

Contents lists available at [ScienceDirect](#)

Journal of International Financial Markets, Institutions & Money

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

A note on modeling world equity markets with nonsynchronous data



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ARTICLE INFO

Article history:

Received 22 August 2016

Accepted 15 May 2017

Available online 20 May 2017

JEL classification:

C32

F31

F36

G14

G15

Keywords:

Equity markets

Information transmission

Multivariate cointegration

Error correction modeling

Vector autoregression

ABSTRACT

We investigate information transmission in world equity markets using lengthy time series of daily data for nine developed equity markets over the 1999–2014 (post-Euro) time interval. Three nine-variable systems are examined, including stock indexes in both local currency and US dollars plus foreign exchange rates. After finding only weak evidence of cointegration in the three nine-variable systems, vector autoregression models are used to identify which price indexes drive the others. Our initial tests are consistent with earlier findings; that is, the US market appears to be the clear price leader. However, after constructing alternative models with the US data series lagged one period (making it the *first* market reported each day rather than the *last*), the results are reversed; the US is no longer the price leader. The US market is driven by nearly all other markets, while making little or no impact on the others. Thus, in earlier studies using nonsynchronous data reported by calendar date, it only appears that the US drives other stock markets, when in fact the US is merely an equal participant in information transmission around the world.

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1. Introduction

Wake to the financial headlines on any given morning and you will find that a sell-off in Asia has spread to Europe and that, all too often, both continents are reacting to a late plunge on Wall Street.¹

As the quote from *The Economist* suggests, the common belief is that price information is transmitted from the United States marketplace to foreign equity markets. Indeed, much of the empirical evidence supports this assertion, although the results are mixed. The transmission of price innovations from one national marketplace to another has been widely studied. However, these studies have used price level data from a variety of national stock market indexes, different sample time periods, different innovation frequencies, and different statistical techniques to investigate the topic. Moreover, many of these studies have used price data denominated in the US dollar, but many also have used index price levels denominated in the local currency of the country index. Because of these issues, it is difficult to compare the results of one study with another or to determine if differences in methodology matter.

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¹ "All in the Same Boat", *The Economist*, September 10, 2011, p. 82.

Certainly, investors and market observers should be interested in whether price leadership in world equity markets differs when price level changes are measured in US dollars or local currencies. For example, if the US is the market price leader when price levels are denominated in US dollars but not local currency, then this knowledge is more relevant for US investors with overseas equity positions who should anticipate price level changes in their foreign equity positions after a large innovation in the US market than it is for investors with a different numeraire currency. For that matter, if the US is the price leader when prices are denominated in the US dollar but not in local currency, it is suggested that a currency effect is important in determining price leadership. Knowledge about how information is transmitted from one national market to another helps us better understand the world financial markets.

2. Literature review

The literature in this area is large. The following brief literature review is meant to be representative, but in no way an exhaustive account of the major techniques and findings.

One of the most well-known studies on information transmission in world equity markets is by [Eun and Shim \(1989\)](#). They use daily stock market index data denominated in local currency covering the time period December 31, 1979 through December 20, 1985. They conclude from a nine-market VAR system analysis that (p. 243) “. . . the US stock market turns out to be, by far, the most influential in the world. Innovations in the US stock market are rapidly transmitted to other markets in a clearly recognizable pattern, whereas no single foreign market can significantly explain the US market movements.”

[Koch and Koch \(1991\)](#) employ a dynamic simultaneous equations model to determine the daily local currency returns across eight national equity markets for the years 1972, 1980, and 1987. Their model allows estimation of contemporaneous lead/lag relationships across foreign markets to reveal the international market linkages after accounting for current and lagged effects. They find that the Japanese market moved from being a market follower to more of a leader, whereas the US markets influence waned.

[Richards \(1995\)](#), using quarterly data denominated in US dollars over the time period December 1969 through December 1994, tests for multivariate cointegration among nine national equity markets. His tests indicate that markets are not cointegrated around a common world component but that country-specific factors influence long-run stock market performance.

[Masih and Masih \(2001\)](#) conduct a multivariate cointegration analysis for nine national equity markets using monthly averaged stock index data converted into US dollars over the time period of January 1982 through June 1994. Testing indicates a single cointegrating vector. Vector error correction models (VECMs) indicate that innovations in the US market explain movements in the Japanese market, and innovations in the British stock market seems to cause fluctuations in the Japanese, German, South Korean, and Australian markets.

[Masih and Masih \(2002\)](#) conduct a multivariate cointegration analysis using monthly stock market price levels over the period January 1972 through June 1996 for the U.S. and five other stock markets. They divide their data into two sub-periods to examine cointegration in a pre- and post-globalization periods. Tests indicate two and one cointegrating vector(s), respectively. In the latter period, their VECM suggests that price changes in the US market lead price changes in Canada and Great Britain, but not Japan, Australia, or Germany.

[Bessler and Yang \(2003\)](#) study international stock market interdependence using the same nine national equity markets studied by [Eun and Shim \(1989\)](#). Their daily stock index price data covers the time period from June 4, 1997 through June 15, 1999. Their data are converted into US dollars, whereas Eun and Shim's data are in local currency. Bessler and Yang find one cointegrating vector that arises as a linear combination of two or more of the nine national price series. Innovation accounting techniques applied to the error correction model show that while (p. 285) “. . . the US market is highly influenced by its own historical innovations, it is also influenced by market innovations from Great Britain, Switzerland, Hong Kong, France, and Germany. . . . More importantly, . . . the US market is probably the only market that has a consistently strong impact on. . . - other stock markets in the longer-run (30 days). Arguably, this can be interpreted, consistent with Eun and Shim, as evidence of the US market's role as the leader in world markets.”

[Heilmann \(2010\)](#) uses weekly price series data denominated in both US dollars and local currencies in a multivariate cointegration analysis of the US and eight Asian national equity markets over the January 1995 through August 2010 period. In local currencies, he finds that each of the nine indexes is integrated of order one. His VECM indicates that innovations in the US market influence price changes in all other markets, except Thailand and Malaysia. Japan, the largest Asian economy, is not influential on any market, but reacts to changes in the US, Hong Kong, Malaysian, and Philippines stock markets. In US dollars, each market is also integrated of order one, there continues to be one cointegrating vector, and the US market is again the most influential.

The results of these studies indicate that, while there is some commonality, there are many differences. Collectively these studies suggest that VAR and/or cointegration results are not necessarily consistent within a common time period depending upon whether the researcher is using price time series denominated in local currencies or a common currency, say, the USD. This, in turn, suggests that the exchange rates time series may have a significant effect on the results. To see this, assume there are n markets: $n - 1$ foreign markets and the US market. Let z_{jt} (Z_{jt}) denote the closing price level of foreign market j 's index ($j = 1, \dots, n - 1$) on day t ($t = 1, \dots, T$) in local currency (USD), where $Z_{jt} = z_{jt} * f_{x_{jt}}$, and $f_{x_{jt}}$ is the American term exchange rate for converting local currency j into US dollars on day t . Daily continuously compounded rates of return in local currency are generated by taking the natural log of the daily price relatives: in USD $R_{jt} = \ln(Z_{jt}/Z_{jt-1})$; in local currency $r_{jt} = \ln(z_{jt}/z_{jt-1})$; and, the exchange rate change is $e_{jt} = \ln(f_{x_{jt}}/f_{x_{jt-1}})$. It follows that

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