Evolving Market Efficiency in Istanbul Stock Exchange


Alovsat Muslimov
Types of the Efficiency of Financial Markets

- **Operational Efficiency**: Transactions are carried out cheaply. Satisfied when financial intermediaries are competitive enough.

- **Allocational Efficiency**: Prices of securities are adjusted according to their risks, i.e. securities with the same level of risk will offer the same expected return.

- **Informational Efficiency**: The prices fully reflect all the information available and relevant to security valuation.
The Capital market is efficient if
that is \( \phi_{t-1}^m = \phi_{t-1} \), the information market uses to determine security prices at \( t-1 \),
includes all information available.

And \( \phi_{t-1}^m \)
that is, the market understands the implications of the available information for the
joint distribution of returns.

**Summary:** Market efficiency means that the market is aware of all available
information and uses it correctly

\[
f_m \left( p_{1t}, \ldots, p_{nt} \bigg| \phi_{t-1}^m \right) = f \left( p_{1t}, \ldots, p_{nt} \bigg| \phi_{t-1} \right)
\]
Three Levels of Informational Efficiency

- **Weak Form Efficiency**: Security prices fully reflect the information contained in past price movements. It is not possible to trade profitably purely on the basis of historical price information.

- **Semistrong Form Efficiency**: Security prices fully reflect all publicly available information. It is not possible to trade profitably on the basis of information from publicly available sources.

- **Strong Form Efficiency**: The prices fully reflect all relevant information whether it is publicly available or not. It is not possible to trade profitably on the basis of inside knowledge or any other sources of the information.

**Note**: Strong form efficient markets are efficient in semistrong form, and the market which is semistrong form efficient is efficient is weak form efficient but not vice versa.
Weak Form Market Efficiency and Infant Markets

- No profit opportunities exist on the past movement in asset prices. That is prices follow random walk.

\[ r_t = \beta_0 + \sum_{i=1}^{p} \beta_i r_{t-i} + e_i \]

that is \( \beta_i = 0, \ i > 0 \)

- However, two factors should be considered.
  - Infant Markets may initially lack weak-form efficiency (time-varying coefficients or division of time period into two parts)
  - Changing variance structure may result in spurious serial correlation property and market efficiency may falsely rejected.
Previous Studies

- There is evidence that Istanbul Stock Exchange lacks even weak-form efficiency. (Muradoğlu and Ünal, 1994; Balaban and Kunter, 1997; Okay, 1998).

- This study differs from previous studies in the empirical literature
  - in its research method (GARCH-M together with ARIMA to consider changing variance structure);
  - its broadest cross-sectional coverage (it tests ISE-100 index along with all stocks constituting ISE-100 index);
  - its widest time period coverage (1986-2001 period);
  - its attempt to capture evolution process of the informational efficiency of Istanbul Stock Exchange.
Sample and Data


- Individual stocks return series include monthly data of all stocks that constitute ISE-100 index. Covered time period is 1986-2001.

- Due to case number restriction of ARIMA and GARCH models, we analyze stocks with at least 50 monthly observations. This restriction has reduced total sample size to 71 stocks.
Research Methodology

\[ r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r_{t-2} + \beta_3 r_{t-3} + \beta_4 r_{t-4} + e_t \]

AR(4) – Fourth Order Autoregressive Model

\[ r_t = \beta_0 + \beta_1 r_{t-1} + \beta_2 r_{t-2} + drift h_t + e_t \quad e_t \sim (0, h_t) \]

AR(2) Standard GARCH-M (Generalized Autoregressive Conditional Heteroscedastic in Mean) Model

\[ h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1} \]
# Findings of market efficiency tests for individual stocks

## Table 1: Summary of AR(4) and GARCH-M (1,1) Analyses

<table>
<thead>
<tr>
<th>Presence of GARCH Effect</th>
<th>No GARCH Effect</th>
<th>GARCH Effect</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autocorrelation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant Autocorrelation</td>
<td>13 (18%)</td>
<td>12 (17%)</td>
<td>25 (35%)</td>
</tr>
<tr>
<td>Insignificant Autocorrelation (Random Walk)</td>
<td>20 (28%)</td>
<td>26 (37%)</td>
<td>46 (65%)</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>33 (46%)</td>
<td>38 (54%)</td>
<td>71 (100%)</td>
</tr>
</tbody>
</table>
### Market efficiency tests for ISE 100 Index

**AR(2) Standart GARCH-M (1,1) Model**

<table>
<thead>
<tr>
<th>Period</th>
<th>Regression Results</th>
<th>Model Name</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 June 1991 – 29 November 2001 Period Weekly Data (Full Period)</td>
<td>[ r_t = 0.012 + 0.191 r_{t-1} + 0.012 r_{t-2} - 0.005 h_t ] (0.67)  (2.68)**  (0.2)  (-0.01) [ h_t = 0.000 + 0.725 h_{t-1} + 0.187 e_{t-1} ] (2.69)<em><strong>(13.77)</strong></em>  (5.33)***</td>
<td>AR(2) Standart GARCH-M (1,1) Model Results</td>
<td>523</td>
</tr>
<tr>
<td>13 June 1991 - 08 August 1996 Period Weekly Data (First Period)</td>
<td>[ r_t = 0.008 + 0.003 r_{t-1} + 0.07 r_{t-2} + 0.043 h_t ] (0.24)  (0.05)  (1.00)  (0.1) [ h_t = 0.001 + 0.666 h_{t-1} + 0.147 e_{t-1} ] (1.59)  (4.35)***  (2.53)**</td>
<td>AR(2) Standart GARCH-M (1,1) Model Results</td>
<td>261</td>
</tr>
<tr>
<td>15 August 1996 – 29 November 2001 Period Weekly Data (Second Period)</td>
<td>[ r_t = 0.148 + 0.791 r_{t-1} + 0.038 r_{t-2} - 0.039 h_t ] (0.99)  (2.06)**  (0.75)  (-0.19) [ h_t = 0.000 + 0.625 h_{t-1} + 0.237 e_{t-1} ] (2.69)<em><strong>(13.77)</strong></em>  (5.33)***</td>
<td>AR(2) Standart GARCH-M (1,1) Model Results</td>
<td>262</td>
</tr>
</tbody>
</table>
### Market efficiency tests for ISE 100 Index

#### AR(1) Standart GARCH-M (1,1) Model

<table>
<thead>
<tr>
<th>Model</th>
<th>Period</th>
<th>Weekly Data</th>
<th>AR(1) Standart GARCH-M (1,1) Model Results</th>
<th>N=</th>
</tr>
</thead>
<tbody>
<tr>
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<td>13 June 1991 – 29 November 2001 Period</td>
<td></td>
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<td>523</td>
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<td></td>
<td>13 June 1991 – 08 August 1996 Period</td>
<td></td>
<td></td>
<td>261</td>
</tr>
<tr>
<td></td>
<td>15 August 1996 – 29 November 2001 Period</td>
<td></td>
<td></td>
<td>262</td>
</tr>
</tbody>
</table>

**Model Equations:**

\[
 r_t = 0.100 r_{t-1} + 0.153 h_t \\
 (2.19)** (3.23)**
\]

\[
h_t = 0.000 + 0.716 h_{t-1} + 0.188 \epsilon_{t-1} \\
(2.67)** (12.82)** (5.25)**
\]

\[
r_t = 0.184 r_{t-1} + 0.178 h_t \\
(2.68)** (2.17)**
\]

\[
h_t = 0.000 + 0.62 h_{t-1} + 0.23 \epsilon_{t-1} \\
(1.68)* (4.9)** (3.18)**
\]

\[
r_t = 0.009 r_{t-1} + 0.144 h_t \\
(0.13) (2.32)**
\]

\[
h_t = 0.001 + 0.65 h_{t-1} + 0.16 \epsilon_{t-1} \\
(1.61) (4.16)** (2.68)**
\]
## Market efficiency tests for ISE 100 Index
### MA(1) Standart GARCH-M (1,1) Model

#### 13 June 1991 – 29 November 2001 Period
**Weekly Data (Full Period)**

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_t = 0.092 e_{t-1} + 0.154 h_t )</td>
<td>( (1.95)^* )</td>
<td>( (3.31)^{***} )</td>
</tr>
<tr>
<td>( h_t = 0.000 + 0.715 h_{t-1} + 0.189 e_{t-1} )</td>
<td>( (2.67)^* )</td>
<td>( (12.79)^{***} )</td>
</tr>
</tbody>
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<th>Equation</th>
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<th>T-statistics</th>
</tr>
</thead>
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<tr>
<td>( r_t = 0.169 e_{t-1} + 0.178 h_t )</td>
<td>( (2.48)^{**} )</td>
<td>( (2.29)^{**} )</td>
</tr>
<tr>
<td>( h_t = 0.000 + 0.62 h_{t-1} + 0.23 e_{t-1} )</td>
<td>( (1.69)^* )</td>
<td>( (4.75)^{***} )</td>
</tr>
</tbody>
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<th>Equation</th>
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<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_t = 0.007 e_{t-1} + 0.141 h_t )</td>
<td>( (0.11) )</td>
<td>( (2.28)^{**} )</td>
</tr>
<tr>
<td>( h_t = 0.001 + 0.65 h_{t-1} + 0.16 e_{t-1} )</td>
<td>( (1.62) )</td>
<td>( (4.28)^{***} )</td>
</tr>
</tbody>
</table>

#### 13 June 1991 – 08 August 1996 Period
**Weekly Data (First Period)**

<table>
<thead>
<tr>
<th>Model Results</th>
<th>N=261</th>
</tr>
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#### 15 August 1996 – 29 November 2001 Period
**Weekly Data (Second Period)**

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<tr>
<th>Model Results</th>
<th>N=262</th>
</tr>
</thead>
</table>
The Analysis of the Determinants of Random-Walk Behavior of Stock Returns

- Discriminant analysis is conducted to determine which types of the stocks are more likely to show random-walk behavior.
- Discriminating Variables:
  - The relative size of the market capitalization of individual stocks (MC) (computed as the average weight of constituent companies in the ISE National-100 Index in December 2001)
  - The relative size of the liquidity of individual stocks (LIQ) (computed as the ratio of the liquidity of individual stocks to the total liquidity of the Istanbul Stock Exchange in December 2001)
  - Value turnover ratio (VT) (computed as traded value / daily average market capitalization calculated according to stock kept in custody at Takasbank in December 2001)
  - The price to book ratio of individual stocks (MVBV) (computed using data in December 2001)
- Dependent Variable
  - Random-walk behavior of stock returns
    - 0 = Stock returns show non-random walk behavior
    - 1 = Stock returns show non-random walk behavior
The Analysis of the Determinants of Random-Walk Behavior of Stock Returns

Table 4: Results of the Discriminant Analysis

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>MC</th>
<th>LIQ</th>
<th>VT</th>
<th>MVBV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Random Walk</td>
<td>17</td>
<td>1.95</td>
<td>1.46</td>
<td>10.50</td>
<td>5.22</td>
</tr>
<tr>
<td>Random Walk</td>
<td>42</td>
<td>1.00</td>
<td>1.09</td>
<td>10.62</td>
<td>4.92</td>
</tr>
<tr>
<td>Total:</td>
<td>59</td>
<td>1.27</td>
<td>1.20</td>
<td>10.59</td>
<td>5.01</td>
</tr>
</tbody>
</table>

Tests of Equality of Group Means
Wilk’s Lambda (F-statistics are on parentheses)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.97</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.05)</td>
<td>(0.47)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td></td>
</tr>
</tbody>
</table>

- The results of discriminant analysis shows that discriminant function is not statistically significant.
- From these results we may also conclude that random-walk behavior of individual stock returns is not discriminated by research variables.