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**How does the choice of Value-at-Risk estimator influence asset allocation decisions?** (English)

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Summary: Considering the growing need for managing financial risk, Value-at-Risk (VaR) prediction and portfolio optimisation with a focus on VaR have taken up an important role in banking and finance. Motivated by recent results showing that the choice of VaR estimator does not crucially influence decision-making in certain practical applications (e.g. in investment rankings), this study analyses the important question of how asset allocation decisions are affected when alternative VaR estimation methodologies are used. Focusing on the most popular, successful and conceptually different conditional VaR estimation techniques (i.e. historical simulation, peak over threshold method and quantile regression) and the flexible portfolio model of *R. Campbell* et al. ["Optimal portfolio selesction in a Value-at-Risk framework", J. Banking Finance. 25, No. 9, 1789–1804 (2001; doi:10.1016/S0378-4266(00)00160-6)], we show in an empirical example and in a simulation study that these methods tend to deliver similar asset weights. In other words, optimal portfolio allocations appear to be not very sensitive to the choice of VaR estimator. This finding, which is robust in a variety of distributional environments and pre-whitening settings, supports the notion that, depending on the specific application, simple standard methods (i.e. historical simulation) used by many commercial banks do not necessarily have to be replaced by more complex approaches (based on, e.g. extreme value theory).

**MSC:**

91G10 Portfolio theory
91G70 Statistical methods; risk measures

**Keywords:**

Value-at-Risk; portfolio optimisation; shortfall constraints; simulation

**Software:**

CAViaR; Dowd

**Full Text:** DOI

**References:**

[1] Abad, P., Benito, S. and López, C., A comprehensive review of value at risk methodologies. \textit{Spanisch Rev. Financ. Econ.}, 2014, 12(1), 15-32.

[2] Alexander, C., \textit{Market Risk Analysis}. \textit{Value-at-Risk Models}. Vol. IV, 2008 (John Wiley & Sons: Chichester).

[3] Alexander, G. and Baptista, A., Portfolio performance evaluation using the value at risk. \textit{J. Portfolio Manage.}, 2003, 29(4), 93-102.

[4] Allen, D., Singh, A. and Powell, R., EVT and tail-risk modelling: Evidence from market indices and volatilities. \textit{North Am. J. Econ. Finance}, 2013, 26, 355-369.

[5] Aloui, C. and Mabrouk, S., Value-at-risk estimations of energy commodities via long-memory, asymmetry and fat-tailed GARCH models. \textit{Energy Policy}, 2010, 38(5), 2326-2339.

[6] Andersen, T., Bollerslev, T., Diebold, F. and Vega, C., Real-time price discovery in global stock, bond and foreign exchange markets. \textit{J. Int. Econ.}, 2007, 73(2), 251-277.

[7] Ang, A. and Chen, J., Asymmetric correlations of equity portfolios. \textit{J. Financ. Econ.}, 2002, 63(3), 443-494.

[8] Angelidis, T., Benos, A. and Degiannakis, S., The use of GARCH models in VaR estimation. \textit{Stat. Method.}, 2004, 1(1-2), 105-128. · Zbl 1072.62103

[9] Artzner, P., Delbaen, F., Eber, J. and Heath, D., Coherent measures of risk. \textit{Math. Finance}, 1999, 9(3), 203-228. · Zbl 0980.91042

[10] Arzac, R. and Bawa, S., Portfolio choice and equilibrium in capital markets with safety-first investors. \textit{J. Financ. Econ.}, 1977, 4(3), 277-288.

[11] Auer, B., Does the choice of performance measure influence the evaluation of commodity investments?\textit{Int. Rev. Financ. Anal.}, 2015a, 38, 142-150.

[12] Auer, B., Extreme value theory, asset ranking and threshold choice: A practical note on VaR estimation. \textit{J. Risk}, 2015b, 18(1), 27-44.

[13] Bali, T., Mo, H. and Tang, Y., The role of autoregressive conditional skewness and kurtosis in the estimation of conditional VaR. \textit{J. Banking Finance}, 2008, 32(2), 269-282.

[14] Bali, T. and Theodossiou, P., A conditional-SGT-VaR-approach with alternative GARCH models. \textit{Ann. Oper. Res.}, 2007, 151(1), 241-267. · Zbl 1132.91455

[15] Bao, Y., Lee, T. and Saltoğlu, B., Evaluating predictive performance of value-at-risk models in emerging markets: A reality check. \textit{J. Forecasting}, 2006, 25(2), 101-128.

[16] Bao, Y., Lee, T. and Saltoğlu, B., Comparing density forecast models. \textit{J. Forecasting}, 2007, 26(3), 203-225.

[17] Barone-Adesi, G., Bourgion, F. and Giannopoulos, K., Don't look back. \textit{Risk}, 1998, 11(8), 100-103.

[18] Basel Committee , \textit{Overview of the Amendment of the Capital Accord to Incorporate Market Risk}, 1996 (Basel Committee on Banking Supervision: Basel).

[19] Baur, D. and Lucey, B., Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. \textit{Financ. Rev.}, 2010, 45(2), 217-229.

[20] Bauwens, L. and Laurent, S., A new class of multivariate skew densities, with application to generalized autoregressive heteroskedasticity models. \textit{J. Bus. Econ. Stat.}, 2005, 23(3), 346-354.

[21] Bauwens, L., Laurent, S. and Rombouts, J., Multivariate GARCH models: A survey. \textit{J. Appl. Econometrics}, 2006, 21(1), 79-109.

[22] Berkowitz, J., Christoffersen, P. and Pelletier, D., Evaluating value-at-risk models with desk-level data. \textit{Manage. Sci.}, 2011, 57(12), 2213-2227.

[23] Berkowitz, J. and O'Brien, J., How accurate are value-at-risk models at commercial banks?\textit{J. Finance}, 2002, 257(3), 1093-1111.

[24] Bertsimas, D., Lauprete, G. and Samarov, A., Shortfall as a risk measure: properties, optimization and applications. \textit{J. Econ. Dyn. Control}, 2004, 28(7), 1353-1381. · Zbl 1200.91133

[25] Bianchi, R., Drew, M. and Fan, J., Combining momentum with reversal in commodity futures. \textit{J. Banking Finance}, 2015, 59, 423-444.

[26] Billio, M. and Pelizzon, L., Value-at-risk: A multivariate switching regime approach. \textit{J. Empirical Finance}, 2000, 7(5), 531-554.

[27] Block, A., Righi, M., Schlender, S. and Coronel, D., Investigating dynamic conditional correlation between crude oil and fuels in non-linear framework: The financial and economic role of structural breaks. \textit{Energy Econ.}, 2015, 49, 23-32.

[28] Bollerslev, T., Generalized autoregressive conditional heteroskedasticity. \textit{J. Econometrics}, 1986, 31(3), 307-327. · Zbl 0616.62119

[29] Bollerslev, T., Modelling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH model. \textit{Rev. Econ. Stat.}, 1990, 72(3), 498-505.

[30] Bollerslev, T., Chou, R. and Kroner, K., ARCH-modeling in finance: A review of the theory and empirical evidence. \textit{J. Econometrics}, 1992, 52(1-2), 5-59. · Zbl 0825.90057

[31] Boudoukh, J., Richardson, M. and Whitelaw, R., The best of both worlds: A hybrid approach to calculating value at risk. \textit{Risk}, 1998, 11(5), 64-67.

[32] Brooks, C., Clare, A., Dalle Molle, J. and Persand, G., A comparison of extreme value theory approaches for determining value at risk. \textit{J. Empirical Finance}, 2005, 12(2), 339-352.

[33] Campbell, R., Huisman, R. and Koedijk, K., Optimal portfolio selection in a value-at-risk framework. \textit{J. Banking Finance}, 2001, 25(9), 1789-1804.

[34] Cappiello, L., Engle, R. and Sheppard, K., Asymmetric dynamics in the correlations of global equity and bond returns. \textit{J. Financ. Econometrics J.}, 2006, 4(4), 537-572.

[35] Chen, C., A finite smoothing algorithm for quantile regression. \textit{J. Comput. Graphical Stat.}, 2007, 16(1), 136-164.

[36] Chen, C. and Wei, Y., Computational issues for quantile regression. \textit{Indian J. Stat.}, 2005, 67(2), 399-417. · Zbl 1192.62114

[37] Chen, J., Measuring market risk under the Basel accords: VaR, stressed VaR, and expected shortfall. \textit{Aestimatio: IEB Int. J. Finance}, 2014, 8, 184-201.

[38] Chen, Q. and Gerlach, R., The two-sided Weibull distribution and forecasting financial tail risk. \textit{Int. J. Forecasting}, 2013, 29(4), 527-540.

[39] Chordia, T., Subrahmanyam, A. and Tong, Q., Have capital market anomalies attenuated in the recent era of high liquidity and trading activitiy?\textit{J. Accounting Econ.}, 2014, 58(1), 41-58.

[40] Chou, H. and Wang, D., Estimation of tail-related value-at-risk measures: Range-based extreme value approach. \textit{Quant. Finance}, 2014, 14(2), 293-304. · Zbl 1294.91192

[41] Choudhry, M., \textit{An Introduction to Value-at-Risk}, 5th ed., 2013 (John Wiley & Sons: Chichester).

[42] Christodoulakis, G. and Satchell, S., Correlated ARCH: Modelling the time-varying conditional correlation between financial asset returns. \textit{Eur. J. Oper. Res.}, 2002, 139(2), 351-370. · Zbl 1159.91461

[43] Christoffersen, P., \textit{Elements of Financial Risk Management}, 2003 (Academic Press: Waltham). · Zbl 1235.91001

[44] Consigli, G., Tail estimation and mean-VaR portfolio selection in markets subject to financial instability. \textit{J. Banking Finance}, 2002, 26(7), 1355-1382.

[45] Cont, R., Empirical properties of asset returns: Stylized facts and statistical issues. \textit{Quant. Finance}, 2001, 1(2), 223-236. · Zbl 1408.62174

[46] Cont, R., Deguest, R. and Scandolo, G., Robustness and sensitivity analysis of risk measurement procedures. \textit{Quant. Finance}, 2010, 10(6), 593-606. · Zbl 1192.91191

[47] Danielsson, J. and Morimoto, Y., Forecasting extreme financial risk: A critical analysis of practical methods for the Japanese market. \textit{Monetary Econ. Stud.}, 2000, 18(2), 25-48.

[48] Dowd, K., Backtesting market risk models. In \textit{Measuring Market Risk}, 2nd ed., pp. 321-350., 2005 (John Wiley & Sons: Chichester).

[49] Duffie, D. and Pan, J., An overview of value at risk. \textit{J. Derivatives}, 1997, 4(3), 7-49.

[50] Égert, B. and Kočenda, E., Time-varying synchronization of European stock markets. \textit{Empirical Econ.}, 2011, 40(2), 393-407.

[51] Eling, M., Does the measure matter in the mutual fund industry?\textit{Financ. Anal. J.}, 2008, 64(3), 54-66.

[52] Eling, M. and Schuhmacher, F., Does the choice of performance measure influence the evaluation of hedge funds?\textit{J. Banking Finance}, 2007, 31(9), 2632-2647.

[53] Elton, E., Gruber, M., Brown, S. and Goetzmann, W., \textit{Modern Portfolio Theory and Investment Analysis}, 2007 (John Wiley & Sons: Chichester).

[54] Embrechts, P., Küppelberg, C. and Mikosch, T., \textit{Modelling Extremal Events}, 1997 (Springer: Heidelberg).

[55] Engle, R., Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. \textit{J. Bus. Econ. Stat.}, 2002, 20(3), 339-350.

[56] Engle, R. and Manganelli, S., CAViaR: Conditional autoregressive value at risk by regression quantiles. \textit{J. Bus. Econ. Stat.}, 2004, 22(4), 367-381.

[57] Engle, R. and Sheppard, K., Theoretical and empirical properties of dynamic conditional correlation multivariate GARCH, NBER Working Paper No. 8554, Cambridge, 2001.

[58] Ergen, I., Two-step methods in VaR prediction and the importance of fat tails. \textit{Quant. Finance}, 2015, 15(6), 1013-1030. · Zbl 1398.91683

[59] Gençay, R. and Selçuk, F., Extreme value theory and value-at-risk: Relative performance in emerging markets. \textit{Int. J. Forecasting}, 2004, 20(2), 287-303.

[60] Gerlach, R. and Wang, C., Forecasting risk via realized GARCH, incorporating the realized range. \textit{Quant. Finance}, 2016, 16(4), 501-511.

[61] Gilli, M. and Këllezi, E., An application of extreme value theory for measuring financial risk. \textit{Comput. Econ.}, 2006, 27(2-3), 207-228. · Zbl 1153.91498

[62] Giot, P. and Laurent, S., Modelling daily value-at-risk using realized volatility and ARCH type models. \textit{J. Empirical Finance}, 2004, 11(3), 379-398.

[63] Girardi, G. and Ergün, A., Systemic risk measurement: Multivariate GARCH estimation of CoVaR. \textit{J. Banking Finance}, 2013, 37(8), 3169-3180.

[64] Gjika, D. and Horváth, R., Stock market comovements in central Europe: Evidence from the asymmetric DCC model. \textit{Econ. Model.}, 2013, 33, 55-64.

[65] Glasserman, P., Heidelberger, P. and Shahabuddin, P., Variance reduction techniques for estimating value-at-risk. \textit{Manage. Sci.}, 2000, 46(10), 1349-1364. · Zbl 1232.91348

[66] Greene, W., \textit{Econometric Analysis}, 6th ed., 2008 (Prentice Hall: Upper Saddle River, NJ).

[67] Haas, M., Mittnik, S. and Paolella, M., A new approach to Markov switching GARCH models. \textit{J. Financ. Econometrics}, 2004a, 2(4), 493-530.

[68] Haas, M., Mittnik, S. and Paolella, M., Mixed normal conditional heteroskedasticity. \textit{J. Financ. Econometrics}, 2004b, 2(4), 211-250.

[69] Hammoudeh, S., Yuan, Y., McAleer, M. and Thompson, M., Precious metals-exchange rate volatility transmissions and hedging strategies. \textit{Int. Rev. Econ. Finance}, 2010, 19(4), 633-647.

[70] Hansen, B., Autoregressive conditional density estimation. \textit{Int. Econ. Rev.}, 1994, 35(3), 705-730. · Zbl 0807.62090

[71] Hansen, P., Huang, Z. and Shek, H., Realized GARCH: A joint model for returns and realized measures of volatility. \textit{J. Appl. Econometrics}, 2012, 27(3), 877-906.

[72] Hansen, P. and Lunde, A., A forecast comparison of volatility Models: Does anything beat a GARCH(1,1)?\textit{J. Appl. Econometrics}, 2005, 20(7), 873-889.

[73] Harvey, C. and Siddique, A., Conditional skewness in asset pricing tests. \textit{J. Finance}, 2000, 55(3), 1263-1295.

[74] Ho, L., Cadle, J. and Theobald, M., Portfolio selection in an expected shortfall framework during the recent 'credit crunch' period. \textit{J. Asset Manage.}, 2008, 9(2), 121-137.

[75] Hsu, C., Huang, C. and Chiou, W., Effectiveness of copula-extreme value theory in estimating value-at-risk: Empirical evidence from Asian emerging markets. \textit{Rev. Quant. Finance Accounting}, 2012, 39(4), 447-468.

[76] Hwang, S. and Valls Pereira, P., Small sample properties of GARCH estimates and persistence. \textit{Eur. J. Finance},

2006, 12(6-7), 473-494.

[77] Ibbotson, R. and Sinquefield, R., Stocks, bonds, bills, and inflation: Simulation of the future (1976-2000). \textit{J. Bus.}, 1976, 49(3), 313-338.

[78] Ilmanen, A., Stock-bond correlations. \textit{J. Fixed Income}, 2003, 13(2), 55-66.

[79] Jansen, D., Koedijk, K. and de Vries, K., Portfolio selection with limited downside risk. \textit{J. Empirical Finance}, 2000, 7(3-4), 247-269.

[80] Jondeau, E. and Rockinger, M., Conditional volatility, skewness, and kurtosis: Existence, persistence, and comovements. \textit{J. Econ. Dyn. Control}, 2003, 27(10), 1699-1737. · Zbl 1178.91226

[81] Jones, P. and Olson, E., The time-varying correlation between uncertainty, output, and inflation: Evidence form a DCC-GARCH model. \textit{Econ. Lett.}, 2013, 118(1), 33-37.

[82] Jorion, P., Risk\^{}\{2\}: Measuring the risk in value at risk. \textit{Financ. Anal. J.}, 1996, 52(6), 47-56.

[83] Jorion, P., \textit{Value at Risk: The New Benchmark for Managing Financial Risk}, 3rd ed., 2007 (Mc-Graw-Hill: New York).

[84] Joy, M., Gold and the US-dollar: Hedge or haven?\textit{Finance Res. Lett.}, 2011, 8(3), 120-131.

[85] Kahneman, D., Knetsch, J. and Thaler, R., Experimental tests of the endowment effect and the Coase theorem. \textit{J. Political Economy}, 1990, 98(6), 1325-1350.

[86] Kalin, D. and Zagst, R., Portfolio optimization: Volatility constraints vs. shortfall constraints. \textit{OR-Spektrum}, 1999, 21(1-2), 97-122. · Zbl 0916.90020

[87] Keim, D. and Stambaugh, R., Predicting returns in the stock and bond markets. \textit{J. Financ. Econ.}, 1986, 17(2), 357-390.

[88] Kinateder, H., Basel II vs. III - A comparative assessment of minimum capital requirements for internal model approaches. \textit{J Risk}, 2016, 18(3), 25-45.

[89] Klein, T. and Walther, T., Oil price volatility forecast with mixture memory GARCH. \textit{Energy Econ.}, 2016, 58, 46-58.

[90] Koenker, R. and Bassett, G., Regression quantiles. \textit{Econometrica}, Jan. 1978, 46(1), 33-50. · Zbl 0373.62038

[91] Koenker, R. and Hallock, K., Quantile regression. \textit{J. Econo. Perspectives}, 2001, 15(4), 143-156.

[92] Koenker, R. and Park, B., An interior point algorithm for nonlinear quantile regression. \textit{J. Econometrics}, 1996, 71(1-2), 265-283. · Zbl 0855.62030

[93] Krokhmal, P., Uryasev, S. and Palmquist, J., Portfolio optimization with conditional value-at-risk objective and constraints. \textit{J. Risk}, 2001, 4(2), 43-68.

[94] Kuester, K., Mittnik, S. and Paolella, M., Value-at-risk prediction: A comparison of alternative strategies. \textit{J. Financ. Econometrics}, 2006, 4(1), 53-89.

[95] Laubsch, A., \textit{Risk Management: A Practical Guide}, 1999 (Risk Metrics Group: New York).

[96] Ledoit, O., Santa-Clara, P. and Wolf, M., Flexible multivariate GARCH modeling with an application to international stock markets. \textit{Rev. Econ. Stat.}, 2003, 85(3), 735-747.

[97] Lee, J., The comovement between output and prices: Evidence from a dynamic conditional correlation GARCH model. \textit{Econ. Lett.}, 2006, 91(1), 110-116.

[98] Leibowitz, M. and Kogelman, S., Asset allocation under shortfall constraints. \textit{J. Portfolio Manage.}, 1991, 17(2), 18-23.

[99] Li, M. and Yang, L., Modeling the volatility of futures return in rubber and oil - A copula-based GARCH model approach. \textit{Econ. Model.}, 2013, 35, 576-581.

[100] Ling, D. and Naranjo, A., Commercial real estate return performance: A cross-country analysis. \textit{J. Real Estate Finance Econ.}, 2002, 24(1), 119-142.

[101] Linsmeier, T. and Pearson, N., Value at risk. \textit{Financ. Anal. J.}, 2000, 56(2), 47-67.

[102] Lucas, A. and Klaassen, P., Extreme returns, downside risk, and optimal asset allocation. \textit{J. Portfolio Manage.}, 1998, 25(1), 71-79.

[103] Lucey, B. and Li, S., What precious metals act as safe havens, and when? Some US evidence. \textit{Appl. Econ. Lett.}, 2015, 22(1), 35-45.

[104] Lucey, B., Poti, V. and Tully, E., International portfolio formation, skewness and the role of gold. \textit{Front. Finance Econ.}, 2006, 3(1), 49-68.

[105] Lucey, B. and Voronkova, S., Russian equity market linkages before and after the 1998 crisis: Evidence from stochastic and regime-switching cointegration tests. \textit{J. In. Money Finance}, 2008, 27(8), 1303-1324.

[106] MacKenzie, D., \textit{An Engine, Not a Camera: How Financial Models Shape Markets}, 2006 (MIT Press: Cambridge).

[107] Marimoutou, V., Raggad, B. and Trabelsi, A., Extreme value theory and value at risk: Application to oil market. \textit{Energy Econ.}, 2009, 31(4), 519-530.

[108] Martins-Filho, C. and Yao, F., Estimation of value-at-risk and expected shortfall based on nonlinear models of return dynamics and extreme value theory. \textit{Stud. Nonlinear Dyn. Econometrics}, 2006, 10(2), 1-41. Article 4. · Zbl 1225.62141

[109] McNeil, A., Extreme value theory for risk managers. In \textit{Internal Modeling and CAD II}, pp. 93-118, 1999 (Risk Books: London).

[110] McNeil, A. and Frey, R., Estimation of tail-related risk measures for heteroscedastic financial time series: An extreme value approach. \textit{J. Empirical Finance}, 2000, 7(3-4), 271-300.

[111] Meyer, J., Two-moment decision models and expected utility maximization. \textit{Am. Econ. Rev.}, 1987, 77(3), 421-430.

[112] Meyer, J. and Rasche, R., Sufficient conditions for expected utility to imply mean-standard deviation rankings: Empirical evidence concerning the location and scale condition. \textit{Econ. J.}, 1992, 102(410), 91-106.

[113] Michaud, R. and Michaud, R., Estimation error and portfolio optimization: A resampling solution. \textit{J. Investment Manage.}, 2008, 6(1), 8-28.

[114] Mögel, B. and Auer, B., How accurate are modern value-at-risk estimators derived from extreme value theory?\textit{Rev. Quant. Finance Accounting}, 2018, 50(4), 979-1030.

[115] Nadarajah, S., Zhang, B. and Chan, S., Estimation methods for expected shortfall. \textit{Quant. Finance}, 2014, 14(2), 271-291. · Zbl 1294.91196

[116] Nakatani, T. and Teräsvirta, T., Testing for volatility interactions in the constant conditional correlation GARCH model. \textit{Econometrics J.}, 2009, 12(1), 147-163. · Zbl 1190.62160

[117] Ornelas, J., Silva Júnior, A. and Fernandes, J., Yes, the choice of performance measure does matter for ranking of US mutual funds. \textit{Int. J. Finance Econ.}, 2012, 17(1), 61-72.

[118] Peiró, A., Skewness in financial returns. \textit{J. Banking Finance}, 1999, 23(6), 847-862.

[119] Pérignon, C. and Smith, D., The level and quality of value-at-risk disclosure by commercial banks. \textit{J. Banking Finance}, 2010, 34(2), 362-377.

[120] Prakash, A., Chang, C. and Pactwa, T., Selecting a portfolio with skewness: Recent evidence from US, European, and Latin American equity markets. \textit{J. Banking Finance}, 2003, 27(7), 1375-1390.

[121] Pritsker, M., The hidden dangers of historical simulation. \textit{J. Banking Finance}, 2006, 30(2), 561-582.

[122] Roy, A., Safety-first and the holding of assets. \textit{Econometrica}, 1952, 20(3), 431-449. · Zbl 0047.38805

[123] Scarrott, C. and MacDonald, A., A review of extreme value threshold estimation and uncertainty quantification. \textit{REVSTAT - Stat. J.}, 2012, 10(1), 33-60. · Zbl 1297.62120

[124] Schuhmacher, F. and Auer, B., Sufficient conditions under which SSD- and MR-efficient sets are identical. \textit{Eur. J. Oper. Res.}, 2014, 239(3), 756-763. · Zbl 1339.91053

[125] Schuhmacher, F. and Eling, M., Sufficient conditions for expected utility to imply drawdown-based performance rankings. \textit{J. Banking Finance}, 2011, 35(9), 2311-2318.

[126] Schuhmacher, F. and Eling, M., A decision-theoretic foundation for reward-to-risk performance measures. \textit{J. Banking Finance}, 2012, 36(7), 2077-2082.

[127] Sharpe, W., The Sharpe ratio. \textit{J. Portfolio. Manage.}, 1994, 21(1), 49-58.

[128] Silvennoinen, A. and Teräsvirta, T., Modeling multivariate autoregressive conditional heteroskedasticity with the double smooth transition conditional correlation GARCH model. \textit{J. Financ. Econometrics}, 2009, 7(4), 373-411.

[129] Su, J., How to mitigate the impact of inappropriate distributional settings when parametric value-at-risk approach is used. \textit{Quant. Finance}, 2014, 14(2), 305-325. · Zbl 1294.91198

[130] Tobin, J., Liquidity preference as behavior towards risk. \textit{Rev. Econ. Stud.}, 1958, 25(2), 65-86.

[131] Tse, Y. and Tsui, A., A multivariate GARCH model with time-varying correlations. \textit{J. Bus. Econ. Stat.}, 2002, 20(3), 351-362.

[132] Tularam, G. and Saeed, T., Oil-price forecasting based on various univariate time-series models. \textit{Am. J. Oper. Res.}, 2016, 6(3), 226-235.

[133] Watanabe, T., Quantile forecasts of financial returns using realized GARCH models. \textit{Japanese Econ. Rev.}, 2012, 63(1), 68-80.

[134] Wu, P. and Shieh, S., Value-at-risk analysis for long-term interest rate futures: Fat-tail and long memory in return innovations. \textit{J. Empirical Finance}, 2007, 14(2), 248-259.

[135] Yamai, Y. and Yoshiba, T., Value-at-risk vs. expected shortfall: A practical perspective. \textit{J. Banking Finance}, 2005, 29(4), 997-1015.

[136] Yang, L. and Hamori, S., Gold prices and exchange rates: A time-varying copula analysis. \textit{Appl. Financ. Econ.}, 2014, 24(1), 41-50.

[137] Yao, H., Li, Z. and Lai, Y., Mean-CVaR portfolio selection: A nonparametric estimation framework. \textit{Comput. Oper. Res.}, 2013, 40(4), 1014-1022. · Zbl 1349.91323

[138] Zakamouline, V., The performance measure you choose influences the evaluation of hedge funds. \textit{J. Performance Measurement}, 2011, 15(3), 48-64.