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Time spans between price maxima and price minima in stock markets

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HIGHLIGHTS

- We investigate the distribution of time spans between price maxima and minima.
- Both the time spans of price fall and price rise yield an exponential distribution.
- Price rise/fall asymmetry is observed from parameters of the distribution.
- The empirical results are robust across eight representative stock markets.

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ABSTRACT

We empirically investigate the distribution of time spans between price maxima and price minima in international stock markets, where a time span is defined as the time interval between a local price minimum and a local price maximum, and local price extrema are identified by a method introduced by Preis and Stanley (Preis et al. (2011), Preis (2011), Preis and Stanley (2011, 2010), Preis (2010), Preis and Stanley (2010), Stanley et al. (2010), Preis and Stanley (2009)). The empirical results show that both the tail distributions of time spans from local price maxima to local price minima and the tail distributions of time spans from local price minima to local price maxima yield an exponential distribution. In addition, price rise/fall asymmetry is observed by comparing the values of the exponents of the distribution curves. These results are robust across eight representative stock markets.

1. Introduction

Stylized empirical facts that emerge from statistical analysis of price variations in various financial markets have become a major topic of study over many decades, both from an academic and a practical perspective. These stylized facts are universal regularities, independent of time, place and specific compositional details and can be used to study financial data sets and the adequacy of financial theories. Cont [1] presents a set of stylized empirical facts that emerge from a statistical analysis of price variations in various financial markets. These stylized facts include non-Gaussian distributions, heavy tails, aggregational Gaussianity [2–4], absence of linear autocorrelation, slow decay of autocorrelation in absolute returns [5,6], volatility clustering [7–9], conditional heavy tails, leverage effects [10], volume/volatility correlations [11–16], power-law long range cross-correlations [17,18], intermittency, asymmetry of time scales and gain/loss asymmetry [19–21].

While these stylized facts about price series generally involve returns, relatively little research has focused on time spans between price maxima and price minima. This paper therefore seeks to uncover empirical regularities regarding market price behavior by exploring the statistical distribution of time intervals of price extrema. Local price extrema are identified in this paper using an approximation method to determine whether a stock price is larger/smaller in a given time period,

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Table 1
Descriptive statistics on index returns.

Panel A: mature stock market				
	United States	United Kingdom	Japan	France
Index	S&P500	FTSE100	NIKKEI225	CAC40
Sample period	03/01/50–30/04/13	02/04/84–30/04/13	04/01/84–30/04/13	01/03/90–30/04/13
Obs	15 932	7344	7208	5864
Mean	0.000286	0.000239	0.000046	0.000127
Std. dev	0.0097	0.0112	0.0145	0.0142
Skewness	−1.0306	−0.3766	−0.2725	−0.0230
Kurtosis	30.697	11.319	11.368	7.4328
JB-stat	511 418*	21 354*	21 120*	4801.7*
ADF-test	−91.816*	−39.885*	−63.566*	−37.103*
Panel B: emerging stock market				
	South Korea	India	Indonesia	Hong Kong
Index	KS11	BSE30	JKSE	HSI
Sample period	01/07/97–30/04/13	01/07/97–30/04/13	01/07/97–30/04/13	31/12/86–30/04/13
Obs	3905	3910	3846	6547
Mean	0.000244	0.001007	0.000501	0.000333
Std.dev	0.0198	0.0166	0.0173	0.0175
Skewness	−0.1945	−0.0905	−0.1912	−2.3863
Kurtosis	7.1400	8.5328	10.012	59.364
JB-test	2813.4*	4992.5*	7903.5*	872 853*
ADF-test	−58.834*	−58.284*	−53.751*	−44.526*

* denote statistical significance at the 1% levels.

a method introduced by Preis and Stanley [22–27,32,33]. Preis and Stanley revealed that the volume of each transaction increases dramatically as the end of a trend sequence is reached, while the time interval between each transaction drops. In other words, as prices start to rise or fall, stock is sold more frequently and in larger chunks. Preis and Stanley report that this behavior is consistent with the intriguing possibility that traders become tense and panic because they are scared of missing a trend switch. Our empirical results show that both the tail distributions of time spans from local price maxima to local price minima and the tail distributions of time spans from local price minima to local price maxima yield an exponential distribution.

Furthermore, price rise/fall asymmetry is observed by comparing the values of the exponents of the distribution curve, which is consistent with the stylized fact known as gain/loss asymmetry. The phenomenon of price rise/fall asymmetry or gain/loss asymmetry can be described by the observation that downward price movements are not equal to upward price movements. Using the inverse statistics approach [28,29], Jensen et al. [19] were the first to propose a simple and useful quantitative measure of price rise/fall asymmetry, defined as the difference between the exponents of the distribution curve of waiting times needed to obtain the same magnitudes of positive/negative returns. This phenomenon was later widely observed in different stock indices, including the S&P 500, and Dow Jones Industrial Average (DJIA) [19,21,30], as well as with foreign exchange [31]. Using the same method, Karpio et al. [20] also confirmed that waiting times for losses of a given magnitude are shorter than waiting times for gains of the same magnitude in mature markets, but they pointed that opposite pattern in emerging markets. Our work provides another way of confirming and measuring price rise/fall asymmetry, one that shows consistency across mature and emerging markets.

This paper is structured as follows. The next section provides basic information and describes our data. The third section presents the methods employed in the study and our results. The final section offers a summary.

2. Data and preliminary analysis

The selected data set comprises daily closing prices and corresponding trading volumes for four indices from mature markets and four indices from emerging markets. The stock indices are the S&P500 (United States), the FTSE100 (United Kingdom), the NIKKEI 225 (Japan), the CAC40 (France), the KS11 (South Korea), the BSE30 (India), the JKSE (Indonesia) and the HSI (Hong Kong). The sample period begins with the date that a given stock price index was recorded on each stock market and ends on April 30, 2013. All data are taken from the website http://finance.yahoo.com/. Table 1 provides basic information about each market and some descriptive statistics regarding price changes.

Following the conventional approach, the return series has been generated by taking the first log difference of the daily closing price

$$r_t = \ln(p_t/p_{t-1}) \tag{1}$$

where p_t is daily closing price at day t.

Table 1 presents basic statistics regarding stock returns in each market considered. Kurtosis ($value > 3$), found for the raw return series of each market, indicates a fat tail and greater peakedness than is characteristic of a normal distribution. Skewness indicates that return series are negatively skewed. Based on the Jarque–Bera test, the null hypothesis of a normal