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R Square Measure of Stock Synchronicity

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Stock market synchronicity is a new area of research for finance and economics literature. Morck at al (2000) are among the first to propose a model of stock market synchronous behaviour of emerging markets and suggested that R square values of emerging markets are higher than the developed economies. This study analyses stock market data of eight emerging economies and three developed nations, and finds evidence that R square values of emerging economies are higher than their counterparts. It is also found that higher inflation, country geographical size, low level of corporate governance mechanism and inflation causes stock price to move in the same direction in observed emerging economies.

Keywords: Synchronicity, R square, Correlation, panel data

1. Introduction

Emerging markets exhibit higher stock price synchronicity than the developed economics. Stock synchronicity refers the tendency of a stock market to move in the same direction in a particular period of time; such as a given day or week. However, the stock synchronicity could be upward or downward depending upon the overall movement of the stock market. Morck et al.(2000) are among the first who propose two models to measure stock return synchronicity over a particular period of time. Both the models capture the level of firm specific information that is reflected in individual firm share prices. In addition, Khandaker and Heaney (2008) use a large time series data and replicate both these model to measure the stock market synchronicity. They suggested that higher inflation, country wide corruption and poor corporate governance mechanism causes higher stock market synchronicity in emerging economies.

This paper particularly uses the second model of stock market synchronicity suggested by Morck et al.(2000) and Khandaker and Heaney (2008) to analyse the selected emerging economies. The study uses eight emerging countries and three developed economics for the analysis. It is found that country specific characteristics such as voice & accountability, corruption index and geographical size are negatively correlated with R square measure and inflation is positively correlated consistent with Morck et al.(2000). In addition, China, Malaysia and Turkey exhibit the highest R square synchronicity during the study period, where as Germany and Japan exhibit the lower level of R square values. Finally there is evidence that higher R square values are evident in emerging markets.

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2. Recent Literature

Morck et al. (2000) are among the first who successfully argue that share prices in emerging economies move more closely together than the developed markets. They use bi-weekly stock return data to measure stock return synchronicity for 40 countries around the world. They argue that a lack of corporate transparency, less information disclosure policy, corruption and less corporate governance mechanisms influence the poorer economies stock market to move in the same direction. They found that poorer economies often do not have well structured financial systems and less disclosure policy might influence the stock market to follow the overall market in a particular direction in a given week.

Further, Morck et al. (2000) found that stock price synchronicity is negatively correlated with a country's size. They suggest that a 'small country effect' might cause the higher stock price co-movement found in smaller countries. This finding is further supported by Levine and Zervos (1998) and Khandaker and Heaney (2008) who also argue that smaller countries often have under developed financial markets leading to lower financial growth. However, this is to note that Khandaker and Heaney (2008) use a longer time period and large set of stock market data to analyse the stock market synchronous behaviour, where as Morck et al. (2000) use a large set of countries over a short time period of time.

There is also evidence that individual stocks are becoming more synchronous for average countries. For example, Li et al. (2003) examine the Canadian stock market and compare this with Mexico and the East Asian markets[i]. Li et al. (2003) found that Canadian stocks move less synchronously than Mexican stocks. They argue that since Canada entered into the free trade agreement with the US, its stocks have exhibited a permanent increase in firm-specific variation because of increased market openness to the US market. In addition, Skaife et al. (2006) find that lower R-square values are associated with more informative prices in developed economies, where as higher R square values are associated with low informative prices in the stock market and lower corporate governance mechanism (Nguyen and Aman 2006, Wurgler 2000).

It is to note that the concept of stock market synchronicity is not very new to the finance literature. For example, French and Roll (1986) and Roll (1988) argue that high stock prices and a well-informed market generate low stock synchronicity. Roll (1988) shows that the movement of stock prices depends on several related factors which include firm-level and market-level information that is capitalised into stock prices.

However, it is found from the existing literature that stock markets in emerging economies are more synchronous over time than in developed markets. Higher stock synchronicity is evident from countries that do not respect private property rights, and corporate governance mechanisms are less effective in those economies.

3. Research Methodology and Data

3.1 Research Methodology

The study uses synchronicity measure developed by Morck et al.(2000) called the R square measure. The R-square synchronicity measure is the most popular model in the literature for capturing stock market synchronicity. For Example, Roll (1988) found that individual stocks in the USA exhibit low R-square statistics due to the higher disclosure policy. Chan and Hameed (2006) also use this measure to explain analyst coverage for emerging markets and argue that emerging economies exhibit higher stock price co-movement due to the high cost of collecting firm-specific information.

Further, Morck et al. (2000) argue that lower firm-specific information is produced in emerging markets which results in higher R-square values, while higher firm-specific information produced in developed markets results in lower R-square values. In addition, Jin and Mayers (2004) argue that countries with higher R-square values experience more frequent market crashes.

However, given the simple market model share return can be expressed as a fraction of share market return:

$$R_{i,t} = \alpha_i + \beta_i R_{m,it} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the firm i return for period t, $R_{m,it}$ is the market return of firm i for t period, $\varepsilon_{i,t}$ is the error term and α_1 and β_i are estimated parameters. The R^2 measure is the percentage of variation in weekly return of stock i in country j explained by variations in country j 's market return, or:

$$R_{it}^2 = \left(\frac{Cov(R_i\ R_m)}{\sigma_i\ \sigma_m} \right)^2 \quad (2)$$

where Cov($R_i R_m$) is the covariance between the share returns and share market returns and σ_i is the standard deviation for asset i.

A high R-square indicates a high degree of stock return synchronicity and a low R-square indicates a low degree of stock return synchronicity for a given stock for a particular period of time, e.g. a given week or day.

3.2. Data

The study analyses stock market data from eleven economies, including three developed economies and eight emerging markets. The data span the period from January 1996 to December 2005. It is to note that the study uses DataStream database to collect weekly stock return data. However the study also uses yahoo

finance database where a gap exists in DataStream database. The study uses both the live stocks and the dead stocks to minimize the survivorship bias problem. Table 1 illustrate the total number of observed firm data collected from the DataStream and yahoo finance database. In total the study analyses 6.6 million weekly firm observations for estimating R square measure for developed and emerging countries.

Table 1
Total number of observed firms for R square synchronicity analysis

Emerging Country	No of Firms	Developed Country	No of Firms
Argentina	216	Australia	2,709
China	1,905	Germany	1,506
Cyprus	144	Japan	2,842
Malaysia	1,316		
Sri Lanka	301		
Taiwan	1,145		
Turkey	515		
Zimbabwe	100	Total number of firms	12,699

3.3. Panel Data Analysis Variables

The study uses six country-level stock synchronicity explanatory variables for panel data analysis; these include voice and accountability, regulatory control, GDP per capita, inflation, geographical size of a country and corruption index.

Corporate governance indices e.g. voice & accountability and regulatory control collected from the World Bank corporate governance database. These governance indicators reflect the statistical compilation of responses to questions concerning the quality of governance. It is to note that, the World Bank uses six corporate governance indicators for measuring the good governance system, which is divided into three clusters. The governance indicators are measured in units ranging from -2.5 to 2.5. Higher values correspond to better governance outcomes and lower values correspond to poorer outcome. For example, a country that ranks 2.0 in terms of corporate transparency maintains strong transparency in government and private sectors. This also indicates that there is a strong flow of information in the market. In contrast, if a country has a rank of -2.0 for the rule of law indices, this would indicate a relatively poor quality legal system. The study also collected GDP per capita and inflation data from World Bank database.

Further, corruption indexes data are collected from Transparency International database a German based organization. Transparency International first presented their corruption index (CP) in 1995. The corruption index is based on the past three year's corruption perception data. The corruption index uses public opinion surveys to measure the level of corruption in a country and the corruption scale ranges from 1 to 10 points. Countries with greater transparency are awarded higher points (maximum 10) and countries with lower transparency are awarded fewer points (minimum 0).

In addition, geographical size of a country data is collected from CIA world factbook website. The CIA world factbook is published by the Central Intelligence Agency, USA. The CIA website provides accurate and reliable country level data including geographical size.

4. Descriptive Statistics Analysis

Table 2 illustrates the descriptive statistics of R-square measure for eight emerging countries. The data span the period from January 1996 to December 2005. It is found that China, Malaysia, Turkey and Taiwan exhibit higher R square measure stock synchronicity for the emerging country group. China exhibits .241 and Malaysia exhibits .254 R-square values during the observation periods which are the highest R-square synchronicity during the observation period for any emerging counties with standard deviation 0.127 and 0.179. Turkey on the other hand exhibits 0.239 R-square values with standard deviation of 0.183. This suggests that Turkey, Malaysia and China have the highest R-square value during the observation period, a result which is consistent with previous literatures.

Table 2
Descriptive Statistics for Emerging Country Group

	Mean	Median	Maximum	Minimum	Std. Dev.
Argentina	0.104	0.035	0.622	0.000	0.141
China	0.241	0.260	1.000	0.000	0.127
Cyprus	0.159	0.120	0.797	0.000	0.161
Malaysia	0.254	0.255	0.848	0.000	0.179
Sri Lanka	0.121	0.044	0.762	0.000	0.157
Taiwan	0.173	0.155	1.000	0.000	0.127
Turkey	0.239	0.218	0.771	0.000	0.183
Zimbabwe	0.122	0.076	0.590	0.000	0.134
Average	0.177				

Further, China and Taiwan exhibit R-square values of maximum 1.000 during the observation period which is unexpected. This suggests R-square measure of stock synchronicity could be as high as 100 percent for a given week in emerging countries. This is a surprising finding though consistent with Morck et al (2000).

Table 3 illustrate R-square measure of observed developed countries. It is found that Germany and Japan exhibit lower level of R-square value during the observation period. However, the average R-square synchronicity measure for the developed country group is 0.019, quite lower than the emerging country group (0.177). This suggests that the observed developed country group exhibit lower level of stock synchronicity than the observed emerging country group during the study period.

Table 3
Descriptive Statistics for Developed Country Group

	Mean	Median	Maximum	Minimum	Std. Dev.
Australia	0.041	0.017	1	0.000	0.087
Japan	0.007	0.001	1	0.000	0.06
Germany	0.010	0.001	1	0.000	0.069
Average	0.019				

The study also run ANOVA test statistics to examine whether there are any statistical mean differences in the R-square measure between the developed country and the emerging country group. Table 4 illustrates ANOVA test statistics between two groups. It is found that there is a statistical mean difference in the R-square synchronicity measure at one percent significant level between two groups.

Table 4
ANOVA test Statistics for the R-square Measure.

	Sum of Squares	Degrees of Freedom	Mean Square	F- Statistics	Sig.
Between Groups	.054	1	.054	18.398	.002
Within Groups	.026	9	.003		
Total	.080	10			

Sub-Period Data

To check the possibility of changes in the level of R-square synchronicity measure during the observation period from 1996 to 2005, the study divide the time series into five sub-periods, 1996-97, 1998-99, 2000-01, 2002-03 and 2004-05. Table 5 illustrates the descriptive statistics of R-square synchronicity measure over the five sub-periods for the emerging county group.

Table 5
Sub period R-square synchronicity measure for emerging countries
Form January 1999 to 2005

Country	1996-1997	1998-1999	2000-2001	2002-2003	2004-2005
	R-square	R-square	R-square	R-square	R-square
Argentina	0.246	0.238	0.128	0.099	0.176
China	0.387	0.306	0.252	0.321	0.201
Cyprus	0.176	0.163	0.283	0.251	0.093
Malaysia	0.376	0.450	0.324	0.186	0.112
Sri-Lanka	0.089	0.098	0.185	0.162	0.149
Taiwan	0.233	0.231	0.254	0.223	0.162
Turkey	0.259	0.317	0.366	0.284	0.181
Zimbabwe	0.157	0.1	0.081	0.211	0.238
Average	0.240	0.238	0.234	0.217	0.164

Studies find that countries exhibit higher R-square measure during the full period, also exhibit the higher synchronicity for the sub periods. Examples include China

and Turkey. However, the levels of R-square measure stock synchronicity remain volatile in sub periods for most of the emerging countries.

Table 6 illustrates R-square variation by sub-periods for the developed country group. It is found that developed countries exhibit lower level R-square values during the observed sub-periods, especially Japan exhibits lowest R-square values in all sub periods. It is to note that the result is conflicting for Japan with the previous studies.

Table 6
Sub Period R square Synchronicity for developed Countries
Form January 1999 to 2005

Country	1996-1997	1998-1999	2000-2001	2002-2003	2004-2005
	R-square	R-square	R-square	R-square	R-square
Australia	0.015	0.028	0.015	0.026	0.019
Germany	0.017	0.024	0.011	0.011	0.021
Japan	0.008	0.012	0.012	0.012	0.019
Average	0.013	0.021	0.013	0.016	0.020

However, Japan has a history of volatile stock market and R-square stock synchronicity measure only the stock market co-movement rather than stock market volatility. It is possible for a volatile stock market to exhibit low level of stock market synchronicity, e.g. Japan. Further analysis of this question remains for future research.

5. Panel Data Analysis

The model

The study uses ordinary least square model and white adjusted standard errors in a fixed effect model for the panel analysis. Table 7 illustrates cross sectional panel analysis using both models. The study also tests correlations between the explanatory variables to check the multicollinearity between the explanatory variables. However, the paper used the following model to explain R-square measure of stock synchronicity.

$$RSqu_i = \alpha + \beta_1 RC_i + \beta_2 VC_i + \beta_3 IN_i + \beta_4 CP_i + \beta_5 GDP_i + \beta_6 \log(SIZE_i) + \varepsilon_i \quad (3)$$

Where $RSqu_i$ represents R-square measure for stock synchronicity of country i and α is a constant. RC_i is the regulatory control index, VC_i is the voice and accountability index, IN_i is the inflation, CP_i is the corruption index, GDP_i is the gross domestic product per capita / 10,000, $SIZE_i$ is geographical size and ε_i is the error term. The natural log of geographical size is used to limit the effect of skewness on this variable.

Table 7
Panel data analysis for R square synchronicity measure

Here, the first column includes variable names, second column includes pooled regression findings and third column includes findings of the fixed effect model. Two values are reported below the estimated coefficient. The first in parenthesis is the t statistic using white adjusted standard errors and the second, in the brackets, is the P value for the statistic.

Variables	Pooled regression model	Fixed effect model
Regulatory Control	**0.102**	**0.093**
	(3.987)	(3.161)
	[0.000]	[0.003]
Corruption Index	**-0.019**	**-0.018**
	(-1.573)	(-1.604)
	[0.124]	[0.117]
GDP Per Capita /10000	**0.000**	**0.000**
	(-2.706)	(-3.151)
	[0.010]	[0.003]
Inflation	**0.000**	**0.000**
	(0.782)	(0.671)
	[0.439]	[0.507]
Voice & Accountability	**-0.070**	**-0.071**
	(-2.947)	(-5.033)
	[0.005]	[0.000]
Log (Geographical Size)	**-0.005**	**-0.007**
	(-0.867)	(-1.233)
	[0.391]	[0.225]
R-square	**0.722**	**0.748**

The study finds evidence that corruption index is negatively correlated with the R-square synchronicity measure at the 15 percent significance level using the pooled regression analysis. It is a significant result for the study because it is argued that higher corruption rate causes higher stock price synchronicity thus higher R square. Further, it is found that emerging countries rank lower in corruption index and developed economies rank higher due to the level of corruption. The findings are consistent with Morck et al. (2000) and Khandaker and Heaney (2008). In addition, Khandaker and Heaney (2008) argued that higher corruption indicates weaker political system and civil rights which causes corrupt economies to rank lower in the property rights index.

Regulatory control is an important governance mechanism thought necessary to establish a good governance system in a country. The study finds that regulatory control is positively correlated with R-square measure at the one percent

significance level. It is to note that both the governance mechanisms are important to establish a good governance system in a country. The finding is significant as it is argued that countries with good governance mechanism have structured capital markets thus exhibit lower stock price synchronicity.

Another governance mechanism 'voice and accountability' is negatively correlated with the R-square measure at one percent level which is surprising. Nevertheless, the study finds evidence that some of the observed emerging economies, such as Taiwan and Cyprus ranked higher in 'voice and accountability' index than some of the developed nations (e.g. Japan) though exhibit higher R-square values during the observation period. Conversely, the study also uses white adjusted standard error in a fixed effect model for the panel analysis. The results are unchanged with small variation in coefficient.

Unexpectedly GDP per capita is positively correlated with the R-square measure at the one percent significant level using both the models. This is a surprising result as it is assumed that high GDP per capita countries produce lower level of stock market synchronicity and lower R-square values. However, the coefficient for GDP per capita is close to zero suggesting immaterial impact to this model.

Geographical size is negatively correlated with the R-square synchronicity measures and inflation is positively correlated. This result is consistent with Khandaker and Heaney (2008) and Morck et al. (2000) who suggested that country geographical size is generally negatively correlated with stock market synchronicity. However, the impact of both these variables on R-square measure synchronicity is not statistically significant and co-efficient of both these variables are close to zero.

6. Discussion

It is found from the analysis that the R-square values for the developed economies are less than the emerging economies using the sample countries. In total, the study uses 6.6 million weekly firm observations and 12,699 firm data from eight emerging economies and three developed markets. The study finds evidence that emerging economies exhibit 0.177 R-square values during the observation period compared to the R-square values of 0.019 from the developed economies. There is evidence that emerging economies like China and Malaysia could have 100 percent of the stock to move in the same direction in a given week thus having R-square values of 1.00. it is a very significant result and consistent with the findings of Morck et al. (2000), Alper and Yilmaz (2004) and Khandaker and Heaney (2008). In addition, Japanese stock market exhibits lowest R-square values during the observed full period and sub period analysis suggesting that stock market volatility and synchronicity are not to capture similar aspects of stock market behaviour.

It is found that R-square values are lower in high inflationary economies than low inflationary economies though the result is not statistically significant. Morck et al. (2000) argued that high inflation causes high stock price synchronicity in emerging economies. Further, the study finds evidence that emerging countries like Turkey exhibits higher R-square values and also has exhibit high level of inflation.

However, in recent years Turkey exhibits lower level of inflation which also affects its R-square values in sub period 2002-03 and 2004-05.

Corporate governance mechanisms have strong impact on R-square synchronicity values. The study uses two corporate governance mechanisms and found that 'voice and accountability' is significantly associated with the R-square measure values. Previous studies also show that countries with high corporate governance mechanism exhibit a low level of stock market synchronicity. Examples include Germany and Japan. In addition, countries do not respect the private property rights has high level of corruption and also ranked low in corporate governance index, thus exhibits a high R-square values. Example includes China and Turkey (La-Porta et al. 1998).

There is also evidence that country geographical size has some impact on its R-square values thus stock synchronicity measure. For example, it is found that most of the countries of the world conduct the major part of their trading internally and large countries often have structured debt and equity markets which directly influence the growth of the economy; such as Australia and the USA. In contrast, smaller countries tend to have fewer large firms in their capital market which can manipulate the financial markets and could lead to higher stock price synchronicity (Morck et al 2000). However, it is assumed that the geographical size impact is not statistically significant in this case due to the small number of large country in the sample.

The study presented evidence that stock market synchronicity is higher in emerging markets than the developed economies using the R-square measure. There is also evidence that high inflation, country geographical size, low level of corporate governance mechanism and inflation causes stock price to move in the same direction in emerging economies. Although this study uses a large time series data from eight emerging economies and three developed markets, a further research is necessary to identify the country specific characteristics of emerging market synchronous behaviour.

Endnotes

[i] Li et al. (2003) use *R-square* synchronicity measures for their cross-sectional analysis.

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