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Correlation dynamics and international diversification benefits

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ABSTRACT

Forecasting the evolution of security co-movements is critical for asset pricing and portfolio allocation. Hence, we investigate patterns and trends in correlations over time using weekly returns for developed markets (DMs) and emerging markets (EMs) over the period 1973–2012. We show that it is possible to model co-movements for many countries simultaneously using BEKK, DCC, and DECO models. Empirically, we find that correlations have trended upward significantly for both DMs and EMs. Based on a time-varying measure of diversification benefits, we find that it is not possible to circumvent the increasing correlations in a long-only portfolio by adjusting the portfolio weights over time. However, we do find some evidence that adding EMs to a DM-only portfolio increases diversification benefits.

1. Introduction

Forecasting the dynamics of co-movements in international equity returns is of paramount importance for international finance. The traditional case for the benefits of international diversification has relied largely on the existence of low and stable cross-country correlations. Initially, the literature studied developed markets (DMs), but over the last few decades much of the focus has shifted to the diversification benefits offered by emerging markets (EMs).

Have cross-country correlations remained low and stable over time? It is far from straightforward to address this ostensibly simple question without making additional assumptions. Computing rolling correlations has well-known drawbacks. Multivariate GARCH models, as per Longin and Solnik (1995), for example, seem to provide a solution. However, as discussed by Solnik and Roulet (2000), the implementation of these models using large numbers of countries is subject to well-known dimensionality problems. As a result, most of the available evidence on the time-variation in cross-country correlations is based on factor models. For example, Bekaert, Hodrick, and Zhang (2009) investigated international stock return co-movements for 23 DMs during 1980–2005, and found an upward trend in return correlations only among the subsample of European stock markets, not for North American and East Asian markets.

We argue that recent advances make it feasible to overcome the problems of dimensionality and convergence. We characterize time-varying correlations using weekly returns during the period 1973–2012 for a large number of EMs and DMs without relying on a factor model. We implement models that overcome the dimensionality problems, and that are easy to estimate. To do so, we rely on the variance targeting idea of Engle and Mezrich (1996) and the

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numerically efficient composite likelihood procedure proposed by Engle, Shephard, and Sheppard (2008). We use the flexible dynamic conditional correlation (DCC) model of Engle (2002) and Tse and Tsui (2002). As a robustness exercise, we report on the dynamic equicorrelation (DECO) model of Engle and Kelly (2012), which can be estimated on large sets of assets using conventional maximum likelihood estimation. We also contrast our findings with those obtained using the more traditional scalar BEKK model of Engle and Kroner (1995). Thus, we demonstrate that it is possible to estimate correlation patterns in international markets using large numbers of countries and extensive time series, without relying on a factor model that may bias inference. Our implementation is relatively straightforward and computationally fast, which allows us to report results using several different estimation approaches, while assessing the robustness of our findings.

Our results based on BEKK, DCC, and DECO models are extremely robust and suggest that the correlations have been trending upward for both DMs and EMs. We find that the correlation between DMs is higher than the correlation between EMs at all times in the sample. For emerging markets, the correlation with developed markets is generally somewhat higher than the correlation with the other emerging markets, but the differences are small. While the range of correlations for DMs has narrowed around the increasing trend in correlation levels, this is not the case for EMs. Although these results are robust across methodologies, the BEKK model yields substantially more outliers than the DCC approach, suggesting that the latter allows for a more realistic modeling of correlation patterns, due to its richer parameterization.

Our robust finding of an upward trend in correlations is all the more remarkable because the parametric models we use enforce mean-reversion in volatilities and correlations, and we estimate the models using long samples of weekly returns. The data clearly pull the models away from the average correlation, and any reversion to the mean in the samples we investigate is temporary. Christoffersen, Errunza, Jacobs, and Langlois (2012) build on this and allow for a parametric trend in their model of dynamic copula correlations. The implementation of their model is more complex and relies heavily upon Monte Carlo simulation.

We develop a time-varying measure of diversification benefits that is based on time-varying optimal portfolio weights and the dynamic correlations. We find that, in a long-only portfolio, it is not possible to circumvent the increasing correlations by adjusting the portfolio weights over time. Consistent with the patterns in correlations, diversification benefits have decreased for both emerging and developed markets. However, the level of diversification benefits is still higher in emerging markets, and thus, emerging markets still offer investors correlation-based diversification benefits.

The paper proceeds as follows. Section 2 provides a brief outline of BEKK, DCC, and DECO correlation models, with special emphasis on the estimation of large systems. Section 3 presents the data, together with empirical results on time variation in international equity market correlations. Section 4 conducts a real-time forecasting exercise, and Section 5 concludes.

2. Correlation dynamics and diversification measures

This section outlines the various models we use to capture the dynamic dependence across equity markets. We first describe how the conventional scalar BEKK model of Engle and Kroner (1995) can be implemented simultaneously on many assets. We then introduce the dynamic conditional correlation (DCC) model of Engle (2002) and Tse and Tsui (2002), which allows for added flexibility, in that it separates the modeling of the volatility dynamics from that of the correlation dynamics, the latter of which is our main focus. Finally, we describe the DECO model, which can be viewed as a special case of DCC, and so is included mainly to aid in assessing the robustness of our empirical findings.

2.1. The scalar BEKK approach

In the existing literature, the estimation of dynamic dependence models for large-scale systems of countries using extended time periods has been judged to be impractical and/or impossible because of dimensionality problems.[1] Therefore, existing implementations of multivariate GARCH models have traditionally used a limited number of countries. We argue that it is feasible to estimate such large systems using a number of recent advances. Because it is not always obvious how to relate some of the models we use, such as DCC, to models previously used in the literature, we start by explaining how these innovations help in estimating more traditional multivariate GARCH models. We illustrate this using the scalar BEKK model, which is arguably the most often-used empirical model for capturing dynamic dependence in large systems.[2] In this model, the return on asset i at time t is assumed to follow the dynamic

$$R_{i,t} = \mu_{i,t} + \varepsilon_{i,t} = \mu_{i,t} + \sigma_{i,t} z_{i,t} \tag{1}$$

$$\sigma_{i,t}^2 = \omega_i + \alpha \varepsilon_{i,t-1}^2 + \beta \sigma_{i,t-1}^2, \tag{2}$$

where $\sigma_{i,t}^2$ denotes the conditional variance, and where the conditional mean dynamic, $\mu_{i,t}$, can be specified using either an asset pricing model that captures the equity premium or a simple univariate autoregressive model as we do below.

The covariances between assets i and j follow the dynamic

$$\sigma_{ij,t} = \omega_{ij} + \alpha \varepsilon_{i,t-1} \varepsilon_{j,t-1} + \beta \sigma_{ij,t-1}. \tag{3}$$

The defining characteristic of the scalar BEKK model is that the persistence parameters α and β are identical across all conditional variances in Eq. (2) and across all conditional covariances in Eq. (3). This requirement ensures that the conditional covariance matrix for all assets is positive semi-definite at all times, and therefore ensures that

1 See for instance Solnik and Roulet (2000) for an excellent discussion. See Longin and Solnik (1995) and Karolyi (1995) for early examples of bivariate models.

2 The BEKK model is most often used for estimating factor models with a GARCH structure; see for instance Carrieri, Errunza, and Hogan (2007) and De Santis and Gerard (1997, 1998) for examples. For more general multivariate GARCH models with regime switching, see Baele (2005), Baele and Inghelbrecht (2009) and Ramchand and Susmel (1998).