International Stock Markets: A co integration Analysis

‘‘For the first time, we are going to see the reality of a global exchange and it will be a high growth market’’

Frank Zarb, Nasdaq chief executive

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Dedicated to the memory of my beloved Father

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Abstract

A dynamic model of ten international stock markets is being examined for the widespread notion of co-integration. The globalization effect has radically changed the way stock markets and investors are behaving. In this new financial environment the co movement of the markets is inevitable, though the continuous flow of global funds between the economies, affects the course of these markets in a similar way. Time series of the stocks are entailing unknown and not easily measured factors. Traditional methodologies of statistic test cannot produce reliable outcomes. Four different approaches are used to discover, whether there is some kind of relation between the international stock markets.

Introduction

A general implication of co movement of the international stock markets has been raised from the fact that they seem to follow the same trends in a long term period as well as in a short time period. This relation cannot be interpret by a linear equation, because financial time series are suffering from stochastic trends and drifts, making them non-stationary.

The sensitivity to the global effects of each local stock market differs, whereas some stock markets are the 'leaders', others the 'followers' and in a very minor percentage the 'individuals'. To determine a stock market in which category is, first is needed to analyze the various criteria that affect the behaviour of that market. A stock market mostly reflects the economy of the country that is located. However, there are several other factors contributing in the formation of this financial system and determine its trend, starting from the capital, the labour, the land, the integrity of the economy to the geographical location, the legislating system and the stability of the government, the welfare of the society and many others not easily recognised. The difficulty lies on the sensitivity of the stock market on each criteria and how it is affected from them. Also the stocks, except of the fundamental characteristics, include several other factors non parametric or not easily located or measured. The value of the index or of the stock is a diversified number consisting of various influential factors that are contributing to a special consistency of the stock. This substantial complexity of the stocks values affects the indexes, which are evaluated on a percentage basis from each individual stock.

Each investor acts in an individual way, though he is equipped with the same knowledge, investing tools and experience. Information's and news diffuse in to the financial network rapidly and equally. However, the hypothesis that all the members of the financial system are equally informed, objects to the ability of each investor to rate which information is trustable and useful. Apparently, the creation of an efficient portfolio and the percentage that should be invested on stocks and which stocks should be used, is being affected by the stocks analysis with the widespread investing tools and investing theories. But, the final decision relies more on personal characteristics and timing. The psychology of each investor affects his decision process, lead-

ing him in different outcomes. Since that is reflected on the price of a stock and more general to the stock market as whole, creates problems to forecast or even predict the trend of the stock. It is hard to distinguish which parameter is going to have greater impact in a portfolio management decision, though the psychology parameter is not easily measured. There were several cases that all the financial and economic data were cautious and the stocks were having an ascending trend and vice-versa.

Fundamental and technical analysis is used separately or joint to explain the trend of the stocks. Each strategy has advantages and disadvantages, as well as enemies and followers. Both analyses are using alternate ways to generate the same outcome to the investor; profits. The problem lies on there insufficiency to determine a bondage or a co movement between the stock markets or between the stocks individually.

The analysis of a business' health starts with financial statement analysis that includes ratios. It looks at dividends paid, operating cash flow, new equity issues and capital financing. The earnings estimates and growth rate projections published widely by Thomson Reuters and others can be considered either 'fundamental' (they are facts) or 'technical' (they are investor sentiment) based on your perception of their validity.

The determined growth rates (of income and cash) and risk levels (to determine the discount rate) are used in various valuation models. The foremost is the discounted cash flow model, which calculates the present value of the future

- dividends received by the investor, along with the eventual sale price. (Gordon model)
- earnings of the company, or
- cash flows of the company.

The amount of debt is also a major consideration in determining a company's health. It can be quickly assessed using the debt to equity ratio and the current ratio (current assets/current liabilities).

The simple model commonly used is the Price/Earnings ratio. Implicit in this model of a perpetual annuity (Time value of money) is that the 'flip' of the P/E is the discount rate appropriate to the risk of the business. The multiple accepted is adjusted for expected growth (that is not built into the model).

Growth estimates are incorporated into the PEG ratio but the math does not hold up to analysis.[neutrality disputed] Its validity depends on the length of time you think the growth will continue.

Computer modelling of stock prices has now replaced much of the subjective interpretation of fundamental data (along with technical data) in the industry. Since about year 2000, with the power of computers to crunch vast quantities of data, a new career has been invented. At some funds (called Quant Funds) the manager's decisions have been replaced by proprietary mathematical models.

Technical analysis is a financial markets technique that claims the ability to forecast the future direction of security prices through the study of past market data, primarily price and volume. In its purest form, technical analysis considers only the actual price and volume behaviour of the market or instrument, on the assumption that price and volume are the two most relevant factors in determining the future direction and behaviour of a particular stock or market. Technical analysts may employ models and trading rules based, for example, on price and volume transformations, such as the relative strength index, moving averages, regressions, inter-market and intra-market price correlations, cycles or, classically, through recognition of chart patterns.

Technical analysis is widely used among traders and financial professionals, but is considered in academia to be pseudoscience. Academics such as Eugene Fama say the evidence for technical analysis is sparse and is inconsistent with the weak form of the generally-accepted efficient market hypothesis. Economist Burton Malkiel argues, "Technical analysis is an anathema to the academic world." He further argues that under the weak form of the efficient market hypothesis, "...you cannot predict future stock prices from past stock prices."

However, there are also many stock traders who proclaim technical analysis not as a science for predicting the future but instead as a valuable tool to identify fa-

vourable trading opportunities and trends. The assumption is that all of the fundamental information and current market opinions are already reflected in the current price and when viewed in conjunction with past prices often reveals recurring price and volume patterns that provide clues to potential future price movement.

In the foreign exchange markets, its use may be more widespread than fundamental analysis. While some isolated studies have indicated that technical trading rules might lead to consistent returns in the period prior to 1987, most academic work has focused on the nature of the anomalous position of the foreign exchange market. It is speculated that this anomaly is due to central bank intervention.

As mentioned above, the insufficiency of estimating the non parametric factors or generalising a equation explaining the data, is based on the fact that the time series (stocks, stock markets index) are having unit roots, an unknown variable. However, the key assumption for all the macroenomic relations is that there is stability through the time, something definitely opposite with the unit root problem. All these conclude to the difficulty of estimating a qualified relation equation, though the complexity of this relation will overwhelm the common methodologies. If the procedure is not severe constructed, to include factors that cannot separated from the values, the final outcomes will be spurious. Common logic usually ignores these special characteristics of the market or stock values, because it is very hard and time consuming to define their influence to the trend of the value. Despite that, Quantitative analysis is a more preferred technique, which tries to overcome these failures and uses the mathematical models to explain some issues.

A quantitative analyst is a person who works in finance using numerical or quantitative techniques. Similar work is done in most other modern industries, but the work is not called quantitative analysis. Although the original quants were concerned with risk management and derivatives pricing, the meaning of the term has expanded over time to include those individuals involved in almost any application of mathematics in finance. An example is statistical arbitrage.

According to Fund of Funds analyst Fred Gehm, "There are two types of quantitative analysis and, therefore, two types of quants. One type works primarily with mathematical models and the other primarily with statistical models. While there is no logical reason why one person can't do both kinds of work, this doesn't seem to happen, perhaps because these types demand different skill sets and, much more important, different psychologies. A typical problem for a numerically oriented quantitative analyst would be to develop a model for pricing and managing a complex derivative product. A typical problem for statistically oriented quantitative analyst would be to develop a model for deciding which stocks are relatively expensive and which stocks are relatively cheap. The model might include a company's book value to price ratio, its trailing earnings to price ratio and other accounting factors. An investment manager might implement this analysis by buying the underpriced stocks, selling the overpriced stocks or both.

Relation of the Stock Markets

It is widely spread the assumption that there is some source of co movement in the global stock markets. The financial crises, as well as the periods of bullish attitude, are usual effects in the stock market system. These crises are generated from different factors and they are causing similar results to the financial system. However, it has been observed that there is a co movement in cases like this, which is not just a random effect or a simultaneous trend. The interaction between the markets it's a logical consequence of the even more expanding globalisation effect.

Emerging economies are highly affected by the more mature economies. Their financial systems are directed mostly from external fund. Through the process of elevating to a mature economic system they are adopting characteristic from the already well structured economies or they are linking some of their basic economic variables (exchange rates, interests) with the mature economies. Therefore, it is inevitable to exist a relation between the mature and developing stock markets. Asian, Mexican, Russian crisis were followed by a sequence of stock and exchange rate crisis in other markets. Any correlation between emerging stock markets of different geographical location is very low, but not neglected. The same hypothesis can be interpreted for the relation of the mature markets from the emerging ones. Such cases were noted through the years, but they were very rare and usually did not last long.

However, the opinions are varying, whether the mature markets are affected by the emerging markets, in cases like China's and India's economies. These economies are being developed with an abnormal rate, far from the usual standards, causing a predominant power to the worldwide trade and the external funds sourced to these countries. But the history shows, that the sensitivity of the mature markets from shocks directed from these kinds of economies does not last for a long period. Maybe the absorbing powers of the mature stock markets can easily filter these shockwaves and finally overwhelm them. The consistency of the mature markets is reacting protectively in cases like this. One reason is that the mature markets are aware of cases, when higher levels were reached in such short term and the volatile break outs that they suffer from, because they have faced these 'extraordinary' effects before their maturity period

Stable economies, which they are hosting great value companies, with healthy fundamentals, would be expected to be more reluctant to external shocks. In fact, the independency levels should be higher. More specific, there are cases, through the history of financial system, that financial crisis of one country's economy, vastly affected all the other economies (Dot-com crisis (1999), Sub-prime loan Crisis (2007), Asian financial Crisis (1997)). Particularly, these shocks are starting from one mature economy and then they are inter transmitted to the other mature economies. The domino effect has been seen several times and in most cases, when a financial crisis was taken place the consequences where more radical and long lasted.

The increasing correlation or contagiousness of financial markets—which also, at times, is called "synchronization" or "co movement"—is a major aspect of financial globalization, and one that more often than not has remained beneath the popular radar. A research paper by the economist Sébastien Wälti(2004) argues that modern market shocks—such as movements in interest rates or oil prices—are often relevant internationally, and that country-specific shocks are now more easily transmitted across borders due to increased efficiency of trade and finance.

Financial Network and Investing Policies

The global economies are directed by a great source of funds circulating around the international economies daily. Last decades this trend changed the behaviour of stock markets and their investors. Nowdays, the course of stock markets originates more from the international financial status. Investing policies are more internationally oriented and the portfolio management projects are using stock not only from the local stock markets to lower their risk exposure, but from a global pool of stocks.

What changed the financial environment, enhanced the stock markets and make them more co- integrated, is IPO's(listing in a stock market different than the origin country), Hedge funds and mutual funds, the cooperation or merge and acquisition of stock markets and more flexible legislating system for the exchange of stocks, or without using a local stock market platform.

IPO's are often issued by smaller, younger companies seeking the capital to expand, but can also be done by large privately owned companies looking to become publicly traded. IPO's can be a risky investment. For the individual investor, it is tough to predict what the stock will do on its initial day of trading and in the near future because there is often little historical data with which to analyze the company. Except from that, there is always the key parameter of a Leveraged Buy-out (LBO) or the hostile take over from a larger company or an investor or a joint venture. There are several cases, that the management or even the ownership changed hand over a night. Also, most IPO's are of companies going through a transitory growth period, which are subject to additional uncertainty regarding their future values.

Nowadays, even more companies are having initial public offers in stock markets, alternative than their homeland. Big capitalisation stock markets are gathering a great number of foreign companies listed. United States markets are the first choice for foreign companies, thus it concentrates the highest percentage of foreign stock market capitals in addition with the simple listing rules and a very coordinate security exchange commission. But the decision for choosing the best foreign market to be listed is rather the capital concentration. United Kingdom follows the United States in foreign listed companies.

The crisis of 99', with the burst of internet bubble, affected the number of IPO's listing. Stock markets were dominated by a bearish attitude due to the poor condition of the markets, postponing all the IPO listing for this year. However, this was only a break in the bullish trend generated by the low interest rates. Two years later, the '9/11' terrorist attack caused again the decrease of listings. Economies gradually overwhelmed this shock, concentrating in a more reluctant interest rate policies, making provision for high liquidity financial markets. Financial markets respond to these parameters sourcing the companies, with low cost capital and enhancing the development globally. Six years after the bombing attack in United States the IPO listing reached a record high.

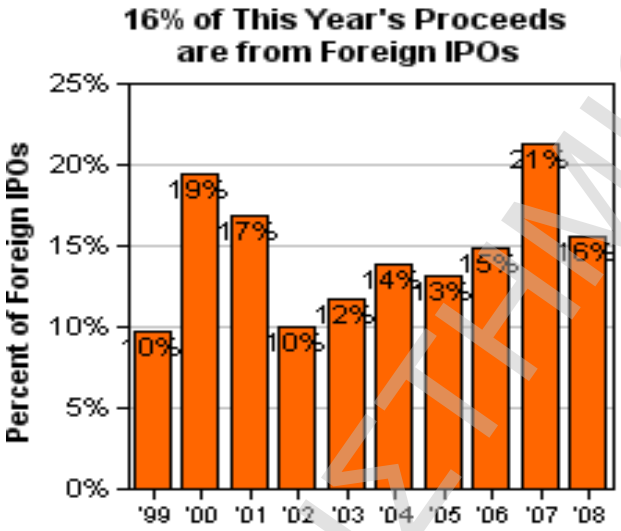


Figure 1: Foreign IPO'S Percentage In United States(1999-2008)

Funds can take both long and short positions, use arbitrage, buy and sell undervalued securities, trade options or bonds, and invest in almost any opportunity in any market where it foresees impressive gains at reduced risk. Funds strategies vary enormously -- many hedge against downturns in the markets -- especially important today with volatility and anticipation of corrections in overheated stock markets. The primary aim of most funds is to reduce volatility and risk while attempting to preserve capital and deliver positive returns under all market conditions. The flexibility of these funds to invest in different stock markets simultaneously creates a continuous

flow of cash. When a funds collapses may be the reason for a domino effect in the international economies.

The twenty first century was characterised by an unsimilar outburst of Hedge Funds creation and Sovereign Wealth Funds(SWF). Due to the continuous increase of all the commodities prices (especially Diesel) and the non attracting interest rates (Low profit Bonds), the financial system was flooded by an extreme cash flow, resulting in a concentration of non exploiting funds. Furthermore, the change of investor strategies to more risky and short term policies, made the hedge funds the most usual sanctuary for investing the surplus of funds. The results were rather expected. Global hedge funds grow geometrically each year, with the 2007 to be the record year for hedge funds capitalisation.

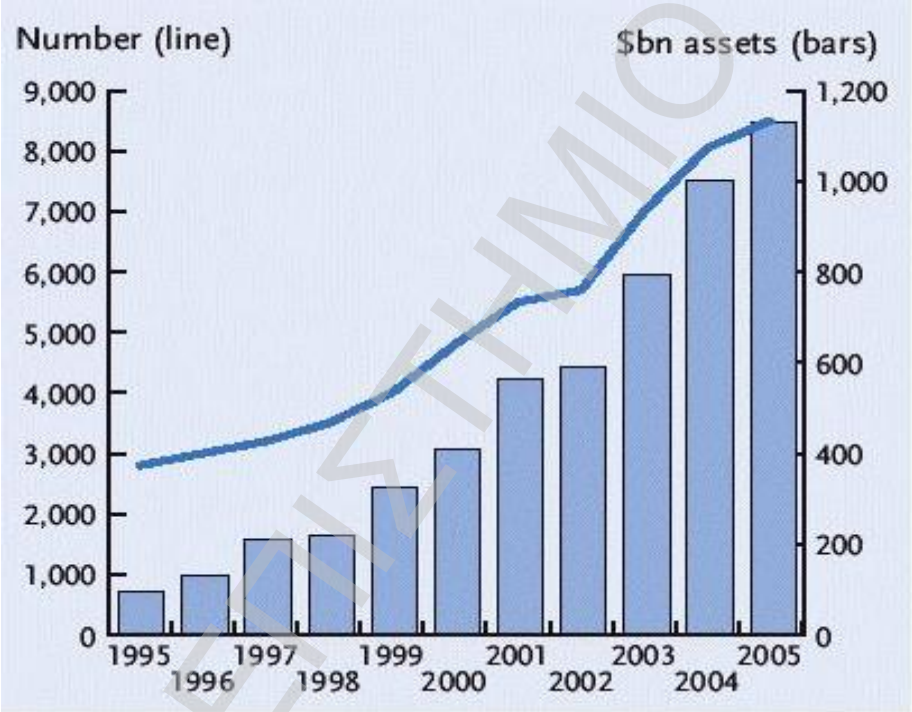


Figure 2: Global Hedge Funds Capitalization(1995-2005)

Mutual fund is simply a financial intermediary that allows a group of investors to pool their money together with a predetermined investment objective. The mutual fund will have a fund manager who is responsible for investing the pooled money into specific securities (usually stocks, bonds or derivatives). When you invest in a mutual fund, you are buying shares (or portions) of the mutual fund and become a share-

holder of the fund. Mutual funds are one of the best investments ever created because they are very cost efficient and very easy to invest in (there is no need to figure out which stocks or bonds to buy or in which stock market to enter). By pooling money together in a mutual fund, investors can purchase stocks or bonds with much lower trading costs than if they tried to do it on their own. But the biggest advantage to mutual funds is diversification. The diversification is created by investing in different stock markets, indexes, stocks, derivatives e.t.c. The percentage of each investment varies and depends on the strategy of the mutual fund. Emerging markets are generating higher performances. China is the leader in concentration and absorption of equity funds. Latin America rank second in performance.

A sovereign wealth fund (SWF) is a state-owned investment fund composed of financial assets such as stocks, bonds, property, precious metals or other financial instruments. Sovereign wealth funds have gained world-wide exposure by investing in several Wall Street financial firms including Citigroup, Morgan Stanley, and Merrill Lynch. These firms needed a cash infusion due to losses resulting from the credit crunch.

Some sovereign wealth funds are held solely by central banks, which accumulate the funds in the course of their fiscal management of a nation's banking system; this type of fund is usually of major economic and fiscal importance. Other sovereign wealth funds are simply the state savings which are invested by various entities for the purposes of investment return, and which may not have significant role in fiscal management.

The accumulated funds may have their origin in, or may represent foreign currency deposits, gold, SDRs and IMF reserve positions held by central banks and monetary authorities, along with other national assets such as pension investments, oil funds, or other industrial and financial holdings. These are assets of the sovereign nations which are typically held in domestic and different reserve currencies such as the dollar, euro and yen. Such investment management entities may be set up as official investment companies, state pension funds, or sovereign oil funds, among others.

There have been attempts to distinguish funds held by sovereign entities from foreign exchange reserves held by central banks. The former can be characterized as

maximizing long term return, with the latter serving short term currency stabilization and liquidity management. Many central banks in recent years possess reserves massively in excess of needs for liquidity or foreign exchange management. Moreover it is widely believed most have diversified hugely into assets other than short term, highly liquid monetary ones, though almost no data is available to back up this assertion. Some central banks even have begun buying equities or derivatives of differing ilk (even if fairly safe ones, like Overnight Interest rate swaps).

The contribution of these investments relies on a more exogenous trend of the financial society to participate in global pool of funds and enhance the antagonism between the global economies as well as to seek for investing bargains in foreign economies. Economies, with low taxation and reluctant financial systems are gathering a high percentage of global funds. Switzerland and Belgium always were the pioneers, because of the well-structured financial system and with attracting currency exchange(Swiss Franc). The results of these policies made these countries the paradise for the wealthiest Financial Organisations. A great number of funds (mutual, hedge, sovereign funds) are located in Belgium

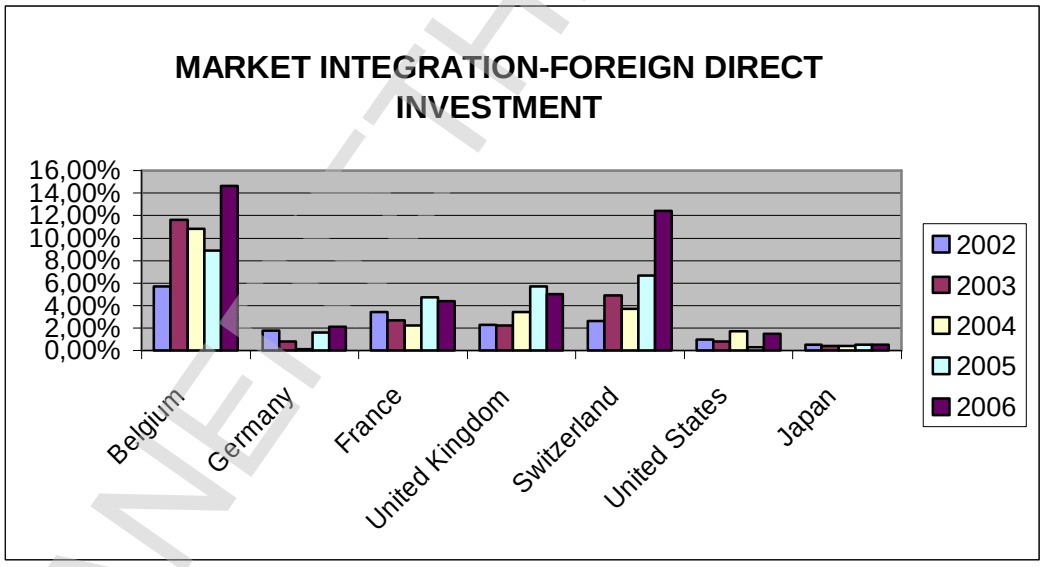
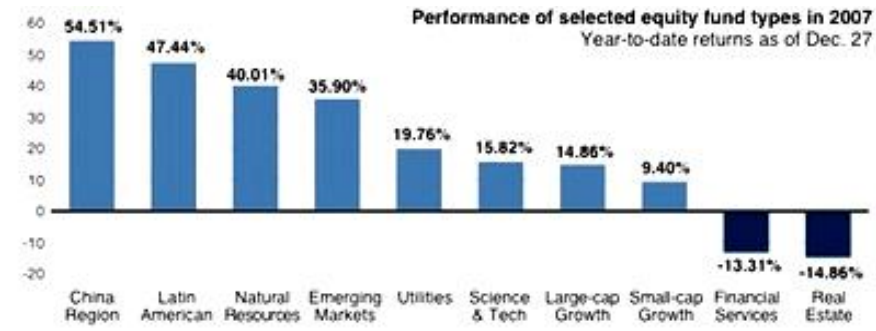


Figure 3: Market Integration-Foreign Direct Investments (Inwards and Outwards divided by GDP)



Fund type	Total net assets in billions	Three-year return	Five-year return	Fund type	Total net assets in billions	Three-year return	Five-year return
China Region	$24.4	39.00%	36.03%	Science & Tech	$39.2	9.35%	16.39%
Latin American	$23.8	47.66%	48.79%	Large-cap Growth	$396.4	8.93%	11.91%
Natural Resources	$74.1	31.08%	30.94%	Small-cap Growth	$107.4	8.56%	15.68%
Emerging Markets	$218.1	33.31%	35.53%	Financial Services	$16.4	2.50%	10.13%
Utilities	$24.1	19.29%	21.15%	Real Estate	$80.3	7.57%	17.87%

NOTE: Net assets are as of Nov. 30. All three-year and five-year returns are annualized.

Figure 4: Global Mutual Funds Returns and Capitalisation (as of 2007)

Another key factor is the cooperation or the merge and acquisition of the stock markets. Cooperation is achieved from creating a common platform. Common platforms give the privilege to companies listed in one stock market to trade its stocks to the other cooperating market, through the common platform. Expanding the investing areas helps the companies to have access to more funds and different approach investors, with all the positive and negative effects of this action. In the case of a merge and acquisition, large capitalisation markets are acquiring other smaller or equivalent markets contributing in the globalisation of the financial markets.

Another factor is the new investing policies that are affecting the operation of the stock markets. The Markets in Financial Instruments Directive (MiFID) as subsequently amended is a European Union law which provides a harmonised regulatory regime for investment services across the 30 member states of the European Economic Area (the 27 Member States of the European Union plus Iceland, Norway and Liechtenstein). The main objectives of the Directive are to increase competition and consumer protection in investment services. This new policy gives the right to all European Financial companies to execute orders of their clients in any country compliant with the MiFiD regulation. Under MiFID, Celent estimates that the three largest EU jurisdictions (France, Germany, and the UK) will surface over 100 million additional trades annually. Spending will increase as well, but at a slower rate: from €38

million yearly to close to €50 million, according to figures published by Celent 23 January 2007.

Nevertheless, Financial and investing institutions cooperated and created new platforms, Multilateral Trading Facilities (MTF). These platforms concentrate all the major global stocks, where they can trade with less expense than the traditional markets. Furthermore, they are giving more motives to companies to enrol. One exclusive privilege is the anonymity of the trader. As a result, the hedging or the shorting of a stock can be easily achieved, without harming the creditability of the investor. Such 'dark pools' are becoming even more popular these days, because a great number of shares can change hands, without attracting anticipating investors or hostile traders.

Finally, another policy with propably negative effects is the over the counter exchange. Companies that are not listed or financial derivatives that are not traded through a centralised or a formal exchange, can be traded through a broker based network. An Over-the-counter contract is a bilateral contract in which two parties agree on how a particular trade or agreement is to be settled in the future. It is usually from an investment bank to its clients directly. Forwards and Swaps are prime examples of such contracts. It is mostly done via the computer or the telephone. For derivatives, these agreements are usually governed by an International Swaps and Derivatives Association agreement. The OTC market has a lot of opportunities, but also has a great degree of risk. However, it is an alternate method of investing from the traditional stock markets and starts to concentrate more investors as well as more companies, which are not qualified to enter the usual exchange markets.

International Stock Markets

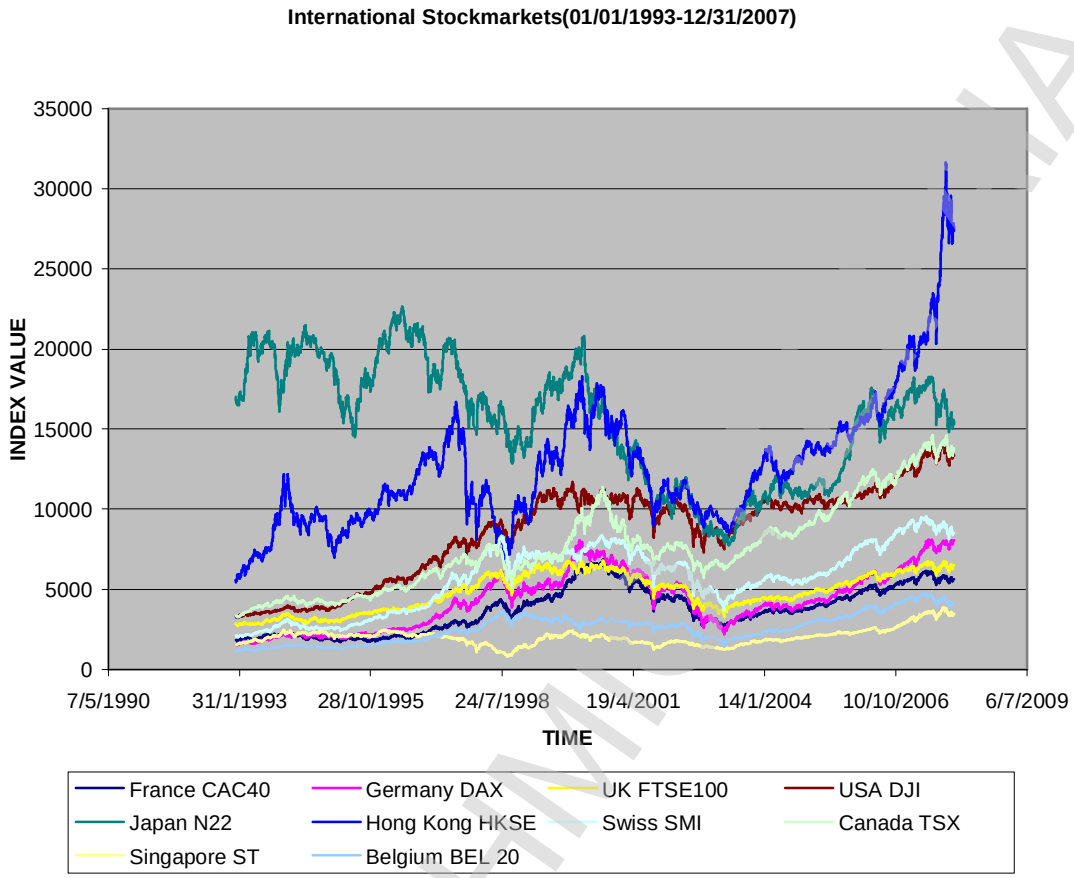


Figure 5: Stock Market Indices (1993-2007)

Ten different stock market series are used in this study for the period 1993 to 2007 totalling 3145 observations each. Five of them are originated from Europe, namely CAC40, DAX, FTSE100, BEL, and SMI, two from North America, DJI and TSX, and three from Asia, NIKKEI, HKSE, and FTSE ST. The selection was based on continental basis and the maturity of the market. All these stock markets concentrate the biggest percentage of capitalisation globally as well as a vast number of all the specialisation and size companies. All of them can be defined as mature economies and with a well structured financial system.

Daily observations are used, and the missing values are omitted from all the stock markets, concentrating only to the known values. The omitted values are less than one percent in the sample and they do not affect the statistic and econometrics

procedures. Also, there were not used indexes from the same stock market to avoid heteroskedacity and multicorrelation problems.

Stockmarkets

1. **Dow Jones Industrial Index (DJI index)**

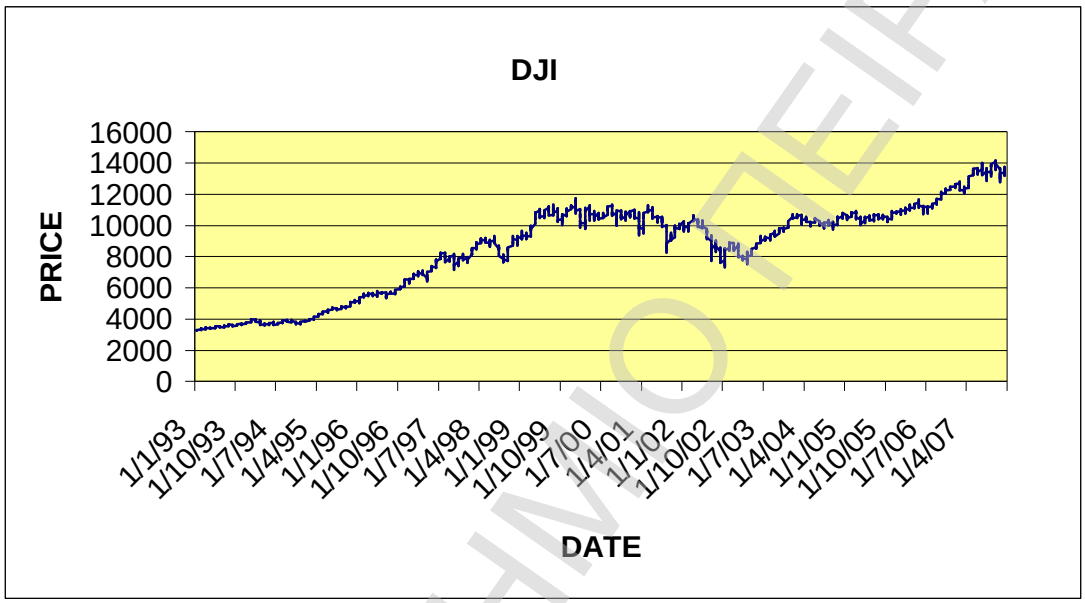


Figure 6: Dow Jones Index (1993-2007)

Dow Jones index consists of the thirty widely public industrial companies. Now days, the name of industrial is rather historical, because none of the companies has any relation with heavy industry. The daily price of the Dow Jones is calculated by a scaled average. The number of companies is divided by a divisor, which changes whenever one of the component stocks has a stock spilt or stock dividend, to generate the value of the index

To calculate the DJIA, the sum of the prices of all 30 stocks is divided by a divisor. The divisor is adjusted in case of splits, spin-offs or similar structural changes, to ensure that such events do not in themselves alter the numerical value of the DJIA. The initial divisor was the number of component companies, so that the DJIA was at first a simple arithmetic average; the present divisor, after many adjustments, is less

than one (meaning the index is actually larger than the sum of the prices of the components).

Events like stock splits or changes in the list of the companies composing the index alter the sum of the component prices. In these cases, in order to avoid discontinuity in the index, the Dow divisor is updated so that the quotations right before and after the event coincides.

In fourteen year period Dow Jones managed to rise more than ten thousands points. This trend ended once, when there was great instability in the financial markets. The period of great instability is being located in a period between the last years of twenty century and the first two an half years of twenty first century, were the index was balancing around the ten thousand points. This was the effect of the terrorist attack in United States and before that, the collapse of the dot net industry financial bubble. After a four year period Dow Jones entered in a new bullish era reflecting the great surplus of funds entered in the financial system from the petroleum gains.

The histogram shows the concentration of the prices around the area of ten thousand points, which can be identified as the long term boundary. The histogram area is rather small, identifying Dow Jones as a rather stable stock market with a long term up warding trend. Medium range figure reflects the rather normal trend, except the periods where financial instabilities exist in the global economies.

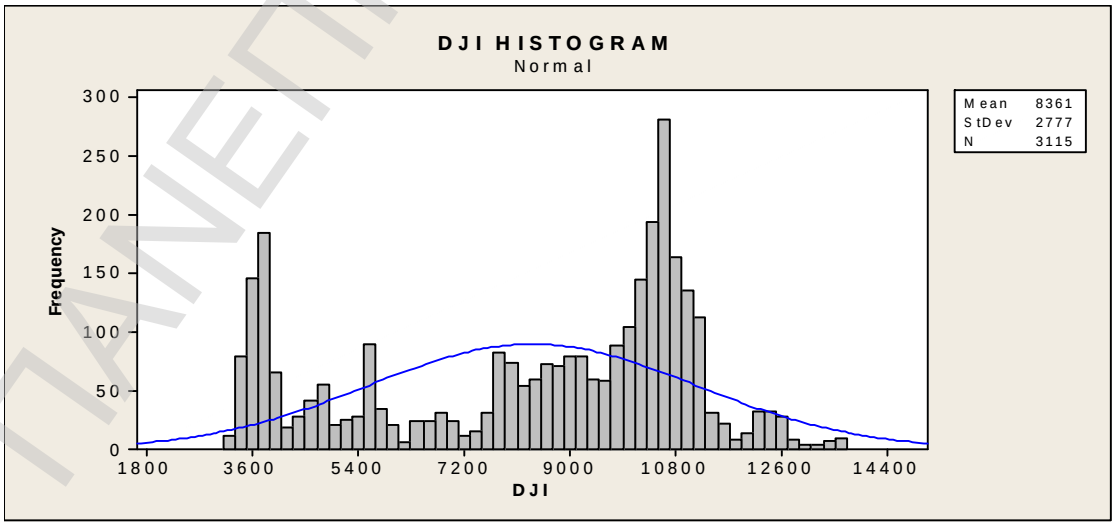


Figure 7: Dow Jones Index Histogram (1993-2007)

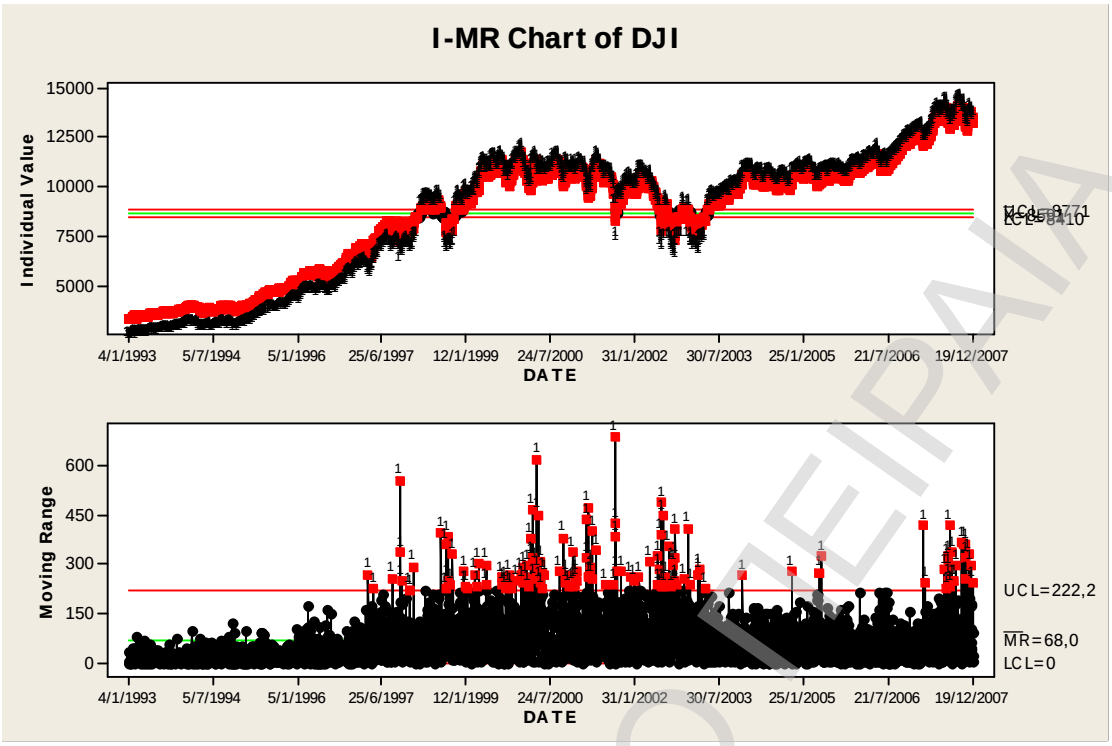


Figure 8: Dow Jones Index Medium Range Graph (1993-2007)

2. Toronto Stock Exchange (TSX)

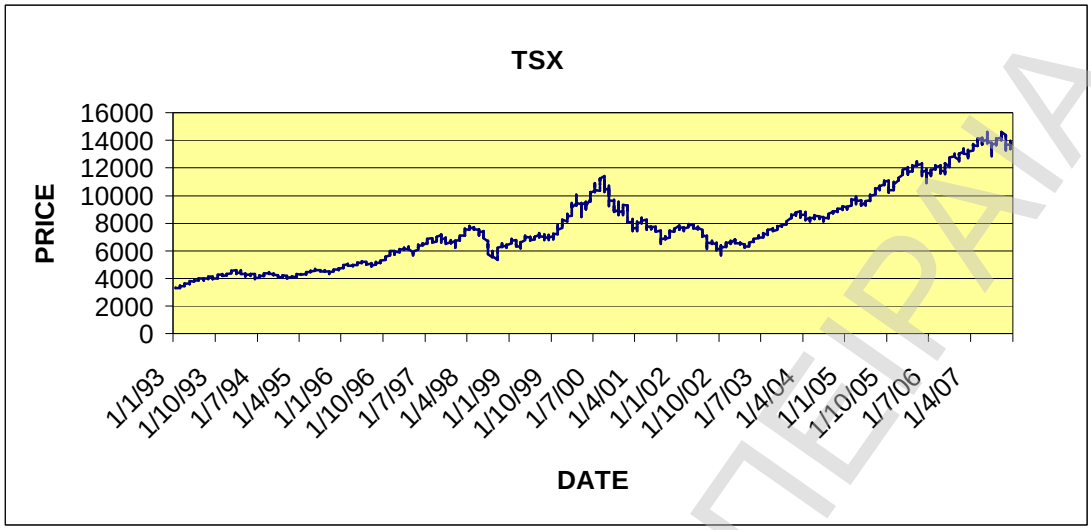


Figure 9: Toronto Stock Exchange (1993-2007)

The Toronto Stock Exchange (TSX; abbreviated TSE until 2001) is the largest stock exchange in Canada, the third largest in North America and the seventh largest in the world by market capitalization. Based in Toronto, it is owned and operated by TSX Group for the trading of senior equities. A broad range of businesses from Canada, the United States and other countries are represented on the exchange. In addition to conventional securities, the exchange lists various exchange-traded funds, split share corporations, income trusts and investment funds.

The TSX Group is the leader in the oil & gas sector - more oil & gas companies are listed on Toronto Stock Exchange (TSX) and TSX Venture Exchange than any other exchange in the world. At the end of June 30, 2007, there were 434 oil & gas companies with a total market capitalization of $544.9 billion listed on Toronto Stock Exchange and TSX Venture Exchange. Oil & gas companies continue to raise equity on our exchanges with $5.56 billion raised in the first half of 2007, and $10.5 billion raised in 2006. Over 10 billion oil & gas shares, valued at $169.2 billion, traded on Toronto Stock Exchange and TSX Venture Exchange in the first half of 2007.

The histogram shows that the most of the pries are oriented around the seven thousand points. This can be defined as a boundary, though there is great pike in the

area of 3500 and four hundred. The volatility of TSX is rather low and the trend alternates rarely.

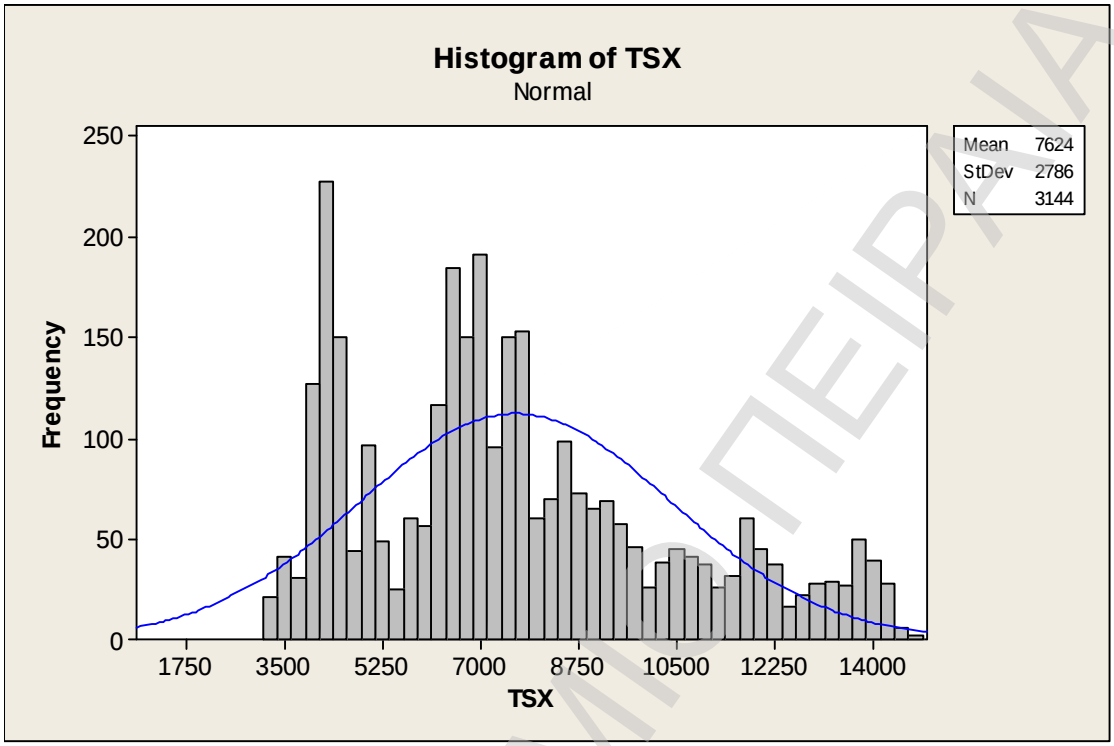


Figure 10: Toronto Stock Exchange Histogram (1993-2007)

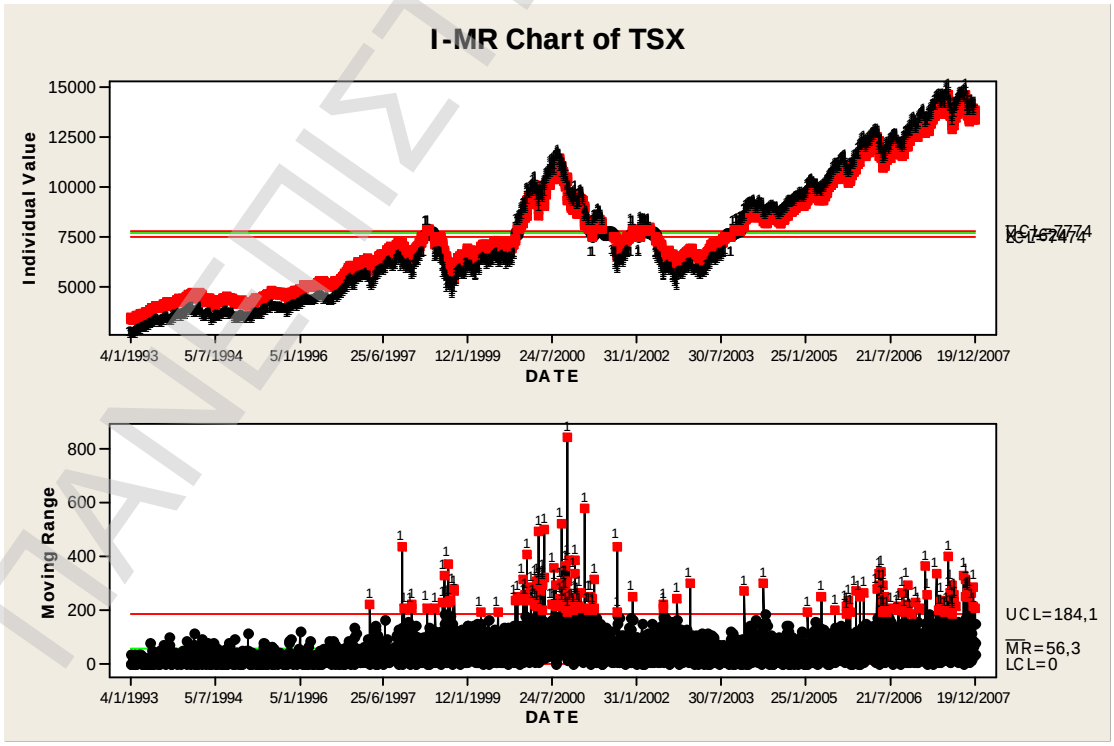


Figure 11: Toronto Stock Medium Range Graph (1993-2007)

3. Nikkei Heikin Kabuka Stock Exchange (NIKKEI 225)

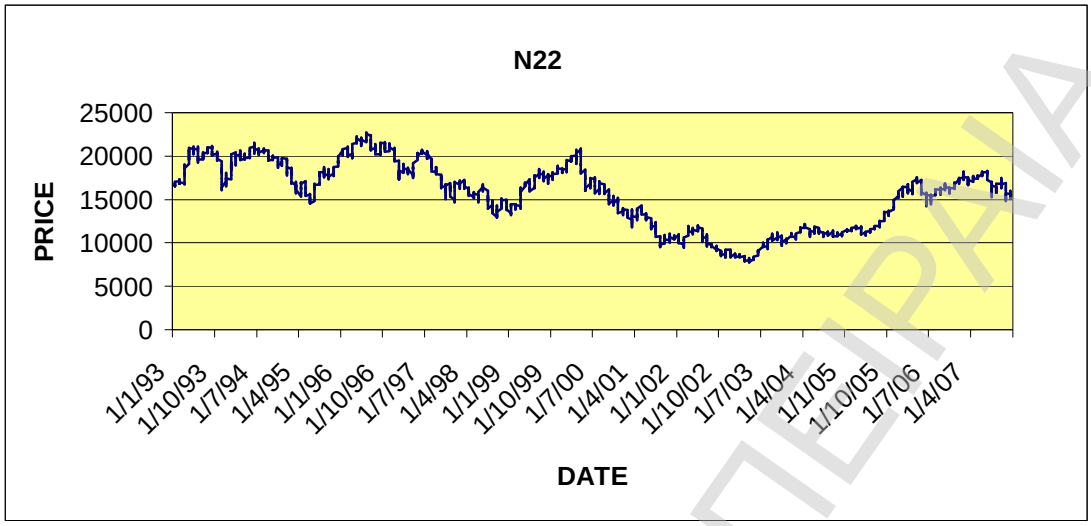


Figure 12: Nikkei Stock Exchange (1993-2007)

Nikkei225 is a stock market index for the Tokyo Stock Exchange (TSE). The Nikkei average is the most watched index of Asian stocks. It has been calculated daily by the Nihon Keizai Shimbun (Nikkei) newspaper since 1971. It is a price-weighted average (the unit is Yen), and the components are reviewed once a year.

The historical course of NIKKEI is different from the other stock markets distinguish it in a more local preserved market than exogenous. The crucial point, is the Financial System collapse of the Asian economies, which has barely affected Nikkei in contrast with all the other Major East Financial Markets (1997). Japan was not much affected by the crisis but was going through its own long-term economic difficulties.

Nevertheless, NIKKEI has never reached the high historical peaks in contrast with the global stock markets. The histogram reflects these volatile market, where is very difficult to locate a border area or price. The numerous pikes are widely spread on the pattern and histogram area is large in contrast to the above stock markets.

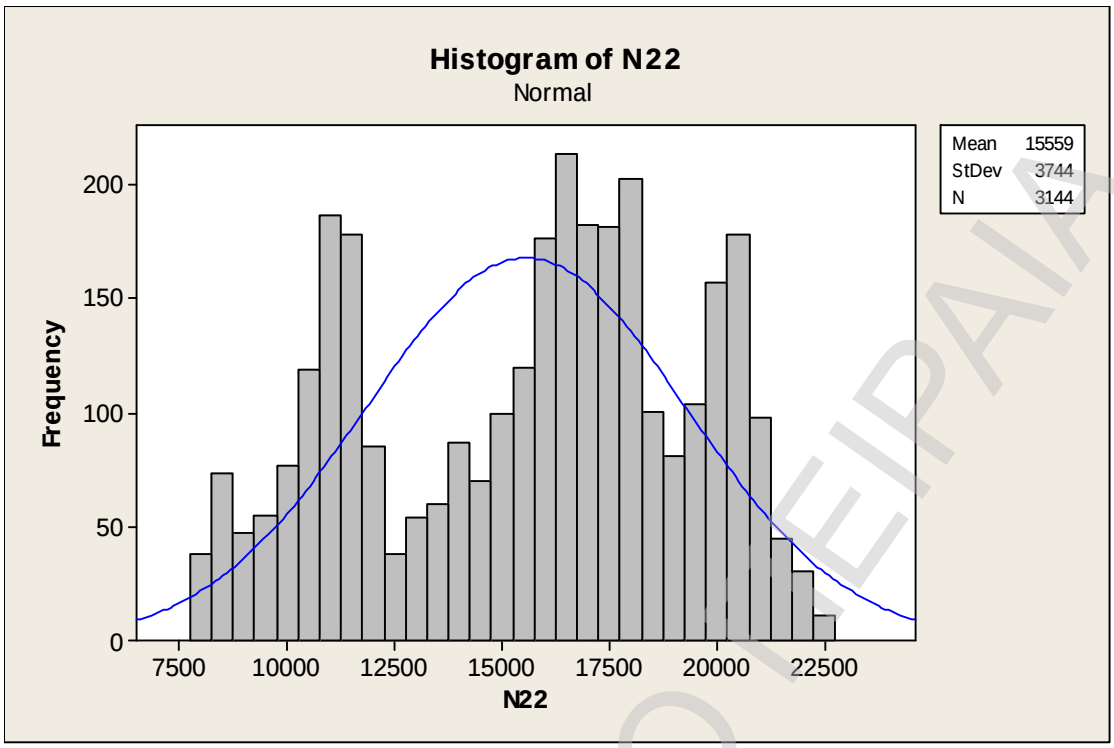


Figure 13: Nikkei Stock Exchange Histogram (1993-2007)

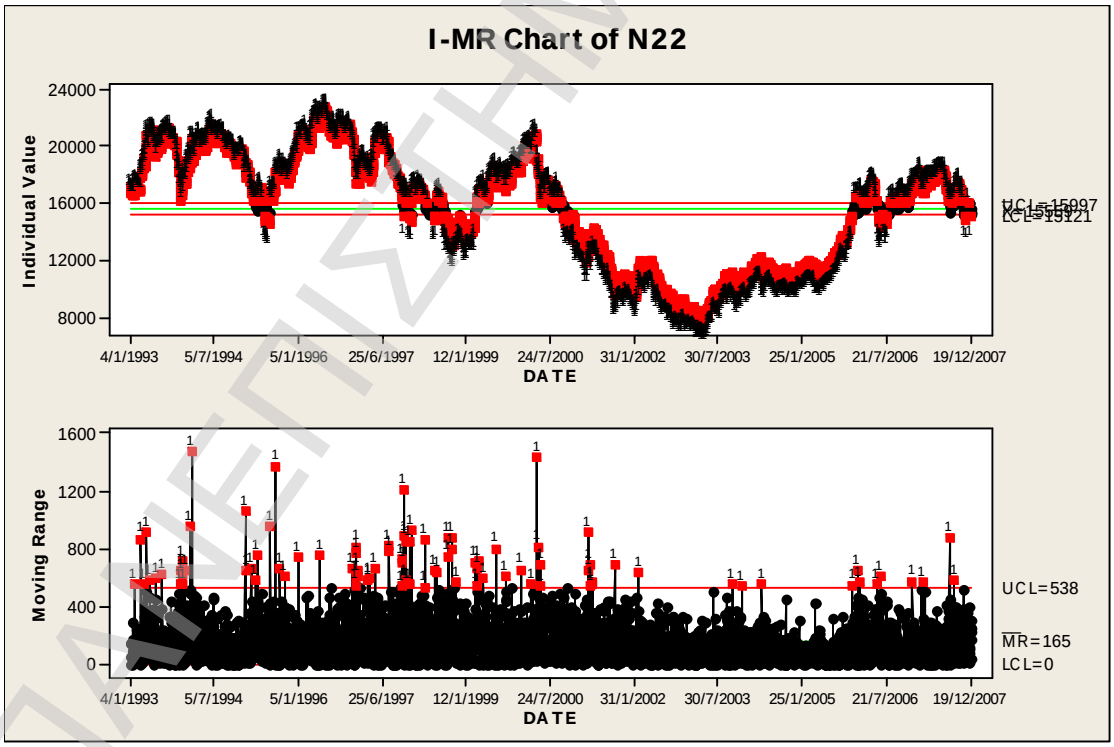


Figure 14: Nikkei Stock Exchange Medium Range Graph (1993-2007)

4. Hong Kong Stock Exchange (HKSE)

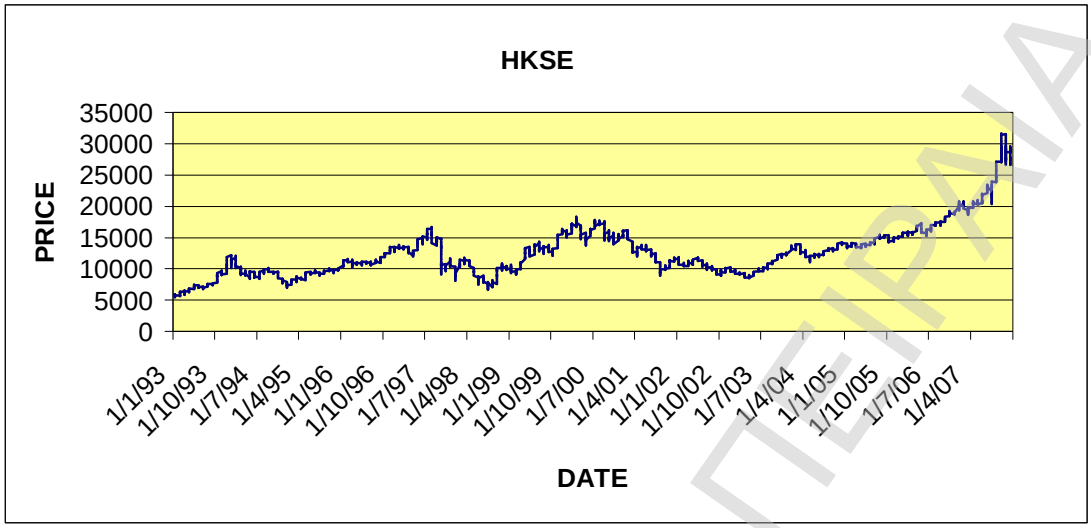


Figure 15: HKSE Stock Exchange (1993-2007)

The Hong Kong Stock Exchange is the stock exchange of Hong Kong. The exchange has predominantly been the main exchange for Hong Kong where shares of listed companies are traded. More commonly known as the Hang Seng Index, it is Asia's second largest stock exchange, behind the Tokyo Stock Exchange.

In nineteen ninety three Hang Seng reached the ten thousand points for first time in history. This record high did not last long and after four years the index affected by the Asian Financial Crisis collapsed over five thousand points. The crisis has been overwhelmed three years later when a two years rally led him again on new records high, above fifteen thousand points. Then, the global stock market crisis shocked Hang Seng, loosing about six thousand points. The downward trend ended in two thousand three, when the index entered a new bullish trend and reached the highest point of thirty thousand points.

The figures below reflect all the events mentioned above. Except the cases, when a critical financial event occurs, the index seems to be rather smooth. However, it is obvious the 'bubble' effect that led this market to the highest peaks and has never managed to elevate to this high peaks until the present days.

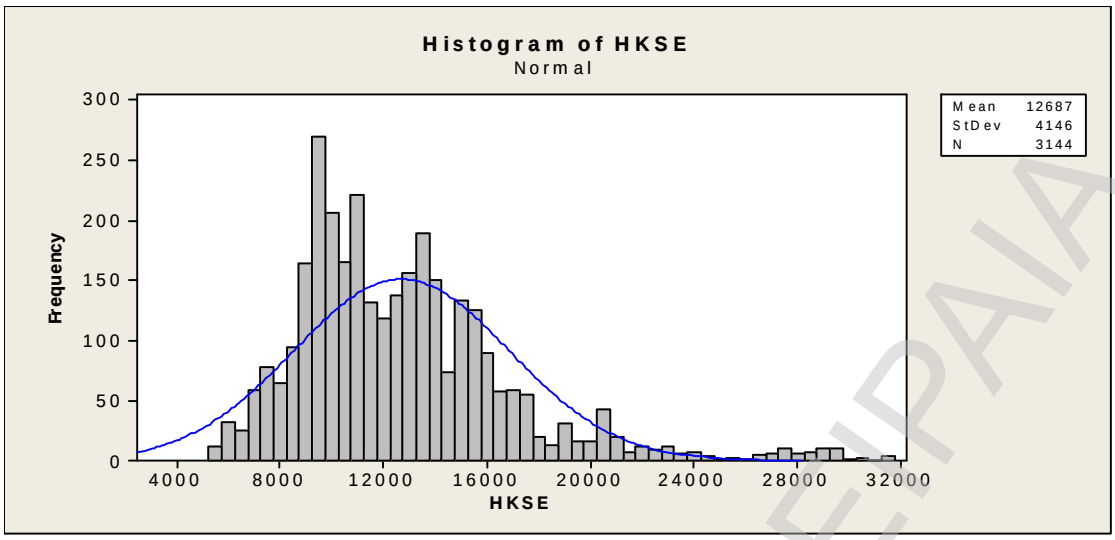


Figure 16: HKSE Stock Exchange Histogram (1993-2007)

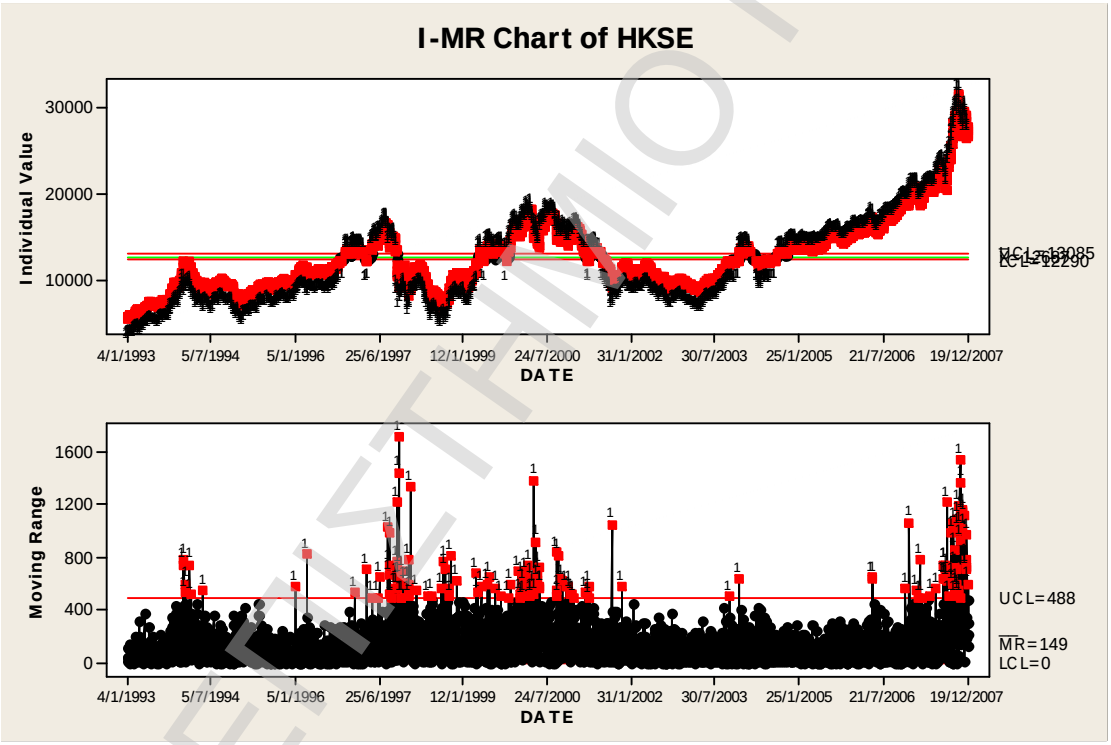


Figure 17: HKSE Stock Exchange Medium Range Graph (1993-2007)

5. Straits Times Index (STI)

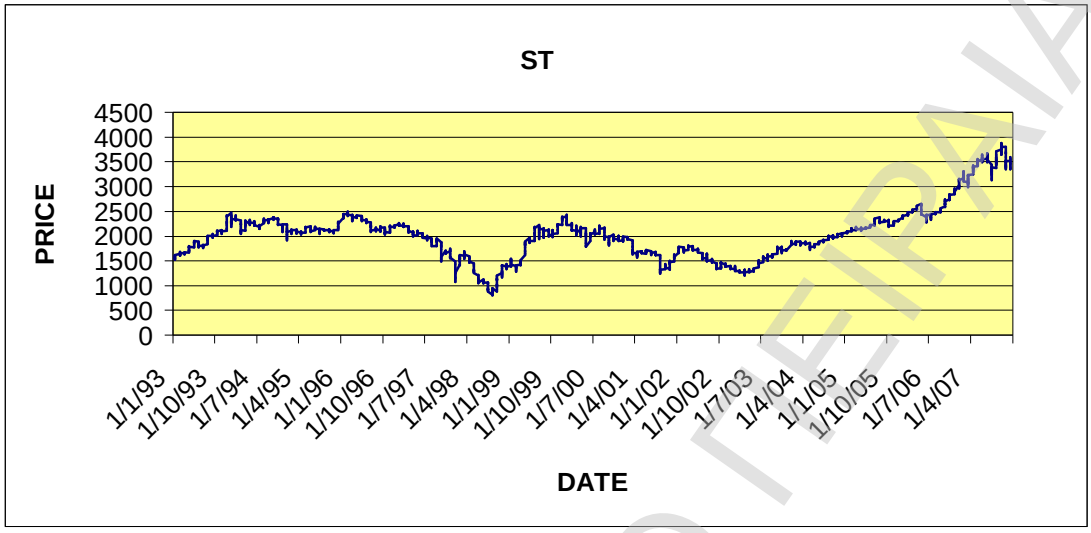


Figure 18: ST Stock Exchange (1993-2007)

The Straits Times Index (STI or ST) is a market value-weighted stock market index based on the stocks of 30 representative companies listed on the Singapore Exchange.

Launched in the wake of a major sectoral re-classification of listed companies by the Singapore Exchange, which saw the removal of the "industrials" category, the STI replaced the Straits Times Industrials Index (STI), and began trading 31 August 1998 at 885.26 points, in continuation of where the STI left off. Then, it represented 78% of the average daily traded value over a 12-month period and 61.2% of total market capitalisation on the exchange.

Constructed by the Singapore Press Holdings, the Singapore Exchange and Professor Tse Yiu Kuen from the Singapore Management University, it comes under formal review at least once annually, and may also be reviewed on an ad-hoc basis when necessary. One such review, for instance, raised the number of stocks from 45 to 50, which took effect when trading resumed on 18 March 2005. This change reduced the index representation of the average daily traded value to 60%, while increasing its total market capitalisation to 75%.

New additions included after 5 February 2007 include Thai Beverage, Suntec REIT, Olam, Genting International, Labroy Marine and CapitaCommercial Trust. BIL, Dairy Farm, Haw Par Corporation and TPV Technology will be removed from the list.

The Singapore Exchange, London's FTSE Group, and Singapore Press Holdings announced on 6 June 2007 that the Straits Times Index will be set for a major overhaul by the end of 2007. The number of component stocks will be reduced from 50 to 30 and at the same time, 18 new indices will be created. The trial values of the revamped STI and the series of FTSE ST Indices were made available on the FTSE website beginning October to facilitate technical testing.

Singapore stock exchange histogram and medium range graph are similar to Hong Stock exchange index. Asian financial crisis effected ST, which is highly reflected in the patterns. In that period the volatility of the market is very high. ST can be characterised as medium volatility stock market. Histogram prices are concentrated around the highest peaks and the medium range peaks are not so often.

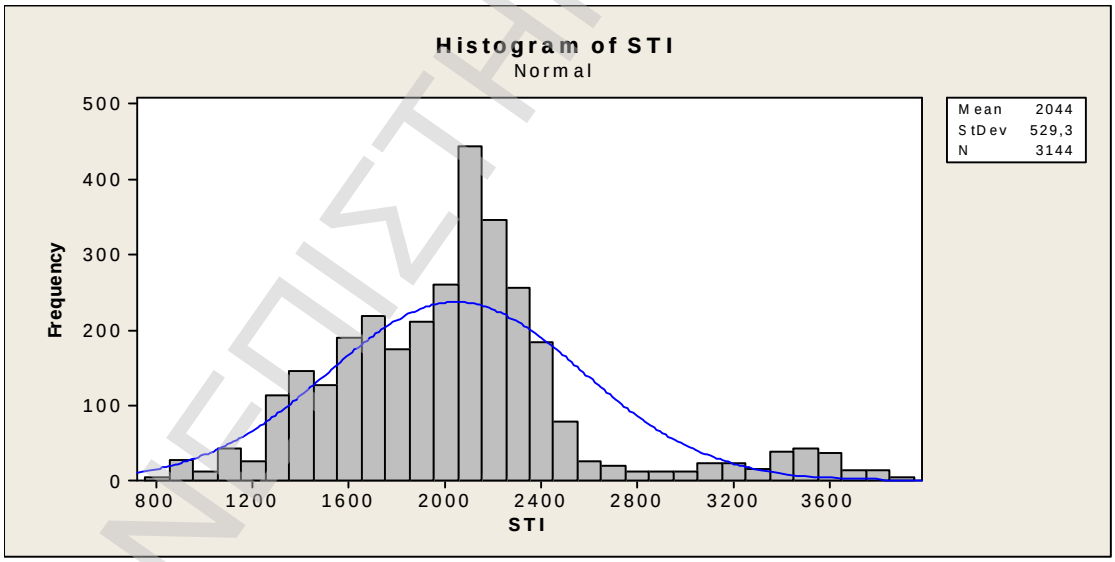


Figure 19: STI Stock Exchange Histogram (1993-2007)

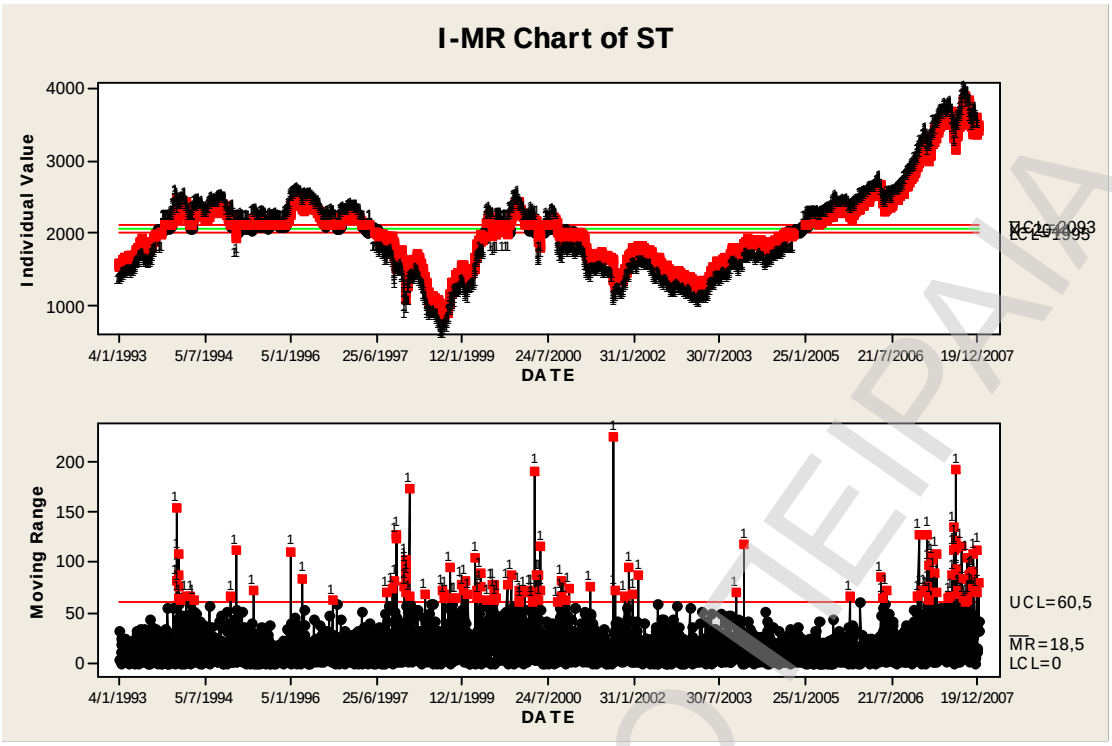


Figure 20: STI Stock Exchange Medium Range Graph (1993-2007)

6. Deutsche Aktien Xchange 30(DAX 30)

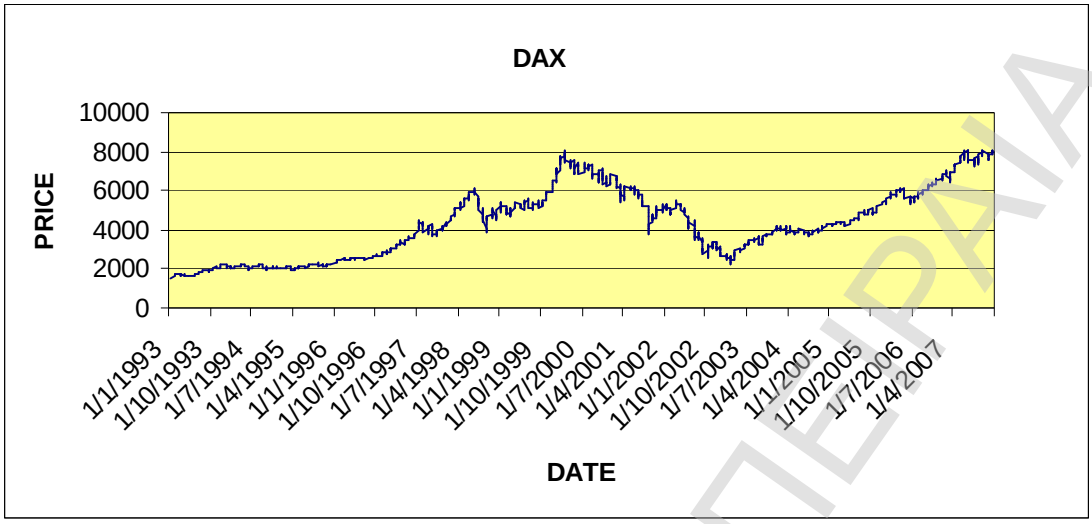


Figure 21: DAX Stock Exchange (1993-2007)

Deutsche Aktien Xchange 30 consists of the thirty major companies exchanging in the market of Germany. Concentrating the majority of the European funds, it gives the pace to all the financial markets in Europe. DAX 30 (Deutscher Aktien IndeX 30, formerly Deutscher Aktien-Index 30 (German stock index) is a Blue Chip stock market index consisting of the 30 major German companies trading on the Frankfurt Stock Exchange. Prices are taken from the electronic Xetra trading system. The L-DAX Index is an indicator of the German benchmark DAX 30 Index's performance after the Xetra electronic-trading system closes based on the floor trading at the Frankfurt Stock Exchange. The L-DAX Index basis is the "floor" trade (Parketthandel) at the Frankfurt stock exchange; it is computed daily between 09:00 and 17:30 Hours CET. Then the L-DAX (Late DAX 30) is calculated from 17:30 to 20:00 CET. The Eurex, a European electronic futures and options exchange based in Zurich, Switzerland with a subsidiary in Frankfurt, Germany, offers options (ODAX) and Futures (FDAX) on the DAX from 08:00 to 22:00 CET. Dax follows a similar course as the entire west Financial Markets.

After 93' the index followed a bullish attitude reaching the highest peaks. Inevitably, Dax has been affected by the global crisis and lost all the gains of one decade in a period of two years. Thereafter, he entered a bullish rally reaching again the highest peaks.

This stock market can be characterised as mature, following a rather stable trend, reflecting the economy of all the European Community. The volatile areas are faced in periods similar to the global crisis. The characteristics of his histogram are similar to all the other European Markets used in the sample. All the values are spread in a normal distribute in the plot area. Also, the volatile outbursts of the index are gathered as well, in the same periods, as all the western Stock markets. Medium range graph reflects this relation.

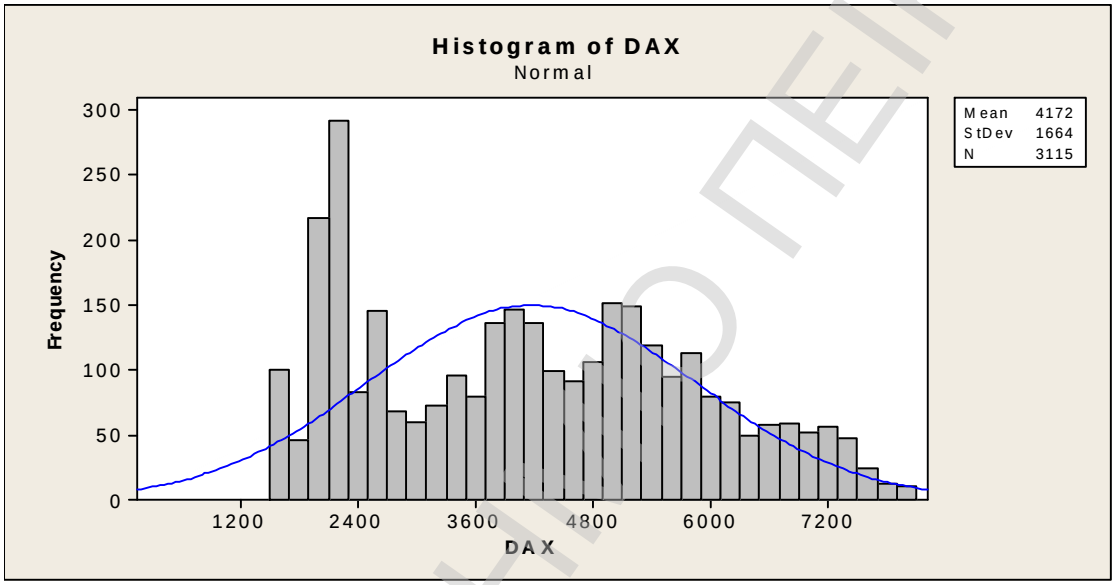


Figure 22: DAX Stock Exchange Histogram (1993-2007)

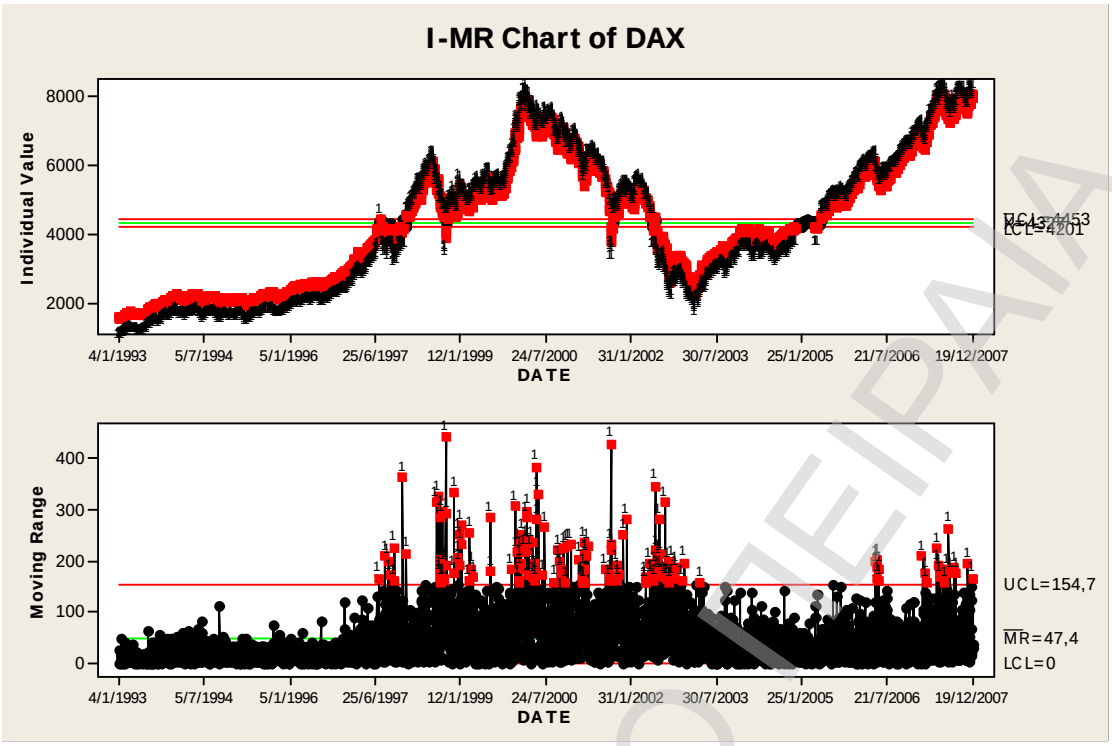


Figure 23: DAX Stock Exchange Medium Range Graph (1993-2007)

7. Cotation Assistée en Continu (CAC 40)

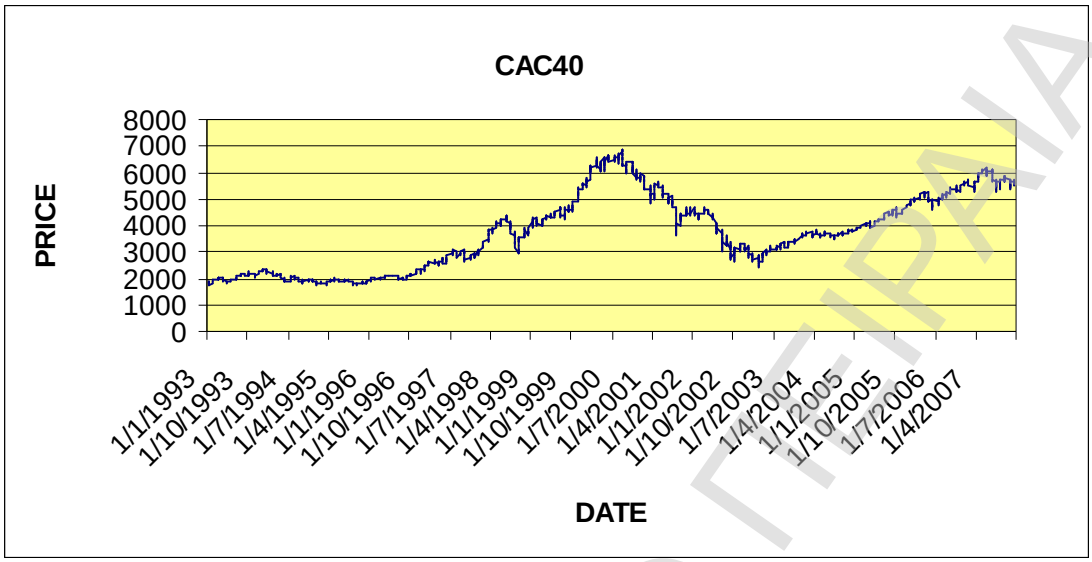


Figure 24: CAC Stock Exchange (1993-2007)

The index represents a capitalization-weighted measure of the 40 most significant values among the 100 highest market caps on the Paris Bourse (now Euronext Paris). It is one of the main national indices of the pan-European stock exchange group Euronext alongside Brussels' BEL20, Lisbon's PSI-20 and Amsterdam's AEX.

The CAC 40's base value of 1,000 was set on 31 December 1987, equivalent to a market capitalisation of 370,437,433,957.70 French francs. In common with many major world stock markets, its all-time high to date (6922.33 points) was reached at the peak of the dot-com bubble in September 2000. In 1 December 2003, the index's weighting system switched from being dependent on total market capitalisation to free float market cap only, in line with other leading indices.

The CAC 40 index composition is reviewed quarterly by an independent Index Steering Committee (French: Conseil Scientifique). If any changes are made, they are effected a minimum of two weeks after the review meeting. At each review date, the companies listed on Euronext Paris are ranked according to free float market capitalisation and share turnover over the prior 12 months. From the top 100 companies in this ranking, forty are chosen to enter the CAC 40 such that it is "a relevant benchmark for portfolio management" and "a suitable underlying asset for derivatives prod-

ucts". If a company has more than one class of shares traded on the exchange, only the most actively traded of these will be accepted into the index (generally this will be the ordinary share).

The CAC 40 is a market value-weighted index. The number of issued shares (used to calculate the market cap and hence the index weight) of a company is reviewed quarterly, on the third Friday of March, June, September and December. Since December 2003, the index weightings of companies in the index have been capped at 15% at each quarterly index review, but these range freely with share price subsequently. A capping factor is used to limit the weights to 15% (if necessary), and is reviewed annually by the Index Steering Committee on the third Friday of September.

In common with many major world stock markets, its all-time high to date (6922.33 points) was reached at the peak of the dot-com bubble in September 2000. In 1 December 2003, the index's weighting system switched from being dependent on total market capitalisation to free float market cap only, in line with other leading indices.

Although the CAC 40 is almost exclusively composed of French-domiciled companies, about 45% of its listed shares are owned by foreign investors, more than any other main European index. German, Japanese, American and British investors are amongst the most significant holders of CAC 40 shares. This large percentage is due to the fact that CAC 40 companies are more international, or multinational, than any other European market. CAC 40 companies conduct over two thirds of their business and employ over two thirds of their workforce outside France.

The histogram plot and medium range plots are similar to DAX stock market. Cac 40 is a stable mature market. All the values of the histogram are normally distributed in the plot area, except a period of volatility, which can be observed from the peak exceeding the usual values. Medium range plot is revealing the co movement relation of the European stock markets.

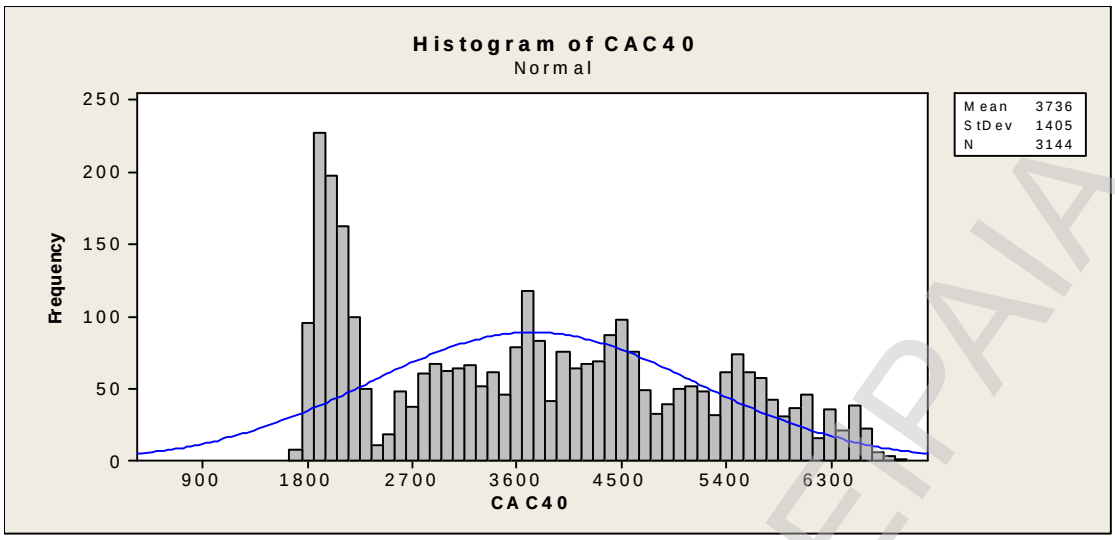


Figure 25: CAC 40 Stock Exchange Histogram (1993-2007)

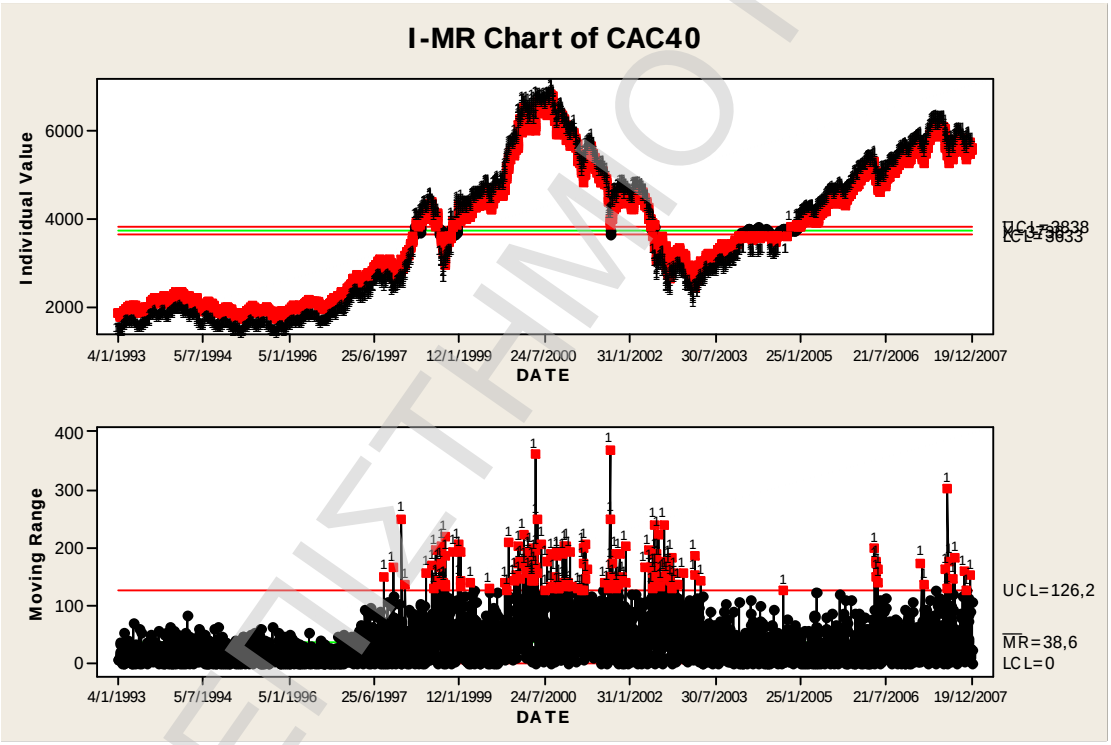


Figure 26: CAC 40 Stock Exchange Medium Range Graph (1993-2007)

8. Swiss Market Index (SMI)

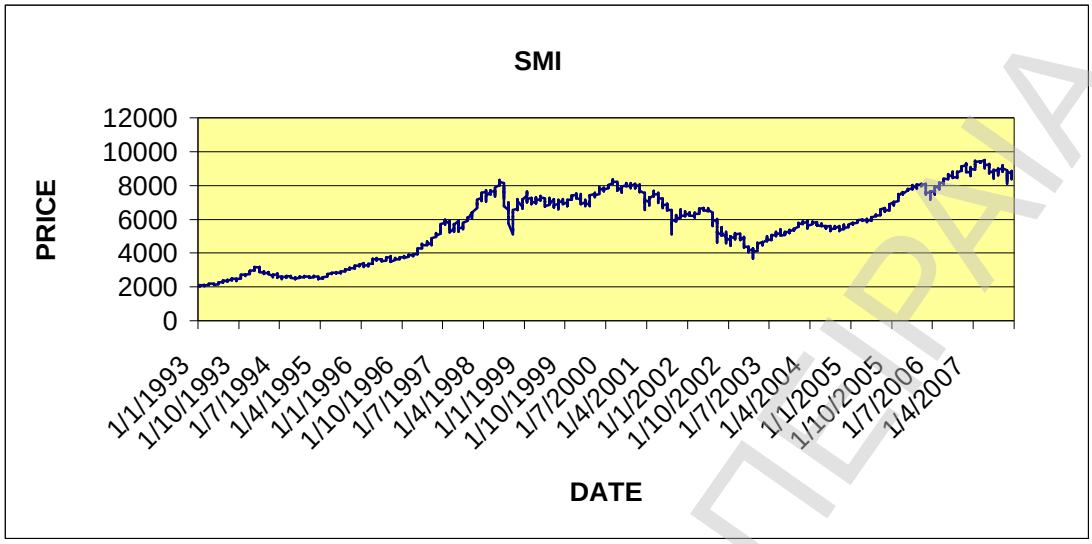


Figure 27: Swiss Market Index Stock Exchange (1993-2007)

The Swiss Market Index (SMI) is Switzerland's blue-chip stock market index, which makes it the most important in the country. It is made up of twenty of the largest and most liquid SPI large- and mid-cap stocks. As a price index, the SMI is not adjusted for dividends, but a performance index that takes account of such distributions is available (the SMIC - SMI Cum Dividend).

The SMI was introduced on 30 June 1988 at a baseline value of 1500 points. Its composition is examined once a year. Calculation takes place in real-time: as soon as a new transaction occurs in a security contained in the SMI, an updated index level is calculated and displayed.

The securities contained in the SMI currently represent more than 90% of the entire market capitalisation, as well as of 90% trading volume, of all Swiss and Liechtenstein equities listed on the SWX Swiss Exchange. Because the SMI is considered to be a mirror of the overall Swiss stock market, it is used as the underlying index for numerous derivative financial instruments such as options, futures and index funds

Swiss economy has been always characterised by stability, something that can been found also in the stock market historical prices. The volatility is rather low and only if there is a vast global effect, the index behaviour exceeds the usual trend. The

histogram reflects the normal distribute of the values. Medium range plot is volatile in the same period as all the west stock markets.

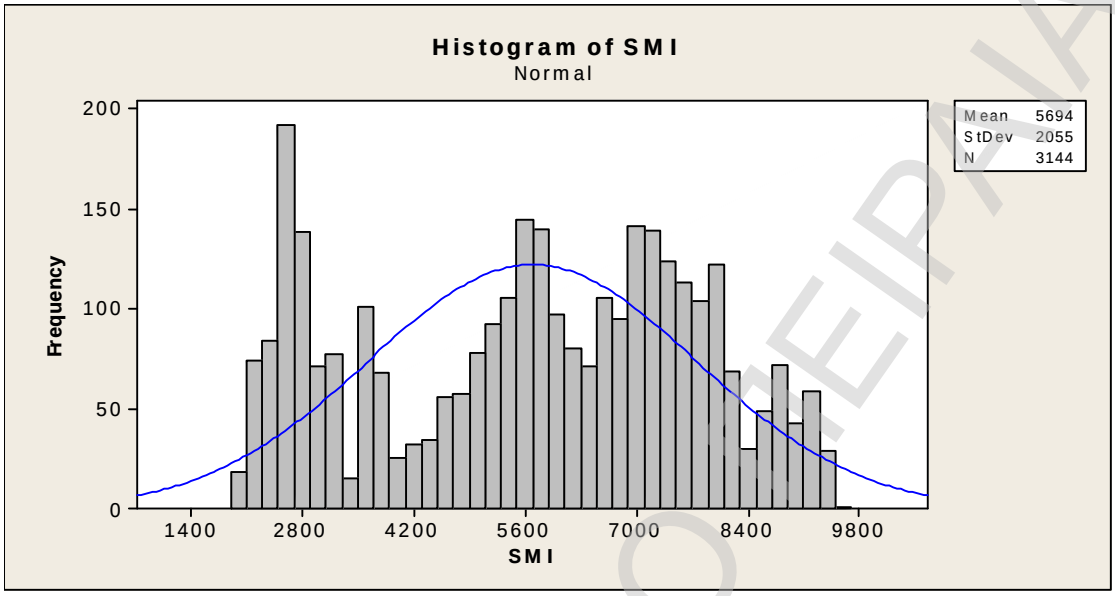


Figure 28: Swiss Market Index Stock Exchange Histogram (1993-2007)

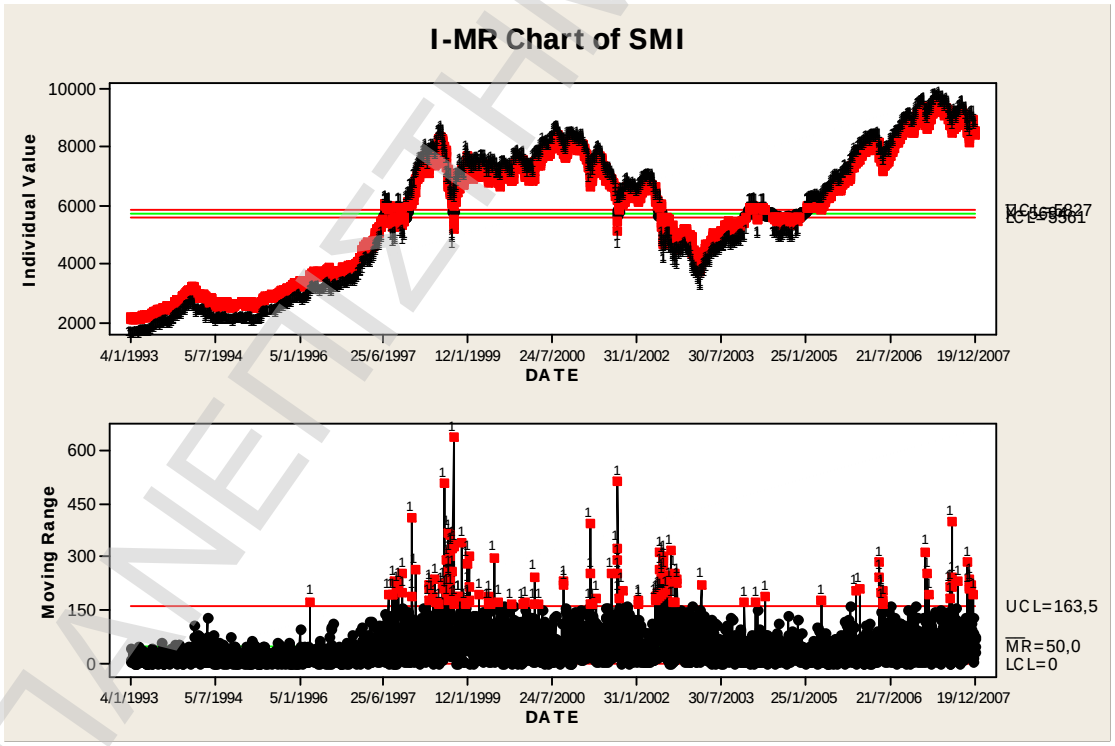


Figure 29: Swiss Market Index Stock Exchange Medium Range Graph (1993-2007)

9. Blegium Stock Exchange(BEL20)

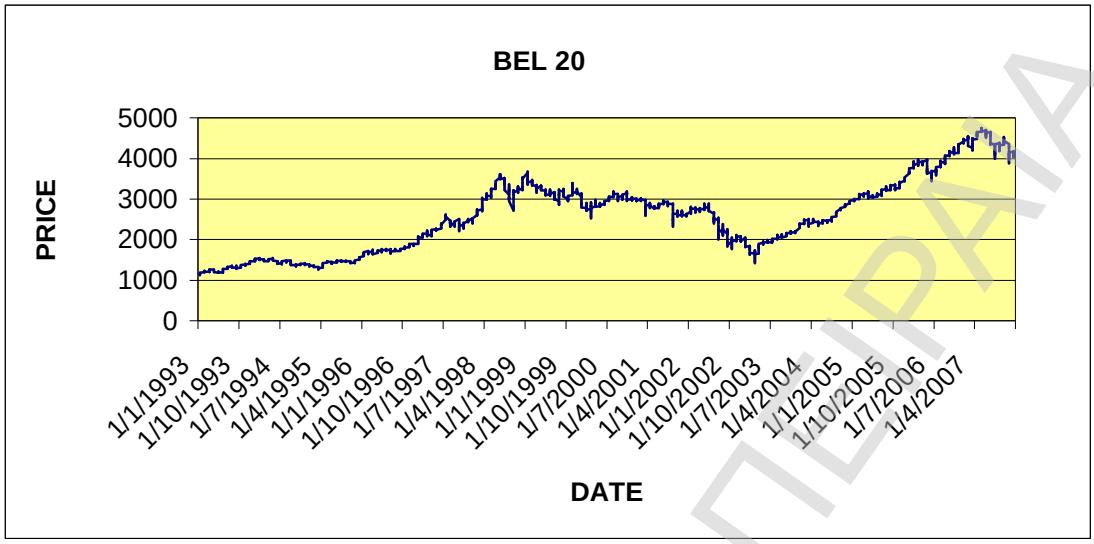


Figure 30: BEL20 Exchange (1993-2007)

The BEL20 is the benchmark stock market index of Euronext Brussels. In general, the index consists of a minimum of 10 and a maximum of 20 companies traded at the Brussels Stock Exchange. Since Nyrstar was promoted to the index on 4 March 2008, the BEL20 has contained a full 20 listings.

The composition of the BEL20 index is reviewed annually based on closing prices at the end of the calendar year. These changes are effected on the first trading day of every March. In addition to meeting a set of criteria demanding a company be "representative of the Belgian equity market", at least 15% of its shares must be considered free float in order to qualify for the index. In addition, a candidate for inclusion must possess a free float market capitalisation (in Euros) of at least 300000 times the price of the index on the last trading day of December. The minimum requirement for an existing constituent to remain in the index is a market cap of 200000 times the index value. At each annual review, the weights of companies in the index are capped at 15%, but range freely with share price subsequently. The BEL20 is a market value-weighted index.

The similarity to the other European Stock markets is obvious. Low volatility index and a rather stable trend. Histogramm observations are normally distributed in

the plot area and the medium range has peaks in the same period of the global financial crisis.

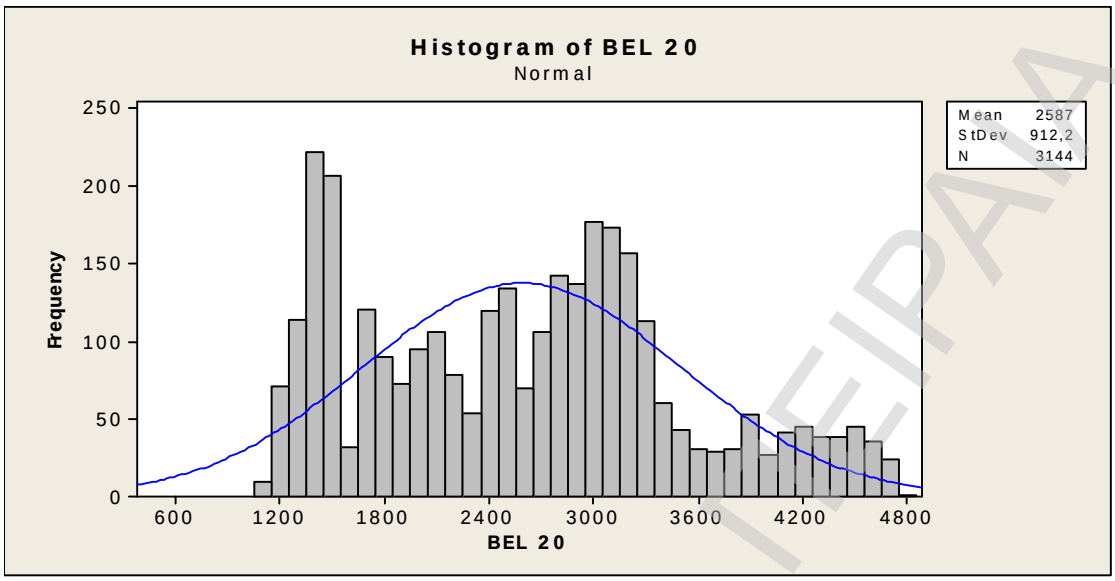


Figure 31: BEL 20 Stock Exchange Histogram (1993-2007)

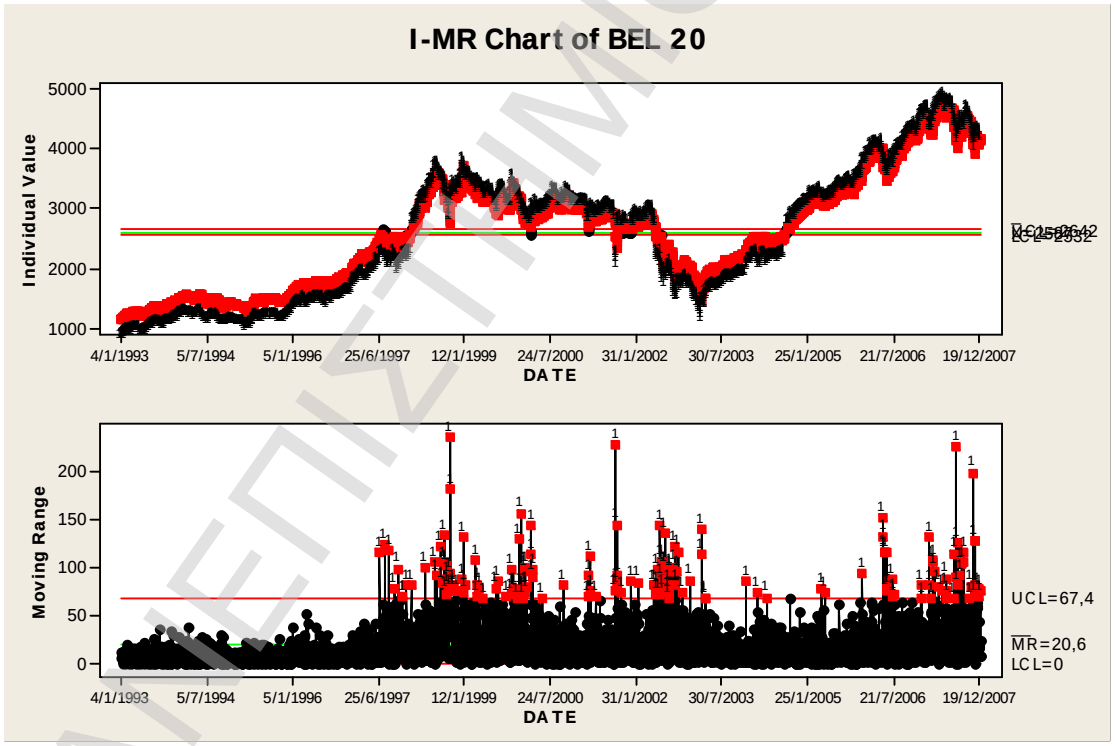


Figure 32: BEL 20 Stock Exchange Medium Range Graph (1993-2007)

10. London Stock Exchange

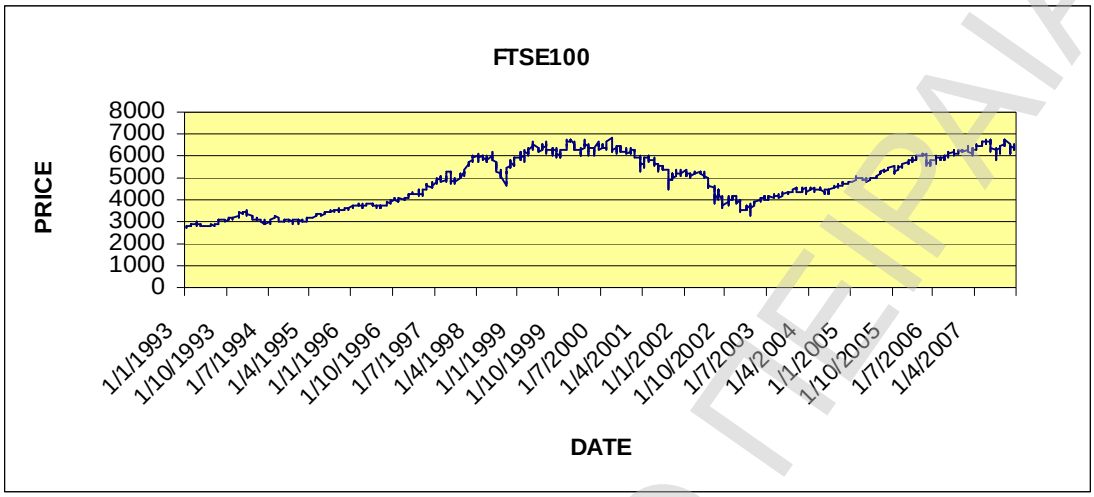


Figure 33: FTSE 100 Exchange (1993-2007)

The FTSE 100 Index (abbreviated Financial Times Stock Exchange Index) is a share index of the 100 most highly capitalised companies listed on the London Stock Exchange. The index began on 3 January 1984 with a base level of 1000; the highest value reached to date is 6950.6, on 30 December 1999.The index is maintained by the FTSE Group, an independent company which originated as a joint venture between the Financial Times and the London Stock Exchange.

FTSE 100 companies represent about 80% of the market capitalisation of the whole London Stock Exchange. Even though the FTSE All-Share Index is more comprehensive, the FTSE 100 is by far the most widely used UK stock market indicator. Other related indices are the FTSE 250 Index (which lists the next largest 250 companies after the FTSE 100), the FTSE 350 Index (which is the aggregation of the FTSE 100 and 250), FTSE SmallCap Index and FTSE Fledgling. The FTSE All-Share aggregates the FTSE 100, FTSE 250 and FTSE Small Cap.

The constituents of the index are determined quarterly; the largest companies in the FTSE 250 Index are promoted if their market capitalisation would place them in

the top 90 firms of the FTSE 100 Index. As of 2006, the threshold for inclusion is about £2.9 billion. As of 29 December 2006 the 6 largest constituents of the index were BP, Royal Dutch Shell, HSBC Holdings, the Vodafone Group, the Royal Bank of Scotland Group and GlaxoSmithKline, which were each valued at more than £60 billion.

Component companies must meet a number of requirements set out by the FTSE Group, including having a full listing on the London Stock Exchange with a Sterling or Euro dominated price on SETS, and meeting certain tests on nationality, free float, and liquidity.Most of the companies listed on this index usually include the abbreviation plc at the end of their name, indicating their status of public limited company.

The index follows the same pattern as of Dow Jones, but not so volatile. The impact of the terrorist attack in United States has also affected FTSE. However, there was a significant progress the last years and the index has reached the top peaks. In the histogram plot, the observations are exceeding the usual values frequently. However, the distribution of the observations is rather normal.

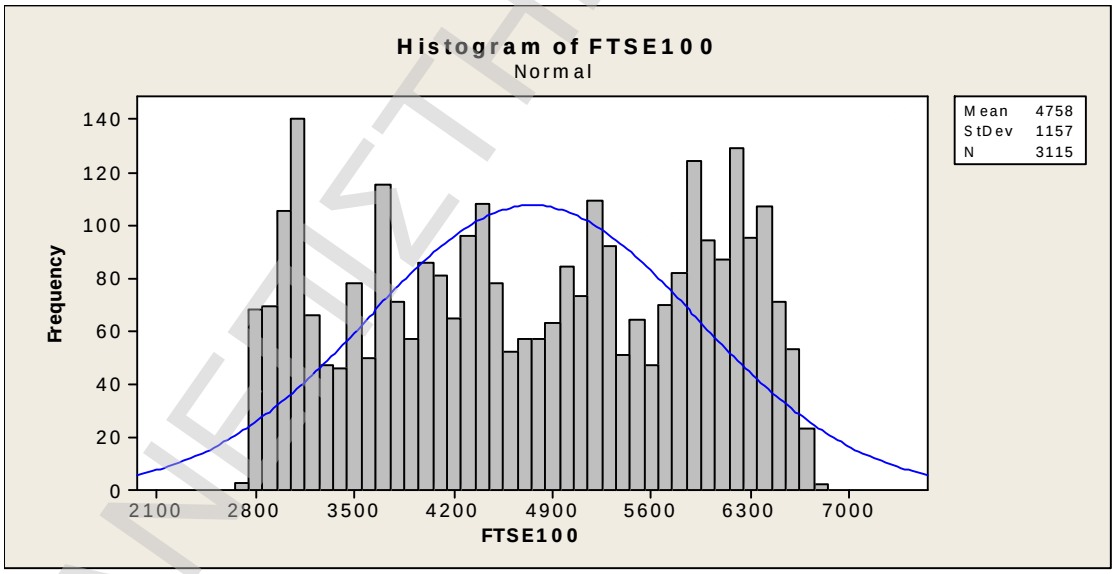


Figure 34: FTSE 100 Stock Exchange Histogram (1993-2007)

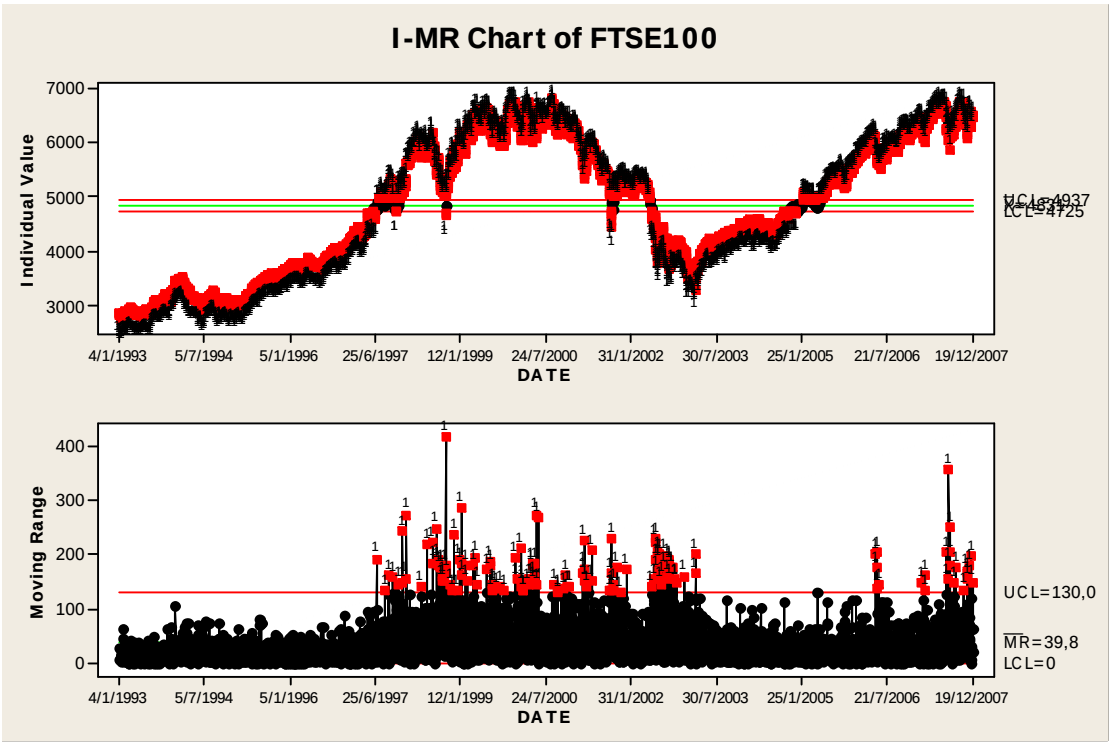


Figure 34: FTSE 100 Stock Exchange Medium Range Graph (1993-2007)

Empirical Evidence (Plot analysis)

West stock markets(DJ,TSX,FTSE100,DAX,BEL20,CAC40,SMI) seem to have the same characteristics. Their volatility is rather small and generally concentrates in periods were great magnitude financial shocks occur, bearish or bullish. Therefore, they tend to have more stable trend, and more specific in this period examined, up warding. Only, Dow Jones exceeds the usual volatility trends, thus it is more internationally oriented stock market and gathers a significant number of non-west investors and companies in contrast with all the other West markets.

After 2002, the west stock markets seem to have a more related trend. Co-movement characteristics can easily noticed, where as the alternation of trend occurs simultaneously in the West Stock markets.

The three other stock markets(N22,HKSE,STI), are having more individual trends and in many cases they are leaded only from the local economy. Their volatility is very high, thus they have an upwarding trend in long term period. N22 appears

to have this different characteristic and subsequently the trend of this market can not be easily related with the trend of all the others. Hong Kong and Singapore stock exchange are showing a small tendency to interact, but in minor percentage in contrast with the West stock markets interaction. However, only in cases of great financial shocks the Asian stock markets interact with the West stock markets and in minor percentage.

Again, the N22 is excluded from this relation. Only after 2002 there is an increase in the interaction with the other stock markets. Globalisation effect, the extinction of the stag inflation in Japan economy and the Japan Yen currency carry trade maybe some reasons for this change.
Hong Kong and Singapore stock exchange always had a more west-oriented trend, for the reason that a great source of funds is generated from the west economies to these local stock markets.

In conclusion, the co-movement notion can be extracted from the examination of the plots. Furthermore, if the examination focuses in the last six years, the characteristics of co-movement are more globally spread in the financial system. The globalisation effect in relation with some macro economic variables (Low interest rates) has shaped the way stock markets are interacting. Nevertheless, the plot analysis is not a so reliable tool for causation to be examined. The co movement theory can be faulty concluded through plot analysis.

Statistic Analysis

Correlation

In probability theory and statistics, correlation, (often measured as a correlation coefficient), indicates the strength and direction of a linear relationship between two random variables. In general statistical usage, correlation or co-relation refers to the departure of two variables from independence. In this broad sense there are several coefficients, measuring the degree of correlation, adapted to the nature of data.

A number of different coefficients are used for different situations. The best known is the Pearson product-moment correlation coefficient, which is obtained by dividing the covariance of the two variables by the product of their standard deviations. Despite its name, it was first introduced by Francis Galton(1888).

Mathematical properties

The correlation coefficient ρX, Y between two random variables X and Y with expected values μX and μY and standard deviations σX and σY is defined as:

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{E((X-\mu_X)(Y-\mu_Y))}{\sigma_X \sigma_Y},$$

where E is the expected value operator and cov means covariance. Since μX = E(X), σX2 = E(X2) − E2(X) and likewise for Y, we may also write

$$\rho_{X,Y} = \frac{E(XY) - E(X)E(Y)}{\sqrt{E(X^2) - E^2(X)}\,\sqrt{E(Y^2) - E^2(Y)}}.$$

The correlation is defined only if both of the standard deviations are finite and both of them are nonzero. It is a corollary of the Cauchy-Schwarz (1821-1888) inequality that the correlation cannot exceed 1 in absolute value.

The correlation is 1 in the case of an increasing linear relationship, −1 in the case of a decreasing linear relationship, and some value in between in all other cases, indicating the degree of linear dependence between the variables. The closer the coefficient is to either −1 or 1, the stronger the correlation between the variables.

If the variables are independent then the correlation is 0, but the converse is not true because the correlation coefficient detects only linear dependencies between two variables. Here is an example: Suppose the random variable X is uniformly distributed on the interval from −1 to 1, and Y = X2. Then Y is completely determined by X, so that X and Y are dependent, but their correlation is zero; they are uncorrelated. However, in the special case when X and Y are jointly normal, uncorrelatedness is equivalent to independence.

A correlation between two variables is diluted in the presence of measurement error around estimates of one or both variables, in which case disattenuation provides a more accurate coefficient.

Pearson Correlation

If we have a series of n measurements of X and Y written as xi and yi where i = 1, 2, ..., n, then the Pearson product-moment correlation coefficient can be used to estimate the correlation of X and Y . The Pearson coefficient is also known as the "sample correlation coefficient". The Pearson correlation coefficient is then the best estimate of the cor relation of X and Y . The Pearson correlation coefficient is written:

$$r_{xy} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{(n-1)s_x s_y} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\ \sqrt{n\sum y_i^2 - (\sum y_i)^2}}.$$

$$r_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y},$$

where $\bar{x}$ and $\bar{y}$ are the sample means of X and Y , sx and sy are the sample standard deviations of X and Y and the sum is from i = 1 to n. As with the population correlation, we may rewrite this as

$$r_{xy} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{(n-1)s_x s_y} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\ \sqrt{n\sum y_i^2 - (\sum y_i)^2}}.$$

Again, as is true with the population correlation, the absolute value of the sample correlation must be less than or equal to 1. Though the above formula conveniently suggests a single-pass algorithm for calculating sample correlations, it is notorious for its numerical instability (see below for something more accurate).

The square of the sample correlation coefficient, which is also known as the coefficient of determination, is the fraction of the variance in yi that is accounted for by a linear fit of xi to yi . This is written

$$r_{xy}^2 = 1 - \frac{s_{y|x}^2}{s_y^2},$$

where sy|x2 is the square of the error of a linear regression of xi on yi by the equation y = a + bx:

$$s_{y|x}^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - a - bx_i)^2,$$

and sy2 is just the variance of y:

$$s_y^2 = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2.$$

Note that since the sample correlation coefficient is symmetric in xi and yi , we will get the same value for a fit of yi to xi :

$$r_{xy}^2 = 1 - \frac{s_{x|y}^2}{s_x^2}.$$

This equation also gives an intuitive idea of the correlation coefficient for higher dimensions. Just as the above described sample correlation coefficient is the fraction of variance accounted for by the fit of a 1-dimensional linear submanifold to

a set of 2-dimensional vectors (xi , yi), so we can define a correlation coefficient for a fit of an m-dimensional linear submanifold to a set of n-dimensional vectors. For example, if we fit a plane z = a + bx + cy to a set of data (xi , yi , zi) then the correlation coefficient of z to x and y is

$$r^2 = 1 - \frac{s^2_{z|xy}}{s^2_z}.$$

The distribution of the correlation coefficient has been examined by R. A. Fisher and A. K. Gayen.

Correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless. Interesting examples include a positive correlation between teachers' salaries and the consumption of alcohol and a superb positive correlation between the death rate in the UK and the proportion of marriages solemnized in the Church of England. Economists debate correlations which are less obviously meaningless.

Pearson Correlation is the most common. The calculate formula that is usually used is:

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N})(\sum Y^2 - \frac{(\sum Y)^2}{N})}}$$

The correlation coefficient assumes a value between –1 and +1. If one variable tends to increase as the other decreases, the correlation coefficient is negative. Conversely, if the two variables tend to increase together the correlation coefficient is positive. For a two-tailed test of the correlation:

Ho: r = 0 versus H_1: r ≠ 0 where r is the correlation between a pair of variables. Also, the p-value is generated on this process reflecting the propability of rejecting the Ho is a mistake.

Empirical Evidence

	CAC40	DAX	FTSE100	DJI	N22	HKSE	SMI	TSX	ST	BEL 20
CAC40	1,00									
p-value	0,00									
DAX	0,97	1,00								
p-value	0,00									
FTSE100	0,92	0,96	1,00							
p-value	0,00	0,00								
DJI	0,90	0,90	0,89	1,00						
p-value	0,00	0,00	0,00							
N22	-0,25	-0,15	-0,14	-0,45	1,00					
p-value	0,00	0,00	0,00	0,00						
HKSE	0,73	0,79	0,71	0,76	0,04	1,00				
p-value	0,00	0,00	0,00	0,00	0,01					
SMI	0,93	0,96	0,97	0,94	-0,26	0,74	1,00			
p-value	0,00	0,00	0,00	0,00	0,00	0,00				
TSX	0,85	0,86	0,79	0,90	-0,25	0,88	0,88	1,00		
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00			
ST	0,30	0,36	0,26	0,28	0,43	0,77	0,28	0,56	1,00	
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00		
BEL 20	0,86	0,91	0,91	0,90	-0,18	0,78	0,96	0,91	0,43	1,00
p-value	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 1: Pearson Correlation Estimates (1993-2007)

For a propability of a=0,05 all the p-values are lower 0,01%, rejecting the Ho hypothesis.

All the European stock markets have great correlation above (85%) and they follow the same trend. The same result is with the American stock markets (TSX and DJI), (above 79%).With the Asian stock markets the correlation varieties. There is significant correlation between the European stock markets and HKSE(above 75%) and same trend, insignificant with the N22 (below 25%) and negative trend, and finally with ST , insignificant with the same trend.

The American stock markets share a correlation above 90% and positive. As mentioned above, they have great correlation with the European stock markets. DJI

and N22 have a meager correlation with negative trend -44%, whereas DJI and HKSE share a correlation of 76% positive. STI and DJI are not having any great relation, sharing a percentage of 28 positive.

The Canadian Stock Market(TSX) has small relation with Tokio Stock Exchange(N22) and with opposite trend -25%. However, the relation of TSX with STI leans to 56%, with the same trend and with a higher relation to HSKE 88%, with positive trend.

The relation of European and American stock markets is very strong. The inter connection of these continents is highly feeded by the mutual exchange of funds. Direct investments to these economies, ensure the minimum risk for the investors. The maturity, as well as the stability, of these same characteristics financial system, works as an attractor for the European and American investors. The data provided bellows are reflecting the direct investments to EU from the other continents. Direct investments between EU and North America are exceeding all the other different directed investments. Furthermore, the trend is rather upwarding.

The second table reflects the abroad investments from EU nations to all the other continents. Consequently, the results are the same. The ratio of direct investments exchange from EU to North America is the highest.

Stocks of foreign direct investment in the EU-25 by investor continent - (million EUR)						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Extra EU-25	**1295598**	**1265279**	**1484575**	**1728078**	**1818028**	**2044160**
Africa	8508	9418	9725	14638	19353	23500
North America	**785884**	**740604**	**808466**	**906447**	**936019**	**1018867**
Central America	137165	130036	214596	222571	228646	260916
South America	4289	5272	9160	11931	14097	24986
Asia	109388	113600	133670	160415	162030	208085
Oceania (including Australia)	22036	16876	23100	37878	23389	17745

Table 2: Direct investments in the EU-25 by investor Continent

EU-25 stocks of foreign direct investment held abroad by continent - (million /EUR)						
	2001	**2002**	**2003**	**2004**	**2005**	**2006**

Extra EU-25	**2017386**	**1904845**	**2011069**	**2212936**	**2458021**	**2737508**
Africa	60371	64748	84453	110205	119206	125090
North America	**1000607**	**843194**	**828890**	**895803**	**947161**	**1078455**
Central America	110946	125422	157355	211558	255424	287048
South America	165522	97318	137139	145100	167767	168047
Asia	249985	246915	295774	345415	368344	367573
Oceania (including Australia)	53081	55266	60111	67178	58720	55651

Table 3: Foreign investments from the EU-25 by investor Continent

Asian Stock markets, are having the most unusual relationship. The N22 and HKSE are sharing a 4% correlation and N22 with STI 43%, having in both cases the same trend. Finally, HSKE and STI are having great correlation 77%, with positive relation.

Lastly, the only externally influenced by the western stock markets are Hong Kong Stock Exchange and Singapore stock exchange in a small percentage though. Hong Kong was always western oriented (colony till 1997), thus a great number of business where created or entrepreneur by western capitals.

Singapore stock exchange is being characterised as an emerge market and affected primarily from the local economy. Furthermore, it has a substantial role to the Asian markets, and this reflected on the relation with the HKSE, sharing a correlation of 77%, which is very high.

In conclusion, the geographical orientation or maybe the same characteristic financial systems shows the great impact between the stock markets of the same continent, except Japan, which seems to be non influenced by external factors

As mentioned above, the correlation effects diversifies in each case studied, but the general conclusion is that there is a co movement notion. But, if the period examined narrows to the last five years the results are extraordinary. All the stock markets have correlation above 75%, with the same trend. These outcome, outlies from the fact that, as for mentioned, the last decade was crucial in global economies behaviour. The globalisation effect, achieved to synchronise all the stock markets and transform them to more exogenous. Maybe, this is explained by the bullish trend that characterised the stock markets, the last five years. However, this opposition is meaning-

less, because there is no rule that explains this fact. Even the hypothesis of a similar economic environment (low interest rates, high cash flow) satisfies the notion of co movement. It easily noticed, that even the Asian stock markets ‘’followed’’ the bullish trend of the west stock markets.

	CAC40	DAX	FTSE100	BEL 20	DJI	SMI	N22	HKSE	TSX	ST
CAC40	1									
DAX	0,98	1								
FTSE100	0,99	0,98	1							
BEL 20	0,90	0,91	0,93	1						
DJI	0,87	0,92	0,89	0,92	1					
SMI	0,97	0,97	0,98	0,96	0,91	1				
N22	0,89	0,90	0,92	0,96	0,90	0,96	1			
HKSE	0,79	0,87	0,82	0,88	0,93	0,85	0,84	1		
TSX	0,79	0,84	0,85	0,96	0,93	0,89	0,93	0,92	1	
ST	0,78	0,85	0,83	0,93	0,95	0,87	0,89	0,96	0,97	1

Table 4: Pearson Correlation Estimates (2001-2007)

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Econometric Analysis

Regression (Ordinary Least Squares)

To examine whether there is a linear equation describing any relation between the stock markets, the OLS (Ordinary Least Squares) methodology is used. The b-coefficient will determine the relationship between the dependent variable and the independent. In this case, ten different equations are going to be estimated, thus the dependant variable will change for the ten different stock markets.

Mathematical properties

Denote two variables Y and X. In these bi-variable system Y is the dependant non-stochastic variable and X is the independent stochastic. Under the hypothesis of the best linear equation estimators the following procedure is generated:

Denote a system of m equations in stacked form as:

$$\begin{Bmatrix} y_1 \\ y_2 \\ . \\ y_m \end{Bmatrix} = \begin{Bmatrix} x_1 & 0 & 0 & 0 \\ 0 & x_2 & 0 & 0 \\ . & . & . & . \\ 0 & 0 & 0 & x_m \end{Bmatrix} \begin{bmatrix} b_1 \\ b_2 \\ . \\ b_m \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ . \\ e_m \end{bmatrix}$$

where y_m is a T vector, x_m is a $T \times k_m$ matrix, and b_m is a k_m vector of coefficients(k=number of independent variables and T=sample n). The error terms e have an $MT \times MT$ covariance matrix V. The system may be written in compact form as:

$$Y = BX + E$$

Under the standard assumptions, the residual variance matrix from this stacked system is given by:

$$V = E(ee') = s^2(I_M \times I_T)$$

The OLS estimator of the estimated variance matrix of the parameters is valid under the assumption that $V = s^{2} \times I$. The estimator for b is given by,

$$b = (X'X)^{-1} \times X \times y$$

and the variance estimator is given by:

$$\text{var}(b) = s^{2}(X'X)^{-1}$$

where S^{2} is the residual variance estimate for the stacked system.

The generated outcomes will be examined with the tests of t-statistics, F-statistic, R^{2}, Durbin Watson for First Order correlation, Breusch Godfrey for high-order serial correlation and Lagrange Multiplier-Heteroskedacity test.

Tests

- **t-statistic**

This test is used to examine whether the coefficient of the generated equation is equal to zero.

Under the hypothesis $H_0 : b_n = 0$ and $H_1 : b_n \neq 0$

If $|t_{est}| > t_{a,T}$ we reject the hypothesis H_0, whereas

$$t_{b_i} = \frac{b}{\sqrt{e'_{est}\, e_{est} / (T-k)}}$$

, $e = Y - Xb$,n=1,2,3…∞ ,k= number of independent variables

In this case a rule of thumb is going to be used for the critical level of the t-statistic. If t estimated is larger than 1,96, then the H_0 hypothesis will be rejected.

- **F-Statistic**

The F-statistic reported in the regression output is from a test of the hypothesis that all of the slope coefficients (excluding the constant, or intercept) in a regression are zero. For ordinary least squares models, the F-statistic is computed as:

Under the hypothesis $H_0 : b_n = 0$ and $H_1 : b_n \neq 0$ (at least one b coefficient), where n=1,2… ∞,

$$F = \frac{R^2 / (k-1)}{(1-R^2) / (T-k)}$$, k=number of independent variables and T=sample n

If $F_{est} > F_{(a,k-1,T-k)}$, then the H_0 is rejected. The F-statistic test is a joint test, meaning that even if all the t-statistics of b coefficients are equal to zero, the F-statistic maybe highly significant.

- **R-squared**

The R-squared (R^2) statistic measures the success of the regression in predicting the values of the dependent variable within the sample. In standard settings, (R^2) may be interpreted as the fraction of the variance of the dependent variable explained by the independent variables. The statistic will equal one if the regression fits perfectly, and zero if it fits no better than the simple mean of the dependent variable. It can be negative for a number of reasons. For example, if the regression does not have an intercept or constant, if the regression contains coefficient restrictions, or if the estimation method is two-stage least squares or ARCH.

The calculate formula for R-squared (R^2) is:

$$R^2 = 1 - \frac{e_{est}' e_{est}}{(y - y_{est})'(y - y_{est})}$$,whereas $y_{est} = \sum_{t=1}^{T} y_t / T$

where y_{est} is the mean of the dependent variable.

One problem with using(R^2) as a measure of goodness of fit is that the will never decrease as you add more regressors. In the extreme case, you can always obtain an (R^2) of one if you include as many independent regressors as there are sample observations. The adjusted (R^2), commonly denoted as ($\overline{R}^2$), penalizes the (R^2) for the addition of regressors which do not contribute to the explanatory power of the model. The adjusted is computed as:

$$\overline{R}^2 = 1 - (1 - R^2)\frac{T-1}{T-k}$$

The ($\overline{R}^2$) is never larger than the (R^2), can decrease as you add regressors, and for poorly fitting models, may be negative.

- **Durbin Watson for First Order Correlation**

EViews reports the Durbin-Watson (DW) statistic as a part of the standard regression output. The Durbin-Watson statistic is a test for first-order serial correlation. More formally, the DW statistic measures the linear association between adjacent residuals from a regression model. The Durbin-Watson is a test of the hypothesis p=0 in the specification:

$$u_t = pu_{t-1} + e_t$$

If there is no serial correlation, the DW statistic will be around 2. The DW statistic will fall below 2 if there is positive serial correlation (in the worst case, it will be near zero). If there is negative correlation, the statistic will lie somewhere between 2 and 4.

The Hypothesis is H_0 = There is no serial correlation

If d<2, There is positive Correlation, and H_0 is rejected

If d=2,There is no correlation, and H_0 is not rejected

If d>2, There is negative Correlation, and H_0 is rejected

Positive serial correlation is the most commonly observed form of dependence. As a rule of thumb, with 50 or more observations and only a few independent variables, a DW statistic below about 1.5 is a strong indication of positive first order serial correlation. See Johnston and DiNardo (1997) for a thorough discussion on the Durbin-Watson test and a table of the significance points of the statistic.

There are three main limitations of the DW test as a test for serial correlation. First, the distribution of the DW statistic under the null hypothesis depends on the data matrix . The usual approach to handling this problem is to place bounds on the critical region, creating a region where the test results are inconclusive. Second, if there are lagged dependent variables on the right-hand side of the regression, the DW test is no longer valid. Lastly, you may only test the null hypothesis of no serial correlation against the alternative hypothesis of first-order serial correlation.

Two other tests of serial correlation-the Q-statistic and the Breusch-Godfrey LM test-overcome these limitations, and are preferred in most applications.

- **Breusch Godfrey for high-order serial correlation**

The null hypothesis of the LM test is that there is no serial correlation up to lag order p, where is a pre-specified integer. The local alternative is ARMA(r,q) errors, where the number of lag terms p=max(r,q). Note that this alternative includes both AR(p) and MA(p) error processes, so that the test may have power against a variety of alternative autocorrelation structures. See Godfrey (1988), for further discussion.

The test statistic is computed by an auxiliary regression as follows. First, suppose you have estimated the regression:

$$Y = bX + e$$

where b are the estimated coefficients and e are the errors. The test statistic for lag order p is based on the auxiliary regression for the residuals $e = Y - Xb_{est}$:

$$e_t = X_t + (\sum_{q=1}^{p} a_q e_{t-q}) + u_t$$

Following the suggestion by Davidson and MacKinnon (1993), EViews sets any presample values of the residuals to 0. This approach does not affect the asymptotic distribution of the statistic, and Davidson and MacKinnon argue that doing so provides a test statistic which has better finite sample properties than an approach which drops the initial observations.

The Obs*R-squared statistic is the Breusch-Godfrey LM test statistic. This LM statistic is computed as the number of observations, times the (uncentered)(R^2) from the test regression. Under quite general conditions, the LM test statistic is asymptotically distributed as a $x^2(p)$.

The hypothesis examined is $H_0 =$ LM test statistic is asymptotically distributed as a $x^2(p)$ $H_1 \neq$ LM test statistic is not asymptotically distributed as a $x^2(p)$

If N(R^2)> $x^2(p)$, then we reject the H_0 and there is a problem of serial correlation

- **White's Heteroskedasticity Test**

This is a test for heteroskedasticity in the residuals from a least squares regression (White, 1980). Ordinary least squares estimates are consistent in the presence of heteroskedasticity, but the conventional computed standard errors are no longer valid. If you find evidence of heteroskedasticity, you should either choose the robust standard errors option to correct the standard errors (see Heteroskedasticity Consistent Covariances (White)) or you should model the heteroskedasticity to obtain more efficient estimates using weighted least squares.

White's test is a test of the null hypothesis of no heteroskedasticity against heteroskedasticity of some unknown general form. The test statistic is computed by an auxiliary regression, where we regress the squared residuals on all possible (nonredundant) cross products of the regressors. For example, suppose we estimated the following regression:

$$y_t = b_1 + b_2 x_t + b_3 z_t + e_t$$

where the b are the estimated parameters and e the residual and z conditional variables. The test statistic is then based on the auxiliary regression:

$$e_t^2 = a_0 + a_1 x_t + a_2 z_t + a_3 x_t^2 + a_4 z_t^2 + a_5 x_t z_t + u_t$$

The Obs*R-squared statistic is White's test statistic, computed as the number of observations times the centered (R^2) from the test regression. White's test statistic is asymptotically distributed as a x^2 with degrees of freedom equal to the number of slope coefficients (excluding the constant) in the test regression.

The hypothesis examined is $H_0 =$ White's test statistic is asymptotically distributed as a $x^2(k-1)$ $H_1 \neq$ White's test statistic is not asymptotically distributed as a $x^2(k-1)$

If N(R^2)> $x^2(k-1)$, then we reject the H_0 and there is a problem of heteroskedacity.

White also describes this approach as a general test for model misspecification, since the null hypothesis underlying the test assumes that the errors are both homoskedastic and independent of the regressors, and that the linear specification of the model is correct. Failure of any one of these conditions could lead to a significant test statistic. Conversely, a non-significant test statistic implies that none of the three conditions is violated.

Empirical Evidence

		b-Coefficients									
	a-Coeffic	BEL20	CAC40	DAX	DJI	FTSE100	HKSE	NIKKEI	SMI	ST	TSX
BEL 20	-512,65		-0,23	0,02	-0,01	0,18	-0,07	-0,01	0,40	0,51	0,10
CAC40	328,23	-0,51		0,82	0,01	0,39	-0,11	-0,04	-0,18	0,32	0,20
DAX	-1052,30	0,04	0,70		-0,06	0,09	0,10	0,02	0,38	-0,11	-0,09
DJI	2149,59	-0,12	0,05	-0,31		1,30	0,13	-0,24	0,26	0,17	0,26
FTSE100	774,05	0,19	0,18	0,05	0,14		0,03	0,06	0,34	-0,19	-0,18
HKSE	-3235,56	-2,35	-1,82	1,82	0,45	1,05		-0,02	-0,17	3,83	0,70
NIKKEI	6409,59	-0,91	-1,30	0,75	-1,88	4,21	-0,04		0,01	4,61	-0,01
SMI	-121,57	0,69	-0,14	0,35	0,05	0,56	-0,01	0,00		-0,52	0,15
ST	343,78	0,45	0,13	-0,05	0,02	-0,16	0,10	0,05	-0,27		0,05
TSX	1172,37	1,01	0,90	-0,48	0,25	-1,66	0,19	0,00	0,84	0,57	

Table 5: B-coefficient Estimates

The b coefficients of the estimate regression appear an inelastic relation between the stock markets (if all the other independent variables are zero the independent variable has a coefficient that $0<|b|<1$), meaning that the reaction in change of independent price has minor effect in the dependant, thus no relations or small relation and vice versa

In some cases there is elastic relation ($|b|>1$).

- DJI and FTSE100 has an elastic relation(b=1,30)
- HKSE has an elastic relation with BEL20(b=2,35),CAC40(b=1,82),DAX(b=1,82),ST(b=3,83)
- NIKKEI has an elastic relation with CAC40 (b=-1,30), DJI (b= -1,88),FTSE100 (b=4,21),ST (b=4,61)
- TSX has an elastic relation with BEL20(b=1,01)

		t-Statistic									
	a-coeffic	BEL20	CAC40	DAX	DJI	FTSE100	HKSE	NIKKEI	SMI	ST	TSX
BEL 20	-15,33		-20,40	1,74	-2,11	10,66	-24,14	-5,87	34,56	30,44	19,09
CAC40	6,44	-20,40		65,78	1,41	15,53	-28,40	-12,66	-8,88	11,64	26,48
DAX	-24,15	1,74	65,78		-7,69	3,61	25,86	6,62	21,71	-4,36	-12,12
DJI	21,15	-2,11	1,41	-7,69		26,02	13,83	-51,05	6,14	2,92	14,75
FTSE100	23,82	10,66	15,53	3,61	26,02		10,20	31,56	27,19	-9,75	-36,15
HKSE	-16,36	-24,14	-28,40	25,86	13,83	10,20		-1,53	-2,07	42,95	22,28
NIKKEI	22,89	-5,87	-12,66	6,62	-51,05	31,56	-1,53		0,12	32,16	-0,18
SMI	-2,69	34,56	-8,88	21,71	6,14	27,19	-2,07	0,12		-22,74	21,16
ST	10,70	30,44	11,64	-4,36	2,92	-9,75	42,95	32,16	-22,74		9,78
TSX	11,05	19,09	26,48	-12,12	14,75	-36,15	22,28	-0,18	21,16	9,78	

Table 6: T-statistic Estimates

However the elasticity between the dependant and independent occurs only when the b coefficient is statistically significant **(**$|t|$ >1,96)

- DJI and FTSE100 b coefficient is statistically significant(t=26,02)
- HKSE b_i (where i=BEL20,CAC40…TSX) coefficient is statistically significant with BEL20 (t=-24,14),CAC40 (t=-28,40),DAX (t=25,86),ST (t= 42,95)
- NIKKEI b_i (where i=BEL20,CAC40…TSX) coefficient is statistically significant with CAC40 (t=-12,66), DJI (b= -51,05),FTSE100 (t=31,56),ST (t= 32,16)
- TSX b_i (where i=BEL20,CAC40…TSX) coefficient is statistically significant with BEL20(t=19,09)

The conclusion that can be extracted from the above analysis is that between these stock markets there is a relation sometimes positive when b<0 and negative when b>1. However, the results can be spurious. The examination must continue with the other tests

	R^2-adj	F-statistic	White-het	Durbin Wa	Breusch G.
BEL 20	0.965999	9922,70	1.372	0,03	3.062,0
CAC40	0.968642	10788,44	1.499	0,03	3.045,2
DAX	0.983250	20501,27	1.101	0,04	3.030,0
DJI	0.967014	10238,68	984	0,04	3.029,1
FTSE100	0.978868	16177,25	367	0,05	2.995,6
HKSE	0.941907	5.663	1.349	0,04	3.013,8
NIKKEI	0.846381	1.925	666	0,04	3.024,2
SMI	0.988566	30195,42	834	0,05	3.000,3
ST	0.910147	3.538	1.003	0,03	3.045,0
TSX	0.964570	9.509	1.110	0,04	3.024,1

Table 7: Test Values

Firstly, the ($\overline{R}^2$)>85(usually in financial analysis an ($\overline{R}^2$)>0,25 is enough significant) is significant, meaning that the independent variables explain very well the changes in the dependant variable.

Secondly, the $F_{est} > F_{(0,005,9,3135)}$=5,19, ensuring that there is always a coefficient that in not equal to zero.

In conclusion, all the regressions are qualified to explain, whether there is a relation between the variables. To finalise this hypothesis, the individuality of the residuals must be verified.

Heteroscedacity is examined with the White Heteroskedacity statistic. If N(R^2)> $x^2(0{,}005{,}9)$ =23,60, then H_0 is rejected and there is a problem of heteroskedacity. In all cases, the H_0 is rejected and consequently the residuals are suffering from heteroskedacity. The transformation of series to a logarithmic form may solve the problem, but it will be difficult to extract any meaningful results, cause the transformation will affect the series. On the other hand, if heterockedacity is neglected, the outcomes will not be substantial for exploration, though the coefficients will not be the best linear unbiased estimators(OLS hypothesis).

Durbin Watson statistics d is equivalent from 0,03 to 0,05, thus there is positive autocorrelation in all cases and H_0 is rejected. Therefore, the residuals are affected by previous years prices and first order autocorrelation is surely a negative effect to estimation process. In this case, the OLS estimation is not qualified for trustful outcomes.

For higher order autocorrelation, the Breusch Godfrey test for up to order three autocorrealtion(p=3) is N(R^2)> $x^2(p)$ =12,84 and statistic significance a=0,005. The H_0 is rejected and there is a problem of heteroskedacity for higher levels.

The same methodology as heterockedacity can be applied but the logarithmic form of the series will not give reliable and trustful results.

In conclusion, the OLS estimation is not credible for estimating the relation of the stock markets. These results were expected, though the time series are known to suffer from heteroskedacity and autocorrelation. The residuals, which represent all the unknown factors, cannot be neglected. All these unknown factors, as formentioned, are shaping the course of the stockmarkets and they are not easily measurable. The transformation of the sample, maybe result in abnormalities to the estimators and fur-

ther to the final results. Even, if the solution of regression equation transforming is applied, it will have great impact to the results. Not to mentioned, that such a solution is very difficult to applied and time-consuming.

For all the reasons mentioned above, is more preferable to avoid this procedure for explaining the relations between the stock markets.

Co-integration Analysis

A general implication of a simultaneous movement for the international stock markets has been raised from the fact that they seem to follow the same trend in the long as well as in the short run period. This relation cannot be interpreted by a linear equation, because financial time series are suffering from stochastic trends and drifts, making them non-stationary due to unit root problem.

The problem of a non-stationary series and the lack of identifying a dynamic model trustful to explain the reasons of equilibrium between the samples, due to the usual phenomenon of unit roots, has been exposed by Granger and Newbold (1974) and by Nelson and Plosser (1982) who manifested the possibility of predicting a model which will be spurious, or non sense. Box and Jenkins (1970) proposed another procedure to eradicate this instability by transforming the time series in differences and producing stationary ones. However, a problem of misspecification could be still implied because a level of integrated values produced by this method is not easily explainable.

This problem has been overwhelmed, as it is shown by Granger (1981) especially for the same level of a differentiated series, with a set of linear combinations which are stationary. In addition, Engle and Granger (1987) have established the procedure showing that series at the same level of integration can have equilibrium relations which are stationary while series at different levels of integration not. This relation is being denoted by the term of co-integration and reveals the simultaneous movement of a group of series which have a type of a long-term equilibrium. Johansen (1995) methodology examines this assumption with the maximum likelihood procedure which is preferable than the Engle and Granger methodology mainly because of the multivariate aspect of the former compare to the later. The Johansen's procedure is going to be use in this study in an attempt to evaluate the degree of co integration between five European and five non European stock markets.

Co-integration and Related Tests

Recently, a vast literature has appeared (see, e.g., *Eun and Shim, 1989*; *Koch and Koch, 1991*; *Brocato, 1994*; *Leachman and Francis, 1995*; *Francis and Leach-*

man, 1998; and *Bessler and Yang, 2003*) exploring the long-term co-integration relations and/or short term dynamic interactions among major international stock markets, which also involve some major European stock markets.

Two stock market indexes are said to be co-integrated if, in the long run, they do not drift "too far" apart. In a more formal definition, two variables are co-integrated "if the variables are integrated but a linear combination of these variables is stationary".

According to the co-integration theory, (see, e.g., *Arshanapalli and Doukas, 1993* for more details on the subject), if two stock markets are collectively efficient in the long run, then their stock prices cannot be co-integrated. There is more than one method of conducting co-integration tests, presented in the literature. Namely, two tests are nowadays being widely applied for testing the presence of co-integration.

The unit root tests of *Dickey and Fuller (1979; 1981)* are usually utilized to establish the order of integration. *Dickey and Fuller (1979, 1981)* provide one of the most influential works in the field of unit root tests. The Dickey- Fuller test can be applied both in the case of a lower AR process and a higher AR process.

Secondly, the co-integration of the variables is examined using the *Johansen (1988)* procedure. One can test the cross-country market efficiency hypothesis by means of the multivariate co-integration test of *Johansen (1991; 1988)*. The Johansen co-integration test is applied to check for common stochastic trends, long-run relationships, between the stock indexes. The null hypothesis is that there is no co-integration among the stock prices. This procedure provides more robust results than other co-integration methods when there are more than two variables (*Gonzalo, 1994*).

Several authors have utilized unit-root and co-integration methodology in order to investigate for interdependence between major international stock markets. For example, *Chan, Gup and Pan (1992)* empirically examine the weak-form efficient market hypothesis for a series of 18 international stock markets by using unit root tests proposed by *Phillips, (1987) and Perron, (1988*). They also test whether these stock markets are collectively efficient by co-integration tests. Also, they investigate stock market integration by dividing the data into 4 sub-samples. The authors concluded that only few stock markets are co-integrated to other stock markets. *Granger*

(1986) and *McDonald and Taylor (1988; 1989)* have shown that the prices from two efficient markets cannot be co-integrated.

There is also a growing literature with a focus on stock markets within Europe. *Taylor and Tonks (1989)* and *Corhay, Rad and Urbain (1993)* found much evidence for co-integration among several major European stock markets in the late 1970s and 1980s. *Dickinson (2000)* argued that a co-integrating relationship among the major European stock markets exists after the 1987 stock crash and it may be partly driven by the long-run relationships of macroeconomic fundamentals among these countries. *Dickinson (2000)* also observed that short-run international linkages among major European markets, which do not appear in their long-run relationship increased greatly during that period. *Lin et al., (1989)* provide an excellent analysis of the reasons behind linkage of financial markets.

By contrast, *Chan, Gup and Pan (1997)* found little evidence for co-integration among several major European stock markets and among most European Economic Community member countries, particularly during the period after the 1987 crash. *Gerrits and Yuce (1999)* documented that the long-run relationship among major European markets has weakened during the period 1990–1994. *Pynnonen and Knif (1998)* and *Knif and Pynnonen (1999)* extended consideration to small European well developed markets. *Pynnonen and Knif (1998)* reported little interaction between two Scandinavian stock markets, while *Knif and Pynnonen (1999)* found some positive evidence on the interdependence among small European markets.

Yang Min and Li (2003), using once again co-integration theory, examined the impact of the EMU on the long-run structure of European stock market integration by comparing co-integration relations among the eleven European stock markets and the US in two different periods, before and after the EMU. The authors utilize the co-integration trace test statistics (*Johansen, 1991*) to test the number of co-integrating vectors. The authors notice that two co-integrating vectors are found in both the periods before and after the EMU. The results clearly indicate that large EMU markets (Germany, France, Italy and the Netherlands) are more integrated with each other after the EMU. Several small EMU markets are also more integrated with the large EMU markets, while the three smallest EMU markets (Austria, Belgium and Ireland) became more isolated from other EMU markets after the EMU launched.

Another interesting work on the specific area was done by *Choudhry (1996)*, who investigates the long-run relationship between international stock prices in the 1920s and the 1930s using unit root and co-integration tests, using stock indexes from six European countries (namely, France, Italy, Spain, Poland, Sweden and Czechoslovakia). Tests are conducted using, first, the longest time period and also using various sub-periods. Sample statistics (i.e. mean, variance, skew ness, and kurtosis) are also presented for each of the stock indexes. He reported that the results gave no evidence of co-integration between the specific stock markets.

Stationarity

The following discussion outlines the basics features of unit root tests. By necessity, the discussion will be brief. (see, for example, Davidson and MacKinnon, 1993, Chapter 20, Hamilton, 1994, Chapter 17, and Hayashi, 2000, Chapter 9).

Consider a simple AR(1) process:

$$y_t = r y_{t-1} + x_t' d + e_t$$

where x_t are optional exogenous regressors which may consist of constant, or a constant and trend, ρ and δ are parameters to be estimated, and the e_t are assumed to be white noise. If , $|r| \geq 1$ is a nonstationary series and the variance of y increases with time and approaches infinity. If $|r| < 1, y$ is a (trend-)stationary series. Thus, the hypothesis of (trend-)stationarity can be evaluated by testing whether the absolute value of ρ is strictly less than one.

Stock market time series used in this study must be examined for the level of their integration by using the Augmented Dickey-Fuller (1979, 1981) and Phillips and Peron (1988) methodologies.

The Augmented Dickey-Fuller (ADF) Test

The standard DF test is carried out by estimating Equation $y_t = ry_{t-1} + x_t' d + e_t$ after subtracting y_{t-1} from both sides of the equation:

$$\Delta y_t = ay_{t-1} + x_t' d + e_t$$

where α=ρ-1. The null and alternative hypotheses may be written as,

Ho:α=0

H_1:α<0

and evaluated using the conventional t-ratio for :

$$t_a = a'/(se(a'))$$

where a' is the estimate of a, and $se(a')$ is the coefficient standard error.

Dickey and Fuller (1979) show that under the null hypothesis of a unit root, this statistic does not follow the conventional Student's t-distribution, and they derive asymptotic results and simulate critical values for various test and sample sizes. More recently, MacKinnon (1991, 1996) implements a much larger set of simulations than those tabulated by Dickey and Fuller. In addition, MacKinnon estimates response surfaces for the simulation results, permitting the calculation of Dickey-Fuller critical values and -values for arbitrary sample sizes..

The simple Dickey-Fuller unit root test described above is valid only if the series is an AR(1) process. If the series is correlated at higher order lags, the assumption of white noise disturbances e_t is violated. The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the y series follows an AR(1) process and adding p lagged difference terms of the dependent variable y to the right-hand side of the test regression:

$$\Delta y_t = ay_{t-1} + x_t' d + b_1 \Delta y_{t-1} + b_2 \Delta y_{t-2} + ... + b_r \Delta y_{t-r} + u_t$$

This augmented specification is then used to test the hypothesis using the t-ratio. An important result obtained by Fuller is that the asymptotic distribution of the t -ratio for α is independent of the number of lagged first differences included in the ADF regression. Moreover, while the assumption that y follows an autoregressive (AR) process may seem restrictive, Said and Dickey (1984) demonstrate that the ADF test is asymptotically valid in the presence of a moving average (MA) component, provided that sufficient lagged difference terms are included in the test regression.

There are two practical issues in performing an ADF test. First, you must choose whether to include exogenous variables in the test regression. You have the choice of including a constant, a constant and a linear time trend, or neither in the test regression. One approach would be to run the test with both a constant and a linear trend since the other two cases are just special cases of this more general specification. However, including irrelevant regressors in the regression will reduce the power of the test to reject the null of a unit root. The standard recommendation is to choose a specification that is a plausible description of the data under both the null and alternative hypotheses. See Hamilton (1994a, p. 501) for discussion.

Second, you will have to specify the number of lagged difference terms (which we will term the "lag length") to be added to the test regression (0 yields the standard DF test; integers greater than 0 correspond to ADF tests). The usual (though not particularly useful) advice is to include a number of lags sufficient to remove serial correlation in the residuals. EViews provides both automatic and manual lag length selection options. For details, see Automatic Bandwidth and Lag Length Selection.

The Phillips-Perron (PP) Test

Phillips and Perron (1988) propose an alternative (nonparametric) method of controlling for serial correlation when testing for a unit root. The PP method estimates the non-augmented DF test equation , and modifies the t-ratio of the a coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test is based on the statistic:

$$est(t_a) = t_a\left(\frac{g_0}{f_0}\right)^{\frac{1}{2}} - \frac{T(f_0 - g_0)(se(a'))}{2 f_0^{\frac{1}{2}} s}$$

where a' is the estimate, and t_a the t-ratio of a, $(se(a')$ is coefficient standard error, and s is the standard error of the test regression. In addition, g_0 is a consistent estimate of the error variance (calculated as $(T-k)s^2/T$, where k_0 is the number of regressors). The remaining term, f_0, is an estimator of the residual spectrum at frequency zero.

There are two choices you will have make when performing the PP test. First, you must choose whether to include a constant, a constant and a linear time trend, or neither, in the test regression. Second, you will have to choose a method for estimating .

The asymptotic distribution of the PP modified -ratio is the same as that of the ADF statistic. MacKinnon lower-tail critical and p-values for this test will be used.

Johansen Test

The value of the estimates of these tests in their first differences must be smaller than the critical values, indicating that the corresponding time series are integrated in first level I (1). When all stock market time series are integrated in first level I (1), the co-integration test proposed by Johansen can be conducted.

Consider a general kth order VAR model:

$$\Delta Y_t = D + \Pi Y_t - 1 + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_t - 1 + e_t$$

where Yt is an (n x 1) vector to be tested for co-integration and ΔYt = Yt- Yt-1. D is the deterministic term which may take different forms such as a vector of zeros or non-zeros constants depending on several properties of the data. Π and Γ are non unit matrices of coefficients. The co-integration relationship can be determined from matrix Π. If matrix Π = 0 there is no co-integration. In a bi-variable case, i.e. n = 2, the two variables are co-integrated only if the rank of matrix Π equals 1 (Johansen and Juselius 1990), considering that the kth order of VAR has a vector of εt, that is a multivariate normal white noise process with mean 0 and finite covariance matrix.

Johansen (1998) proposed to test for co-integration by examining a combination of null hypotheses as follows. If the rank of matrix Π = 0 there is no-co-integration in the set of series in question, if the rank of matrix Π = m, where m is the number of the series used, all the series m are stationary, and if the rank of matrix Π = r, where 0<r<1, then the series are co-integrated.

Alternatively co-integration can be tested by examining the trace and the maximum Eigenvalues as stated below:

$$l_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - l_i)$$

$$l_{\max} = -T \ln(1 - l_{r+1})$$

where $l_1,\ldots, l_r$, are the r largest squared canonical correlations between the residuals obtained by regressing ΔYt and Yt-1 on ΔYt-1, …, ΔYt-k-1, where k = 0, 1, 2,...,n. The critical values are provided by MacKinnon, Haug and Michelis (1999) for p-values and by Osterwald and Lenum (1992) for λ (r).

In this case the hypotheses examined are:

Ho: r = 0 and Ha: r = 1, if λ (r) > critical value

Ho: r $\leq$ 1 and Ha: r = 2, if λ (r) > critical value

Ho: $r \leq m-1$ and Ha: $r = m$, if $\lambda (r) >$ critical value

The above test terminates where there is a non-significant result.

Inefficiency can be concluded if there is no sign of co-integration. However, if there is a co-integrated estimated equation, restrictions can be set for the static significance of the coefficients.

4. Data

Ten different stock market series are used in this study for the period 1993 to 2007 totalling 3145 observations each. Five of them are originated from Europe, namely CAC40, DAX, FTSE100, BEL, and SMI, two from North America, DJI and TSX, and three from Asia, NIKKEI, HKSE, and FTSE ST as it is shown in Figure 1. All series are considered to have a stochastic trend whereas in the co-integration equations are considered to have only an intercept. The logarithmic form of all the series, follow the first level of integration I (1). There is also no sign of autocorrelation in the residuals of all the differences used which can be verified by using the Lagrange Multiplier test.

The null hypothesis that is examined refers to the existence of a relation between the stock market series, co-integration, against the alternative of non existence of such a relation. Before the Johansen test has been applied, the rank of the appropriated VAR process must be determined. For calculations a smaller sample, consisting of data for a period of five years, is used and lag structure is being tested through the calculation of the corresponding Likelihood Ratio test statistic (Sims 1980). The test denotes that the maximum lag is a VAR (9) process. To determine the final co-integration model the order of the matrix Π which is $r < n = 10$ must be defined as well. The procedure shows that there is only one co-integration relation as it is shown in Table 2. The residuals of the co-integration equation are not correlated following the normal distribution. Finally, an error correction model (ECM) is also estimated.

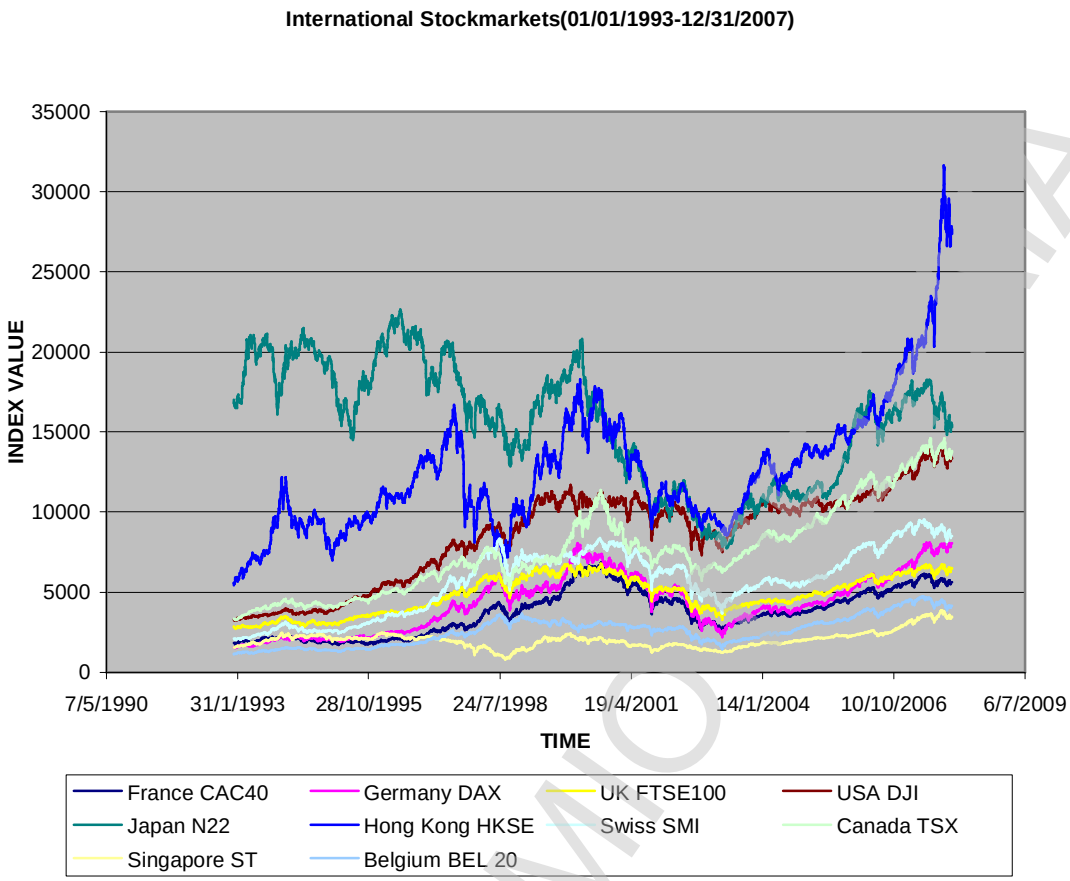

Figure 35: Stock Market Indices 1993-2007

5. Empirical Evidence

The estimates of the coefficients of the final equation are considered as the long run relation coefficients of the stock market series. However, there are cases that the t-statistic is insignificant showing that the certain stock market index is not having great impact in the long-run trend of the dependant variable. Such cases are the TSX index, the NIKKEI index and the FTSE ST index. These stock market indices seem to have no significant statistic relation with all the other stock market indices even though for the long run equilibrium they are being affected by them. Generally speaking, the Asian stock market indices are following their own trends, while in the case of the HKSE index the high influence of western funds on it seems to be reflected clearly contributing in the long-run equilibrium.

The European stock market indices are having the same tendency except FTSE100 and SMI. Apparently, this is the effect of different economic strategies and the exclusion from the euro currency area. However, the most exogenous stock market index is the DAX, the short run parameter in the final equation is much higher compared to others, which can be contributed to the fact that German stock market is bigger in size and more saturated playing a crucial role in the European stock market as a whole.

The unit root test summary in the first part of Table 7 indicates that the series are suffering from unit root problem since the null hypothesis of non-stationarity is not rejected at 5% significance level. The problem disappeared in the second part of Table 1 where the first difference form of the series is used and the null hypothesis of non-stationarity is rejected at 5% significance level. All the series are examined individually and with an exogenous individual trend in each series.

Unit Root Test Summary		
Endogenous Variable: Log(x), where x = DJI, FTSE, e.t.c.		
Exogenous Variable: Individual Trend		
Automatic Selection of lags based on AIC: 0 to 28		
Ho: Non-stationarity		
Method	Statistic	Prob*
Ho: Unit Root		
ADF - Fisher Chi-squared	7,58	0,99**
PP - Fisher Chi-squared	6,78	0,99**
***Probabilities for Fisher tests are computed using an asymptotic Chi squared**		
Distribution. All other tests assume asymptotic normality.		
****Ho: Not rejected for a=0,05**		
Unit Root Test Summary(First Differences)		
Endogenous Variable: d(Log(x)), where x = DJI, FTSE, e.t.c.***		
Exogenous Variable: Individual Trend		
Automatic Selection of lags based on AIC: 0 to 28		
Ho: Non-stationarity		
Method	Statistic	Prob**
Ho: Unit Root		
ADF - Fisher Chi-squared	1.853,83	0***
PP - Fisher Chi-squared	2557,39	0***
***Probabilities for Fisher tests are computed using an asymptotic Chi squared**		
Distribution. All other tests assume asymptotic normality.		
****Ho: Rejected for a=0,05**		

Table 7: Unit Root Tests Summary, Stock Market Indices 1993-2007

As it is shown in Table 8 setting two different sets of hypotheses, the first hypothesis Ho: r = 0 vs Ha: r = 1 in the first set is not rejected while the second hypothesis of Ho: r = 1 vs Ha: r = 2 in the second set is rejected based on the trace and max-Eigen statistics. Trace and max-Eigen estimates are less than their corresponding critical values at 5% significance level. This is an indication of one at most one long run equilibrium equation in the sample examined. .

	a=0,05					
	TRACE	C.V.	P-values	MAX-EIGEN	C.V.	P-values
Ho: r = 0 vs Ha: r = 1	244,4501	239,2354	0,0285	76,36317	64,50472	0,026
Ho: r = 1 vs Ha: r = 2	168,0869*	197,3709	0,5292	51,96976*	58,43354	0,1881
*Ho is not rejected for a=0,05						

Table 8: Johansson's Co-integration Equations, Stock Market Indices 1993-2007

Table 9 presents the b coefficients and t-statistics estimated for each particular equation when alternative dependant variable is set in each case in a form of Log(x), where x = DJI, FTSE, e.t.c. The estimated variables are in vector form transformed in a linear equation for every single equation.

LAG(9), a=0,05

	B coef	HKSE	TSX	BEL20	CAC40	DAX	DJI	FTSE100	NIKKEI	SMI	ST
1	HKSE	1	0,52	1,96	4,81	2,86	-3,75	-11,50	0,68	-1,75	-0,75
	t-statistic		0,76	4,23	3,69	3,64	-4,80	-6,96	1,36	-1,97	-1,33
2	TSX	1,92	1	*3,77*	9,26	5,51	-7,22	-22,13	1,31	-3,37	-1,44
	t-statistic	2,56		3,91	3,69	4,20	-4,90	-7,18	1,49	-1,97	-1,34
3	BEL20	0,51	0,27	1	*2,45*	1,46	-1,91	-5,87	0,35	-0,89	-0,38
	t-statistic	2,77	0,76		3,69	3,58	-4,82	-7,20	1,36	-1,98	-1,36
4	CAC40	0,21	0,11	0,41	1	*0,59*	-0,78	-2,39	0,14	-0,36	-0,16
	t-statistic	2,45	0,73	3,74		3,91	-4,93	-9,28	1,36	-1,98	-1,28
5	DAX	0,35	0,18	0,69	1,68	1	*-1,31*	-4,02	0,24	-0,61	-0,26
	t-statistic	2,49	0,86	3,74	4,04		-5,02	-7,01	1,35	-2,06	-1,30
6	DJI	-0,27	-0,14	-0,52	-1,28	-0,76	1	*3,06*	-0,18	0,47	0,20
	t-statistic	-2,46	-0,75	-3,78	-3,81	-3,76		7,16	-1,35	2,01	1,25
7	FTSE100	-0,09	-0,05	-0,17	-0,42	-0,25	0,33	1	*-0,06*	0,15	0,06
	t-statistic	-2,46	-0,76	-3,90	-4,95	-3,63	4,94		-1,37	1,98	1,22
8	NIKKEI	1,47	0,76	2,88	7,07	4,21	-5,52	-16,90	1	*-2,58*	-1,10
	t-statistic	2,47	0,80	3,76	3,71	3,58	-4,77	-7,02		-2,44	-1,21
9	SMI	-0,57	-0,30	-1,12	-2,74	-1,63	2,14	6,56	*-0,39*	1	0,43
	t-statistic	-2,45	-0,73	-3,76	-3,71	-3,74	4,88	6,94	-1,67		1,21
10	ST	-1,34	-0,70	-2,62	-6,44	-3,83	5,02	15,39	-0,91	2,35	1,00
	t-statistic	-2,69	-0,81	-4,20	-3,90	-3,85	4,92	6,98	-1,35	1,97	

Table 9: Co-integration Equations b-Coefficients, Dependent Variables=Log(x), where x = HSKE, DJI, e.t.c, Stock Market Indices 1993-2007

As it is shown in Table 3 the b coefficient of the Canadian stock market index (TSX) is not significant at 5% level in any single equation, since all corresponding t-statistics are less than the critical value, indicating no significant effect of this index to the other stock market indices, however it is affected by all other indices except the Japanese (NIKKEI) and the Singapore (ST) stock market index.

The Japanese stock market index (NIKKEI) is not significant at 5% level in any single equation, since all corresponding t-statistics are less than the critical value, indicating no significant effect of this index to the other stock market indices; however it is affected by all other stock market indices except the Canadian (TSX) and the Singapore (ST) stock market index.

The Singapore stock market index (ST) is not significant at 5% level in any single equation, since all corresponding t-statistics are less than the critical value, indicating no significant effect of this index to the other stock market indices; however it is affected by all other stock market indices except the Canadian (TSX) and the Japanese (NIKKEI) stock market index.

In all other cases there is a strong evidence of co-integration, positive or negative depending on the sign of the corresponding b coefficient, between the stock market indices of the study.

The co-integration graph, as it is shown in Appendix 1, reflects the influence between the stock market indices. From 1993 till the early 00's the co-integration equation follows a seemingly unrelated movement with high and low peaks in an irregular pattern. A significant change is being noted after the late 90's and early 00's when the markets started to have a more related course. This period was determined by highly bearish trend and then the stabilization, before the bullish rally of the period from 2003 till the first quarter of 2007 to be started. Profoundly, the bullish attitude of all the global investors and the high cash flow with the combination of the globalization efforts enhanced the economies and make them more vulnerable to global effects.

This change on economies has been reflected in the stock market indices too, which seem to be more affected by one another.

Conclusion

These ten stock markets are shaping the course of global economy. Concentrating the highest percentage of global funds, they dominate on the financial network. Moreover, investors from all around the world prefer these stock markets for their portfolios creation. The data generated reflect a period of fourteen years, a period of great contrast and with various financial shocks. Asian financial crisis, the financial bubble of the dot com industry, as well as not financial events such as the terrorist attack in United Stated, drastically changed the financial conditions. Also, macroeconomic indexes such as the interest rates, exchange difference, diesel prices played a significant role in this period examined. Finally, the efforts of all the countries to enter in to the global scene, deserting policies, which concentrate to protective measures for their economies as a frontier to exogenous shocks, created a global financial environment with intercontinental cash flows.

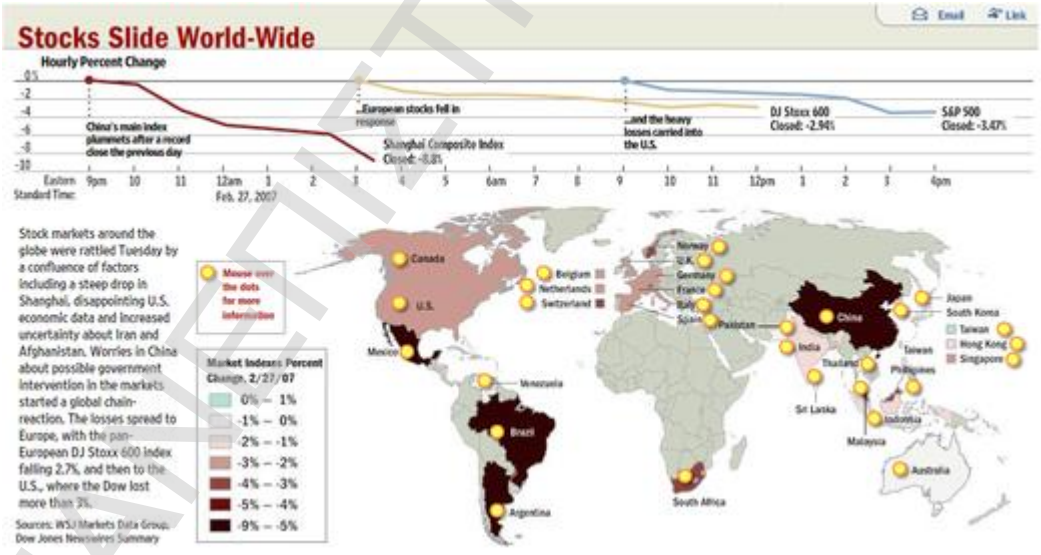

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Figure 35: Co movement:''Stocks Slide World Wide''

Nowadays, the local economies are having a meager role to the trend of global financial markets. Even, traditional economies with stationary economic systems are seeking to gradually change their behavior to open markets. The constant change of financial system and their liberation, loosen the strict investing policies. Stocks from different markets are participating in various stock market or platforms. Therefore, the inter connection of the markets is inevitable.

Four different approaches were used to verify if there is any trustful and meaningful relation between ten mature stock markets:

The graph analysis of the stock markets indexes reflected a co movement trend between the examined stock markets. This empirical estimation method prints out the tendency or the international stock markets to inter transmit the trend from one to the other. More specific, there are cases were the stock markets even synchronized. The final outcome is that the recent years the phenomenon of co movement is more noticeable. The scientific integrity of this method does not necessarily succumb to the personal opinion of the analyst.

Correlation estimation diminishes the error in relation with the graph analysis. The measure of the co movement, through Pearson correlation concludes in the same results. Stock markets are having a co movement tendency, which is reinforced the last few years. Even the Asian stock markets seem to inherit the globalization characteristics and follow the international financial trend.

Linear estimation method, with the procedure of ordinary least squares does not imply anything about the co movement notion between the stock markets, though it cannot insert the unknown factors in to the estimations. For that reason, is neglected as not sufficient.

Finally, Johansen estimation generates ten different equations to determine that there is at least one cointegration relation between the stock market. Profoundly, the results are trustful and meaningful, because there is a at least one co integration equation between the stock markets. Furthermore, the same phenomenon is appeared in the results. The co integration relation is becoming stronger the last few years. Graphs show a smoothness of the co integration equation meaning higher dependence

between the variables. Equation graphs are rarely expand over the limits of graph after 2002. The relation of the stock markets is more stable and efficient.

Concentrating in the results the hypothesis of co movement or co integration is realistic. Markets inter connection is inevitable, though all the economic fractions of the past have been overwhelmed and a global financial network has been formed. This change is growing rapidly the last decades. The mature, globalised markets will still give the pace to the financial course. Therefore, the domination of these markets to global financial network will be inevitable.

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APPENDIX 1: Co-integration Equation, Stock Market Indices 1993-2007