Available online at www.sciencedirect.com
ScienceDirect
Physica A 377 (2007) 173–180
PHYSICA A
www.elsevier.com/locate/physa

Non-linear dynamic linkages in the international stock markets

Zeynel Abidin Ozdemir[a,*], Esin Cakan[b]

[a]Department of Economics, Gazi University, Besevler, 06500, Ankara, Turkey
[b]The Graduate Center, The City University of New York, 365 Fifth Avenue, New York, NY 10016, USA

Received 3 August 2006; received in revised form 30 October 2006
Available online 4 December 2006

Abstract

This study examines the dynamic relationship between the major stock indices of the US, Japan, France and the UK by using the non-linear Granger-causality test. The empirical evidence indicates that there is a strong bi-directional non-linear causal relationship between the US and the others. While the US stock market Granger causes significantly the other considered stock markets, Japan and France do not linear Granger cause the US, but just the UK does.

Keywords: Stock markets; Non-linear causality

1. Introduction

Few studies in the late 1980s and early 1990s detected that financial time series exhibit non-linear dependence [1,2]. Scheinkman and LeBaron [3] showed that a substantial part of variation of US weekly stock returns seems to come from nonlinearities as opposed to randomness. Unfortunately, these findings were neglected by the literature and studies on causality relied on traditional linear Granger causality tests, even though these tests generally have low power against non-linear relationships [4].

Following the Baek and Brock [4] test, Baek and Brock proposed a non-parametric statistical methodology for uncovering non-linear causal relationships, Hiemstra and Jones [5] modify the test and report highly significant bi-directional non-linear causality between daily returns on the Dow Jones Industrial Average and the percentage changes in New York Stock Exchange (NYSE) trading volume over the 1915–1946 and 1947–1990 periods. Fujihara and Mougoue [6] show that significant bi-directional non-linear causality exists between returns and trading volume of three petroleum future contracts. Abhyankar [7] finds a significant bi-directional non-linear causal relationship between the FTSE 100 index futures and cash markets.

Asimakopoulos et al. [8], who investigate the non-linear relationship between currency future returns, finds uni-directional non-linear causality relationships among British Pound, Deutche Mark, the Japanese Yen, Swiss Frank and US dollars. They also filter the residuals using GARCH(1,1) model and report insignificant and statistically weaker non-linear causality relationships.

*Corresponding author. Tel.: +90 312 212 68 53x1531; fax: +90 312 213 20 36.
E-mail address: zabidin@gazi.edu.tr (Z.A. Ozdemir).

0378-4371/$ - see front matter
doi:10.1016/j.physa.2006.11.013

The integration of world capital markets has increased over the last decade with the increase in easiness of capital flow across countries and financial integration, which is stimulated by the development and growth of derivative securities. Most of the studies found that financial markets in the US are the most influential markets [9–13]. Fuerstenberg and Jeon [14] investigated the factors that move global markets and examined the correlation between the New York, Tokyo, Frankfurt and London market for the period 1986–1988. Eun and Shim [9] find that substantial amount of interdependence exists among international stock markets. It is well known historically at least that the US market has always had an influence on other markets. The October 1987 crash triggered great interest in the interrelation of global stock markets. There is evidence of greater interdependence among international stock markets after the October 1987 crash and the breakdown of the Japanese 'bubble economy' at the end of 1989. Especially, the Japanese market started to play a more active role in the global stock market after 1987 and 1989 [10]. The Japanese market also influences most of the Asia-Pacific stock markets which illustrates the international significance of it [11]. Therefore, we choose 1990 as the starting date of this study to cover the impact after the 1989 period.

The interrelations among international stock markets have received a great deal of attention after the crash of the US equity markets in October 1987 followed by the bust of the Japanese "bubble economy" at the end of 1989. Cross-market interdependence in returns and volatilities appear to be bi-directional between the US and foreign markets [15]. Since national stock markets operate in diverse time zones with the result that markets are nonsynchronous, we expect that especially Japan and the US stock markets have dynamic linkages. It has been found that the peak response of all the European and Asian-Pacific markets to the US innovations happen within a one-day lag [9]. Kiymaz and Berument [16] also argue that the highest volatility occurs in Japan on Mondays, on Fridays in the United States and on Thursdays in the United Kingdom. Dornau [17] examines the causality between the US, Europe and Japanese stock markets considering one-day time lag by covering the period from 15 October, 1985 to 20 October, 1997. It considers the financial crises that the Japanese market experienced so the data are divided into four periods like October 1985–October 1987, March 1988–October 1989, March 1990–December 1992 and January 1993–October 1997, respectively. However, that study finds linear Granger causality from NYSE to NIKKEI in the first, second and the fourth periods. It finds a bi-directional linear Granger causality between NIKKEI and NYSE in the third period.

In most of the studies above, interrelation of international stock markets are analysed using cointegration analysis, linear Granger causality and impulse response functions in the framework of vector autoregressive (VAR) models. These studies have showed that the US stock market affects the other stock markets linearly, but the reverse has not been supported, except by Dornau [17] who found that the US markets are influenced by others. However, the findings of the latter study are weak. The aim of that study is to investigate whether the latest finding is caused by non-linear causal ties that exist across international equity markets.

To the best of our knowledge, there is no other study that investigates the non-linear Granger causality on these indices. In this study, the modified Baek and Brock [4] test, that was fully developed by Hiemstra and Jones [5], is used to examine the non-linear dynamic linkages between the US and the other stock markets. First, stationarity of each series is tested. Second, linear Granger-causality test is applied to find the relation of DOW with the other markets without any error correction term since the series do not have any long run relationships. Third, the non-linear Granger-causality test is applied. The study finds significant non-linear Granger causality from Nikkei225 to DOW and from CAC40 to DOW, which cannot be captured by the linear Granger-causality tests. FTSE100 and DOW have bi-directional relation in both types of tests. In short, in addition to linear dependencies, stock markets may exhibit highly non-linear dependencies.

The rest of the paper is organized as follows: the next section discusses the linear and non-linear Granger-causality tests. The third section presents the data set and the empirical results of the test and the last section concludes with remarks of the study.

2. Testing methodology

2.1. Testing for linear Granger causality

Granger's [18] causality definition is the source of causality tests between two stationary series. Formally, a time series Y_t Granger-causes another time series X_t if series X_t can be predicted better by using past values of