Economic Modelling 29 (2012) 2724–2733

Contents lists available at SciVerse ScienceDirect

Economic Modelling

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

Interrelationships among the Taiwanese, Japanese and Korean TFT-LCD panel industry stock market indexes: An application of the trivariate FIEC–FIGARCH model

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ARTICLE INFO

Article history:
Accepted 12 August 2012

JEL classification:
G10
G15
G17

Keywords:
Long memory
FIEC-FIGARCH model
Spillover effects
Fractional cointegration

ABSTRACT

The purpose of this study is to analyze the interrelationships among the Taiwanese, Japanese and Korean TFT-LCD panel industry stock market indexes by applying a trivariate FIEC-FIGARCH model. The empirical results confirm that the FIEC-FIGARCH model can be used to capture long memory behavior and allow us to conclude that mean and volatility spillover, and long memory effects are found in these three markets. Furthermore, we found that deviations in the long-run equilibrium for Japanese TFT-LCD panel industry adjust back very slowly in comparison to the other two countries; and that, in terms of conditional covariance, dynamic interrelationships exist among the TFT-LCD panel industry stock market indices of these three countries.

1. Introduction

In recent years the global economy has become more integrated due to the trends of internationalization and liberalization and the rapid progress of R&D, applied science, networking, etc. sensitizing local stocks to turbulences in foreign financial markets, for instance, the stock price vibrations derived from the Asian Financial Crisis in 1997, the acute stock price vibrations after the dreadful 911 terrorist attacks in United States, etc. Taiwan is also part of the internationalization trend; its entrance into the World Trade Organization (WTO) and its exportation oriented economy are characteristics that favor international influences in Taiwanese stock prices. Considering these circumstances and also that the volatility of equity markets might exhibit long memory effects, the international price transmission effects on the equity market of TFT-LCD panel industry are worth being analyzed by enterprises, government officials and scholars due to its importance for Taiwan economy.

The TFT-LCD panel industry is characterized by (1) high capital requirement, entrance barriers and exit costs; (2) highly intensive technology along with complicated processes of production; (3) short-term product life cycle; (4) price sensitive to market demand, supply and economic cycles; (5) popular international division of labor; (6) high market concentration; (7) completeness of industry structure that helps to create competitive advantage; (8) material cost accounting for high percentages; (9) high brain circulation and (10) high concentration of shareholding of domestic TFT-LCD panel firms.[1] The global development of the TFT-LCD panel industry is primarily concentrated in Taiwan, Korea and Japan. Japan was the largest producer of TFT-LCD panels until 1995, when Korea overtook the leadership by pursuing a low price strategy. The Won depreciation during Asian financial crisis (1997) sharpened the price differences, leading Japan to withdraw from the mass production of TFT-LCD panels, and to switch to research and development (R&D) in new technology and marketing channels. As for Taiwan, the production of small and medium sized TFT-LCD panels was established early and kept until Japan released the technology of large size TFT-LCD panels and transferred this knowledge to Taiwan. While Japanese firms gained from running brand channels, Taiwanese firms seize the technology transfer; it was a good deal for both countries. Taiwan began the mass production of large-size TFT-LCD panels in 1998 based on the competitive advantages of OEM and ODM for internationally known computer producers. Thus, the market share of Taiwan increased from only 2% in 1999 to more than 40% by 2004 and kept rising; in 2006 Taiwan TFT-LCD panel firms were given the award of global-best profit margin. Meanwhile the Korean TFT-LCD panel industry established a complete system of key parts of TFT-LCD panels obtaining large global market shares with self-owned brands.

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[1] Industrial Economics and Knowledge Center (IEK), as part of Taiwan's premier research body, the Industrial Technology Research Institute (ITRI).

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http://dx.doi.org/10.1016/j.econmod.2012.08.014

Between 2004 and 2005 the global production of large-scale TFT-LCD grew 25% from US$34 billion in 2004 to US$43 billion in 2005 with laptops, monitors and LCD TV screams as the principal components of a demand mainly supplied by Taiwan, Japan and Korea. This profitable industry attracts international securities investors that pay strong attention to the stock price volatility because their concern focuses on the portfolio diversification rather than in a single company performance. Their forecast analysis for risk hedging, arbitrage searching and correlations seizing technify local stock markets and increase the spillover effects of international events into the local economies. These circumstances make the investigation of the interrelationships among the TFT-LCD industry stock market indexes of Taiwan, Japan and Korea[2] a very important topic for the future development of these industries as well as a model for other industries sharing similar characteristics. In order to make easier to understand this paper, some terms wide used in it will be explained as follows: **TFT-LCD** are liquid crystal displays (LCD) which use thin-film transistor (TFT) technology to improve image quality used in television sets, computer monitors, mobile phones, handheld video game systems, personal digital assistants, navigations systems, projectors, etc. **Stock market index** is a method of measuring a section of the stock market. In our study the indexes measure the TFT-LCD panel industry for Taiwan, Japan and Korea by weighting the stock value of each firm in the panel industry within the corresponding country to reflect the market capitalization of its components. **Long memory** in time series data means that past behavior and information affects the data for long time with dependency effects (Cheung, 1993; Davidson, 2004). Various findings of long memory phenomenon in the volatility of financial instruments cannot be properly explained with GARCH models, as for example, slowly decaying autocorrelations and mean reversion phenomenon, which are exhibit for the sample data employed in this study as indicated later. In these cases, the conventional integer cointegration method can be used to establish stationary relationships between linear combination of different variables, but cannot be used to delineate the effects of long-term lag for autocorrelation series. Therefore, this study proposes employing the fractionally integrated error correction (FIEC) model and the fractionally integrated GARCH (FIGARCH) model to capture the long memory effects of financial time series data.

Fractionally integrated general autoregressive conditional heteroskedacity (FIGARCH) model implies a finite persistence of volatility shocks (while there is no persistence in the GARCH framework), i.e., long memory behavior and a slow rate of decay after a volatility shock. An IGARCH model implies complete persistence of a shock and seemed to quickly fall out of favor. Interestingly, the FIGARCH (1,d,1) nests a GARCH(1,1) with $d=0$ and the IGARCH model for $d=1$ (Beine et al., 1999). Stock prices volatility is unpredictable and heteroskedacity, therefore a precise heteroskedacity model is needed to simulate the volatility clustering phenomenon, i.e., large volatility usually followed by large volatility and small volatility usually followed by small volatility. The pioneer in these kinds of models was Engle (1982) who developed the ARCH model to analyze series that exhibit constant unconditional (or long-run) variance with periods in which the variance is relatively high. Bollerslev (1986) generalized the model allowing for both autoregressive and moving-average components in the heteroskedacity variance with the benefit that a more parsimonious GARCH representation is much easier to identify and estimate; however, GARCH models can only capture the persistence of short-term volatility while the FIGARCH model, derived by Baillie, et al. (1996), better capture the long memory dynamic dependencies in the conditional variance. A number of studies reveal that the FIGARCH model adequately simulates the long memory in volatility of financial data well, see, for example, Brunetti and Gilbert (2000), Beine et al. (2002), Tang and Shieh (2006) and Figuerola-Ferretti and Gilbert (2008). In particular, Mendes and Kolev (2008) investigate the interdependence in emerging markets, which can be driven by conditional short and long range dependence in volatility. Mendes and Kolev (2008) also fit copulas model to pairs of filtered returns, which using FIGARCH process to the joint excess residuals. Their empirical results indicate that long memory in volatility is responsible for chances in increasing external dependence.

Fractionally integrated error correction (FIEC) is the name of the model established by Granger (1986) to analyze variables when fractional cointegration prevails. In general, two or more economic variables are fractionally cointegrated if both are of the same fractional order, whereas a linear combination of them has a smaller fractional order. By incorporating a FIGARCH model into a FIEC model, this study formulates a FIEC-FIGARCH model to analyze the interrelationships among the TFT-LCD panel industry stock market index (from now on TFT-LCD index) of Taiwan, Japan and Korea, created by the authors especially for this study and applicable for further analysis, by itself and important contribution of our study for the industry. Long term memory is a different approach that the widespread short-term methodology but the empirical results prove the validity of our proposal. Following our ideas, empirical results would provide useful information for investors looking for price discoveries, hedging or diversification benefits within the TFT-LCD panel industry, it would also help governmental agencies to make their policy-related decisions.

The remaining parts of this study are organized as follows. Section 2 outlines the theoretical foundation of FIEC-FIGARCH Model. Section 3 summarizes the empirical methodology, followed by the empirical results reported in Section 4. Finally, Section 5 presents some concluding remarks.

2. Theoretical foundations

2.1. Long memory properties

This study uses a fractionally integrated process to delineate the long memory property of financial variables. Cheung (1993) characterized the property of the long memory process by hypothesizing that if the conventional null hypothesis of the unit root test cannot be rejected, then the time series is not I (0) stationary. Even if a time series is not a stable I (0) process, the series could still exhibit the phenomenon of long-term and slow process of mean reversion, i.e., relatively flat fluctuations of the process, indicating that the series will possibly be stationary in the long-term. Therefore, the long memory demonstrates that a time series exhibits the phenomena of long-term and slow autocorrelation, as well as very slow decaying autocorrelations. This reflects the impacts of lags from previous periods on the current period of the variable under consideration. In other words, the variable itself appears to behave with long memory.

2.2. The fractionally integrated process

Granger and Joyeux (1980) proposed using fractionally integrated models to characterize the long memory property of economic or financial time series data. Such models are also more appropriate for depicting the cointegrating relationships among economic or financial variables. Basically, a fractionally integrated process is referred to as a fractionally differenced process. The salient feature of a fractionally differenced process is that the correlogram decays at a much slower rate than that of a process with short-term memory.

[2] The respective indexes have been constructed specially for this research by grouping the stock price of panel industry firms within each country.