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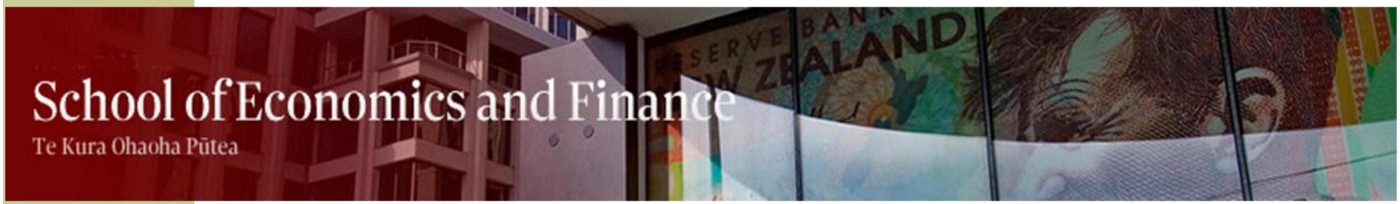

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On the dynamics of international stock market efficiency

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On the dynamics of international stock market efficiency

Abstract

Purpose – to measure the temporal change in market efficiency of 17 international stock indices based on small firms.

Design/methodology/approach – The Granger causality procedures is used to gauge the relative level of market efficient of the small firm stock indices. The corresponding stock index based on large firms is used as the reference of market efficiency. The magnitude of the causality is a measure of the degree that the small firm index is less efficient that the big firm index. The level of market efficiency is estimated on non-Mondays and Mondays.

Findings – At the start of the data in 1990, Mondays are less efficient than non-Mondays. On non-Mondays, the level of efficiency increases over the period 1900 to 2010. The rate of increase in efficiency on Mondays is greater than it is on non-Mondays. The evidence is that market efficiency increases over time at a decreasing rate.

Originality – Examines a new way of using the Granger causality procedure to examine the dynamics of market efficiency.

Keywords
Market efficiency, International, Stock indices, Panel model, Granger causality

Paper type Research paper

On the dynamics of international stock market efficiency

1. Introduction

This paper explores an alternative approach to the examination of the dynamics of market efficiency. The Granger (1969) causality procedure (see, for example, Wickremasinghe, 2011) is used to assess market efficiency. Except for a structural break analysis or a recommendation for it in some cases (see, for example, Karim and Majid, 2010; Narayan and Narayan, 2007), most authors stop short of exploring the dynamics of the Granger causality coefficient. Using a panel data regression model, we examine the way that the relative market efficiency of 17 international stock indices evolves over a period of 21 years. The focus is on stock indices based on relatively smaller firms. The corresponding stock index based on relatively larger firms is used as the gauge of market efficiency. The words 'big' and 'small' are used to differentiate between the two classes of index.

In an international study of the Monday effect in 50 stock indices, Keef, Khaled and Zhu (2009) make three observations. First, the degree of anomalous price behavior decreases over time. They equate anomalous behavior with market inefficiency. Using ME to represent the level of market efficiency, this observation can be represented by

$$ME = ME(t), \quad ME'(t) > 0 .$$

This is called Hypothesis 1.

Second, the rate of the temporal reduction of the anomalous behavior is larger for less developed economies. Third, the level of economic development goes hand in hand with market efficiency. These observations can be represented as $ME'(t) = f(ME)$, where $f_{ME} < 0$. The implication of this, under Hypothesis 1, is that market efficiency increases at a decreasing rate:

$$ME''(t) = f_{ME} ME'(t) < 0.$$

This is called Hypothesis 2.

Our research question relates to the degree that these between-country results also occur within a country, i.e., between two indices from the same country. The subjects in this study are a big index and a small index from 17 countries. The term '*GC* coefficient' is used to represent the degree to which the returns of the big index Granger-cause the returns of the small index. As conceptual framework, we posit that the *GC* coefficient is a measure of the inefficiency of the small index using the big index as the reference.

We examine the temporal change in the *GC* coefficient on non-Mondays and on Mondays. Under the assumption that the market efficiency of the big index is stable over time, there is support for Hypothesis 1 if the *GC* coefficient on non-Mondays, or Mondays, decreases over time. If one is prepared to accept that the market efficiency of the big index increases over time, then the decline of the *GC* coefficient provides support for Hypothesis 2. There is extensive evidence that stock index returns on Mondays are anomalous. Our conjecture is that the *GC* coefficient on Mondays will also be anomalous. There is further support for Hypothesis 2 if two conditions are met. They are: (i) at the start of the data in 1990, the *GC* coefficient on Mondays is larger than the *GC* coefficient on non-Mondays, and (ii) the *GC* coefficient on Mondays declines at a faster rate compared to non-Mondays.

2. Methodology

The stock index price series are obtained from Datastream. Our search isolated 17 countries where: (i) index price data for two indices are available for a period of 21 years (1 January 1990 to 31 December 2010) and (ii) we could reliably classify one index as being 'big' and other index as being 'small'. Our sample of countries is constrained by data availability. There are 89,230 possible trading days in the period. After missing values are taken into account, there are 86,316 cases available for analysis. Table 1 provides details of the indices.

Unreported preliminary analyses use four lags of the returns of both indices and the panel approach as described below. There are three important results. First, the returns of the small index do not Granger-cause the returns of the big index. Second, the returns of the big index Granger-cause the returns of the small index. These results are not exceptional. Third, with the latter result, the first lag of the big index is the only statistically non-zero estimated coefficient.

We do not fit the same empirical model (i.e., estimated coefficients) to all countries. Rather, we allow each country to have their unique empirical model in the framework of a panel regression. We finesse the 'average' of the 17 estimated coefficients for each independent variable. A Kronecker combination of the one-lag Granger model with the temporal variable and the Monday variable gives

$$
\begin{aligned}
r_{i,t}^{S} = & \sum_{i=1}^{17} \alpha_{0,i} D_i + \sum_{i=1}^{17} \beta_{0,i} D_i Y_t + \sum_{i=1}^{17} \gamma_{0,i} D_i M_t + \sum_{i=1}^{17} \delta_{0,i} D_i M_t Y_t \\
& + \sum_{i=1}^{17} \alpha_{1,i} D_i r_{i,t-1}^{S} + \sum_{i=1}^{17} \beta_{1,i} D_i r_{i,t-1}^{S} Y_t + \sum_{i=1}^{17} \gamma_{1,i} D_i r_{i,t-1}^{S} M_t + \sum_{i=1}^{17} \delta_{1,i} D_i r_{i,t-1}^{S} M_t Y_t \\
& + \sum_{i=1}^{17} \alpha_{2,i} D_i r_{i,t-1}^{B} + \sum_{i=1}^{17} \beta_{2,i} D_i r_{i,t-1}^{B} Y_t + \sum_{i=1}^{17} \gamma_{2,i} D_i r_{i,t-1}^{B} M_t + \sum_{i=1}^{17} \delta_{2,i} D_i r_{i,t-1}^{B} M_t Y_t \\
& + e_{i,t}
\end{aligned}
\quad , \qquad (1)
$$

where $r_{i,t}^{S}$ and $r_{i,t}^{B}$ are the daily rates of return of the small indices and the big indices, respectively, with subscript *i* representing the country, Y_t is a temporal indicator (= 0 in 1990 through to 20 in 2010) and M_t is a dummy variable which takes on a value of 1 if day *t* is a Monday, otherwise zero. The constant is suppressed and D_i (*i* = 1 ... 17) represents 0,1 dummy variables -- one for each country. The average of the 17 coefficients for each independent variable is denoted with an 'overbar'. As an illustration, the average coefficient of the *Constant* $\overline{\alpha}_0$ is

$$\overline{\alpha}_0 = (\sum_{i=1}^{17} \alpha_{0,i})/17 \quad . \qquad (2)$$

The averages and their corresponding standard errors are calculated by the use of linear restriction tests within the panel regression.

The coefficients in the first row of equation (1), i.e., those with a subscript of 0, measure the Monday effect and the temporal effect in the returns of the small index. The coefficients in the second row, i.e., those with a subscript of 1, are mandated by the Granger causality test. Since they are control variables, the estimated coefficients in row one and row two are reported without comment. The primary focus is on the four sets of coefficients in row three – those with a subscript of 2. When converted to an average of the 17 countries, they capture the average magnitude of Granger causality –

hereafter, they are called the *GC* coefficients with the unwritten connotation of 'average'. The conventional interpretation is: (i) coefficient $\overline{\alpha}_2$ is the *GC* coefficient on non-Mondays in 1990 (i.e., when $Y_t = 0$), (ii) coefficient $\overline{\beta}_2$ measures the temporal slope of the *GC* coefficient on non-Mondays, (iii) the *GC* coefficient on Mondays in 1990 is given by $\overline{\alpha}_2 + \overline{\gamma}_2$ and (iv) the temporal slope of the *GC* coefficient on Mondays is given by $\overline{\beta}_2 + \overline{\delta}_2$.

Equation (1) is estimated by the panel EGLS method using cross-section weights and panel corrected standard errors. This provides control for heteroscedasticity and contemporaneous correlation of the errors across countries. The lagged rates of return provide control for serial correlation.

3. Results and Discussion

The panel regression results are presented in Table 2. In 1990, the *GC* coefficient on non-Mondays is significantly positive ($\hat{\overline{\alpha}}_2 = 0.1468$, $p < 0.001$). This strong Granger causality declines at a statistically significant rate ($\hat{\overline{\beta}}_2 = -0.0069$, $p = 0.04$). This provides support for Hypothesis 1 under the assumption that the market efficiency of the big indices, on average, does not change over time. As suggested earlier, these results also support Hypothesis 2 if this latter assumption is changed to allow the market efficiency of the big indices to systematically increase over time.

In 1990, there is weak statistical evidence that the *GC* coefficient is greater on Mondays compared to non-Mondays ($\hat{\overline{\gamma}}_2 = 0.1263$, $p = 0.10$). However, in economic terms the difference is of practical importance. The estimated *GC* coefficient on Mondays ($\hat{\hat{\alpha}}_2 + \hat{\hat{\gamma}}_2 = 0.2731$) is almost twice the size of the coefficient on non-Mondays. The *GC* coefficient declines at a faster rate on Mondays compared to non-Mondays ($\hat{\hat{\delta}}_2 = -0.0136$, $p = 0.07$). Again, the statistical evidence is weak but the difference in the temporal slope is of economic importance. The slope on Mondays, $\hat{\hat{\beta}}_2 + \hat{\hat{\delta}}_2 = -0.0205$, is almost three times the slope on non-Mondays. In terms of slope and intercept, the *GC* coefficient results on Mondays dominate non-Mondays -- thus there is stronger support for Hypothesis 1. The results for Mondays also provide weak, in a statistical sense, support for Hypothesis 2. In a practical dimension, the support is far stronger.

4. Conclusions

Based on a pair of stock indices from 17 countries, the conclusion is reached that market efficiency increases over time (Hypothesis 1) at a decreasing rate (Hypothesis 2). The sample of countries can be classified as being highly developed. The study raises two issues. First, an interesting question is the degree that the results apply to less developed countries. *Ceteris paribus*, these countries are expected to provide stronger support for the hypotheses. Second, researchers into stock market anomalies and/or market efficiency should take into account the degree that the magnitude of the anomaly (e.g., Marquering, Nisser & Valla (2006) and/or the level of market efficiency evolves over time.

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Table 1

Countries and their Stock Indices

Country	Big	Small
Australia	S&P/ASX 20	S&P/ASX Small ord
Austria	DS Market (50 firms)	HSBC Smaller
Denmark	OMXC 20	S&P Small
Finland	DS Market (50 firms)	OMXH
France	CAC 40	DS Market (250 firms)
Germany	DAX 30	CDAX General
Hong Kong	Hang Seng	Hang Seng Small cap
Ireland	DS Market (50 firms)	S&P Small
Italy	Milan COMIT 30	Milan COMIT General
Japan	NIKKEI 225 Average	NIKKEI 500
Korea	SE Large-sized	SE Small-sized
Netherlands	AEX Index	Midkap
Singapore	FTSE W Singapore	S&P Small
Spain	IBEX 35	IBEX Medium cap
Sweden	OMXS 30	DS Market (70 firms)
UK	FTSE 100	FTSE All share
USA	Dow Jones Industrials	NYSE Composite

Table 2
Small Index Effects (equation 1)

Variable	Coefficient	Estimated Coefficient[(a)]	Standard Error	t	p
Panel A: M_t and Y_t effects on $r_{i,t}^S$					
Constant	$\overline{\alpha}_0$	0.0318	0.0259	1.23	0.220
Y_t	$\overline{\beta}_0$	–0.0011	0.0022	–0.50	0.614
M_t	$\overline{\gamma}_0$	–0.1211	0.0582	–2.08	0.037
$M_t Y_t$	$\overline{\delta}_0$	0.0063	0.0050	1.27	0.206
Panel B: $r_{i,t-1}^S$ effects on $r_{i,t}^S$					
$r_{i,t-1}^S$	$\overline{\alpha}_1$	–0.0553	0.0373	–1.48	0.138
$r_{i,t-1}^S Y_t$	$\overline{\beta}_1$	0.0039	0.0037	1.06	0.287
$r_{i,t-1}^S M_t$	$\overline{\gamma}_1$	0.1887	0.0863	2.18	0.029
$r_{i,t-1}^S M_t Y_t$	$\overline{\delta}_1$	–0.0065	0.0085	–0.77	0.444
Panel C: $r_{i,t-1}^B$ effects on $r_{i,t}^S$					
$r_{i,t-1}^B$	$\overline{\alpha}_2$	0.1468	0.0326	4.50	< 0.001
$r_{i,t-1}^B Y_t$	$\overline{\beta}_2$	–0.0069	0.0033	–2.10	0.035
$r_{i,t-1}^B M_t$	$\overline{\gamma}_2$	0.1263	0.0763	1.66	0.098
$r_{i,t-1}^B M_t Y_t$	$\overline{\delta}_2$	–0.0136	0.0076	–1.79	0.074

Note:
(a) These are averages over the 17 countries.