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Original Articles

Predicting the Daily Covariance Matrix for S&P 100 Stocks Using Intraday Data—But Which Frequency to Use?

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Abstract

This article investigates the merits of high-frequency intraday data when forming mean-variance efficient stock portfolios with daily rebalancing from the individual constituents of the S&P 100 index. We focus on the issue of determining the optimal sampling frequency as judged by the pe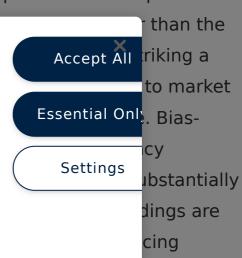rformance of these portfolios. The optimal sampling ⟨frequency⟩ ⟨...⟩er than the popular ⟨...⟩ ⟨...⟩riking a balance ⟨...⟩ to market microstr⟨ucture⟩ ⟨...⟩. Bias-corre⟨cted⟩ ⟨...⟩cy covaria⟨nce⟩ ⟨...⟩ubstantially affect th⟨e⟩ ⟨...⟩dings are also robu⟨st⟩ ⟨...⟩cing frequency.

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ACKNOWLEDGMENTS

Notes

[1] Zhang et al. ([2005](#)) focus solely on estimating the variance but here we apply their approach to covariances as well, as suggested by Zhang ([2005](#)).

[2] We should note that the two time-scales estimator of Zhang et al. ([2005](#)) is derived under the same model assumptions (see Equation ([4](#)) in Zhang et al., [2005](#)). By using it in the same format for covariances we acknowledge that for example the weights for the covariance matrices at two frequencies may be suboptimal and that the estimator may be biased. Of course in our empirical work we can see whether despite these reservations the idea itself is useful for predicting covariances.

[3] http://www.price-data.com/

[4] For obvious reasons the overnight return from 10 to 17 September, 2001 (the first trading day after 9/11) has been dropped.

Notes: T... various sampling ... 5, 1997, through ... ean reflects the a... riance is the average ... he realized covarian... s and over all 1788 ... ple variances of the realized covariances. In Panel A the "standard" realized covariance

matrix V$_{t-1, h}$ given in (1) is used. Panel B is based on the two time-scales estimator given in (2), while Panel C shows results for the lead-lag corrected estimator given in (3), with Bartlett-kernel weights $d_l = 1 - l/(q + 1)$ and $q = 1$.

[5]An exception is the realized variance at the one- and two-minute frequencies, where also the variance increases due to the increased importance of bid-ask bounce.

[6]We experimented with alternative values for q, which led to qualitatively similar findings. Detailed results are available upon request. The issue of determining the optimal value of q is beyond the scope of this article and is left for future research.

[7]As explained below, we require part of the sample period to initialize the conditional covariance matrix estimates, which in our case equals 122 trading days. This implies that the effective sample period available for portfolio construction and evaluation runs from October 8, 1997 until May 27, 2004 (1666 trading days).

[8]Fleming et al. (2003) use a similar approach when assessing the effect of transaction costs.

[9]Note that our approach here differs from Fleming et al. (2003). Our method of holding multiple portfolios simultaneously is commonly applied in the literature on stock selection, see Jegadeesh and Titman (1993) and Rouwenhorst (1998), among many others.
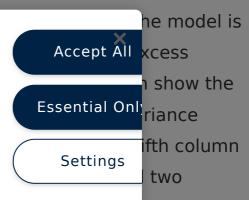
[10]Fleming et al. (2003) show that actually using the (unrestricted) multivariate GARCH model leads to a better fit of the data as expected, but the covariance matrix forecasts result in worse portfolios than those obtained from the rolling covariance estimator. They cite the smoothness of the rolling estimator as the main reason for this.

Notes: The table shows the decay rates (α) that maximize the likelihood of the model in (13) and ____ ____ he model is estimate ____ xcess returns (____ show the optima ____ riance upda ____ ifth column when th ____ two columns ____ contemp ____

Notes: The table shows the out-of-sample performance of the overall minimum variance portfolio, with weights given in (6), and the minimum variance portfolio given a target level of return of 10%, with weights given in (8), constructed using rolling covariance matrix forecasts based on various sampling frequencies and based on different ways of measuring the realized covariance matrix (standard, two time-scales, and 1 lead and 1 lag). For the target return portfolios, we report the mean return (μ_P) and standard deviation (σ_P) in annualized percentage points, the Sharpe ratio (SR), the annualized basis points fee (Δ_γ) an investor with quadratic utility and constant relative risk aversion of γ would pay to switch from the daily returns covariance matrix estimate to the intraday returns of the optimal portfolios, and average daily turnover (TO) in percentage points. For the minimum variance portfolios, we report the standard deviation (α_{MVP}) in annualized percentage points average daily turnover (TO) in percentage points.

[11]We examined the sensitivity of our results to the target return level by varying μ_P between 2% and 18%. These alternative target return levels led to qualitatively similar conclusions as those reported below. Detailed results are therefore not shown here, but are available on request.

Notes: The table shows the out-of-sample performance of the overall minimum tracking error portfolio, with weights given in (6), and the minimum tracking error portfolio given a target level of return of 1%, with weights given in (8), constructed using rolling covariance matrix forecasts based on various sampling frequencies and based on different ways of measuring the realized covariance matrix (standard, two time-scales, and 1 lead and 1 lag). For the target active return portfolios, we report the mean active return (μ_P) and tracking error (TE_P) in annualized percentage points, the information ratio (IR), the annualized basis points fee (Δ_γ) an investor with quadratic utility and constant relative risk aversion of γ would pay to switch from the daily returns covarian   and
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"standard" way of measuring the realized covariance matrix. We report the mean return (μ_P) and standard deviation (α_P) in annualized percentage points, the Sharpe ratio (SR), and the annualized basis points fee (Δ_γ) an investor with quadratic utility and constant relative risk aversion of γ would pay to switch from the daily returns covariance matrix estimate to the intraday returns of the optimal portfolios. The column headed c indicates the level of transaction costs, expressed in annualized percentage points, which correspond with the reduction in the annualized portfolio return if the entire portfolio would have to be traded every day during the whole year. The column headed h indicates the optimal sampling frequency, expressed as the length of the corresponding return interval in minutes.

Notes: The table shows the out-of-sample performance of the minimum tracking error portfolio given a target level of return of 1%, with weights given in (8), constructed using rolling covariance matrix forecasts based on daily returns and on intraday returns at the sampling frequency that maximized the information ratio, based on the 'standard' way of measuring the realized covariance matrix. We report the mean active return (μ_P) and tracking error (TE_P) in annualized percentage points, the information ratio (IR), the annualized basis points fee (Δ_γ) an investor with quadratic utility and constant relative risk aversion of γ would pay to switch from the daily returns covariance matrix estimate to the intraday returns of the optimal portfolios. The column headed c indicates the level of transaction costs, expressed in annualized percentage points, which correspond with the reduction in the annualized portfolio return if the entire portfolio would have to be traded every day during the whole year. The column headed h indicates the optimal sampling frequency, expressed as the length of the corresponding return interval in minutes.

Notes: The table shows the out-of-sample performance of the overall minimum volatility (tracking error) portfolio, with weights given in (6), and the minimum variance portfolio given an [...] s given in (8), cons[...] sampling frequenc[...] A shows result[...] S&P 500 retur[...] olio perform[...] olumns 2 and 3, a[...] estimates of α_h. C[...] (panel A) or the information ratio and tracking error (panel (B) for the resulting portfolios. Columns 5

and 9, headed 'LogL', show the SR/IR and σ_P/TE$_P$ for portfolios constructed with decay parameters for the conditional covariance matrix that are estimated by maximizing the log-likelihood over the complete out-of-sample period.

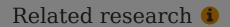Related research ⓘ

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