INCREASING LINKAGES OF STOCK MARKETS AND PRICE VOLATILITY

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ABSTRACT

This study is aimed to discuss forms of linkages that exist between the world stock markets, and to indicate to what extent the present interaction factors are increasing in the last decade. The study analyzed published data, as well as correlation between monthly changes of local price indices for 16 stock markets in 1994 and 1998.

The study indicated that there were significant changes during the nineties arising from introducing liberal regulatory rules, increasing foreign trading, increasing in number of cross listed firms and equity portfolio flows. The study found that there are significant positive increases from 1994 to 1998, in the degree of correlation between the majority of selected stock markets. Increasing linkages suppose to increase data dissemination, thus increase stock market efficiency, but with the existing cross-markets volatility transmission phenomenon, increasing linkages should be scrutinized carefully.

Financial Risk and Financial Risk Management, Volume 16, pages 349–373.

ISBN: 0-7623-0858-3

1. INTRODUCTION

The integration of international stock markets may be considered as the most significant change in the global capital market, which has been introduced to the stock markets in the last two decades. Many stock exchanges removed restrictions and admitted listing of stocks on more than one exchange. The national stock exchanges are moving towards increasing linkages to other international stock exchanges. There are continuous increases in share of the listed foreign firms and in share of the non-residents' stock transactions. The increasing linkages are extended from developed stock markets to other emerging stock markets, as well as from stock markets to other financial and banking systems.

Integration and liberalization of stock markets received and interpreted as a positive signal in the development of global stock markets, which may lead to various advantages, such as: reducing the cost of equity capital as reported by Beakert and Harvey (2000), Stulz, (1999) Doukas and Switzer (2000) and Miller (1999). Increasing liquidity, reducing risk, increasing diversification, and increasing the investor base as reported by Hargis (2000), Claessencs (1995), and Jayaraman et al. (1993), and increasing investments opportunity as concluded by Henry (2000).

On the other side, the increasing of linkages provides some disadvantages such as a mistake in one market or volatility surprises may be transferred to other stock markets (King, 1990) and (Jeong, 1999). The free capital flow and increasing linkages may transfer the volatility of inflation and exchange rate from one market to another as happened to the financial markets in Mexico during 1994 and East Asian region during the years 1997–1998. This may be considered as a risk factor and may lead to stronger co-movements, and reducing the expected gains from international diversification (Shawky et al., 1997). The majority of stock market experts considered the decline in international stock indices as the most risky factor in destabilizing of other national stock markets due to the increasing linkages of stock markets (Sabri, 1995a, b).

Various studies examined the stock market linkages, the majority of these related studies intended to report whether there is positive or negative correlation among stock price volatility, cross-markets in different times and under different conditions, and to discuss the stability of the stock volatility over time. Other studies discussed the issue between stock markets in various times, periods and conditions, before, after and around the 1987 stock market crash. However, there are few studies discussed and explored factors that may create stock markets linkages.

Therefore, this study aims at examining such factors, which increase international linkages of global stock markets, which is increasing rapidly in the last decade. In more details, this paper intends to accomplish the following purposes: First: to present the forms of linkages which are considered as the main factors in creating interactions between stock markets and may lead to close market integration. Second: to indicate to what extend the present interaction factors are increasing in the last decade. Third: to examine the changes occurred in the international stock market linkages using empirical investigation of the performance indices' movement during two different years (1994–1998).

The rest of paper is organized in the following sections: Section 2 is devoted to present the review of literature, Section 3 presents the methodology. Section 4 explores forms and factors of linkages, between stock markets; Section 5 presents the findings of the empirical investigation, while Section 6 is devoted to summary and conclusion.

2. REVIEW OF THE RELATED LITERATURE

Various studies discussed the issue of international linkages of stock markets in the last decade, especially after the 1987 stock market crises. The majority of those studies used one or more of correlation or regression models to examine the price, returns or indices for different periods. They covered different regions, including developed and emerging markets and examined linkages between both markets. Some studies covered one or more regions, while others covered global samples.

Examples of these studies: Wu and Su (1998) found that there is significant dynamic relation exist among four major stock markets including U.S., Japan, Britain, and Hong Kong, in addition, the correlation among stock markets has been increased considerably after 1987 and it is increasing in the recent years. Arshanapalli and Doukas (1993) results show that the degree of international co-movements among stock price indices increased substantially, with the exception of Nikkei index, and the U.S. stock market had impact on the French, German and U.K. markets in the post crash period. Ramchand and Susmel (1998) found that the correlation between the U.S. market and others are higher in a high volatility market situation, in which foreign markets become highly correlated with U.S. markets.

De Sants and Impohoroglu (1997) found evidence of time-varying volatility, and reported that the level of volatility in emerging stock markets is higher than that of mature markets. Moreover, Koutomos, (1996) and Kanas (1998)

discussed the volatility in European stock markets, and found that volatility interactions are extensive and reciprocal between England, Germany, France and Italy. Bracker and Koch (1999) reported that international equity markets move together more when the market is volatile or falling. Janakiramanan and Lamba (1998) found that the U.S. markets influences all other Pacific-Basin Stock markets except the market of Indonesia. Longin and Solnik (2001) found that the correlation among stock markets increases in bear markets, but not in bull markets. The IMF report (2000) concluded that emerging market assets remain heavily dependent upon the mature market developments including the risk perceptions and tolerance of investor. Bekaert and Harvey (1997) reported that capital market liberalization increases the relation between local market returns and the world market.

Finally, the findings of the above studies may be summarized as follows: The linkages among stock markets are existed and began to increase after the 1987 stock market crisis. The correlation of price volatility between stock markets is changing over time. Emerging stock markets become more correlated with developed stock markets. Correlation between stock markets tends to increase during unstable and high volatility periods. The U.S. stock market influences the majority of other European, Asian and Latin American stock markets.

3. METHODOLOGY

This study aimed to investigate the stock market linkages using twofold methods:

First: Analysis of Published Data

This study examined the related published data in regard to various forms of stock market linkages for the last decade (1990–2000), as reported by Emerging Stock Markets Fact books of IFC, International Federation of Stock Exchanges Database, International Capital Markets reports of IMF, and the annual Factbooks of the world international stock exchanges. The forms of stock market linkages may be summarized as follows: stock markets are moving towards globalization. Removing restrictions from foreign ownership and increasing of stock market liberalization. Introducing liberal regulatory rules in stock exchanges to attract foreign equities and investors. Increasing net private portfolio flows across developed and emerging markets. Increasing number of firms issuing equity in multiple international markets. Increasing number of cross listed national corporations in international stock exchanges. Increasing the number of the of cross listed firms in emerging

stock exchanges. And increasing linkages between developed stock markets and emerging stock markets.

Second: Empirical investigations

The study examined the linkages of stock markets as presented in the first part of this study. The Pearson Correlation Coefficient between the stock market indices' movement was calculated between each pairs' indices for the selected 16 stock market exchanges. Using the monthly change percentages of the local price indices for the stock exchanges. The monthly changes of stock price index for two years (1994 and 1998) is examined in order to determine to what extend the correlation among stock market exchanges has been increased as a result of the significance changes in increasing linkages. The selected period witnessed significant increasing in stock markets linkages as expressed by introducing more liberal rules in stock exchanges, in increasing number of cross listed companies, increasing of the share of foreign trading and ownership in stock markets, and in trading of stocks outside their home exchanges.

In addition, the output correlation's data between the two periods was tested using T *test* was used to determine whether the difference between the correlation between each pairs for the selected 16 stock market in 1994 (r_1) is significantly different from the degree of correlation in 1998 (r_2). This covered developed stock markets groups, emerging stock market group and between both developed-emerging stock markets. The value of t test computed and compared for each group at level of 0.05 significant. The stated directional hypotheses for this part was articulated as follows:

- There is a significant increase in positive correlation between developed stock markets based on monthly movement of stock market indices.
- There is a significant increase in positive correlation between emerging stock markets based on monthly movement of stock market indices.
- There is a significant increase in positive correlation between developed and emerging stock markets based on monthly movement of stock market indices.

The used data for the second part were based on International Financial Corporation database for emerging stock markets, and the stock market Factbooks for developed stock markets. The sample of the second part covered 16 national stock market exchanges in both developed and emerging stock markets, covering all geographical regions as presented in Table 1. The trading value of the selected sample of stock markets form about 84% of the total world trade value in 1999 (IFC, 2000).

Table 1. The Selected Sample of Stock Exchanges.

Market Groups	Countries	Trade Value IN $ M (1999)	Stock Exchanges and Index
Developed			
	Australia	105.999	Australian (All Ordinaries)
	Singapore	97.985	Straits Time Index
	Japan	1.849.228	Tokyo Nikkei 225 Index
	Hong Kong	244.886	Hong Kong (All Ordinaries)
	Canada	364.625	Toronto Composite Index
	U.K.	1.377.859	London (FTSE 100 Index)
	USA	18.574.100	NYSE (Dow- Jones)
	Germany	1.357.841	Frankfurt (DAX)
Emerging			
	South Africa	72.917	JSE Overall
	Korea	733.591	Korea (KSE)
	Turkey	81.277	ISE Composite
	Greece	188.722	ASE General
	Malaysia	48.512	Kuala Lumbar (KLSE)
	Taiwan	910.016	Taiwan (TSE Average)
	Argentina	7.781	Bolsa Index General
	Mexico	36.042	BMV General

4. FORMS OF STOCK MARKETS LINKAGES

The stock market linkages have been intensified in the last decade. The evidence of increasing forms and size of stock market linkages may be found by tracking the stock markets linkages during the last decade between 1990 and 2000. This part of the paper is devoted to explore this issue, covering the most important forms of linkages, which may be summarized as follows:

4.1. Introducing Liberal Rules in Stock Exchanges

The Global stock markets witnessed a significant change related to the liberalization of its rules, to permit foreign trading and investments. Generally, there are various barriers, which facing the flow of funds between countries. There are direct legal constrains as imposed by governmental laws or individual listed corporations, as well as indirect barriers such as capital gains and income tax regulations, and regulations regarding stock market transactions. In addition, others obstacles, which may hinder the flow of equity

portfolio, such as laws of controlling local exchange rates and transferring of funds outside the boarders.

For direct foreign trading restrictions, the restrictions are imposed either by the corporate laws or stock exchanges' laws in the most of middle East countries some of the Latin American countries and south Asia Countries. However, in some countries, the restrictions in foreign investments are imposed by the individual corporation's bylaw, and not by the governmental laws as in Switzerland, Finland and Thailand (Stulz & Wasserfallen, 1995). Other restrictions of ownership may impose only in specific sectors such as financial sector as in Brazil, Russia, and Sir Lanka. In other countries there are special shares issue for local residents, and other shares issue for foreign investors. For example a company in Switzerland may issue bearer shares, registered shares and restricted shares with different vote right (Gardiol et al., 1997). The majority of European companies issue bearer shares, which do not permit control on the ownership of the stock trading.

The world stock market witnessed relaxing in all of the above restrictions in the last decade. The evidence of reducing or eliminating the restrictions in foreign investments may be found in Table 2. It shows that the number of countries introduced changes in their investment regimes from 35 to 60 between 1991 and 1998, and the number of regulatory changes favorable to foreign investments increased from 80 states to 136 states (UNCTAD, 1999). In addition, out of the fifty two emerging stock markets states, thirty five states have removed the ceiling of ownership for listed stocks up to 100% of the total equities by the end of 1998. While the other seventeen states removed the restrictions on foreign ownership partially, such as Brazil: 49%, Trinidad and Tobago: 30%, India 24%, Korea: 39%, Philippines: 40%, Taiwan: 30%, Thailand: 49%, Russia: 9%–25%, Ghana: 74, Jordan: 50%, Saudi Arabia 25%, Tunisia: 49.9%, and Zimbabwe: 40% (IFC, 1999). The liberalization of stock market increases the trading volume of stock markets and liquidity, but may lead to increase the volatility. Levine and Zervos (1998) found that stock

Table 2. National Regulatory Changes for Foreign Investments Between 1991–1998.

	1991	1998
Number of countries introduced changes in their investments regimes	35	60
Number of regulatory changes favorable to Foreign investments	80	136

Source: UNCTAD, 1999.

markets become more liquid and more volatile as a result of stock markets liberalization.

4.2. Increasing of Cross Listing Companies

The practice of cross listing is the most significant phenomena that create linkages among stock exchanges. The idea of cross listing is that a listed firm on a domestic exchange is looking for second or more stock exchanges to be listed there at the same time. The number of dual listed firms has been increased significantly in the last decade. Cross listing started in the late seventies, by the large multinational corporations to be listed in two or more of the developed stock exchanges. Today, it is not limited to multinational corporations, but it's extended to many national firms even located in emerging countries. The majority of foreign firms listed in more than one stock exchange have to meet dual requirements of these exchanges. Firms which may not meet the second exchange requirements use the so called depository receipts as alternative for cross listing. Martell (1999) found that 67% of the foreign listed companies in NYSE were using global depositary receipts method.

Table 3 presents a summary of foreign listed firms in the international exchanges which include 12 foreign listed firms or above as in 1999. It indicates that there are 20 stock exchanges in which more than 12 foreign firms are listed and accounted for 98% of the total foreign listed firms in the world stock exchanges in 1999. To compare between 1981, 1994 and 1999, its clear that there are significant increase of cross listing in most of the stock exchanges such as NYSE, NASDAQ, London, Tokyo, Paris, Australian, and Luxembourg. In addition, new developed stock exchanges started to admit foreign firms only in the ninnies such as Milan, Madrid, and Lisbon.

The top five stock markets based on the number of foreign listed firms is classified as developed stock markets, and is accounted for 62% of the number of foreign listed firms. These are: London, NASDAQ, NYSE, Frankfurt, and Luxembourg. The top five exchanges witnessed significant increase from 1981, to 1994, to 1998. In addition, many stock exchanges started to include foreign firms in the nineties only such as Vienna, Hong Kong and Lima. The cross-listed firms are extended to emerging stock exchanges such as Johannesburg.

In addition, the number of cross listing of Latin American firms in foreign exchanges started by 2 companies in 1989, and increased to 106 listed firms in 1991, mostly in U.S. stock exchanges. The trading value of Mexican, Argentine, and Chilean stocks traded in the U.S. were greater than the total value traded in their respective domestic stock markets during the year 1995 (Hargis, 2000). In addition, the concept of cross listing is expanded to even

Table 3. Number of Foreign Listed Firms in Stock Market Exchanges Between 1981 and 1999.

Stock Exchanges	1981 a	1994 b	1999 c
London	478	462	499
NASDAQ	0	–	429
NYSE	42	–	406
Frankfurt	177	227	234
Luxembourg	124	217	226
Paris	162	195	176
Zurich	168	242	173
Amsterdam	257	215	154
Brussels	150	141	122
Australian	21	–	70
New Zealand	–	–	58
Toronto	67	–	47
Singapore	167	–	43
Tokyo	15	–	43
Johannesburg	–	–	24
Stockholm	–	8	23
Bermuda	–	–	23
Oslo	–	14	20
Irish	–	–	19
Vienna	0	–	17
Hong Kong	0	–	13
Lima	0	–	12
Total	1828		2831
Total dual listed firms in the world stock exchanges in 1999			2900

Source: Based on, a: Biddle and Saudagaran, 1989, b. FESE, 1994, c: IFSC, 2000 and HKSE Fact Book, 1999.

small stock markets classified as frontier stock exchanges, such as Botswana stock exchange, which includes 9 foreign listed firms (IFSE, 2000).

The number of cross listing is expected to increase, due to the competitions among the international stock exchanges, to attract other foreign stocks for dual listing. Mueller (1999), Cheung and Lee (1995) argued that there will be more non-U.S. companies, that would list on the NYSE if it accepts the IASC standards instead of the American accounting standards. The main obstacle of cross listing is the different requirements of accounting standards, which is going to be removed by adapting International Accounting Standards

Committee by many developed and emerging countries. This will lead gradually to international accounting harmonization, thus make cross listing process more beneficiary and less costly.

As a consequence of increasing the number and trading of cross listed firms in many of stock exchanges, some leading corporations are traded now in foreign stock exchanges almost the same size as traded in their home exchanges. For example, the trading value of the major Dutch corporations' stocks traded in foreign exchanges from 30% to 46% of the total trading value; the foreign exchanges include NYSE, NASDAQ, London, Germany, and Swiss Exchanges (Amsterdam Stock Exchange, 2000).

4.3. Increasing of the Foreign Trading Value

Beside the increasing number of cross listed firms, there are significant increasing of the traded value of foreign transactions related to foreign listed firms in the last decade. In some of stock exchanges, the ratio of foreign trade value of stock transactions exceeded the value of the domestic transactions such as in the London Stock exchange. In other exchanges the share of foreign trade formed between 1% to 24% of the total trading values of stocks, as presented in Table 4.

Table 4. The Value of Foreign Stock Trading in 1994 and in 1999. (Million and percentages)

Exchange	Currency	Foreign % 1994	Foreign % 1999	1999 Total value
London	GBP	54%	58%	2,092,895.20
Stockholm	SEK	1%	24%	2,609,016.60
Johannesburg	ZAR		15%	529,941.00
Frankfurt	EUR	3%	11%	1,472,829.00
New Zealand	NZD		10%	25,621.20
Brussels	EUR		8%	265,403.90
NYSE-USA	USD		8%	8,910,485.30
Lima	PEN		7%	9,308.90
Switzerland	CHF	6%	5%	847,359.80
Oslo	NOK	1%	5%	445,603.40
Luxembourg	EUR	2%	4%	991.80
NASDAQ–USA	USD		3%	10,463,198.60
Paris	EUR	1.8%	2%	3,481,036.00
Amsterdam	EUR	2%	1%	421,724.00

Source: Based on a: IFSE, Database, September 2000, b: FESE, annual Report, 1994.

In addition, the trade value of foreign transactions in increased significantly in the last few years. For example, the total foreign transactions in German Stock Markets increased from 10,711 Euro million in 1995 to 193,209 Euro million in 1999, with an increase of 1700% (German Stock Fact book, 1999). This tremendous increase is almost existed in the majority of both developed and emerging stock markets as presented in Table 5. It shows that the foreign trading value of stock transactions increased between 1998 and 1999 of more than 100% in eight stock exchanges. For stock exchanges such as Milan, which started dealing with foreign stock transactions recently, the increasing ratio, were about 553% just between 1998 and 1999.

4.4. Increasing Foreign Ownership in Stock Markets

Up to the nineteen eighties, the majority of ownership of equity portfolio in the major stock markets were mainly owned by domestic residences. Cooper and Kaplanis (1994) found that in 1987, 100% of stock equities in Sweden, 98% in U.S., 91% in Italy, 79% in the U.K., 75%, in Germany, and 94% in Spain were owned by residents. Stulz (1999), Cooper and Kaplanis (1994), and Tesar (1995) argued that this is due to what is know as the home bias and to the cost of transferring investments cross-borders. The home bias concept is related to

Table 5. Value of Foreign Stock Trading in 1998 and 1999.

Exchange and Currency		1998 (Million, Local Currency)	1999 (Million, Local Currency)	Increase %
EUR	Italy, Milan	513.9	3,355.6	553%
BMD	Bermuda	27,836.5	86,924.0	212%
ZAR	Johannesburg	27,391.1	81,560.3	198%
SEK	Stockholm	211,209.5	616,214.0	192%
CAD	Toronto	459.0	1,248.8	172%
HKD	Hong Kong	1,386.9	3,391.3	145%
EUR	Luxembourg	19.3	43.7	126%
EUR	Paris	36,066.9	73,815.0	105%
TWD	Taiwan	36,398.0	70,707.0	94%
EUR	Germany	88,238.5	167,345.0	90%
EUR	Madrid	1,050.4	1,803.5	72%
USD	NASDAQ	215,848.6	349,144.7	62%
EUR	Amsterdam	1,730.7	2,781.0	61%
USD	NYSE	561,362.4	686,636.8	22%

Source: Based on IFSE, Database, September 2000.

the fact that equity portfolio are concentrated in local markets and not on international foreign markets in spite of the benefit which may gained from diversification. Kang and Stulz (1997) reported that foreign investments are strongly biased against small firms, while it biased with large firms and with good accounting performance firms.

However, this situation is changing gradually. For example, the foreign ownership of U.S. stock equities increased from US$11,240 million in 1995 to US$107,522 million in 1999, with an increase of about 957% in five years (IMF, 2000). Many pension funds in developed and emerging markets are spreading their investments to benefit from diversification and reducing risk. For example, the U.K. pension funds owned about 27% of total equity owned by the pension funds in international equity during the period from 1991 to 1997 (Timmermam & Blake, 2000).

For other stock markets, the share of foreign ownership is increasing rapidly as presented in Table 6. It constituted more than 50% of total ownership in London, Amsterdam and Helsinki Exchanges, and more than one third of the total ownership in other five stock exchanges, while the foreign ownership constituted less than 10% only in Japan and U.S. stock markets.

Table 6. Share of Foreign Ownership in Stock Markets Equities. (1995–2000)

Stock Market Exchanges	Sources	Foreign Ownership of Total Equities
Copenhagen Stock Exchange	a	24%
Helsinki Exchanges Groups	a	60%
Amman Stock Market	a	44%
London Stock Exchange	a	66% clients or equities
Amsterdam Stock Exchange	a	50%
Egypt Stock Exchange	a	23%
New Zealand	a	40%
USA	b	7%
Japan	c	6% (Large firms) 1% (Small firms)
Argentina	d	38%
Chile	d	17%
Mexico	d	25%
Peru	d	38%
Venezuela	d	36%

Source: Based on: a: Fact books of the respective stock exchanges (1999–2000); b: For USA: United States, Board of Governors of the Federal Reserve System, 2000; c: For Japan: Kang and Stulz, 1997; d: For Latin American Countries: Campollo-Palmer, 1997.

4.5. Increasing Equity Portfolio Flows

The flows of portfolio equity investments from developed markets to developing countries, increased from 3.7 billion in 1990 to $49.2 billion in 1996 (IFC, 2000). However, the net private portfolio across stock market witnessed high fluctuations during the period from 1995 to 1999 as a consequence of Asia finical crises in 1997–1998 as presented in Table 7. It shows that there are negative flow of equity portfolio from Asia and Russia in the last two years, as well as a decrease of inflow of equity portfolio in other regions. Froot et al. (2001) argued that is due to the sensitivity of local stock prices to foreign fund inflows, which is positive and large.

The existed high volatility of equity portfolio flows between stock markets created unstable linkages. Thus, there is some serious criticism against the portfolio capital flow, as a short-term rather than long term investment. Grabel (1996); Singh and Weisse (1998) considered this as not helping developing countries in enhancing long term economic growth, and may lead to various problems such as: economic and financial crises, undermining the existing bank and financial systems, and increase volatility.

The capital flow of equity portfolio is not able to take full advantage of international portfolio diversification, has unstable structure relation between stock markets and less stable aspects compared to the foreign direct investments flow as concluded by the World Bank report (2000), and Shawky et al. (1997). Accordingly, increasing the linkages of stock markets as a consequence of increasing equity portfolio flows to emerging countries may be

Table 7. Net Private Portfolio Investments Flows to Emerging Markets Between 1992–1999.
(in billion $)

Regional Markets	1992	1995	1998	1999
Africa	1.8	1.4	4.3	4.4
Asia	9.0	14.2	− 17.9	− 5.6
Asian Countries: Indonesia, Korea, Malaysia, Thailand	6.4	17.4	− 6.0	6.3
Europe	2.3	14.6	0.7	6.6
Russia	0.0	10.3	3.9	− 1.1
Middle East	12.7	3.8	6.7	7.3
Western Hemisphere	30.3	3.0	17.7	10.6
Brazil	14.5	11.7	14.8	3.2

Source: IMF, International Capital Markets, September 2000.

consider as negative aspect and may lead to destabilizing of emerging stock markets.

5. FINDINGS OF THE EMPIRICAL STUDY

This part of the study aims at testing whether the increasing forms of linkages between stock markets have an impact on the correlation between movements of the stock market indices. Accordingly, this part examined the existed correlation between each pairs for a sample of 16 developed and emerging stock markets from different geographical regions, in two different years (in 1994 and 1998). This done based on the monthly price movements of stock market local indices. The findings of this part are presented in three sections as follows:

5.1. Comparison Between Price Movements

To compare between the emerging and developed markets during the 1994 and 1998 years, Table 8 presents the monthly changes in percentages of the local price Indices for the selected stock markets in 1994. Which includes eight developed stock markets (HKSE, 1999, 1994; Germany stock Market, 1999), and eight emerging stock markets (IFC, 1995, 1999). The local price indices' performance shows high volatility during the 1994 between the developed stock markets, such as that at the end of March, June and November. The performance of the related price indices was decreased in the majority of developed stock markets. However, this association movement had limited extend to the other eight emerging stock markets during 1994.

Table 9, shows the price movements of the selected sample during 1998, the association between the performance of prices' indices was closer between the developed and emerging stock markets, especially that in August and in May movements. At the end of August, all of the selected sixteen stock price indices witnessed losses from -8.2% to -39%. A close situation may be found also, during May movements of stock prices. This high association is also applied when the performance of price indices improves. At the end of October and November, the performance for fifteen stock price indices was improved at the same time covering the losses of August. This high association between price movements of the selected sample of stock markets also existed and reported at the end of February.

Table 8. Monthly Changes of the Local Price Index for the Selected Stock Markets during 1994 in %.

Months	1	2	3	4	5	6	7	8	9	10	11	12
Developed												
Australia	6.3	− 5.7	− 5.8	0.6	0.8	− 4.5	3.6	2.9	− 4.4	0.8	− 7.5	1.2
Japan	16.1	− 1.1	− 4.4	3.2	6.3	− 1.6	− 0.9	0.86	− 0.52	2.2	− 4.6	3.4
Hong Kong	− 3.8	− 8.8	− 12.2	− 1.2	5.0	− 7.9	6.7	3.8	− 2.9	− 0.1	− 12	− 3.7
Singapore	− 3.6	0.2	− 11.2	10.3	− 0.2	− 2.9	20.9	4.9	0.9	2.0	25.8	− 0.1
Toronto	5.4	− 2.9	− 2.1	− 1.5	1.4	27.0	3.9	4.1	0.1	− 1.4	− 4.6	3.0
London	2.2	− 5.0	− 7.3	1.3	− 4.9	− 1.8	5.6	5.5	− 6.9	2.4	− 0.5	− 0.5
New York	6.0	− 3.4	− 5.1	1.3	2.1	− 3.5	3.9	3.9	− 1.8	1.7	− 4.3	2.5
Germany	2.0	3.8	− 1.4	− 4.9	7.0	3.0	− 4.8	− 2.7	8.1	− 2.3	1.7	− 2.3
Emerging												
South Africa	− 2.8	1.9	1.9	8.5	0.7	0.2	4.6	3.2	− 2.7	0.9	0.6	1.9
Korea	9.2	− 2.8	− 5.6	4.8	3.4	− 0.7	− 0.6	1.8	11.3	5.3	− 2.8	− 4.4
Turkey	− 2.8	− 25.4	− 6.1	7.2	− 2.3	34.0	10.0	16.2	6.1	− 7.2	13.2	3.3
Greece	10.1	1.1	5.9	− 1.5	− 13.0	− 1.3	− 0.4	0.1	0.6	− 4.3	3.9	2.6
Malaysia	− 13.2	1.7	− 15.4	10.7	− 5.8	1.8	1.6	10	0.0	− 1.9	− 8.6	− 4.1
Taiwan	0.7	− 11.5	− 3.1	9.3	2.7	0.7	13.3	4.3	1.2	− 8.0	− 2.5	12.5
Argentina	12.8	− 5.7	− 12.4	− 0.5	10.2	− 14.5	8.5	8.7	− 3.3	− 5.9	− 7.2	− 11.6
Mexico	6.9	− 7.0	− 6.8	− 4.8	8.3	− 8.9	8.8	9.8	1.6	− 7.1	1.5	− 8.3

Source: IFC, 1995, and HKSE, 1994.

Table 9. Monthly Changes of the Local Price Index for the Selected Stock Markets during 1998 in %.

Months	1	2	3	4	5	6	7	8	9	10	11	12
Developed												
Australia	1.5	1.5	1.7	0.7	− 1.7	− 1.8	1.4	− 8.2	4.3	2.3	4.8	1.4
Japan	9.0	1.2	− 1.8	− 5.4	0.2	1.0	3.5	− 13.9	− 5.0	1.2	9.7	− 7.0
Hong Kong	− 18.4	24.8	− 1.4	− 9.3	− 14.0	− 6.9	− 7.9	− 10.0	9.7	24.3	2.8	− 3.6
Singapore	− 16.7	18.3	− 1.5	− 8.8	− 13.7	− 13.6	0.6	− 15.7	9.8	28.2	17.6	1.7
Toronto	0.1	5.9	6.6	1.4	− 1.0	− 3.0	− 5.9	− 20.2	1.5	10.6	2.2	2.2
London	6.3	5.6	2.9	− 0.1	− 1.0	− 0.7	0.1	− 10.0	− 3.5	7.4	5.6	2.4
New York	0.0	8.1	3.0	3.0	− 1.8	0.6	− 0.8	− 15.1	4.0	9.5	6.1	0.7
Germany	4.5	6.0	8.3	0.1	8.3	5.9	− 0.5	− 17.7	4.4	7.5	− 0.4	
Emerging												
South Africa	5.6	8.3	6.8	8.7	− 7.4	− 11.3	3.7	− 29.9	3.6	14.3	− 3.6	− 3.4
Korea	48.4	− 1.8	− 12.3	− 12.4	− 20.1	− 11.5	15.3	− 9.7	0.1	24.0	17.5	24.5
Turkey	2.8	− 7.8	− 0.4	28.7	− 11.1	10.0	5.4	− 39.0	− 14.0	− 3.1	17.4	0.8
Greece	− 5.7	1.71	41.3	31.0	− 1.2	− 8.7	18.3	− 22.2	− 2.5	2.0	16.1	9.0
Malaysia	− 4.2	30.9	− 3.5	− 13.0	− 14.0	− 13.4	− 11.6	− 24.8	23.3	8.5	23.7	16.9
Taiwan	− 0.7	13.8	− 1.21	− 8.7	− 4.8	− 4.5	1.4	− 14.4	4.3	3.9	1.1	− 10.6
Argentina	− 8.8	8.0	3.0	− 0.7	− 11.6	− 4.8	6.9	− 30.7	12.8	11.8	3.8	− 8.2
Mexico	− 12.6	4.7	4.8	1.6	− 11.2	− 5.5	− 0.9	− 29.5	19.3	14.2	− 7.5	4.3

Source: IFC, 1999, and HKSE, 1998 and Germany Stock Market Fact Book, 1999.

Table 10. The Significant Correlation Between the Selected Stock Markets as Existed in 1994 Based on Monthly Changes of Local Price Indices.

	Japan	HK	Toronto	London	NY	SA	Malaysia	Argentina	Mexico
Australia	0.737	0.758	0.840	0.698	0.985			0.738	
Japan					0.719				
Hong Kong			0.663		0.790			0.726	0.623
Singapore						0.660	0.732		
Toronto					0.866			0.750	0.659
Lodon					0.703				
New York								0.770	
South Africa							0.591		
Argentina									0.894

Note: Correlation is significant at the 0.01 level.

5.2. The Correlation Existed Between Stock Markets Indices

The Pearson Correlation Coefficient between the stock market indices' movement in 1994 was calculated between each pairs' of indices for the selected 16 stock market exchanges. Out of the total possible stock market pairs, only 17% reported significant correlation between stock price movements during 1994 as presented in Table 10. It shows that there is a significant correlation between developed stock markets with the exception of Germany, while only four emerging markets reported significant correlation including South Africa, Argentine, Mexico, and Malaysia. During the year of 1994. The end of month stock price indices shows no associations for Germany, Korea, Turkey, Greece and Taiwan.

However, this situation had been changed significantly during 1998 year, as presented in Table 11. It shows that there is a significant correlation between the stock market indices' movement for more than half of possible relations of the selected 16 stock markets. A significant correlation is also found between the majority of both developed and emerging stock markets. This includes Germany, which had a negative association during the 1994 year, but in 1998, it had a significant correlation of price movements with the majority of the developed countries. In addition, Malaysia, Taiwan, Argentine, Mexico, Greece and Turkey had significant correlation with other emerging and developing stock markets.

Table 12 presents a number of Stock markets, which shows significant correlation in price Index with other price indices. It shows that the number of

Table 11. The Significant Correlation Between the Selected Stock Markets as Existed in 1998 Based on Monthly Changes of Local Price Indices.

	Japan	Singapore	Toronto	London	NY	Germany	SA	Turkey	Greece	Malaysia	Taiwan	Argentine	Mexico
Australia	0.596	0.639	0.796	0.695	0.860		0.791	0.575		0.736	0.670	0.861	0.752
Japan				0.763	0.548	0.739							
Hong Kong		0.909	0.569		0.668					0.727	0.644	0.662	0.654
Singapore			0.629		0.743					0.791	0.683	0.748	0.667
Toronto				0.832	0.940	0.731	0.864			0.626	0.657	0.773	0.781
London					0.811	0.818	0.744				0.622	0.574	
New York						0.680	0.854	0.570		0.712	0.689	0.890	0.797
Germany								0.600					
South Africa									0.577		0.570	0.834	0.776
Turkey									0.638				
Malaysia											0.859	0.633	0.620
Taiwan												0.635	0.659
Argentine													0.879

Note: Correlation is significant at the 0.01 level.

Table 12. Number of Associated Markets with Other Stock Indices.

Stock Exchanges Indices	Significant Correlation in 1994	Significant Correlation in 1998
Australia	6	11
Japan	2	4
Hong Kong	5	7
Singapore	2	8
Toronto	3	11
London	2	8
New York	6	13
Germany	0	5
South Africa	2	8
Korea	0	0
Turkey	0	4
Greece	0	2
Malaysia	2	8
Taiwan	0	10
Argentina	5	9
Mexico	3	9
Total	38	116

associated stock markets increased for all selected stock markets between 1994 and 1998, with the exception of Korea. New York, Toronto, Australia, and Taiwan have had the most associated stock markets (more than ten markets) compared to other stock markets during 1998. The number of associated stock markets increased from 40% to 1000% for the selected sample from 1994 to 1998, with the exception of Korea, which had no association with any of the selected markets in both years. In Taiwan, there was no association with any stock market in 1994, while there was a significant correlation with ten stock markets during 1998.

Finally, to indicate to what extend the correlation between each pairs of the selected stock markets has been increased significantly. Table 13 presents a list of stock market pairs which witnessed an increase of more than 100% in the degree of correlation of price index movement between the year 1994 and the year 1998. It shows that there are about 30 pairs of stock markets witnessed an increase of more than 100% in the degree of correlation between 1994 and 1998. Many of the stock market pairs that show negative correlation in 1994 such as Toronto – South Africa, Germany – Toronto, Germany – New York, Turkey – Greece, South Africa – Mexico, and South Africa – Greece had significant correlation of the stock price movements during 1998.

Table 13. List of Stock Market Pairs that Witnessed Increase More Than 100% in the Degree of Correlation Between the Year 1994 and 1998.

Stock Market Pairs	Correlation in 1994	Correlation in 1998
Australia – South Africa	0.135	0.791
Toronto – South Africa	− 0.022	0.864
London – South Africa	0.377	0.744
New York – South Africa	0.102	0.854
Australia – Malaysia	0.154	0.736
Hong Kong – Malaysia	0.378	0.727
New York – Malaysia	0.194	0.712
Singapore – Mexico	0.121	0.667
Singapore – Taiwan	0.227	0.683
Singapore – Argentine	0.321	0.748
Australia – Singapore	0.280	0.639
Hong Kong – Singapore	0.402	0.909
London – Japan	0.263	0.763
Toronto – London	0.457	0.832
Singapore – New York	0.328	0.743
Japan – Germany	0.119	0.739
Germany – Toronto	− 0.224	0.731
Germany – London	− 0.691	0.818
Germany – New York	− 0.330	0.680
Germany – Australia	− 0.393	0.562
South Africa – Turkey	0.063	0.536
South Africa – Greece	− 0.228	0.577
Turkey – Greece	− 0.046	0.638
Malaysia – Taiwan	0.290	0.859
South Africa – Argentine	0.021	0.834
Argentine – Malaysia	0.121	0.633
Taiwan – Argentine	0.293	0.635
South Africa – Mexico	− 0.107	0.776
Malaysia – Mexico	0.032	0.620
Mexico – Taiwan	0.330	0.659

It should be pointed here the impact of regional affiliation on the degree of the correlation between stock price monthly movements. Such as the correlation between Greece and Turkey, the correlation between the Latin American stock markets, the correlation between Australia, Hong Kong, Singapore and Taiwan. Moreover, some of the regional stock markets witnessed closer association to the developed stock markets between 1994 and 1998, such as Asian and Latin American Markets.

Table 14. Average Correlation Between 1994 and 1998 and *t* Test Values for Groups of Stock Markets.

Groups	1994		1998		N	T Test	Significant at
	Mean	SD	Mean	SD			
Developed – Emerging	0.220	0.340	0.512	0.236	64	7.132	0.000
Developed	0.324	0.449	0.604	0.235	28	2.834	0.009
Emerging	0.122	0.298	0.434	0.264	28	4.590	0.000

5.3. Test of the Stated Positive Hypotheses

The study found that the average correlation for the selected sample of both developed and emerging stock markets increased from 0.220 in 1994 to 0.512 in 1998. This means that there was an increase of 133% of the degree of correlation during the period. For the developed stock markets the average correlation increased from 0.324 in 1994 to 0.604 in 1998, with an increase of 86% during the period. For emerging stock markets the average correlation increased from 0.122, in 1994 to 0.434 in 1998, with an increase of 256% during the period.

It is clear that the average correlation between developed stock markets (0.604) is much higher than the association between the emerging stock markets (0.434) in 1998. This may be due to the fact that the positive correlation between many pairs of emerging stock markets was materialized around the 1997 stock market crisis in Asia and thereafter. While the high positive correlation between developed stock markets was initiated since 1987 stock crisis. However, the percent increase for emerging stock market of correlation between emerging stock markets is much higher than that of the developed market during the period.

To indicate whether the increased percentage of correlation between 1994 and 1998 for the selected stock markets was significantly different or not, the t test was calculated and presented in Table 14. It shows that the degree of correlation (r_1) in 1994 is significantly different than the degree of correlation (r_2) in 1998 at less than 0.01, for the three groups of stock markets. Thus, the stated directional hypotheses for the three groups "There is a significant increase in positive correlation between developed, emerging, and both markets based on monthly movement of stock market indices" has been are confirmed.

6. SUMMARY AND CONCLUSIONS

The paper presented forms of linkages between the world stock markets that exist during the period 1990 to 2000. The forms of stock markets linkages include removing restrictions by stock exchanges imposed on foreign ownership fully or partially. Increasing of stock market liberalization dealing with foreign stocks. Introducing liberal regulatory rules in stock exchanges to attract foreign equities and investors. Increasing the flows of net private portfolio between developed and emerging markets. Increasing of the trading volume of firms shares outside home exchanges. Increasing the number of cross-listed corporations in two or more stock exchanges. Increasing number of the cross listed corporations from emerging economies to be listed in other markets, and increasing the volume of foreign transactions of stocks' trading.

The analysis of published data related to the above factors as presented in stock exchange fact books, International Federation of stock Exchanges Database, IFC fact books and other related sources indicated that there was significant increase in the above factors that lead to more linkages among individual and regional stock markets. The study indicated that there were significant changes during the nineties arising from introducing liberal regulatory rules, in increasing foreign trading, increasing number of cross listed firms and transactions' activities and in equity portfolio flows.

Increasing of stock market linkages was reflected in the high correlation of stock price movements between the majorities of the world stock markets. The study found that a significant correlation was found between 38 stock market pairs in 1994, and increased to 117 stock market pairs in 1998. In addition, there was a significant positive increase from 1994 to 1998 in the degree of correlation between the majority of the selected developed and emerging stock markets based on monthly changes of performance' indices.

The increasing linkages of stock market should be considered carefully, due to the fact that many studies reported that stock market linkages are increasing more in high volatile stock prices and during unstable periods, thus may lead to the transmission of stock volatility to other stocks. Example of these studies are: (Login & Solnik, 2001; Lin et al., 1994; De Santis & Imrohoroglu, 1997; Ramchand & Susmel, 1998; Janakiramanan & Lamba, 1998; Jeong, 1999; Solnik et al., 1996; Koutmos, 1999 and Bracker et al., 1999). The increasing of the foreign listed firms may also have negative aspects in this regard than other factors. Due to the fact that the dual listed shares are priced in different market places, with different currencies, different methods of pricing, different methods of settlements and other related conditions, which may increase the

movement of stock price volatility as examined by Lin et al. (1994) Kane et al. (2000), Werner and Kleidon (1996), and Chan et al. (2000).

Therefore, the negative aspects of increasing linkages and open borders between stock markets should be considered, which may lead to a stock market crisis as happened in 1987, and 1997. Increasing linkages suppose to increase data dissemination, and thus increase efficiency of the stock market. However, with the existing new situation of stock volatility spillover, this issue should be scrutinized carefully in the coming era. In which linkages and correlation between stock markets in both developed and emerging markets are expected to intensify and be more associated with each other than it is now.

REFERENCES

Amsterdam Stock Exchange (2000). *Amsterdam Stock Exchange: Facts & Figures July.* Amsterdam, Netherlands.

Arshanapalli, B., & Doukas, J. (1993). International stock market linkages: evidence from the pre- and post October 1987 period. *Journal of Banking & Finance*, *17*, 193–208.

Bekaert, G., & Harvey, C. R. (1997). Emerging equity market volatility. *Journal of Financial Economics 43*, 29–77.

Biddle, G., & Saudagaran, S. M. (1989). The effects of financial disclosure levels on firms' choices among alternative foreign stock exchange listings. *Journal of International Financial Management and Accounting*, *1*, 56–87.

Bracker, K., Docking, D. S., & Koch, P. D. (1999). Economic determinants of evolution in international stock market integration. *Journal of Empirical Finance*, *6*, 1–27.

Bracker, K., & Koch, P. D. (1999). Economic determinants of the correlation structure across international equity markets. *Journal of Economic and Business*, *15*, 443–472.

Campollo-Palmer C. (1997). Equity investments in emerging markets. NYSE. Conference on the Globalization of Financial Markets, Working paper, Mexico.

Chan, K., Chockalingam, M., & Lai., K. W. L. (2000). Overnight information and intraday trading behavior: Evidence from NYSE cross-listed stocks and their local market information. *Journal of Multinational Financial Management*, *10*, 495–509.

Cheung, C. S., & Lee, J. (1995). Disclosure environment and listing on foreign stock exchanges. *Journal of Banking & Finance*, *19*, 347–362.

Claessencs, S. (1995). The emergence of equity investment in developing countries: overview. *The World Bank Economic Review*, *9*, 1–18.

Cooper, I., & Kaplanis, E. (1994). Home bias in equity portfolios, inflation hedging and international capital markets equilibrium. *Review of Financial Studies*, *7*, 45–60.

Copenhagen Stock Exchange (2000). *Factbook 2000*. Copenhagen Stock Exchange, Copenhagen.

De Santis, G., & Imrohorglu, S. (1997). Stock returns and volatility in emerging financial markets. *Journal of International Money and Finance*, *16*, 561–579.

FESE (1994–2000). *European Stock Exchanges Statistics Annual Reports*. FESE, Brussels.

FESE (2000). *The Federation of European Stock Exchanges Database*. FESE, Brussels. Available on line: www.fese.be.

Froot, K. A., O'Connell, P. G., & Seasholes, M. S. (2001). The portfolio flows of international investors. *Journal of Financial Economics, 59*, 189–216.

Gardiol, L., Gibson-Asner, R., & Tuchshmid, N. S. (1997). Are liquidity and corporate control priced by shareholders? Empirical evidence from Swiss dual class shares. *Journal of Corporate Finance*, *3*, 299–323.

Germany Stock Market (1999). *Deutshe Borse Factbook 1999*. Frankfurt, Germany.

Grabel, I. (1996). Marketing the third world: the contradictions of portfolio investment in the global economy. *World Development, 24*, 1761–1776.

Hargis, K. (2000). International cross-listing and stock market development in emerging economics. *International Review of Economics and Finance*, *9*, 101–122.

Henry, P. B. (2000). Stock market liberalization, economic reform, and emerging market equity prices. *Journal of Finance*, *55*, 529–563.

HKSE (1994). *Hong Kong Stock Exchange Fact Book 1994*. Hong Kong Exchange & Clearing Limited.

HKSE (1998). *Hong Kong Stock Exchange Fact Book 1998*. Hong Kong Exchange & Clearing Limited.

IFC (1995). *Emerging Stock Markets Factbook 1995*, International Financial Corporation, Washington, D.C.

IFC (1999). *Emerging Stock Markets Factbook 1999*, International Financial Corporation, Washington, D.C.

IFC (2000). *Emerging Stock Markets Factbook 2000*. Standard & Poor's, Washington, D.C.

IFSE (2000). *International Federation of Stock Exchanges Data Base*. FIBV, Paris. Available on line www. fibv.com.

IMF (2000). International Capital Markets: Development, Prospects and Key Policy Issues. *World Economic and Financial Surveys*, Washington, September.

Janakiramanan, S., & Lamba, A. S. (1998). An empirical examination of, linkages between Pacific-Basin stock markets. *Journal of International Financial Markets, Institutions & Money, 8*, 155–173.

Jayaraman N., Shastri, K., & Tandon, K. (1993). The impact of international cross listings on risk and return, the evidence from American depository receipts. *Journal of Banking & Finance*, *17*, 91–103.

Jeong, J. (1999). Cross-border Transmission of stock price volatility: evidence from the overlapping trading hours. *Global Finance Journal, 10*, 53–70.

Kanas, A. (1999). Volatility spillover across equity markets: European Evidence. *Applied Financial Economics*, *8*, 245–257.

Kane A., Lehmann, B. N., & Trippi, R. R. (2000). Regularities in volatility and the price of risk following large stock market movements in the U.S. and Japan. *Journal of International Money and Finance*, *19*, 1–32.

Kang, J., & Stulz, R. M. (1997). Why is there a home bias? An analysis of foreign portfolio equity ownership in Japan. *Journal of Financial Economics*, *46*, 2–28.

King, M. A. (1990). Transmission of volatility between stock markets. *The Review of Financial Studies*, (Vol. 3, No. 1), 5–33.

Koutmos, G. (1999). Asymmetric price and volatility adjustments in emerging Asian stock markets. *Journal of Business Finance & Accounting*, *26*, 83–102.

Levine, R., & Zervos, S. (1998). Capital control liberalization and stock market development. *World Development*, *26*, 1169–1183.

Lin, W., Engle, R. F., & Ito, T. (1994). Do bulls and bears move across borders? International transmission of stock returns and volatility. *The Review of Financial Studies*, *7*, 507–538.

Longin, F., & Solnik, B. (2001). Extreme correlation of international equity markets. *Journal of Finance*, *56*, Forthcoming.

Martell, T. F., Rodriguez, L. Jr., & Webb, G. P. (1999). The impact of listing Latin American ADRs on the risks and returns of the underlying shares. *Global Finance Journal*, *19*, 147–160.

Miller, D. P. (1999). The market reaction to international cross-listings: Evidence from depositary receipts. *Journal of Financial Economics*, *51*, 103–123.

Mueller, G. (1999). Global financial accounting standards setting at crossroads. *Emerging Issues in International Accounting Proceeding*, 7–11. Niagara University, USA.

Ramchand, L., & Susmel, R. (1998). Volatility and cross correlation across major stock markets. *Journal of Empirical Finance*, *5*, 397–416.

Sabri, N. R. (1995a). Stabilization of stock markets; the case of the Frankfurt exchange. *Journal of Multinational Financial Management*, *5*(3), 23–32.

Sabri, N. R. (1995b). Experts' opinions towards the stock market stability during the stock market crisis. *International Journal of Commerce and Management*, *5*(2–3), 130–146.

Shawky, H. A., Kuenzel R., & Mikhail, A. D. (1997). International portfolio diversification: A synthesis and an update. *Journal of International Financial Markets, Institutions & Money*, *7*, 303–327.

Singh, A., & Weisse, B. (1998). Emerging stock markets, portfolio capital flows and long-term economic growth micro and macroeconomics perspectives. *World Development*, *26*, 607–622.

Solnik, B., Boucrelle, C., & Le Fur, Y. (1996). International market correlation and volatility. *Financial Analysts Journal*, *52*(5), 17–35.

Stulz, R. M. (1999). *Globalization of equity markets and the cost of capital*. BSI Gamma Foundation, Switzerland.

Stulz, R. M., & Wasserfallen, W. (1995). Foreign equity investment restrictions, capital flight, and shareholder wealth maximization: theory and evidence. *The Review of Financial Studies*, *8*, 1019–1057.

Tesar, L. L. (1995). Home bias and high turnover. *Journal of International Money and Finance*, *14*, 467–492.

Timmermam, A., & Blake, D. (2000). *Determinants of international portfolio performance*. BSI Gamma Foundation, Switzerland.

UNCTAD, World Investment Report (1999). *Foreign Direct Investment and the Challenge of Development United Nations*, New York and Geneva.

Werner, I. M., & Kleidon, A. W. (1996). U.K. trading of British cross – listed stocks: An intraday analysis of market integration. *The Review of Financial Studies*, *9*, 619–664.

World Bank (2000). *Global Development Finance 2000*. The World Bank, Washington, D.C.

Wu, C., & Su, Y. (1998). Dynamic relations among international stock markets. *International Review of Economics and Finance*, *7*, 63–84.