Journal of International Money and Finance 29 (2010) 743–759

Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Dependence structure between the equity market and the foreign exchange market–A copula approach

Cathy Ning*

Department of Economics, Ryerson University, 350 Victoria Street, Toronto, ON M5B 2K3, Canada

JEL code:
C32
C51
C52
G15
F30

Keywords:
Copulas
Tail dependence
Dependence structure
GARCH
Stock return
Foreign exchange rate return

A B S T R A C T

This paper investigates the dependence structure between the equity market and the foreign exchange market by using copulas. In particular, several copulas with different dependence structure are compared and used to directly model the underlying dependence structure. We find that there exists significant symmetric upper and lower tail dependence between the two financial markets, and the dependence remains significant but weaker after the launch of the euro. Our findings have important implications for both global investment risk management and international asset pricing by taking into account joint tail risk.

1. Introduction

Studying the co-movements across financial markets is an important issue for risk management and portfolio management. There is a great deal of research focusing on the co-movements of international equity markets. Chakrabarti and Roll (2002) find that the correlations increased from the pre-crisis to the crisis period in both Asian and European stock markets. They also find that the diversification potential was bigger in Asia than in Europe in the pre-crisis period, but this was reversed during the crisis. Other examples of research on the co-movements of equity markets can be found in Karolyi and Stulz (1996), Longin and Solnik (2001), Forbes and Rigobon (2002), while the methodology used is along the line of correlations and conditional correlations. Since the limitations of correlation-based models as identified in Embrechts et al. (2002), research has started to use copulas to directly model

* Tel.: +1 416 979 5000x6181; fax: +1 416 598 5916.
E-mail address: qning@ryerson.ca

0261-5606/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jimonfin.2009.12.002

the dependence structure across financial markets. Works along this line include Mashal and Zeevi (2002), Hu (2006) and Chollete et al. (2006), who report asymmetric extreme dependence between equity returns, i.e., the stock markets crash together but do not boom together. While the above literature focuses on the dependence structure and co-movements in equity markets via copulas, Patton (2006a) also employs copulas to model the asymmetric exchange rate dependence and finds that the mark and yen exchange rates are more correlated when they are depreciating against the US dollar than when they are appreciating.

While there is extensive literature studying the co-movements between the international equity markets and some literature on modeling the dependence structure between the exchange rates via copulas, there is little literature on using copulas to study the co-movements across markets of different asset types, such as the equity and foreign exchange markets. In this paper, we consider both equities and foreign exchange rates in our study since the foreign exchange market is by volume one of the largest financial markets and currency is an important asset in international financial portfolios. In the literature, Giovannini and Jorion (1989) include exchange rates as assets in their portfolios. For global investors who wish to diversify portfolios internationally, the co-movements and dependence structure between equities and exchange rates would have important implications for their cross market risk management. There has been extensive research (both theoretical and empirical) on the relationship and co-movements between these two markets. Theoretical research includes the "flow-oriented" models of exchange rate (see Dornbusch and Fischer (1980)) and the "stock oriented" models of exchange rate (see Branson (1983) and Frankel (1983)). All these models argue that the stock market impacts the exchange rate and vice versa. Empirical studies of the interaction or causality relationship between the stock price and the exchange rate lead to mixed results (positive correlation, negative correlation, existence or nonexistence of causality, causality one way or the other).

In this paper, we endeavor to investigate the dependence between the equity returns and the exchange rate returns, by using a relatively new technique: copulas. The methodology we use in this paper differs in a fundamental way from most of the methods used in the literature in analyzing dependence between the financial markets, which is also sometimes called co-movement. We will use dependence or co-movement interchangeably in this paper. The questions we intend to answer are: what is the dependence structure between these two assets? Is there any extreme value dependence[1]? Is the dependence symmetric or asymmetric? By answering these questions, we hope to better understand the co-movements of stock-currency markets and the risks associated with the dependence structure between markets.

A copula is a function that connects the marginal distributions to restore the joint distribution. The advantage of using copulas in analyzing the co-movement concerned is multifold. First, copulas allow us to separately model the marginal behavior and the dependence structure. This property gives us more options in model specification and estimation. Second, the copula function can provide us not only the degree of the dependence but also the structure of the dependence. It allows for the tail dependence and asymmetric dependence. Linear correlation does not give the information about tail dependence and the symmetry property of the dependence. Third, unlike correlation, copulas do not require elliptically distributed random variables of the interest. As a result, they are especially useful when modeling the dependence between asset returns (especially from high frequency data). Finally, copulas are invariant to increasing and continuous transformations. This property is very useful as transformation is commonly used in economics and finance. For example, the copula does not change with returns or logarithm of returns. This is not true for the correlation, which is only invariant under liner transformations.

To study the stock-foreign exchange dependence, we specify both the marginal models for the returns and a joint model for the dependence. We employ the AR-t-GARCH models for the marginal

[1] There has been growing interest in the research on extreme events and market co-movement, both theoretically and empirically. In addition to Longin and Solnik (2001), Mashal and Zeevi (2002), Hartmann et al. (2003), Hu (2006), Chollete et al. (2006), and Cappiello et al. (2006), DeVaries and Jansen (1991) examine the 1987 US stock market crash via the tail probability of the US stocks. Dungey and Tambakis (2005) analyze international financial contagion during financial market extremes. Hong et al. (2008) develop a theoretical model based on the communication process between advisors and investors to explain dot-com bubble. Chollete (2008) proposes a theoretical model and find that extremes are endogenous.