Journal of Empirical Finance 7 (2000) 373–388
Journal of EMPIRICAL FINANCE
www.elsevier.com/locate/econbase

Stochastic correlation across international stock markets

Clifford A. Ball [a,*], Walter N. Torous [b]

[a] *Owen Graduate School of Management, Vanderbilt University, Nashville, TN 37203, USA*
[b] *Anderson School of Management, UCLA, Los Angeles, CA 90095, USA*

Abstract

This paper examines the correlation across a number of international stock market indices. As correlation is not observable, we assume it to be a latent variable whose dynamics must be estimated using data on observables. To do so, we use filtering methods to extract stochastic correlation from returns data. We find evidence that the estimated correlation structure is dynamically changing over time. We also investigate the link between stochastic correlation and volatility. In general, stochastic correlation tends to increase in response to higher volatility but the effect is by no means consistent. These results have important implications for portfolio theory as well as risk management.

Keywords: Stock market; Stochastic correlation; Volatility

1. Introduction

Modeling the dynamics of security returns and their risk characteristics remains an important task for both financial research as well as its application. For example, risk management techniques used to assess value at risk (VaR) have gained in popularity in recent years. A common approach in calculating VaR is

* Corresponding author. Tel.: +1-615-322-2909; fax: +1-615-343-7177.

0927-5398/00/$ - see front matter
PII: S0927-5398(00)00017-7

based on the assumption that the underlying security returns are conditionally multivariate normally distributed and then uses standard portfolio theory to determine the variance of a particular portfolio to assess its risk exposure.

Advances to this approach have for the most part involved the more careful modeling of the covariance structure of the underlying security returns. In particular, much effort has been expended on accurately modeling the dynamics of volatility. For example, Generalized Autoregressive Conditional Heteroscedastic (GARCH) models (Engle, 1982; Bollerslev, 1986; Nelson, 1991) and stochastic volatility models (Harvey et al., 1994; Kim et al., 1998) have increasingly been used to characterize the volatility of returns of common stocks and other assets.

This paper focuses on the *correlation* structure of security returns. To the extent that economic and political conditions do change over time, we would expect the correlation between international stock markets to change as well. The changing nature of this correlation is consistent with recent empirical evidence. For example, Longin and Solnik (1995) use a GARCH model to investigate the behavior of monthly international equity returns and conclude that the correlation between these returns is dynamically changing. Ramachand and Susmel (1998) fit a switching ARCH model to weekly international stock market returns and find evidence of markedly different correlations across regimes. Using daily returns of American Depository Receipts (ADRs) to avoid nonsynchronicity problems, Karolyi and Stulz (1996) also find evidence of changing correlation in the daily returns of US and Japanese indices. Changing correlation characterizes returns within domestic markets as well. Kroner and Ng (1998) fit a bivariate ARCH model to the weekly returns of US small and large cap portfolios and conclude that varying the restrictions placed on the evolution of variances as well as correlation can lead to markedly different model parameter estimates.

While much effort has been expended on modeling the multivariate structure of covariance, most of this research has used GARCH models. Multivariate GARCH models for conditional covariance, however, suffer from increasing parameter dimensionality and are often practical to estimate only after imposing severe restrictions, for example, assuming correlation coefficients are constant (Bollerslev, 1990). In this paper, we model the correlation coefficient as a latent variable and use filtering methods to estimate the resultant nonlinear model on the basis of observed security returns. Our approach allows for more flexibility in modeling the dynamics of correlation than the GARCH approach and provides a natural setting in which to assess whether other exogenous factors, such as stock market volatility (Solnik et al., 1996), statistically affect the behavior of correlation.

The plan of this paper is as follows. Section 2 details the methodology used to estimate the resultant stochastic probit model. We consider the use of both single period returns as well as longer return windows. After describing our returns data in Section 3, we present our empirical results in Section 4. The implications of stochastic correlation for risk management are explored in Section 5. Section 6 concludes the paper.