10	1,90	0,15	0,05	0,19	1,95	0,34	0,01	0,60	1,34	0,15	1,35	0,75
EGARCH	3,63	7,18	0,30	0,57	3,93	7,75	0,78	0,55	4,87	0,24	5,65	0,79	0,03	0,08	1,98	0,09	2,00	0,17
HS 50	1,22	9,15	0,07	0,68	1,29	9,84	7,82	10,43	0,34	0,63	8,16	11,06	1,21	8,23	1,32	0,60	2,53	8,83
HS 100	0,80	7,18	1,23	0,57	2,04	7,75	1,10	7,05	0,09	0,66	1,19	7,71	3,96	4,36	3,58	1,92	7,55	6,29
HS 250	2,92	2,46	1,70	0,30	4,62	2,76	0,00	0,55	2,40	0,24	2,40	0,79	6,91	1,53	1,04	0,21	7,96	1,74
HS 500	7,17	5,40	0,53	0,47	7,70	5,87	0,14	0,14	0,53	0,10	0,67	0,24	4,87	2,80	1,65	0,29	6,52	3,09
HS 1250	26,80	16,05	2,45	0,39	29,25	16,44	4,74	0,55	0,87	0,24	5,61	0,79	14,79	2,80	0,68	0,29	15,46	3,09

Table 13. Japan (NIKKEI) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	2,28	9,15	0,61	0,68	2,89	9,84	0,14	8,68	0,00	0,75	0,14	9,43	0,16	0,08	0,00	0,09	0,16	0,17
MA Z 100	0,47	7,18	0,22	1,22	0,70	8,40	0,45	5,56	0,27	0,58	0,72	6,14	0,35	0,08	1,36	0,09	1,71	0,17
MA Z 250	0,47	2,46	0,22	0,30	0,70	2,76	0,10	2,01	0,26	0,35	0,36	2,37	0,35	0,08	1,36	0,09	1,71	0,17
MA Z 500	6,19	13,60	0,05	0,54	6,24	14,14	0,10	1,18	0,26	0,29	0,36	1,47	0,01	0,07	1,76	0,05	1,77	0,12
MA Z 1250	20,15	16,05	0,82	0,39	20,97	16,44	0,73	1,18	0,08	0,29	0,81	1,47	0,76	0,08	0,07	0,09	0,83	0,17
RM 50 .90	4,42	1,36	0,06	0,23	4,48	1,59	1,10	8,68	0,15	0,75	1,25	9,43	4,87	0,60	0,40	0,15	5,27	0,75
RM 100 .90	4,42	1,36	0,06	0,23	4,48	1,59	1,10	8,68	0,15	0,75	1,25	9,43	4,87	0,60	0,40	0,15	5,27	0,75
RM 250 .90	4,42	1,36	0,06	0,23	4,48	1,59	1,10	8,68	0,15	0,75	1,25	9,43	4,87	0,60	0,40	0,15	5,27	0,75

Table 13. Japan (NIKKEI) Christoffersen test statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
RM 500 .90	4,42	1,36	0,06	0,23	4,48	1,59	1,10	8,68	0,15	0,75	1,25	9,43	4,87	0,60	0,40	0,15	5,27	0,75
RM 1250 .90	4,42	1,36	0,06	0,23	4,48	1,59	1,10	8,68	0,15	0,75	1,25	9,43	4,87	0,60	0,40	0,15	5,27	0,75
RM 50 .94	2,92	3,82	0,77	1,89	3,69	5,71	0,51	7,05	0,31	0,66	0,82	7,71	3,96	0,08	0,58	0,09	4,54	0,17
RM 100 .94	2,28	3,82	0,61	1,89	2,89	5,71	0,30	5,56	0,41	0,58	0,71	6,14	1,76	0,08	0,15	0,09	1,92	0,17
RM 250 .94	2,28	2,46	0,61	2,32	2,89	4,78	0,30	5,56	0,41	0,58	0,71	6,14	1,76	0,08	0,15	0,09	1,92	0,17
RM 500 .94	2,28	2,46	0,61	2,32	2,89	4,78	0,30	5,56	0,41	0,58	0,71	6,14	1,76	0,08	0,15	0,09	1,92	0,17
RM 1250 .94	2,28	2,46	0,61	2,32	2,89	4,78	0,30	5,56	0,41	0,58	0,71	6,14	1,76	0,08	0,15	0,09	1,92	0,17
RM 50 .97	11,69	18,64	2,85	0,26	14,54	18,90	2,37	18,59	0,54	0,19	2,91	18,78	8,05	1,53	0,07	0,21	8,12	1,74
RM 100 .97	1,22	7,18	0,36	1,22	1,57	8,40	0,30	8,68	0,00	0,75	0,30	9,43	1,21	0,60	0,26	0,15	1,48	0,75
RM 250 .97	0,47	7,18	0,17	1,22	0,64	8,40	0,00	7,05	0,03	0,66	0,04	7,71	0,16	0,08	0,00	0,09	0,16	0,17
RM 500 .97	0,47	7,18	0,17	1,22	0,64	8,40	0,00	7,05	0,03	0,66	0,04	7,71	0,16	0,08	0,00	0,09	0,16	0,17
RM 1250 .97	0,47	7,18	0,17	1,22	0,64	8,40	0,00	7,05	0,03	0,66	0,04	7,71	0,16	0,08	0,00	0,09	0,16	0,17
KS 50	38,13	74,10	0,78	1,12	38,91	75,22	61,28	75,43	0,08	0,22	61,36	75,65	26,85	21,25	0,32	0,18	27,18	21,43
KS 100	60,29	74,10	2,18	0,06	62,47	74,16	82,77	97,91	0,01	0,00	82,78	97,91	34,97	30,83	0,51	1,98	35,48	32,80
KS 250	77,99	95,50	1,09	0,01	79,08	95,51	89,69	101,83	0,55	0,01	90,24	101,84	46,24	30,83	3,17	1,98	49,41	32,80
KS 500	127,54	189,08	1,61	0,97	129,16	190,05	82,77	126,26	1,04	0,30	83,81	126,56	69,36	74,03	3,70	0,18	73,06	74,21
KS 1250	171,03	238,92	1,13	0,44	172,15	239,35	111,69	139,04	0,24	0,05	111,93	139,09	108,46	101,71	1,41	1,18	109,87	102,89
GK 50	15,69	21,36	0,36	0,16	16,05	21,52	8,70	23,28	0,00	0,07	8,70	23,35	14,79	8,23	0,20	0,60	14,98	8,83
GK 100	17,12	18,64	0,02	0,26	17,14	18,90	6,99	16,39	0,15	0,27	7,14	16,67	9,26	8,23	0,42	0,60	9,68	8,83
GK 250	18,61	21,36	0,06	0,16	18,67	21,52	5,44	14,29	0,10	0,37	5,54	14,67	6,91	10,49	1,24	0,72	8,15	11,21
GK 500	40,17	40,04	0,97	0,48	41,14	40,52	5,44	12,30	0,75	0,49	6,19	12,80	11,89	18,32	0,75	1,18	12,64	19,50
GK 1250	50,97	58,18	1,12	0,02	52,08	58,21	6,99	18,59	0,02	0,19	7,01	18,78	16,33	15,55	3,33	1,02	19,66	16,56
RS 50	26,80	33,40	0,06	0,00	26,86	33,40	20,89	28,33	0,28	0,01	21,18	28,34	34,97	34,26	0,51	0,00	35,48	34,27
RS 100	28,58	36,67	0,13	0,65	28,70	37,32	13,68	25,76	0,87	0,04	14,55	25,80	39,33	27,51	2,07	1,76	41,40	29,27
RS 250	30,40	33,40	0,22	0,85	30,62	34,24	15,94	25,76	0,30	0,04	16,24	25,80	39,33	21,25	3,62	1,36	42,96	22,61
RS 500	50,97	50,68	1,12	0,13	52,08	50,81	15,94	18,59	0,30	0,19	16,24	18,78	34,97	24,31	3,02	1,55	37,99	25,86
RS 1250	60,29	82,47	0,44	0,05	60,73	82,52	18,35	23,28	0,50	0,07	18,84	23,35	41,59	24,31	4,06	1,55	45,64	25,86
P 50	17,12	24,20	0,02	0,09	17,14	24,29	15,94	33,71	0,78	0,00	16,72	33,72	28,80	27,51	0,09	0,03	28,89	27,54
P 100	18,61	24,20	0,06	0,09	18,67	24,29	10,57	18,59	0,49	0,19	11,06	18,78	30,81	15,55	2,30	1,02	33,10	16,56
P 250	18,61	21,36	0,65	0,16	19,26	21,52	9,61	14,29	0,00	0,37	9,62	14,67	21,33	15,55	2,30	1,02	23,63	16,56
P 500	40,17	40,04	0,97	0,48	41,14	40,52	6,99	14,29	0,15	0,37	7,14	14,67	30,81	18,32	2,13	1,18	32,94	19,50
P 1250	50,97	50,68	1,12	0,13	52,08	50,81	8,70	20,89	0,00	0,13	8,70	21,01	26,85	15,55	3,38	1,02	30,23	16,56
YZ 50	14,30	21,36	0,25	0,16	14,55	21,52	6,99	18,59	0,03	0,19	7,02	18,78	10,54	6,18	0,01	0,48	10,55	6,67
YZ 100	15,69	16,05	0,00	0,39	15,69	16,44	1,90	16,39	0,05	0,27	1,95	16,67	6,91	4,36	1,24	0,38	8,15	4,74
YZ 250	11,69	18,64	0,09	0,26	11,78	18,90	3,46	8,68	0,00	0,79	3,46	9,46	5,85	6,18	1,02	0,48	6,87	6,67
YZ 500	40,17	40,04	0,97	0,48	41,14	40,52	2,37	8,68	1,59	0,79	3,96	9,46	10,54	10,49	0,57	0,72	11,11	11,21
YZ 1250	50,97	43,50	1,12	0,34	52,08	43,84	4,74	14,29	0,04	0,37	4,77	14,67	13,30	12,93	2,64	0,86	15,94	13,79
GARCH	3,63	3,82	0,94	0,38	4,57	4,20	0,51	7,05	0,31	0,66	0,82	7,71	1,21	0,07	0,14	0,05	1,36	0,12
EGARCH	1,22	3,82	0,36	0,38	1,57	4,20	0,10	5,56	1,17	1,17	1,27	6,73	0,76	2,47	0,07	0,01	0,83	2,48
HS 50	1,71	21,36	0,48	0,16	2,19	21,52	2,89	12,30	4,95	0,49	7,84	12,80	2,41	6,18	0,35	0,48	2,76	6,67
HS 100	0,80	11,30	0,25	0,73	1,06	12,03	0,51	8,68	0,31	0,75	0,82	9,43	1,21	2,80	2,99	0,29	4,20	3,09
HS 250	0,23	2,46	0,34	0,30	0,57	2,76	1,10	0,15	0,09	0,19	1,19	0,34	0,41	0,08	0,02	0,09	0,43	0,17
HS 500	10,47	2,46	0,91	0,30	11,38	2,76	0,00	0,15	0,43	0,19	0,43	0,34	0,41	0,08	2,46	0,09	2,86	0,17
HS 1250	18,61	2,46	0,65	0,30	19,26	2,76	0,45	0,00	0,13	0,14	0,58	0,14	0,76	0,08	0,07	0,09	0,83	0,17

Table 14. Thailand (SET) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	0,23	1,36	4,17	0,23	4,40	1,59	5,67	0,62	0,13	5,12	5,79	5,74	0,73	6,18	6,09	5,82	6,82	12,01
MA Z 100	1,78	0,09	2,34	0,12	4,12	0,21	3,94	0,14	3,80	4,35	7,74	4,49	0,73	4,36	6,09	6,82	6,82	11,18
MA Z 250	0,07	0,56	4,72	0,17	4,79	0,73	8,98	2,89	2,68	0,03	11,66	2,92	1,94	0,60	7,95	11,19	9,89	11,79
MA Z 500	12,97	18,64	3,02	0,26	15,99	18,90	18,71	4,97	1,41	0,01	20,12	4,98	2,80	1,53	9,06	9,42	11,86	10,95
MA Z 1250	50,97	21,36	1,73	0,16	52,70	21,52	3,94	0,62	1,30	5,12	5,24	5,74	10,34	0,07	9,42	16,97	19,76	17,04
RM 50 .90	2,92	3,82	6,12	0,38	9,04	4,20	1,99	0,15	0,00	0,19	1,99	0,34	0,03	6,18	3,39	1,51	3,42	7,70
RM 100 .90	2,92	2,46	6,12	0,30	9,04	2,76	2,56	0,00	0,00	0,14	2,56	0,14	0,03	6,18	3,39	1,51	3,42	7,70
RM 250 .90	2,92	2,46	6,12	0,30	9,04	2,76	2,56	0,00	0,00	0,14	2,56	0,14	0,03	6,18	3,39	1,51	3,42	7,70
RM 500 .90	2,92	2,46	6,12	0,30	9,04	2,76	2,56	0,00	0,00	0,14	2,56	0,14	0,03	6,18	3,39	1,51	3,42	7,70
RM 1250 .90	2,92	2,46	6,12	0,30	9,04	2,76	2,56	0,00	0,00	0,14	2,56	0,14	0,03	6,18	3,39	1,51	3,42	7,70
RM 50 .94	1,71	2,46	4,65	0,30	6,36	2,76	3,21	1,18	0,01	0,29	3,22	1,47	0,01	8,23	3,96	4,97	3,97	13,20
RM 100 .94	0,80	1,36	5,85	0,23	6,65	1,59	4,76	0,00	0,07	0,14	4,83	0,14	0,73	8,23	6,09	4,97	6,82	13,20
RM 250 .94	0,80	1,36	5,85	0,23	6,65	1,59	4,76	0,00	0,07	0,14	4,83	0,14	0,73	8,23	6,09	4,97	6,82	13,20
RM 500 .94	0,80	1,36	5,85	0,23	6,65	1,59	4,76	0,00	0,07	0,14	4,83	0,14	0,73	8,23	6,09	4,97	6,82	13,20
RM 1250 .94	0,80	1,36	5,85	0,23	6,65	1,59	4,76	0,00	0,07	0,14	4,83	0,14	0,73	8,23	6,09	4,97	6,82	13,20
RM 50 .97	7,17	11,30	5,57	0,73	12,73	12,03	0,51	4,22	0,31	1,41	0,82	5,62	0,03	8,23	2,88	4,97	2,90	13,20
RM 100 .97	0,07	0,56	4,72	0,17	4,79	0,73	2,56	0,15	0,92	3,17	3,47	3,32	0,73	6,18	6,09	5,82	6,82	12,01
RM 250 .97	0,03	0,56	5,97	0,17	6,00	0,73	3,94	0,00	0,04	3,71	3,98	3,71	0,73	4,36	6,09	6,82	6,82	11,18
RM 500 .97	0,03	0,56	5,97	0,17	6,00	0,73	3,94	0,14	0,04	4,35	3,98	4,49	0,73	4,36	6,09	6,82	6,82	11,18
RM 1250 .97	0,03	0,56	5,97	0,17	6,00	0,73	3,94	0,14	0,04	4,35	3,98	4,49	0,73	4,36	6,09	6,82	6,82	11,18
KS 50	53,24	58,18	2,43	4,65	55,68	62,83	40,66	45,38	3,88	0,27	44,54	45,65	10,54	15,55	1,17	6,09	11,71	21,64
KS 100	72,76	62,05	0,90	4,12	73,66	66,17	38,95	39,41	4,27	2,11	43,22	41,51	17,94	27,51	0,20	3,39	18,13	30,90
KS 250	97,32	109,06	0,71	0,53	98,03	109,59	26,40	36,52	0,94	2,40	27,34	38,92	17,94	30,83	0,20	3,39	18,13	34,22
KS 500	178,11	273,79	2,53	1,36	180,64	275,15	17,13	36,52	0,56	2,40	17,69	38,92	10,54	27,51	1,17	3,96	11,71	31,47
KS 1250	300,13	451,46	2,50	1,44	302,62	452,91	89,69	90,22	14,21	3,31	103,91	93,53	1,21	10,49	1,64	9,06	2,85	19,55
GK 50	25,07	9,15	2,84	0,95	27,90	10,11	0,30	0,55	0,41	2,72	0,71	3,27	0,11	10,49	4,60	9,06	4,71	19,55
GK 100	21,74	9,15	2,21	0,68	23,95	9,84	0,73	2,01	1,84	1,97	2,57	3,99	0,01	8,23	3,96	10,32	3,97	18,55
GK 250	34,18	21,36	3,61	0,16	37,79	21,52	1,49	0,55	2,40	2,72	3,89	3,27	0,11	1,53	4,60	9,42	4,71	10,95
GK 500	80,66	62,05	0,35	4,12	81,01	66,17	7,77	2,89	2,35	0,03	10,12	2,92	1,94	1,53	7,95	9,42	9,89	10,95
GK 1250	115,10	118,38	1,03	0,36	116,13	118,74	0,24	0,15	0,19	3,17	0,43	3,32	8,31	0,08	8,00	13,53	16,31	13,61
RS 50	88,84	74,10	0,79	1,14	89,63	75,24	40,66	36,52	3,88	2,40	44,54	38,92	19,60	27,51	0,69	3,96	20,29	31,47
RS 100	70,20	47,04	1,14	0,17	71,34	47,21	35,63	30,98	5,09	3,05	40,72	34,03	16,33	21,25	0,00	5,31	16,33	26,56
RS 250	83,35	62,05	0,65	0,61	84,00	62,67	20,89	25,76	0,84	3,80	21,73	29,57	8,05	18,32	0,59	6,09	8,63	24,42
RS 500	112,06	152,60	1,30	0,47	113,36	153,07	6,99	18,59	0,02	2,05	7,01	20,64	3,14	10,49	2,01	9,06	5,16	19,55
RS 1250	181,69	238,92	0,90	0,71	182,59	239,63	18,35	42,36	11,87	0,36	30,21	42,72	0,35	1,53	5,31	9,42	5,66	10,95
P 50	36,13	30,22	4,70	1,07	40,83	31,30	10,57	14,29	0,67	0,37	11,24	14,67	9,26	15,55	1,47	6,97	10,73	22,52
P 100	36,13	11,30	4,70	0,80	40,83	12,10	4,08	14,29	0,01	2,68	4,09	16,97	5,85	15,55	1,33	6,97	7,18	22,52
P 250	40,17	18,64	1,31	0,26	41,48	18,90	1,90	8,68	0,05	3,86	1,95	12,54	1,21	10,49	1,64	9,06	2,85	19,55
P 500	91,64	70,01	0,59	3,17	92,23	73,18	0,04	2,01	0,66	1,97	0,70	3,99	1,21	10,49	1,64	9,06	2,85	19,55
P 1250	137,17	152,60	1,64	0,47	138,81	153,07	1,10	23,28	4,45	1,53	5,55	24,81	2,80	1,53	9,06	9,42	11,86	10,95
YZ 50	17,12	7,18	3,41	0,57	20,53	7,75	0,14	0,55	0,53	2,72	0,67	3,27	0,35	10,49	5,31	9,06	5,66	19,55
YZ 100	11,69	3,82	1,85	0,38	13,55	4,20	1,08	2,01	2,11	1,97	3,18	3,99	0,01	8,23	3,96	10,32	3,97	18,55
YZ 250	18,61	13,60	0,62	0,54	19,23	14,14	3,94	0,00	3,80	3,71	7,74	3,71	1,94	1,53	7,95	9,42	9,89	10,95
YZ 500	67,67	40,04	0,71	2,16	68,38	42,19	13,26	4,97	0,79	0,01	14,05	4,98	1,94	1,53	7,95	9,42	9,89	10,95
YZ 1250	97,32	109,06	0,71	0,16	98,03	109,22	0,45	0,00	0,27	3,71	0,72	3,71	10,34	0,07	9,42	16,97	19,76	17,04

Table 14. Thailand (SET) Christoffersen test statistics (part 2)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
GARCH	9,31	3,82	4,44	1,89	13,75	5,71	8,98	0,14	0,37	4,35	9,35	4,49	3,84	0,07	4,97	6,08	8,81	6,14
EGARCH	4,42	1,36	4,91	0,23	9,33	1,59	6,67	0,55	0,19	2,72	6,86	3,27	3,84	0,08	4,97	13,53	8,81	13,61
HS 50	3,63	11,30	5,49	0,80	9,13	12,10	2,37	4,22	0,02	1,41	2,39	5,62	0,16	4,36	2,42	6,82	2,58	11,18
HS 100	1,71	7,18	0,02	0,57	1,73	7,75	0,02	2,01	2,70	6,77	2,72	8,79	0,76	2,80	1,64	2,42	2,40	5,22
HS 250	1,22	3,82	0,07	0,38	1,29	4,20	3,94	0,14	3,80	4,35	7,74	4,49	0,03	0,08	3,39	13,53	3,42	13,61
HS 500	26,80	13,60	0,47	0,54	27,27	14,14	6,67	2,89	2,05	7,46	8,72	10,35	1,25	0,60	6,97	11,19	8,22	11,79
HS 1250	62,72	11,30	0,53	0,73	63,24	12,03	1,49	0,14	0,61	4,35	2,10	4,49	10,34	0,07	9,42	16,97	19,76	17,04

Table 15. Brazil (BOVESPA) Christoffersen test statistics (part 1)

	Period 1						*Period 2*						*Period 3*					
	LRuc		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*		*LRuc*		*LRind*		*LRcc*	
VaR	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*	*5%*	*1%*
MA Z 50	2,92	18,64	3,62	1,22	6,54	19,86	0,45	0,55	1,60	0,24	2,05	0,79	0,76	4,36	0,41	1,92	1,17	6,29
MA Z 100	6,19	24,20	6,19	1,55	12,37	25,75	3,21	0,62	1,10	0,07	4,31	0,69	0,16	8,23	2,88	1,17	3,04	9,40
MA Z 250	7,17	36,67	8,18	8,84	15,34	45,50	1,08	0,15	0,48	3,17	1,55	3,32	0,16	1,53	0,00	3,02	0,16	4,55
MA Z 500	20,15	54,39	6,17	5,23	26,32	59,62	13,26	0,62	3,86	0,07	17,13	0,69	0,16	2,80	0,00	2,42	0,16	5,22
MA Z 1250	0,80	9,15	1,23	0,68	2,04	9,84	20,82	2,89	18,87	0,03	39,70	2,92	3,84	0,07	1,17	0,05	5,01	0,12
RM 50 .90	3,63	13,60	0,02	0,93	3,66	14,53	1,10	2,01	4,45	0,35	5,55	2,37	3,14	6,18	0,79	0,48	3,93	6,67
RM 100 .90	3,63	13,60	0,02	0,93	3,66	14,53	1,10	2,01	4,45	0,35	5,55	2,37	3,14	6,18	0,79	0,48	3,93	6,67
RM 250 .90	3,63	13,60	0,02	0,93	3,66	14,53	1,10	2,01	4,45	0,35	5,55	2,37	3,14	6,18	0,79	0,48	3,93	6,67
RM 500 .90	3,63	13,60	0,02	0,93	3,66	14,53	1,10	2,01	4,45	0,35	5,55	2,37	3,14	6,18	0,79	0,48	3,93	6,67
RM 1250 .90	3,63	13,60	0,02	0,93	3,66	14,53	1,10	2,01	4,45	0,35	5,55	2,37	3,14	6,18	0,79	0,48	3,93	6,67
RM 50 .94	3,63	16,05	0,30	1,07	3,93	17,12	1,10	4,22	2,46	1,41	3,57	5,62	3,96	6,18	0,58	0,48	4,54	6,67
RM 100 .94	2,28	16,05	0,59	1,07	2,87	17,12	0,04	3,03	4,20	0,42	4,25	3,45	1,76	4,36	0,15	0,38	1,92	4,74
RM 250 .94	2,28	13,60	0,59	0,93	2,87	14,53	0,04	2,01	4,20	0,35	4,25	2,37	1,76	4,36	0,15	0,38	1,92	4,74
RM 500 .94	2,28	13,60	0,59	0,93	2,87	14,53	0,04	2,01	4,20	0,35	4,25	2,37	1,76	4,36	0,15	0,38	1,92	4,74
RM 1250 .94	2,28	13,60	0,59	0,93	2,87	14,53	0,04	2,01	4,20	0,35	4,25	2,37	1,76	4,36	0,15	0,38	1,92	4,74
RM 50 .97	9,31	33,40	4,44	0,85	13,75	34,24	5,44	10,43	5,32	0,63	10,76	11,06	5,85	10,49	1,33	0,88	7,18	11,37
RM 100 .97	5,27	16,05	2,36	1,07	7,63	17,12	0,10	0,55	1,17	0,24	1,27	0,79	1,76	6,18	1,32	1,51	3,08	7,70
RM 250 .97	3,63	16,05	3,17	1,07	6,80	17,12	1,08	0,55	2,11	0,24	3,18	0,79	0,76	6,18	0,41	1,51	1,17	7,70
RM 500 .97	3,63	16,05	3,17	1,07	6,80	17,12	1,08	0,55	2,11	0,24	3,18	0,79	0,76	6,18	0,41	1,51	1,17	7,70
RM 1250 .97	3,63	16,05	3,17	1,07	6,80	17,12	1,08	0,55	2,11	0,24	3,18	0,79	0,76	6,18	0,41	1,51	1,17	7,70
KS 50	38,13	91,09	5,87	7,44	44,01	98,54	23,58	39,41	7,16	2,11	30,74	41,51	21,33	41,47	3,20	0,41	24,53	41,87
KS 100	77,99	132,75	8,79	6,17	86,79	138,92	18,35	33,71	3,67	2,71	22,01	36,42	32,86	49,07	3,40	3,36	36,26	52,44
KS 250	115,10	199,89	12,87	12,16	127,97	212,04	27,86	45,38	7,52	6,56	35,38	51,95	34,97	57,05	4,49	0,02	39,46	57,08
KS 500	167,52	285,69	10,67	9,89	178,19	295,58	12,61	36,52	5,73	12,23	18,33	48,75	41,59	57,05	2,89	0,49	44,48	57,54
KS 1250	103,13	178,44	10,72	3,16	113,85	181,61	44,16	61,48	5,99	6,83	50,15	68,31	28,80	34,26	2,85	0,00	31,66	34,27
GK 50	17,12	43,50	5,28	4,17	22,41	47,66	6,99	8,68	6,54	3,86	13,53	12,54	10,54	18,32	1,47	0,30	12,01	18,62
GK 100	23,38	54,39	4,98	8,27	28,36	62,66	1,48	7,05	2,18	0,97	3,66	8,02	16,33	15,55	2,96	0,45	19,29	16,00
GK 250	18,61	62,05	9,23	9,98	27,84	72,03	0,30	4,22	8,61	1,41	8,92	5,62	11,89	18,32	0,26	0,30	12,15	18,62
GK 500	50,97	86,75	9,56	8,18	60,53	94,93	1,99	0,15	17,69	0,19	19,68	0,34	14,79	18,32	0,68	0,30	15,46	18,62
GK 1250	15,69	33,40	5,88	0,85	21,56	34,24	3,94	0,14	11,26	0,10	15,20	0,24	0,35	0,60	0,18	0,15	0,53	0,75
RS 50	26,80	66,00	7,84	3,62	34,63	69,62	8,70	12,30	5,57	3,04	14,27	15,34	17,94	24,31	1,18	0,09	19,12	24,40

Table 15. Brazil (BOVESPA) Christoffersen test statistics (part 2)

RS 100	28,58	66,00	5,16	9,12	33,73	75,12	2,37	8,68	3,31	0,79	5,68	9,46	21,33	18,32	1,73	0,30	23,06	18,62
RS 250	36,13	78,25	10,87	9,79	47,01	88,04	1,48	5,56	9,08	1,17	10,56	6,73	21,33	21,25	1,73	0,18	23,06	21,43
RS 500	62,72	91,09	11,81	7,44	74,53	98,54	0,73	0,55	14,70	0,24	15,43	0,79	23,12	21,25	4,44	0,18	27,55	21,43
RS 1250	32,27	47,04	4,09	1,51	36,36	48,55	1,49	0,00	12,23	3,71	13,73	3,71	0,01	0,60	0,03	0,15	0,04	0,75
P 50	17,12	47,04	3,41	1,51	20,53	48,55	3,46	10,43	6,78	3,43	10,24	13,86	4,87	12,93	1,65	0,65	6,52	13,58
P 100	23,38	50,68	7,02	5,85	30,40	56,52	0,02	5,56	0,98	1,17	1,00	6,73	11,89	8,23	2,63	1,17	14,52	9,40
P 250	15,69	62,05	10,91	13,64	26,60	75,69	0,04	4,22	9,92	1,41	9,96	5,62	10,54	15,55	0,41	0,45	10,95	16,00
P 500	46,53	86,75	9,02	8,18	55,55	94,93	4,76	0,15	12,10	0,19	16,86	0,34	10,54	15,55	0,41	0,45	10,95	16,00
P 1250	11,69	30,22	3,46	1,07	15,15	31,30	7,77	1,50	14,99	0,05	22,76	1,55	0,35	0,08	0,18	0,09	0,53	0,17
YZ 50	14,30	43,50	6,51	4,17	20,81	47,66	4,74	8,68	5,78	3,86	10,52	12,54	9,26	15,55	1,81	0,45	11,07	16,00
YZ 100	15,69	50,68	5,88	5,85	21,56	56,52	0,04	5,56	0,66	1,17	0,70	6,73	14,79	12,93	1,83	0,65	16,61	13,58
YZ 250	18,61	70,01	9,23	11,60	27,84	81,61	0,04	3,03	9,92	1,67	9,96	4,70	10,54	15,55	0,41	0,45	10,95	16,00
YZ 500	44,37	82,47	9,82	6,19	54,19	88,66	3,21	0,15	14,94	0,19	18,15	0,34	10,54	15,55	0,41	0,45	10,95	16,00
YZ 1250	14,30	30,22	4,38	1,07	18,68	31,30	6,67	1,50	13,96	0,05	20,63	1,55	0,35	0,08	0,18	0,09	0,53	0,17
GARCH	1,22	13,60	5,23	0,54	6,44	14,14	0,45	0,15	3,75	0,19	4,20	0,34	0,35	0,60	0,18	0,15	0,53	0,75
EGARCH	1,22	11,30	0,99	0,73	2,21	12,03	1,08	1,50	2,11	0,05	3,18	1,55	0,03	0,08	1,05	0,09	1,07	0,17
HS 50	10,47	16,05	2,19	1,07	12,66	17,12	1,48	12,30	2,18	3,04	3,66	15,34	3,14	4,36	0,02	1,92	3,17	6,29
HS 100	7,17	18,64	5,57	2,34	12,73	20,98	0,10	1,18	1,17	0,29	1,27	1,47	1,21	4,36	1,64	1,92	2,85	6,29
HS 250	8,21	16,05	7,44	6,50	15,65	22,55	0,02	0,14	2,70	0,10	2,72	0,24	0,41	0,60	0,02	0,15	0,43	0,75
HS 500	32,27	18,64	12,70	2,34	44,96	20,98	6,67	1,50	2,05	0,05	8,72	1,55	0,03	1,53	0,00	3,02	0,03	4,55
HS 1250	6,19	5,40	2,01	0,47	8,20	5,87	11,72	8,09	18,54	0,00	30,26	8,09	1,25	2,47	0,45	0,01	1,71	2,48

Table 16. Model abbreviations (part 1)

Abbreviation	***Description***
MA Z 50	Equally Weighted Moving Average. Normal Distribution, Sample Window of 50 obs
MA Z 100	Equally Weighted Moving Average. Normal Distribution, Sample Window of 100 obs
MA Z 250	Equally Weighted Moving Average. Normal Distribution, Sample Window of 250 obs
MA Z 500	Equally Weighted Moving Average. Normal Distribution, Sample Window of 500 obs
MA Z 1250	Equally Weighted Moving Average. Normal Distribution, Sample Window of 1250 obs
RM 0.90 50	RiskMetrics, Lamda=0.90, Sample Window of 50 obs
RM 0.90 100	RiskMetrics, Lamda=0.90, Sample Window of 100 obs
RM 0.90 250	RiskMetrics, Lamda=0.90, Sample Window of 250 obs
RM 0.90 500	RiskMetrics, Lamda=0.90, Sample Window of 500 obs
RM 0.90 1250	RiskMetrics, Lamda=0.90, Sample Window of 1250 obs
RM 0.94 50	RiskMetrics, Lamda=0.94, Sample Window of 50 obs
RM 0.94 100	RiskMetrics, Lamda=0.94, Sample Window of 100 obs
RM 0.94 250	RiskMetrics, Lamda=0.94, Sample Window of 250 obs
RM 0.94 500	RiskMetrics, Lamda=0.94, Sample Window of 500 obs
RM 0.94 1250	RiskMetrics, Lamda=0.94, Sample Window of 1250 obs
RM 0.97 50	RiskMetrics, Lamda=0.97, Sample Window of 50 obs
RM 0.97 100	RiskMetrics, Lamda=0.97, Sample Window of 100 obs
RM 0.97 250	RiskMetrics, Lamda=0.97, Sample Window of 250 obs
RM 0.97 500	RiskMetrics, Lamda=0.97, Sample Window of 500 obs
RM 0.97 1250	RiskMetrics, Lamda=0.97, Sample Window of 1250 obs
KS 50	Kernel Estimation, Sample Window of 50 obs
KS 100	Kernel Estimation, Sample Window of 100 obs
KS 250	Kernel Estimation, Sample Window of 250 obs
KS 500	Kernel Estimation, Sample Window of 500 obs

Table 16. Model abbreviations (part 2)

Abbreviation	***Description***
KS 1250	Kernel Estimation, Sample Window of 1250 obs
GK 50	Garman and Klass Extreme Value Approach, Sample Window of 50 obs
GK 100	Garman and Klass Extreme Value Approach, Sample Window of 100 obs
GK 250	Garman and Klass Extreme Value Approach, Sample Window of 250 obs
GK 500	Garman and Klass Extreme Value Approach, Sample Window of 500 obs
GK 1250	Garman and Klass Extreme Value Approach, Sample Window of 1250 obs
RS 50	Rogers and Satchell Extreme Value Approach, Sample Window of 50 obs
RS 100	Rogers and Satchell Extreme Value Approach, Sample Window of 100 obs
RS 250	Rogers and Satchell Extreme Value Approach, Sample Window of 250 obs
RS 500	Rogers and Satchell Extreme Value Approach, Sample Window of 500 obs
RS 1250	Rogers and Satchell Extreme Value Approach, Sample Window of 1250 obs
P 50	Parkinson Extreme Value Approach, Sample Window of 50 obs
P 100	Parkinson Extreme Value Approach, Sample Window of 100 obs
P 250	Parkinson Extreme Value Approach, Sample Window of 250 obs
P 500	Parkinson Extreme Value Approach, Sample Window of 500 obs
P 1250	Parkinson Extreme Value Approach, Sample Window of 1250 obs
YZ 50	Yang and Zhang Extreme Value Approach, Sample Window of 50 obs
YZ 100	Yang and Zhang Extreme Value Approach, Sample Window of 100 obs
YZ 250	Yang and Zhang Extreme Value Approach, Sample Window of 250 obs
YZ 500	Yang and Zhang Extreme Value Approach, Sample Window of 500 obs
YZ 1250	Yang and Zhang Extreme Value Approach, Sample Window of 1250 obs
GARCH	GARCH model, Conditional Normal Distribution, Sample Window of 1250 obs
EGARCH	EGARCH model, Conditional Normal Distribution, Sample Window of 1250 obs
HS 50	Historical Simulation, Sample Window of 50 obs
HS 100	Historical Simulation, Sample Window of 100 obs
HS 250	Historical Simulation, Sample Window of 250 obs
HS 500	Historical Simulation, Sample Window of 500 obs
HS 1250	Historical Simulation, Sample Window of 1250 obs