Predicting Large Covariance Matrices Using a Characteristic-based Conditionally Heteroskedastic Factor Model

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Abstract

We are interested in predicting the covariance matrix of excess returns, y_{it} with $i = 1, \ldots, n$ and $t = 1, \ldots, T$, of a large number of financial assets ($n >> T$). To this end, we extend the characteristic-based factor model of Connor, Hagmann and Linton [Econometrica, 2012] by introducing conditionally heteroskedastic factors. The model is given by:

$$y_{it} = f_{ut} + \sum_{j=1}^{J} g_j(X_{ji}) f_{jt} + \epsilon_{it} \tag{1}$$

where f_{ut} denotes the return of a factor that is relevant to all assets and has unit factor loadings. The factor returns $f_{jt},\ j = 1, \ldots, J$, instead, are related to J asset characteristics via the characteristic-based betas $g_j(X_{ji})$, where X_{ji} denotes the time-invariant and continuously distributed characteristic j of asset i. The function g is a smooth and time-invariant function of the jth characteristic. The asset-specific returns, ϵ_{it}, are assumed to have zero mean and to be cross-sectionally and temporally uncorrelated. We incorporate conditional heteroskedasticity into this model by assuming that the factors follow a multivariate GARCH process. We provide some asymptotic results and present an empirical application of the model using data on US securities.