Estimating time-varying conditional correlations between stock and foreign exchange markets

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Abstract

This study explores the dynamic interaction between stock market returns and changes in nominal exchange rates. Many financial variables are known to exhibit fat tails and autoregressive variance structure. It is well-known that unconditional covariance and correlation coefficients also vary significantly over time and multivariate generalized autoregressive model (MGARCH) is able to capture the time-varying variance-covariance matrix for stock market returns and changes in exchange rates. The model is applied to daily Euro-Dollar exchange rates and two stock market indexes from the US economy: Dow-Jones Industrial Average Index and S&P500 Index. The news impact surfaces are also drawn based on the model estimates to see the effects of idiosyncratic shocks in respective markets.
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1. Introduction

The salient features of financial asset prices are well-known and well documented by economists and econophysicists. Unconditional distributions of many financial returns have thicker tails than Gaussian distribution and variances change over time

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in clusters [1–6]. These stylized facts have important implications for option pricing, optimal portfolio allocation, and risk management. Of equal importance is the interaction among a set of financial variables such as the relationship between a financial asset and a market portfolio. This paper considers the case for stock market returns and exchange rates.

As noted recently by Plerou et al. [7] correlations among financial variables may evolve through time in a complex manner. Furthermore, both variables may be determined simultaneously and the precise nature of interaction between currency value and firm value may be extremely complicated. There are a number of micro channels by which exchange rate and stock prices are tightly linked. Exchange rate exposure is the concept used by economists to describe the situation in which share value of a firm is influenced by changes in foreign currency (see Ref. [8]). When the domestic currency depreciates (an increase in the exchange rate defined in terms of domestic currency), products or services of exporter firms become cheaper in the global markets leading to more revenues and hence an increase in the stock value. On the other hand, importer firms suffer from an increase in the costs of production due to depreciation of the domestic currency, leading to a decrease in the stock value. Even if firms do not engage in international trade activities their future inflow and outflow may still be altered by the changes in currency value. For example, factors of production may be affected by currency changes or firms in non-traded goods industries may be affected by those firms in traded goods industries. Since the stock price is merely a discounted sum of future dividends of a firm, any factors affecting the future inflow or outflow will alter the value of its stocks. The empirical evidence on the relationship between exchange rates and stock prices is mixed: while some of these studies (e.g., Refs. [9,10]) provide a positive correlation, some of them (e.g. Refs. [11–14]) have failed to find a relation between changes in market values and exchange rates, and Ref. [15] found a significant time-varying correlation.

There is another channel that may add to the complexity of the relationship between stock prices and exchange rates. Large capital inflows may lead to a decrease in interest rates and an increase in stock prices resulting in strengthening (i.e., appreciation) of domestic currency. Ref. [16] shows theoretically and empirically that portfolio choice largely depends on exchange rate dynamics and there exists a significant negative correlation between stock and foreign exchange markets. It is also shown by Hau and Rey [16] that strong equity markets may not always be accompanied with appreciation of domestic currency due to unhedged exchange rate risk in international equity portfolios.

The purpose of this paper is to analyze the relationship between foreign exchange rate and stock prices by focusing on the dynamic variance–covariance structure. We make use of a multivariate generalized autoregressive conditional heteroskedasticity model to capture the volatility clustering effect, time-varying covariances and volatility spill-overs between foreign exchange markets and stock markets. This framework also enables us to analyze the effects of information arrivals on volatilities and covariances. In particular, we draw news impact surfaces which are simply three-dimensional graphs of variances, covariances and correlation coefficients as a function of shocks to variables in the model. The model is applied to daily