

The economic determinants of comovement across African stock markets

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Summary: The aim of this study is to investigate the economic forces behind African stock markets interdependence using the recent and high frequency data, which spans a large period from 2004 to 2014 this by following two steps. First, we applied DCC-GARCH model to extract the dynamic conditional correlations between the selected markets, which are used as proxies measuring the stock markets interdependence. Second, we regress all the possible "time varying correlations" on potential economic variables, and then, estimate the regressions in two different ways, first as a pooled sample; second, as a system of seemingly unrelated regression (SUR) analysis. The results indicate the existence of trend toward more stock market interdependence as all possible pairs of stock markets interact significantly over time especially after the recent financial crisis. This result is confirmed by the pooled regression and SUR analysis, which suggest positive coefficient of the time trend and the 2008-crisis's dummy variable. The results of the pooled regression show that in addition to the contagion effect, a significant proportion (more than 36%) of the comovement among stock markets could be explained by economic factors, as several variables are significantly associated with the evolution of stock market comovement over time, some factors promote the interdependence some others depress it.

Keywords: African Stock Markets; Interdependence; Economic Determinants; DCC-GARCH; Pooled Regression; SUR.

Jel Classification Codes : C22 ; G1 ; G15 ; F15

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I- Introduction :

The interdependence of stock markets is the most important change occurred in the global financial markets. There is evidence of increasing convergence of international stock markets in recent years; as a result, different stock markets start to modify their structure to be integrated, merger, allied or consolidated with other stock exchanges either domestically or cross-borders. Many scholars point out that globalization, deregulation, and technological developments are the major causes of development of integration phenomenon among stock exchanges. In addition to these indicators, there are other latent factors such as trade relationships, macroeconomic factors that may affect the discount cash flow and trade relationship, and indicator of market development which all may also determine the integration process between stock exchanges worldwide.

The existing literature highlight that the nature and the extent of stock market interdependence vary widely depending on the time period and the countries involved. These differences emerge an important question such, why the extent of international interdependence varies over time and across different pairs of countries? Is the comovement of stock markets contagion in the true sense of the word, or can be explained by economic fundamentals? This calls for examining the factors that influence the relationships and dynamic linkage between stock markets. The more dependent stock markets facilitate the access to foreign capital, but this

interdependence may also make the markets more vulnerable to the external shocks, and it decreases the potential gain from international diversification. So, it is crucial to understand the forces behind the stock markets comovement to grasping the potential risks and rewards from international diversification.

Different pairs of equity markets display different degree of interdependence over time. For a given pair of countries the equity market interdependence is expected to vary systematically with the degree of economic integration. Theoretically, it is expected that the divergence behavior across nations in several macroeconomic factors, tends to be associated with divergent behavior across their national equity market. For example, the interdependence through capital flows and trade (imports/exports) imply interdependence in investors' valuation decision across national equity markets. In this perspective, it is expected that pairs of countries exhibiting high degree of economic integration should also experience significant comovement in their respective equity markets. Moreover, since for a given pair of countries, the magnitude and the nature of economic integration vary over time, so, the extent of stock market interdependence is expected to vary systematically.

Our hypothesis is that the extent of stock market comovement may depend upon certain macroeconomic factors; we empirically investigate this hypothesis by following two step procedures. First, we examine how the comovement in daily return for a given pair of national equity market varies over time by calculating the dynamic conditional correlations between daily rates of return across pairs of country which is used as measure of the stock market interdependence. Then, we specify a set of macroeconomic variables that characterized and influence the degree of economic integration between each pair of countries. Second step, consists on incorporating these variables in a pooled time series regression model across all 52 possible pairs of markets. In end, we first estimate the time varying correlation using GARCH dynamic conditional correlations technique (DCC-GARCH) to find the degree of interdependence for different pairs of selected countries. Then, all the possible time varying correlations are regressed on potential macroeconomic variables, and then estimated in two different ways, first all equations are estimated as a pooled sample; second, the different equations are estimated as a system of seemingly unrelated regression (SUR) analysis, to explain the cause of the stock market comovement on the African countries.

II- Literature Review:

Several studies suggest that countries that exhibit a high economic integration should also show a high comovement in their respective capital markets. These empirical investigations used different econometric techniques and focused on various sample in different time spans, for answer the following question why different pairs of international stock markets display different degree of comovement over time? The results of these studies are different but in overall all of them indicate that economic, financial, geographical and cultural factors contribute directly or indirectly in the extent of stock market interdependence over time. We can summarize these studies as follows:

(Chen & Zhang, 1997) tried to determine whether different stock market correlations across countries (emerging and developed markets) can be explained by the extent of bilateral trade between these countries. Authors split the world into four regions: the Europe, Japan, the Asian Newly Industrialized Economies and US. Then they calculated each country's correlation with each region. Results reveal significant and positive link between stock market interdependence and the extent of bilateral trade relationship. Authors concluded that important part of the variation in different market correlation is explained by the extent of bilateral trade. This result was supported by (Bekaert & Havey, 1997) who found that trade is important in explaining equity correlations particularly in the emerging markets context.

Two year later (Bracker & Koch, 1999), extend the studies of (Chen & Zhang, 1997), by taking into account other economic factors. In this study authors first, investigated why stock market relationships evolve over time for that they estimate the annual (Geweke, 1982) measure of feedback for various pairs of markets. The (Geweke, 1982), test statistics were then regressed against a set of macroeconomic variables in a pooled model. The results suggest that imports, the size differential, the physical distance between markets, the trend, dummy variable for different blocks of countries and the intercepts for each region have significantly influence the degree of comovement among different pairs of markets, while exports, the interest rate differential, the inflation differential, the percentage change in bilateral exchange rate, and the volatility of bilateral exchange rate does not contribute in the comovement of these markets.

The comovement in its large concept is presented in the study of (Barberis, Shleifer, & Wurgler, 2002), the authors distinguish and assess the three view of comovement among different trade securities that are the traditional fundamental view, the category based comovement and the Habitat-based comovement, by using data on stock inclusions into and deletion from the S&P 500 index. They found that the stock included into the index begin to comove more with other stock in the index and less with stock out of the index, this finding supports the theories based on shifts in demand.

(Pretorius, 2002) estimated cross section and time series models, to determine the factors that influence the correlation between different pairs of emerging markets during the period 1995 to 2000. The results revealed that, in on cross-sectional basis, the correlation between two countries is significantly explained by only two factors namely extent of bilateral trade and industrial production growth differential. While the results of time series regression indicate that, in addition to the extent of bilateral trade, industrial production growth differential, crisis dummy variable and regional dummy variable were significant in explaining the pairwise correlation coefficient. Furthermore, author concluded that the countries in the same region are more correlated than countries in different regions. In addition, the results show that the model explained only 40% of the variation in the correlation coefficient, while the remainder (60%) of the variation may be due to the contagion effect.

(Johnson & Soenen, 2003) investigated the extent to which the equity market of Latin Americas are integrated with the US equity market, as well as the factors that affect the level of integration; using daily returns for the period from 1988 to 1999. The empirical results show that the percentage of contemporaneous association between the eight equity markets of the Americas and the stock market in the United States is significantly high. The stock market comovements are significantly and positively influenced by the extent of trade with the United States. While, an increase in the volatility of bilateral exchange rate and a high ratio of stock market capitalization relative to that of the United States have a low contribution in explaining the stock markets comovement.

(Forbes & Chinn, 2004) examined forty emerging and five large markets, authors found that direct trade flows with large economies are the major factor in explaining financial market comovement; while, trade competition, foreign investment and bank lending does not appear to have any significant effect in cross section market linkages.

(Walti, 2005) follows (Rigobon & Forbes, 2002) correction model for determining the macroeconomic factors of stock market interdependence across fifteen industrialized countries over the period 1973 to 1997. Author used structural regression technique, in which the dependent variable is the correlation as measure of integration, while the explanatory variables include a set of economic variables. The results indicate that, greater intensity of trade relations and level of financial openness has a strong positive effect on the comovement between different pairs of markets; in the other hand the fixed exchange rate contribute positively to comovements. Author

concludes that there are some other factors that explain the stock return comovement such as: common language, informational asymmetries and the similarity of economic structure across countries.

(Carrieri, Errunza, & Hogan, 2007) attempted to characterize the world market integration, by using monthly data for eight emerging markets namely Argentina, Brazil, Chile, India, Korea, Mexico, Taiwan and Thailand. Authors assessed market integration and then applied a pooled regression with four explanatory variables. The empirical results suggest that the financial development and market liberalization strongly contribute in explaining the stock return comovement in the emerging markets; while, trade openness and world market volatility do not appear to have power for explaining the integration of emerging stock markets.

(Morgado & Tavares, 2007) examined the influence of bilateral economic integration factors on the comovement of stock return of 40 developed and emerging markets over the period 1970 to 1990. The empirical evidences reveal that bilateral trade intensity has strong positive impact on the correlation, while real exchange rate volatility, the asymmetry of output growth, the dissimilarity of export structures have significant negative impact on market comovement. In addition, the findings point out that, countries with law or civilities developed and convergent, exhibit a higher correlation of stock returns.

(Lin & Cheng, 2008) analyzed the economic factors that drive the stock market comovement between Taiwan and its four trading partners namely China, Japan, Hong Kong and US, using a nonlinear Multinomial Logit Model. The empirical results reveal that interest rate differential, the change in bilateral exchange rate and the stock market return volatility significantly explain the stock market comovement between these countries.

(Büttner & Hayo, 2011) examined the factors that drive stock market integration between EU members over the period 1999- 2007. In the first step, they calculate the dynamic conditional correlation using DCC-MGARCH models, then they construct pooled OLS model. The results reveal that there is evidence toward more integration among the EU members. The integration among the EU member states is negatively influenced by the foreign exchange risk; while, the relative and absolute size of market capitalization enhances the integration. Interest rate spreads and business cycle synchronization have no effect on equity market integration. In this study, authors conclude that the nominal determinants of equity market integration are more important than real determinants.

(Guesmi, 2011) investigated the driving forces of the regional equity market integration during the period 1996 to 2008, the study focused on 4 regional trading blocs namely: Latin America, Southeastern Asia, Southeastern Europe and Middle East. In this study author use multivariate BEKK-GARCH (1,1) method and nonlinear regression, the empirical results show that the regional level of trade openness and market development significantly explained the time varying degree of integration of the four selected regions. While for the Middle East, the two factors that contribute to stock return movement are inflation and individual market volatility.

Recently, (Mobarek, 2012) studied the determinant of comovement between stock markets of developed countries (France, Germany, Japan, UK and US) and five emerging countries (Brazil, China, India, Russia and South Africa) over the period from 1995 to 2010. Author used the (Geweke, 1982) measure of feedback (as measure of stock market integration) along with pooled time series regression to identify and explain the change in stock market integration. The empirical results suggest that overall 32% of the stock market comovement is explained by explanatory variables (trade, differential in inflation rate, growth rate and interest rate, market size differential and the trend). The explanatory power is more significant in the case of developed market and the markets that are member of European Union. The results also revealed that, import dependence, market size differential, difference in GDP growth rate and trend contribute in explaining the evolution of stock market interdependence over time.

In the same year, (Didier, Love, & Martínez Pería, 2012) analyzed the factors driving the comovement between US stock market returns and stock market returns in 83 countries during the 2007–2008 crisis, by using various measures namely trade, financial linkages and corporate, macroeconomic and financial risks. The findings indicate that financial linkages, including foreign investment flows, contribute largely on correlations between the US and other markets during the GFC period. In addition, the countries with vulnerable banking and corporate sectors exhibit a high comovement with the US market. Authors highlighted that trade was not an important factor in explaining comovement in stock market returns during the period of turmoil.

(Bakri & Xin Ning, 2013) investigated the driving forces behind stock market integration among ASEAN-5 emerging stock markets, by using pooled OLS and panel data regression analysis over the period from 2001 to 2010. The results reveal that bilateral trade and the stock market volatility contribute in explaining the comovement of the stock markets in this region.

More recently, (Narayan, Zia Islam, & Srikanthakumar, 2014) analyzed the time varying correlations and the causes of these correlations of six emerging Asian markets with Australia, China, India and US, over period from January 2001 to March 2012. In the first step of the study, authors used GARCH-DCC model to assess the dynamic conditional correlations between different country pairs, then to find the causes of interdependence, in second step they regress this correlation against different repressors using EGARCH model. The main findings of this study are: (i) the time varying bilateral correlations are highly volatile. (ii) The higher correlation between the underlying stock market is mainly due to both economic and financial conditions for all groups under study. (iii) The global financial crisis seems strongly affect the pairwise correlation especially in the two group “Asia-US and Asia-China”.

III– Methods and Materials:

III.1. Data description and sources

In this section we use daily closing price indices of the stock markets of eight African countries, together with the stock market price indices of the Japan, UK and US which represent three developed stock markets. The eight African stock markets indices are: Egypt (EGX30), Kenya (NASI), Mauritius (SEMDEX), Morocco (MADEX), Nigeria (NSE_ASI), South Africa (FTSE/JSE), Tunisia (TUNIDEX), Zambia (LASI). The data are obtained from (ASEA, 2013), (Yahoo, 2013) and from (Bloomberg, 2013). The data of Consumer price index (CPI), interest rate, exchange rate and industrial production index were extracted from various issues of International Financial Statistics (IFS) published by the IMF. Trade data were obtained from IMF’s Direction of Trade (DOT) publication. We use the data covering the third quarter 2004 to the first quarter of 2014. The correlations coefficient is calculated for each quarter based on the daily observations obtained in this quarter. We have 52 cross-sectional equations each with 39 quarter observations (i.e. we have time series cross-section data). In next section, we investigate the possibility of time-varying correlations using a multivariate DCC-GARCH model.

III.2. Model specification

Development of the economic model begins with previous evidences that show the potential effect of macroeconomic and financial factors (such as interest rate, inflation rate, industrial production growth, market size, exchange rate, etc.) on expected returns in national equity market. While, these previous work serves to investigate potential macroeconomic determinants of the return of national equity markets; we are interested in modeling the determinant of the correlation or the extent of interdependence across different pairs of national stock markets. We suggest that the stock market of country i should be more sensitive to changing economic conditions in country

j if such conditions are expected to have greater influence on the average of well-being of the firms in country i . In general, this should be the case when the macroeconomic factors may indirectly affect the extent of stock market interdependence through the cash flow model or through their influence on bilateral trade conditions. According to (Pretorius, 2002), the comovement between different stock markets might be explained through three horizons: first, the economic integration, second category is stock market characteristics, finally, the contagion' effect.

➤ Economic integration

Generally, change in the indicators that characterize and influence the economic integration, can also be the factors that drive the stock market interdependence over time. There exist two categories of economic variables that affect the degree of stock market interdependence.

First, the degree of economy ties between countries, for example, the stronger the bilateral trade ties between two countries, the higher the degree of comovement should exist between their stock markets. In term of bilateral trade relationship, four different variables can be selected; the main cause behind this selection is to encompass the point of view of both countries in each pair, as each of the four factors could have a different impact on the comovement of two given stock markets. While theoretically total exports from country i to county j equal total import of country j from country i ($X_{ij} = M_{ji}$), but since we measure the relative export from country i to country j (as X_{ij}/X_i) and relative import of country j from country i (as M_{ji}/M_j) these two measure are not equal ($X_{ij}/X_i \neq M_{ji}/M_j$), this occurs because $X_i \neq M_j$. This clarify that $(X_{ij}/X_i)_t$ and $(M_{ji}/M_j)_t$, reflect two distinct measure of bilateral trade relationship. International trade is considered to foster business cycle synchronization across countries, and thus affect the degree of their stock market dependence. The possibility for exporting from i to j should be positively related to country j economic performance. Therefore, if country i sells a greater share of its total export to country j (if X_{ij}/X_i is larger), then the stock market of country i should be more sensitive to country j 's stock market movements; same explanation for the positive coefficient on (X_{ji}/X_j) .

The extent to which country i relies on country j for i 's total import (M_{ij}/M_i) could have opposing effect on the comovement of the two countries' stock market. We could explain that by the fact that when the economy (and stock market) of country i does well, its consumers and producers acquire more imports from its trading partners, so the economy of country j and its stock market do well. Thus, we might expect greater import dependence of country i to country j to be associated with greater integration between stock markets i and j (i.e. positive coefficient of M_{ij}/M_i). However, an improvement of the exporting ability for country i 's firms, might arouse a greater response in country i 's stock market; this means that the capacity of country i 's exporting firms to compete with firms from country j might be inversely related to its import dependence with country j (i.e. a negative coefficient on M_{ij}/M_i). The two states lead to expect either positive or negative influence of import dependence on the extent of stock market integration. Similar reasoning leads to the expectation of positive or negative coefficient on country j 's import dependence on country i (i.e. M_{ji}/M_j).

Second, based on the cash flow model, several macroeconomic variables, such as inflation and interest rates, exchange rate and industrial production growth affect stock market performance. Since these variables influence stock market returns, the correlation between these variables across countries will influence the correlation between the respective countries stock markets.

➤ **The cash flow model**

Stock prices (P) can be written as follow:

$$P = \frac{(1+g)D_0}{k-g} \quad (1)$$

It is obvious that the forces that affect stock prices and hence returns are those that affect the discount factors, k , or growth rate in dividends, g . Interest rate, inflation rate and industrial production influence the stream of cash flows through their impact on discount rate or growth rate, this in turn will systematically affect stock prices. The degree of convergence in interest rate across countries is considered to be an important measure of financial integration, as it reflects free capital mobility and arbitrage-free conditions. A large variation in the inflation differential between country i and country j , or in the exchange rate between country i and country j , implies deviations in the terms of trade and cause a deviation in PPP. Likewise, real interest differentials and exchange rate changes together can cause deviations from interest rate parity (IRP). Any deviation from PPP or IRP is expected to influence trade and capital flows across countries. Therefore, they influence the well-being or profitability of firms in either national stock market (Bodurtha, Cho, & Senbet, 1989). Hence these deviations may have a bearing on the extent of comovement across international equity markets. Thus, greater divergence in interest rates, inflation rates, or currency valuation (i.e. an increase in $|\pi_i - \pi_j|_t$, $|r_i - r_j|_t$) or $|\% \Delta e_{ij}|_t$, is likely associated with less comovement across equity markets (small $\text{Corr}_{ij,t}$) so, the coefficients on the three variables is expected to be negative in the regression model.

Bilateral exchange rate volatility or exchange rate risk ($\sigma(e_{ij})_t$), is major source of uncertainty that impose cost on individual businesses trading goods or capital assets across market i and j . If the bilateral exchange rate is less volatile the currency risk premium should be decline, this imply more similar discount rates thereby decreasing the cost of hedging currency risk. This should give more homogeneous valuation of equities and increase incentives to invest in foreign markets, thereby leading to higher market integration.

➤ **Stock market characteristics**

Some features of equity markets such as volatility, liquidity and market size, etc. have the powerful to affect the extent of stock market comovement. The size of national equity market may reflect its stage of development, and may indicate the degree of a national equity market liquidity, information costs, and transaction cost associated with trading equity in that market. With this perspective, an increase in disparity in market size over time (larger $|\text{Size}_i - \text{Size}_j|_t$) may indicate greater differences in liquidity, information costs, and transaction cost across two markets, resulting in less comovement (small correlation). Over time, as the size differential of two markets increase (decrease), the extent of their comovement will decrease (increase), thus, we expect that the size of two equity markets to be negatively related to the correlation between their returns. The market size in this model is calculated as a weighted average of total outstanding shares of each listed company multiplied by the share price.

Volatility, according to portfolio theory, higher risk should be associated with higher expected return, where risk is often measured by volatility. Since the return of any stock market is a function of its volatility, two markets with less, same or more volatility should gain less, same or more returns. When the two markets' volatilities converge (diverge), the prices should also converge (diverge); thus, we expect a negative relationship between the stock market interdependence and their relative volatility.

Turnover rate is a way of measuring the liquidity of a company's stock, in other words, stock market's turnover ratio measures how often shares change hands. The turnover ratio is defined as total number of shares traded for a given period divided by the average market capitalization for the same period. The higher the share turnover, the easier it is for investors to buy or sell shares of the stock, so we expect that the stock market correlation is negatively related with the relative stock turnover rate.

$$\text{Turnover ratio (Tur)} = \frac{\text{value of share traded}}{\text{market capitalization}} \quad (2)$$

➤ Contagion effect

The contagion refers to the spread of either economic booms or economic crises (shocks) throughout a geographic region. In our context, contagion is defined as the comovement of asset markets that does not occur as result of the comovement of fundamentals. The interdependence refers to high degree of comovement during period of stability as well as crisis, contrary to the contagion which imply an increase of comovement across markets after the global shock (Rigobon & Forbes, 2002). In this study to test the contagion effect, the 2008 global financial crisis dummy variables will be used.

➤ Trend

A time trend is included in the regression to encompass the fact that stock market comovement is expected to increase over time due to increasing globalization, continuous improvements in communication and information technology, the eased flow of information, trade and capital across borders and the increasing cross-listing of stock and mergers between stock markets of different countries. Therefore, the coefficient of time trend is expected to be positive. We hypothesize that the extent of comovement between pair of national markets may depend upon the extent to which the above mentioned variables converge or diverge across two markets All these variables are incorporated in the final regression model (equation 3) as follow:

$$\text{Corr}_{ij,t} = \alpha + \beta_1 X_{i,t} + \beta_2 X_{j,t} + \beta_3 M_{i,t} + \beta_4 M_{j,t} + \beta_5 \pi_{ij,t} + \beta_6 r_{ij,t} + \beta_7 \text{Ind}_{ij,t} + \beta_8 e_{ij,t} + \beta_9 \sigma e_{ij,t} + \beta_{10} \text{Size}_{ij,t} + \beta_{11} \text{Vol}_{ij,t} + \beta_{12} \text{Tur}_{ij,t} + \beta_{13} \text{Dum}_{2008} + \beta_{14} \text{Trend}_t + \varepsilon_{ij,t} \quad (3)$$

IV- Results and discussion :

IV.1. Results from the DCC-GARCH models

With the eleven selected countries we get 52 distinct correlations for each quarter, the results are presented in the **figure1** in the Appendices; the estimated correlations (the quarterly time varying stock market correlations) for different pairs of selected countries. The visual inspection of the graph shows:

(1) Different increase and decrease state of the degree of correlation between the different stock returns over time, and most of these charts show an upward trend.

(2) The different correlations are quite high, specifically, the equity returns in Egypt shows quite high correlation with all other countries stock returns. The returns in Morocco market is highly correlated with Egypt, South Africa, Tunisia and with foreign markets (Japan, UK and US). The South Africa equity returns are correlated with the returns of other African markets and highly correlated with developed market specifically UK equity markets (as the correlation among these two market is the most higher in the sample) as we see in the graph the correlation among the two markets returns is more than 0.5 and it increased over time, this might be due to the fact that the companies listed on the JSE has a dual-listing on London stock exchange. Finally, Tunisia shows a

higher correlation with Morocco market. Whereas the stock returns in Mauritius is the less correlated with other countries. In addition, UK equity returns show high correlation with all other countries stock market returns compared to Japan and US, which may be due to the fact that UK market has trading hour overlap with all African markets, while US has overlapping trading hour only with Morocco and South Africa, and Japan share the trading time only with Mauritius.

(3) All the correlations are volatile. From the different charts of the figure below, we observe that there is an increase in the correlation after the 2008 global financial crisis this may due to the contagion effect of the crisis, for example, we observe that the correlation between the US equity returns and the equity returns of other countries is increased in this period. Some of these correlations keep increase and some other after reached a given peak have started to turn into the original level.

The global financial crisis seems to have an amplified effect on the recent integration process, as we see from the graph that the correlations begin to increase prior the 2008 financial turmoil, but this increase is very low compared to the period post-crisis (since in this period there is also contagion effect between stock returns in different countries). This means that there are other underlying factors, which may have also contributed to the correlations. We investigate this further in the next section.

IV.2. Results of the pooled regression analysis

Table 1 reports the results of the pooled regression analysis over 11 years sample period (2004-2014) for all 52 countries pairs as well as for 28 pairs of African markets and 24 pairs of African markets with developed markets (Japan, UK and US). The pooled cross-pairs time series regression has been estimated for group of countries located in the same (Africa) and different (distinct region) geographical zone, to examine whether there is a difference in explanatory power of the independent variables among the two groups.

The variables of the model are jointly significant at 1% level, and ten of the fourteen selected variables in the model are individually significant at different level and with different power across the three cases. All of the significant variables have the expected effect on the stock market comovement. Specifically, one or several measures of bilateral trade relationships are able to significantly influence stock market interdependence over time, it is observed that, the bilateral export has significant positive effect, while the bilateral import has negative and significant effect when the market are in the same region, and positive significant on the stock market comovement when the market are from different regions. Contrary to the economic theory the inflation rates differential and interest rates differential are never statistically significantly in influencing the degree of interdependence between the stock market in all cases. Next, the industrial production growth appears to be negative and significant; from the statistics we conclude that every unit increase in the industrial production growth differential between two countries, their correlation coefficient will decrease by 0.54, 1.9 and 1.4 basis points for all countries sample and for the same region group and for Africa with foreign countries sample respectively. The bilateral exchange rate change has no influence on stock market interdependence while its volatility appears to have negative and significant effect on the stock market interdependence in all cases. As expected, the market size differential has negative effect on the correlation between the two markets return. Over time, as the size differential of two markets increase by unit, the extent of their comovement will decrease by 2.44, 3.05 and 1.7 basis point for the three cases respectively.

The results also reveal negative relationship between correlation of the two stock markets and their volatility; means that when the two stock markets' volatilities converge (diverge), the prices should also converge (diverge). The turnover ratio is found to be significant only in the case of within region, as we see there is negative relation between the turnover and the return comovement

across pairs of African markets, this may due to the investors' treatment of the asset liquidity (investors make a short investment and they prefer the more liquid asset) so as the turnover diverge across (increase in the Tur_i / Tur_j) markets their correlation decrease, however across region the turnover has no effect.

The financial crisis dummy variable has a positive and significant impact on the correlation coefficients, as we see the correlation between two markets were on average 4.54, 3.35 and 7.71 basis points higher than usual during and after financial crisis. This result confirms the hypothesis that the interdependence among stock markets increase during and after the crisis, this due especially to the contagion effect. In addition, it is observed that, the crisis has higher effect (two times) between African markets with foreign markets than among the African markets themselves. Finally, the African markets exhibited a significant trend toward increasing comovement over time throughout the 11 years sample among themselves as well as with foreign markets. These two final results support the results of the graph of the correlation shown in previous section which indicated that almost all the correlation exhibited an upward trend, and the global financial crisis has amplified the extent of comovement, as shown in the graph that the correlations begin to increase prior the 2008 financial turmoil, but this increase is very low compared to the period post-crisis (since in this period there is also contagion effect between stock returns in different countries). These results confirm that the globalization, economic integration, and the contagion effect are all contributed to the correlations, or increase the interdependence of the selected stock markets.

The results also show that goodness-of-fit statistics (R^2 and the F-statistics) indicate that the explanatory variables included in the model explain a significant portion of stock market comovement. The R-square indicate that 36.14%, 47.16% and 30.33% of the variation in the correlation coefficients is explained by the variation in the independent variables for the three cases respectively, which is evidence of a reasonably good fit. This explanatory power is strong for the group of African markets 47.16%; so, it can be concluded that from the economic point of view, this function is an acceptable model and it is more appropriate in explaining the correlations among stock markets in the same region compared to different region. Our economic model contributes to the literature by establishing the indicators that determine the extent of interdependence between Africa stock markets; this will provides opportunity to policy-makers and investors to analyze different scenarios and to predict the effect of certain macroeconomic changes on the correlation between stock markets.

IV.3. Results of the seemingly unrelated regression (SUR)

The table 2 reports the results of estimating the system of equations as seemingly unrelated regression (SUR) model. The estimation of this model yields 14 parameter estimates for each of the 52 regression equations. For brevity, in the table below, we provide only the nature and strength of these results by specifying the frequency that each parameter estimate takes on a (significant) positive or negative value across all 52 equations. Overall, the results of the SUR model are in line with those of the pooled regression analysis, as it is observed from the table that the economic variables that enter significantly across substantial number of country pairs are, bilateral trade (imports, exports), industrial growth differential, the volatility of bilateral exchange rates, the size differential, the relative volatility between two stock markets, crisis dummy variable and the trend.

More specifically the bilateral trade measures appear in two different sign, for the export dominant sign is positive, as we see the coefficient of the export is positive 45 times (with 24 and 28 coefficients significant), while, it is negative and insignificant in seven equations. These results suggest that, the exports have positive influence on the equity markets comovement; means that the bilateral exports improve the stock markets interdependence. However, the bilateral imports have a mixed effect on the stock market comovement, this variable display a little bit more negative than positive effect on the returns comovement. We found that almost the positive influence occurred

when the markets are in distinct region, while, the negative is appeared when the market in the same region. The plausible explanation for that is first, the capacity of African countries' exporting firms to compete with each other in exporting goods; this might be inversely related to its import dependence, this in turn decline the dependence across their stock market (i.e. a negative coefficient on M_i, M_j). Whereas the positive and significant coefficient in other equations indicate that the African countries import important quantity from the japan UK and US so, this greater imports dependence of countries is associated with greater interdependence between their stock markets.

The industrial growth differential reveals a negative influence on the correlation, as it is negative in 38 equations and significant in 25 of 38 equations. These results indicate that, as industrial growth diverge across two markets; the stock returns also tend to diverge leading to less comovement.

Contrary to the results of the pooled regression analysis, which reveal no significant effect of the interest rates and inflation rates differential on the comovement between different pairs of stock markets, the results of the SUR model indicate that the coefficient of real interest rates are negative and significant in ten equations, while the coefficient of inflation rates differential is negative and significant in twelve equations. These finding suggest that, as real interest rates or the inflation rates diverge across two markets, the stock returns also tend to diverge resulting in lower correlation.

In other hand, contrary to the pooled regression results the bilateral exchange rates show evidence of negative effect, as we see the coefficient of this variable is positive 35 times (with no coefficient significant), and negative 17 times (with 11 coefficient significant). These results suggest that the bilateral exchange rates do not appear to play an important role in explaining equity market interdependence. However, the volatility in bilateral exchange rates show a stable dampening effect on the correlations across national equity markets, as presented in the table the coefficient of this variable is negative in 32 of 52 equations and is statistically significant in 26 of the 52 equations.

The results show a mixed evidence for coefficient of the size, as we see the coefficient of the size differential is negative in 39 of 52 equations, and it is statistically significant in 23 of 39 equations, while it is positive in 13 equations and significant only in 3 equations. These results lead toward the argument that an increase in disparity in markets' size, over time ($\text{larger } | \text{Size}_i - \text{Size}_j |$) may indicate greater differences in liquidity, information costs, and transaction cost across two markets, resulting in less comovement (small correlation).

The results also indicate that, two markets exhibit low comovement if their volatilities diverge, as, the coefficient of the ratio of volatility is negative 40 times (with 21 coefficient significant), while it is positive twenty times (with no significant coefficient). The turnover ratio is found to be positive in 23 equations (with no significant coefficient); while, it is negative in 29 case (with eight coefficients significant) as we see there is negative relation between the turnover and the returns comovement across eight pairs of stock markets. These results suggest that the relative turnover between two markets has dampening effect on the stock markets comovement.

Contrary to our expectation, we find the coefficient of the 2008 dummy variable is negative eleven times (with 6 coefficient significant), there is a negative effect of 2008 financial crisis on the correlation between Kenya market and the market of Egypt, Japan and Mauritius, and between Mauritius market and the market of Nigeria, South Africa and US. These results suggest that the crisis does not always increase the correlation among different stock markets. However, the frequency of positive coefficient is more than the negative so, we can conclude that generally, the crisis increases the interdependence of the stock market through the contagion effect, as in our case the coefficient of dummy variable is positive in 41 equations and positive and significant in 26 of 52 equations (i.e. positive and significant in 50% of different pairs).

Finally, the trend is positive in 49 equations, and significant in 37, this finding supports the trend toward greater interdependence over time.

V- Conclusion:

In this study, we investigated to what degree the stock markets in Africa are interdependent, and we examined the factors that affect the level of the interdependence among these stock markets. To this end first, we used daily returns for different stock market index from 2004 through 2014 with DCC-GARCH model to construct a quarterly time series of the dynamic conditional correlations, which are used as an indicator of stock market interdependence. Second, we specified a set of macroeconomic factors for each pair of countries, and then, all the possible correlations are regressed on potential macroeconomic determinants. Finally, we estimated the regression equations in two different ways first all the equations are estimated as pooled sample; second, the different equations are estimated as a system of seemingly unrelated regression. From the empirical results we suggest that:

There is quite high degree of market comovement, as all possible pairs of market interact significantly over time. In addition, the global financial crisis seems to have an amplified effect on the extent of comovement across different markets, since, almost all correlations show an upward trend after the 2008-financial crisis.

The countries' integration, as measured by explanatory variables can explain 36% of the variation in the dynamic correlations. This explanatory power becomes stronger for the group of the same region (Africa) markets (47%). However, in the case of distinct region group the model can explain only 30% of the variation in the correlation coefficients, which means that, the remaining 70% of this variation may be due to other explanatory variables that have been excluded in this model. This explanatory power of our model indicates that the spillovers effect occurs due to economic and financial ties between the selected countries' economy.

Several variables are significantly associated with the evolution of stock market interdependence over time. The statistically significant variables include on global level the import and export dependence, the difference in industrial growth rates, volatility in bilateral exchange rates, stock market size differential, the ratio of markets volatility, 2008-crisis dummy variable as well as the time trend. Contrary to the economic theory the bilateral exchange rate change, inflation rates and interest rates are insignificant in influencing the degree of comovement between the stock market in all cases. Moreover, the relative turnover between two countries' stock markets do not appears to play an important role in explaining the stock market interdependence in our sample.

The estimation of the SUR model yields 14 parameter estimates for each of the 52 regression equations. In overall, the results of the SUR analysis largely corroborate the pooled results, as it's found that the economic variables that enter significantly across substantial number of country pairs are the same as those found in the pooled regression analysis. However, in the SUR analysis the results are more specified as they show in which pair a given variable is significant, positive/ negative.

The key recommendations we can make from this study are:

- To manage their risk, investors should invest in markets with low correlation.
- Investing in frontier market (countries whose economies are even less developed and accessible than those of emerging markets) can be a good way to diversify a portfolio.

- The stakeholders can take their decision for their investment in the overseas market by looking at the short-term and long-term integration of specified stock market with other selected markets.
- The current study covers the period of the mortgage crisis, as it showed that the crisis increases the interdependence of stock markets, so we suggest that investors avoid trading in the period of the crisis due to bad news circulating among traders, which leads to a rise in market volatility and uncertainty.

No piece of academic research is fully complete and perfect and the current research is not an exception. Indeed, the countries in the developing world change very frequently due to the communication, new technology, and regional and international financial developments. In such changing environments, the behavior of stock markets also changes over time and hence, research in these countries is never ‘complete’. Nevertheless, the current research demonstrates the learning process of the researcher and contributes to knowledge about this important topic. As a result, it should represent a starting point for further work on the topic of market interdependence and spillover effect in stock markets in general and in the African markets in particular.

- Appendices:

Table 1: Pooled regression results

Dependent variable	Corr _{ij}	All countries	Same region (Africa)	Distinct region
Intercept		0.284*** (0.0078)	0.265*** (0.0067)	0.287*** (0.014)
Export	X_i	0.019*** (0.0032)	0.0118** (0.005)	0.0026** (0.001)
	X_j	0.0127*** (0.0018)	0.0104*** (0.0012)	0.2017*** (0.023)
Import	M_i	-0.012*** (0.004)	-0.0204* (0.0116)	0.051*** (0.012)
	M_j	-0.0243* (0.0147)	-0.0296** (0.0148)	0.021* (0.011)
Inflation differential (π_{ij})		-0.0042 (0.0027)	-0.0083 (0.0077)	-0.014 (0.0096)
Real interest rate (r_{ij})		-0.0028 (0.0049)	-0.00049 (0.00038)	-0.0012 (0.001)
Growth (ind_{ij})		-0.0054* (0.0028)	-0.019** (0.0085)	-0.014** (0.006)
% change in bilateral exchange rate (e_{ij})		0.0012 (0.0043)	0.0068 (0.0042)	0.0011 (0.0007)
Bilateral exchange rate volatility (σe_{ij})		-0.1207** (0.0504)	-0.364*** (0.1038)	-0.162*** (0.056)
Size differential ($Size_{ij}$)		-0.0244** (0.0097)	-0.0305*** (0.0074)	-0.017* (0.01)
Market volatility (Vol_{ij})		-0.015* (0.0089)	-0.011* (0.0064)	-0.047** (0.021)
Turnover (Tur_{ij})		-0.0018 (0.0012)	-0.0017* (0.001)	0.051 (0.094)

Financial crisis effect (Dum_08)	0.0454*** (0.0022)	0.0335*** (0.0067)	0.077*** (0.012)
Time trend (trend)	0.0163*** (0.0012)	0.0148*** (0.0031)	0.0096** (0.0041)
Number of observations	2028	1092	936
R-Squared R²	0.3614	0.4716	0.3033
Adjusted R²	0.3569	0.4514	0.2926
F-Statistics	81.16***	23.41***	28.54***

Source: Eviews output

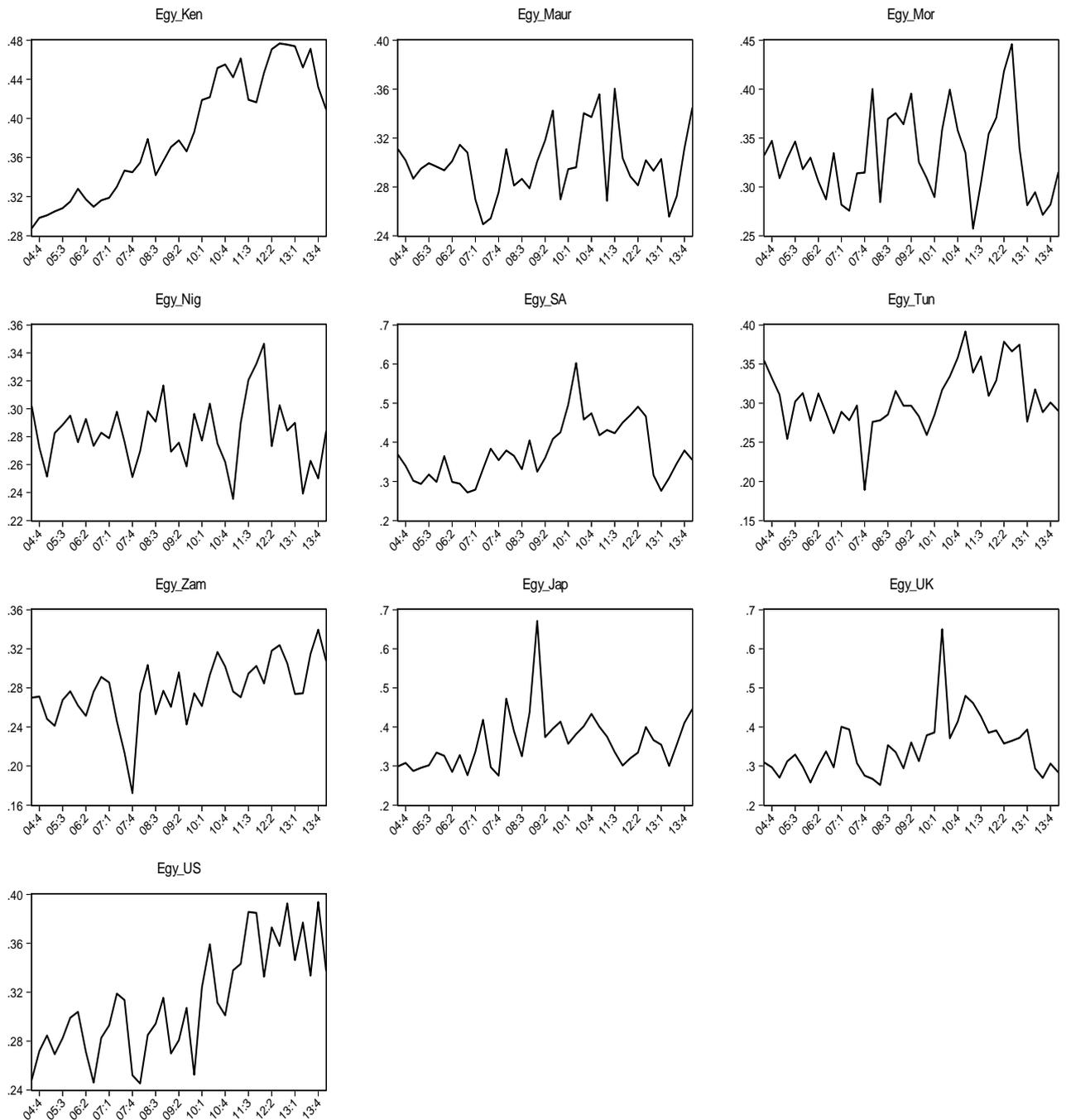
Table 2: results of seemingly Unrelated Regression (SUR)

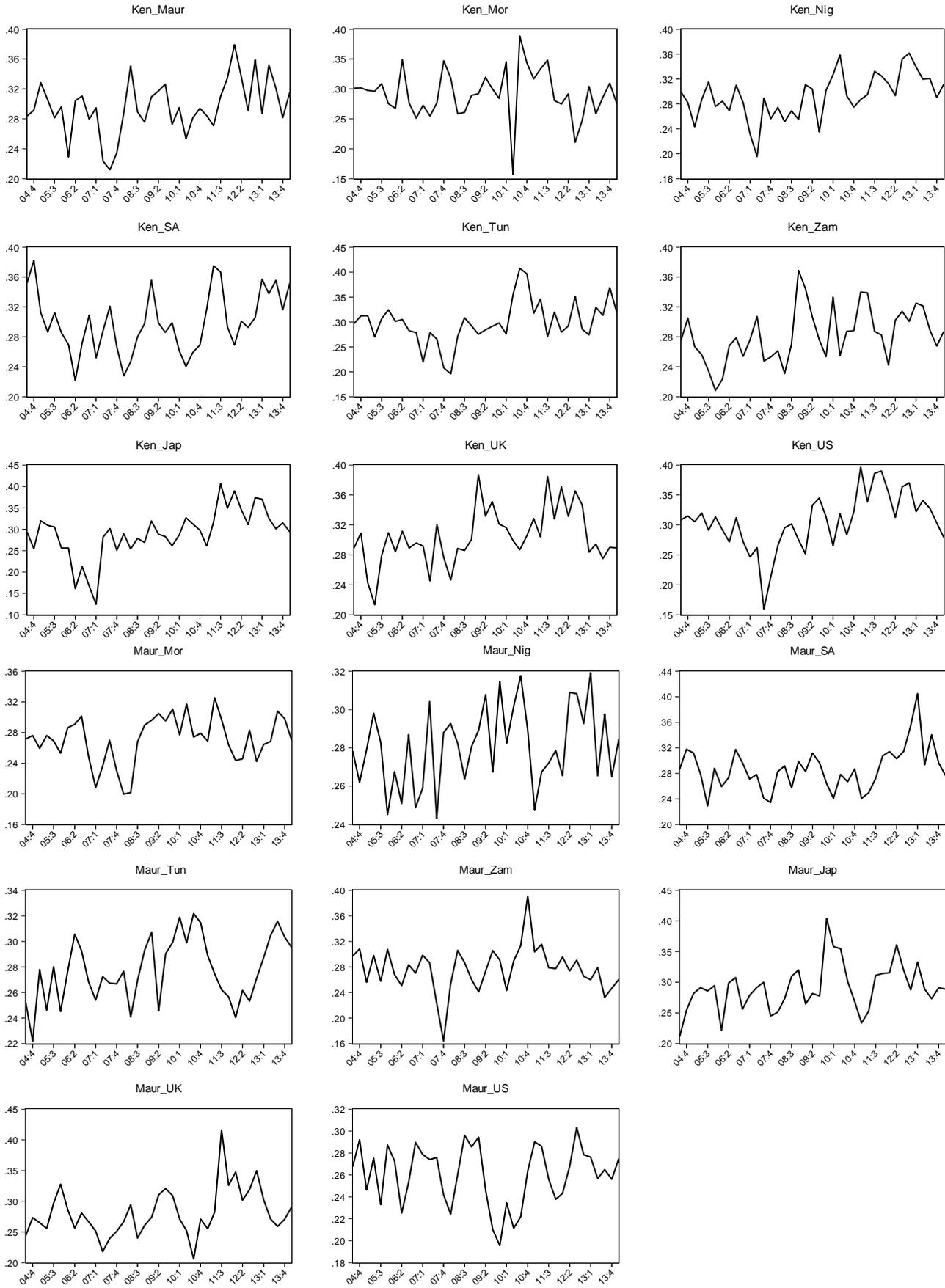
Variables	Number of positive coefficients	Number of positive and significant coefficients	Number of negative coefficients	Number of negative and significant coefficients
Intercept	49	39	3	1
X_i	45	24	7	0
X_j	45	28	7	0
M_i	24	8	28	12
M_j	26	14	26	16
π_{ij}	15	0	37	12
r_{ij}	12	0	40	10
Ind_{ij}	14	0	38	25
e_{ij}	35	0	17	11
σe_{ij}	20	0	32	26
Size_{ij}	13	3	39	23
Vol_{ij}	12	0	40	21
Tur_{ij}	23	0	29	8
Dum_08	41	26	11	6
Trend	49	37	3	0

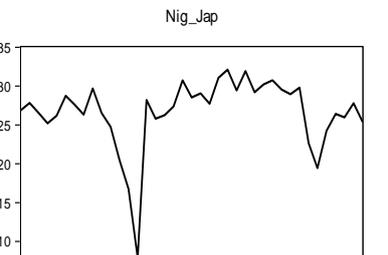
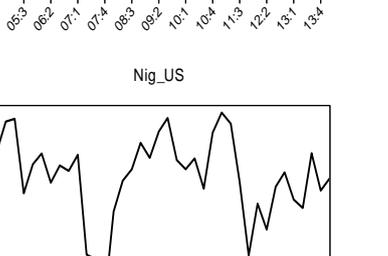
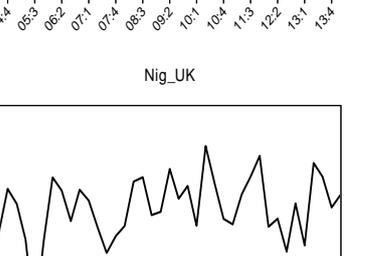
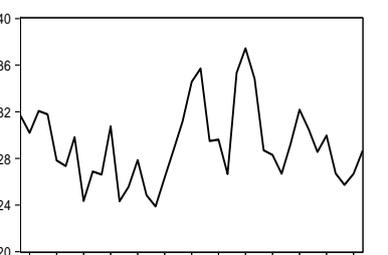
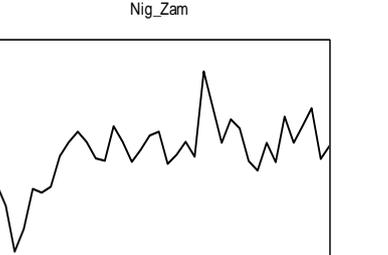
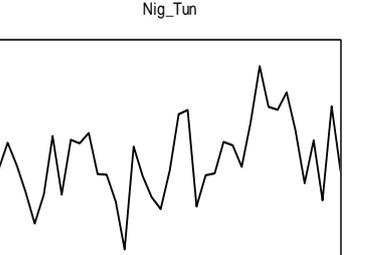
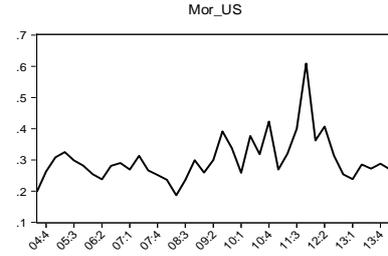
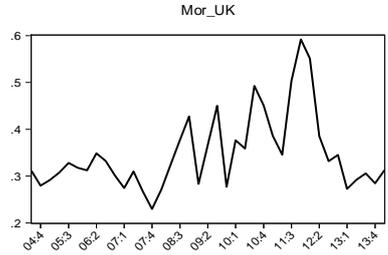
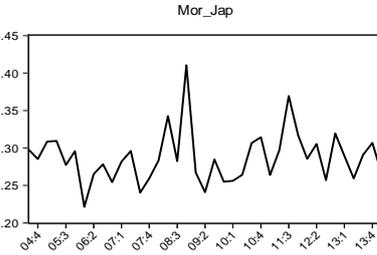
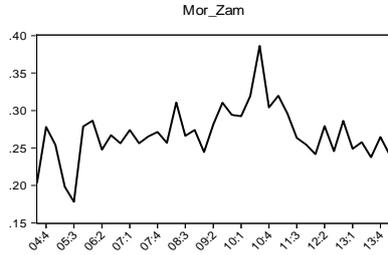
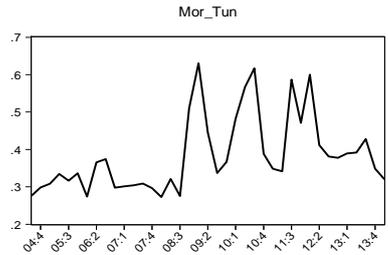
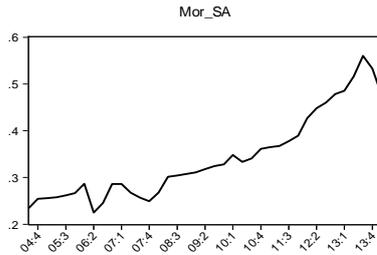
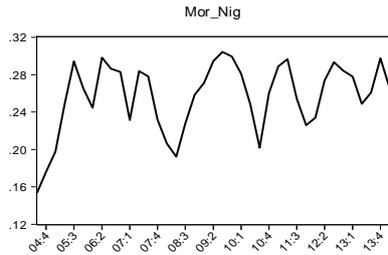
Source: Eviews output

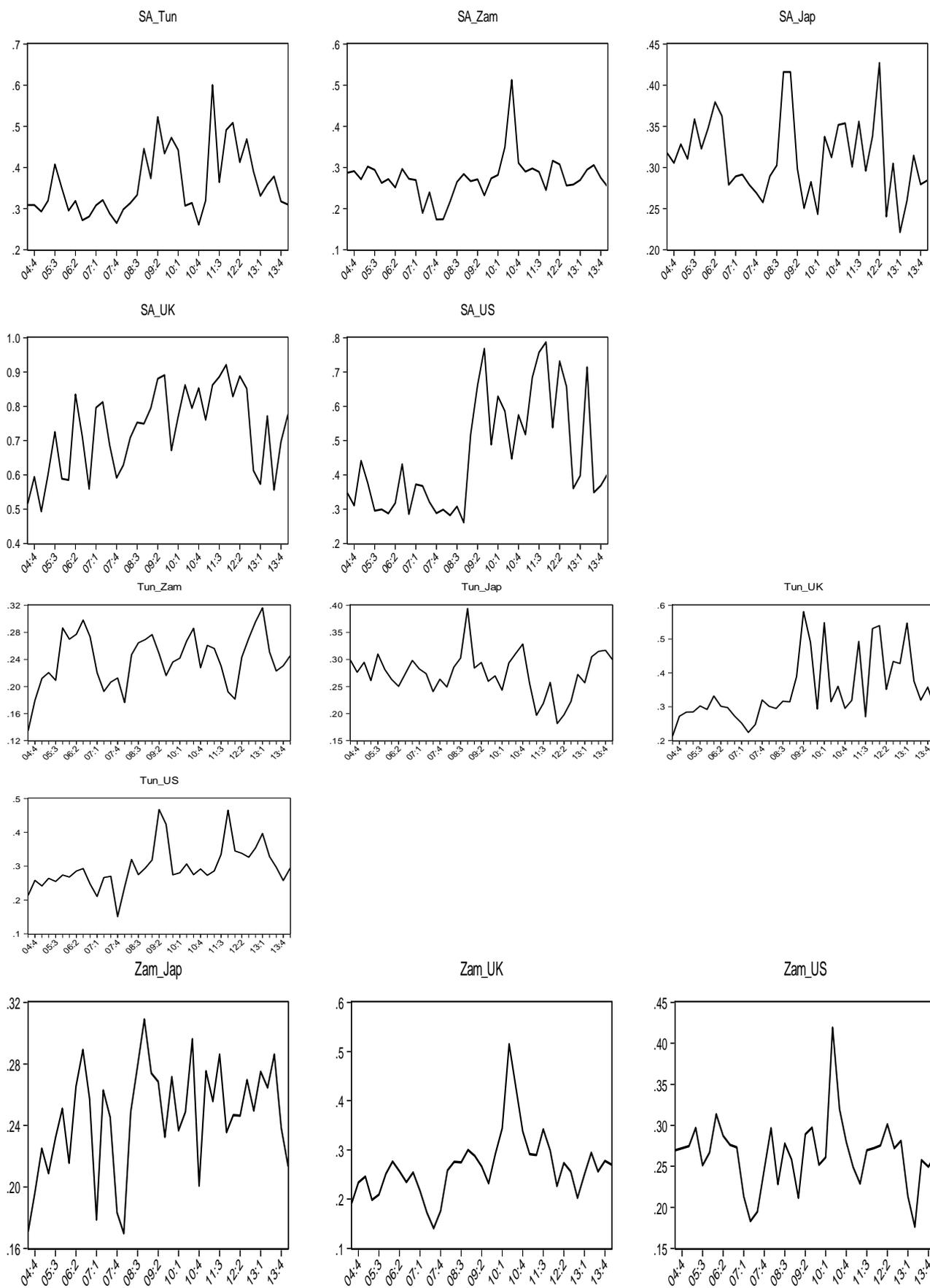
Figure 1: Time-varying correlation between stock returns

Correlations among the returns of the selected stock markets









Source: Stata software output

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