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# Determinant of Stock Market Return Correlation: An Extended Gravity Model Approach

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***Abstract***

*During the last several years a large number of studies have expressed increasing concerns regarding to importance of stock market correlation across the countries due to diversification problem. Most of the empirical studies try to measure correlation between stock market returns across countries without questioning that what drives correlation. The main objective of this study is to investigate the determinant of correlation between Istanbul Stock Exchange (ISE) return and stock market returns for selected countries over the 1991:1–2006:12 period by employing the extended gravity model with a panel regression econometric technique.*

*This study departure from previous studies in two ways. First, study focuses on determinant of correlation between ISE return and selected 39 developed and developing countries from different regions. Second, two new variables (level of democracy and European Union (EU) membership) used to explain correlation between ISE return and return of selected countries stock market.*

*Result from panel data regression showed that ISE is more correlated with democratic countries stock market. Also, if there is volatility in world stock markets return, correlation between ISE and selected stock market returns will increase*

***Keywords:*** *Equity market correlation, panel data*

***JEL Codes:*** *G11,G15, C23*

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## 1. Introduction

The co-movement between stock markets are important to investors for applying the portfolio selection model (diversification). With globalization, stock markets' linkages getting closer and closer and fluctuation in one market influences the other markets. Therefore, the last several years a large number of studies have focused on stock market returns correlation between countries to measure contagion. Those studies can be separated into two parts. First part of the studies tries to measure stock market correlation across the countries in a better way by using new econometrics techniques . Second part of studies investigates the determinant of correlation between stock market returns across the countries . In general, second part of studies applies the gravity model with financial, geographical and socio-politics variables and try to provide empirical evidence that these variables do have some explanatory power to explain the determinant of correlation between stock market returns. Even if this study is to similar to second part of studies it is departure from previous studies in several ways. First, this study focuses on determinant of correlation between ISE and selected 39 developed and developing countries stock market return from different regions . Second, two new variables (level of democracy and European Union (EU) membership) introduced to explain correlation between ISE return and return of selected countries stock market.

Our study building is an extended gravity model. Dependent variable of model is the correlation of stock market returns between ISE and selected countries. Therefore, in first step, we use monthly data from January 1991 to December 2006 for 39 countries to measure stock market correlations. The correlations between ISE and selected countries are calculated over the 4 years (48 observations) monthly return data (pair wise correlation). In second step, calculated correlation dependent variable tried to be explained by using following explanatory variables: democracy, trade value, world stock market return, distance, gross domestic product, neighbor country dummy, EU member dummy and developed country dummy.

The rest of the paper is organized as follows. Section 2 outlines the literature related to stock market correlation and determinant of correlation. Section 3 explains data and the specification of model to estimate. Section 4 present the results from panel regression model. The final section is conclusion.

## 2. Literature Review

Even if there are a large number of empirical studies investigating the correlation between stock market returns across countries, a few studies focused on determinant of correlation between stock market returns and those studies cannot reach a general conclusion about what drives correlation between stock market returns.

Some of empirical studies argue that stock market correlation between countries will increase in crash times such as Masih and Masih (1997) and Forbes and Rigobon (2002). According to Forbes and Chinn (2004), correlation across markets is found to be higher during the financial crisis times and this has to be taken to account to avoid misleading interpretation.

Knif, Kolari and Pynnonene (2005) study showed that increase in volatility of stock market in local and national level would increase correlation between stock market returns. At the same time, some empirical studies showed that correlation can be explained by real economic variables (trade, financial liberalization, common trade partners, GDP etc.) and geographical variables (distance, common border, colonial links etc.) such as Karolyi and Stulz (1996), Pretorius (2002), Dungey, Fry and Martin (2006), Bayoumi, Fazio, Kumar and MacDonald (2007) and Lucey and Zhang (2010).

### *2.1. Stock Market Returns Correlation*

Correlation is a measure of the strength of the association between two variables. It is usually standardized as a number between 1 and -1. A correlation value which is close to 1 or -1 indicates a strong correlation between two variables, a value close to 0 indicates a very little correlation. In general, correlation coefficient measures the degree of the association between two variables. The most popular and simplest measure of correlation is Pearson and Pairwise' s correlations.

Correlation between stock markets is an important concern for investor since it reducing the opportunities for international diversification and increasing contagion. Accurate forecast of correlation between stock markets will help investors' optimal portfolio allocation.

How to measure correlation between stock markets is a widely debated issue. First, Grubel (1968) expounded the benefits from international portfolio diversification and since then stock markets correlation have been analyzed in a large variety of studies.

The earliest studies by King and Wadhwani (1990) and Bertero and Mayer (1990) presented and discussed the evidence of changes in unconditional covariance and correlations between stock returns on high-frequency data around the October 1987 crash. Their result showed that overlapping opening hours and increase in market volatility increase contagion effect. Since then, many authors proposed different econometrics techniques to test the stability of correlations.

ARCH and GARCH models used by Longin and Solnik (1995), Edwards and Susmel (2000), Tse and Tsui (2002) and Berben and Jansen (2005). Cointegration models used by Longin and Solnik (1995), Kasa (1992) and Serletis and King (1997).

Those traditional approaches have been recently criticized by Forbes and Rigobon (2002). They showed that structural model featuring constant correlation between stock market returns but stock market volatility and cross-market correlations tent to increase in a period of turmoil. Forbes and Rigobon analyzed the 1987 US stock market crash, the 1994 Mexican Peso crisis and the 1997 East Asian crisis to show that test based on unadjusted correlation coefficients support the contagion, while adjusted correlation coefficients find no-contagion.

Kasa (1992) showed that stock markets in US, Japan, England, Germany and Canada tent to move together over the period of 1974–1990. This is an evidence that all these markets have similar structure of dividend payments and diversification is not possible for investors.

Kanas (1998) investigated the correlation between US and major European stock markets by using daily data. The result showed that there is no pairwise correlation between US and major European stock markets, hence investors may reduce risks by diversifying his portfolio between US and European stocks.

Ramchand and Sussmel (1998) investigated the correlation between US and other stock markets by using a switching ARCH model and weekly data. The result showed that correlation between US and other stock markets are 2 to 3.5 times higher when US stock market is in a high volatility state rather than a low

volatility state. It can be said that volatility is a major determinant of correlation.

By using bivariate GARH model, Longin ve Solnik (1995) found that correlation across the countries are unstable over time and abnormal volatility of the U.S. stock market is main factor of increasing stock market correlation. Longin ve Solnik (2001) suggested extreme value theory to correct correlation coefficient.

Based on the extreme value theory and monthly data, Longin and Solnik claim that correlation between stock markets are related to market trend rather than market volatility. Their results showed that correlations tend to increase specially in the case of negative returns. Correlation will be higher in bear markets than in bull markets. Also, result showed that in the periods of extreme returns, correlation is mainly affected by market trend rather than volatility.

Bogfiglioli and Favero (2005) investigated contagion between US and German stock markets by using monthly data. Results from co-integration and vector error correction models showed that normal fluctuations in the US stock markets have no effect on the German stock market but abnormal fluctuations have statistically significant effect. This is a sign of contagion effect from the US market to the German market. Abnormal fluctuations are a short-term issue. Therefore, investors may benefit from diversification of an asset allocation with a long-term horizon but not short-term horizon.

Knif, Kolari and Pynnönen (2007) analyzed the time-varying conditional correlation of stock market returns for selected countries by using daily data for period 1990–2005. Their results showed that national and world market volatilities are main factor behind correlations. Correlation has been increased in recent years and there is weaker evidence to support the argument of correlation increase during bearish market (market downturn).

Efendioglu and Yoruk (2005) tried to estimate relationship between Turkish stock market and five European stock markets using co-integration model and data from July 1993 to March 2005. Result showed that there is no cointegration between Turkish stock market and five European stock markets.

Bayri and Guloglu (2005) tried to estimate relationship between Turkish stock market with the US and EU stock markets using co-integration model and monthly data for two subperiod 1989–2001 and 2001–2004. Results showed

that there is coi-ntegration Turkish stock market and seven of 11 EU member's stock markets which have high trade value with Turkey. Also, they found that co-integration between Turkish and the US stock markets.

Yorulmaz and Ekici (2010) investigated relationship between Turkish, Brazilian and Argentina stock market returns using GARCH model and daily data from January 2001 to July 2008. Results showed that there are spillover from Brazilizn and Argentina stock markets to Turkish stock market and Turkish stock market to Brazilian stock market. Turkish stock market has no effect on Argentina stock market.

Studies related to stock markets correlation reach following results:

- Correlation between stock market returns are increase over time due to liberalization and deregulation in the money and capital markets . In recent years, liberalization of international capital flows, political and economic integrations, innovation of the financial products and deregulation of financial markets and institutions increased the degree of international economic and financial integration. At the same time, the improvement in electronic communication systems make financial information and financial transactions easier and cheaper in local and international level.
- Correlation between stock markets tend to increase when stock returns decrease sharply and deeply (financial crises) . If investors' trading decision also based on information about price changes in other stock markets then a sharp and deep decrease in one of the stock market may be signal to investors that contagion is possible. Therefore, risk in one market may be transmitted other markets.
- Correlation between stock market returns tend to increase when volatility is high .
- Correlation between stock market returns tend to increase during worldwide bearish markets .
- Daily return correlation between stock market returns tend to increase during overlapping trading hours.

*2.2. Application of the Extended Gravity Model to Stock Market Correlation*

Even if most of the studies focus on existence of correlation between stock market returns, there are increasing number of empirical studies which try to explain determinant of stock market returns using real economic, geographical and social variables such as economic sizes, trade value, exchange rates, world stock market return, financial liberalization, common trade partners, distance, common land borders, common language etc.

After empirical success of the gravity model to trade theory, it has been recently applied to the different areas too. Therefore, the gravity model has been recently used to explain determinant of correlation among the stock market returns between countries.

Using gravity model, Bayoumi, Fazio, Kumar and MacDonald (2007) found that distance variable has huge power to explain correlation among the stock market returns between countries.

Flavin, Hurley and Fabrice (2002) investigated the effect of several geographical variables on stock market correlation between countries. Their result show that sharing a common border and the number of overlapping opening hours have positive and statistically significant effect on stock market correlations whereas great circle distance, common language and colonial links have no effect on stock market correlations.

Karolyi and Stulz (1996) tried to explain determinant of stock market return correlation between U.S. and Japan. Even if they could not find statistically significant relationship between stock market return correlation and following variables: the U.S.nmacroeconomic announcements, Yen/Dollar exchange rate, treasury bill returns and industry effect, they found that stock market return correlation between U.S. and Japan positively affected by large shocks to these markets. Bracker and Koch (1999) investigated the determinant of co-movement between U.S. and eight developed countries stock market using data from 1972 to 1993. Their results showed that co-movement between stock markets significantly related to overlapping opening hours, bilateral import dependence and size of two markets.

Pretorius (2002) explored the determinant of stock market return co-movement between 10 emerging countries stock market. He found that correlation between countries stock market returns are positively related to

bilateral trade and negatively related to growth rates difference between two countries. Also, results showed that correlation coefficient increases between same region countries during the 1998 Asian financial crisis time

Lucey and Zhang (2010) investigated the determinants of stock market return correlation between countries using data from 1995 to 2007. Their gravity model included following variables: distance, market size, bilateral trade, region dummy and religion dummy. Results showed that correlation between stock market returns increased if both countries have same religion and same region. As distance increases between both countries correlation decreases too. Bilateral trade is positively related to correlation. However, stock market size has no significant effect on correlation.

### 3. Data and Methodology

B Our study building is an extended gravity model. Dependent variable in our model is the correlation of stock market return between ISE and selected countries. Therefore, in first step, to obtain time-varying values we use monthly data from January 1991 to December 2006 for 39 countries to measure stock market return correlations. The correlation between ISE and selected countries are calculated over the 4 years (48 observations) monthly return data (pair-wise correlation) . We follow the usual approach adopted in most studies (Kanas (1998), Pretorius, 2005; Dellas and Hess, 2005, Bayoumi, Fazio, Kuran and MacDonald (2007)) by capturing synchronization as the value of the pairwise correlation of stock returns across countries over a given period.

Table 1 shows time varying pairwise correlations between ISE and selected countries. In general, correlation between ISE and selected countries tend to increase over time as early studies point out. Average correlation increased from 0,08 (1991-1994 period) to 0,43 (2003-2006 period).

**Table 1.** Time Varying Pairwise Correlations between ISE and Selected Countries

| Countries | 1991–1994 | 1995–1998 | 1999–2002 | 2003–2006 | Average |
|---|---|---|---|---|---|
| ARGENTINA | 0,00 | 0,01 | 0,28 | 0,37 | **0,17** |
| AUSTRALIA | 0,22 | 0,28 | 0,03 | 0,45 | **0,25** |
| AUSTRIA | 0,40 | 0,25 | 0,24 | 0,33 | **0,31** |
| BRAZIL | 0,23 | 0,25 | 0,21 | 0,47 | **0,29** |
| BULGARIA | | | | 0,22 | **0,22** |
| CANADA | 0,11 | 0,31 | 0,18 | 0,62 | **0,30** |
| CHILE | 0,25 | -0,05 | 0,40 | 0,28 | **0,22** |

| | | | | | |
|---|---|---|---|---|---|
| CHINA | | | 0,08 | 0,56 | **0,32** |
| COLOMBIA | 0,66 | 0,17 | 0,44 | 0,36 | **0,26** |
| DENMARK | | | 0,49 | 0,42 | **0,45** |
| EGYPT | | | 0,22 | 0,24 | **0,23** |
| FINLAND | 0,09 | -0,02 | 0,46 | 0,63 | **0,29** |
| FRANCE | -0,07 | 0,30 | 0,26 | 0,46 | **0,24** |
| GREECE | | 0,37 | 0,14 | 0,42 | **0,31** |
| HUNGARY | | | | 0,56 | **0,56** |
| INDIA | 0,10 | 0,06 | 0,25 | 0,43 | **0,21** |
| INDONESIA | | | 0,32 | 0,32 | **0,32** |
| IRELAND | 0,11 | 0,35 | 0,12 | 0,55 | **0,28** |
| ISRAEL | 0,10 | 0,20 | 0,22 | 0,43 | **0,24** |
| ITALY | -0,10 | 0,02 | 0,49 | 0,58 | **0,25** |
| JAPAN | -0,10 | 0,02 | 0,49 | 0,58 | **0,25** |
| KOREA | 0,13 | 0,11 | 0,09 | 0,62 | **0,24** |
| MALAYSIA | 0,36 | 0,30 | 0,16 | 0,12 | **0,23** |
| MEXICO | 0,42 | -0,06 | 0,13 | 0,62 | **0,28** |
| NETHERLANDS | 0,11 | 0,12 | 0,48 | 0,56 | **0,32** |
| NEW ZELAND | 0,18 | 0,21 | 0,10 | 0,29 | **0,19** |
| NORWAY | 0,10 | 0,21 | 0,37 | 0,57 | **0,31** |
| PAKISTAN | -0,14 | 0,03 | 0,31 | 0,14 | **0,09** |
| PERU | -0,21 | 0,01 | 0,21 | 0,38 | **0,10** |
| PHILIPPINES | 0,19 | 0,11 | 0,03 | 0,01 | **0,08** |
| PORTUGAL | 0,16 | 0,26 | 0,25 | 0,41 | **0,27** |
| SINGAPORE | 0,24 | 0,31 | -0,03 | 0,41 | **0,23** |
| SOUTH AFRICA | 0,20 | 0,06 | 0,43 | 0,54 | **0,31** |
| SPAIN | 0,25 | 0,17 | 0,09 | 0,54 | **0,26** |
| SWEDEN | 0,10 | 0,21 | 0,37 | 0,57 | **0,31** |
| THAILAND | | | 0,12 | 0,35 | **0,23** |
| UNITED KINGDOM | 0,20 | 0,04 | 0,27 | 0,49 | **0,25** |
| UNITED STATES | 0,24 | 0,21 | 0,40 | 0,55 | **0,35** |
| VENEZUELA | -0,19 | -0,06 | 0,03 | 0,16 | **-0,02** |
| **Average** | **0,08** | **0,15** | **0,25** | **0,43** | |

In second step, calculated correlation (COR) dependent variable tried to be explained by using following explanatory variables: democracy (DE), trade value (TR), world stock market return (WSM), distance (DIS), gross domestic product (GDP), neighbor country dummy (D1), European Union member dummy (D2) and developed country dummy (D3).

Extented gravity based model to analysis the determinant of correlation between ISE and selected countries can be written as:

$LNCOR_{ijt} = c + \beta_1 DE_{jt} + \beta_2 LNTR_{ijt} + \beta_3 LNWSM_t + \beta_4 LNDIS_{ijt} + \beta_5 LNGDP_{ijt} + \beta_6 D1 + \beta_7 D2 + \beta_8 D3 + \varepsilon_t$

Table 2 shows selected variables, expected sign of variables and data sources.

**Table 2:** Selected Variables, Expected Signs, Data Sources and References

| **Variables** | **Explanation** | **Expected Signs** | **Data Sources** |
|---|---|---|---|
| Correlation | Pair-wise correlation between ISE and selected countries | | MSCI[4] |
| GDP | Real GDP of selected countries | + | World Bank's WDI |
| Trade Value | Trade value between Turkey and selected countries | + | IMF, Direction of Trade Statistics |
| World Stock Market Return | World Stock Market Return | + | MSCI |
| Democracy | Democracy of selected countries is scale between 1-7. Lower number means more democratic | - | www.freedomhouse.org |
| Distance | Distance between Turkey and selected countries | - | CPEI, www.cepii.fr |
| Neighbor Country Dummy (D1) | If selected country is neighbor to Turkey 1, otherwise 0. | + | |
| European Union Dummy (D2) | If selected country is EU member 1, otherwise 0. | + | |
| Developed Country Dummy (D3) | If selected country is developed country 1, otherwise 0. | + | |

## 4. Estimation Results of the Extended Gravity Model

The extended gravity model is estimated by using panel data. In panel data, choosing the right econometric technique is crucial to get consistent and efficient estimates. A random effect model is more applicable in our panel data set because of short time dimension (4 period) and long cross-section dimension (39 countries). Hausman-test results showed that random effect model is appropriate for our data set.

[4] Authors' calculation from Morgan Stanley Country Index (MSCI).

**Table 3:** Dependent Variable: Correlation

| | **Model 1** | **Model 2** | **Model 3** | **Model 4** | **Model 5** |
|---|---|---|---|---|---|
| DE | -0.0071088 (0.008)* | -.0070994 (0.008)* | -.0061177 (0.035)** | -.0054837 (0.091)*** | -.0068698 (0.011)** |
| LNTR | 0.0066042 (0.186) | .0086334 (0.118) | .0057248 (0.261) | .0063076 (0.208) | .0039096 (0.496) |
| LNGDP | 0.0196822 (0.098)*** | .0192711 (0.10)*** | .0193665 (0.10)*** | .0165616 (0.182) | .0179767 (0.135) |
| LNWSM | 0.0014438 (0.000)* | .001434 (0.000)* | .0014643 (0.000)* | .0014602 (0.000 )* | .0014829 (0.000)* |
| LNDIS | - 0.000033 (0.34) | | | | |
| D1 | | -.0776795 (0.386) | | | |
| D2 | | | | 0294627 (0.368) | |
| D3 | | | | | -.0308365 (0.374) |
| Constant | -.0942278 (0.191) | -.0920313 (0.203) | -.1101879 (0.138) | -.0725751 (0.341) | -.065755 (0.400) |
| Hausman Test | 4.28 (0.36) | 4.29 (0.35) | 4.32 (0.34) | 4.30 (0.35) | 4.28 (0.36) |
| Wald Test | 75.03 (0.000) | 75.64 (0.000) | 75.73 (0.000) | 75.70 (0.000) | 75.89 (0.000) |
| $R^2$ | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| Observation | 139 | 139 | 139 | 139 | 139 |

The values in parentheses are p-values. (*), (**) and (***) indicate that the estimated coefficient is statistically significant at the 1%, 5% and 10% significance level, respectively.

The result in Table 3 showed that the sign of democracy variable has correct sign and statistically significant all 5 models. ISE is more correlated with democratic countries' stock market. If it is considered that democratic countries have more open economy and developed stock market, this result will not be surprise.

The estimated coefficients of WSM are statistically significant and have expected sign all 5 model. If there is a volatility in world stock market return, correlation between ISE and selected countries stock market returns will increase.

Real GDP variables of selected countries have a positive sign as expected and marginally significant in first 3 models. This result showed that size effect is important.

Even if the estimated coefficient of trade and distance variables have correct sign, they are statistically insignificant. Finally, all dummy variables statistically insignificant and neighbor country and developed country dummies have wrong sign.

**5. Conclusion**

Nowadays, globalization and technological improvement in telecommunication increases linkages between stock markets. Fluctuation in one market influences the other markets instantly. Therefore, correlation between stock markets have become an important concern for investor since it reducing the opportunities for international diversification and increasing contagion.

Most of the empirical studies try to measure correlation between stock market returns across countries without questioning that what drives correlation. Therefore, the main objective of this study was to identify the determinant of stock market correlation between ISE and selected countries. After the Hausman test, the random effect models were used to estimate the effect of selected variables on correlation between ISE and selected 39 countries. Study applies the concert of extended gravity model from trade theory to the determinant of correlation by using panel regression econometric technique over the 1991:1–2006:12 period.

Result from pair wise correlation calculation showed that correlation between ISE and selected countries increase over time. Average correlations are 0,08 in 1991-1994 period, 0,15 in 1995-1998 period, 0,25 in 1999-2002 period and 0,43 in 2003-2006 period.

Result from panel data regression showed that correlation between ISE and selected countries stock market return can be explain by democracy, WSM return and real GDP variables. Even if trade value, distance and EU member dummy variables have correct sign, they were not statistically significant. Finally, Neighbor country and developed country dummies have wrong sign and statistically insignificant.

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