Price-Volume Granger Causality Tests

in the Egyptian Stock Exchange (EGX)

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Abstract

The Egyptian stock exchange (EGX) has undertaken a number of initiatives over the years to help improve its microstructure. This has motivated us to use Granger causality tests to examine the effects that some of these initiatives may have had on the information dissemination environment of the EGX. We hypothesize that following the implementation of these initiatives, there would be improvements in information dissemination, which should lead to improvements in the contemporaneous relation between stock returns and trading volume. Additionally, since the EGX is an emerging stock market, we conjecture that there would be Granger causality between stock returns and trading volume. Using weekly EGX data on the 34 most active companies stretching from 2011 to 2017, this study finds that price changes Granger cause trading volume up to 8 weeks (lags), supporting the sequential information arrival model in the EGX. We also find a robust contemporaneously positive asymmetric relationship between price change and trading volume. The results confirm our hypotheses, two well-documented characteristics of the price-volume relationship as well as two major adages of Wall Street, namely, it takes volume to move prices and volume in bull markets is heavier than volume in bear markets. Overall, our results imply that although there is some sequential diffusion of information, the EGX's efforts at improving its microstructure through initiatives such as the 2009 Presidential Degree on structure and governance, appear to have helped in improving access to information – as exemplified by our evidence of strong contemporaneous positive price-volume relationship.

Keywords: stock returns, trading volume, emerging stock market, price-volume relationship, Granger causality tests

1. Introduction

As the second largest stock market in Africa (Omran, 2007) and the regional hub market of the North Africa and Maghreb region (Hearn et al., 2010), the Egyptian stock exchange (EGX) is one of the premier stock exchanges in Africa and the leading stock exchange in North Africa. Desirous of improving its trading infrastructure in order to appeal to investors (including foreign investors and institutional investors), the EGX, according to Girard and Omran (2009), has, since May 2001, been implementing a number of initiatives including the introduction of automated trading system, establishment of the Egypt Information Dissemination Company to disseminate information and increase transparency, etc. Girard and Omran (2009) examined the effects of the earlier initiatives implemented by the EGX and find that over the 1998 to 2005 period, the initiatives have led to some improvements in trading efficiency and information dissemination. However, the EGX has continued its path of improvements including, notably, the 2009 enactment of Presidential Decree No. 191 on the structure and governance of the EGX (see history of the EGX at http://www.egx.com.eg/en/History.aspx).

Given the continued attempts at improving the microstructure of the EGX, it is crucial to establish whether or not the recent initiatives (including Presidential Decree No. 191) have improved the information dissemination environment of the EGX. And yet, no study, to the best of our knowledge, has examined the information architecture of the EGX since the study by Girard and Omran (2009) which covered the 1998 to 2005 period. Our study therefore attempts to fill this gap by examining the price-volume relationship in the EGX, with the hope of establishing whether the recent initiatives have helped enhance the information architecture of the EGX.

While there are several approaches to examining the structure of financial markets (including analyzing the price-volatility link as in Girard and Omran, 2009), the predominant view in the literature seems to be that the stock price change-trading volume analytic approach is perhaps one of the most robust approaches. As Karpoff (1987), for instance observed, the relationship between price change and trading volume provides some of the best insights into

the structure of financial markets. Following this rationalization, several authors have used the price-volume relationship to investigate the structure of financial markets, including Hiemstra and Jones (1994), Assogbavi et al. (1995), Saatcioglu and Starks (1998), Lee and Rui (2002), Chen (2012) and Sampath and Garg (2018). We follow this strand of literature and use the price-volume relationship to investigate the hypothesis that stock returns and trading volume have a positive contemporaneous relationship as well as the hypothesis that there exist causal relationships between stock price changes and trading volume in the Egyptian stock exchange.

Using data on the 34 heavily traded stocks listed on the EGX from 2011 to 2017, we find strong evidence that price changes Granger cause trading volume up to 8 weeks (lags), which supports the notion of some sequential information dissemination in the EGX. We also find strong evidence that trading volume is positively and contemporaneously related to price changes and this relationship is asymmetrically positive (i.e., positive price changes lead to heavier volume than negative price changes). This strong and robust contemporaneous relationship implies that the recent EGX improvement initiatives may have had positive effects on the instantaneous incorporation of information into stock prices and trading volume, leading to the strong contemporaneous relationship between stock price changes and trading volume. As well, these results are consistent with our hypotheses and with previous studies (e.g., Chen, 2012; Li et al., 2016; Sampath and Garg 2018) that document a significant contemporaneous relationship between the two variables. The results also support two Wall Street adages: "it takes volume to move prices" and "volume is heavier in bull markets than in bear markets". It should, however, be noted that the significant unidirectional Granger causality (from stock price changes to trading volume) with longer causal lags (of 8 weeks) that we find suggests that the EGX is still maturing, as far as its information dissemination architecture is concerned. Our Granger causality results also highlight the possibility that noise traders are using past stock price changes to inform their trading decisions, leading to past stock price changes Granger causing trading volume. While our study is similar to Girard and Omran (2009) because it also provides insights on the structure of the EGX, it differs from their study in a couple of important ways. First, we analyzed the price-volume relationship while they studied the price-volatility relationship. Second, while their study covered the 1998-2005 period, our study covers the recent 2011-2017 period.

The remainder of this paper is organized as follows. The relevant literature review is presented in section two; the hypothesis, data and methodology are discussed in section three; our results are analyzed and discussed in section four; and, section five concludes the paper.

2. Prior Literature

The importance of understanding the relationship between price change and trading volume was first articulated by Karpoff (1987). Among other reasons, the price-volume relationship helps discriminate between competing theories on information dissemination in financial markets; helps in analyzing the validity of information content of event studies; helps in assessing the distribution of stock returns (e.g., Epps and Epps, 1976); and, finally, it can help to better understand technical analysis (see Blume et al., 1994). In addition, the price-volume relationship can help establish the validity of two important Wall Street folklore related to stock prices and trading volume, viz.: "it takes volume to make prices move" and that "volume is heavier in bull markets than in bear markets" (Karpoff, 1988). The important role that the relationship between price change and volume plays in helping us understand the structure of financial markets has motivated several authors, over the last four decades, to offer theoretical expositions and/or empirical evidence on the subject matter. It has been established, from both the theoretical and empirical literatures, that price change has a positive correlation with trading volume (e.g., Karpoff, 1987; Hiemstra and Jones, 1994).

Theoretically, Copeland's (1976) landmark paper on the sequential information arrival model, which has been extended by Jennings et al. (1981), suggests that stock price changes are positively associated with trading volume because of the expectation that market participants' demand will be continuously sequentially adjusted as new information is received, until the new information is fully received by all market participants and a final equilibrium is established. Karpoff (1987) discusses other theoretical models that hypothesize a positive correlation between returns and volume including the mixture of distributions model and the conjecture that the volume-return nexus is facilitated by its link to systematic risk. Noise trader models and tax- as well as non-tax-related motives also suggest a positive association between stock returns and trading volume (Hiemstra and Jones, 1994).

On the empirical front, many studies have confirmed the presence of a positive relationship between stock price change and trading volume in different markets. Starting from the 1960s to about 1990, price-volume relationship studies were mainly conducted on advanced stock markets. However, in recent years, with growing and better structured emerging markets, numerous empirical results using data on emerging economies such as South America, China and India have started surfacing. Karpoff (1987) concludes, after reviewing the earlier studies, that volume is positively linked to the magnitude of price change and to price change per se in equity markets.

The price-volume empirical literature continues to grow over time and an increasing number of studies continue to investigate the price-volume relationship in developed as well as in emerging markets. Hiemstra and Jones (1994) use U.S. data to examine the dynamic relation between stock returns and trading volume and find, on the one hand, the presence of a unidirectional causality from stock returns to percentage volume changes when they use linear Granger causality tests. However, they find the presence of a bidirectional relationship, on the other hand, when they use nonlinear Granger causality tests. Assogbavi et al. (1995) use Canadian data and validate the positive asymmetric price-volume relationship. The authors demonstrate that positive price changes are associated with higher trading volume than negative price changes. Brailsford (1996) use Australian stock market data and finds support for the asymmetric price-volume relationship. In emerging markets, Saatcioglu and Starks (1998) also find a positive relationship between trading volume and both the magnitude of price change and price change per se – in support of asymmetry; but they do not find strong evidence supporting the contention that stock prices Granger-cause trading volume. Lee and Rui (2002) document evidence of a contemporaneously positive relationship between trading volume and stock returns in the U.S., U.K. and Japanese stock markets but they do not find evidence of any causality between trading volume and stock returns. Using S&P 500 price index data, Chen (2012) finds strong evidence of asymmetric contemporaneous relationship between returns and volume. The author also finds that stock returns have a contemporaneously negative correlation with trading volume (i.e., negative asymmetry) in bear markets but are contemporaneously positively correlated with volume (i.e., positive asymmetry) in bull markets. Chen's (2012) findings also support the presence of unidirectional Granger causality in the S&P 500, with past stock returns predicting trading volume in both bear and bull markets but past trading volume having a weaker ability to predict returns. Gold et al. (2013) analyze the Dow Jones Industrial Average component stocks and find, consistent with the tax-loss hypothesis, positive average abnormal daily December trading volume for depressed stocks (i.e., stocks whose prices have declined) and negative average abnormal daily December trading volume for other stocks. Cook and Watson (2017) use different definitions of price change and find strong contemporaneous and bidirectional causal relationship between price change (calculated using daily FTSE 100 high values) and trading volume in the U.K. Kao et al. (2019) use U.S. data and find that contemporaneous and lagged trading volume positively influence stock returns, leading them to conclude that there is an asymmetric correlation between price change and trading volume.

The recent literature continues to support the contemporaneous and causal price-volume relationship in not only developed markets but in emerging markets as well. For instance, Li et al. (2016) find, using nonlinear Granger tests, a bidirectional causality between stock price changes and trading volume in China. Hsu et al. (2016) examine the price-volume relationship around stock price reversals and rebounds in Taiwan and find asymmetric effects on the price-volume relationship around price increases as well as price decreases. As well, the findings of Gupta et al. (2018) indicate that lagged stock returns Granger cause trading volume in the long run in both China and India, while the findings of Sampath and Garg (2018) do not only indicate strong evidence of a positive association between stock returns and trading volume in India but also indicate a lead-lag relation with strong evidence of Granger causality from stock returns to trading volume. Abdelzaher (2019) finds the January 25, 2011 Arab Spring revolution in Egypt significantly negatively affected trading volume in the one-year pre- and post-event periods. Girard and Omran (2009) find that earlier initiatives undertaken by the EGX to improve its information environment have led to some improvements in trading efficiency and information dissemination over the 1998 to 2005 period.

The price-volume relationship has also been documented in markets other than equity markets. In the foreign exchange market, Kumar (2017) finds a contemporaneous relationship between currency futures price changes and trading volume; the author also finds a one-way Granger causality running from currency futures price changes to trading volume. In the bitcoin market, El Alaoui et al. (2018) find a positive association between bit coin price changes and trading volume. In the real estate market, while Tsai (2019) finds that price and volume efficiently react to information with no lead-lag relationships under normal conditions, the author reports that during boom periods or busts periods in the U.S. housing market, there is a lead-lag relationship between price and volume.

However, it is important to mention that not all of the price-volume relationship studies find evidence of a positive relationship between stock returns and trading volume. For example, Saatcioglu and Starks (1998) find that the well-documented contemporaneous association between returns and volume is insignificant in Mexico and that the contemporaneous relation between absolute returns and volume is insignificant in Brazil. Wang et al. (2018) also find that out-of-sample, the price-volume relationship has a weak predictive power.

So far in the literature, there is a dearth of empirical evidence on the price-volume relationship in African stock markets. However, with the Africa continent becoming an important economic player (Leke and Yeboah-Amankwah, 2018; Leke et al., 2018) and African financial markets beginning to appeal to global investors who look to diversify their portfolios, there is an increasing need to investigate the price-volume relationship in the major African stock markets.

This study is an attempt to provide the much-needed evidence on the price-volume relation in Africa.

3. Hypothesis, Data and Methodology

3.1 Hypothesis

Since the EGX has undertaken several initiatives in recent years to improve the information environment of the market and Girard and Omran (2009) find earlier initiatives to have led to some improvements, we contend that the recent initiatives would also lead to some improvements in information flow in the EGX. As a result, we expect to find a strong contemporaneously positive relationship between price change and trading volume. Therefore, we hypothesize that:

H_1: The magnitude of stock returns would be contemporaneously positively related to trading volume in the EGX.

H_2: Stock returns per se would be contemporaneously positively related to trading volume in the EGX.

However, since the EGX is still an emerging market with evolving market microstructure, we expect to find some level of market inefficiency – as it is the case for most emerging markets. As a result, past trading volume and past stock price changes would potentially have some influence on current trading volume and stock returns. Consequently, we hypothesize that:

H_3: Stock returns would Granger-cause trading volume in the EGX.

H_4: Trading volume would Granger-cause stock returns in the EGX.

3.2 Data and Sample

The EGX data used in this paper come from DataStream. They are weekly data covering our study period that stretches from 2011 to 2017 and comprise closing stock prices, volume traded, market capitalization and number of shares outstanding. Since the variables needed to test our hypotheses are stock returns and trading volume, we calculate them using the DataStream data. Stock return/price change is calculated as the natural log of the current week's price divided by the natural log of the previous week's price. Trading volume is calculated as volume traded divided by shares outstanding. To avoid common problems related to missing data in the analysis, only corporations with weekly data covering at least 95% of the entire study period are selected. Out of the about 167 EGX listed firms that have some data in the DataStream database at the end of our sample period in 2017, only 34 are eligible for inclusion in our analysis. The descriptive statistics about the sampled companies are presented in Table 1.

Table 1. Descriptive Statistics

	Stock Returns					Trading Volume	Market Cap (EGP Millions)
	Mean	Median	Std Dev	Skewness	Kurtosis	Average	Average
ALEXANDRIA MRL.OILS	0.0030	0.0000	0.0491	0.8292	11.9527	0.0065	5,781.02
AMER GROUP	-0.0024	0.0000	0.0702	-0.0011	3.8828	0.0094	2,722.17
ARAB COTTON GINNING	0.0005	0.0000	0.0700	0.5524	6.7617	0.0133	1,016.72
ARABIA INVS.DEV.FIN.	-0.0009	0.0000	0.0662	0.2279	6.0685	0.0132	487.44
ASEK COMPANY FOR MINING	-0.0005	0.0000	0.0670	0.3468	6.1371	0.0026	364.00
CITADEL CAPITAL	-0.0055	-0.0076	0.0687	-0.0609	4.6818	0.0098	2,589.21
COML.INTL.BANK (EGYPT)	0.0032	0.0005	0.0453	-0.0649	5.1908	0.0013	40,976.51
EFG HERMES HDG.	0.0004	0.0000	0.0622	0.3366	5.6866	0.0039	7,979.44
EGYP.FOR TOURISM RSTS.	-0.0011	0.0000	0.0687	-0.1091	4.6124	0.0075	1,170.71
EGYPT IRON & STEEL	0.0006	-0.0024	0.0781	0.7641	7.8015	0.0018	3,898.62
EGYPTIAN CHEMICAL IND	-0.0010	0.0000	0.0793	0.5240	8.5386	0.0029	2,726.60
EGYPTIAN ELECTRIC CABLE	-0.0002	0.0000	0.0567	-0.0257	4.2779	0.0068	469.98
EGYPTIAN FINL.& INDL.	-0.0002	-0.0040	0.0536	0.3754	3.9545	0.0038	751.45
EGYPTIAN KUWAITI HOLDING	-0.0019	0.0000	0.0472	-0.0654	8.1047	0.0008	787.10
EGYPTIANS ABROAD INVS.	-0.0009	-0.0025	0.0698	-0.2893	5.7629	0.0071	179.55
EGYPTIANS HOUSING DEV.	-0.0003	-0.0033	0.0702	-0.0515	6.0731	0.0044	334.79
EL AHLI INV.& DEV.	-0.0006	0.0000	0.0712	-0.0309	5.3814	0.0056	174.36
ELSAEED CONTRACT AND REAL ESTATE	0.0003	0.0000	0.0587	-0.0274	4.9961	0.0167	552.84
EXTRACTED OILS DERIVATRE	0.0008	0.0000	0.0599	-0.0396	5.9255	0.0074	152.53
GIZA GENERAL CONTRACTING	0.0008	0.0000	0.0645	-0.1597	5.4004	0.0857	281.37
HELIOPOLIS HOUSING	0.0047	0.0003	0.0617	0.3026	5.4226	0.0046	5,080.04
MARIDIVE & OIL SERVICES	-0.0055	0.0000	0.0520	-0.0378	7.9924	0.0009	350.56
MEDINET NASR HOUSING	0.0033	0.0005	0.0573	0.4337	6.4743	0.0082	5,217.57
MENA TOURISM & RLST.INV.	-0.0018	0.0000	0.0656	0.1126	7.0530	0.0057	128.20
NATIONAL DEV.BANK	0.0024	0.0012	0.0589	0.2162	5.6211	0.0019	1,286.00
PALM HILLS DEVS.SAE	-0.0005	0.0000	0.0708	-0.0349	5.4333	0.0082	4,489.63
PIONEERS HOLDING	0.0032	0.0000	0.0726	0.1641	4.2999	0.0039	4,202.26
SIDI KERIR PETROCHEM.	0.0015	0.0000	0.0395	0.0550	5.1311	0.0004	7,850.35
SIX OF OCT.DEV.& INV.	0.0008	-0.0013	0.0721	0.4619	7.1363	0.0072	3,119.06
SOUTH VALLEY CEMENT	-0.0001	-0.0021	0.0568	-0.1981	4.6855	0.0013	2,346.84
TALAAT MOUSTAFA GROUP	0.0005	0.0000	0.0596	-0.2239	5.5968	0.0017	13,573.42
TELECOM EGYPT	-0.0010	0.0007	0.0423	-0.5255	4.4741	0.0004	20,954.50
UNITED ARAB SHIPPING	0.0005	0.0000	0.0739	0.1619	5.4543	0.0131	180.60
UNITED HOUSING & DEV.	0.0019	-0.0008	0.0573	-0.0054	5.7181	0.0038	942.24
Overall Average	0.0001	0.0000	0.0630	0.1541	6.5180	0.0080	4,209.34

Presented in Table 1 are descriptive statistics (i.e., mean, median, standard deviation, skewness and kurtosis) on stock returns as well as average volume and average market capitalization for the 34 sampled EGX firms over the 2011 to 2017 sample period.

Table 1 demonstrates that the 34 companies cut across the size spectrum – from small- to medium- to large-sized firms. While the average market capitalization is about 4.2 billion EGP, market capitalization of the sampled firms ranges from a minimum of 128.2 million EGP to a maximum of 41.0 billion EGP over the sample period. Sampling firms across the size spectrum is beneficial because the results of the study would be generalizable to a broad range of companies including small, medium and large companies. The average weekly stock return is about 0.01% and average weekly trading volume is about 0.8%.

3.3 Methodology

Before investigating the stock price change-trading volume causality question, we first analyze the two contemporaneous characteristics of the price-volume relationship in the EGX. Since the vector autoregressive (VAR) model is the predominant methodology used to examine the return-volume relation in the literature, we follow the literature and use the same approach in this study. For the causality relationship tests, we follow Chen (2012) and use Granger causality tests.

3.3.1 Estimating Contemporaneous Price-Volume Relationship

To explore the contemporaneous correlation between stock returns and trading volume, we follow Karpoff (1988) and estimate the following regression equations:

$$V_t = \propto + \beta_1 |R_t| + \varepsilon_t \tag{1}$$

$$V_t = \propto + \beta_1 R_t + \varepsilon_t \tag{2}$$

where $V_t = \frac{Volume\ Traded_t}{Number\ of\ Shares\ Outstanding_t}$ and

$R_t = \ln(\frac{Closing\ Price_t}{Closing\ Price_{t-1}})$.

We estimate Equation 1 for each of the sampled companies using the ordinary least squares (OLS) regression technique to first test the cotemporaneous positive relationship between the magnitude of price change and trading volume (H_1). Then, still using the same OLS regression technique, we analyze the asymmetric nature of the relationship by regressing the returns per se on volume as formulated in Equation 2 (H_2). To investigate the relationship at the aggregate portfolio level for the combined 34 sampled companies, we pool the data for the companies and use the panel data with firm fixed effects regression technique to estimate Equation 1 and Equation 2 for the pooled data.

3.3.2 Estimating Price-Volume Causal Relationship

The causal relationships between stock price change and trading volume (H_3 and H_4) are analyzed in this paper by following the extant literature and estimating the following VAR models:

$$V_t = \propto + \sum_{i=1}^{j} \beta_i V_{t-i} + \sum_{i=1}^{k} \gamma_i |R_{t-i}| + \varepsilon_t \tag{3}$$

$$|R_t| = \propto + \sum_{i=1}^{j} \gamma_i |R_{t-i}| + \sum_{i=1}^{k} \beta_i V_{t-i} + \varepsilon_t \tag{4}$$

where j and k are the number of lags.

The estimation of VAR models requires the specification of the number of lags to use. To help determine the ideal number of lags (j and k) for the VAR models, we use Akaike's (1974) information criterion (AIC). Saatcioglu and Starks (1998) highlighted the possibility of autocorrelation in Granger causality tests. Consequently, we use the Durbin-Watson as well as the Breush-Godfrey statistics to test for serial correlation. We then use the Cochrane-Orcut and Prais-Winsten estimation approach to correct for first-order serial correlation in all the VAR regressions.

To validate the conjecture of sequential dissemination of information, we lean on Hiemstra and Jones' (1994) emphasis on the important role of tests of causality to help establish whether knowledge of past stock price (trading volume) movements help improve predictions of contemporaneous and future movements in volume (stock prices). Hence, we use Granger Causality tests (following Hiemstra and Jones, 1994) to ascertain whether or not there is a unidirectional or bidirectional causal relationship between stock price change/returns and trading volume.

We use the block exogeneity F test to test for Granger causality. A standard block exogeneity F test of the significance or otherwise of the γ_i coefficients in Equation 3, will indicate whether or not returns Granger-cause volume (H_3). To determine whether or not volume Granger-cause returns (H_4), the significance or otherwise of the block exogeneity F test for the β_i coefficients (in Equation 4) is used. If returns Granger-cause volume, then the inclusion of past returns (in addition to past volume) in the VAR regressions would lead to improved forecasts of future volume. Likewise, if trading volume Granger-cause stock returns, then the inclusion of past volume (in addition to past returns) in the VAR models would lead to improved predictions of future stock returns.

4. Results

4.1 Stock Returns and Trading Volume Relationship

We used a two-pronged approach to analyze the contemporaneous relationship between stock returns and trading volume. In our first approach, which is aimed at testing hypotheses 1 and 2 for the portfolio of 34 Egyptian Stock Exchange listed firms, we estimate Equation 1 and Equation 2 by pooling the weekly data for the firms and controlling for firm fixed effects. The results of the firm fixed effects regressions for the portfolio of 34 Egyptian stocks are reported in Table 2.

Table 2. Contemporaneous Price-Volume Relation using Pooled Data and Controlling for Firm Fixed Effects

	Volume	Volume
Absolute Stock Returns	0.0511***	-
	(7.14)	-
Stock Returns	-	0.0487***
	-	(9.95)
Constant	0.0049***	0.0063***
	(2.70)	(3.50)
Firm Fixed Effects	Yes	Yes
N	10,964	10,964
R^2	0.1632	0.1668
F	62.68***	64.36***

Results of the firm fixed effects regressions that regress trading volume on absolute stock returns and signed stock returns for the pooled sample of 34 EGX firms over the 2011 to 2017 sample period are reported in Table 2. The results for Equation 1 ($V_t = \propto + \beta_1 |R_t| + \varepsilon_t$) are presented in column 2 while column 3 presents the results for Equation 2 ($V_t = \propto + \beta_1 R_t + \varepsilon_t$). The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. (t statistics are in parentheses)

Consistent with prior literature, the results from Table 2 indicate a strong positive contemporaneous relationship between stock returns and trading volume. The results of the estimates of Equation 1 (Table 2 column 2) support our first hypothesis (H_1) and indicate that there is a strong positive relationship between the magnitude of price change and trading volume. This finding is also well documented in the literature (e.g., Saatcioglu and Starks, 1998) and lends support to the Wall Street adage that "it takes volume to make prices move". In fact, regressing trading volume on absolute stock returns yields a positive coefficient which is significant at the 1% level. This connotes that in the Egyptian context, there is strong evidence of a contemporaneously positive relationship between absolute price change and trading volume.

The results of the firm fixed effects regression that regresses trading volume on stock returns per se (Equation 2) are reported in Table 2 column 3. The coefficient of the independent variable, the stock returns per se, is positive (as expected) and statistically significant at the 1% level. The significant positive relationship supports our second hypothesis (H_2) and implies that there is heavy trading volume associated with positive stock returns than negative stock returns. The strong positive association between returns and volume are not only consistent with prior literature (e.g., Karpoff, 1987; Hiemstra and Jones, 1994; Lee and Rui, 2002; Sampath and Garg, 2018) but also confirm the validity of another important Wall Street adage in the Egyptian stock market, that "volume is relatively heavy in bull markets and light in bear markets". With R^{2}s that are greater than 15% for both regression models, we conclude that the price-volume models also fit the data well.

While our first approach involved estimating the contemporaneous price-volume relationship for the pooled portfolio of 34 companies, our second approach to establishing the extent to which trading volume and stock returns are contemporaneously correlated involves re-estimating Equations 1 and 2 for each of the 34 individual firms. The results of regressing absolute trading volume on stock returns (Equation 1) for each company are presented in Table 3.

Table 3. Firm Level Absolute Price Change-Volume Relationship

Company	$\propto$	t	β_1	t	N	Model F	R^2
ALEXANDRIA MRL.OILS	0.0033***	4.56	0.1029***	7.12	322	50.64***	0.1366
AMER GROUP	0.0048***	6.08	0.0860***	7.61	323	57.87***	0.1527
ARAB COTTON GINNING	0.0108***	11.64	0.0508***	3.92	323	15.33***	0.0456
ARABIA INVS.DEV.FIN.	0.0093***	9.75	0.0821***	5.84	321	34.14***	0.0967
ASEK COMPANY FOR MINING	0.0015***	3.91	0.0223***	4.07	323	16.60***	0.0492
CITADEL CAPITAL	0.0070***	7.65	0.0525***	3.95	323	15.63***	0.0464
COML.INTL.BANK (EGYPT)	0.0007***	5.78	0.0175***	6.35	323	40.38***	0.1117
EFG HERMES HDG.	0.0024***	8.06	0.0306***	6.36	322	40.44***	0.1122
EGYP.FOR TOURISM RSTS.	0.0051***	6.45	0.0464***	4.09	323	16.71***	0.0495
EGYPT IRON & STEEL	0.0014***	8.10	0.0072***	3.37	321	11.35***	0.0343
EGYPTIAN CHEMICAL IND	0.0018***	3.82	0.0200***	3.28	321	10.73***	0.0325
EGYPTIAN ELECTRIC CABLE	0.0038***	5.18	0.0702***	5.38	323	28.99***	0.0828
EGYPTIAN FINL.& INDL.	0.0017***	4.23	0.0516***	6.99	323	48.91***	0.1322
EGYPTIAN KUWAITI HOLDING	0.0005**	1.98	0.0098*	1.96	323	3.83*	0.0118
EGYPTIANS ABROAD INVS.	0.0052***	8.03	0.0361***	3.82	323	14.62***	0.0435
EGYPTIANS HOUSING DEV.	0.0032***	7.97	0.0219***	3.81	323	14.49***	0.0432
EL AHLI INV.& DEV.	0.0041***	7.98	0.0282***	3.85	323	14.80***	0.0441
ELSAEED CONTRACT AND REAL ESTATE	0.0109***	7.20	0.1332***	5.20	323	27.04***	0.0777
EXTRACTED OILS DERIVATRE	0.0033***	4.22	0.0921***	6.99	322	48.83***	0.1324
GIZA GENERAL CONTRACTING	0.0714***	4.66	0.2961	1.24	323	1.54	0.0048
HELIOPOLIS HOUSING	0.0019***	4.09	0.0599***	8.14	323	66.33***	0.1712
MARIDIVE & OIL SERVICES	0.0005***	5.47	0.0117***	6.80	323	46.24***	0.1259
MEDINET NASR HOUSING	0.0075***	3.04	0.0159	0.37	322	0.14	0.0004
MENA TOURISM & RLST.INV.	0.0030***	3.68	0.0576***	4.63	323	21.45***	0.0626
NATIONAL DEV.BANK	0.0012***	6.88	0.0167***	5.80	322	33.67***	0.0952
PALM HILLS DEVS.SAE	0.0064***	12.90	0.0340***	4.90	322	24.02***	0.0698
PIONEERS HOLDING	0.0028***	8.15	0.0208***	4.49	321	20.12***	0.0593
SIDI KERIR PETROCHEM.	0.0001***	2.99	0.0100***	8.58	323	73.67***	0.1867
SIX OF OCT.DEV.& INV.	0.0033***	4.81	0.0750***	7.91	323	62.53***	0.1630
SOUTH VALLEY CEMENT	0.0008***	4.73	0.0114***	3.76	323	14.17***	0.0423
TALAAT MOUSTAFA GROUP	0.0004**	2.32	0.0282***	9.02	323	81.28***	0.2021
TELECOM EGYPT	0.0002***	7.36	0.0057***	7.33	323	53.78***	0.1435
UNITED ARAB SHIPPING	0.0094***	8.52	0.0703***	4.71	321	22.22***	0.0651
UNITED HOUSING & DEV.	0.0017***	2.86	0.0501***	4.71	321	22.18***	0.0650

For each of the 34 EGX firms over the 2011 to 2017 sample period, Table 3 presents the Equation 1 ($V_t = \propto + \beta_1 |R_t| + \varepsilon_t$) OLS regressions' results regressing trading volume on absolute stock returns. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

The results of the individual firm level regressions in Table 3 are consistent with the pooled results and corroborate the strong positive relationship between absolute stock returns and trading volume. As shown in Table 3, a significantly positive relationship between trading volume and absolute stock returns is documented for 32 firms out of the 34 firms.

As well, the positive relationship is significant at the 1% level for 31 firms and only 1 firm has a significantly positive association between absolute price change and trading volume at the 10% level. The firm level results in Table 3 also support hypothesis 1.

The firm level regressions that regress trading volume on stock returns per se (Equation 2) are reported in Table 4.

Table 4. Price-Volume Relationship at the Firm Level

Company	$\propto$	t	β_1	t	N	Model F	R^2
ALEXANDRIA MRL.OILS	0.0063***	10.72	0.0598***	5.11	322	26.09***	0.0754
AMER GROUP	0.0095***	17.96	0.0554***	7.35	323	54.02***	0.1440
ARAB COTTON GINNING	0.0132***	21.47	0.0672***	7.77	323	60.30***	0.1581
ARABIA INVS.DEV.FIN.	0.0132***	20.66	0.0707***	7.46	321	55.71***	0.1487
ASEK COMPANY FOR MINING	0.0026***	10.30	0.0158***	4.29	323	18.42***	0.0543
CITADEL CAPITAL	0.0100***	16.62	0.0437***	5.02	323	25.25***	0.0729
COML.INTL.BANK (EGYPT)	0.0013***	14.17	0.0037*	1.86	323	3.47*	0.0107
EFG HERMES HDG.	0.0039***	18.03	0.0039	1.15	322	1.32	0.0041
EGYP.FOR TOURISM RSTS.	0.0075***	14.30	0.0282***	3.72	323	13.85***	0.0414
EGYPT IRON & STEEL	0.0018***	15.11	0.0096***	6.52	321	42.57***	0.1177
EGYPTIAN CHEMICAL IND	0.0029***	8.48	0.0111**	2.54	321	6.44**	0.0198
EGYPTIAN ELECTRIC CABLE	0.0068***	13.52	0.0466***	5.28	323	27.83***	0.0798
EGYPTIAN FINL.& INDL.	0.0038***	14.70	0.0349***	7.29	323	53.13***	0.1420
EGYPTIAN KUWAITI HOLDING	0.0008***	4.40	-0.0022	-0.57	323	0.33	0.0010
EGYPTIANS ABROAD INVS.	0.0071***	17.10	0.0385***	6.37	323	40.59***	0.1122
EGYPTIANS HOUSING DEV.	0.0043***	17.22	0.0270***	7.49	323	56.04***	0.1486
EL AHLI INV.& DEV.	0.0057***	18.03	0.0395***	8.89	323	78.97***	0.1974
ELSAEED CONTRACT AND REAL ESTATE	0.0167***	17.46	0.1262***	7.79	323	60.71***	0.1590
EXTRACTED OILS DERIVATRE	0.0072***	14.15	0.0764***	8.89	322	79.11***	0.1982
GIZA GENERAL CONTRACTING	0.0851***	8.57	0.5351***	3.45	323	11.93***	0.0358
HELIOPOLIS HOUSING	0.0045***	14.00	0.0322***	6.25	323	39.10***	0.1086
MARIDIVE & OIL SERVICES	0.0009***	13.54	0.0064***	4.86	323	23.60***	0.0685
MEDINET NASR HOUSING	0.0081***	4.85	0.0178	0.61	322	0.38	0.0012
MENA TOURISM & RLST.INV.	0.0058***	10.89	0.0508***	6.20	323	38.48***	0.1070
NATIONAL DEV.BANK	0.0019***	15.45	0.0098***	4.85	322	23.51***	0.0684
PALM HILLS DEVS.SAE	0.0083***	24.84	0.0315***	6.83	322	46.71***	0.1274
PIONEERS HOLDING	0.0038***	17.34	0.0173***	5.69	321	32.37***	0.0921
SIDI KERIR PETROCHEM.	0.0004***	11.97	0.0028***	3.19	323	10.19***	0.0308
SIX OF OCT.DEV.& INV.	0.0072***	13.82	0.0187***	2.61	323	6.79***	0.0207
SOUTH VALLEY CEMENT	0.0013***	11.64	0.0098***	5.01	323	25.11***	0.0725
TALAAT MOUSTAFA GROUP	0.0017***	11.76	-0.0040*	-1.67	323	2.80*	0.0086
TELECOM EGYPT	0.0004***	17.79	0.0019***	3.38	323	11.44***	0.0344
UNITED ARAB SHIPPING	0.0131***	17.48	0.0675***	6.66	321	44.42***	0.1222
UNITED HOUSING & DEV.	0.0037***	8.77	0.0297***	3.97	321	15.77***	0.0471

This table reports the Equation 2 ($V_t = \propto + \beta_1 R_t + \varepsilon_t$) OLS regressions' results regressing trading volume on stock returns for each of the 34 EGX firms over the 2011 to 2017 period. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

The results of the individual firm level regressions in Table 4 support hypothesis 2 and confirm the strong positive relationship between price change and volume documented at the pooled portfolio level. Out of the 34 companies, the relationship between stock returns and trading volume is statistically significant for 31 companies (i.e., more than 90% of the companies). Out of the 31 significant results, the relationship is significantly positive for 30 companies (i.e., 97%

of the companies) and only one company has stock returns that are weakly significantly negatively related to trading volume (at the 10% level). Of the significant results, over 90% (28 out of 31) are significantly positive at the 1% level while 1 out of 31 is significant at the 5% level and 2 out of 31 (including the one case of a negative relationship) are significant at the 10% level.

Overall, the hypotheses that stock returns are contemporaneously and asymmetrically positively related to trading volume (H_1 and H_2) are confirmed by the results reported in Tables 2 to 4. The strong positive price-volume relationship suggests that the recent initiatives undertaken by the EGX may have helped to improve the information flow and efficiency of the market. Specifically, we conjecture that as new information arrives in the Egyptian stock exchange (as proxied by trading volume), it is instantaneously incorporated into stock prices – suggesting some improved level of market efficiency. These results are also consistent with prior studies documenting a positive relationship between returns and trading volume and additionally support two Wall Street adages. Thus, similar to Girard and Omran's (2009) conclusion that earlier initiatives undertaken by the EGX helped in improving information flow, we also conclude that the recent initiatives undertaken by the EGX to improve its structure and information transparency appear to be positively impacting the information environment as new information (proxied by trading volume) is contemporaneously impounded into stock prices, leading to the strong positive contemporaneous price-volume relationship.

4.2 Price-Volume Granger Causality Tests

To further investigate the price-volume relationship, the paper attempts to test hypothesis 3 and hypothesis 4 in order to ascertain whether there are causal relationships between stock price change and trading volume. As pervasively done in the literature, we examine the question of causal links between returns and volume by estimating the Equation 3 and Equation 4 vector autoregressive (VAR) models and then performing Granger causality tests. Since the VAR regressions require the specification of lags, we leverage Akaika's (1974) information criteria (AIC) to determine the ideal number of lags to use in the VAR regressions. We summarize the optimal number of lags suggested by AIC in Table 5.

Table 5. Best number of Lags for Granger Causality Tests

AIC Recommended Lags	Number of Companies	% of Companies	Cumulative %
0	1	2.9%	2.9%
1	8	23.5%	26.5%
2	5	14.7%	41.2%
3	7	20.6%	61.8%
4	6	17.6%	79.4%
5	1	2.9%	82.4%
6	1	2.9%	85.3%
7	0	0.0%	85.3%
8	5	14.7%	100.0%

We use Akaike's (1974) information criteria (AIC) to determine the optimal number of lags and report the count statistics for the 34 EGX firms in Table 5.

From Table 5, AIC recommends lags of 0 to 3 for two-thirds of the sampled firms and lags of 0 to 4 for almost 80% of the 34 firms. Indeed, for all the firms, AIC recommends lags of no more than 8, suggesting that it may take up to 8 weeks for past technical information on price and volume to be fully reflected in current prices and volume. This gradual incorporation of lagged values, leading to a slightly longer horizon (of 8 weeks) over which past technical information on price and volume are incorporated into current stock prices and trading volume, potentially signals some level of market inefficiency. Thus, since it takes about 2 months for lag values to be fully incorporated into current stock prices and trading volume, we surmise that the Egyptian stock market is slightly less efficient compared to stock markets in advanced countries.

Since the AIC information in Table 5 suggests that lags of 0 to 8 are appropriate for all companies, we use 8 lags to run the VAR regressions and to perform Granger causality tests. Hiemstra and Jones (1994) also note that 8 lags is one of the most commonly used lags in the literature. We pooled the portfolio of 34 firms and run the VAR regressions and Granger causality tests on the pooled data, controlling for firm fixed effects and correcting for first order serial correlation.

Table 6. Pooled VAR (with Firm Fixed Effects) and Granger Causality Tests

	Volume	t	Absolute Stock Returns	t
Volume Lag 1	0.5269***	37.75	0.0192	0.57
Volume Lag 2	-0.0742***	-7.26	0.0018	0.08
Volume Lag 3	-0.0088	-0.88	0.0343	1.34
Volume Lag 4	0.1565***	16.29	-0.0464*	-1.89
Volume Lag 5	0.0295**	2.08	-0.0025	-0.10
Volume Lag 6	0.0096	0.61	0.0220	0.63
Volume Lag 7	0.1607***	10.00	0.0108	0.27
Volume Lag 8	0.0115	0.83	0.0019	0.06
Absolute Stock Returns Lag 1	-0.0060	-1.06	0.4647***	33.09
Absolute Stock Returns Lag 2	0.0098*	1.65	-0.1485***	-10.07
Absolute Stock Returns Lag 3	0.0122**	2.12	0.1059***	7.29
Absolute Stock Returns Lag 4	-0.0116**	-2.09	0.0261*	1.87
Absolute Stock Returns Lag 5	0.0051	0.89	-0.0172	-1.23
Absolute Stock Returns Lag 6	0.0003	0.05	0.0088	0.61
Absolute Stock Returns Lag 7	-0.0088	-1.53	-0.0167	-1.16
Absolute Stock Returns Lag 8	0.0108*	1.90	0.0594***	4.49
Constant	0.0013	1.13	0.0150***	5.61
Firm Fixed Effects	Yes		Yes	
N	4,222		4,797	
R2	0.6488		0.2465	
Model F	157.31***		31.70***	
Absolute Stock Returns Lags Block F	2.29**		-	
Volume Lags Block F	-		0.90	

This Table documents results of pooled VAR regressions with firm fixed effects and Granger causality tests. Equation 3 results are reported in column 2 where trading volume is regressed on the first 8 lags of volume and the first 8 lags of absolute stock returns. The t statistics for Equation 3 are reported in column 3. Equation 4 results are presented in column 4 where absolute stock return is regressed on the first 8 lags of volume and the first 8 lags of absolute stock returns. The t statistics for Equation 4 are reported in column 5. We correct the VAR regressions for first order autocorrelation in the data. The symbols ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Results of Equation 3 are reported in column 2 of Table 6. The block exogeneity F test rejects the null hypothesis that the 8 lags of stock returns are statistically indistinguishable from zero. The statistically significant block exogeneity F tests for the lags of stock returns indicate that past stock returns significantly Granger-cause trading volume at the 5% conventional level of significance. This supports hypothesis 3. Also, consistent with the sequential information arrival hypothesis espoused by Copeland (1976), our results imply that trading interests created by changes in prices are not spontaneously cleared until about two months (i.e., 8 weeks or 8 lags) later. This suggests that in the Egyptian stock market, some investors are late in the information queue and it could take up to two months (8 weeks) for the information content of past returns to be impounded in stock trading. It should be noted that this is not out of the ordinary, especially for emerging/frontier financial markets, since the information architecture of these markets are still developing.

On the question of whether trading volume Granger-cause stock returns (hypothesis 4), however, we are unable to reject the null hypothesis since the block exogeneity F statistic is statistically indistinguishable from zero. Consequently, we conclude that in the Egyptian context, trading volume does not Granger-cause stock returns. Our results do not support hypothesis 4.

All in all, our Granger causality tests show that in the Egyptian stock market, there is a unidirectional Granger causality from stock returns to trading volume but not from trading volume to stock returns. Given that the EGX is an emerging financial market, the unidirectional causality may also suggest that noise traders using prior price change information as the basis for their trading decisions may be driving up volume, leading to stock returns Granger causing trading volume. The results of the Granger causality tests of this study are similar to the results of

Chen (2012) and Sampath and Garg (2018), who find strong evidence of causality from returns to volume but not from volume to returns.

5. Conclusion

Using data on a portfolio of 34 most active stocks from 2011 to 2017, this paper investigates the price-volume relationship in the EGX, one of the growing emerging stock markets in Africa. Our findings are, in general, consistent with prior studies on the price-volume relationship (e.g., Saatcioglu and Starks, 1998; Chen, 2012). Our results confirm that stock price changes are positively related to trading volume both at the individual firm level and the portfolio level. As for the nature of the relationship, our results indicate that the price-volume relationship is asymmetric. These findings support the two oldest Wall Street adages related to price and volume. The strong positive contemporaneous relationship also suggests that the various initiatives undertaken by the EGX may be having a positive effect in improving the information dissemination environment of the exchange. Additionally, when we investigate causal relationships, our results support only a unidirectional relationship that price change Granger causes trading volume (with lags extending up to 8 weeks) but not the other way around. This finding leads us to conclude that in the EGX, the information is sequentially distributed, thus impinging on the ability of investors at the end of the information queue to react rapidly. This delay in information dissemination and the absence of volume Granger causing price could be a source of some inefficiency in the EGX.

Overall, our findings are consistent with prior studies on the price-volume relation in other jurisdictions. Given the continuing development of African financial markets and their potential attractiveness to global investors from a portfolio diversification perspective, we believe that our study is beneficial to not only the academic world but to practitioners, including investors who might be interested in implementing investment strategies like momentum in the EGX. Since momentum and other investment strategies' performance may be influenced by the information environment and microstructure of the EGX, the empirical results we present in this study may be beneficial to investors. A potential limitation of our study relates to the use of weekly data. Although the use of weekly data is the predominant approach in the literature, Karpoff (1987) raised the possibility that the price-volume relationship could be affected by the data measurement frequency. Consequently, our results could be driven by the use of weekly data. We therefore suggest that future research analyze the price-volume relationship in the EGX using other data frequencies such as monthly data, quarterly data or annual data.

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