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A Multivariate Cointegration Analysis of the United Arab Emirates Stock Prices

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Abstract. We investigate predictability among different assets in the unofficial assets market in the UAE using cointegration, causality, and the impulse response functions methodologies. The main results indicate that there exist strong long-run and short-run relationships among different stock prices in the UAE. Therefore, it is possible to use changes in some indices to predict changes in other indices both in the long-run and in the short-run. This result indicates the lack of efficiency in the unofficial assets market in the UAE.

Keywords: Stock prices, United Arab Emirates, Cointegration, Causality, Predictability.

JEL classification: G15

Introduction

In efficient asset markets, asset prices at one time incorporate all available information at that time. However, if two asset prices are cointegrated, an error correction representation would exist which implies that part of the changes in these asset prices can be predictable which is inconsistent with market efficiency as suggested, for example, by Granger [1] and Richards [2][1]. If stock markets are cointegrated, then these prices tend to move together over long periods of time although they fluctuate and depart away from each other in the short-run. Cointegration tests among stock markets have been used in many studies such as Chaudhuri [4], Corhay *et al.* [5], Hassan and Naka [6], Smith *et al.* [7], Ewing *et al.*, [8], and Richards [2]. However, in a multivariate system, Caporale and Pittis [9] show that cointegration among assets does not necessarily imply

[1] Note that market efficiency here is defined as the unpredictability of asset prices. This definition has been criticized by many researchers. For example, Levich [3] argues that market efficiency should be defined as the lack of arbitrage opportunities.

predictability. They argue that cointegration tests can be used to investigate predictability among assets where the number of predictable assets is equal to the cointegration rank in the n-assets system. Moreover, Crowder [10] argues that cointegration tests are not sufficient and we need to investigate causality and exogeneity to determine predictability.

The UAE stock market has seen dramatic changes during the last decade, formal stock markets were introduced in both Dubai and Abu Dhabi, new federal legislations were also introduced and foreign participation is allowed as it is keen to develop a full-fledged international market that will provide breadth and depth. Privatization is an issue which the UAE government is keen to introduce, specially the local government of Abu Dhabi this surely will bring new issues to the market. A market which has seen expansion in introducing new companies. In 1996 two new companies were floated one of them was heavily subscribed by almost eight times. In 1997 four more new companies offered their shares to the public, they were also heavily subscribed. The Abu Dhabi Islamic Bank was oversubscribed by a massive 21 times. The Oasis International Leasing Company and Emmaar Properties were both more than five times oversubscribed. Because of high demand for securities, price of these stocks increased dramatically, in some cases almost 200%, although none of theses companies started their actual operation. This high demand for securities is due to the fact that UAE is a country with high liquidity with few available investment opportunities.

Interest by citizens to invest in the stock market has led to a surge in stock prices. All stock prices have risen sharply especially during 1998, when some of the prices rose almost 1000%. This surge in stock prices did not last long, and prices have fallen sharply since then. The National Bank of Abu Dhabi Share Price Index stood at 1853 in 1993, and 3340 in 1997, and has come sharply down to 2465 in 2000 this is more than 35% decline between the years 1997 and 2000. This crash which started in few share prices, in less than few days affected all other share prices regardless of the sizes of the companies and their fundamentals. This led many to question the relationship among these prices in a country without an official stock market.

This paper uses cointegration, causality, and impulse response functions to study predictability among different assets in the unofficial assets market in the United Arab Emirates (UAE, thereafter). More specifically, the paper tests predictability among asset prices in two groups. The first consists of the banking sector, the insurance sector, and the services sector. The second group consists of the small banks, medium banks, and large banks. Bivariate and trivariate cointegration methodology is used to assess predictability among these assets in each group in the long run. The short run predictability is investigated using Granger causality tests and the impulse response functions. If asset (A) is found to cause asset (B), then asset (A) is said to have information relevant in predicting changes in asset (B). On the other hand, the impulse response functions show the strength and the length of the effect of a shock to asset (A) upon asset (B).

The rest of the paper is organized as follows: section two provides a brief overview of the UAE stock market. Section 3 explains the econometric methodology. Explanation of the data and empirical results are provided in section four while section five concludes the study.

An overview of the UAE Stock Market

The United Arab Emirates is considered one of the richest developing countries in the world in terms of per capita income. However, about 37% of the country's income stems from oil. The economy is considered to be open to the outside world and has a good degree of economic freedom relative to other economies in the Middle East. Moreover, modern infrastructures, the strength of the banks, transportation, and other services sectors, and political stability have provided a good and a stable environment for businesses to conduct their operation. The seven emirates (Abu Dhabi, Dubai, Sharjah, Ajman, Umm al Quawain, Ras al Khaima and Fujairah) which formed the federation, each has taken a different role in the economy. The two principal emirates, Abu Dhabi and Dubai have taken different, but complementary lines, with Abu Dhabi expanding its oil capacity and heavy industry, while Dubai promotes itself as a trading, manufacturing, tourism and international services base.

The emergence of an official stock market in the UAE is a new phenomenon; it only started in March 2000. However, the unofficial stock market still plays a great role in the economy, as not all companies have listed their shares on this official stock market. Plans for an official stock market have been on the drawing board since 1982. At that time, a high commission for a stock market was formed for the sole purpose of drafting a legislative proposal for the establishment of such market. The commission approved the establishment of a stock exchange in the form of a network located in different emirates. Unfortunately, the plan didn't see the light due to the stock market crash (Al Manakh) in the neighboring state of Kuwait at that time. This crash didn't affect the Kuwaiti citizens only but also the UAE citizens who used to invest heavily in that market.

The effort to establish a formal stock market did not stop, in March 1994; the UAE cabinet issued a decree that formed a commission for the establishment of an official stock market. It included representatives from the UAE Central Bank, the Ministry of Economy and Commerce and the Ministry of Finance and Industry. The commission's effort culminated in a draft proposal of a federal law concerning the establishment and organization of a stock market. However, the introduction of an official stock market was delayed until March 2000, when Dubai announced the establishment of its financial market with only 7 companies listed on the exchange. Abu Dhabi postponed opening its official market until October 2000. The unofficial market is still in place, and the UAE investors are facing three markets.

The delay in the establishment of an official market was due to the fact that a formal stock market will require substantial new federation legislation, which must be agreed upon by all the emirates. Another reason was the disagreement between Abu Dhabi and Dubai on the physical location of the exchange. The foreign participation was another sticking point. Dubai is keen to develop an international financial market with foreign participation so as to provide breadth and depth to the market, while Abu Dhabi took a conservative view of only Arabian Gulf investors' participation. [2]

Trading on the UAE unofficial stock market is usually conducted through brokers and banks, and it is confined to UAE nationals. Recently, one of the largest companies, Emmar, which is listed on the Dubai Financial Market, has allowed foreign ownership of its shares with a limit of 20% of its capital.

Due to the rapid expansion in the economy in recent years, the UAE stock market has also grown in a very fast pace. Market capitalization at the end of March 1996 was US$11.9 billion and in the year 2000 the number of public companies stood at around 93 companies, with market capitalization of US$24 billion an increase of nearly 100%. This makes the UAE stock market the third largest in terms of capitalization in the GCC after Saudi Arabia and Kuwait.

Econometric Methodology

We use the Augmented Dickey and Fuller (ADF) of Dickey and Fuller [12] and [13] to test for the presence of unit roots among the various stock indices. The test can be carried out by estimating the following regression:

$$\Delta X_t = \alpha + \beta T + \rho X_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta X_{t-i} + e_t \qquad (1)$$

where X_t is the variable in question in period t, T represents a time trend, Δ is the difference operator, e_t is an i.i.d. disturbance with mean zero and variance σ^2, and k denotes the number of lags of the differences in the ADF equation. The hypothesis of unit root is equivalent to testing $\rho = 0$.

Bivariate and trivariate cointegration tests are used to assess for long run predictability among asset prices. We use the Johansen [14] and [15] and Johansen and Juselius [16] maximum likelihood technique. This technique is summarized as follows:

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[2] See United Arab Emirates [11, pp. 75-81].

if $X_1, X_2,$ and X_3 are integrated of order one, I(1), then we estimate the following vector autoregressive models:

$$\Delta X_t = \sum_{j=1}^{k-1} \Gamma_{0,j} \Delta X_{t-j} + v_{0,t}$$
$$\Delta X_{t-k} = \sum_{j=1}^{k-1} \Gamma_{1,j} \Delta X_{t-j} + v_{1,t} \qquad (2)$$

where X_t *is 1 × 2* or *1 × 3* vector of *I(1)* variables, $\Gamma's$ are matrices of unknown parameters, and *v's* are normal $(0, \Sigma)$. From the residual vectors, we could construct two likelihood ratio test statistics: the trace test and the maximal eigenvalue test. As noted by Johansen and Juselius [16], the trace test may lack power relative to the maximal eigenvalue test, however, the trace test is shown to be robust to the non-normality of the errors relative to the maximal eigenvalue test, as shown by Cheung and Lai [17], thus, we employed both tests here. These two tests are given by

$$\tau_{trace} = -T \sum_{j=r+1}^{\rho} \ln(1-\lambda_j) \qquad r = 0,\ 1,\ 2 \text{ and } \rho = 2,\ 3$$
$$\tau_{\max} = -T \ln(1-\lambda_{\tau+j}) \qquad (3)$$

where λ's are the ρ-r smallest canonical correlation of $v_{0,t}$ with respect to $v_{1,t}$.

Causal relations among stock market price indices are investigated using the Granger causality tests given by Granger [18-20] and Granger & Weiss [21]. If a stock market index causes another index, it can be claimed that stock prices variability for these two indices are fundamentally linked in the short run. We examine causality from one variable to another using the following three variable vector auto regression VAR (3) model:

$$\Delta Y_t = \alpha + \beta_1 \Delta Y_{t-1} + \ldots + \beta_k \Delta Y_{t-k} + \gamma EC_t + u_t,\ \ u_t \sim i.i.d.(0, \Sigma_u) \qquad (4)$$

Where Y_t is a vector of stock price indices, k is the number of lags in the VAR system, EC_t is an error correction series, and Δ is the difference operator. We use the differences in variables since, as we will see below, all the price series are non-stationary. Moreover, the inclusion of the error correction series follows the fact that if stock price indices are cointegrated, then causality must exist among some of the variables in the system in at least one direction. Therefore, we add an error correction

series to the system only if cointegration is not rejected. Granger causality tests of Y_{1t} on Y_{2t} are, then, performed through F-tests of the significance of the Y_{1t} lags.

Finally, short-run relationships are also investigated using the impulse response functions. The impulse responses or "dynamic multipliers" represent time path responses of variables to exogenous shocks to variables in a VAR system. These functions are calculated in a three-variable cointegrated VAR system for each group. If indices in each group are cointegrated, then shocks to the system may move the time path of the system to a new equilibrium rather than dying out in the long run. This reflects the error correction properties of the cointegrated variables. Following Lütkepohl and Reimers [22], the following error correction representation is used:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} - \Pi Y_{t-p} + u_t \qquad (5)$$

where $\Gamma_i = -(I_k - A_1 - \ldots - A_i)$, $i = 1, \ldots, p-1$ and A_i are coefficients in the usual k-dimensional VAR system, and the rank of Π is restricted to the cointegration rank $r \leq k$.

Data and Empirical Results

This study uses the daily share price indices created by the United National Bank [23] in the UAE "The UNB Market Index" along with its sub indices. The period of the study extends from January 1, 1998 to March 31, 2000. Prices for the compilation of the index are provided by the Union Securities, the brokerage arm of the Union National Bank. The UNB Market Index consists of 43 actively traded companies in the UAE over the counter market. The 43 shares and the sub-indices are presented in the Appendix.

Each company, in the Index is weighted in accordance with the market value of publicly held shares (free float). In other word, the Index reflects the market capitalization of shares that are actually traded in the market, rather than the total capitalization.

The importance of this adjustment is substantiated by the fact that the adjusted market capitalization (free float market capitalization) forms only 48% of the unadjusted market value.

All prices in the indices have been adjusted for bonus issues, rights issues and stock splits, respectively. The computations of all indices are as follows:

$$\frac{\text{free float market capitalization}}{\text{base value free float market capitalization}} \times 100$$

The unit root tests results are displayed in Table 1. It is evident from the Table that all variables are integrated of order one. The number of lags that is used is four and these results are found to be robust for different lag structures.

Table 1. Augmented Dickey Fuller unit root tests

Variable	Constant	Constant & Trend	No C or T
Bank	-1.202	-1.999**	-0.387
Insurance	-0.584	-1.823**	-0.420
Services	-1.912	-2.196*	-0.292
Large Banks	-0.546	-1.926**	-0.532
Medium Banks	-1.900	-2.160*	-0.216
Small Banks	-1.244	-1.814**	-0.316
D(Bank)	-7.296	-7.441	-7.301
D(Insurance)	-7.977	-8.209***	-7.977
D(Services)	-8.067	-8.100	-8.073
D(Large Banks)	-7.074	-7.299	-7.067
D(Medium Banks)	-6.830	-6.869	-6.835
D(Small Banks)	-11.127	-11.222	-11.136

* Constant is significant at the 5% level
** Both constant and trend are significant at the 5% level
***Only Trend is significant at the 5% level
D(.) refers to first difference
Critical Values for ADF Unit Root Tests: -2.866, -3.419, and –1.940, for C, C+T, and None respectively.

Table 2 shows the results of the bivariate cointegration tests. Using the trace test, cointegration is rejected in three out of six cases, namely: for the indices of insurance - services, large banks - medium banks, and medium banks – small banks pairs. However, using the L-max test, cointegration is not rejected in all cases.

Table 2. Bivariate cointegration tests

Variables	Trace statistics		L-max statistics		Normalized coint. coeff.
	r=0	r=1	r=0	r=1	
Bank, Insurance	18.56	2.39	16.17	2.39	(1.000, -1.065, 1.134)
Services, Bank	52.44	3.96	48.48	3.69	(1.000, -1.181, 22.459)
Insurance, Services	16.62	0.52	16.10	0.52	(1.000, -0.997, 5.631)
Lbank, Mbank	11.47	0.81	10.65	0.81	(1.000, -1.047, 1.140)
Lbank, Sbank	18.09	0.83	17.26	0.83	(1.000, -0.325, -60.011)
Mbank, Sbank	13.38	2.19	11.18	2.19	(1.000, -0.336, -67.204)

10% critical are 17.79 for r=0 and 7.50 for r=1 for the trace test and 10.29 for r=0 and 7.50 for r=1 for the L-max test. Cointegration is performed by including an intercept is in the cointegration relations only.

Trivariate cointegration tests are shown in Table 3. Using the trace test, one cointegrating relationship is found among the banks, insurance, and services indices, and no cointegration is found among the large banks, medium banks, and small banks indices. However, the L-max test shows that there exist two cointegrating relations among the banks, insurance, and services indices as well as among the large banks, medium banks, and small banks indices.

Tables 2 and 3 together indicate that there exist a strong long-run relationships among the banks, insurance, and services indices and among the large banks, medium

banks, and small banks indices. This result suggests that it is possible to predict changes in one of these indices using information available from other indices in each group. In other words, this is strong evidence that the unofficial stock market in the UAE is not efficient.

Table 3. Trivariate cointegration tests

Variable	Constant	Constant & Trend	No C or T
Bank	-1.202	-1.999**	-0.387
Insurance	-0.584	-1.823**	-0.420
Services	-1.912	-2.196*	-0.292
Large Banks	-0.546	-1.926**	-0.532
Medium Banks	-1.900	-2.160*	-0.216
Small Banks	-1.244	-1.814**	-0.316
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* Constant is significant at the 5% level

** Both constant and trend are significant at the 5% level

***Only Trend is significant at the 5% level

D(.) refers to first difference

Critical Values for ADF Unit Root Tests: -2.866, -3.419, and –1.940, for C, C+T, and None respectively.

Tables 4 and 5 show the results of the trivariate Granger causality tests[3]. In the case of banks, insurance, and services indices, causality exists in one direction in 4 out of 6 cases and two-way causality exists in 1 out of three cases indicating strong short run linkages among these indices. The banks index is caused only by both the services and the insurance indices and it fails to cause either index. The insurance and the service indices display two-way causality indicating that there exists a stronger short-run relationship between these two indices compared to their relationship with the bank index. In the case of large, medium, and small banks, one-way and two-way causalities exist in all cases which indicate very strong short run linkages among them.

Table 4. Trivariate Granger causality tests (bank insurance services) within cointegration

		Banks	Insurance	Services
Caused By	**Banks**	-	1.916 (0.1061)	1.285 (0.2746)
	Insurance	2.795 (0.0255)	-	2.441 (0.0457)
	Services	30.103 (0.0000)	15.762 (0.0000)	-

(.) Indicate p-values

[3] We have estimated the variance decompositions which only support the results of the impulse response functions. These tables are available from the authors upon request.

Table 5. Trivariate Granger causality tests (large banks, medium banks and small banks)

		Lbank	Mbank	Sbank
Caused by	**Lbank**	-	6.798 (0.0000)	6.457 (0.0000)
	Mbank	2.619 (0.0341)	-	8.795 (0.0000)
	Sbank	3.833 (0.0044)	3.644 (0.0060)	-

(.) Indicate p-values

Figures 1 and 2 show the dynamic adjustments of the variables to exogenous shocks in a VAR system for the bank, services, and insurance indices. Since these response functions are formulated within cointegration, the responses of the variables to each shock would be permanent. That is, responses level out at some new equilibrium. In Fig. 1, a one percent standard deviation shock to the banks index evokes permanent responses to itself and to the insurance index leading to new equilibriums in around a week. The response of the services index to a shock in the banks index is very week. A shock to the insurance index evokes permanent responses to itself and to the other two indices. The responses of both the services and the banks indices level out after six days. Similarly, a shock to the services index evokes permanent responses to itself and to the other two indices but the response of the banks index levels out in around three days while it takes the insurance index more than ten days to reach the new equilibrium. In all, it seems that the strong effects come from the services and the insurance indices while the banks index has the least effect on the other two indices. This result goes in line with the results provided by the Granger causality tests.

Figure 2 shows the response functions for the small banks, medium banks, and the large banks indices. It is evident from the figure that shocks to these variables evoke strong responses in every case. A shock to the large banks index evokes significant responses to itself, to the medium banks, and to the small banks indices. The response of the medium and small banks indices are gradual and level out at their new equilibrium in around 8 days. A shock to the medium banks index evokes an immediate response to the large banks index which levels out in around six days, and a gradual and very short life response to the small banks index. Finally, the responses to shocks to the small banks index are weakest relative to the other two shocks (closest to zero) and they level out in around a week. In all it seems that changes in the large, medium, and small banks indices are strongly linked in the short-run. This result supports the evidence provided by the Granger causality tests.

Combining these results with Granger causality tests, it seems that there are strong relationships among UAE stock prices in both groups in the study. However, the strongest effects for the first group of indices run from the services and the insurance indices to each other and to the banks index while for the second group of indices strong run causation is evident in every direction. Therefore, these results indicate that one can easily use one of these indices to forecast changes in other indices in the short run for every group of indices.

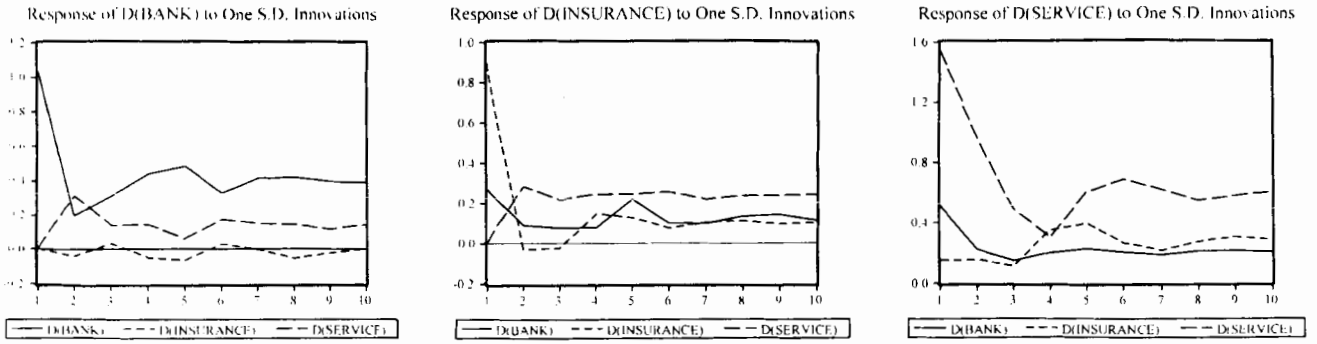

Fig. 1. The impulse response functions (large banks, medium banks, and small banks).

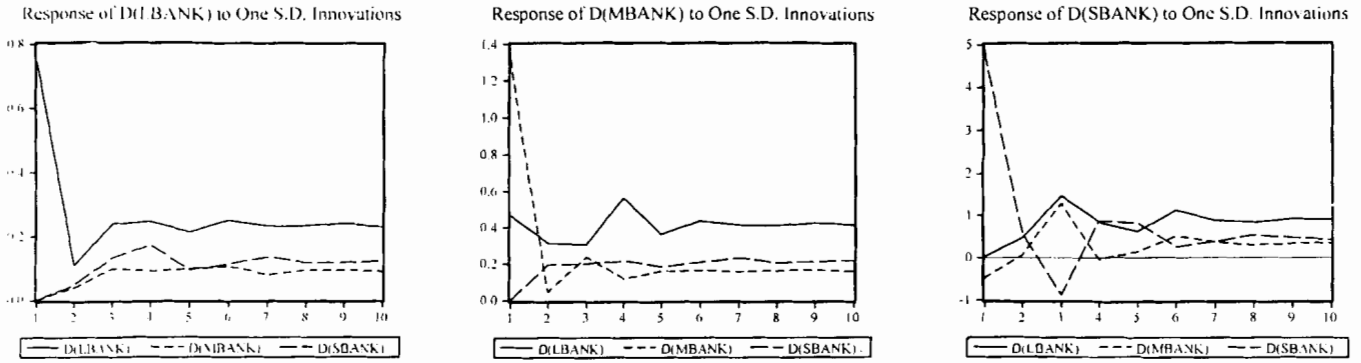

Fig. 2. The impulse response functions (large banks, medium banks, and small banks).

Conclusion

It seems from the results of the paper that strong long run and short run relationships exist among different stock prices in the UAE. These results support the expectation that the stock market is inefficient in the UAE. This result is not surprising because the stock market in the UAE is newly developed and only recently became official with sound regulations. One main implication of the study is that authorities in the UAE should direct their effort to the development of the official stock market and that all companies should be encouraged to be listed in that market. Moreover, economic laws must emphasise a greater deal of transparancy and availability of information of companies to increase the degree of efficiency in the UAE stock market. At that point, information provided by companies, every thing else fixed, should have the main affect of their stock prices.

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Appendix

Banking sub-sector index composition

Sub-sector	Bank	Average asset 1998 (AED Mil.)
Large Bank Index (Asset size >AED 10 Billion)	National Bank of Abu Dhabi (NBAD)	33.133
	National Bank of Dubai (NBD)	23.717
	Abu Dhabi Commercial Bank (ADCB)	21.631
	Emirates Bank International (EBIL)	
	Mashreq Bank	17.779
Medium Bank Index (Asset size AED 5-10 Billion)	Union National bank (UNB)	7.331
	Commercial Bank of Dubai (CBD)	5.409
(Asset size AED < 5 Billion)	National Bank of Fujairah (NBF)	2.350
	Invest Bank for Trade & Investment (InvestBank)	1.933
	National Bank of Ras Al Khaimah (NBRAK)	1.651
	National Bank of Umm Al Quwain (NBUAQ)	1.567
	Bank of Sharjah (BoS)	1.417
	Union Arab Bank (UAB)	1.416
	Commercial Bank International (CBI)	1.390
	National Bank of Sharjah (NBS)	1.237
	First Gulf Bank (FGB)	1.195

تحليل اسعار الأسهم في الإمارات العربية المتحدة باستخدام التكامل المشترك المتعدد

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ملخص البحث. يهدف هذا البحث إلى دراسة القدرة على توقع التغييرات في بعض أسعار الأسهم في سوق الأوراق المالية غير الرسمي في دولة الإمارات العربية المتحدة و ذلك بالنظر لتغيرات أسعار أسهم أخرى في السوق نفسه. و تستخدم الدراسة لهذا الشأن بعض الطرق المتطورة في دراسات تحليل السلاسل الزمنية مثل التكامل المشترك و علاقات السببية. وقد قسمت اسهم الشركات المستخدمة في هذه الدراسة لمجموعتين تضم الأولى أسهم البنوك و التأمين و الخدمات بينما تضم الثانية أسهم البنوك الكبيرة و المتوسطة و الصغيرة. و تشير النتائج الرئيسة للبحث إلى أنه توجد علاقات قوية بين أسعار الأسهم ضمن كل مجموعة سواء على المدى الزمني الطويل أو القصير أي أن هنالك مقدرة عالية على استخدام التغييرات في أسعار بعض الأسهم لاستقراء التغييرات المستقبلية لأسعار الأسهم الأخرى. هذه النتيجة تشير إلى الضعف الشديد في كفاءة سوق الأسهم غير الرسمي في دولة الإمارات العربية المتحدة.