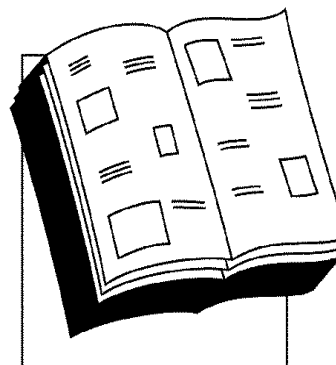


ПРОБЛЕМЫ УЧЕТА, АНАЛИЗА, АУДИТА И СТАТИСТИКИ



ABDO ALI NASSER ALDINE

STATISTICAL FORECASTING OF STOCK PRICES IN LEBANON BASED ON ADAPTIVE MODELS

Nowadays, there are a lot of methods and models to forecast the future values of stock prices, the statistical methods being one of them. The statistical methods have proved to be efficient in the study of time-series, especially the exponential smoothing methods have become very popular among researchers due to their reliability. This research explores time-series analysis of three stocks of Beirut Stock Exchange in three different sectors of the economy over the period from 2017 through 2020. It provides analysis based on exponential smoothing methods and decomposition of daily time-series data using STATISTICA software; the forecasting methods are deduced using MAPE and SSE with the best value of α . It was found that the adaptive forecasting methods (Brown's model) can be effectively applied for daily forecasting values of Lebanese stock prices, and using historical N days stock price on its own can provide a relatively accurate prediction of $N + 1$ day's stock price.

Keywords: Lebanese stocks; decomposition; smoothed data; trend; Brown's model; forecasting.

UDC 311.174+ 336.761.5

Introduction. Historically, Lebanon had a relatively vital capital market in the Middle East before the stock exchange was closed for twenty years due to the civil war (1975–1995). Since its reopening in 1996, the stock market has been shrinking. The establishment of Solidere in the late 1990s and the renaissance of commercial banks motivated the stock market for a while before the volatility of the market hold back. Despite its big history and spirited past, the Lebanese stock market today is inactive and is contracting. In general, liquidity in Lebanese market is low, consistent with low trading activity, small number of listed companies, and low market capitalization, the low trading activities in the stock market is also believed to be contributing to investors and issuers' lack of confidence in the market, due to the political turmoil in Lebanon and its neighbors, making high risk for investments in the country. Forecasting stock prices is faced with the problem of the so-called «mood» of the exchange. The leading role here is played by the phenomenon of mass psychology of a large number of stock market participants. Such phenomena cannot be rationally explained, much less predicted.

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However, patterns exist. The processing of historical data on the movement of securities prices also confirms that the patterns of market movements exist. Forecasting is usually based on information available in the time series of stock market securities. The high requirements for forecast results have led to the emergence of adaptive forecasting methods. In this paper we attempt to find the best adaptive methods and more reliable for each stock studied, we test which one is better for each stock price and measure their accuracy using MAPE and SSE where it is necessary. This paper presents the work which stimulated the use of these methods and prompted a substantial amount of additional research in the Lebanese Market and especially in three stocks, each one from a sector, SOLA (Construction sector), BYB (Banking sector) and HOLC (Industrial sector). One of the most essential prerequisites for the success and sustained growth of emerging economies or markets is political stability. The country's political stability has been shaken several times in last four years.

In addition, the article provides a decomposition of the time series using STATISTICA software into seasonal, trend and cyclic components. Moreover, Adaptive forecasting methods are based on intensive analysis of information contained in separate time series, the models describing the structure of the stock price, as a rule, has a very clear meaning and simple mathematical formulation. The paper is organized as follow, section one is a literature review of the adaptive forecasting models and their development through the years, section two lists the methods used and describes the data collected, section three presents the results and the discussion of these results, and finally section four concludes the paper and opens the door to other researches and points to be discussed later.

Unlike other models where trading volume, opening price and other technical indicators are fed into the model, we built our forecasting models only using an adjusted close price in previous N days as input to predict price on day $N + 1$. This is because the stock price might be affected.

1. Literature Review. Nowadays there are a lot of methods and models to forecast the future values of the price, like machine learning methods, statistical methods. The statistical methods have proved to be efficient in the study of time-series, and especially, the exponential smoothing methods have become very popular among researchers due to their robustness (Gardner, 2006) [1]. The importance of these methods has been stressed in recent works (Gardner, 2006; Taylor, 2006) [2], and for example, the RiskMetrics document recommends the use of exponential methods to estimate the conditional volatility of financial markets (RiskMetrics, 1996) [3]. The adaptive exponential smoothing (AES) model has the advantage that their parameters vary as the time-series modifies its behavior allowing to forecast sudden variations. As a consequence, the AES method has been used to forecast market volatility (Taylor, 2004) [4] of important stock indexes like the Nikkei 225 Index of the Japan market (Leung, Daouk, & Chen, 2000) [5]. The exponential smoothing methods were often considered a collection of ad hoc techniques for extrapolating various types of univariate time series. Although exponential smoothing methods were widely used in stock market and industry, they had received little attention from statisticians and did not have a well-developed statistical foundation. These methods have its origin in the 1950s and 1960s with the work of Brown (1959, 1963) [6; 7], Holt (1957, reprinted 2004) [8], and Winters (1960) [9], there are three exponential smoothing techniques named: simple exponential smoothing, Holt's exponential smoothing, and Holt-Winters method. The simple exponential smoothing method requires little computation, and it is used when the data pattern has neither a cyclic variation nor a trend in the historical data. Holt's method, also known as the double exponential smoothing method, is used in time series that contains a trend. For seasonal time series, the Holt-winters technique is useful because it can capture both a trend and seasonality in the historical data. Pegels (1969) [10] provided a simple but useful classification of the trend and the seasonal patterns depending on

whether they are additive (linear) or multiplicative (nonlinear). Muth (1960) [11] was the first to suggest a statistical foundation for simple exponential smoothing (SES) by demonstrating that it provided the optimal forecasts for a random walk plus noise. Further steps towards placing exponential smoothing within a statistical framework were provided by Box and Jenkins (1970) [12], Roberts (1982) [13], and Abraham and Ledolter (1983, 1986) [14; 15], who showed that some linear exponential smoothing forecasts arise as special cases of ARIMA models. However, these results did not extend to any nonlinear exponential smoothing methods. Exponential smoothing methods received a support from two papers published in 1985, which laid the foundation for much of the subsequent work in this area. First, Gardner (1985) [16] provided a thorough review and synthesis of work in exponential smoothing to that date and extended Pegels' classification to include damped trend. Later in the same year, Snyder (1985) [17] showed that SES could be considered as arising from an innovation state space model (i. e., a model with a single source of error).

2. Data, materials and methods. The data for the three shares SOLA, BYB and HOLC was collected from the www.investing.com on a daily basis from January 2017 till August 2020. The data for each share is analyzed alone and it is divided into two or more parts according to the trend reverse. According to the length of a time series, we have selected the best methods and techniques for long time series which differ from those used for the short time series. In long time series we have used the decomposition of time series applying the STATISTICA software to find the seasonal factor, the adjusted data and the smoothed data given the actual data A_i , then we use these new data to find the cyclic components, the adjusted cyclic components, the trend component, the forecast value F_i and the error of forecast $A_i - F_i$.

After that when the trend reverses in the studied shares, for the short time series we have built another method of forecasting, the Brown's linear model. When building this model, the mathematical description is summarized by the following steps:

- For the first few points of the time series, we build a linear model $Y_t = a_0 + a_1 t$. The values of the parameters a_0 and a_1 are estimated by using the least square method.
- Using the parameters a_0 and a_1 found in the previous step, we find the forecast one step ahead $y_1 = a_0(0) + a_1(0)t$;
- Find the value $\varepsilon_j = y(i) - y(t)$;
- Correct the model's parameters according to the following formulas

$$\begin{aligned} a_0^{(t)} &= a_0^{(t-1)} + a_1^{(t-1)} + (1 - \beta^2)\varepsilon_t & \text{where } \beta &= 1 - \alpha \\ a_1^{(t)} &= a_1^{(t-1)} + (1 - \beta)^2 \varepsilon_t & \alpha & \text{ is the smoothing parameter;} \end{aligned}$$

- Using the parameters adjusted in the previous step, we find the forecast for the next time period ($t = 1$): $y_{t+\tau} = a_0^{(t)} + a_1^{(t)}\tau$.

- A point forecast for the future is calculated using the formula $y_t(n+t) = a_0(n) + a_1(n)\tau$ ($t = 1; 2; \dots$), where n is the number of observations.

SOLA share. The data about the price of SOLA was collected for the period from January 1, 2017 till August 23, 2020. The data were split into two parts. For the first part from January 1, 2017 till December 8, 2019 when the share price trend was decreasing, the data was analyzed and treated using the STATISTICA software. We found the adjusted and the smoothed data (Figure 1), the seasonal factor, the trend component, the cyclic component (cyclic component = smoothed component – trend component). Also we adjusted the cyclic component by taking the average of cyclic components in two years 2018 and 2019 for the period lying between June 8 and September 7 of both years. Then we found the difference between the two averages and added the difference obtained to the previous

cyclic component to obtain the adjusted cyclic component. After that we used the adjusted cyclic component of the year 2018 for the period from September 7 to December 8 to fill in the original cyclic component for the same period but in the year 2019. The next step was to calculate the final forecast F_i by using the formula $F_i = (\text{Trend component} + \text{Cyclic component}) \times \text{seasonal factor} / 100$, then after the calculation of F_i , the error of forecasting was calculated as well as the MAPE.

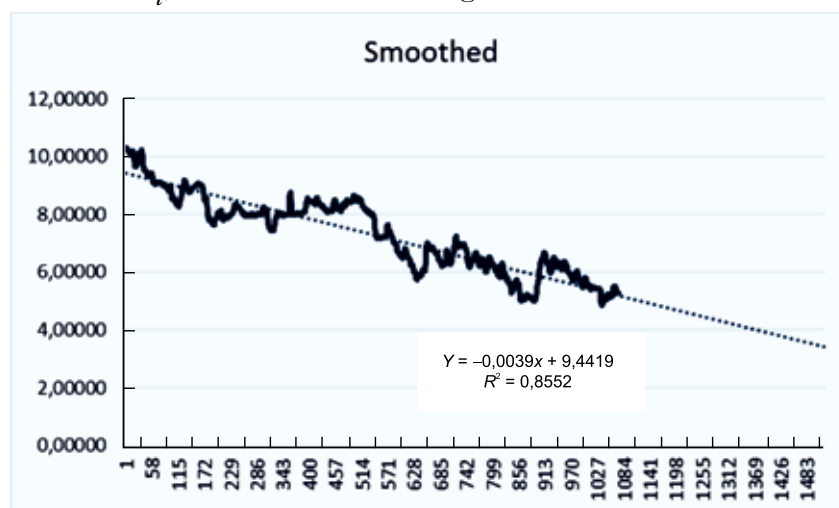


Fig. 1. Smoothed data of SOLA from January 1, 2017 till December 8, 2019

In the first period studied, SOLA share price was in downtrend due to several factors, first of all the investors were satisfied with the increase in the interest rate set by the commercial banks for the depositors on dollar and Lebanese pound deposits during this period. The interest rate increased from 6,263 % in 2017 to 9,697 % in 2019 which is considered the highest interest rate in the middle east, so the investors were not so interested in the construction sector while they could earn money easily. In addition, the number of real estate sales to foreigners and especially to Arabs decreased by about 50 % between 2010 and 2019, and decreased by 18 % during the year 2019 because of unfavorable political situation in Lebanon and the drop in oil prices from the peak of \$110 per barrel in 2014 to an average of \$64 per barrel in 2019 which affected the Arab investors in Solidere.

The second part is from December 9, 2019 till August 23, 2020. In this short period the trend was reversed into an uptrend (Figure 2). The calculation was done using the Brown's method mentioned above. The calculation of equations and the forecasting was built on 31 data points from December 9 till January 8. As a result of forecasting for two days August 24 and August 25 we found the prediction prices to be 14,20 and 14,21, with respective forecasting error of $\varepsilon = -0,1953$ and $\varepsilon = -0,2011$, with the selected value of $\alpha = 0,1$, because in the last days of the data the price of the share doesn't present a high fluctuation. This method of forecasting gives us an accurate result.

Yet the company's shares have soared since the demonstrators first took to the streets in October, even as the rest of the stock market sank, real estate and Solidere shares, which trade in dollars, are suddenly popular, the local currency tumbles in the black market and the cash-strapped government weighs defaulting on its Eurobonds. They're scrambling to protect their savings from potential banking collapses or their dollar deposits from being converted into Lebanese pounds if the foreign-exchange squeeze gets more acute. «You have a new class of investors», said Faysal Barbir, head of fixed income at FFA Private Bank in Beirut. «These investors were bank depositors that are now looking to diversify, and they have very limited options» [18]. Despite Solidere's unpopularity, it is seen as a safe bet compared to other stocks such as banks.

Solidere made a \$42 million profit in the first half of 2019, as its most recent financial statements show, compared with a loss of almost \$100 million a year earlier. «We can see quite a bit of demand on land», said Ghazi Youssef, a Solidere board member and former lawmaker. «A lot of people are trying to park their money in real estate. People are getting scared», said Raja Makarem, chief executive of Ramco, a real estate advisory firm in Beirut. «Some people are rushing out of the banking system to go to real estate, thinking this will be a good temporary shelter for them until things get better. It hasn't paid dividends to shareholders in more than five years, though it plans to do so again in 2021», Youssef said [18].

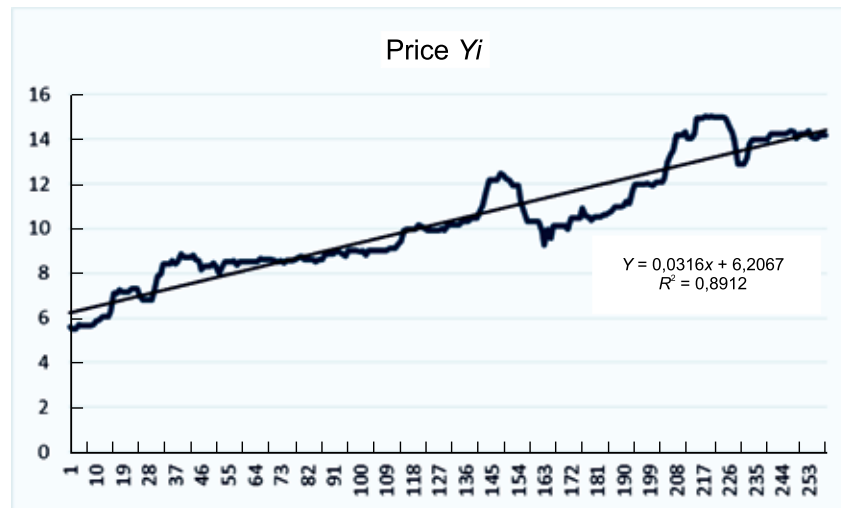


Fig. 2. SOLA share's price from December 9, 2019 till August 23, 2020

Solidere was a bright spot for investors looking to protect their funds as the country's financial conditions deteriorated. The massive explosion that destroyed vast stretches of real estate in Beirut suddenly changed a lot of that. Since the escalation of the economic and financial crisis, with escalating inflation and restrictions imposed on withdrawing deposits, many investors have turned to their US dollar denominated stocks as a safe haven, which has led to the increase in its share price by more than 150 % since October 20, 2019.

Solidere's share price continues its rally, driven by the depositors' efforts to convert their bank deposits into investments in light of the restrictions imposed on them and the growing fears of heresies. The improvement in Solidere's share prices was accompanied by a noticeable increase in the real estate sales, which contributed to reducing the size of its debts from about \$650 million to less than \$80 million. Some experts expect prices to rise further if demand continues in light of the limited shares offered for sale. Solidere's stock is still almost the only one that witnesses trading, while bank shares did not witness any serious trading in their shares during the last quarter of last year. According to a report by Arabian Business, the Lebanese company Solidere, based in Downtown Beirut, has achieved a strong performance that reflects the boom in the real estate market, despite the political, economic and financial crises that Lebanon has been suffering for some time, indicating that the company's shares jumped 220 percent from 5 dollars at the end 2019 to \$16 later. According to Solidere's financial results, its revenue from the sale of land increased by 51,4 percent to reach \$228,7 million in the first half of the year 2020, from \$151 million in the same period in 2019.

Byblos. The study of Byblos share prices is done for the same period as that of SOLA's share prices. The data is divided into two periods, the first period from January 1, 2017 till February 1, 2020 when the prices went on downtrend but not so sharp (Figure 3). Suddenly in February 2020, BYB's share prices had a shock and the price decreased rapidly, so we have studied the second period

from February 1, 2020 till August 19, 2020 alone. In the first period the price of BYB's shares decreased slowly because the volume of transactions on BSE was badly affected by the delay of the political and security tensions taking place in the region and in Lebanon. The investors in this period of an uncertain political situation tried to sell their shares and get out from the market. In the first part the forecast and the calculation was done using the STATISTICA software. While in the second part the calculation was done using Brown's method (for $\alpha = 0,1$). Also we found the best value of alpha ($\alpha = 0,3901$) for which SSE is minimum and which is consistent with the actual values of the stock.

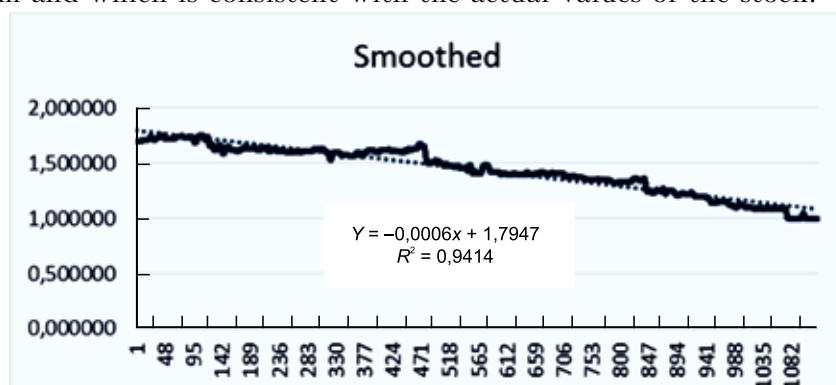


Fig. 3. Smoothed data of BYB's share from January 1, 2017 till February 1, 2020

While there are many valuation factors that affect the share price of any bank, there are some that are more universal and widely used, like expected growth, banking risks, earnings potential, overall market sentiment, expectations about the future, the demand for banking services and the cost of capital.

On the other side, BYB's share price was influenced by the interest rate policy generated by the central bank in the recent years. In general, a bank tries to maximize the amount of interest it generates from loans and minimize the interest it pays out on deposits because deposits are liabilities for banks, while loans are their assets. During 2017 till October 2019 the interest rate given to the depositors was increased while the interest rate earned from loans increased, but less rapidly, which affected the bank profit, and therefore it affects the BYB's share price and put more pressure on this price.

One of the most important factors that facilitated the big fall in the price starting from February 2020, is the rating of the BYBLOS bank. Ratings downgraded Byblos Bank's Long-Term Issuer Default Rating (IDR) to 'CCC' from 'B-' and Viability Rating (VR) to 'ccc' from 'b-'.

The downgrades follow Fitch's recent downgrade of the Lebanese sovereign to 'CCC' (see «Fitch Downgrades Lebanon to 'CCC'» dated August 23, 2019 at www.fitchratings.com). Byblos' ratings are constrained at the current level by the sovereign rating. Byblos Bank had a loss of \$122 million in 2019 due to the allocation of «collective provisions» for the bank's expected credit losses on its portfolio of Lebanese Eurobonds. The customer deposits fell by 7,37 % in H1-2020 to around \$16,10 billion. The demand for loans decreased starting from October 2019, no companies have been investing to expand their businesses. That means there's less loan and fee income for the bank. The profit reported by BYBLOS bank in each quarter decreased with respect to earlier quarter since October 2019, which affected also the share prices and pushed it to a big fall.

HOLC share. Holcim Liban SAL is a Lebanon-based company engaged in the manufacture, processing and distribution of cement and its derivatives. HOLC shares have been listed in Beirut Stock Exchange since 2007. The study was conducted on this company's shares over the period from January 1, 2017 till August 25, 2020. The

data is divided into two parts, the first part is from January 1, 2017 till October 21, 2018 when there was an upward trend; the second part is from October 22, 2018 till August 25, 2020. The data for the first part (long part) was treated using STATISTICA software. The trend component was found by the equation $y = 0,0088t + 10,981$; the cyclic component and the adjusted cyclic component determined the forecast value and the error value. In this period the share prices increased from 11,75 dollar per share to approximately 18 dollars per share. This growth in prices refers to the loan facilities provided by the bank sector to investors and ordinary customers to build and buy apartments; the demand for cement and its derivatives increased and the confidence level grew in these shares. In the second part, a downtrend started from October 2018 till August 2020. One of the factors contributing to this decrease, was the fact that from the early 2019 the General Organization of Housing and the commercial banks stopped giving loans to the people for buying apartments, so the real estate sector and the investor faced a problem to sell the buildings and the apartments, and the demand for cement decreased. In the second period the trend was broken sharply from June 3, 2019 till July 2020, especially after the October 2019 revolution, we treat this case carefully, we calculate the average variation in price during this period, then we have replaced the old data by a new data obtained by calculation during the period of broken trend. Also we have tried the best value of alpha that minimize the SSE and MAPE. After the calculation we found that for $\alpha = 0,353009$, SSE is minimum, and for $\alpha = 0,491501$, MAPE is minimum.

Conclusion. In this paper it has been found that the adaptive forecasting methods (Brown's model) can be effectively applied for forecasting the values of Lebanese stock prices. We can say that using historical N day's stock price on its own can provide a relatively accurate prediction on $N + 1$ day's stock price.

In conclusion, this paper explores time-series analysis of 3 stocks of Beirut Stock Exchange in three different sectors over the period from 2017 through 2020. It provides daily forecasts and analysis based on exponential smoothing methods and decomposition using STATISTICA software. We deduce the best forecasting methods using MAPE and SSE. Since the profitable strategies are related with the predictable character of the market movement and the forecasting techniques can help with better investment decision making. Our study shows the possibility to develop support decisions for the Lebanese stock market based on the prediction done in this paper.

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НАССЕР АЛЬДИНЕ АБДУ АЛИ

СТАТИСТИЧЕСКИЙ ПРОГНОЗ ЦЕН АКЦИЙ В ЛИВАНЕ НА ОСНОВЕ АДАПТИВНЫХ МОДЕЛЕЙ

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В настоящее время существует множество методов и моделей для прогнозирования будущих значений цен акций, и статистические методы одни из них. Статистические методы доказали свою эффективность при изучении временных рядов, особенно методы экспоненциального сглаживания стали очень популярны среди исследователей из-за их надежности. В этом исследовании дан анализ временных рядов трех акций Бейрутской фондовой биржи в трех разных секторах экономики за период с 2017 по 2020 год. Представлен анализ, основанный на методах экспоненциального сглаживания и декомпозиции ежедневных данных с использованием программного обеспечения STATISTICA, определены методы прогнозирования на основе расчета MAPE и SSE с лучшим значением α . Было установлено, что методы адаптивного прогнозирования (модель Брауна) могут быть эффективно применены для однодневного прогноза значений цен ливанских акций и использование исторических цен акций за N дней обеспечивает относительно точный прогноз цены акций на $N + 1$ день.

Ключевые слова: ливанские акции; декомпозиция; сглаженные данные; тренд; модель Брауна; прогнозирование.

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