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Risk spillovers in international equity portfolios ☆

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ABSTRACT

We define risk spillover as the dependence of a given asset variance on the past covariances and variances of other assets. Building on this idea, we propose the use of a highly flexible and tractable model to forecast the volatility of an international equity portfolio. According to the risk management strategy proposed, portfolio risk is seen as a specific combination of daily realized variances and covariances extracted from a high frequency dataset, which includes equities and currencies. In this framework, we focus on the risk spillovers across equities within the same sector (sector spillover), and from currencies to international equities (currency spillover). We compare these specific risk spillovers to a more general framework (full spillover) whereby we allow for lagged dependence across all variances and covariances. The forecasting analysis shows that considering only sector- and currency-risk spillovers, rather than full spillovers, improves performance, both in economic and statistical terms.

1. Introduction

How can we define risk spillovers? How can we model risk spillovers in an international equity portfolio? If we take risk spillover into account, does the forecasting ability of portfolio risk increase? What are the economic consequences of only limited risk spillovers? In this paper, we address these fundamental questions.

In order to characterize the risk relations across assets, we assume that the asset covariance matrix is dynamic and we characterize the dependence across its elements. Then, we introduce the concept of risk spillover which defines the dependence of a given asset variance on the past covariances and variances of assets that either belong to the same or different economic sectors or asset classes. When the dependence encompasses all assets included in a portfolio, we refer to it as full risk spillover. At the other extreme, there is an absence of risk spillover, i.e. when the risk of any asset is a function only of its past risk. There is a vast spectrum of partial risk spillover between none and full spillover risk. To envisage these, we assume the point of view of a U.S.

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investor holding an international equity portfolio of nine U.S. stocks and three foreign stocks. The underlying twelve companies run their business in four sectors. The investor is essentially concerned by two kinds of risk spillovers: first, the currency-risk spillover, which arises from the foreign companies that perform business predominately abroad and/or use foreign accounting currencies. Second, the sector-risk spillover that stems from companies with the common exposure to sector-wide risk factors. More specifically, we focus on three structures of partial risk spillover in the variance–covariance matrix. First, we consider what we call "limited-risk spillover", that is to say, the interaction of risks within economic sectors and between the three exchange rates (we consider currencies as an asset class per se). It should be stressed that this definition of partial risk spillover discards any risk spillover across economic sectors and between equities and currencies. Second, we consider the "currency-risk spillover", in which the risk spillover is given by the currency risk, and only impacts international equities. Finally, we discuss the "pervasive-risk spillover" that combines the limited- and currency-risk spillovers mentioned above. This corresponds to the joint presence of risk spillover between currencies, within equities in the same economic sector, and from currencies to international equities.

Building on the concept of risk spillover, we propose a flexible and feasible approach to model equity portfolio risk which involves exchange rate risks. This model lends itself to adaptable definitions of risk and various structures of risk forecasting. It is worth noticing that one could consider many other definitions of partial-risk spillover (e.g. the cross-sector risk spillover) and other asset classes (e.g. government or corporate bonds). We limit our analysis to an international equity portfolio, based on our firm belief that this approach can easily be extended to encompass many other interactions between asset variances/covariances and how these relations evolve over time. Though this is not within the scope of this paper, such a portfolio design can be used to study to the efficient hedging of currency risks.

One of the benefits of efficient hedging in an international exposure is the reduction of the portfolio variance, see for example Glen and Jorion (1993). In addition, as shown in Campbell et al. (2010), risk-minimizing global equity investors should short those currencies that are more positively correlated with equity returns and should hold long positions in those currencies that are more negatively correlated with returns. Our paper contributes to this strand of the literature by proposing a modeling approach to spillover risk and challenging the view that some currencies have diversification benefits. In fact, by opportunely modeling spillover risks, the economic assessment of these diversification benefits become less clear.

This approach is consistent with the variety of investment funds in the financial industry and makes a broad spectrum of risk management strategies viable. For instance, the investor can believe ex ante that an asset class, such as hedge fund investments, should by its very nature be poorly correlated with other (traditional) securities, such as stocks and bonds. Another example is represented by the unclear connection between currencies and equities, or even among sectors that may be pro-cyclical (e.g. manufacturing and resources) or counter-cyclical (e.g. pharmaceutical and health sectors). Those alternative spillover designs might be easily obtained as generalizations or sub-cases of our modeling approach.

From the technical side, our study relies on the Wishart autoregressive model (WAR) proposed by Gourieroux et al. (2009). The model is based on a dynamic extension of the Wishart distribution. This specification is compatible with financial theory, satisfies the constraints on volatility matrices, has a flexible form and, most importantly, maintains the coefficients' interpretability, even when specifications are restricted. The main innovation proposed in this paper is the introduction of specific model parametrizations that allows the dynamics of the spillover between variances to be controlled by imposing a particular structure on the coefficient matrices of the WAR model. The parametrization makes use of block structures on the model parameter matrices. Wehence name our specification *Block WAR*. The use of block structures in parameter matrices is similar to that adopted in Billio et al. (2006), Billio and Caporin (2009), and Engle and Kelly (2008) that introduce a block structure for the correlation matrix. Similar approaches have been considered in Asai et al. (2008) for multivariate stochastic volatility models. Finally, Caporin and Paruolo (forthcoming) present a more general spatial solution to the curse of dimensionality problem in multivariate volatility specifications. Their specification includes as a special case block structures on the coefficient matrices.

After the model estimation, we perform a forecasting analysis to evaluate the economic implications which stem from different characterizations of the risk spillover. The forecasting ability of several alternative model specifications is assessed both in statistical and economic terms. On the economic side, the crucial mechanism is that the optimized portfolio weights and the variance forecasts depend on how spillovers are structurally modeled. Consistent with the recent literature on realized volatility, the empirical analysis is based on high frequency data of 12 stocks quoted on US equity markets and 3 exchange rates over a period of seven years, including those of the recent financial crisis.

The paper is organized as follows: Section 2 introduces the econometric model used to analyze and forecast the sequence of covariance matrices while accounting for possible spillover effects. Section 3 describes the model estimation procedure; Data and model specification are presented in Section 4; the economic value of considering risk spillover is analyzed in Section 5. Section 6 concludes the paper.

2. Modeling variance spillovers

We now introduce the model used to analyze and forecast the sequence of realized variance–covariance matrix for the 15 assets in our study. Later, we describe the set of alternative parametric restrictions to the spillovers between variances that help to reduce the complexity of the full model estimation, and those which might be driven by some economic criterion (e.g. assets classification) or data. As we mention in the introduction, we presume that realized covariance sequences are available and so will not tackle the problem of the optimal estimation of realized variances and covariances. Details on these aspects could be found in Zhang et al. (2005), Bandi and Russel (2008), Hansen and Lunde (2006), Barndorff-Nielsen et al. (2008a) and Zhang (2010), among others.