



## Correlation Based Clustering of the Amman Stock Exchange

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### ABSTRACT

This study classifies firms listed on Amman Stock Exchange (ASE) into clusters based on pairwise stock correlations. The partitioning level technique is based on the decrease in firms' concentration in their clusters when one additional cluster is created. The results indicate that 5 and 9 clusters lower the concentration significantly and thus are selected as the grouping levels. The concentration of firms in some clusters is very low while the concentration in other clusters is very high. The clustering outcome indicates that ASE could be characterized by high  $R^2$  and return synchronicity.

**Keywords:** Clusters, Pairwise Return Correlations, Diversification

**JEL Classifications:** G10, G11, M21

### 1. INTRODUCTION

Financial market researchers followed a variety of approaches to construct homogeneous stock groupings. Unfortunately, most of these industry classifications are only applied to developed markets and few classification schemes are provided to emerging markets. This study fills that gap by providing new industry classification based on stocks return correlations. The issue of industry diversification in emerging markets is of particular concern to investors as stocks commove more in these markets. Therefore, grouping firms according to their return correlation provide a better context for investment analysis. For example, if equity market participants consider a set of companies that belong to different correlation-based industries, then meaningful diversification benefits can be obtained leading to a lower volatility for stock portfolio.

I classify firms listed at Amman stock exchange (ASE) during the period of 2010-2015 into different number of clusters based on pairwise correlation. ASE adopts a general (or coarse) classification level (financial, services, industrial) and finer classification (banks, insurance, diversified financial services, real estate, health care services, educational services, hotels and tourism, transportation, technology and communication, media, utilities and energy, commercial services, pharmaceutical and medical industries, chemical industries, paper and cardboard industries, printing and packaging, food and beverages, tobacco and cigarettes, mining

and extraction industries, engineering and construction, electrical industries, textiles leathers and clothing, glass and ceramic industries. The ASE classification provides scant guidance on how to select the partitioning level when assigning stocks into groups. In the correlation-based clustering, I suggest that a finer level classification can be obtained when stocks abnormal concentration in their groups falls. Abnormal concentration is measured as the difference between the percentage of stocks in any group and their normal percentage. The classification levels are those that provide the highest decrease in the abnormal concentration. The results indicate that 5 and 9 clusters lower the concentration significantly and thus are selected as the grouping levels. In each classification, I provide the name and ASE code for each company. Some clusters have a few firms while other clusters have a lot of firms. This finding is interpreted as ASE has high  $R^2$  and return synchronicity.

### 2. DATA CONSTRUCTION

The sample covers all firms listed in ASE. Monthly market capitalization and cash dividends are obtained from monthly statistical bulletins available at ASE website. Return for firm (i) is calculated as the change in market capitalization (MV) plus any dividend (CF) paid during month (t) divided by market capitalization in month (t-1).

$$R_{it} = (MV_t - MV_{t-1} + CF_t) / MV_{t-1} \quad (1)$$

**Table 1: Firms with highest positive and negative pairwise correlation**

| Firms in the pair  | Pairwise correlation | General industry affiliation | Specific industry affiliation                                  |
|--|----------------------|------------------------------|--|
| Jordan hotels and Tourism, Siniora Food Industries                     | -0.691               | Services and Industrial      | Hotels and Tourism, Food and Beverages                         |
| Jordan International Investment, Philadelphia Insurance                | -0.669               | Financial and Financial      | Real Estate, Insurance   |
| Consulting Group, Jordan Emirates Insurance                            | -0.656               | Services and Financial       | Health Care Services, Insurance                                |
| Masaken, Jordan Emirates Insurance                                     | -0.557               | Financial and Financial      | Real Estate, Insurance   |
| Bindar, National Poultry   | -0.510               | Services and Industrial      | Commercial Services, Food and Beverages                        |
| The Arab International Food Factories, Bank of Jordan                  | -0.507               | Industrial and Financial     | Food and Beverages, Banks                                      |
| Jordan Investment and Tourism Transport (Alfa), Jordan Wood Industries | -0.507               | Services and Industrial      | Transportation, Engineering and Construction                   |
| Jordan Emirates Insurance, Shareco Brokerage                           | -0.502               | Financial and Financial      | Insurance, Diversified Financial Services                      |
| Jordan Investment Trust, Premier Business and Projects                 | -0.500               | Financial and Industrial     | Diversified Financial Services, Chemical Industries            |
| Top Positive correlation   |                      |                              |  |
| Specialized Investment Compounds, Ad-Dulayl Park                       | 0.614                | Financial and Financial      | Real Estate, Real Estate                                       |
| ISRAA Islamic Finance, Masaken   | 0.621                | Financial and Financial      | Diversified Financial Services, Real Estate                    |
| Ad-Dulayl Park, Al Amal Investment                                     | 0.640                | Financial and Financial      | Real Estate, Diversified Financial Services                    |
| Philadelphia Pharmaceuticals, United Cable Industries                  | 0.650                | Industrial and Industrial    | Pharmaceutical and Medical Industries, Electrical Industries   |
| Darkom Investment, Siniora Food Industries                             | 0.659                | Financial and Industrial     | Diversified Financial Services, Food and Beverages             |
| United Cable Industries, Al Assas                                      | 0.660                | Industrial and Industrial    | Electrical Industries, Engineering and Construction            |
| Jordan Dubai Islamic Bank, Nopar for Trading                           | 0.733                | Financial and Services       | Banks and Commercial Services                                  |
| The Jordan Pipes Manufacturing, Northern Cement                        | 0.753                | Industrial and Industrial    | Engineering and Construction, Mining and Extraction Industries |
| Union Investment Corporation, Union Land Development Corporation       | 0.773                | Financial and Financial      | Diversified Financial Services, Real Estate                    |
| Model Restaurants, Siniora Food Industries                             | 0.816                | Services and Industrial      | Hotels and Tourism, Food and Beverages                         |

MV is calculated by multiplying the number of shares outstanding by the stock's price. Changes in the number of shares outstanding may alter the estimated return. For example, new stocks issues increase the size and market value of firms. However, this increase in market value should not result in a higher return. I investigate the reason behind the change in the number of shares outstanding by reading the corporate actions announcement available at ASE website. If the reason is due to stock split or stock dividend, then the return estimated from equation 1 is independent from these transactions as they do not change the market value. However, if the reason is due to new issues or repurchases then the market value (MV) in month (t) is calculated as the shares outstanding during month (t-1) multiplied by the closing price at the end of month (t).

I delete monthly observations that do not have an announcement about the change in shares outstanding. There are 131 cases where firms change their shares outstanding. There are 20 (111) cases of a decrease (increase) in shares outstanding. There are many firms that cover the accumulated losses by lowering shareholders equity. In this case, the decrease in shares outstanding would be part of return calculation and thus MV in month (t) is calculated as the shares outstanding during month (t) multiplied by the closing price at the end of month (t).

I consider all firms listed on ASE with trading activity in all months during the sample period. I remove firms with <36 monthly

return observations. The final sample consists of 194 firms and the number of pairwise correlation between these firms is 18,721 ( $[194*195]/2$ ).

### 3. PAIRWISE CORRELATION

Pearson correlation between any two individual stocks (i and j) is defined as below:

$$P_{ij} = \text{cov}(i,j) / \sigma_i \sigma_j \quad (2)$$

Correlation is a measure of co-movements between two returns series. It reflects the linear relation between any two stocks. Strong positive (negative) correlation indicates that the return series of stock i tend to be move in the same (opposite) direction of return series of stock j. Weak correlation, however, indicates the return series of stock i does not commove with the return of stock j. There are 7,676 negative pairwise correlation and 11,046 positive correlations, indicating a clear overweight toward positive correlations. The highest positive correlation is 0.816 between model restaurants (tick symbol: FOOD) and Siniora food industries (SNRA). The highest negative correlation is -0.691 between Jordan Hotels and Tourism and Siniora Food Industries. The mean of pairwise correlation is 0.036 and the standard deviation is 0.143. Table 1 reports the highest and lowest ten pairwise correlations and the ASE industry affiliation of each firm in the pair.

ASE classify listed firms into general and specific industry affiliation. The general classification groups firms into three industries while the specific classification groups firms into 23 industries. There are three pairs among the highest ten positive pairwise correlations that do not belong to the same general industry classification. Also, there are three pairs among the highest ten negative pairwise correlations that belong to the same classification. We may expect that firms that are highly positively correlated to share common factors and thus to fall into the same general industry classification. The fact that some highly positively correlated firms fall into different ASE general industry classification suggests that there is portion of the correlation across firms that is due either to non-fundamental factors such as noise trading or to fundamental factors (such as sales growth, size and book-to-market ratios) not captured by the ASE classification.

#### 4. CORRELATION-BASED CLASSIFICATION

Although financial analysts and professional asset managers use many financial and economic analysis techniques to pick stocks for the portfolio, many investors rely on industry classification to diversify their capital into stocks of various sectors or industries. In this context, correlation-based classification enables investors to select the stocks that weakly commove with each other because the classification form stock categories with high within-group return correlation and low return correlation outside the group.

To form clusters based on the correlation coefficient, we need to obtain the distance matrix.<sup>1</sup> Following Mantegna (1997) and Rosén (2006), the distance between any 2 firms in the pair is given as below:

$$d_{ij} = [2 \cdot (1 - p_{ij})]^{1/2} \quad (3)$$

$d_{ij}$  ranges from 0, for totally correlated stocks to 2 for totally anti-correlated stocks. For uncorrelated stocks, the distance is  $2^{1/2}$ .

In order to examine how the firms cluster with each other, I group the stocks into different number of clusters using the average linkages method and then observe the percentage of firms in each cluster. I examine the difference between the percentage of firms in each cluster and normal percentage which equals one divided by the number of clusters. For example, in 3 clusters case, the normal percentage of firms in each cluster is 33.33% (one divided by number of clusters). If the percentage of firms in a cluster is  $>33.33\%$  then the abnormal clustering is the amount of the excess percentage (the percentage  $-33.33\%$ ). Then, I calculate the average abnormal clustering by dividing the sum of abnormal clustering by the number of clusters.

As shown in Table 2, increasing the number of clusters may not necessarily reduce abnormal clustering. However, when we increase the number within some range, the abnormal clustering goes down indicating that firms could be partitioned into more

**Table 2: Average abnormal clustering**

| Number of clusters | Average abnormal clustering | The change in average abnormal clustering when one additional cluster is created |
|--------------------|-----------------------------|--|
| 2 clusters         | 0.490                       |  |
| 3 clusters         | 0.656                       | -0.167   |
| 4 clusters         | 0.709                       | -0.052   |
| 5 clusters         | 0.279                       | 0.429  |
| 6 clusters         | 0.302                       | -0.023   |
| 7 clusters         | 0.282                       | 0.020  |
| 8 clusters         | 0.241                       | 0.041  |
| 9 clusters         | 0.102                       | 0.139  |
| 10 clusters        | 0.109                       | -0.007   |
| 11 clusters        | 0.118                       | -0.009   |
| 12 clusters        | 0.110                       | 0.008  |
| 13 clusters        | 0.110                       | 0.000  |
| 14 clusters        | 0.115                       | -0.005   |
| 15 clusters        | 0.083                       | 0.033  |
| 16 clusters        | 0.075                       | 0.008  |
| 17 clusters        | 0.057                       | 0.018  |
| 18 clusters        | 0.046                       | 0.011  |
| 19 clusters        | 0.054                       | -0.009   |
| 20 clusters        | 0.064                       | -0.010   |
| 21 clusters        | 0.062                       | 0.002  |
| 22 clusters        | 0.062                       | 0.000  |
| 23 clusters        | 0.070                       | -0.008   |
| 24 clusters        | 0.072                       | -0.002   |
| 25 clusters        | 0.047                       | 0.025  |
| 26 clusters        | 0.048                       | -0.001   |
| 27 clusters        | 0.045                       | 0.002  |
| 28 clusters        | 0.036                       | 0.009  |
| 29 clusters        | 0.035                       | 0.001  |
| 30 clusters        | 0.040                       | -0.005   |

Average abnormal clustering is the average of the difference between stocks concentration in their clusters and their normal concentration (which is one divided by the number of clusters, for example, the normal concentration is 20%, 11.11% for 5 and 9 clusters respectively)

groups. Simply, we can pick the number of clusters that reduce the abnormal clustering the most. The difference is highest when we move from 4 clusters (average abnormal clustering is 0.709) to 5 clusters (average abnormal clustering is 0.279) with a difference of 0.429. The second highest difference is when we move from 8 clusters (average abnormal clustering is 0.241) to 9 clusters (average abnormal clustering is 0.102) with a difference of 0.139. In this case, the coarse partitioning level is 5 clusters and the fine partitioning level is nine. If we want to obtain a finer level classification, then 13 clusters should be selected because it provides the third highest decrease in abnormal clustering.

As shown in Table 3, we might find firms that belong to the same cluster but to a different general ASE classifications. For example, in 5 cluster case, Arab bank and Arab Potash belong to the same cluster even though the former is financial and the latter is industrial. The fact that there are a few firms in 1 cluster and a lot of firms in another cluster could indicate a high  $R^2$  and return synchronicity. For example, there is 1 firm (Winter Valley Tour) in cluster 4 and 2 firms (Zarqa Educ and Zara Investments) in cluster 5 while the majority of stocks (95% of all stocks) in clusters 1 and 2. The 9 cluster classification shows that there are 2 clusters that have only 1 firm and another cluster that has

<sup>1</sup> The clustering was performed using the average linkages method in MATLAB software.

Table 3: The 5 and 9 clusters classifications

| 5 clusters     |                      |        |          | 9 clusters     |                          |        |          |
|----------------|----------------------|--------|----------|----------------|--------------------------|--------|----------|
| Cluster number | Company's short name | SYMBOL | ASE CODE | Cluster number | Company's short name     | SYMBOL | ASE CODE |
| 1              | Bank Al Etihad       | AJIB   | 111005   | 1              | Jc Bank                  | JCBK   | 111003   |
| 1              | Arab Banking Co      | UBSI   | 111007   | 1              | JDIB Bank                | JDIB   | 111006   |
| 1              | Capital Bank         | ABCO   | 111009   | 1              | Cairo Amman Bank         | CABK   | 111021   |
| 1              | Cairo Amman Bank     | EXFB   | 111017   | 1              | Jerusalem Ins            | JERY   | 121007   |
| 1              | Bank of Jordan       | CABK   | 111021   | 1              | Arab Int Uni Ins         | AIUI   | 121020   |
| 1              | Arab Bank            | BOJX   | 111022   | 1              | Islamic Insur Co         | TIIC   | 121025   |
| 1              | Alnir Alarabi        | ARBK   | 113023   | 1              | Al-Belad Med Srv         | ABMS   | 131002   |
| 1              | Almanara Insurance   | AAIN   | 121003   | 1              | Jordanian Electric Power | JOEP   | 131004   |
| 1              | Arab Orient Ins      | ARSI   | 121013   | 1              | Irbid Electricity        | IREL   | 131010   |
| 1              | Arab Ins             | AOIC   | 121014   | 1              | Shipping Line            | SHIP   | 131012   |
| 1              | Arab Int Uni Ins     | ARIN   | 121017   | 1              | J. Press Foundat         | PRES   | 131013   |
| 1              | Eura Arab Ins        | AIUI   | 121020   | 1              | Jor Press/Publish        | JOPP   | 131030   |
| 1              | Arab Assurers        | AMMI   | 121023   | 1              | Salam Int Trn Td         | SITT   | 131034   |
| 1              | Arab Jor Insur       | ARAS   | 121026   | 1              | Jordan Express           | JETT   | 131080   |
| 1              | Darkom               | ARGR   | 121027   | 1              | Jordan Telecom           | JTEL   | 131206   |
| 1              | AL-Belad Med SRV     | DRKM   | 121033   | 1              | Transport Barter         | NAQL   | 131208   |
| 1              | Arab Intl Hotel      | ABMS   | 131002   | 1              | Royal Jordanian          | RJAL   | 131213   |
| 1              | Alshamekha Real      | AIHO   | 131005   | 1              | Winter Valley Tour       | WIVA   | 131235   |
| 1              | Arab Int Inv Edu     | VFED   | 131011   | 1              | Nopar For Trading        | NOTI   | 131238   |
| 1              | Arab Fin Inv         | AIEI   | 131052   | 1              | Methaq                   | MEET   | 131240   |
| 1              | Al Sharq Inv         | AFIN   | 131070   | 1              | Contempro                | COHO   | 131241   |
| 1              | Arab East Invst      | AIPC   | 131078   | 1              | High Performance         | HIPR   | 131246   |
| 1              | EJADA                | AEIV   | 131082   | 1              | Al-Sanabel Int           | SANA   | 131249   |
| 1              | AL-Amin for Inv      | EJAD   | 131088   | 1              | Al-Rakaez                | RICS   | 131261   |
| 1              | Century Inv GRP      | AAFI   | 131089   | 1              | Alentkaeya Company       | ENTK   | 131287   |
| 1              | AL-Dawliyah H&M      | CEIG   | 131097   | 1              | Arab Invest Proj         | APCT   | 141003   |
| 1              | Consulting Group     | MALL   | 131098   | 1              | National Steel           | NAST   | 141011   |
| 1              | East Real Estate     | CICO   | 131207   | 1              | Jor Worsted Mill         | JOWM   | 141014   |
| 1              | Bindar               | REAL   | 131218   | 1              | Nat/Cabl/Wire/Mf         | WIRE   | 141039   |
| 1              | Arabian Dev Co       | BIND   | 131219   | 1              | Arab Potash Co           | APOT   | 141043   |
| 1              | AL-Amal Inv          | INMA   | 131225   | 1              | El-Zay Ready Wr          | ELZA   | 141061   |
| 1              | Amad Realst Invst    | AMAL   | 131231   | 1              | Ready Mix Conert         | RMCC   | 141065   |
| 1              | Emmar Inv Dev        | AMAD   | 131234   | 1              | Arab Elect Ind           | AEIN   | 141072   |
| 1              | Contempro            | EMAR   | 131237   | 1              | Nutridar                 | NDAR   | 141094   |
| 1              | Arab Inv Union       | COHO   | 131241   | 1              | Arab Steel Pipes         | ASPMM  | 141098   |
| 1              | AL-Sanabel Int       | UNAI   | 131247   | 1              | Hayat phar. Ind          | HPIC   | 141210   |
| 1              | Bilad Investment     | SANA   | 131249   | 1              | Jos Eco                  | JOSE   | 141216   |
| 1              | Deera                | BLAD   | 131250   | 1              | Jor Petrolm Ref          | JOPT   | 142041   |
| 1              | AL-Rakaez            | DERA   | 131255   | 2              | Socgen Bk - Jordanie     | SGBJ   | 111020   |
| 1              | Comp. Leasing        | RICS   | 131261   | 2              | Bank of Jordan           | BOJX   | 111022   |
| 1              | AL-Tahdith           | LEAS   | 131264   | 2              | Alnir Alarabi            | AAIN   | 121003   |
| 1              | Dimensions           | THDI   | 131265   | 2              | Jor French Ins           | JOFR   | 121009   |
| 1              | Darat                | JEDI   | 131271   | 2              | Almanara Insurance       | ARSI   | 121013   |
| 1              | Amoun Int Inv        | DARA   | 131274   | 2              | Arab Orient Ins          | AOIC   | 121014   |
| 1              | AFAQ Energy          | AMON   | 131285   | 2              | Arab Ins                 | ARIN   | 121017   |
| 1              | Alentkaeya Company   | MANE   | 131286   | 2              | National Insurance       | NAAI   | 121021   |
| 1              | Arab Invest Proj     | ENTK   | 131287   | 2              | Jor Int Insur Co         | JIJC   | 121022   |
| 1              | Arab Alum Ind        | APCT   | 141003   | 2              | Med Gulf-Jordan          | MDGF   | 121032   |
| 1              | Dar Aldawa DV/IV     | AALU   | 141006   | 2              | Jor Hotel Tours          | JOHT   | 131003   |
| 1              | Arab Pharma Chem     | DADI   | 141012   | 2              | Alshamekha Real.         | VFED   | 131011   |
| 1              | Akary                | APHC   | 141023   | 2              | J D Properties           | JDPC   | 131017   |
| 1              | Compland Dev and Inv | WOOL   | 141031   | 2              | Natl Portfolio           | MHFZ   | 131018   |
| 1              | Arab Potash Co       | ATTA   | 141036   | 2              | Jor Duty Fre Shp         | JDFS   | 131022   |
| 1              | Eqbal Inv Co         | APOT   | 141043   | 2              | Jordan Intl Trad         | JITC   | 131023   |
| 1              | EL-Zay Ready WR      | EICO   | 141048   | 2              | Arab Int Inv Edu         | AIEI   | 131052   |
| 1              | Arab Elect Ind       | ELZA   | 141061   | 2              | Jor Loan Grnt Co         | JLGC   | 131071   |
| 1              | Comprehensive        | AEIN   | 141072   | 2              | Jor Inv and Trsm         | ALFA   | 131083   |
| 1              | Arab INT'L Food      | INOH   | 141086   | 2              | Spec Inv Jor             | SIJC   | 131086   |
| 1              | Arab Steel Pipes     | AIFF   | 141092   | 2              | Itihad Schools           | ITSC   | 131093   |
| 1              | Ekbal Print Co       | ASPMM  | 141098   | 2              | Century Inv Grp          | CEIG   | 131097   |
| 1              | Ad-Dulayl Park       | EKPC   | 141100   | 2              | Bindar                   | BIND   | 131219   |
| 1              | AL-Quds Ready Mix    | IDMC   | 141106   | 2              | Arabian Dev Co           | INMA   | 131225   |
| 1              | Arab Pesticides      | AQRM   | 141208   | 2              | Masafat Transport        | MSFT   | 131243   |

(Cont...)

Table 3: (Continued)

| 5 clusters     |                          |        |          | 9 clusters     |                       |        |          |
|----------------|--------------------------|--------|----------|----------------|-----------------------|--------|----------|
| Cluster number | Company's short name     | SYMBOL | ASE CODE | Cluster number | Company's short name  | SYMBOL | ASE CODE |
| 1              | Al Assas                 | MBED   | 141209   | 2              | Arab Inv Union        | UNAI   | 131247   |
| 2              | Jor Islamic Bank         | ASAS   | 141214   | 2              | Kafa`A Investments    | KAFA   | 131267   |
| 2              | Jor Kuwait Bank          | JOIB   | 111001   | 2              | Israa Islamic Fin     | ISRA   | 131282   |
| 2              | Jc Bank                  | JOKB   | 111002   | 2              | Masaken               | MSKN   | 131284   |
| 2              | Housing BK TRD FIN       | JCBK   | 111003   | 2              | Amoun Int Inv         | AMON   | 131285   |
| 2              | JDIB Bank                | THBK   | 111004   | 2              | Jordan Dairy          | JODA   | 141004   |
| 2              | Invest Bank              | JDIB   | 111006   | 2              | Premier               | ACDT   | 141010   |
| 2              | Socgen BK - Jordanie     | INVB   | 111014   | 2              | Akary                 | WOOL   | 141031   |
| 2              | Jordan Ahli Bank         | SGBJ   | 111020   | 2              | Jor Cement Fact       | JOCM   | 141042   |
| 2              | Middle East Ins          | AHLI   | 111033   | 2              | Univ Mod Ind Co       | UMIC   | 141052   |
| 2              | Jordan Insurance         | MEIN   | 121002   | 2              | Nat Chlorine          | NATC   | 141054   |
| 2              | Jerusalem Ins            | JOIN   | 121004   | 2              | Mesc_Jordan           | JNCC   | 141059   |
| 2              | Jor French Ins           | JERY   | 121007   | 2              | Union Tobacco         | UTOB   | 141074   |
| 2              | Holy Land Ins            | JOFR   | 121009   | 2              | Arab Int'l Food       | AIFF   | 141092   |
| 2              | Joemirates Ins           | HOLI   | 121010   | 3              | Housing Bk Trd Fin    | THBK   | 111004   |
| 2              | Philadelphia Ins         | JEIC   | 121015   | 3              | Middle East Ins       | MEIN   | 121002   |
| 2              | National Insurance       | PHIN   | 121018   | 3              | Jordan Insurance      | JOIN   | 121004   |
| 2              | Jor Int Insur Co         | NAAI   | 121021   | 3              | Holy Land Ins         | HOLI   | 121010   |
| 2              | Islamic Insur Co         | JJIC   | 121022   | 3              | Joemirates Ins        | JEIC   | 121015   |
| 2              | Med Gulf-Jordan          | TIIC   | 121025   | 3              | Arab Assurers         | ARAS   | 121026   |
| 2              | First Insurance          | MDGF   | 121032   | 3              | Arab Jor Insur        | ARGR   | 121027   |
| 2              | Jor Hotel Tours          | FINS   | 121034   | 3              | Mediterr. Tourism     | MDTR   | 131035   |
| 2              | Jordanian Electric Power | JOHT   | 131003   | 3              | Zara Investments      | ZARA   | 131067   |
| 2              | Irbid Electricity        | JOEP   | 131004   | 3              | Al Sharq Inv          | AIPC   | 131078   |
| 2              | Shipping Line            | IREL   | 131010   | 3              | Specz. Trdg and Invst | SPTI   | 131081   |
| 2              | J Press Foundat          | SHIP   | 131012   | 3              | Petra Education       | PEDC   | 131221   |
| 2              | J D Properties           | PRES   | 131013   | 3              | Ihdathiat Co          | IHCO   | 131236   |
| 2              | Natl Portfolio           | JDPC   | 131017   | 3              | International Inv     | JIGI   | 131253   |
| 2              | Taj Tourist Proj         | MHFZ   | 131018   | 3              | Deera                 | DERA   | 131255   |
| 2              | Jor Duty Fre Shp         | TAJM   | 131019   | 3              | Rum Group             | RUMM   | 131262   |
| 2              | Jordan Intl Trad         | JDFS   | 131022   | 3              | Comp. Leasing         | LEAS   | 131264   |
| 2              | Jordan Expat Inv         | JITC   | 131023   | 3              | Ibn Alhaytham H       | IBNH   | 131279   |
| 2              | Resources Invest         | JEIH   | 131025   | 3              | Sura                  | SURA   | 131283   |
| 2              | Jor Press/Publish        | JOMA   | 131027   | 3              | Ubour                 | TRUK   | 131290   |
| 2              | Salam Int Trn Td         | JOPP   | 131030   | 3              | Arab Alum Ind         | AALU   | 141006   |
| 2              | Mediterr. Tourism        | SITT   | 131034   | 3              | Jor Industr Chem      | JOIC   | 141026   |
| 2              | Jor Inv Trust            | MDTR   | 131035   | 3              | Jor Wood Industr      | WOOD   | 141038   |
| 2              | Jor Trade Fac            | JOIT   | 131039   | 4              | Invest Bank           | INVB   | 111014   |
| 2              | Union Inv                | JOTF   | 131062   | 4              | United Insurance      | UNIN   | 121008   |
| 2              | Jor Loan Grnt Co         | UINV   | 131069   | 4              | Eura Arab Ins         | AMMI   | 121023   |
| 2              | Tajcateringhousing       | JLGC   | 131071   | 4              | Jor Inv Trust         | JOIT   | 131039   |
| 2              | Specz Invst Comd         | JNTH   | 131076   | 4              | Zarqa Educ            | ZEIC   | 131051   |
| 2              | Jordan Express           | SPIC   | 131077   | 4              | Jor Trade Fac         | JOTF   | 131062   |
| 2              | Specz Trdg and Invst     | JETT   | 131080   | 4              | Amad Realst Invst     | AMAD   | 131234   |
| 2              | Jor Inv and Trsm         | SPTI   | 131081   | 4              | General Mining        | GENM   | 141005   |
| 2              | Spec Inv Jor             | ALFA   | 131083   | 4              | Indstral/Comm/Agr     | ICAG   | 141009   |
| 2              | Real Estate Dv           | SIJC   | 131086   | 4              | Jor Paper Cardbg      | JOPC   | 141017   |
| 2              | Un For Fincl Inv         | REDV   | 131087   | 4              | General Invest        | GENI   | 141029   |
| 2              | Ittihad Schools          | UCFI   | 131090   | 4              | Mid Pharma Ind        | MPHA   | 141073   |
| 2              | Jordan Telecom           | ITSC   | 131093   | 4              | Nat'l Poultry         | NATP   | 141084   |
| 2              | Transport Barter         | JTEL   | 131206   | 4              | Jor Veg Oil Ind       | JVOI   | 141141   |
| 2              | Royal Jordanian          | NAQL   | 131208   | 4              | Travco                | TRAV   | 141203   |
| 2              | Isra Edue                | RJAL   | 131213   | 4              | Jordan Pharma         | JPHM   | 141204   |
| 2              | Petra Education          | AIFE   | 131220   | 4              | Jor Clothing Co       | CJCC   | 141213   |
| 2              | Int' Brokerage           | PEDC   | 131221   | 5              | Jor Pipes Manfact     | JOPI   | 141019   |
| 2              | Offtec Holding           | IBFM   | 131224   | 5              | Pearl San P Conv      | PERL   | 141081   |
| 2              | Jo Realestate            | OFTC   | 131228   | 5              | Arab Pesticides       | MBED   | 141209   |
| 2              | South Electronics        | JRCD   | 131229   | 5              | Northern              | NCCO   | 141224   |
| 2              | Ihdathiat Co             | SECO   | 131230   | 6              | Jor Islamic Bank      | JOIB   | 111001   |
| 2              | Nopar for Trading        | IHCO   | 131236   | 6              | Jor Kuwait Bank       | JOKB   | 111002   |
| 2              | Taameer Jor Hldgs        | NOTI   | 131238   | 6              | Arab Jor/Inv/Bank     | AJIB   | 111005   |
| 2              | Methaq                   | TAMR   | 131239   | 6              | Bank Al Etihad        | UBSI   | 111007   |
| 2              | Masafat Transport        | MEET   | 131240   | 6              | Arab Banking Co       | ABCO   | 111009   |

(Cont...)

Table 3: (Continued)

| 5 clusters     |                      |        |          | 9 clusters     |                         |        |          |
|----------------|----------------------|--------|----------|----------------|-------------------------|--------|----------|
| Cluster number | Company's short name | SYMBOL | ASE CODE | Cluster number | Company's short name    | SYMBOL | ASE CODE |
| 2              | High Performance     | MSFT   | 131243   | 6              | Capital Bank            | EXFB   | 111017   |
| 2              | Shareco              | HIPR   | 131246   | 6              | Jordan Ahli Bank        | AHLI   | 111033   |
| 2              | First Finance        | SHBC   | 131248   | 6              | Arab Bank               | ARBK   | 113023   |
| 2              | Jordan Consulting    | FFCO   | 131251   | 6              | Darkom                  | DRKM   | 121033   |
| 2              | International Inv    | JOMC   | 131252   | 6              | First Insurance         | FINS   | 121034   |
| 2              | Palaces              | JIG    | 131253   | 6              | Arab Intl Hotel         | AIHO   | 131005   |
| 2              | Future Arab          | PRED   | 131257   | 6              | Taj Tourist Proj        | TAJM   | 131019   |
| 2              | Rum Group            | FUTR   | 131258   | 6              | Jordan Expat. Inv       | JEIH   | 131025   |
| 2              | Int'l Cards Co       | RUMM   | 131262   | 6              | Resources Invest        | JOMA   | 131027   |
| 2              | Kafa`A Investments   | CARD   | 131263   | 6              | Union Inv               | UINV   | 131069   |
| 2              | Tuhama Investments   | Kafa   | 131267   | 6              | Arab Fin Inv            | AFIN   | 131070   |
| 2              | First Jordan         | THMA   | 131268   | 6              | Union Land Dev          | ULDC   | 131073   |
| 2              | Professional         | FRST   | 131269   | 6              | Tajcateringhousing      | JNTH   | 131076   |
| 2              | Model Restaurants    | PROF   | 131270   | 6              | Spcz. Invst Comd        | SPIC   | 131077   |
| 2              | Sabaek Invest        | FOOD   | 131272   | 6              | Arab East Invst         | AEIV   | 131082   |
| 2              | Shira                | SABK   | 131275   | 6              | Real Estate Dv          | REDV   | 131087   |
| 2              | Ibn Al-Haytham H     | SHRA   | 131278   | 6              | Ejada                   | EJAD   | 131088   |
| 2              | ISRAA Islamic Fin    | IBNH   | 131279   | 6              | Al-Amin For Inv         | AAFI   | 131089   |
| 2              | Sura                 | ISRA   | 131282   | 6              | Un For Fincl Inv        | UCFI   | 131090   |
| 2              | Masaken              | SURA   | 131283   | 6              | Al-Dawliyah H and M     | MALL   | 131098   |
| 2              | Ubour                | MSKN   | 131284   | 6              | East Real Estate        | REAL   | 131218   |
| 2              | Jordan Poul Proc     | TRUK   | 131290   | 6              | Isra Edue               | AIFE   | 131220   |
| 2              | Jordan Dairy         | JPPC   | 141002   | 6              | Int' Brokerage          | IBFM   | 131224   |
| 2              | General Mining       | JODA   | 141004   | 6              | Offtec Holding          | OFFC   | 131228   |
| 2              | Indstral/Comm/Agr    | GENM   | 141005   | 6              | Jo Realestate           | JRCD   | 131229   |
| 2              | Premier              | ICAG   | 141009   | 6              | South Electronics       | SECO   | 131230   |
| 2              | National Steel       | ACDT   | 141010   | 6              | Al-Amal Inv             | AMAL   | 131231   |
| 2              | Jor Worsted Mill     | NAST   | 141011   | 6              | Emmar Inv Dev           | EMAR   | 131237   |
| 2              | Jor Paper Cardbg     | JOWM   | 141014   | 6              | Taameer Jor Hldgs       | TAMR   | 131239   |
| 2              | Jor Phosphate Mn     | JOPC   | 141017   | 6              | Bilad Investment        | BLAD   | 131250   |
| 2              | Jor Pipes Manfact    | JOPH   | 141018   | 6              | First Finance           | FFCO   | 131251   |
| 2              | Int Co Med Inv       | JOPI   | 141019   | 6              | Jordan Consulting       | JOMC   | 131252   |
| 2              | Jor Indstr Chem      | ICMI   | 141021   | 6              | Palaces                 | PRED   | 131257   |
| 2              | General Invest       | JOIC   | 141026   | 6              | Future Arab             | FUTR   | 131258   |
| 2              | Jor Wood Industr     | GENI   | 141029   | 6              | Int'l Cards Co          | CARD   | 131263   |
| 2              | Nat/Cabl/Wire/Mf     | WOOD   | 141038   | 6              | Al-Tahdith              | THDI   | 131265   |
| 2              | Jor Cement Fact      | WIRE   | 141039   | 6              | Tuhama Investments      | THMA   | 131268   |
| 2              | Nat Chlorine         | JOCM   | 141042   | 6              | First Jordan            | FRST   | 131269   |
| 2              | Jordan Ind Res       | NATC   | 141054   | 6              | Professional            | PROF   | 131270   |
| 2              | Mesc_Jordan          | JOIR   | 141055   | 6              | Dimensions              | JEDI   | 131271   |
| 2              | Ready Mix Concr      | JNCC   | 141059   | 6              | Darat                   | DARA   | 131274   |
| 2              | Jor Steel            | RMCC   | 141065   | 6              | Sabaek Invest           | SABK   | 131275   |
| 2              | Mid Pharma Ind       | JOST   | 141070   | 6              | Afaq Energy             | MANE   | 131286   |
| 2              | Pearl San P Conv     | MPHA   | 141073   | 6              | Jordan Poul Proc        | JPPC   | 141002   |
| 2              | Nat'l Poultry        | PERL   | 141081   | 6              | Dar Aldawa Dv/Iv        | DADI   | 141012   |
| 2              | Nat'l Alum Ind       | NATP   | 141084   | 6              | Jor Phosphate Mn        | JOPH   | 141018   |
| 2              | Nutridar             | NATA   | 141091   | 6              | Compland Dev and Inv    | ATTA   | 141036   |
| 2              | Jor Veg Oil Ind      | NDAR   | 141094   | 6              | Eqbal Inv Co            | EICO   | 141048   |
| 2              | Travco               | JVOI   | 141141   | 6              | Jordan Ind Res          | JOIR   | 141055   |
| 2              | Jordan Pharma        | TRAV   | 141203   | 6              | Jor Steel               | JOST   | 141070   |
| 2              | First Nat Veg Oil    | JPHM   | 141204   | 6              | Comprehensive           | INOH   | 141086   |
| 2              | Hayat Phar. Ind.     | FNVO   | 141205   | 6              | Nat'l Alum Ind          | NATA   | 141091   |
| 2              | Jor Clothing Co      | HPIC   | 141210   | 6              | Ekbal Print Co          | EKPC   | 141100   |
| 2              | Joseco               | CJCC   | 141213   | 6              | Ad-Dulayl Park          | IDMC   | 141106   |
| 2              | Petrochemicals       | JOSE   | 141216   | 6              | First Nat Veg Oil       | FNVO   | 141205   |
| 2              | Philadelphipharma    | IPCH   | 141217   | 6              | Al-Quds Ready Mix       | AQRM   | 141208   |
| 2              | Siniora              | PHIL   | 141219   | 6              | Al Assas                | ASAS   | 141214   |
| 2              | Northern             | SNRA   | 141222   | 6              | United Cable Industries | UCIC   | 141215   |
| 2              | Jor Petrolm Ref      | NCCO   | 141224   | 6              | Petrochemicals          | IPCH   | 141217   |
| 3              | United Insurance     | JOPT   | 142041   | 6              | Philadelphia Pharma     | PHIL   | 141219   |
| 3              | Union Land Dev       | UNIN   | 121008   | 7              | Consulting Group        | CICO   | 131207   |
| 3              | Univ Mod Indco       | ULDC   | 131073   | 7              | Shareco                 | SHBC   | 131248   |

(Cont...)

Table 3: (Continued)

| 5 clusters     |                         |        |          | 9 clusters     |                      |        |          |
|----------------|-------------------------|--------|----------|----------------|----------------------|--------|----------|
| Cluster number | Company's short name    | SYMBOL | ASE CODE | Cluster number | Company's short name | SYMBOL | ASE CODE |
| 3              | Union Tobacco           | UMIC   | 141052   | 7              | Shira                | SHRA   | 131278   |
| 3              | United Cable Industries | UTOB   | 141074   | 7              | Int Co Med Inv       | ICMI   | 141021   |
| 4              | Winter Valley Tour      | UCIC   | 141215   | 7              | Arab Pharma Chem     | APHC   | 141023   |
| 5              | Zarqa Educ              | WIVA   | 131235   | 8              | Philadelphia Ins     | PHIN   | 121018   |
| 5              | Zara Investments        | ZEIC   | 131051   | 9              | Model Restaurants    | FOOD   | 131272   |

5 firms. On the other hand, there is a cluster that has 65 firms (or 34% of all firms in the sample). Morck et al. (2000) suggest that stock returns are synchronous in low-income economies due to poor and uncertain protection of private property rights and poor protection for public investors from corporate insiders. They argue that the lack of property protection impedes the capitalization of firm-specific information into stock prices because the information is less useful to risk arbitrageurs, leading to a higher stock return synchronicity. Khandaker and Heaney (2009) examined stock market synchronous behavior of 41 countries and found that emerging economy stock markets are more synchronous than the developed economy stock markets. The results of this study are in line with the findings of these studies.

## 5. CONCLUSION

This study classifies firms listed at ASE into clusters based on pairwise stock correlations. The results show that 5 and 9 clusters are appropriate partitioning level. The concentration of firms in some clusters is very low while the concentration in other clusters

is very high. For example, there are some clusters that have only 1 or 2 firms whereas other clusters have the majority of firms (the percentage could reach to 95%). The clustering outcome indicate that ASE may have high  $R^2$  and return synchronicity. This result is consistent with many studies which show that emerging markets exhibit higher stock price and return synchronicity.

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