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Author Declarations

1. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than for which it is now submitted.
2. The program of advanced study of which this thesis is part has consisted of:
   i) Research methods course during the undergraduate study
   ii) Examination of several thesis guides of particular universities both in Turkey and abroad as well as a Professional book on this subject.

Hüseyin ŞEKER with Nihat Solakoğlu

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Abstract

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The aim of this paper is to examine the time varying correlation structure of market returns in Turkey and other emerging and devoloped markets from January 2000 to March 2006. The descriptive statistics, the unconditional bivariate correlations, traditional time-varying correlations and rolling correlations are examined in this paper. From examination , it is seen that there are noticable differences among ISE market, other emerging markets and devoloped markets and it is apparent that correlation structure is not independent of time. Later, Dynamic Conditional Correlation-Multivariate GARCH model, the effect of macroeconomis announcements of Turkey are going to be examined and conclusions are going to be added to the paper.

Key words: Dynamic Conditional Correlation (DCC), Multivariate GARCH (MVGARCH)

Model, Istanbul Stock Exchange (ISE)

1. Introduction

The aim of this paper is to examine the time varying correlation structure of market returns in Turkey and other emerging or developed markets. In other words, this study plans to investigate the comovements between local and foreign market returns to shed some light on the effectiveness of international diversification patterns from an international investor perspective. Moreover, not only the unconditional bivariate correlations but also the time-varying correlations will be investigated. Although it is possible to find some studies in the literature, this study is the most comprehensive that examine the relationship between Turkish Stock Exchange with world's stock exhanges.

The integration between global stock market and Turkish stock market has increased in recent years. This seems mainly due to large amount of foreign capital flows to Turkish stock market. As of April 31, 2007 the share of foreign investors in Istanbul Stock Exchange (ISE) is about 70 percent.[1] There may be questions in minds whether or not this share makes İstanbul Stock Exchange "Foreign Stock Exchange" and this is good or bad situation for İstanbul Stock Exchange. By investigating the relationship over time, this study can shed some light on this contagion effect.

In this study, we are going to examine correlation of returns in Turkish Stock Exchange with major world's stock exchanges, some emerging and some developed. For this purpose in mind, we are going to look at unconditional correlations, traditional time-varying correlations- such as rolling regression – as well as Engel's (2002) Dynamic Conditional Correlation (DCC) and Multivariate GARCH (MVGARCH) Model for this examination. We would also test whether the correlations are affected by certain macro announcements in Turkey, whether local or international, as captured by Reuters screeen.

[1] According to Istanbul Stock Exchange Settlement and Custody Bank Inc. (ISE Takasbank A.Ş.)

The remainder of this study is structured as follows. In section 2, we summarize stock returns index for each market, describe these markets briefly and explain data set used in the study. In section 3, we provide summary of emprical studies in global and regional stock market correlations, exchange rate correlations, price and return correlations. Section 4 presents preliminary analysis. Section 5 presents model with discussion of estimation results. Section 6 examines the 5-minute effect of macroeconomic news on Istanbul stock exchange. Section 7 provides concluding remarks.

2. Stock Indeces and Data Set

Stock exchange is a corporation or mutual organization which provides company to trade stock and other securities. Origin of the term stock exchange comes from 13th century that Venetian Bankers began to trade in goverment securities. In 1602, Dutch East India Company issued the first shares on the Amerikan stock exchange. In the 19th century, exchanges were opened to trade future contracts on commodities, interest rates, shares, as well as option contracts.

The origin of organized securities market in Turkey has its root in the second half of the 19th century. First securities market in the Ottoman Empire was established in 1866 under the name of "Dersaadet Securities Exchange." In 1922, it is reorganized under the new name of "İstanbul Securities and Foreign Exchange Bourse." ISE is founded in 1986 and the only corporation in Turkey for securities exchange established to provide trading in equities, bonds, revenue sharing certificates, private sector bonds, foreign securities and real estate certificates as well as international securities. At the time of 1986, there were 41 national companies and 36 intermediare investment corporations in Istanbul stock exchange. As of 2006, it is home to abouth 320 national companies and the number of intermediare investment corporatios is about 100.

In 2006, some of the world stock exchanges market capitilazion values (in trillions of U.S dollars) is as follow:[2] Newyork $22.6 , Tokyo $4.5, Nasdaq $3.6, London $3.5 Toronto $1.8, Hong Kong$1.5 , Frakfurt $1.4, Madrit $1.1, ISE $1.5 .

A stock market index is a listing of stock and a statistic reflecting the composite value of its components. There are many stock index used in the world. In this study, we are going to use 19 stock market index. These are ISE national -100 index, ISE -50 index, ISE-30 index, Dow index, S&P500 index, Nasdaq index, Nikkei 225 index, DAX index, CAC 40 index, FTSE100 index, AEX index, Argentina Merval index, RTS index, Brussels BEL 20 index, Bovespa index, ATX index, Helsinki 25 index, Hang Seng index, and IBEX-35 index. ISE National 100 index is used as main indicator of the Turkish stock market. It is created in 1986 and has 100 company. It is the float capitalization-weighted index. Dow index is the oldest contiuning US stock market index and created on 1896. It consists of 30 of the largest public companies in the US and is scaled average index. S&P500 index is created on 1957 and a stock market index containing the stocks of 500 most widely US corporations. After Dow index, it is most widely watched index of large-cap US stocks. It is the float weighted index. Nasdaq index measures all Nasdaq domestic and international based common type stocks listed on the nasdaq stock market. It is created on 1971 and includes over 3.000 corporations. It is market value weighted index. Nikkei 225 index is created on 1971 and a stock market index for Tokyo stock exchange. It consists of 225 corporations and is a price weighted average index. Dax index is a blue chip stock market index for Germany consisting of the 30 major companies trading on the Frankfurt stock exchange. It is created on 1987 and it is a free float weighted index. CAC 40 index is French stock market index consisting of 40 French corporations. It is created on 1987 and is free float weighted index. FTSE100 index is created on 1984 and share index of 100 most highly capitalized companies listed on London stock

[2] From wikipedia.com, the free encyclopedia

exchange. It is a capitalization weighted index. AEX index is created on 1983 and is a stock market index composed of 25 Dutch companies. Argentina Merval index is created on 1986 and has 25 corporations. It is a price weigted index. RTS index is a stock market index of 50 companies that trade on the RTS stock exchange in Moscov. It is created on 1995 and is a capitalization weighted index. Brussels BEL20 index is an index composed of 20 most liquid Belgian company's shares. It is created on 1990 and is a free float market capitalization index. Bovespa index is the main indicator of the Brazilian stock market performance. It is created on 1968 and is an index of about 50 corporations that are traded on the Sao Paula stock exchange. It is a capitalization weighted index. Helsinki 25 index is founded 1988 and has 25 corporations. It is a capitalization weighted index. Hang Seng index is created on 1969 and has 34 corporations. It is also a capitalization weighted stock market index.

We have used montly closing index data spanning the period 3 January 2000-01 March 2006 for above mentioned all indeces in the study. Additionally, we have used monthly closing dollar and euro values for the same period. The data are obtained from Bloomberg and Foreks programs.[3] In order to examine 5-minute effect of news on Istanbul stock exchange, we used 5-minute value of ISE National 100 index, 50 index and 30 index on same macroeconomic news between the period from 1 February 2006 – 31 March 2006.

3. Summary of Emprical Studies

There are several empirical studies using different models focusing on interdependence, volatility spill-overs, exchange rate and price movements in financial markets. Keraney and Poti (2005) examined correlation trend and dynamics in equity markets of Euro area using daily data from 1993 to 2002 on five largest Euro zone stock market indeces (Dax, Cac40, Milan, Amsterdam, and Madrid) with DCC – Multivariate GARCH

[3] These are the online programs that used in financial markets.

model. They confirm the presence of structural break in market index correlations during the process of monetary integration in the Euro zone. Moreover, their result suggest that non-country factors drive the volatility of equity returns. Christofi and Pericli (1998) examined correlation in price changes and volatility of major Latin Amerikan stock markets using daily stock market indeces of Argentina, Brazil, Chile, Colombia and Mexico from 1992 to 1997 with Multivariate VAR-GARCH model. They find that these countries have significant first and second moment time dependencies and these markets exhibit stronger volatility spillovers than other regions of the world. Martens and Poon (2000) examined returns synchronization and daily correlation dynamics between international stock markets using S&P500 index, FTSE100 index, and CAC40 index from 1990 to 1998 with GARCH based method. They found volatility spillovers from US to UK and France and reserve volatility spillover from Europe to US. Bera and Kim (2001) tested constancy of correlation and applied it to US, Japon, German, UK, France and Italy from 1990 to 1995 with Bivariate GARCH model. They suggess a test for constancy of correlation in GARCH model and find highest conditional correlation values in US and UK. Erdal and Gündüz (2001) examined the interdependence of ISE with USA, Japan, Canada, UK, France, Germany, Italy, Israel, Egypt, Jordan, and Morocco from 1996 to 2000. They find that there is no cointegration among stock markets of Turkey, Israel, Jordan, Egypt, and Morocco and ISE is globally integrated with US, UK, Germany, Japan, France, Canada and Italy. They find that there is one lead-lag relation between Turkey and Morocco, that is, Turkey leads to Morocco. Taştan (2005) examined dynamic interdependence, price and volatility transmission and financial integration between Turkish stock market and stock markets in Germany, France, Britain, and USA from 1990 to 2004 with VAR-DCC-Multivariate GARCH framework. He finds significant price spillovers from USA to Turkey whereas price spillovers from Germany, France and Britain to ISE is small and insignificant. Berument and Ince (2004) examined the effect of S&P500's return on

Turkish stock exchange from 1987 to 2004 using Block Recursive VAR model. They find that positive shock to US stock exchange increases ISE in a statically significant manner. However, due to the special cases in the country's state of economy, there is no significant relationship between US and ISE. Lee (2005) examined the comovement between output and prices using US data from 1900 to 2002 with DCC-GARCH model and find that overall price level tended to move in the same direction as output in periods before World War II but in the opposite direction after the war confirming the view that the cyclical behaviour of the overall US price level has changed. Chan (2003) examined the conditional correlated jump dynamics in foreign exchange returns using daily data from 1980 to 2000 of German Mark against British Pound and Japanese Yen against US dollar with Bivariate ARJI-GARCH model. Result is that currency correlations are not driven only by normal disturbances, also diriven by the characteristics of simultaneous jumps. Muthuswamy, Sarkar, Low and Terry (2000) examined the time variation in the correlation structure of US-DM and US-Yen exchange rates in order to calibrate the observed time variation in the correlation structure between their returns using 5-minute data from 1992 to 1993. They find that correlation is not constant over the week. Correlation increases from Monday through Wednesday, folloved decline in Friday, and Friday's correlation is particularly weak compared with the rest of the week. Olson and Mossman (2001) examined the relative importance of the cross-correlations versus macroeconomic variables in models that forecast returns for portfolios of US small stocks from 1950 to 1994. They find that small stock returns can be partially predicted by the past returns of large stocks while larger body of literature has shown that macroeconomic variables can predict future stock returns. Darbar and Deb (2002) investigated characteristics of cross-market correlations using daily data from US stock, bond, money and currency futures markets with logistic exponential GARCH model from 1983 to 1994. They find that there is a weak evidence in some markets that shocks to returns affect conditional correlations before

the cross. On the other hand, they find that there is considerable evidence of transmission of information to cross-market correlations in the post-crash period. Lanza, Monera, and Alear (2006) examined dynamic conditional correlations in returns on West Texas Intermediate (WTI) oil forward and future prices from 1985 to 2004 with multivariate GARCH model. They find that dynamic volatilities in returns in the in the WTI oil forward and future prices can be either independent or interdependent over time and negative shocks have a greater impact on volatility than positive shocks.

4) Empirical Analysis

4.1) Bivariate Correlations

Table 1 presents descriptive statistics, that is average returns, minimums, maximums, medians, standart errors, skewness, kurtosis, Jargue-Bera tests, Shapiro-Wilk W tests. Data used covers the period between January 2003 and March 2006 and includes monthly returns. From the table 1, it is seen that there are noticable differences among ISE market, other emerging markets and developed markets. First of all, monthly average return on ISE national 100 index is 4.237%, which is smaller than return on Hang seng index and larger than returns on other stock markets in the statistics. The ISE national 100 returns fluctuate between -18.13% and 27.41%. Second, standart error of Hong seng index is 10.33%, that is larger than the rest indicating higher volatility and standart error of ISE national 100 is 1.53%. Third, as indicated by skewness statistics, ISE national 100 return seems to be negatively skewed with AEX, Bovespa, Bel 20, Helsinki, ATX, FTSE100, and RTS while positively skewed with other markets in statistics. Finally, it is seen from Jargue-Bera statistics and Shapiro-Wilk statistics that assumption of normality is rejected for all return series.

Table 1: Descriptive Statistics of Returns

Index	Average	Minimum	Maximum	Median	Std. Error	Skewness	Kurtosis	Jarque-Bera Test	Shapiro-Wilk W test b
r_ise100	4,237	-18,138	27,416	5,190	1,530	0,055	0,237	12,428	0.947***
r_ise50	4,213	-18,045	27,783	4,848	1,554	0,069	0,181	12,947	0.973*
r_ise30	4,408	-18,440	29,552	5,113	1,574	0,091	0,471	10,448	0.936***
r_cac	1,443	-6,257	12,802	1,796	0,602	0,174	1,265	5,087	0,989
r_dax	2,011	-7,307	21,378	2,357	0,862	1,085	3,286	7,792	0.969***
r_dow	0,811	-3,450	6,864	0,831	0,430	0,389	-0,610	22,162	0.177***
r_aex	1,094	-9,741	13,716	2,018	0,775	-0,185	0,556	9,931	0.971***
r_bovespa	3,341	-11,449	15,556	3,957	1,083	-0,078	-0,772	23,163	0.869***
r_bel20	1,825	-11,185	14,470	2,490	0,650	-0,431	3,994	2,811	0.963***
r_helsinki	0,135	-78,978	12,133	2,767	2,191	-5,313	31,261	1481,341	0.455***
r_hangseng	9,521	-80,153	393,117	2,099	10,331	5,753	35,386	1919,475	0.215***
r_atx	3,357	-4,590	11,324	3,392	0,586	-0,054	-0,298	17,697	0.184***
r_ftse100	1,142	-9,466	8,654	1,708	0,468	-0,948	3,993	7,439	0.363***
r_merval	3,181	-11,625	19,993	3,711	1,387	0,078	-0,972	25,678	0.937***
r_ibex35	1,722	-5,979	10,667	1,668	0,576	0,322	0,165	13,734	0,981
r_nikkei	1,788	-5,656	9,350	2,193	0,682	0,098	-0,953	25,451	0,995
r_nasdaq	1,497	-7,834	9,182	1,378	0,651	0,064	-0,466	19,553	0.867***
r_russia	3,950	-16,149	17,218	6,720	1,386	-0,453	-0,776	24,501	0.979**
r_sp500	1,043	-3,429	8,104	1,132	0,408	0,502	0,273	13,726	0.297***
r_usd	-0,459	-9,442	7,951	-0,725	0,607	0,135	0,779	8,138	0.815***
r_euro	-0,097	-7,230	8,433	-0,251	0,631	0,273	-0,497	20,351	0.812***

Descriptive statistics are provided for the monthly returns between January 2003 and march 2006.

Table 2 and Table 3 show the unconditional correlation coefficients of markets for the first period (January 2000-December 2002) and second period (January 2003-March 2006) for our sample. We have split the period into two to examine whether we can visually observe differences in unconditional bivariate correlations. The sub-periods are chosen to reflect crisis period, mostly in Turkey but also rest of the world[4], and post-crisis period. The unconditional correlation between CAC and AEX markets for the period between January 2003 and March 2006 is equal to 0.934 and between January 2000 and December 2002 is equal to 0.938, indicating a high positive correlations in both period. Similarly, the unconditional correlation between CAC and DAX markets for the period between January 2003 and March 2006 is equal to 0.933 and between January 2000 and December 2002 is equal to 0.945, indicating a

[4] Within this time period, technology bubble burst in USA and September 11 terrorist bombing occurred. Turkey experinced a severe financial crisis.

high positive correlations in both period. The unconditional correlation between CAC and IBEX35 markets for the period between January 2003 and March 2006 is equal to 0.808 and between January 2000 and December 2002 is equal to 0.834, indicating a high positive correlations in both period. The unconditional correlation between DAX and AEX markets for the period between January 2003 and March 2006 is equal to 0.799 and between January 2000 and December 2002 is equal to 0.839, indicating a high positive correlations in both periods. The unconditional correlation between DAX and AEX markets for the period between January 2003 and March 2006 is equal to 0.903, indicating high positive correlations. This also indicates that diversification of investments between these two markets will not be an effective strategy for an investor. Since the unconditional correlation was around 0.927 for the period between January 2000 and December 2002, we can assume that this high comovement pattern is robust with respect to time. However, it is not possible to generalize this to the other bivariate unconditional correlations. For instance, while the unconditional correlation between DOW and AEX was negative and close to zero in the first period, it is positive and around 0.634 in the second period. The unconditional correlation between CAC and DOW was negative and close to zero in the first period, it is positive and around 0.679 in the second period. The unconditional correlation between DAX and DOW was negative in the first period, it is positive and around 0.717 in the second period. The unconditional correlation between DAX and Helsinki was negative and close to zero in the first period, it is positive and around 0.403 in the second period. The unconditional correlation between DOW and FTSE100 was -0.556 in the first period and it is positive and around 0.640 in the second period. The unconditional correlation between Hang seng and IBEX35 is negative and close to the zero in the first period, it is positive and around 0.553 in the second period. The unconditional correlation between Helsinki and Nasdaq was negative in the first period, it is positive in the second period. The unconditional correlation between FTSE100 and Nasdaq

was negative in the first period, it is positive and around 0.496 in the second period. The unconditional correlation between DOW and S&P500 was negative in the first period, it is positive and around 0.941 in the second period. The conditional correlation between RTS and S&P500 was negative in the first period, it is positive and around 0.864 in the second period. In sum, while unconditional bivariate correlations seems to change a little for some market pairs, we notice a large swings from one period to other for some other market pairs, indicating a need for a closer examination of time-dependence of correlations.

When we look at the bivariate unconditional correlations between ISE100 and other markets, we notice two thinks. First, the unconditional correlations between ISE100 and other markets are not high in both periods and second, there seems to be some differences between two sub-periods. The unconditional correlation between ISE and CAC was 0.599 in the first period, it decreases to 0.420 in the second period. The unconditional correlation between ISE and DAX was 0.571 in the first period, it decreases 0.376 in the second period. The unconditional correlation between ISE and DOW was 0.022 in the first period, it increases 0.411 in the second period. The unconditional correlation between ISE and AEX was 0.465 in the first period, it decreases to 0.339 in the second period. The unconditional correlation between ISE and Bovespa was 0.321 in the first period, it increases to 0.409 in the second period. The unconditional correlation between ISE and BEL20 was 0.234 in the first period, it increases to 0.339 in the second period. The unconditional correlation between ISE and Helsinki are small and there is not important change in the first and second period. The unconditional correlation between ISE and Hang Seng was negative in the first period, it is positive and around 0.024 in the second period. The unconditional correlation between ISE and ATX was negative and close to the zero in the first period, it is positive and around 0.338 in the second period. The unconditional correlation between ISE and FTSE was 0.140 in the first period, it increases to 0.370 in the second period. The unconditional correlation between

ISE and Merval was 0.242 in the first period, it increses to 0.447 in the second period. The unconditional correlation between ISE and S&P500 was 0.148 in the first period, it increases to 0.424 in the second period. The unconditional correlation between ISE and IBEX35, ISE and Nikkei, ISE and nasdaq, and ISE and RTS are positive and small and there are not important change in both periods.

4.2.) Rolling Correlations

Based on Table 2 and 3 findings, it is apparent that correlation structure is not independent of time. Hence, first we examine the correlations between monthly market returns using rolling correlations. These correlations are calculated using the below formula:

$$Corr(X_1,X_2)_{t1-t2}=[Cov(X_1,X_2)/sqrt(var(X_1)*Var(X_2))]_{t1-t2}$$

In this equation, $Cov(X_1, X_2)$ represent the covariance, Var(X) represents the variance, and $Corr(X_1, X_2)$ represents the correlation. The subscript (t_1-t_2) indicates that the calculation uses the time periods between t_1 and t_2. In other words, we kept a rolling window to estimate the bivariate correlation at time t. We used 12 month rolling window. Rolling correlations between ISE100 and other markets are provided in Figure 1. The time lines of rolling correlations indicates that these correlations are time-dependent. In addition, it is clear that sometimes bivariate correlations move together e.g., the dip in rolling correlations between 1999 and 2000 between c(ISE100, CAC) and c(ISE100, DOW) - and sometimes not - e.g., the dip in c(ISE100,DOW) in 2002-2003 period but the lack of dip for c(ISE100, CAC). Moreover, it is clear that there are increase in correlations between ISE and other developed or emerging markets after 2005.

Annual averages obtained from rolling correlations are reported in Table 4 for years between 1998 and 2005. As implied by Figure 1, average monthly correlations changes

significantly from year to year. For example, the correlation between ISE100 and CAC is almost zero for 1999 but reaches to 0.822 for year 2001, indicating almost no comovements and almost complete comovements. This finding seems to apply many of the bivariate correlations.

At the same time, we notice that corelations between ISE100 and many of the developed markets return correlations increase at the crisis period. Interestingly, this finding does not holds for the orrelations between ISE100 returns and other emerging market returns. For example, correlations reach to highest values of 0.822 and 0.797 between ISE100 and CAC and DAX, respectively. The correlations between Argentinian and Russian markets, on the other hand, for the same year, are 0.471 and 0.504, respectively, and these correlations do not correspond to the highest correlations across time. This finding has an important implication for the portfolio creation. It indicates that portfolios created using ISE100 and developed market indexes, for the purpose of risk diversification, will break down under global crisis periods as the correlations will increase significantly. Since bivariate correlations do not change significantly during same periods, it may be a better way to create investment portfolios to diversify away risks.

Table 4 also reports the correlations between ISE100 and foreign exchange rates, specifically US dollar and Euro, for the same time period. Starting with 2001, correlations becomes negative, and especially after 2005 it increases in value. This indicates that, during the current positive environment, an investment portflio consisting of foreign currencies and ISE100 will be an effective way to diversify risks.

4.3.) Dynamic Conditional Correlations

Engle (2002) study generalizes the Bollerslev (1990) Constant Correlation Coefficient (CCC) model with the Dynamic Conditional Correlation (DCC) model. These models impose useful structure on the model parameters that can easily be estimated. The DCC model is also better than the constant correlation alternatives in portfolio selection. However, it has one disadvantage in portfolio selection when large number of assets exist. Specifically, DCC model assumes that all asset-specific conditional correlations follow the same ARMA type dynamic structure and hence can impose a strong restriction.

The DCC model can be represented by:

$$H_t = D_t R_t D_t$$

$$R_t = \text{diag}(Q_t)_{i}^{1/2} Q_t \, \text{diag}(Q_t)_{i}^{1/2}$$

$$Q_t = S(1 - \alpha - \beta) + \alpha \varepsilon_{\tau-1} \varepsilon'_{t-1} + \beta Q_{t-1}$$

In the Bollerslev's (1990) CCC model, the first line in the H_t equation is simpler. Specifically, the CCC model has:

$$H_t = D_t R D_t$$

In other words, the R, sample correlation matric, in the H_t equation shows the conditional variances on the diaogonal and conditional correlations on the off-diagonal elements. As it is clear, with the CCC model, off-diagonal elements are time-independent – that is, it does not

change over time and hence R does not have a time subscript. In sum, conditional correlations are assumed to be constant over time in the CCC model. On the other hand, with the DCC model, the sample correlation matric, R, is a function of time and hence conditional correlations change over time. The model structure for the DCC model, as mentioned earlier, is more restrictive and it takes a form of ARMA type models. In addition, in the DCC model, we can be more specific if we look into the ARMA type structure. That is, if α and β are zero in the Q equation, the DCC model becomes nothing more than CCC model: the conditional correlations become time-independent and hence constant. On the other hand, if they are different from zero, then we will have some kind of autoregressive moving average (ARMA) structure for the correlations (see Engle (2002), and Hafner & Frances (2003) for additional details).

As indicated in the earlier parts of the thesis, one objective is to analyze the cross-correlations between ISE100 return and other financial series, such as other emerging and developed word stock returns and return on foreign currency, and analyze whether these correlations have an ARMA-type structure that we can utilize for prediction/portfolio selection. With this in mind, we have applied MVGARCH-DCC model using bivariate correlations between ISE100 returns and the following return series: CAC, DAX, DOW, BOVESTA, USD and EURO.

For the estimations, we have used monthly returns between 1997:01 and 2006:02, and the results are reported in Table 5. Estimations are undertaken only for the bivariate correlations. For the conditional variances, the structure we used was GARCH(1,1) type. Although there seems to be a some type of ARMA structure based on the significance of DCC(1) or DCC(2) coefficients, statistical insignificance of GARCH(1,1) coefficients for ISE100 returns, which

is not reported in the table, make this finding insignificant. There may be two reasons why these results, as presented in Table 5, are not significant as we expect.

The first reason is the frequency of the financial series we used in the analysis. Instead of using monthly series, a higher frequency data, such as daily or even weekly, can be better to obtain better results. The second reason is the period we consider and related to first reason. With monthly data, we could not focus on a period that we think is break-free. From 1997 to 2006, Turkish economy and world economies are faced with several crisis. Some examples are: 1997 Asian crisis, Russian crisis; Financial crisis in Turkey, Global crisis. These crisis are all occurred before 2002. But, given that our estimation period includes periods of instability ans stability, we may be facing with different structure for the conditional variance and covariance. Hence, when the entire time period is used for the analysis, there is a possibility that we may not find strong results that will show ARMA type structure in conditional variance and/or conditional correlation.

5) Conclusion

This study examines the correlation structure of İstanbul Stock Exchange market returns with some major developed market returns, such as Dow, and major emerging market returns, such as Merval. The objective was to investigate the time-dependency of the correlations across different, whether developed or emerging, markets.

Examination of rolling correlation indicated that correlations definitely change overtime. In addition, correlation of market returns increase during global crisis between developed markets and ISE100 returns. On the other hand, this pattern is not observed among emerging market returns. This finding implies that portfolio diversification using ISE100 and developed market returns will not work under global downturn, a time when investor needs diversification. It also appears that the correlations between ISE100 and foreign currency became negative during and after the 2001 crisis. Moreover, the correlation coefficient seems to follow an increasing trend over time.

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Figure 1: Rolling Correlations

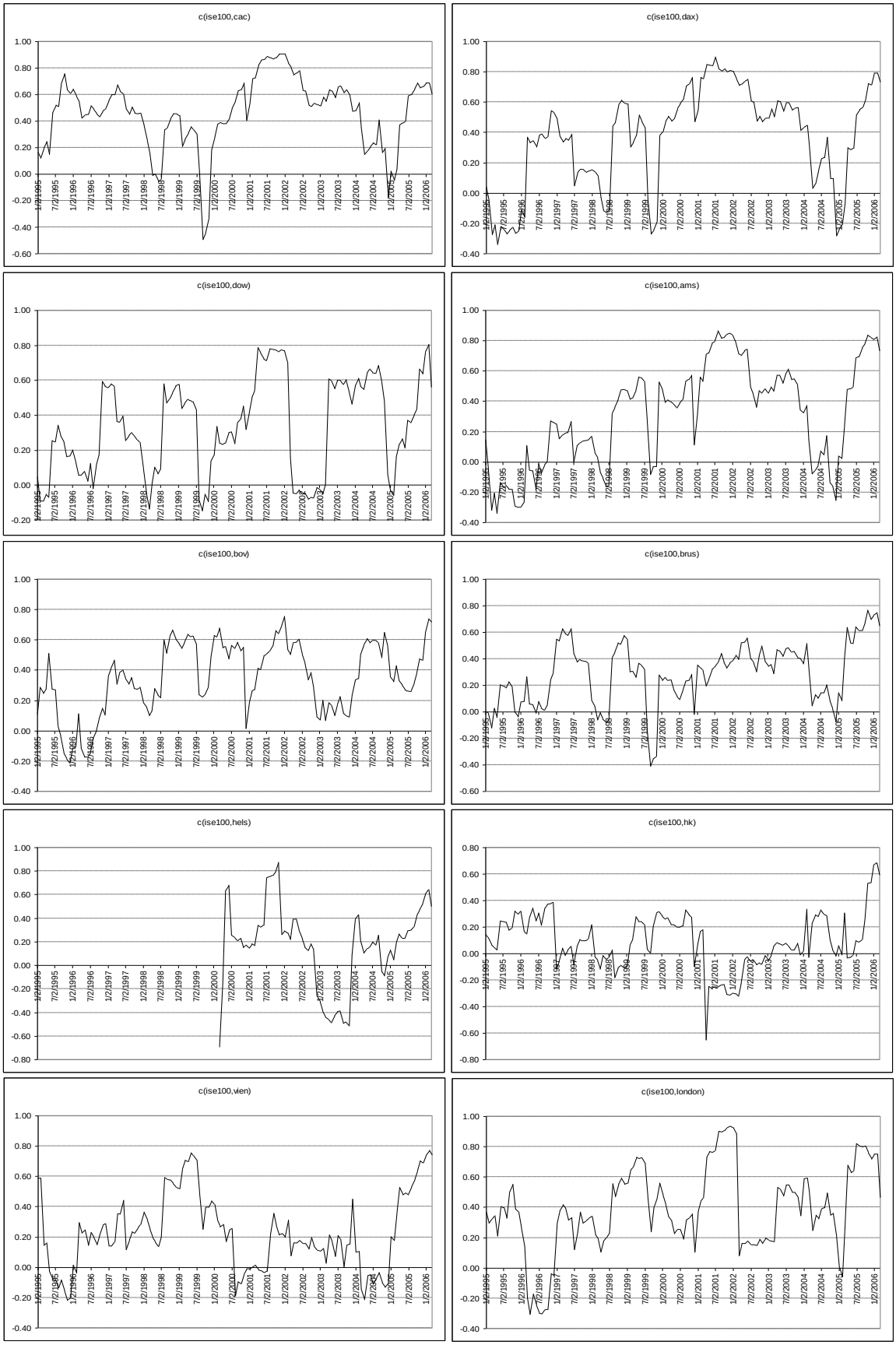

Figure 1: Continued

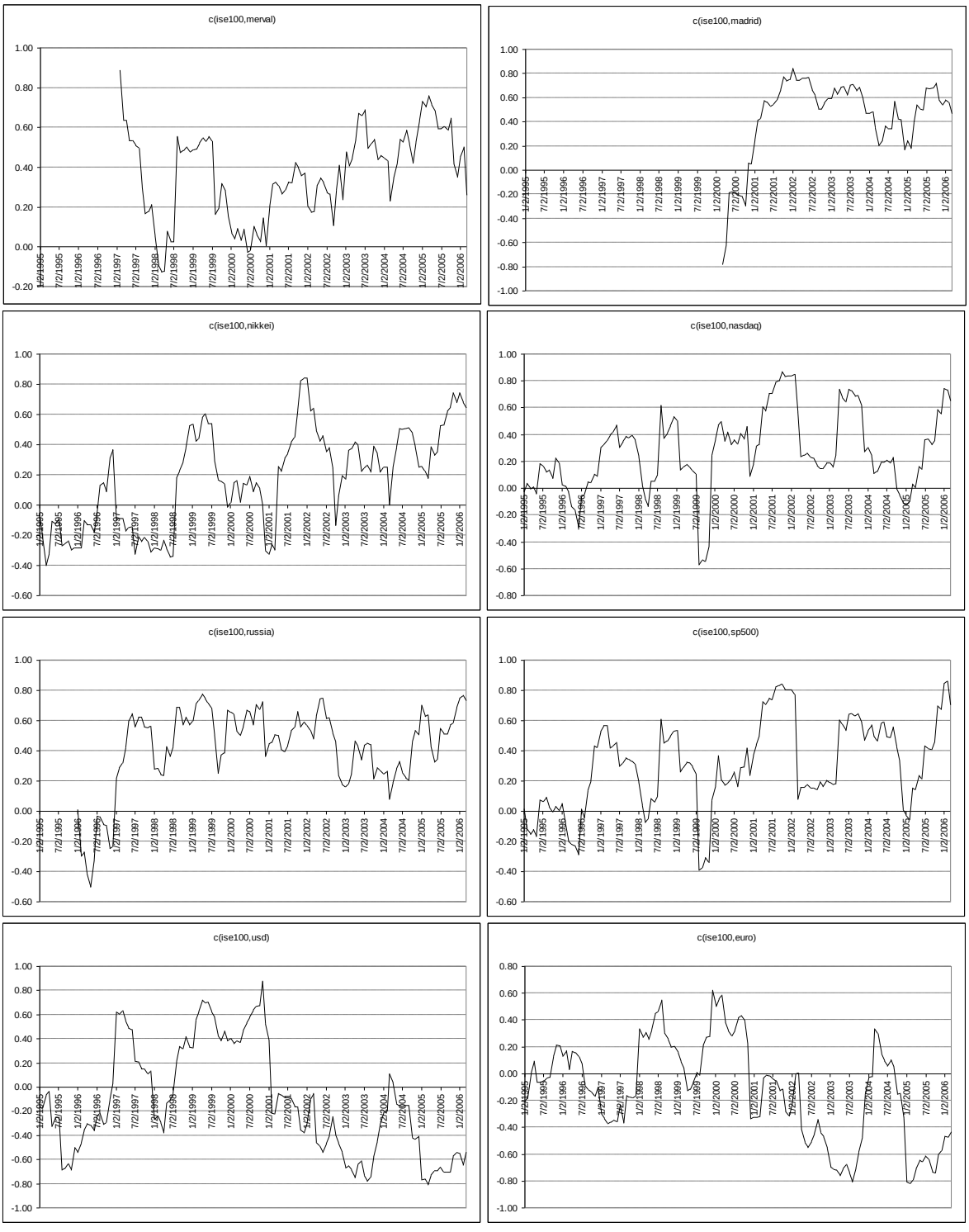

Table 1: Descriptive Statistics of Returns

Index	Average	Minimum	Maximum	Median	Std. Error	Skewness	Kurtosis	Jarque-Bera Test	Shapiro-Wilk W test [b]
r_ise100	4.237	-18.138	27.416	5.190	1.530	0.055	0.237	12.428	0.947***
r_ise50	4.213	-18.045	27.783	4.848	1.554	0.069	0.181	12.947	0.973*
r_ise30	4.408	-18.440	29.552	5.113	1.574	0.091	0.471	10.448	0.936***
r_cac	1.443	-6.257	12.802	1.796	0.602	0.174	1.265	5.087	0.989
r_dax	2.011	-7.307	21.378	2.357	0.862	1.085	3.286	7.792	0.969***
r_dow	0.811	-3.450	6.864	0.831	0.430	0.389	-0.610	22.162	0.177***
r_ams	1.094	-9.741	13.716	2.018	0.775	-0.185	0.556	9.931	0.971***
r_bov	3.341	-11.449	15.556	3.957	1.083	-0.078	-0.772	23.163	0.869***
r_brus	1.825	-11.185	14.470	2.490	0.650	-0.431	3.994	2.811	0.963***
r_hels	0.135	-78.978	12.133	2.767	2.191	-5.313	31.261	1481.341	0.455***
r_hk	9.521	-80.153	393.117	2.099	10.331	5.753	35.386	1919.475	0.215***
r_vien	3.357	-4.590	11.324	3.392	0.586	-0.054	-0.298	17.697	0.184***
r_london	1.142	-9.466	8.654	1.708	0.468	-0.948	3.993	7.439	0.363***
r_merval	3.181	-11.625	19.993	3.711	1.387	0.078	-0.972	25.678	0.937***
r_madrit	1.722	-5.979	10.667	1.668	0.576	0.322	0.165	13.734	0.981
r_nikkei	1.788	-5.656	9.350	2.193	0.682	0.098	-0.953	25.451	0.995
r_nasdaq	1.497	-7.834	9.182	1.378	0.651	0.064	-0.466	19.553	0.867***
r_russia	3.950	-16.149	17.218	6.720	1.386	-0.453	-0.776	24.501	0.979**
r_sp500	1.043	-3.429	8.104	1.132	0.408	0.502	0.273	13.726	0.297***
r_usd	-0.459	-9.442	7.951	-0.725	0.607	0.135	0.779	8.138	0.815***
r_euro	-0.097	-7.230	8.433	-0.251	0.631	0.273	-0.497	20.351	0.812***

Descriptive statistics are provided for the monthly returns between January 2003 and march 2006.
b: Reject the assumption of normality

Table 2: Unconditional Correlations

	r_ise100	r_ise50	r_ise30	r_cac	r_dax	r_dow	r_ams	r_bov	r_brus	r_hels	r_hk	r_vien	r_london	r_merval	r_madrid	r_nikkei	r_nasdaq	r_russia	r_sp500	r_usd	r_euro
r_ise100	1.000	0.998	0.994	0.420	0.376	0.411	0.339	0.409	0.339	0.082	0.024	0.338	0.370	0.447	0.436	0.344	0.266	0.452	0.424	-0.387	-0.281
r_ise50		1.000	0.993	0.405	0.365	0.410	0.329	0.426	0.327	0.070	0.017	0.337	0.348	0.442	0.422	0.348	0.272	0.441	0.424	-0.382	-0.274
r_ise30			1.000	0.410	0.362	0.434	0.327	0.424	0.324	0.080	0.026	0.318	0.361	0.459	0.423	0.363	0.280	0.438	0.436	-0.370	-0.249
r_cac				1.000	0.933	0.679	0.934	0.376	0.825	0.479	-0.258	0.529	0.740	0.250	0.808	0.391	0.583	0.221	0.741	-0.267	-0.335
r_dax					1.000	0.717	0.903	0.355	0.784	0.430	-0.216	0.490	0.715	0.268	0.799	0.335	0.646	0.113	0.771	-0.245	-0.277
r_dow						1.000	0.634	0.578	0.589	0.403	-0.085	0.369	0.640	0.274	0.650	0.432	0.765	0.147	0.941	-0.306	-0.150
r_ams							1.000	0.330	0.834	0.550	-0.270	0.556	0.697	0.135	0.728	0.435	0.554	0.163	0.678	-0.266	-0.398
r_bov								1.000	0.387	0.289	-0.163	0.432	0.360	0.354	0.308	0.309	0.432	0.379	0.568	-0.275	-0.032
r_brus									1.000	0.540	-0.419	0.446	0.662	0.249	0.597	0.212	0.414	0.225	0.666	-0.253	-0.182
r_hels										1.000	0.156	0.314	0.731	0.062	0.360	0.258	0.254	0.226	0.404	-0.069	-0.188
r_hk											1.000	-0.086	0.212	0.102	0.007	-0.005	0.045	0.175	-0.089	-0.122	-0.144
r_vien												1.000	0.406	0.367	0.553	0.413	0.364	0.363	0.453	-0.480	-0.497
r_london													1.000	0.270	0.659	0.333	0.496	0.258	0.674	-0.229	-0.208
r_merval														1.000	0.411	0.109	0.337	0.418	0.354	-0.462	-0.193
r_madrid															1.000	0.344	0.505	0.310	0.675	-0.376	-0.405
r_nikkei																1.000	0.351	0.369	0.359	-0.265	-0.371
r_nasdaq																	1.000	0.153	0.864	-0.359	-0.201
r_russia																		1.000	0.242	-0.563	-0.490
r_sp500																			1.000	-0.391	-0.189
r_usd																				1.000	0.796
r_euro																					1.000

Note: Correlations are calculated for the period between January 2003 and March 2006.

Table 3: Unconditional Correlations

	r_ise100	r_ise50	r_ise30	r_cac	r_dax	r_dow	r_ams	r_bov	r_brus	r_hels	r_hk	r_vien	r_london	r_merval	r_madrid	r_nikkei	r_nasdaq	r_russia	r_sp500	r_usd	r_euro
r_ise100	1	0.99955	0.99776	0.5995	0.57177	0.02263	0.4657	0.32123	0.23495	0.0273	-0.14612	-0.01308	0.14079	0.24223	0.48831	0.27791	0.35442	0.3992	0.1487	-0.24275	-0.28246
r_ise50		1	0.99941	0.61664	0.57902	0.02465	0.49631	0.33725	0.32293	0.03476	-0.14431	-0.01087	0.15137	0.24133	0.51188	0.26746	0.3586	0.4061	0.15617	-0.23497	-0.26829
r_ise30			1	0.61032	0.57939	0.02089	0.47995	0.33537	0.25537	0.02409	-0.14659	-0.02035	0.14875	0.2443	0.50339	0.26908	0.3555	0.39314	0.15495	-0.23511	-0.26701
r_cac				1	0.94506	-0.04409	0.93759	0.67929	0.66052	0.13613	-0.1028	0.13965	0.33027	0.21752	0.83476	0.36392	0.36058	0.41302	0.31754	-0.37513	-0.41135
r_dax					1	-0.06781	0.92729	0.68755	0.63226	0.13918	-0.07853	0.12828	0.34971	0.2554	0.83918	0.34612	0.34369	0.44995	0.34058	-0.35339	-0.40801
r_dow						1	-0.02122	0.07518	0.13787	-0.24799	0.68125	-0.09557	-0.55636	-0.14292	0.04187	0.16693	0.74123	0.09453	-0.53908	-0.06122	-0.00396
r_ams							1	0.66511	0.75899	0.16349	-0.03643	0.1826	0.35919	0.21359	0.82351	0.32956	0.3414	0.38206	0.34502	-0.38161	-0.4084
r_bov								1	0.52491	0.12699	0.02035	0.14538	0.04327	0.25281	0.73764	0.42967	0.5225	0.40661	0.04302	-0.33858	-0.25373
r_brus									1	0.14491	0.05769	0.14874	0.15763	0.08644	0.53255	0.06702	0.27435	0.28749	0.13253	-0.16838	-0.14673
r_hels										1	-0.18366	0.04411	0.45979	0.36312	0.02156	0.00745	-0.24622	0.12324	0.4653	-0.10531	-0.00465
r_hk											1	-0.09156	-0.36702	-0.08579	-0.00956	0.03987	0.49699	0.17115	-0.34198	-0.08313	-0.10962
r_vien												1	0.19456	-0.0376	0.12693	0.29595	0.05837	0.37398	0.19208	-0.01423	-0.08788
r_london													1	0.14887	0.17209	0.15363	-0.49985	0.27707	0.99744	-0.17089	-0.17182
r_merval														1	0.28095	0.05033	0.11189	0.28311	0.15214	-0.4626	-0.4478
r_madrid															1	0.40539	0.48704	0.40411	0.16328	-0.30077	-0.33845
r_nikkei																1	0.43234	0.37388	0.17806	-0.23879	-0.23685
r_nasdaq																	1	0.30154	-0.47883	-0.27476	-0.23065
r_russia																		1	0.29473	-0.23248	-0.31928
r_sp500																			1	-0.18635	-0.18609
r_usd																				1	0.93081
r_euro																					1

Note: Correlations are calculated for the period between January 2000 and December 2002.

Table 4: Rolling correlations

Year	c(ise100,cac)	c(ise100,dax)	c(ise100,dow)	c(ise100,ams)	c(ise100,bov)	c(ise100,brus)	c(ise100,hels)	c(ise100,hk)	c(ise100,vien)
1998	0.223	0.228	0.235	0.151	0.360	0.195	na	-0.043	0.372
1999	0.094	0.224	0.261	0.340	0.470	0.126	na	0.160	0.562
2000	0.470	0.567	0.299	0.415	0.525	0.189	na	0.221	0.125
2001	0.822	0.797	0.693	0.719	0.471	0.333	0.475	-0.194	0.100
2002	0.683	0.637	0.098	0.603	0.468	0.434	0.203	-0.129	0.165
2003	0.594	0.550	0.422	0.518	0.145	0.418	-0.391	0.040	0.156
2004	0.247	0.182	0.558	0.037	0.534	0.168	0.166	0.180	-0.068
2005	0.417	0.340	0.305	0.528	0.349	0.527	0.288	0.160	0.489

Year	c(ise100,london)	c(ise100,merval)	c(ise100,madrid)	c(ise100,nikkei)	c(ise100,nasdaq)	c(ise100,russia)	c(ise100,sp500)	c(ise100,usd)	c(ise100,euro)
1998	0.350	0.195	na	-0.039	0.222	0.450	0.241	0.013	0.327
1999	0.572	0.399	na	0.367	-0.038	0.596	0.078	0.541	0.114
2000	0.299	0.053	na	0.072	0.371	0.605	0.248	0.541	0.340
2001	0.741	0.325	0.568	0.284	0.629	0.504	0.696	-0.125	-0.163
2002	0.283	0.260	0.673	0.382	0.343	0.527	0.263	-0.370	-0.371
2003	0.413	0.529	0.643	0.302	0.531	0.328	0.491	-0.632	-0.643
2004	0.400	0.469	0.367	0.356	0.136	0.298	0.462	-0.190	0.033
2005	0.576	0.616	0.521	0.457	0.223	0.540	0.313	-0.695	-0.693

Note: Average monthly correlations, calculated using rolling correlations method, for the corresponding year are reported.

Table 5: DCC coefficients

	CAC	DAX	DOW	BOV	USD	EURO
DCC1	0.2220*	0.2570**	0.4509***	0.0000	0.0273*	0.4048***
	0.1166	-0.1288	0.0041	0.0014	0.0153	0.0198
DCC2	0.0000	0.0000	0.5490***	0.1338***	0.0000	0.0000
	0.6195	0.2365	0.0050	15.8330	0.8245	0.0175

***,**,* represents statistical significance at 0.01, 0.05 and 0.10 levels, respectively.