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The Stock Price Prediction Formula Using the Concept of Equality in the Amount of Data Between the Average Difference of Order One and Two at Levels n and n+1

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Abstract. Technological developments are getting faster, as is the dissemination of existing information, especially on the capital market. In order for investors to avoid losses from the capital market, a method is needed that is able to analyze the movement of the stock price. This study focuses on the application of the Data Scales Analysis (DSA) method which uses a formula with the concept of the same amount of data between the first and second order average differences at levels n and n + 1 for predicting the stock price of issuers, in predicting stock prices in the capital market. The resulting formula is named JIC-FLY 2 which is a new formula used to predict stock prices in the capital market. The population used in this study are issuers who are members of IDX 30 from the banking sub-sector with the sample used is the issuer of BBCA (PT Bank Central Asia Tbk). The results of this study note that the DSA method with this formula is able to produce the best predictive value, namely DSA 12 with an error percentage of 0.035%.

Keywords: Stock price prediction, difference of order
2020 *Mathematical Subject Classification*: 03Dxx

INTRODUCTION

As one of the financial instruments, stocks are the most sought after financial instruments in the capital market today. According to Budiantara (2012) shares are evidence or signs stating that a person has ownership of the company and can obtain dividends or capital gains from the results of ownership of the go public company. The number of issuers or go public companies that have been listed on the Indonesia Stock Exchange until October 2021 is 754 issuers. Because the function of the capital market is to bring together parties who have excess funds and those who need funds, therefore as a party who has excess funds requires knowledge to analyze movements or changes in stock prices that occur every day.

One technique that can be used in analyzing stock movements is to use technical analysis methods. The problem that is often faced when starting an investment is the lack of knowledge about stock price fluctuations that change every day. This can cause the main goal of an investor to invest not be achieved, thus the expectations held by investors often become a loss. According to Asthri et al. (2016), technical analysis is an analysis that can be used to study movements in the market, both price movements and trading volumes. In general, the reading of capital market movements is seen at the closing price of each period. The closing price is the price in the capital market which is volatile or always changing. Therefore, the closing price was chosen as data that can be analyzed because it is data that is easily understood by the general public.

As a method that can analyze price movements and trading volume, especially in the capital market, there are various forms of technical analysis that can be used, one of which is the stochastic oscillator. In addition to using the stochastic oscillator technical analysis method in reading fluctuating stock price movements, we also need a method that can be used to read trends that are happening in the market. The method that can be used to read the movement of the market trend is the Data Scales Analysis (DSA) method. This DSA method is the latest method was first published in 2021, where Goenawan et al. (2021), explained that the Data Scales Analysis method or commonly referred to as the Data Weigher is a data weighting method or the multilevel data average method that measures data quantitatively which determines the tendency of the weight of a data whether the data is heavy to the left or to the right. In addition to measuring the trend of heavy data to the left or right, this method can also be used to determine the tendency of a trend whether the trend is up or down. In addition to reading a trend, the DSA method can also be used to forecast the closing price of the stock market. So by comparing the two methods, this study will analyze the predictions of stock price movements using a formula with the concept of the same amount of data between the first and second-order average differences at levels *n* and *n+1* for stock price predictions of issuers, the resulting formula is named JIC- FLY 2.

PROVEN JIC-FLY 2 FORMULA

This study applies the DSA method that uses a new formula with the concept of the same amount of data between the first and second order average differences at level *n* and *n + 1* to predict the issuer's stock price which will be used in predicting stock prices in the capital market. The resulting new formula is named the JIC-FLY 2 data extrapolation balance formula.

JIC-FLY 2 formula:

$$D_{n+1} = \frac{t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) - (t-1) \cdot D_1 + 2 \cdot \sum_{i=2}^{t} D_{i;n}}{t-1}$$

where variable n is the sequence number of $K_2^1(t;n) = 1K2(t;n)$.

The explanation below is the proof of the JIC-FLY 2 formula, (Goenawan. 2022) we can obtain the equation for the average difference between orders of one and two (Goenawan & Indriati. 2022), namely:

$$K_2^1(t,n) = \frac{1}{t \cdot (t+1)} \begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & -t+(2 \cdot t-1)) \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix} \quad (1)$$

By using the concept of the similarity of the number of data at levels n and n + 1 then

$$K_2^1(t;n+1) = \frac{1}{t \cdot (t+1)} \begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & -t+(2 \cdot t-1)) \end{bmatrix} \begin{bmatrix} D_2 \\ D_3 \\ D_4 \\ \vdots \\ D_{t+1} \end{bmatrix}$$

Then, a reduction is made between *1K2(n+1)* and *1K2(n)* using the concept that the amount of data is the same between the first and second-order average differences at the *n* and *n+1* levels.

$$t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) = \begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & t-1 \end{bmatrix} \begin{bmatrix} D_2 \\ D_3 \\ D_4 \\ \vdots \\ D_{t+1} \end{bmatrix}$$

$$-\begin{bmatrix} -t+1 & -t+3 & -t+5 & \cdots & t-1 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_t \end{bmatrix}$$

then becomes:

$$t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) = [t-1 \quad -2 \quad -2 \quad \cdots \quad t-1] \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{t+1} \end{bmatrix} \tag{2}$$

and

$$[t-1 \quad -2 \quad -2 \quad \cdots \quad t-1] \begin{bmatrix} D_1 \\ D_2 \\ D_3 \\ \vdots \\ D_{t+1} \end{bmatrix} = (t-1) \cdot D_1 - 2\sum_{i=2}^{t} D_i + (t-1) \cdot D_{t+1}$$

Because the DSA pattern at levels *n* and *n+1* does not change as much as t day, then the notation D_{t+1} can be replaced by D_{n+1} so that

$$t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) - (t-1) \cdot D_1 + 2\textstyle\sum_{i=2}^{t} D_i = (t-1) \cdot D_{n+1} \tag{3}$$

or

$$(t-1) \cdot D_{t+1} = t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) - (t-1) \cdot D_1 + 2\sum_{i=2}^{t} D_i$$

by dividing both sides by *(t – 1)*, it is proven that the JIC-FLY 2 formula can be produced, namely

$$D_{n+1} = \frac{t \cdot (t+1) \cdot (K_2^1(t;n+1) - K_2^1(t;n)) - (t-1) \cdot D_1 + 2 \cdot \sum_{i=2}^{t} D_i}{t-1} \tag{4}$$

DATA SCALES ANALYSIS

Data Scales Analysis is a new method proposed by Stephanus Ivan Goenawan and published for the first time in 2021. The Data Scales Analysis method as described in Goenawan et al. (2021) is a method that determines the tendency of the weight of a set of data whether it is heavier to the right or heavier to the left of the data which is measured quantitatively using data weighting or a new method with multilevel data averages. In Goenawan et al. (2021) also explains that the Data Scales Analysis method can be used to weight data using the weighted value in percent. The formula for weighting data using the DSA method is as follows:

$$K_2^1 = \sum[d \times bT(\%)] \tag{5}$$

Where:

K_2^1 = Data Scales value or DSA value
d = Data results
$bT(\%)$ = weight in percent

Based on equation (5), using ATD be developed a new method by weighting the multilevel average. So the formula for Data Scales Analysis using the best method of multilevel average from the weighting of the data according to Goenawan et al. (2021) are as follows:

$$K_2^1 = (\overline{D}^1) - (\overline{D}^2) \tag{6}$$

Where:

K_2^1 = Data Scales value or DSA value
$\overline{D}^1$ = Average Order 1
$\overline{D}^2$ = Average Order 2

Where the Data Scales Analysis is the result of a dispute between the data at level one minus the data at level two. As for the data level one and two can be known by the following formula, namely:

$$(\overline{D}^1) = \frac{\Sigma^1(dj)}{t} \qquad (7)$$

Where:

$\overline{D}^1$ = Average Order 1

d_j = Data results at level 1

t = lots of data during t periode

and

$$(\overline{D}^2) = \frac{\Sigma^2(dj)}{\frac{t(t+1)}{2}} \qquad (8)$$

Where:

$\overline{D}^2$ = Average Order Order 2

d_j = Data results at level 2

t = lots of data during t periode

The average order of data at level one is obtained from the division formula between the total number of data divided by the number of data at level one. Meanwhile, to get the average order of the data at the second level, it is obtained from the division between the total number of data divided by the number of data at the second level.

FUNCTION EXTRAPOLATION OF IVAN NEWTON (IN) SERIES

The Ivan Newton Series or can be called the IN Series is a new method developed by Stephanus Ivan Goenawan and published in 2019. Goenawan (2019) explains that the IN Series is a new method of further development based on the Newton Series function, so that its function can be used to perform interpolation and extrapolation of data with non-linear functions. The formula for the IN Series is as follows:

$$f(n) = b_0 + b_1 \cdot t + b_2 \cdot \frac{n \cdot (n+1)}{2!} + b_3 \cdot \frac{n \cdot (n+1) \cdot (n+2)}{3!} + \cdots + b_\beta \cdot \frac{\prod_{k=0}^{\beta-1}(n+2)}{\beta!} \qquad (9)$$

Where:

$f(n)$ = function of Ivan Newton's Series

n = variabel data

b_j = konstanta *b sequence j* of the IN Series Function via Pascal's Triangle Pattern

For example, the constant bj of the IN Series function can be obtained using the regularity of Pascal's Triangle which can be seen in eq.(10) as follows:

$$\begin{aligned} b_0 &= +f(n=0) \\ b_1 &= -f(n=-1) + b_0 \\ b_2 &= +f(n=-2) - b_0 + 2 \cdot b_1 \\ b_3 &= -f(n=-3) + b_0 - 3 \cdot b_1 + 3 \cdot b_2 \end{aligned} \qquad (10)$$

In addition to the IN series method, there is also a new formula developed by Stephanus Ivan Goenawan, namely the data extrapolation scale formula (TED) JIC-FLY 2 eq.(4). The TED JIC-FLY 2 formula is an inverse equation that is used to find stock price prediction data, which is derived from the known extrapolated ATD value using the IN series. The eq.(4) which is the TED JIC-FLY 2 formula can be seen again in the eq.(11) along with the following statement:

$$D_{n+1} = \frac{t \cdot \ (t+1) \cdot \left(K_2^1(t;n+1) - K_2^1(t;n)\right) - (t-1) \cdot D_1 + 2 \cdot \sum_{i=2}^{t} D_i}{t-1} \qquad (11)$$

Where:

D_{n+1} is holdings price data on the day to be predicted.

t is the amount of stock price data weighed by DSA.

n is a variable sequence number from *1K2(t;n)* or $K_2^1(t;n)$ that will be used as the basis for value prediction $K_2^1(t;n+1)$ using the IN series.
$K_2^1(t;n)$ is the DSA value closest to one day before the predicted DSA value.
$K_2^1(t;n+1)$ is the extrapolated value of DSA from Series IN.

DATA COLLECTION AND PROCESSING

Data Collection

The data collection carried out is secondary data collection taken from the internet through the finance.yahoo.com website. The data used is data from selected issuers who are members of IDX 30, especially the banking sub-sector, namely PT Bank Central Asia Tbk (BBCA) starting from 9/14/2020 to 1/5/2021, namely:

TABLE 1. Closing Price Data for BBCA

Date	Open	High	Low	Close
9/14/2020	6000	6115	5985	6050
9/15/2020	6040	6100	5860	5860
9/16/2020	5860	5870	5745	5750
9/17/2020	5750	5855	5665	5755
9/18/2020	5700	5735	5570	5630
9/21/2020	5640	5735	5595	5605
9/22/2020	5520	5565	5430	5450
9/23/2020	5450	5585	5425	5505
9/24/2020	5430	5535	5390	5445
9/25/2020	5480	5625	5460	5610
9/28/2020	5650	5695	5500	5515
9/29/2020	5575	5635	5460	5505
9/30/2020	5565	5565	5420	5420
10/1/2020	5485	5570	5480	5570
10/2/2020	5560	5565	5440	5505
10/5/2020	5515	5560	5460	5520
10/6/2020	5630	5715	5600	5700
10/7/2020	5600	5755	5580	5755
10/8/2020	5790	5800	5710	5780
10/9/2020	5750	5775	5720	5775
10/12/2020	5840	5875	5830	5855
10/13/2020	5840	5860	5770	5855
10/14/2020	5840	5900	5810	5900
10/15/2020	5875	5880	5760	5785
10/16/2020	5785	5790	5730	5760
10/19/2020	5750	5900	5710	5900
10/20/2020	5880	5880	5785	5805
10/21/2020	5860	5865	5730	5780
10/22/2020	5740	5800	5705	5800
10/23/2020	5840	5840	5750	5770

Date	Open	High	Low	Close
10/26/2020	5725	5835	5725	5815
10/27/2020	5815	5830	5755	5790
11/2/2020	5760	5825	5720	5820
11/3/2020	5840	5895	5835	5890
11/4/2020	5900	5940	5785	5820
11/5/2020	5900	6180	5900	6150
11/6/2020	6160	6300	6060	6300
11/9/2020	6300	6400	6215	6285
11/10/2020	6395	6600	6380	6480
11/11/2020	6540	6565	6480	6540
11/12/2020	6410	6495	6405	6420
11/13/2020	6420	6450	6320	6390
11/16/2020	6485	6485	6385	6480
11/17/2020	6500	6565	6490	6550
11/18/2020	6550	6575	6540	6570
11/19/2020	6520	6640	6515	6615
11/20/2020	6640	6650	6550	6600
11/23/2020	6600	6610	6550	6600
11/24/2020	6600	6600	6545	6565
11/25/2020	6580	6585	6380	6410
11/26/2020	6350	6490	6300	6480
11/27/2020	6480	6490	6380	6385
11/30/2020	6385	6400	6135	6205
12/1/2020	6220	6435	6220	6395
12/2/2020	6460	6485	6340	6450
12/3/2020	6500	6525	6425	6460
12/4/2020	6460	6465	6360	6390
12/7/2020	6500	6580	6480	6520
12/8/2020	6520	6520	6425	6490
12/10/2020	6590	6600	6540	6575
12/11/2020	6600	6780	6595	6735
12/14/2020	6800	6830	6795	6820
12/15/2020	6830	6900	6605	6790
12/16/2020	6860	6950	6840	6950
12/17/2020	6965	7000	6820	6935
12/18/2020	6935	6935	6755	6800
12/21/2020	6890	6890	6800	6830
12/22/2020	6740	6820	6710	6715
12/23/2020	6905	6905	6620	6725
12/28/2020	6790	6820	6660	6780
12/29/2020	6775	6810	6740	6765
12/30/2020	6800	6800	6700	6770

Date	Open	High	Low	Close
1/4/2021	6800	6855	6720	6835
1/5/2021	6860	7090	6850	7090

DATA PROCESSING

The first data processing is to perform data processing using the DSA method. The processing carried out will be divided into 2 models, namely the Static DSA model and the Dynamic DSA model by forecasting from November 18, 2020 to January 5, 2021.

DSA Models 10 To 19

By using eq.(7) and eq.(8) it will be calculated by finding the average data at level 1 and level 2 in the period DSA 10 – DSA 19. Below in Table 2. is a table of average level 1 and level 2 average.

TABLE 2. Sum of Level 1 and Level 2 DSA 10

ERO 1	RO 1	RO 2	1K2(n)
58105	5810.5	5820.090909	-9.59090909
58025	5802.5	5802.363636	0.136363636
58130	5813	5807.454545	5.545454545
58190	5819	5818.181818	0.818181818
58440	5844	5808	36
58935	5893.5	5824.090909	69.40909091
59440	5944	5853.909091	90.09090909
60120	6012	5892.454545	119.5454545
60890	6089	5950.454545	138.5454545
61495	6149.5	6011.272727	138.2272727
62095	6209.5	6087.545455	121.9545455
62755	6275.5	6170.363636	105.1363636
63415	6341.5	6252.454545	89.04545455

After the average value of level 1 and level 2 is found, then the next process is to calculate the value of bj using the IN series formula. An example of the calculation for DSA 10 can be seen in Table 3. below.

TABLE 3. Calculation of the value of bj DSA

j	1K2(j)		b_j		| b_j |	selected bj
0	89.045	89.045	b0	89.045	89.045	89.045
-1	105.136	-105.136	b1	-16.091	16.091	-16.091
-2	121.955	121.955	b2	0.727	0.727	0.727
-3	138.227	-138.227	b3	1.273	1.273	
-4	138.545	138.545	b4	-14.136	14.136	
-5	119.545	-119.545	b5	-26.182	26.182	
-6	90.091	90.091	b6	-26.000	26.000	
-7	69.409	-69.409	b7	-23.955	23.955	
-8	36.000	36.000	b8	-71.136	71.136	
-9	0.818	-0.818	b9	-291.818	291.818	
-10	5.545	5.545	b10	-885.182	885.182	

j	1K2(j)		b_j		$\|b_j\|$	selected bj
-11	0.136	-0.136	b11	-2004.591	2004.591	
-12	-9.591	-9.591	b12	-3366.818	3366.818	

After the selected bj value is found, the next process is to perform calculations to get the value of $K_2^1(t; n+1)$ by adding up the selected bj values. An example of calculating the value is as follows:

$$K_2^1(t; n+1) = 89{,}045 + (-16.091) + 0{,}727 = 73{,}682$$

The next process is forecasting using the JICFLY 2 formula to get the value of $D_{(n+1)}$ or the predicted price value as shown in Table 4. below:

TABLE 4. Forecasting Calculations with the JICFLY 2 Formula DSA 10

Date	Data	J01
11/5/2020	6150	6150
11/6/2020	6300	12450
11/9/2020	6285	18735
11/10/2020	6480	25215
11/11/2020	6540	31755
11/12/2020	6420	38175
11/13/2020	6390	44565
11/16/2020	6480	51045
11/17/2020	6550	57595
11/18/2020	6791.111	64386.111

The calculation using the JICFLY 2 formula to get the closing price on November 18 is as follows:

$$D_{n+1} = \frac{n \cdot (n+1) \cdot \left(K_2^1(n+1) - K_2^1(n)\right) - (n-1) \cdot D_1 + 2 \cdot \sum_{i=2}^{n} D_i}{n-1}$$

$$D_{n+1} = \frac{10 \cdot (10+1) \cdot (73{,}682 - 89{,}045) - (10-1) \cdot 5820 + 2 \cdot 57595}{10-1}$$

$$D_{n+1} = 6791{,}111$$

After the predicted value on November 18 is found, the next process is to look for the value of $K_2^1(t; n+1)$ to re-check whether the formula calculation process is correct or not. Below is Table 5. to find the value of $K_2^1(t; n+1)$ return is as follows:

TABLE 5. Recalculation of 1K2 DSA Forecast Value 10

Date	Data	J01
11/5/2020	6150	6150
11/6/2020	6300	12450
11/9/2020	6285	18735
11/10/2020	6480	25215
11/11/2020	6540	31755
11/12/2020	6420	38175
11/13/2020	6390	44565
11/16/2020	6480	51045

Date	Data	J01
11/17/2020	6550	57595
11/18/2020	6791.111	64386.111
ERO	64386.111	350071.111
RO	6438.6111	6364.929
1K2(*t*;*n*+*1*)	73.682	

Based on Table 5. it can be interpreted that the calculation results using the JICFLY 2 formula are correct, by reviewing the value of $K_2^1(t; n+1)$ based on the results from Table 3. where the resulting value is 73,682. After the results of the forecasting calculations on November 18, 2020 are found, the next process is to find the error value generated from the forecast by comparing it with the actual data on November 18, 2020, which is 6570. The way that can be done is to find the error value using the MAPE formula .

$$MAPE = \sum_{t=1}^{n} \left| \frac{y_i - \hat{y}_i}{y_i} \right| \times 100$$

$$MAPE = \frac{6570 - 6791{,}111}{6570} \times 100$$

$$MAPE = \frac{-221{,}111}{6570} \times 100$$

$$MAPE = 3{,}365\%$$

It is known that the results of forecasting using the JICFLY 2 formula, the results of the forecasting error made are 3,365%. The next calculation is to do the same thing, the recapitulation of DSA forecasting 10-19 on November 18, 2020 is shown in Table 6.

TABLE 6. Forecasting Recapitulation November 18, 2020 DSA 10 – DSA 19

Data Comparison					
DSA Model	**Date**	**Data**	**JICFLY 2**	**Error**	**MAPE**
DSA 19	11/18/2020	6570	6447.22	122.778	1.869%
DSA 18	11/18/2020	6570	6874.412	-304.41	4.633%
DSA 17	11/18/2020	6570	6561.875	8.125	0.124%
DSA 16	11/18/2020	6570	6616.333	-46.333	0.705%
DSA 15	11/18/2020	6570	6684.286	-114.29	1.740%
DSA 14	11/18/2020	6570	6618.077	-48.077	0.732%
DSA 13	11/18/2020	6570	6705.833	-135.83	2.067%
DSA 12	11/18/2020	6570	6572.273	-2.2727	0.035%
DSA 11	11/18/2020	6570	6603	-33	0.502%
DSA 10	11/18/2020	6570	6791.111	-221.11	3.365%
Selected DSA Method					DSA 12

After finding the best predictive value for November 18, 2020, it is known that for the smallest error value, rank 1 is DSA 12 with a percentage of 0.035%, rank 2 is DSA 17 with a percentage of 0.124%, and rank 3 is DSA 11 with a percentage of 0.502%.

ANALYSIS RESULTS

The Data Scales Analysis method is a new method, which in 2021 was just developed by Stephanus Ivan Goenawan. The DSA method combined with the IN series method can perform data extrapolation, or forecasting of a data. Therefore, in this study, the ability of the DSA method with the IN series will be tested in predicting the closing price in the capital market, especially for the issuer PT Bank Central Asia Tbk or known as the BBCA issuer's stock.

In data processing using the DSA method, the first thing to do is to find the average value of level 1 and level 2 in each period, namely DSA 10 to DSA 19. After the average value of level 1 and 2 is found, then the next process is to find the value of the series IN which will assist in forecasting for the DSA method with the JICFLY formula 2. The results of forecasting calculations with the DSA 10 model are found for the result to be 6791.111 with the actual data being 6570 on 18 November 2020. After the best predictive value is found for 18 November 2020, it is known that for the smallest error value, rank 1 is DSA 12 with a percentage of 0.035%, rank 2 is DSA 17 with a percentage of 0.124%, and rank 3 is DSA 11 with a percentage of 0.502%.

CONCLUSION

Based on the research that has been done, there are several conclusions that can be drawn through this research, including: The Data Scales Analysis (DSA) method is able to forecast the closing price of shares in the banking sub-sector using the DSA 10 to DSA 19 model. The best prediction was found for November 18, 2020, for the smallest error value ranked 1 is DSA 12 with a percentage of 0.035%. In this study, we are able to prove and use a new formula called the TED JIC-FLY 2 Formula, eq.(4) to predict stock prices.

$$D_{n+1} = \frac{t \cdot (t+1) \cdot \left(K_2^1(t; n+1) - K_2^1(t; n)\right) - (t-1) \cdot D_1 + 2 \cdot \sum_{i=2}^{t} D_i}{t-1}$$

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