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Does Entropy Index Explain the Determinant of Capital Market Integration in ASEAN?

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Abstract: Research Question: This study will examine whether the entropy index by Ruefli (1990) could become the main determinant of capital market integration in ASEAN. **Motivation:** Continuing the study of Pretorius (2002) and Bracker and Koch (1999) who successfully used the correlation equation model to explore the capital market integration determinants in several regions, this study utilizes the correlation method to identify some new determinant of the capital market integration in ASEAN such as level of intra industry competition and intensity of role of global investors. **Idea:** This study is proposed a new thinking in the capital market integration i.e. when the capital market is integrated so thus there is no relevant for international diversification; but it will shift to the industrial diversification. **Data:** This study needs not only four data years 2006-2009 but also requires 10 industrial groups from the Global Industry Classification Standard (GICS) version from OSIRIS toward 5 ASEAN countries hence we obtain 240 data observations in order to employ SUR. Especially 10 industrial groups from GICS is used to estimate entropy index by Ruefli (1990) for each industry. **Method/Tools**: We must use SUR (Seemingly Unrelated Regression) and for estimation process is compliance to Zellner's assumption that there should be a contemporaneous correlation of error from each equation of 5 ASEAN countries. **Findings**: we find that the entropy index of Ruefli (1990) is proven as an effective proxy for level of intra industry competition which functions as primary determinant of capital market integration in ASEAN. While the other finding is some stock market such as Malaysia looks so restrictive towards the existence of global investors. The finding confirms the result of Mitchell and Joseph (2010) and Omay and Iren (2019) about the strict foreign exchange control regime in Malaysia. **Contribution**: We are probably one of the market integration studies that obtain industrial structure becomes the main determinant of market integration through entropy index and we reconfirm the studies of Faff and Mittoo (2003), Roll (1992), Pretorius (2002), Carrieri *et al.* (2004) and Hwang and Sitorus (2014) which has considered about industry factors.

Keywords: Entropy index, unconditional and dynamic conditional correlation, SUR (Seemingly Unrelated Regression), stock market in ASEAN
JEL classification: G15, G32, Q02

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1. Introduction

From Cheng (2000) and Yusof and Madjid (2006) and then Do *et al.* (2016), we can identify two groups of studies of market integration namely IRGISG (Intensity of Role of Global Investors Study Group) and Industry Factors Study Group (IFSG). Examples of IRGISG namely Bekaert *et al.* (2002), Edison and Warnock (2003) and Froot and Ramadorai (2008) and examples of IFSG are Tu (1998), Faff and Mittoo (2003) and Carrieri *et al.* (2004). Both of studies claim that Local Pull Factors (LPF) and Global Push Factors (GPF) are more important to one another, although they refer to the theory of stock market interdependence from Pretorius (2002). These conditions will bring to the *first research gap* i.e. the divergence from Local Pull Factors and Global Push Factors as main determinant of market integration.

The theory of stock market interdependence of Pretorius (2002) says there are three determinants of the integration such as the contagion, economic integration and capital market characteristics. Capital market characteristics include volatility, liquidity and industry similarity. From the theory of stock market interdependence it is stated that Global Push Factors associated with contagion because contagion occurs as a result of increased international capital flows. Meanwhile, Local Pull Factors are characteristic of the appeal of a capital market for global investors.

In the view of IRGISG, Global Push Factors will be more relevant as a determinant of integration due to the role of global investors since the era of liberalization of capital markets increased. The role of global investors is demonstrated by the increasing global investor fund flows. According to Froot and Ramadorai (2008), the increased flow of funds will affect the global investor in the stock market index of a country. Dvořák (2005) and Aggarwal *et al.* (2009) states the foreign funds flow will affect the level of integration for a more open capital markets would be utilized by global investors to be more aggressive in penetrating. But the study of Edison and Warnock (2003) and Bae *et al.* (2004) stated that some countries increase the level of protection for local investors. This is because the more negative the dominant role of global investors who are expected to take action to destabilize the local stock exchange to trigger an increase in the volatility of the stock and in turn lead to bubble. Nevertheless study of Bekaert and Harvey (2000) declared that global investor also has the positive role that can bring improved performance and liquidity of the market index trading. Which then becomes a problem is the behavior change of global investors is hard to be detected at any time by the regulator.

Meanwhile in the opinion of Industry Factors Study Group (IFSG), Local Pull Factors more relevant as a determinant of integration as an industry sector will have an attraction for global investors. Before the flow of investment funds, global investors will study the characteristics of each industrial sector. Based on the study of MSCI Barra, every country in ASEAN has a unique respective industry. According to the study of Carrieri *et al.* (2004) and Dutt and Mihov (2008) the industrial sector is expected to affect the level of integration because it has a risk exposure that is worthy of consideration by every global investor in calculating the benefits of international diversification. In the classical model ICAPM, the higher the expected return required of an industry makes the higher the risk to be borne by the industry. Moreover it would be true if the industry is categorized as the global industry such as the Faff and Mittoo (2003). More relevant Local Pull Factors (LPF) as a determinant of integration as well as the industrial sector has two arguments i.e. the similarity of industrial structure and industry strategic risk. According to Roll (1992), industrial structure similarity is that if two countries have similar industrial structures, the comovement between the two countries in the market index will increase along with the high concentration of cash flow.

While it also industry strategic risk associated with competitive conditions in the industry. These factors should be considered by global investors because it adds to the risk component of international diversification. Menchero and Morozov (2011) declared that the global investor can further enhance the benefits of diversification through a more focused strategy of diversification in industries with low levels of competition. But the next question arises of how to measure the level of competition. Biker and Haaf (2002) and Hsin and Tseng (2012) measure the level of industry competition with HHI (Herfindahl Hirschman Indices), whereas the HHI is designed to industry concentration. Industry concentration may reflect the nature of competition in the long life industry. In the turbulence industry such as information technology, concentration does not reflect the nature of competition in the industry and the consequences it was to be inadequate if HHI is continue to used as a proxy of competition. Thus it will create *a second research gap* that is the need for measures the level of competition in the industry as a more appropriate because it is generally a qualitative measure of competition. One of example is Porter's Five Forces. So this study takes a measure of competition is more quantitative. Gauge this competition is the entropy index by Ruefli (1990) that will measure how drastic changes in its ranking in the industry for a period of observation. Entropy indices are calculated by OTSA (Ordinal Time Series Analysis) is considered superior to the HHI (Herfindahl Hirschman Indices).

Based on the first and second gap, it will also be created *the third gap of this study* i.e. how to model simultaneously both determinants of the level of integration of both Local Pull Factors (LPF) and the Global Push Factors (GPF). Simultaneously modeling is expected to justify the theory of stock market interdependence of Pretorius (2002) that these two equally important factors. Simultaneous modeling of both the determinants of integration is still dominated by panel data regression and cointegration techniques. Panel data regression conducted by Chuah (2005) and Bekaert *et al.* (2011) find that the LPF is more important than GPF in emerging markets (including ASEAN). Cointegration techniques in ASEAN were conducted by Click and Plummers (2005) and Kuper and Lestano (2007) with more focus on Global Push Factors. This is because the motive for their study is the detection of long run equilibrium relationship between ASEAN countries indexes and index of developed countries. The findings of these two approaches are contradictory, so in our opinion it was taken a more comprehensive modeling.

Finally for the academic contribution we have two items, first, we will address to examine the capital market integration determinant using two indicators that is entropy index by Ruefli (1990) referred to Roll (1992), Pretorius (2002), Faff and Mittoo (2003), Dutt and Mihov (2008) and the other is the intensity of the role of global investors the basis of international capital mobility argument from Marston (1995) and Mishkin and Eakins (2000) and the role of global investors from Bekaert and Harvey (2005) and Froot and Ramadorai (2008).

Secondly, we extend correlation equation model from Bracker and Koch (1999) and Pretorius (2002) with stressing the derivation of the empirical model (section 3.1 until 3.3) and adding the new factor determinant of capital market integration in ASEAN countries i.e. Entropy Index by Ruefli (1990) and the Entropy Concept by Ng (1995). The estimation of Entropy Index must need data construction of GICS in ASEAN.

2. Literature Review and Hypotheses Development

2.1 Stock Market Interdependence

According to Pretorius (2002), the assumption of stock market interdependence is LOOP (Law of One Price). LOOP itself states an integrated market is the market where the asset has the same expected return regardless of where assets are traded. As for the capital market is segmented then the expected return of asset markets will depend on the location of the related asset. LOOP is a consequence of the enactment of global investors needs to consider the global risks. LOOP enforceability will depend also on how much the mobility of international capital flows. Mobility of international capital flows will increase the linkage of each stock market. International capital flows will become into the mechanism of global investors for international diversification activities. On the one hand they will secure the investment in capital markets of host countries and on the other hand they also will secure savings (risk-free investment) in the country of origin. If there is no substitution effect between saving and investment, international capital flows will continue to flow and the stock market will raise interdependences. Pretorius (2002) states independences of stock market will depend on contagion, economic integration and capital market characteristics.

2.2 Contagion

Contagion can be described as the comovement of the stock market is not caused by the general movement of fundamental factors. There are two factors that work such as the informational factors and institutional factors. Informational factors based on well-known from the comparison between the stock market and the "Keynesian Beauty Contest". By the same analogy with the "Keynesian Beauty Contest", investors in the stock market will sell its investment in specific asset class if they believe that other investors will sell their investments in the same class. Herding behavior of investors will lead to excessive volatility as noted also by Bekaert *et al.* (2005).

While institutional factors related to redemption and about two stage investment strategy of hedge fund. Most of the flow of funds into emerging market is open end fund that commonly purchased by global investors. When faced with large scale withdrawal, then the hedge fund will sell all the assets into more liquid market or they will allocate their assets into several indices-weighting. Their action would create an excessive decline in the performance of the market.

2.2.1 Economic Integration

There are two explanatory factors that is bilateral trade and macroeconomic variables like as interest rate and inflation. The extent of correlation between variables was applied to the two countries thus the correlation between the two countries over the market return will also increase depending on the closeness of the bilateral trade between the two countries. When conducting the return correlation testing in ASEAN, Click and Plummers (2005) finds the similar pattern to the return correlation between Singapore and Malaysia is stronger than the return correlation between Singapore and Philippines.

Bracker and Koch (1999) states that the interest rate and inflation has an influence on the market return. So the correlation between the two variables will also influence the correlation of the market return. It is also reinforced by Roll (1992) that the interest rate and inflation will be considered by global investors when making asset valuations. In contrast to the bilateral trade is positively related to the correlation of stock returns, therefore interest rate and inflation would have a negative influence each other.

2.2.2 Capital Market Characteristics

There are three components of capital market characteristics i.e. the volatility, liquidity and industry sectors (but that overlooked here is the industrial sector). The argument is that when two countries have similar industrial structures, the correlation between the two market indexes will rise. For example, when the two markets in emerging market index is dominated by the stocks in a sector such as Oil and Gas, so when a decline in world oil demand will result in a significant reduction of its share price of Oil and Gas in the two countries. The dominance of this industry sector was much easier to make international factors affecting the movement of market indices compared to the two countries if these countries have a heterogeneous structure of the industry. One important part of the industrial structure according to the study of Ng (1995) is the industry concentration. Industry concentration relates to the opinions of Roll (1992) about the similarity of industrial structure. The stock return correlation between two stock markets will increase when the composition of the growing industrial sectors of both countries has similarities. Increase in correlation is not only because the flow of funds from bilateral relations on the basis of economic policy and business cycles but also due to the homogenization of the international diversification of industrial structure on a global investor. Homogenization of the industry structure here is the dominance of the industrial sector on a consolidated market index.

Roll (1992) then describes the context of the industrial structure in terms of volatility and correlation difference. When an industrial sector in a country has a high volatility will not necessarily follow the same conditions in other countries. This happens because of the dominance of the industrial sector as the dominant sector in each country will vary according to the economic potential of each country. Volatility that occurred that was caused by the excess of (induced) negative international diversification, which in the beginning but then expect an increase in return that there is an increase in correlation. In a study of Roll (1992) the Herfindahl index was used as a proxy for industrial structure affects the volatility of returns. These results reinforce the view that the industrial structure has the potential to be a correlation of stock returns explanatory variables. This is because the volatility or the variance return is the decisive element return correlations are important in addition to the covariance of two related stock returns.

Meanwhile Bekaert and Harvey (1997) suggests the increase in correlation is due to the increased volatility of stock returns. But as soon as they argued that the increased volatility of stock returns will be an attraction for global investors in the international diversification strategy. Despite the high volatility of return raises the level of correlation, but Chen and Zhang (1997) suggests the benefits of international diversification remains a reliable global investors from an industry that provides a higher return. This condition is realized when global investors put forward as a partner country portfolio and this is reinforced Bekaert and Harvey (1997) and Cha and Oh (2000) who found a low correlation between the market return the developed and developing countries. One other issue about the relationship between industry sectors with the stock market interdependence is the relationship between industrial sectors with other industrial sectors. Park and Woo (2002) found a correlation significance of the industry return index in developed countries over the period 1973-2001. Of particular interest is the correlation between the level of the industry in general the European countries is higher when compared to USA, except for industrial TMT (Technology, Media and Telecommunication). The findings of Park and Woo (2002) for non TMT industries in line with the assumption of bilateral trade in economic integration. While for the TMT industry showed higher idiosyncratic risk of the TMT (USA) from TMT (Europe) like as IT Bubble.

2.3 Hypothesis Development

2.3.1 Concept of Entropy

In general, entropy is a measure of the amount of disorder in the system. High entropy means disorder is high while the low entropy reflects the regularity. According to the laws of thermodynamics, the higher the entropy will be more chaotic a system. In the science of industrial organization, entropy is often associated with concentration and competition [see Ng (1995)]. While the financial science, entropy has been used by Tu (1998) to test the integration of capital markets of Taiwan and the USA with entropy-based pricing (EBP) derived from Consumption CAPM (CCAPM). Ng (1995) suggests the concept of entropy to measure industry concentration is relevant because the entropy reflects the number of firms in the industry and the equity market. The essence of entropy in this context aims to measure the level of industry concentration through the information described as a probability distribution of market share. With so entropy can be interpreted as a measure of uncertainty associated company's market share. In her study Ng (1995) using the arithmetic mean value of the minimum and maximum entropy to measure the concentration index depends on the class boundaries, the number of players in one class and size class specific industries.

Because entropy is a measure of disorder, uncertainty and randomness in a system then according to Ng (1995) entropy will also be useful to measure industry competition. The argument of this is the entropy will vary according to shape the pattern of randomness or randomness that occurs. Entropy will depend on the number of firms in the industry and a growing number of companies in the industry will reflect the level of intra industry competition is getting higher and higher entropy. In addition the entropy depends on the distribution of market share will increase competition and higher entropy will too. Entropy was inversely proportional to the concentration of industry, so that a high entropy will reflect the low concentration level and the competition will high.

Associated with Tu (1998), the concept of EBP is derived from the SDF model (Stochastic Discount Factors) proved the integration of Taiwan and the USA. Because of a component model for the function Langrangian EBP (L) is identical with the entropy index Ruefli (1990); $L = \sum_{i=1}^{S} p_j \ln (p_j / q_j) + \sum_{i=1}^{n} \lambda_j (-\sum_{j=1}^{S} p_j X_{ij}) + \lambda_0 (1 - \sum_{j=1}^{S} p_j)$, the concept of entropy will be relevant as a determinant of capital market integration.

2.3.2 The Concept of Intensity Role of Global Investors

Initially Bekaert and Harvey (2000) have not so justified the negative role of global investors that is as speculators. This is related to the phenomenon of increased capital market liberalization in ASEAN exchange authority on the belief that the role of investors in ASEAN investors will give added value to increase trading liquidity and market indexes. But with the Asian monetary crisis of 1997/1998 and 2007/2008 the global financial crisis is the perception of the authority of several exchanges began to change toward the role of global investors. They began to increase the level of resistance but in indirect form are generally in the form of protection against domestic investors. Conducting direct obstacle in the form of restrictions on current stock market is less relevant because of liberalization has done more than 20 years. Thus it may be clear that stock markets are opened for foreigner. If there is more reason for global investors play a positive and negative role is always associated with efforts to secure the benefits of international diversification in emerging markets. As noted by Bekaert and Harvey (1997), emerging market has two attractiveness for global investors such as high volatility and the market index return correlations are low. High volatility can be seen with the dynamics of the movement of market indexes in each ASEAN country. The existence of high volatility is attractive to global investors with short time horizons that do Covered Interest Arbitrage (CIA) which focuses on capital gains in exchange rate risk compensation. While the low correlation to attract global investors with long time horizon which generally as informed investors who seek the fundamental value.

Observing the negative and positive role of global investors, each authority should be familiar with it. Positive role can be seen from non negative NFFF (Net Foreign Fund Flow) what it means more global investors to channel funds to the local exchanges so that the local market indexes rose. However the essence of NFFF is hot money thus possible occurrence of a negative NFFF. It can be recognized during the period of crisis in the form of falling market indexes. As a reaction to that negative role, the exchange authority can increase the level of protection for domestic investors. Level of protection is not just a tight capital controls, such as Malaysia but can be a limitation of series A and B shares in China's capital markets. But this protection must be well managed so that the positive role of global investors is not lost. This is because the status of emerging markets that depend on the intensity of the role of global investors can not be eliminated although the regulators have an option to protect their domestic investors from the aggressive global investors.

2.3.3 Level of Intra Industry Competition and Degree of Capital Market Integration

Engwall (1973) and Ruefli (1990) conducted a study on the importance of industry structure for the company in terms of the dynamics of competition in an industry sector. They hold the view that the importance of analysis of competition between firms as measured by the entropy index in addition to knowing the position of superior and inferior inter-company now also be able to predict the position of superior and inferior among companies in the future. This is because technically the entropy index is calculated on the basis of time-series and use the ordinal scale (ranking) for example 1,2,3,4, 5…. n where for n indicates the number of firms in the industry. Refer to Collins and Ruefli (1992) that is the nature of the dynamics of competition in entropy is derived from the information theory of Shannon. As we know the information theory is related to disorder, uncertainty and randomness in a system.

Characteristic of the dynamics of competition between firms within the business environment can be brought to the dynamics of competition among the company's stock if the company is also related to listing on the stock market of a country. The use of entropy index in evaluating the performance ranking of companies listing on stock exchange will attract the attention of global investors because of the assessment ranking for this by using common ratio scale proved disappointing market participants as in the case of Enron and World at bubble dotcom and probably the fallen of Lehman Brother in 2008 due to global financial crisis.

When examined in the study of capital market integration, the author's knowledge no one has to use the entropy index Ruefli (1990) as a determinant factor. That has existed so far is proving the integration of capital markets in the context of industrial sectors such as studies Cavaglià *et al.* (2000), Ratner and Leal (2005) and Antoniou *et al.* (2007). They have a view of the context of industrial integration is sufficient to provide a picture for global investors see the potential in each industry sector is viable or not as part of their portfolio of industrial diversification. However, when examined using the entropy index, the dynamic changes of each company in one industry sector will be more apparent, so too when they need full information about the general picture of the existing industrial sector in the capital market, then the numbers in the sub-component of entropy (lower, diagonal and upper entropy) is expected to be more objective in the assessment of strategic industry risk. Based on the description, the alternative hypothesis (H1) proposed is:

H1: Level of intra industry competition will influence toward degree of capital market integration in ASEAN countries

2.3.4 The Intensity of Role of Global Investors and Capital Market Integration

Two arguments are used to explain the relationship between the two is the role of global investors and international financial integration through the concept UCIRP (Uncovered Interest Rate Parity). Both of these arguments stem from a grand theory: international capital mobility. According to Sula and Willet (2009), with increasingly free flow of capital from developed country to a developing country as a result of liberalization and free trade, then physical activity, economics and finance of each country as if it had been fused. This happens because the enactment of a good standard in shape, size and price in each country who declare themselves as members of an economic and trade bloc, so that each country will declare readiness to open with each other and compete freely with each other. A manifestation of international capital mobility is greatest in the history of European economic integration which gave birth to the EEC (European Economic Community). On each member of the EEC (see now the EU) will occur in an efficient capital mobility, because member state have been open with each other and compete freely. As for non-members countries, then capital mobility occurs when common rules which would receive a reduction in restrictions.

At a higher level then the international capital mobility will reach the level of Optimum Currency Area (OCA), such as the formation of the Euro Currency in 1999. When the context has led to the standardization of currencies like euro and dollar, the level of integration has led to a discussion of domain Interest Rate Parity (IRP). This is because the flow of capital that occurs because of differences in interest rates. Marston (1995), Bhatt and Virmani (2005) and Solnik and McLeavey (2009) state the interest rate differential may be relevant to CIRP (Covered Interest Rate Parity) and UCIRP (Uncovered Interest Rate Parity). CIRP related to international capital flows are not restricted tend to equate the nominal interest rate if they are tied up in a common currency (single). Seeing the EEC who already have the Euro currency then it should be applied CIRP. However this is not easily realized because the EEC became the European Union has changed and although the Euro (except Pound Sterling) still exist but tend to be less bargaining power Euro against the U.S. dollar. Not easy to apply CIRP create the context of financial integration are discussed with UCIRP. UCIRP associated with unrestricted capital flows tend to equalize nominal interest rates. An effort to cope with exchange rate risk, and then by taking into account differences in domestic interest rate (i_d) and abroad (i_f), make global investors are always looking for opportunities to do the CIA (Covered Interest Arbitrage). According to Marston (1995) and Solnik and Mcleavey (2009), the CIA can be done by purchasing foreign securities because of the condition of the forward discount. The phenomenon of the CIA in lines with the argument that there cointegration between international capital flows and exchange rates in addition to the interest rate even if only for the case of Indonesia. This is because global investors who bring different currency than the local currency on the one hand can be correlated with the movement of local currency and may also be correlated with stock market conditions. Based on a study of Dvořák (2005) and Aggarwal *et al.* (2009) in Indonesia, the activity appeared to be particularly dominant global investors as domestic investors. But the unique despite the inferior performance of global investors in the short term, but were superior in the long run. Explanation of differences in the performance of global investors it is a phenomenon of the difference of information between global investors and domestic investors. Domestic investors are perceived to have the advantage of knowledge of local conditions of Indonesia, while foreign (global) investors are considered to have the experience and global network of brokerage as a form of information superiority. In order to become the most dominant, the investor needs to have a combination of local ownership and global capabilities of information brokerage.

Bekaert and Harvey (2000) state there are two roles of global investors in emerging markets. The first role relates to the actions of global investors in influencing the technical aspects of trading in a stock because it could potentially increase the liquidity, efficiency and value of related shares. While the role of the second act of a global investors to better obtain information superiority. But according to Bekaert and Harvey (2000) the role of negative impact if it is so global investors does not get the information advantages, then they will make a withdrawal. In larger-scale withdrawal of funds called the phenomenon of surge or sudden stop of capital flows (Sula and Willet, 2009). This phenomenon triggers global investor's restrictions such in Malaysia since 1998. The restriction is conduct by increasing level of protection toward domestic investors. It is not only make limit purchase some series stock like as in China and Philippines but also increasing the tight control of capital outflow from Malaysia. Hence starting in 1999 Malaysia imposed this restriction by excluding its investable index from IFC. Based on previous description, we propose alternative hypothesis (H2) as follow:

H2: The intensity of the role of global investors tend to raise the degree of capital market integration in ASEAN countries.

3. Empirical Model Development

3.1 Entropy Index

Ruefli (1990) provides a decrease in the entropy index denoted by H $(S)_k$ by starting from the transition matrix. This transition matrix is defined as a matrix that will show changes in the ranking of all players in an industry (k) can be symbolized as T_k, which has a t_{ij} element that is the frequency of ranking position changes between players in one industry each year divided by the number of years of observation (m). The T_k is then converted to p_k matrix, from the relative transition frequency of the p_{ijk} which can be formulated as follows:

$$p_{ijk} = t_{ijk} / m \qquad (1)$$

Furthermore, with the p_k transition matrix, a number of measures that will provide information about the level of uncertainty associated with the behavior of ranking changes among players in an industry can be raised. Then based on the large number of players denoted as q, then obtained:

$$H(S)_k = [\textstyle\sum_i (\sum_j p_{i,j,k}/n\ p_{i,j,k)}/q/- \ln(1/q)] \qquad (2)$$

where H $(S)_k$ is the entropy index for industry k, i is the row side of the transition matrix and j is the column side of the transition matrix. H (S) $_k$ will reach its maximum condition if ∑ 1.1. / q ln (1 / q) = - ln (1 / q). And because ln (1 / q) = - ln (q) then equation 2 can be written:

$$H(S)_k = [\textstyle\sum_i (\sum_j p_{i,j,k} \ln p_{i,j,k}) /q \ln (q)] \qquad (3)$$

According to Ruefli (1990), H (S) k follows the log-linear property of the entropy function which has three forms of uncertainty position namely improving (lower), holding (diagonal) and worsening (upper). Therefore, for the sake of analysis, H $(S)_k$ which is the total entropy needs to be decomposed into 3 parts, namely lower, diagonal and upper entropy. In the case of the dynamics of the life cycle of the fragmented software industry life cycle, the results of the study of Ruefli (1990) show that the lower entropy position is smaller than the upper entropy. This means that more company members in the industry are downgraded compared to upgraded. This also means that the dynamics of industrial competition are very high because of the short life cycle that has a low level of industrial concentration and high competition as a result of the large number of players in the industry. Based on the previous explanation, the steps of estimating the entropy index from Ruefli (1990) operationally are as follow:

1) Making a tabulation of ranking based on the movement of outcomes such as net profit and sales between companies in the industrial sector. If the context is international diversification, it is more appropriate to use net profit on the grounds that this net profit will determine the target of global investor returns.
2) Make ordinal rank data from the first process.

3) Create a transition matrix.
4) Perform calculations with the formula H $(S)_k$. Following is an example of the steps in the calculation of H $(S)_k$ for the case in Bursa Malaysia as follows:
a) Tabulation of ranking on the basis of net profit 3 shares of the basic material industry sector (code 15 in GICS) namely M, J and P on the Malaysian exchange suppose the results are as follows:

Stock (Code)	2008	2007	2006	2005
(M) Melawar Industrial Group Berhad	2	3	2	3
(J) Jaya Tiasa Holding Berhad	3	1	3	2
(P) Press Metal Berhad	1	2	1	1

b) Make an ordinal rank tabulation from process a with the following results:

Rank Number	2008	2007	2006	2005
1	P	J	P	P
2	M	P	M	J
3	J	M	J	M

c) Perform a transition matrix calculation that is the frequency of ranking position changes between players in one industry each year divided by the number of years of observation. The formula appears as $p_{ijk} = t_{ijk} / m$. And if it is made in a transition matrix table it will be described as below:

Ranking at t	Ranking at t+1			
	1	2	3	Total column
1	$P_i(1,1)$	$P_i(1,2)$	$P_i(1,3)$	$\sum P_i(1,k)$
2	$P_i(2,1)$	$P_i(2,2)$	$P_i(2,3)$	$\sum P_i(2,k)$
3	$P_i(3,1)$	$P_i(3,2)$	$P_i(3,3)$	$\sum P_i(3,k)$
Total row	$\sum P_i(j,1)$	$\sum P_i(j,2)$	$\sum P_i(j,3)$	$\sum P_i(j,k)$

d) Perform the calculation of $H(S)_k$ with the formula $H(S)_k = [\sum_i (\sum_j p_{i,j,k} \ln p_{i,j,k}) /q \ln (q)]$. The estimation of $H(S)_k$ will include 3 components namely diagonal entropy namely $P_i(1,1)$, P_i (2,2) and P_i (3,3), upper entropy including P_i (1,2), P_i (2,3) and P_i (1,3) and finally lower entropy include P_i (3,1), P_i (3,2) and P_i (2,1). The value of $H(S)_k \approx 0$ means the level of competition in an industry is getting lower and vice versa if $H(S)_k \approx 1$.

3.2 Dynamic Conditional Correlation

Conditional Correlation is calculated by the DCC (Dynamic Conditional Correlation) from Engle (2002). Study of Antoniou *et al.* (2007) and Kuper and Lestano (2007) state that DCC has the advantage of UCC (Unconditional Correlation) because it is a combination of the flexibility of the volatility model (GARCH) and is able to produce a parsimony model for estimation of correlation (Log Likelihood). This model is also flexible because it allows different securities of one portfolio to have different volatility measurement models, depending on the GARCH model which is the most optimum for that security. The number of parameters estimated is linearly related to the number of securities in the portfolio to the parsimony model.

Furthermore according to Antoniou *et al.* (2007) and Kuper and Lestano (2007), DCC calculations are generally carried out in three stages namely:

a) GARCH model (1,1) for k asset return where $r_t | F_{t-1} \sim N(0, H_t)$. (4)
b) Calculation of standardized residual that is $\varepsilon_{it} = r_{it} / (h_{it})$ 1/2. (5)
c) Calculation of time-varying correlation ($\rho_{ij,t}$).

Steps a, b and c above can begin with the determination of the conditional variance (H_t) matrix which is formulated as follows:

$$H_t = D_t R_t D_t \quad (6)$$

where R_t is the conditional correlation matrix n x n and D_t is the diagonal matrix n x n whose elements are time-varying standard deviations from the GARCH univariate model with the diagonal i. The GARCH univariate specification for D_t is stated as follows:

$$h_{it} = \omega_i + \alpha_i r_i^2{}_{t-1} + \beta_i h_{t-1} \quad (7)$$

where h_{it} is conditional volatility, $r_i^2{}_{t-1}$ is the past square innovations, and α_i and β_i are the coefficients of the parameters $r_i^2{}_{t-1}$ and h_{t-1}. The specifications of this GARCH univariate can be modified to accommodate asymmetric effects. Next the residuals are standardized with the standard deviation conditional and can be written as follows:

$$\varepsilon_{it} = r_{it}/ (h_{it})^{1/2}; \varepsilon_{it} \sim N(0,R_t) \quad (8)$$

Based on the equation 8 above, conditional correlation is defined as $\rho_{ij,t} = E[\varepsilon_{it},\varepsilon_{jt}]$ which is the Engle (2002) of DCC model. In more detail $\rho_{ij,t}$ can be stated as:

$$\rho_{ij,t} = \frac{E_{t-1}[r_{it}, r_{jt}]}{\{E_{t-1}[r_{it}^2]E_{t-1}[r_{jt}^2]\}^{1/2}} \quad (9)$$

The dynamic correlation structure $\rho_{ij,t}$ consists of Q_t, R_t and Q_t* expressed as follows:

$$Q_t = (1- \alpha_n – \beta_n) Q + \alpha_n (\varepsilon_{t-1},\varepsilon'_{t-1}) + \beta_n Q_{t-1} \quad (10)$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \quad (11)$$

$$\text{diag } (Q_t^*)^{1/2} = \text{diag } [1/(q_{11,t})^{1/2} \ldots\ldots 1/(q_{kk,t})^{1/2}] \quad (12)$$

where $\overline{Q}$ = unconditional covariance from standardized residuals. If $\alpha_n + \beta_n < 1$, the correlation will mean reverting (after shock, the correlation will return to normal levels), and if $\alpha_n + \beta_n = 1$ then this correlation will be integrated. To estimate Q_t* in the component model in equation 12, the log likelihood function is needed as follows:

$$\log L (\theta_1\theta_2 | X_t) = 1/2^T\textstyle\sum_{t=1}[k \log(2\pi) + \log (| R_t |) + 2 \log (| D_t |) + r'_t D^{-1}{}_t R^{-1}{}_t D^{-1}{}_t r_t] \quad (13)$$

Model 13 has 2 components, namely volatility (θ_1) and dynamic correlation (θ_2). As noted from Antoniou *et al.* (2007), the volatility component model (θ_1) and dynamic correlation (θ_2) can be written into models at equation 14 and 15, namely:

$$\log L (\theta_1 | r_t) = -1/2^T\textstyle\sum_{t=1}[k \log(2\pi) + \log (In) + 2\log(| D_t |) + r'_t D^{-1}{}_t R^{-1}{}_t D^{-1}{}_t r_t] \quad (14)$$

$$\log L (\theta_2 | \theta_1, r_t) = -1/2^T\textstyle\sum_{t=1}[k \log(2\pi) + \log (| R_t |) +2\log(| Dt |)+ \varepsilon'_t R_t^{-1} \varepsilon_t^{-1} - \varepsilon'_t \varepsilon_t] \quad (15)$$

Estimated θ_1 with GARCH and θ_2 with maximum likelihood BEKK or Marquardt.

3.3 Empirical Testing Model

Suppose the unconditional correlation function between return for industry i in country j and return for world factors (w) at time t can be formulated as follows:

$$\rho(R_{ijt},R_{wt}) = \frac{\text{Cov } R_{ijt},R_{wt}}{\sigma_{Rijt}.\sigma_{Riwt}} \tag{16}$$

where:

$\rho(R_{ijt},R_{wt})$ = correlation of R_{ijt} and R_{wt} unconditional correlation (estimated by Pearson)
Cov R_{ijt}, R_{wt} = covariance of R_{ijt} and R_{wt} that is $\sum_{i,j,w=1}^{t}[R_{ijt} - E(R_{ijt})].[R_{wt} - E(R_{wt})]$
σ_{Rijt} = standard deviation of R_{ijt} (return of industry i at country j at time t)
σ_{Rwt} = standard deviation of R_{wt} (world indices return w at time t)

If the calculation is done in detail, $\rho(R_{ijt},R_{wt})$ can be displayed in the form:

$$\rho(R_{ijt},R_{wt}) = \frac{\sum_{i,j,w=1}^{t}[R_{ijt}-E(R_{ijt})].[R_{wt}-E(R_{wt})]}{\sigma_{Rijt}.\sigma_{Rwt}} \tag{17}$$

where:

$\rho(R_{ijt},R_{wt})$ = correlation of R_{ijt} and R_{wt} unconditional correlation (estimated by Pearson)
Cov R_{ijt}, R_{wt} = covariance of R_{ijt} and R_{wt} that is $\sum_{i,j,w=1}^{t}[R_{ijt} - E(R_{ijt})].[R_{wt} - E(R_{wt})]$
σ_{Rijt} = standard deviation of R_{ijt} (return of industry i at country j at time t)
σ_{Rwt} = standard deviation of R_{wt} (world indices return w at time t)
$E(R_{ijt})$ = expected return of industry i at country j at time t
$E(R_{wt})$ = expected return of world indices (w) at time t

As is known from Koutolas and Kryzanowski (1994)'s of IAPT model, R_{ijt} and R_{wt} can be considered identical to R_{it} and R_{gt}. R_{it} has a decomposition factor (I_{1t}, I_{2t}, .. I_{nt}). These decomposition factors include industry and country dummies as determinants of R_{it} in the model of King (1966) and Heston and Rouwenhorst (1994). The R_{it} model itself is

$$R_{it} = \beta_0 + \beta_1 I_{1t} + \beta_2 I_{2t} + \beta_3 I_{3t} + \beta_4 I_{4t} + \ldots\ldots + \beta_n I_{nt} \tag{18}$$

where:

R_{it} = return of industry i at time t
I_{1t}, I_{2t}, .. I_{nt} = decomposition factors R_{it} covering country and industry dummies 1, 2, 3, 4, 5, ….. n at time t according to study of Heston and Rouwenhorst (1994)
β_1, β_2, … β_n = coefficient of decomposition factor I_{1t}, I_{2t}, .. I_{nt}
β_0 = intercept from R_{it}

While R_{gt} or R_{wt} because it is an international index return such as MSCI, DJGI, and FTSE will be formulated differently. According to the study of Jorion and Schwartz (1986), R_{wt} is estimated from the F_{it} projection equation which is $F_{it} = R_{it} - (\lambda_0 + \lambda_1 R_{wt})$. Because F_{it} is an error from R_{it} and F_{it} projection equation is intended to overcome the autocorrelation problem between R_{it} and R_{wt}, R_{wt} as a component of ρ (R_{it}, R_{wt}) is approached by the MA (q) process of Bekaert and Harvey (1997), so R_{wt} is:

$$R_{wt} = \delta_0 + \delta_1 \varepsilon_{t-1} + \delta_2 \varepsilon_{t-2} + \delta_3 \varepsilon_{t-3} + \ldots\ldots + \delta_q \varepsilon_{t-q} + \varepsilon_t \tag{19}$$

where:

ε_t = residual of R_{wt} [world (w) return at time t]

$\varepsilon_{t-1}, \varepsilon_{t-2}, \varepsilon_{t-3}, \ldots \varepsilon_{t-q}$ = lag from residual of R_{wt}

q = orde from MA (Moving Average) process

$\delta_0, \delta_1, \delta_2, \delta_3, \ldots \delta_q$ = intercept and coefficient $\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots \varepsilon_{t-q}$

When the R_{it} component in equation (18) and the R_{wt} component in equation (19) are substituted into equation (17) then for ρ (R_{ijt}, R_{wt}) is obtained:

$$\rho(R_{ijt},R_{wt}) = \frac{\sum_{i,j,w=1}^{t} [\beta_0+\sum_{i=1}^{1} \beta_{nt}I_{nt}-E(R_{ijt})].[\delta_0+\sum_{q=1}^{q} \delta_q\varepsilon_{t-q}-E(R_{wt})]}{\sigma_{Rijt}.\sigma_{Rwt}} \quad (20)$$

where:

$\rho(R_{ijt},R_{wt})$ = correlation R_{ijt} and R_{wt} unconditional correlation (by Pearson)

σ_{Rijt} = standard deviation of R_{ijt} (industry return i on country j at time t)

σ_{Rwt} = standard deviation of R_{wt} (international indices return (world) w at time t)

$E(R_{ijt})$ = expected return of industry i on country j at time t

$E(R_{wt})$ = expected return of world (w) indices at time t

R_{it} = $\beta_0 + \sum_{i=1}^{1} \beta_{nt}I_{nt}$ (I is decomposition factor according to equation 3)

R_{wt} = $\delta_0 + \sum_{q=1}^{q} \delta_q\varepsilon_{t-q}$ (q is orde of MA process according to equation 4)

Because ρ (R_{ijt}, R_{wt}) is assumed to be close to the normal distribution (iid: independent and identically distributed) in the form of N (μ, σ) $\approx$ N (0,1) then $\sigma R_{ijt} = 1$, $\sigma R_{wt} = 1$ so $\sigma R_{ijt} \times \sigma R_{wt} = 1$, then on the basis of studies from Longin and Solnik (1995) and Pukthuanthong and Roll (2009) about the nature of the relationship between R_{ijt} and R_{wt}, equation (20) changes to:

$$\rho(R_{ijt},R_{wt}) = \frac{\sum_{i,j,w=1}^{t} [\beta_0+\sum_{i=1}^{1} \beta_{nt}I_{nt}-0].[\delta_0+\sum_{q=1}^{q} \delta_q\varepsilon_{t-q}-0)]}{1.1} \quad (21)$$

where estimation of $\rho(R_{ijt}, R_{wt})$ is carried out by substitution of the property σR_{ijt}, σR_{wt}, R_{it}, R_{wt}, $E(R_{ijt})$ and $E(R_{wt})$ according to the assumption N (0.1). This equation (6) is further simplified to:

$$\rho(R_{ijt},R_{wt}) = [\beta_0 + \sum_{i=1}^{I} \beta_{nt}I_{nt}]+[\delta_0 + \sum_{q=1}^{q} \delta_q\varepsilon_{t-q}] \quad (22)$$

where since $[\delta_0 + \sum_{q=1}^{q} \delta_q\varepsilon_{t-q}]$ is also notified by the R_{wt} residual, $\delta_0 + \sum_{q}^{q} = 1\ \delta_q\varepsilon_{t-q}$ is seen as ε_{it} in ρ (R_{it}, R_{wt}). This is because q is the R_{wt} MA (Moving Average) process order in model (19). So this model (22) can be modified to:

$$\rho(R_{ijt},R_{wt}) = [\beta_0 + \sum_{i=1}^{I} \beta_{nt}I_{nt}]+ \varepsilon_{it} \quad (23)$$

and when applied in country j, the model (23) will change to:

$$\rho(R_{ijt},R_{wt}) = [\beta_0 + \sum_{i,j=1}^{I} \beta_{njt}I_{njt}]+ \varepsilon_{ijt} \quad (24)$$

where:

$\rho(R_{ijt},R_{wt})$ = R_{ijt} and R_{wt} unconditional correlation (by Pearson)

I_{njt} = decomposition factor n for $\rho(R_{ijt},R_{wt})$ in country j at time t

β_{njt} and β_0 = coefficient of I_{njt} and intercept from $\rho(R_{ijt},R_{wt})$
ε_{ijt} = error (residual) from $\rho(R_{ijt},R_{wt})$

Theoretical model (24) can be employed into the empirical model 25 and 26 because component of $\sum_{i,j=1}^{I}\beta_{njt}I_{njt}$ consists of $\beta_1E_{ij,t-1}$, $\beta_2DINDG_{ij,t}$, $\beta_3PGDP_{ij,t-1}$, $\beta_4LNMCAPS_{ij,t-1}$, β_5 $NFFF_{jt}$, β_6FOR_{jt} and $\beta_7d(F_X)_{jt}$. The empirical model $\rho(R_{ijt}, R_{wt})$ is obtained as follows:

$$\rho(R_{ijt},R_{wt}) = f\ [E_{ij,t-1}, DINDG_{ijt}, PGDP_{ij,t-1}, LNMCAPS_{ij,t-1}, NFFF_{jt}, FOR_{jt}, d(F_X)_{jt}] \quad (25)$$

Model equation 25 will be also conducted to test for DCC (Dynamic Conditional Correlation) from estimation process in equation 9. So model equation 25 can be formulated as follow:

$$\rho(R_{jt},R_{wt}) = f\ [E_{ij,t-1}, DINDG_{ijt}, PGDP_{ij,t-1}, LNMCAPS_{ij,t-1}, NFFF_{jt}, FOR_{jt}, d(F_X)_{jt}] \quad (26)$$

From equation 26 we can see that $E_{ij,t-1,}$ is representing to the Level of Intra Industry Competition respecting to the entropy index of Ruefli (1990) and $DINDG_{ijt}$, $PGDP_{ij,t-1,}$ and $LNMCAPS_{ij,t-1}$ are respectively used to supporting industry factors. While for the Intensity of Role of Global Investors we use $NFFF_{jt}$ and FOR_{jt} as the proxies and $d(F_X)_{jt}$ is to supporting international factors. Explanation of each variable will be presented at table 1.

4. Research Method

SUR model in equation 25 and 26 consists of five equations y_1, y_2, y_3, y_4 and y_5 in its simplest form $y = X\beta + e$. For estimating operationally we can set model 25 (UCC) into:

$$\rho(R_{iMt},R_{wt}) = \delta_{10}+\delta_{11}E_{iMt-1} + \delta_{12}\,DINDG_{iMt} + \delta_{13}PGDP_{iMt-1} + \delta_{14}LNMCAPS_{iMt-1} + \delta_{15}NFFF_{Mt} + \delta_{16}FOR_{Mt} + \delta_{17}d(Fx)_{Mt} + \varepsilon_{iMt} \quad (27)$$

$$\rho(R_{iSt},R_{wt}) = \delta_{20} + \delta_{21}E_{iSt-1} + \delta_{22}DINDG_{iSt} + \delta_{23}PGDP_{iSt-1} + \delta_{24}LNMCAPS_{iSt-1} + \delta_{25}\,NFFF_{St} + \delta_{26}\,FOR_{St} + \delta_{27}\,d(Fx)_{St} + \varepsilon_{iSt} \quad (28)$$

$$\rho(R_{iTt},R_{wt}) = \delta_{30} + \delta_{31}E_{iTt-1} + \delta_{32}DINDG_{iTt} +\delta_{33}PGDP_{iTt-1} + \delta_{34}LNMCAPS_{iTt-1} + \delta_{35}NFFF_{Tt} + \delta_{36}FOR_{Tt} + \delta_{37}d(Fx)_{Tt} + \varepsilon_{iTt} \quad (29)$$

$$\rho(R_{iPt},R_{wt}) = \delta_{40} + \delta_{41}E_{iPt-1} + \delta_{42}DINDG_{iPt} + \delta_{43}PGDP_{iPt-1}+ \delta_{44}LNMCAPS_{iPt-1} + \delta_{45}NFFF_{Pt} + \delta_{46}FOR_{Pt} + \delta_{47}d(Fx)_{Pt} + \varepsilon_{Pt} \quad (30)$$

$$\rho(R_{iRt},R_{wt}) = \delta_{50} + \delta_{51}E_{iRt-1}+ \delta_{52}DINDG_{iRt} + \delta_{53}PGDP_{iRt-1} + \delta_{54}LNMCAPS_{iRt-1} + \delta_{55}NFFF_{Rt} + \delta_{56}FOR_{Rt} + \delta_{57}d(Fx)_{Rt} + \varepsilon_{Rt} \quad (31)$$

Following Dufour and Khalaf (2002) and Gatignon (2014), we realized that it must be shown about the contemporaneous correlation of error across using the Breusch-Pagan test of independence of the errors. If $\lambda = T\sum_{i=2}^{M}\sum_{j=1}^{i-1} r_{ij}^2$ is larger than λ^2 (df) of table then we can conclude at least 1 covariance from equation 27 - 31 is not equal to zero. For estimating operationally SUR we can also set model 26 (DCC) into as follow:

$$\rho(R_{Mt},R_{wt}) = \delta_{10} + \delta_{11}E_{iMt-1} + \delta_{12}LNMCAPS_{iMt-1} + \delta_{13}PGDP_{iMt-1} + \delta_{14}NFFF_{Mt} + \delta_{15}FOR_{Mt} + \delta_{16}d(Fx)_{Mt} + \varepsilon_{iMt} \quad (32)$$

$$\rho(R_{St},R_{wt}) = \delta_{20} + \delta_{21}E_{iSt-1} + \delta_{22}LNMCAPS_{iSt-1} + \delta_{23}PGDP_{iSt-1} + \delta_{24}NFFF_{St} + \delta_{24}FOR_{St} + \delta_{25}d(Fx)_{St} + \varepsilon_{iSt} \quad (33)$$

$$\rho(R_{Tt},R_{wt}) = \delta_{30} + \delta_{31}E_{iTt-1} + \delta_{22}LNMCAPS_{iTt-1} + \delta_{23}PGDP_{iTt-1} + \delta_{34}NFFF_{Tt} + \delta_{35}FOR_{Tt} + \delta_{36}d(Fx)_{Tt} + \varepsilon_{iTt} \quad (34)$$

$$\rho(R_{Pt},R_{wt}) = \delta_{40} + \delta_{41}E_{iPt-1} + \delta_{42}LNMCAPS_{iPt-1} + \delta_{43}PGDP_{iPt-1} + \delta_{44}NFFF_{Pt} + \delta_{45}FOR_{Pt} + \delta_{46}d(Fx)_{Pt} + \varepsilon_{iPt} \quad (35)$$

$$\rho(R_{Rt},R_{wt}) = \delta_{50} + \delta_{51}E_{iRt-1} + \delta_{52}LNMCAPS_{iRt-1} + \delta_{53}PGDP_{iRt-1} + \delta_{54}NFFF_{Rt} + \delta_{55}FOR_{Rt} + \delta_{56}d(Fx)_{Rt} + \varepsilon_{iRt} \quad (36)$$

In fact, this study not only uses four data years 2006-2009 but also requires 10 industrial groups from the Global Industry Classification Standard (GICS) version from OSIRIS database toward 5 ASEAN countries hence we can obtain 240 data observations in order to maximize the SUR (Seemingly Unrelated Regression) analysis which is estimated by System Equation and could not be estimated one by one like OLS and GLS as Single Equation. Testing the SUR model in equation 25-36 is to see to what extent is the effectiveness of entropy from Ruefli (1990) as the first determinant of capital market integration in ASEAN. The SUR model (equation 32-36) takes into account the feasibility aspects, namely the presence of contemporaneous correlation of error across of each equation using the Breusch-Pagan test of independence (Dufour and Khalaf, 2002). For explanation of each variable in equation from 26 which will be applied in detail of SUR model at 27-31 and 32-36 equations respectively, we can expose table 1 below.

Table 1: Operational definition for DV (dependent variable) and IDV (independent variable)

Type	Notation	Detail explanation of each variables
DV	$\rho(R_{ijt},R_{wt})$	Unconditional Correlation (UCC) between R_{ijt} (industry *return* i in country j at period t) and R_{wt} (international indexes (*world*) return w at period t), where international index is MSCI. To calculate this correlation we used Pearson techniques To count R_{ijt} we employ database as well as used to entropy index.
DV	$\rho(R_{jt},R_{wt})$	Dynamic Conditional Correlation (DCC) between R_{jt} (market *return* country j at period t) and R_{wt} (international indexes (*world*) return w at period t), where international index is MSCI. To calculate this correlation we used DCC approach by GARCH from Engle (2002).
IDV	$E_{ij,t-1}$	Entropy index from industry i in country j at period t-1 which derived from Ruefli (1990) and Collins and Ruefli (1992). Process to calculate $E_{ij,t-1}$ is important to test the H2. $E_{ij,t-1}$ is calculated by adaptation formula of $H(S)_k = [\sum_i (\sum_j p_{i,j,k} \ln p_{i,j,k}) / q \ln q]$. To calculate $H(S)_k$ we conduct 3 steps: create a database for 10 GICS of 5 countries in ASEAN, to rank the firm in industry by net profit, to make a transition matrix (p_{ijk}).
IDV	$DINDG_{ijt}$	Global industry dummy (D=1) and regional (D=0). This variable is adapted from study of Faff and Mittoo (2003).
IDV	$PGDP_{ij,t-1}$	Proportion of GDP inter industry i in country j at t-1.
IDV	$LNMCAPS_{ij,t-1}$	Log natural of *market capitalization* industry i in country j at t-1.
IDV	$NFFF_{jt}$	*Net Foreign Fund Flow* in country j at period t.
IDV	FOR_{jt}	*Foreign Ownership Restriction* is one minus the ratio between MSCI Investable Index and MSCI Global Index in country j at period t [which could be written as follow: FOR=1- (MSCI-II / MSCI-GI)]. FOR = 1 means market is closed for global investors' participation while FOR = 0 means that market will open 100%. It refers to Edison and Warnock (2003).
IDV	$d\,(Fx)_{jt}$	Deviation of IRP in country j at period t. Formulation with $i_d - i_f$ or $(S_{t+1} - S_t)/S_t$. Code of Fx is *foreign exchange* in country j at period t and not an *identifier*
-	$\delta_0, \delta_{i1t}, \ldots \delta_{i5t}$	Intercept and coefficient for each independent variables.
-	ε_{ijt}	error (residual) for model 4.1 i.e. common factors beside $E_{ij,t-1}$, $DINDG_{ijt}$ $PGDP_{ij,t-1}$, $LNMCAPS_{ij,t-1}$, $NFFF_{jt}$, FOR_{jt} and $d\,(Fx)_{jt}$.

5. Result and Discussion

5.1 Industrial Structure Profile from ASEAN Countries

As seen at Table 2 below, each country in ASEAN has value of entropy index (E_{ijt}) respecting to industry sectors of GICS. Most of ASEAN countries has total entropy about 0.2 – 0.45 as sum of component Lower Entropy (LE), Diagonal Entropy (DE) and Upper Entropy (UE). The value of total entropy which has not exceeded 0.5 indicates that industry sectors of GICS did not expose tight competition. According to Collins and Ruefli (1992), if the industry has low competition, then decision making will be easier because the low strategic risk. Thus in context of international diversification, the low level of intra industry competition will be more attractive for global investor to enlarge their portfolio in ASEAN.

Table 2: Total entropy index result from each ASEAN countries

Industry sectors (GICS code)	Philppines (E_{iPt})	Thailand (E_{iTt})	Malaysia (E_{iMt})	Singapore (E_{iSt})	Indonesia (E_{iIt})
Oil and Gas (10)	0.2425	0.3383	0.3848	0.3528	0.3536
Basic Material (15)	0.3372	0.3517	0.3404	0.3878	0.3344
Industrial Goods (20)	0.3741	0.3256	0.2955	0.2502	0.3237
Services Goods (25)	0.3068	0.3889	0.3388	0.3172	0.3448
Consumer Goods (30)	0.3091	0.2791	0.2499	0.3515	0.2927
Health Care (35)	0	0.2701	0.5484	0.1981	0.2145
Financial Institution (40a)	0.3015	0.3112	0.2512	0.2903	0.3392
Property and Real Estate (40b)	0.2640	0.3741	0.3320	0.3378	0.3698
Technology (45)	0.4508	0.3121	0.3249	0.3582	0.3796
Utilities-Telecommunication (50)	0.4011	0.3243	0.3078	0.3230	0.1182

From Table 2 we can also show that Thailand, Malaysia and Singapore has higher total entropy than Philippines and Indonesia. This implicates that Thailand, Malaysia and Singapore will give more challenge for global investors when form their portfolio since the level of intra industry competition are slightly higher than Philippines and Indonesia. But that condition does not mean Philippines and Indonesia are less attractive. We must see about comparing between Upper Entropy (UE) and Lower Entropy (LE) in ASEAN Countries as presented at Table 3. According to Ruefli (1990), we see that industry with condition of UE < LE will be more interesting since firms of this industry could have raised their ranks.

Table 3: Comparing upper entropy (UE) and lower entropy (LE) in ASEAN

Industry sectors (GICS code)	Philppines	Thailand	Malaysia	Singapore	Indonesia
Oil and Gas (10)	UE = LE	UE = LE	UE = LE	UE = LE	UE > LE
Basic Material (15)	UE > LE	UE > LE	UE < LE	UE > LE	UE > LE
Industrial Goods (20)	UE > LE	UE > LE	UE = LE	UE < LE	UE < LE
Services Goods (25)	UE < LE	UE > LE	UE > LE	UE > LE	UE = LE
Consumer Goods (30)	UE < LE	UE = LE	UE > LE	UE > LE	UE > LE
Health Care (35)	-	UE > LE	UE < LE	UE > LE	UE = LE
Financial Institution (40a)	UE < LE	UE > LE	UE > LE	UE = LE	UE < LE
Property and Real Estate (40b)	UE > LE	UE < LE	UE > LE	UE > LE	UE > LE
Technology (45)	UE > LE	UE > LE	UE > LE	UE > LE	UE > UE
Utilities-Telecommunication (50)	UE > LE	UE = LE	UE = LE	UE > LE	UE = LE

Thus in the attractiveness point of global investors, each ASEAN countries have several condition of UE < LE i.e. Philippines (Financial Institutions), Thailand (Property and Real Estate), Malaysia (Health Care), Singapore and Indonesia (both are Industrial Goods).

5.2 Capital Market Integration Determinant by UCC (Unconditional Correlation)

We conducted two testing with UCC LOC and UCC USD at panel A and B of Table 4. From panel A the amount of 17 independent variables has significant effect. The value λ^2 – test is 39.393 is greater than λ^2 – table and significant at level 1%. Therefore the assumption of CC (contemporaneous correlation) toward residual of SUR will be confirmed.

Table 4: Hypothesis testing using UCC

Independent variables	Model estimation of seemingly unrelated regression (SUR) for 5 ASEAN countries				
	Philippines $\rho(R_{iPt},R_{wt})$	Thailand $\rho(R_{iTt},R_{wt})$	Malaysia $\rho(R_{iMt},R_{wt})$	Singapore $\rho(R_{iSt},R_{wt})$	Indonesia $\rho(R_{iIt},R_{wt})$
Panel A: UCC-LOC					
INTERCEPT	18.145	-7.523	-50.646	11.408	8.194
	(2.03)**	(-3.39)***	(-2.46)**	(0.61)	(2.19)**
$E_{(ij,t-1)}$	0.044	-2.145	0.027	-0.755	0.0059
	(0.60)	(-2.47)**	(0.04)	(-1.76)*	(0.04)
DINDG $_{(ij,t)}$	0.151	-0.188	-0.134	0.088	0.151
	(2.48)**	(-2.19)**	(-1.52)	(1.54)	(2.35)**
$PGDP_{(ij,t-1)}$	-0.001	-0.746	0.527	-0.991	0.0138
	(-0.01)	(-1.76)*	(0.93)	(-3.25)***	(0.07)
LNMCAPS $_{(ij,t-1)}$	-0.0095	0.048	-0.031	0.074	-0.003
	(-0.93)	(1.45)	(-0.71)	(3.64)***	(-0.27)
$FOR_{(j,t)}$	-22.812	14.138	81.747	-25.479	-11.508
	(-2.04)**	(3.71)***	(2.50)**	(-0.59)	(-2.11)**
NFFF $_{(j,t)}$	0.0035	-0.011	-0.134	0.0035	-0.585
	(0.24)	(-1.54)	(-1.85)*	(0.38)	(-2.20)**
DIRP $_{(j,t)}$	19.711	-14.691	-15.456	19.189	-37.082
	(2.96)***	(-1.63)	(-1.97)**	(0.70)	(-1.86)*
R^2	0.33	0.55	0.27	0.44	0.31
λ^2–test	39.393*** (Breusch-Pagan test of independence), *non iterated* SUR				
Panel B: UCC-USD					
INTERCEPT	3.463	-8.532	-4.428	0.704	0.619
	(0.11)	(-5.46)***	(-1.42)	(2.74)***	(0.56)
$E_{(ij,t-1)}$	0.252	-1.151	-0.627	-0.546	0.233
	(0.64)	(-1.29)	(-1.16)	(-1.68)*	(0.85)
DINDG $_{(ij,t)}$	-0.0034	-0.096	0.040	-0.044	0.027
	(-0.03)	(-1.01)	(0.56)	(1.00)	(0.47)
$PGDP_{(ij,t-1)}$	-0.894	-0.375	0.916	0.351	-0.536
	(-1.10)	(-0.82)	(1.98)**	(-1.51)	(-1.51)
LNMCAPS $_{(ij,t-1)}$	0.048	0.0917	-0.044	0.0477	0.0101
	(1.35)	(2.63)***	(-1.26)	(3.17)***	(0.64)
$FOR_{(j,t)}$	-3.582	12.205	7.424	-1.037	-0.776
	(-0.10)	(5.53)***	(1.75)*	(-1.25)	(-0.42)
NFFF $_{(j,t)}$	-1.809	0.354	-0.354	-0.003	0.1007
	(-1.02)	(1.27)	(-1.92)*	(-0.96)	(0.14)
DIRP $_{(j,t)}$	6.066	12.718	2.017	7.508	7.57
	(-0.13)	(1.57)	(0.88)	(1.22)	(1.74)*
R^2	0.30	0.62	0.25	0.48	0.38
λ^2–test	16.29 ** (Breusch-Pagan test of independence), *non iterated* SUR				

Notes: Panel A and Panel B using UCC-LOC and UCC-USD for degree of capital market integration in each ASEAN countries as dependent variable [$\rho(R_{iPt},R_{wt})$ until $\rho(R_{iIt},R_{wt})$] respectively. ***, ** and * indicate significant at level 1%, 5% and 10% respectively. λ^2-test is test for assumption of SUR that is contemporaneous correlation of residual.

The result testing of panel A has indicated that Thailand has owned the most dominant significant independent variables then followed by Singapore. For Philippines, Malaysia and Indonesia the hypothesis testing for level of intra industry competition is failed to reject H_0 (null hypothesis). This means that entropy index has only been evidently to influence degree of integration of Thailand and Singapore. Especially for Singapore it is found the consistent result to reject H_0 for entropy index by Ruefli (1990). This result has implication that the most significantly of entropy index by Ruefli (1990) in Singapore which implied the closest of industrial structure of Singapore with GICS.

Returning to panel A, when we use proxy $NFFF_{(j,t)}$ therefore in the whole ASEAN countries the result is failed to reject H0. The testing result with proxy of $NFFF_{(j,t)}$ has been confirmed by the testing hypothesis result in Malaysia and Thailand. The tight mechanism of Malaysia and Thailand bourse through the high of FOR coefficient make inconclusive prejudice that Malaysia and Thailand bourse still conducts tight control of fund flow from global investors was reasonable enough. However if we compare to Philippines and Indonesia, it will indicate the different context. For both of them although it was failed to reject H_0 like as Malaysia but the testing result is still tend to reject H_0. On Philippines and Indonesia, intensity of role of global investors tend to increase integration since the FOR coefficient has the negative sign which will be different if we are comparing to FOR coefficient of Malaysia and Thailand.

From panel B above it will only eight independent variables for all of equations that significant. The sum of significant variable of UCC-USD is less than UCC-LOC. λ^2–test of 16.29 is bigger than λ^2–table and it is significant at level 1%. So that we conclude that assumption of CC (Contemporaneous Correlation) by SUR $\rho(R_{ijt},R_{wt})$ was still be fulfilled. The level of intra industry competition has not been proved to influence the degree of integration in Philippines, Thailand and Indonesia. Proxy of level of intra industry competition namely $E_{(ij,t-1)}$(entropy) has an effect toward the degree of integration $\rho(R_{ijt},R_{wt})$.

Meanwhile for the other bourse, global investors could consider alternative proxies that is in Thailand with $LNMCAPS_{(ij,t-1)}$ and Malaysia through $PGDP_{(ij,t-1)..}$ When using $NFFF_{(j,t)}$ as the proxy of intensity of role global investors then in all ASEAN countries it is failed to reject $H_{0..}$Non significantly of that fund flow is occurred since the capital control regime like as in Malaysia which could be confirmed by proxy $FOR_{(j,t)}$ on panel B above. The tight of capital control regime in Malaysia is also followed by Thailand that make $NFFF_{(j,t)}$ has no effect significantly toward $\rho(R_{ijt},R_{wt})$ although the sign is positive. Overall we can say the non-significant of fund flow to increase the integration level.

5.3 Capital Market Integration Determinant (Dynamic Conditional Correlation)

From panel A Table 5 below it can be seen the significant result of λ^2 – test is 29.468 greater than λ^2 – table. This result indicates the feasibility model DCC-LOC if estimated by SUR from Zellner. Model DCC-LOC produce 15 significant independent variables consisted of 11 independent variables from first determinant and 4 independent variables from second determinant respectively. When converted to DCC-USD on panel B, value of λ^2 – test is 39.422 larger than λ^2 –table. This result is also indicated the feasibility of model DCC-USD by SUR from Zellner. Model DCC-USD produce 18 significant independent variables consisted of 11 independent variables from first determinant (level of intra industry competition) and 7 independent variables from second determinant (intensity of role of global investors). According to number of significant independent variables then model DCC-USD is better than DCC-LOC.

On first determinant i.e. H_0 is level of intra industry competition do not influence integration level. According to panel C, it will indicate that all H_0 is rejected in five ASEAN countries. $E_{(ij,t-1)}$ is proxy of level of intra industry competition referring to entropy index Ruefli (1990) has proved to influence degree of market integration. When conducting for second determinant i.e. H_0 is intensity of role of global investors tend decrease integration level. From panel A is indicated that H_0 is rejected only for Indonesia and Malaysia. So that intensity of role of global investors still has significant effect toward level of integration. Overall testing hypothesis for proxy $E_{(ij,t-1),}$ $PGDP_{(ij,t-1)}$ and $LNMCAPS_{(ij,t-1)}$

indicates the significant proof in ASEAN both DCC-LOC and DCC-USD. This will carry implication that the better of integration level with DCC regarding to UCC. However in order to measure entropy index, PGDP and LNMCAPS concerning to level of intra industry competition in each bourse, these proxies will contain element of i (cross-section data) which probably will not fit to DCC that only contained element of j (time-series data).

Table 5: Hypothesis testing using DCC

Independent variables	Model estimation of seemingly unrelated regression (SUR) for 5 ASEAN countries				
	Philippines $\rho(R_{Pt},R_{wt})$	Thailand $\rho(R_{Tt},R_{wt})$	Malaysia $\rho(R_{Mt},R_{wt})$	Singapore $\rho(R_{St},R_{wt})$	Indonesia $\rho(R_{It},R_{wt})$
Panel A: DCC-LOC					
INTERCEPT	-13.439	-5.681	3.678	4.391	-6.478
	(-5.93)***	(-1.82)*	(0.86)	(2.71)***	(-2.84)***
$E_{(ij,t-1)}$	9.571	12.917	-2.757	-1.736	7.166
	(6.07)***	(3.09)***	(-1.85)*	(-2.23)**	(2.43)**
$LNMCAPS_{(ij,t-1)}$	0.267	0.176	0.129	-0.134	0.074
	(5.54)***	(0.64)	(0.80)	(-1.71)*	(1.06)
$PGDP_{(ij,t-1)}$	48.387	-30.052	-17.847	-12.512	38.711
	(6.54)***	(-0.47)	(-1.87)*	(-2.01)**	(4.22)***
$FOR_{(j,t)}$	4.119	2.062	-4.096	-1.711	-0.455
	(1.62)	(0.57)	(-0.86)	(-0.92)	(-2.86)***
$NFFF_{(j,t)}$	0.0021	-0.0011	0.0064	-0.00016	0.0019
	(-1.58)	(-1.03)	(2.36)**	(-0.63)	(0.44)
$DIRP_{(j,t)}$	5.142	8.572	3.136	-1.289	0.179
	(3.25)***	(2.88)***	(1.13)	(-0.74)	(0.24)
R^2	0.84	0.34	0.23	0.35	0.54
λ^2–test	29.468 *** (Breusch-Pagan test of independence)				
Panel B: DCC-USD					
INTERCEPT	-2.162	1.529	5.814	3.586	3.412
	(-0.63)	(2.42)**	(2.07)**	(2.32)**	(1.98)*
$E_{(ij,t-1)}$	-3.457	0.898	-12.016	-3.272	1.773
	(-1.72)*	(0.71)	(-10.04)***	(-3.43)***	(0.70)
$LNMCAPS_{(ij,t-1)}$	0.266	-0.288	-0.246	0.0225	0.116
	(4.30)***	(-3.98)***	(-1.75)*	(0.25)	(1.80)*
$PGDP_{(ij,t-1)}$	-59.338	53.423	-9.046	-26.955	-85.368
	(-6.76)***	(3.22)***	(-1.13)	(-3.75)***	(-7.13)***
$FOR_{(j,t)}$	5.636	-2.784	2.622	-0.442	2.242
	(1.66)*	(-3.94)***	(1.80)*	(-1.58)	(3.34)***
$NFFF_{(j,t)}$	0.054	0.0108	0.023	0.00014	-0.018
	(0.74)	(0.98)	(2.81)***	(0.30)	(-0.34)
$DIRP_{(j,t)}$	-2.871	3.2005	-1.508	0.789	-3.446
	(-1.31)	(2.86)***	(-0.70)	(0.42)	(-3.15)***
R^2	0.62	0.31	0.72	0.61	0.62
λ^2–test	39.422 *** (Breusch-Pagan test of independence)				

Notes: Panel A and Panel B using UCC-LOC and UCC-USD for degree of capital market integration in each ASEAN countries as dependent variable [$\rho(R_{iPt},R_{wt})$ until $\rho(R_{iIt},R_{wt})$] respectively. ***, ** and * indicate significant at level 1%, 5% and 10% respectively. λ^2-test is test for assumption of SUR that is contemporaneous correlation of residual.

In order to overcome the limitation of running model SUR, we conduct measurement by median respectively of PGDP and LNMCAPS. This is with the argument of median as the mid point of variable with the lowest standard deviation. It will bring implication to lowering standard of error from coefficient each proxy then will increase t-test (significant level). Specifically it will discuss the contrast result between DCC-LOC and DCC-USD when relating to entropy index. When we use DCC-LOC on the whole bourses, entropy indexes are consistently significant but for using of DCC-USD it cover only 60% of significant number.

That result indicates the effect of USD currency that will become disturbance in relationship among DCC and entropy index. Concerning to role of proxy FOR and NFFF as the second determinant of market integration using by DCC, it can be seen that we get the better result for DCC-USD. When we analyze for DCC-USD, FOR has four significant evidence in Thailand (negative sign) while Philippines, Indonesia and Malaysia (positive respectively). DCC for integration level which will assume to be changed over time to time (time-varying); but it is actually not changing the high-level protection from several bourses. Although Thailand has the low protection level, it will not make international fund flow come to entry significantly. As similar to DCC-LOC, Indonesian has the same result.

5.4 Discussion on Entropy as Determinant for Capital Market Integration

The results of the Entropy test in Singapore and Thailand, which have a significant negative impact on capital market integration (measured by UCC), show that the degree of competition that is not so high (i.e. low value) which has a positive meaning for global investors to make more international diversification in many industry sectors at two countries. Singapore as a developed industrial country and Thailand as a highly innovative country in the industry will serve as a model for Malaysia, Indonesia and the Philippines to further promote the attractiveness of their capital market for global investors. In this case, it improves the attractiveness of the industrial structure so that it is increasingly leading to low total entropy such as Singapore and Thailand.

For the industrial structure conditions are increasingly low total entropy, then every industrial sector must be made to lead to a lower entropy condition that is greater than upper entropy. In a detailed explanation of Setyawan and Wibowo (2019), lower entropy refers to the tendency of companies as members in an industry to experience a rating increase in time series. On the contrary for the industrial structure which has upper entropy conditions. An increase in rating means an increase in profit performance which is the main input for calculating company returns and something global investors are very much pursuing [see Bracker and Koch (1999) and Carrieri *et al.* (2004)]. Overall, our research is the first evidence in the literature on capital market integration studies that industrial structure can be a determining variable for capital market integration through the entropy index by Ruefli (1990). Of course this extends the results of study of Faff and Mittoo (2003), Roll (1992) and Pretorius (2002) only discussed per industry sector category. The use of entropy index by Ruefli (1990) could function as the effective substitute of industrial sector rotation in conducting international diversification in ASEAN from many global investors. As Hwang and Sitorus (2014) claimed that the use of GICS (Global Industry Classification Standard) for industry factors on which to base.

6. Concluding Remarks

This study has two important findings i.e. Singapore has the strong level of intra industry competition in ASEAN and Malaysia has still protective toward the existing of global investors. The result of Singapore can be drawn from the effective of entropy index by Ruefli (1990) as the first determinant of market integration when we conduct testing hypothesis using UCC-LOC, UCC-USD, DCC-LOC and DCC-USD. This result suggest the most potential for global investors to make inter industry diversification since industrial sector in Singapore closed to GICS.

The result of Malaysia can be shown by the still effective of proxy FOR and NFFF. Both variables is becoming the second determinant of market integration by UCC and DCC. Our result confirms the result of Mitchell and Joseph (2010) and also Omay and Iren (2019) about the strict foreign exchange control regime in Malaysia. Therefore it will need more and more approach from global investors to make penetration to Malaysia. They can adapt

Dvořák (2005) strategy namely building trust with local brokerage to inflow the fund into Malaysia.

Finally this study can continue effectively the correlation equation model from Pretorius (2002) and Bracker and Koch (1999) which have put alternative measurement of capital market integration and make model about determinant factors through correlation beside cointegration. In order to make better result in the future, we suggest using of DCC in industrial level from GICS. DCC industrial level from GICS will be fitted with entropy index of Ruefli (1990). This study completes the discussion on the results level difference of integration of capital markets at country and industrial level in ASEAN according to Setyawan and Wibowo (2019). In situations such as the global covid-19 pandemic in the world and especially in ASEAN, every global investor must prioritize a dynamic international diversification strategy based on the risk on and risk off approach from Smales (2016). However, the challenge in estimating the empirical model is combining it with entropy index by Ruefli (1990).

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