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Stock and bond market interactions with level and asymmetry dynamics: An out-of-sample application[☆]

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ABSTRACT

We model the dynamic interaction between stock and bond returns using a multivariate model with level effects and asymmetries in conditional volatility. We examine the out-of-sample performance using daily returns on the S&P 500 index and 10 year Treasury bond. We find evidence for significant (cross-) asymmetries in the conditional volatility and level effects in bond returns. The out-of-sample covariance matrix forecasts of the model imply that an investor is willing to pay between 129 and 820 basis points per year for using a dynamic trading strategy instead of a passive strategy.

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1. Introduction

While there exists a large literature on time-varying conditional variances of stock and bond returns, the number of studies on conditional covariances between these returns is rather limited. Moreover, to date, the *empirical* importance of modeling the covariance between stock and bond returns is largely neglected in existing studies. Given their importance in asset pricing, portfolio selection and risk management, it is crucial to obtain accurate estimates and predictions of the conditional covariances between asset returns. Several studies have introduced univariate models that capture the asymmetric volatility effect, for example Nelson (1991), Engle and Ng (1993) and Glosten, Jagannathan and Runkle (1993). Most of these models successfully outperform their symmetric counterparts in practice. Furthermore, De Goeij and Marquering (2004) show that the presence of asymmetric effects in conditional covariances is very likely if there exist asymmetric effects in the conditional variances of asset returns. As a portfolio manager's optimal portfolio depends on the predicted covariance between assets, relaxing the symmetric volatility specification leads to superior investment choices. Moreover, the introduction of asymmetric volatility in financial models could also be useful in other fields in finance, such as risk management and derivative pricing.

Empirical research on asymmetric effects in conditional covariances between asset returns in a multivariate GARCH model has been scarce. Braun, Nelson and Sunier (1995) estimate a bivariate exponential GARCH model with asymmetries in stock return betas for different sectors. However, they do not explicitly consider asymmetries in covariances. In addition, one of the most influential studies on modeling time-varying covariances is the study by Kroner and Ng (1998). They introduce the

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Asymmetric Dynamic Covariance (ADC) model that proposes asymmetric extensions of the most common multivariate GARCH models. They use data on large and small firms to compare four popular multivariate GARCH models. Their approach does not take into account cross-asymmetric volatilities: the conditional variance and covariance between asset returns can be higher (or lower) after a negative shock in one asset and a positive shock in the other asset, rather than shocks of opposite signs of the same magnitude. In the application of Kroner and Ng (1998) it makes sense not to consider these "cross-asymmetric effects" as these types of shocks are rare between the returns of small and large companies. In contrast, shocks of opposite signs are much more common in stock and bond returns. De Goeij and Marquering (2004) show that these cross-asymmetric effects are statistically significant in a multivariate GJR (Glosten et al., 1993) framework, by modeling dynamic interactions between stock and bond returns.[1]

Besides the (cross-) asymmetries, another factor which improves the ability to forecast (interest rate) volatility is the level effect. This effect implies that conditional volatility depends on the level of returns in addition to the dependency on innovations. Chan, Karolyi, Longstaff and Sanders (1992) estimate a general non-linear short rate process which nests many of the short rate processes currently assumed in the literature. The level effect in Chan, Karolyi, Longstaff and Sanders (1992) is formulated such that the volatility of the interest rate changes is proportional to the power of the interest rate itself. Their model is able to empirically distinguish between different theoretical term structure models. Brenner, Harjes and Kroner (1996) mix a univariate GARCH process with a model for level effects. They introduce a new class of models for the dynamics of interest rate volatility which allows volatility to depend on both interest rate levels and information shocks. They show that the sensitivity of interest rate volatility to levels is substantially reduced when volatility is a function of both levels and unexpected shocks. More recently, Christiansen (2005) has extended this model in a multivariate framework and includes the level effect in a constant (although time-varying) multivariate correlation model. Her model implies that the time-varying behavior in conditional covariances is caused by time variation in the conditional variances. Consequently, her model does not take into account a direct level effect for the dynamics in the covariances. It is therefore an open question whether the conditional covariance between stock and bond returns contains a level effect as well. Variation in interest rates may induce a positive correlation since the prices of stocks and bonds are negatively related to interest rates.

In this paper we extend the existing literature in three ways. First, we extend the asymmetric multivariate model of De Goeij and Marquering (2004) with the multivariate level effect as in, e.g., Christiansen (2005). Thus the model incorporates level effects and cross-asymmetries in conditional variances and covariances. To test the appropriateness of this model we examine the asymmetric volatility behavior of stock and bond market returns using daily data. Second, more general models obviously work better in-sample than simpler models. West and Cho (1995), for example, show that in-sample and out-of-sample results could vary substantially because of estimation error. Therefore, in contrast to similar studies, we concentrate on the *out-of-sample* forecasting performance comparison. Finally, recent GARCH literature has been moving towards the direction of examining what is the "best" model using economic loss functions rather than statistical loss functions (see, e.g., Lopez, 2001 and Ferreira and Lopez, 2005). The fact that a model performs better statistically, does not automatically imply that the model performs well in practice. Therefore, we evaluate the out-of-sample performance using an economic framework, taking into account transaction costs, rather than the traditional statistical framework. Overall, we emphasize the *empirical* applicability of our proposed model rather than the theoretical and in-sample properties.

Our empirical results can be summarized as follows. We find the level effect to be statistically significant for bond return volatility which is consistent with findings in the existing literature. However, the level effect is not significant for stock volatility and the covariance between stock and bond returns. We find strong evidence of asymmetric effects in the conditional variances and covariances of stock and bond returns. In addition, we find significant cross-asymmetric effects in the conditional covariances. We show that, after reasonable transaction costs, it would have been economically profitable to have used dynamic volatility timing employing the most general model with level and asymmetric effects in the out-of-sample period January 2003–September 2005. A mean-variance investor is willing to pay a maximum fee of between 129 and 820 basis points per year to switch from the static strategy to the dynamic strategy. Furthermore, including the asymmetries in the model leads to a higher economic value, out-of-sample. We show that the transaction costs need to be around 17 basis points per trade for the dynamic volatility timing not to be profitable anymore. Finally, our results indicate that the more risk-averse the mean-variance investor is, the more he is willing to pay for using one of the dynamic strategies instead of the passive strategy.

The remainder of this paper is organized as follows. In the next section we introduce the level asymmetric DVECH model. In Section 3 we present the empirical results and in Section 4 we investigate the quality of the covariance matrix out-of-sample forecasts of the models by determining the economic value of a trading rule exploiting the model forecasts. Finally, Section 5 concludes.

2. The level asymmetric diagonal VECH model

In this section we focus on modeling the asymmetric volatility phenomenon in a multivariate context. First, we describe how the first moments evolve over time in the mean equation. We follow Kroner and Ng (1998) and use a VAR framework to model excess returns. To prevent that asymmetric effects in the volatility equation are due to misspecification of the mean equation, we

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[1] Alternatively, Engle (2002) models conditional asymmetric correlations instead of conditional covariances.

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