Stocks

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | DCC-GARCH | | DCC-RGARCH | |
|  | Estimate | Std. error | Estimate | Std. error |
| γ10 | 0.000446 | 0.000379 | 0.000266 | 0.00039 |
| α10 | 9.25E-06 | 4.50E-06 | 7.81E-06 | 6.17E-06 |
| α11 | 0.13339 | 0.049256 | 0.319632 | 0.151019 |
| β11 | 0.832364 | 0.05893 | 0.71037 | 0.133175 |
| γ20 | 0.00088 | 0.00057 | 0.000641 | 0.000594 |
| α20 | 1.46E-05 | 5.34E-06 | 8.86E-06 | 7.32E-06 |
| α21 | 0.088606 | 0.022633 | 0.189927 | 0.062819 |
| β21 | 0.884946 | 0.023231 | 0.842658 | 0.04988 |
| γ30 | 0.00127 | 0.000447 | 0.00128 | 0.000449 |
| α30 | 2.05E-05 | 7.05E-06 | 1.72E-05 | 1.17E-05 |
| α31 | 0.079757 | 0.024802 | 0.299712 | 0.107963 |
| β31 | 0.853045 | 0.036287 | 0.7143 | 0.106576 |
| γ40 | 0.000991 | 0.000523 | 0.000841 | 0.00053 |
| α40 | 2.85E-05 | 1.29E-05 | 2.59E-05 | 1.17E-05 |
| α41 | 0.091531 | 0.031748 | 0.185476 | 0.062023 |
| β41 | 0.829901 | 0.057136 | 0.783371 | 0.066194 |
| γ50 | 0.00098 | 0.000432 | 0.000988 | 0.000433 |
| α50 | 1.42E-05 | 6.11E-06 | 5.84E-06 | 5.93E-06 |
| α51 | 0.076903 | 0.027642 | 0.170722 | 0.053914 |
| β51 | 0.877181 | 0.037421 | 0.841351 | 0.044568 |
| ζ1 | 0.014933 | 0.003295 | 0.016008 | 0.003564 |
| θ1 | 0.959962 | 0.010097 | 0.95579 | 0.011296 |

Currency Pairs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | DCC-GARCH | | DCC-RGARCH | |
|  | Estimate | Std. error | Estimate | Std. error |
| γ10 | 1.91E-05 | - | 2.09E-05 | 0.000134 |
| α10 | 2.34E-06 | - | 2.39E-06 | 2.18E-06 |
| α11 | 0.05 | - | 0.127024 | 0.07086 |
| β11 | 0.8 | - | 0.785997 | 0.143041 |
| γ20 | 0.000258 | 0.000133 | 0.000151 | 0.000162 |
| α20 | -9.34E-07 | 6.21E-07 | 9.65E-07 | 5.29E-07 |
| α21 | 0.939289 | 0.049367 | 0.088526 | 0.024374 |
| β21 | 0.053873 | 0.029199 | 0.888083 | 0.031312 |
| γ30 | 0.000165 | 0.000104 | 4.48E-05 | 0.000115 |
| α30 | 1.63E-06 | 9.34E-07 | 3.83E-07 | 1.88E-07 |
| α31 | 0.839876 | 0.073746 | 0.093789 | 0.019622 |
| β31 | 0.015425 | 0.076719 | 0.889839 | 0.022511 |
| ζ1 | 0.01632 | 0.006084 | 0.021476 | 0.006594 |
| θ1 | 0.966576 | 0.015665 | 0.96732 | 0.012673 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Assets | Mean x 10^2 | Minimum | Maximum | Standard Deviation | Skewness | Kurtosis |
| Currency Rates |  |  |  |  |  |  |
| EUR/INR | 0.0145 | -0.0250 | 0.0281 | 0.0052 | 0.2359 | 5.7742 |
| USD/INR | 0.0179 | -0.0432 | 0.0272 | 0.0064 | -0.3165 | 7.4323 |
| GBP/INR | 0.0159 | -0.0187 | 0.0294 | 0.0047 | 0.4297 | 6.4103 |
| MidCap |  |  |  |  |  |  |
| Vinergy Capital Inc | 0.1430 | -0.1313 | 0.1733 | 0.0246 | 0.5355 | 9.0398 |
| Tanla Platforms Ltd | 0.3614 | -0.1047 | 0.1360 | 0.0332 | 0.1724 | 2.8126 |
| L&T Ltd | -0.0790 | -0.2042 | 0.1267 | 0.0297 | -0.6504 | 8.5976 |
| Stocks |  |  |  |  |  |  |
| Infosys | 0.1241 | -0.1766 | 0.1136 | 0.0187 | -0.8124 | 16.2500 |
| TCS | 0.0999 | -0.0988 | 0.0939 | 0.0171 | -0.1193 | 7.1720 |
| HDFC Bank | 0.0566 | -0.1348 | 0.1097 | 0.0173 | -0.3790 | 13.1487 |
| ICICI Bank | 0.1006 | -0.1966 | 0.1289 | 0.0240 | -0.4436 | 11.2123 |
| Reliance | 0.1096 | -0.1410 | 0.1373 | 0.0207 | 0.0343 | 11.8606 |

Results

We consider three DCC models in the analysis:

(1) The DCC-GARCH model by Engle (2002) summarized by Eqs. (1)–(6), where parameters are estimated based only on closing

prices.

(2) The proposed DCC-RGARCH model summarized by Eqs. (26)–(29). In this specification the RGARCH model described by

Eqs. (23)–(24) is applied in the DCC model instead of the univariate GARCH model.

The considered exchange rates, ETFs and stocks are not cointegrated (according to the Johansen test). Mean equations for returns

are very simple: each mean equation is a constant, because in our data the sample return of any asset is not dependent on its own

past returns nor on the past returns of other assets.

We first compare the fit of the models estimated on the whole sample of data, and then compare the forecasts from these

models. We analyse forecasts of variances and forecasts of covariances separately, because models for variances already exist whereas

forecasting covariances is our main contribution.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Assets | Mean x 10^2 | Minimum | Maximum | Standard Deviation | Skewness | Excess Kurtosis |
| Currency Rates |  |  |  |  |  |  |
| EUR/INR | 0.0145 | -0.0250 | 0.0281 | 0.0052 | 0.236\* | 2.774 |
| USD/INR | 0.0179 | -0.0432 | 0.0272 | 0.0064 | -0.316\* | 4.432\* |
| GBP/INR | 0.0159 | -0.0187 | 0.0294 | 0.0047 | 0.430\* | 3.410\* |
| MidCap |  |  |  |  |  |  |
| Vinergy Capital Inc | 0.1430 | -0.1313 | 0.1733 | 0.0246 | 0.535\* | 6.040\* |
| Tanla Platforms Ltd | 0.3614 | -0.1047 | 0.1360 | 0.0332 | 0.172\* | -0.188 |
| L&T Ltd | -0.0790 | -0.2042 | 0.1267 | 0.0297 | -0.650\* | 5.598\* |
| Stocks |  |  |  |  |  |  |
| Infosys | 0.1241 | -0.1766 | 0.1136 | 0.0187 | -0.812\* | 13.250\* |
| TCS | 0.0999 | -0.0988 | 0.0939 | 0.0171 | -0.119\* | 4.172\* |
| HDFC Bank | 0.0566 | -0.1348 | 0.1097 | 0.0173 | -0.379\* | 10.149\* |
| ICICI Bank | 0.1006 | -0.1966 | 0.1289 | 0.0240 | -0.443\* | 8.212\* |
| Reliance | 0.1096 | -0.1410 | 0.1373 | 0.0207 | 0.034 | 8.861\* |

\*Indicates that the null hypothesis (the skewness or excess kurtosis is equal to zero) was rejected at the 10% significance level.