Effects of Coronavirus on Vegetable Juice Manufacturers

Akane Murakami and Yukari Shirota

***Abstract*—In the paper, we analyze changes of stock prices during the state of emergency declaration due to the COVID 19 that started from 2020/4/7, using the ANOVA (Analysis of Variance) and the multiple-comparison. The data we used are the stock prices of the representative beverage manufacturers in Japan that are Kagome, Ito-en, Suntory food, and Coca-Cola from 2020/4/7 to 2020/6/19. We found that the higher vegetable drink product ratio of a company was, the higher its stock price average became. One clear result is that the stock prices of the beverage manufacturers that produce many vegetable juice products have grown. The regression analysis between the production ratio of the vegetable juice drinks and the stock price growth ratio shows a clear linear increasing relationship. We could say that in the COVID 19 period, investors tended to invest in beverage companies which produced vegetable juice products, from expectations that consumers' demands for vegetable juice products would increase owing to the COVID 19. In addiiton, the investment to vegetable drinks might have been conducted, almost ignoring the company names. We think that the vegetable drink product amounts were more influential to the stock prices, rather than the individual company's performance.**

***Index Terms*—ANOVA (Analysis of Variance), multiple-comparison, vegetable juice, emergency declaration, COVID 19, stock prices, investors' expectations.**

I. Introduction

In the paper, we shall analyze changes of stock prices during the state of emergency declaration due to the COVID 19 that started from 2020/4/7. Our interests are to find growing companies against the damage by the COVID 19 and why they are growing during this period. The target manufacture kind is the beverage drink manufacturing.

In Fig. 1, we present the stock price movement of the Japanese beverage manufacturers from 2020/4/7 to 2020/6/19. These four companies are the Japanese representative beverage manufacturers. The Japanese government declared a state of emergency on 2020/4/7. The period begins from the declaration day. The period is correspondent to the coronavirus lock-down period.

In Fig. 1, we made a stock price of the first day 2020/4/7 to be 1.0 as the base value to see the stock price movement. Among them, Kagome's stock price growth is remarkable. We think that the Kagome's rapid growth is distinctively different from the ordinary fluctuations. The significant products of Kagome are tomato juice drinks and vegetable juice drinks. This growth must be the effect of the coronavirus pandemic. The investors must have expected that consumers' demands would be increase, because people would like to improve their immunity against the coronavirus by drinking the juice products.

If the hypothesis is right, other beverage companies that produce vegetable drinks would also increase the stock prices. We would like to investigate the hypothesis.

First, we shall investigate statistically whether the increase of Kagome's stock prices is significant or not, compared to the other companies' ones. The methods we use are ANOVA (Analysis of Variance) and multiple-comparison [1]. Then, we shall conduct a regression analysis between the production ratio of the vegetable juice drinks and the stock price growth ratio to conceive the cause of the stock price increase. The analysis programs were written in Wolfram Mathematica [2], [3].

In Section II, we shall describe the analysis result by the one-way ANOVA, and we shall describe the result by the two-way ANOVA in Section III. Then, in Section IV, the multiple comparison analysis method is applied to the data and the result will be shown. The regression analysis between the production ratio of the vegetable juice drinks and the stock price growth ratio is also conducted. The analysis results will be evaluated. Finally, we shall conclude the paper.

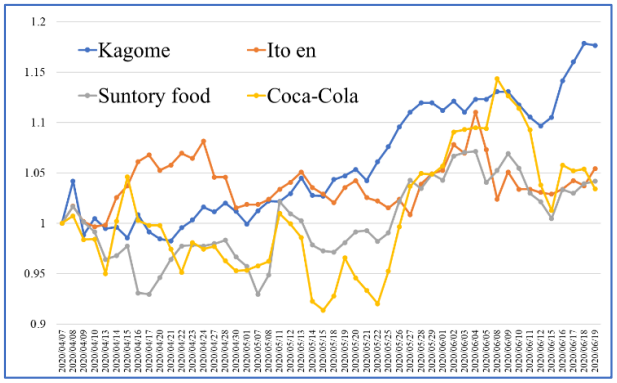

Fig. 1. Stock price index fluctuations from 2020/4/7 to 2020/6/19.

II. Population Average Test by One-Way ANOVA

In this section, we shall investigate the difference of Kagome' stock prices' increase by using a one-way ANOVA method. A one-way ANOVA is a test method for differences among averages/means for a single independent variable when there are over two groups [4].

Base on the stock price index plots in Fig. 1, we calculate the average index values of an individual company. The average values of the four companies are from the top 1.0585 (Kagome), 1.03851 (Ito-en), 1.00198 (Suntory food), and 1.00767 (Coca Cola).

In the ANOVA test, the individual company's stock price index data is called to a group (See Fig. 2). The Group 1 is

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Kagome, the Group 2 is Ito-en, the Group 3 is Suntory food, and the Group 4 is Coca Cola. We partitioned a group's data into 10 parts, so each data is the average of 5-day data. This is because we could ignore the tiny fluctuation of the stock prices.

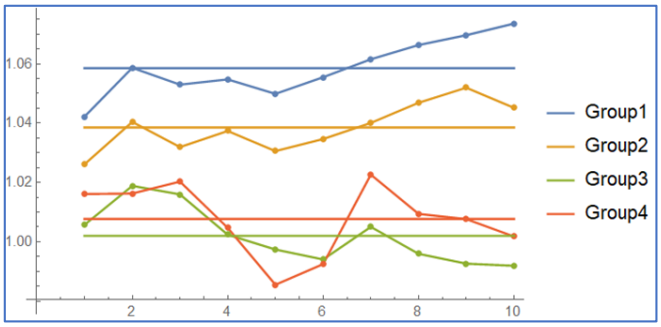

Fig. 2. The representative four beverage manufactures' stock price movement.

As shown in Fig. 2, Group 1 and then Group2 are much higher than the other two groups. The period is correspondent to the coronavirus lockdown period.

We shall test the population average by using a one-way ANOVA. The significant level is set to be 5%, α=0.05. The null hypotheses and alternative hypotheses are as follows where μ represents the population average of each group:

H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
H_1: At least one average is different from the others

The result is shown in Table I. The ANOVA analysis is conducted, using Mathematica by Wolfram.

TABLE I: ONE-WAY ANOVA RESULT BY WOLFRAM MATHEMATICA

ANOVA	DF	SumOfSq	MeanSq	Fratio	Pvalue
Model	3	0.021235	0.007078	72.758100	$2.3752*10^{-15}$
Error	36	0.003502	0.000097		
Total	39	0.024737			

CellMeans	All	1.02666
	Model[1]	1.0585
	Model[2]	1.03851
	Model[3]	1.00198
	Model[4]	1.00767

The resultant F test value was 72.8 and the P-value was 2.38E-15 which is nearly zero. The P-value is much less than 0.05, and so the null hypotheses is rejected. We can say that there is enough evidence to conclude that at least one advantage is different from the others.

TABLE II: RESULTS OF THE VARIANCE EQUIVALENCE TEST

	Statistic	P-Value
Conover	0.9124	0.8224
Bartlett	1.4623	0.691
Levene	0.4604	0.7117
Brown-Forsythe	0.4321	0.7313

Strictly speaking, the ANOVA methods are, in advance, justified when the assumptions of independence, normality, and equal variance hold; especially the assumption of variance homogeneity is most important for the correct analysis of the data [4].

Then, we shall test the variance homogeneity. Before the variance equivalence test, let's see the distributions visually (See Fig. 3). From the right, they are Group 1 in blue (Kagome), Group 2 in yellow (Ito-en), Group 3 in red (Suntory food), and Group 4 in green (Coca Cola).

To smooth probability density functions, we used the Mathematica smoothing probability density function.

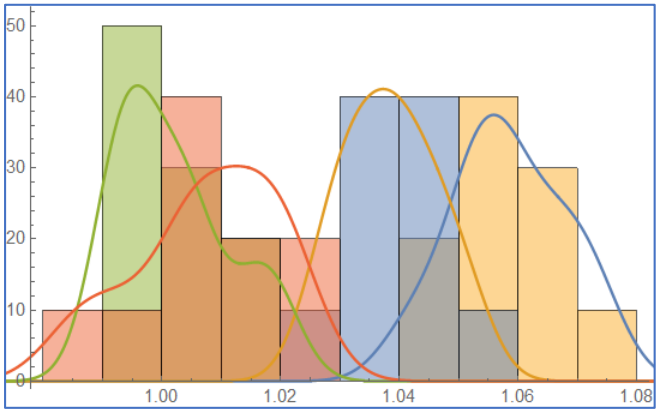

Fig. 3. Histogram of the stock price indices of the four groups and the smoothed probability density functions derived from the distributions.

As shown in Fig. 3, the data seem to keep normality and variance equivalence. Not only this empirical approach to visual verification of the histogram but also the statistical hypothesis test we shall use to test the variance homogeneity.

The methods we used for a test of variance equivalence and the results are shown in Table II. The methods are Conover [5], Bartlett [6], [7], Levene, and Brown-Forsythe [6]-[8]. In these tests, the null hypothesis is that "every groups' variance is equivalent." Therefore, the large P-values such as 0.69 in the Bartlett method mean that the null hypotheses are not rejected, in other words, the variance equivalence is kept. As shown in Table II, different four tests offer the same decision that the variance homogeneity is kept.

Because we tested the variance homogeneity, we can trust the one-way ANOVA result that tells that at least one average is different from others.

III. TEST OF COMPANY AND TIME EFFECTS BY TWO-WAY ANOVA

In this section, we shall investigate the time effects as well as the companies. When we see the Kagome's stock price movement as shown in Fig. 2, the rapid growth in the period can be identified. Therefore, we shall test the existence of the time effects on the stock price movements.

The method we use is a two-way ANOVA without repetition. The two-way ANOVA is a test method to test the effects of two or more independent variables called factors and the possible interaction between them. In this analysis, the following two factors are tested:

(1) companies, and
(2) period

In general, when we use the two-way ANOVA without

repetition, as the precondition, we must suppose that there is no interaction between the two factors [8]. For this reason, we suppose there is no interaction between the two factors.

The input data to the ANOVA test is partitioned as the same as data shown in Fig. 2. The null hypotheses and the alternative one for the companies are as follows:

H_0: There is no difference between the means of stock price index data for four companies.
H_1: There is a difference between the means of stock price index data for four companies.

The hypotheses for the periods are as follows:

H_0: There is no difference between the means of stock price index data for ten periods.
H_1: There is a difference between the means of stock price index data for ten periods.

The number of periods is ten.

TABLE III: VARIANCE VALUES OF EACH PERIOD

1	2	3	4	5
0.000241	0.000397	0.000274	0.000653	0.000879
6	7	8	9	10
0.000968	0.000584	0.001062	0.001317	0.001454

TABLE IV: RESULT OF THE VARIANCE EQUIVALENCE TEST FOR 10 PERIOD DATA SETS

	Statistic	P-Value
Conover	13.0333	0.1611
Bartlett	4.2966	0.8908
Levene	2.3279	0.0400
Brown-Forsythe	2.0154	0.0727

We first conducted the variance equivalence test. The input data which is a variance in the individual period as shown in Table III. The test result is shown in Table IV. The Bartlett method showed that the P-value 0.89 is more than the significant level 0.05. In the Conover method and Brown-Forsythe method, the results also do not reject the null hypothesis of the variance homogeneity.

However, the test result of the Levene method rejected the null hypothesis of which the P-value was 0.039. If it is assumed that the distribution does not follow the normal distribution, the Levene test is preferred to the other test methods. Then, we shall conduct the normality test.

The normality test for the 10 period data sets was as follows:

0.967594, 0.364562, 0.606156, 0.298049, 0.568485,
0.271876, 0.975928, 0.571993, 0.555422, 0.440477.

Although the number of data sets for each mean value is four (companies) and that is too small for the test, we suppose the normality of each data set via the normality test.

Then, back to the result in Table IV, as the variance equivalence test, we will use the Bartlett method instead of the Levene method. The P-value 0.89 of the Bartlett method supports that the variance equivalence is kept, also concerning the period difference; concerning the company difference, the variance equivalence was tested in the previous section. Because we could identify the two kinds of variance homogeneity, we can proceed to the two-way ANOVA.

TABLE V: RESULT OF THE TWO-WAY ANOVA WITHOUT REPETITION

ANOVA	DF	SumOfSq	MeanSq	Fratio	Pvalue
factor1	3	0.0212349	0.0070783	84.7744000	$7.38249*10^{-14}$
factor2	9	0.0012479	0.0001387	1.6606200	0.1480930
Error	27	0.0022544	0.0000835		
Total	39	0.0247371			

The result of the ANOVA test is presented in Table V. The first line there shows the result concerning factor1 and the second line the result concerning factor2. Concerning the factor (1) company, the null hypothesis is rejected, because the P-value is 7.38E-14, almost zero.

However, concerning the factor (2) period, the null hypothesis is not rejected under the significance level 0.05 because $0.14 > 0.05$. We cannot reject that the hypothesis that there is no difference between the means of stock price index data for ten periods.

We can identify only a difference between the means of stock price index data for four companies.

IV. TEST OF COMPANY EFFECTS BY MULTIPLE COMPARISON

When the null hypothesis is rejected in an ANOVA test, in general, we would like to know where the difference among the means exists. For this purpose after ANOVA tests, in general we proceed with multiple comparisons.

The most commonly used multi comparison test is the Tukey test [9]-[11]. The Tukey test is a test of pairwise comparisons of means in an ANOVA study when samples are the same size [12]. We conducted the Tukey test with the significance level 0.05. The result is as follows:

Tukey {{1,2},{1,3},{2,3},{1,4},{2,4}}

which means those five pairs have significant differences.

For example, {1, 2} shows the Group 1 average is enough larger than one of Group 2 under the siginificant level 5%. The result says as follows:

- Kagome (Group1)'s average is greater than other four companies' ones,
- The second Ito-en (Group 2)'s average is greater than the two lower aberages of Suntory food and Coca Cola, and
- However, there is no significant difference between Suntory food (3) and Coca Cola (4).

So far, we can identify the higher two companies' differences through the Tukey multiple comparison test. However, we cannot find a difference between the lower two companies.

V. EVALUATION

In this section, we shall evaluate the results by the hypothesis tests from another viewpoint. We shall first

evaluate the reason of the Kagome's stock price rapid growth and the relationship between the vegetable juice products and the stock price growth.

We found that the newspaper article which says [13]: *Due to the spread of the new coronavirus infection, people's awareness of self-defense has increased and people's attention has been focused on well-balanced vegetable drinks, and the vegetable beverage market in January to April in 2020 was higher than the previous year. Although the April single month of soft drinks has dropped by 20 percent, vegetable drinks are making a distinctive move. Vegetable drinks are expected to grow by 2 to 3 percent throughout this year.*

This newspaper article insisted the increased consumers' awareness to healthy food, for the sake of improved immunity to avert being infected by the coronavirus. In the newspaper articke, expectations of a demand increase for vegetable drinks are also described. We strongly agree with the viewpoint and expectations by the article.

An expected demand increase will increase the stock prices, because investors tend to invest a company of which product demand increase is expected. Such expectations may have increased the stock prices.

Then we shall conduct another analysis by the number of vegetable juice product ratios per company. This is because we thought that if the cause of such expectations were vegetable juice drinks, some symptoms could be seen in other companies, so far as the company manufactured the vegetable drinks.

TABLE VI: THE RATIO OF VEGETABLE JUICE PRODUCTS

	vegetable juice	All	**ratio of vegetable juice**
Kagome	53	80	**0.66**
Ito-en	21	129	**0.16**
Suntory food	2	335	**0.01**
Coca Cola beverage	0	141	**0**

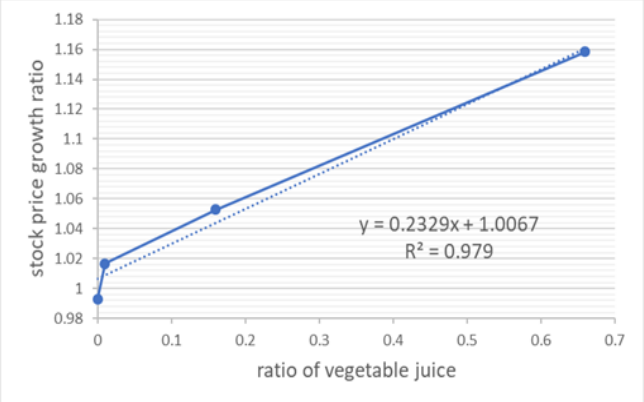

Fig. 4. Regressive analysis between the ratio of vegetable juice drinks and the stock price growth ratio.

We surveyed the product ratio of vegetable juice related drinks among all the juice products of each company (See Table VI). As shown there, Kagome has the largest ratio which is 66 % and secondly Ito-en has the largest ratio which is 16 %. The lower two companies's ratio values are approximately 1% and 0 %. It is clear that Kagome hold the remarkable high ratio of vegetable jouice product, compared with the other companies.

We think that in Kagome, the high vegetable drink ratio seems to be related to directly the rapid growth of the stock price. The second highest ratio 16% of Ito-en also may have increased the stock prices.

In the regression analysis, the predictor variable is set to be the ratio of the vegetable juice product, and the target variable is set to be the stock price growth ratio as the final value by the initial value in the period.

The regression result between the stock price growth ratio and the ratio of vegetable juice products is shown in Fig. 4. There we can see a clear linearity between the predictor variable and the target variable.

The stock price growth ratio is the index value shown in Fig. 1. The regression line was

$$y = 0.2329\,x + 1.0067$$

The R squared value (a coefficient of determination) of the regression is 0.979 which shows an excellent fitting. We can say that the ratio of vegetable juice drinks among their all drinks directly yields the stock price growth.

The stock price growth of Kagome and Ito-en must be considered to be effects of the coronavirus. On the other hands, because the Suntory and Coca Cola do not provide with the vegetable drinks, there was almost no special growth in the stock prices. However, Suntory food produces a few vegetable juice drinks. Therefore, compared to that of Coca Cola, Suntory food may have increased the stock prices. The differences between these companies can be seen in in Fig. 4.

The interesting thing found in Fig. 4 is that the stock growth ratio is independent of the vegetable juice brand names, as far as we see the regression plot; the decline of the fitting line is almost constant among the higher three companies. There it seems to be that the vegetable juice product ratio is more influential than the companies' brand names from the investors' viewpoints.

We can say that in the COVID 19 period the special demand for healthy food will be expected. Among the healthy food, special demands for vegetable juice and tomato juice were greatly expected. Then, the investment was conducted to the beverage companies almost proportionally to the vegetable juice product ratio. We think that this is a reason of the stock prices increase.

VI. CONCLUSION

We analyzed the stock price increase of beverage manufacturing companies during the lockdown state of emergency declaration by the coronavirus in 2020 April and May. We tried to find a relationship between the stock price growth and a special demand for tomato or vegetable juice drinks by the COVID 19. Owing to the coronavirus spread, Japanese government conducted emergency measures against the virus from 2020/04/07 to 2020/05/25. During the period, the people's awareness of self-defense increased and people's attention focused on well-balanced vegetable drinks.

The target of our analysis was Japanese four representative beverage manufacturers. The stock price data is used. The period was from the emergency start date 2020/4/7 to 2020/6/19. The number of stock sales day of the period is 50. Setting the first day's stock price to be 1, we made the stock

price index data. Using the index data, we conducted a one-way ANOVA and a two-way ANOVA.

First, we analysed if there was any difference among the four companies' stock prices, by using the one-way ANOVA. The ANOVA test rejected the null hypothesis that every company's average is equivalent. Secondly, to investigate the two factors of (1) company and (2) period, we conducted a two-way ANOVA.

As a result, the two ANOVA tests rejected the null hypothesis that every company's average was equivalent. After the two-way ANOVA, to find where the difference among the averages exists, we conducted the multiple comparison Tukey test. The Tukey test conducts pairwise comparisons of averages.

Then we can identify the higher two companies' differences through the Tukey multiple comparison test. However, we cannot find a difference between the lower two companies.

To investigate the reason of the stock price increase, we conducted a regression analysis between the ratio of vegetable juice drinks of a company and the stock price growth ratio. The resultant regression line shows a clear linear increasing relationship. The fitting is very nice as the coefficient of determination was 0.979.

From the results, we can say that the investment to the vegetable drinks manufacturing companies might have been conducted, almost ignoring the company names. It seems to be that in the Covid 19 period investors tend to invest in the beverage companies, according to vegetable drink percentages rather than the individual company's performance.

Owing to the Covid 19, special demands are created; for example, medication or foods to boost the immunity, and some antimicrobial products. The investors tend to look for the special demand to be created for their investment. The results of this paper presented one example of the special demand effect by the Covid 19 on the stock prices.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Murakami and Shirota conducted the research. Murakami analyzed the data. Shirota mainly evaluated the data. Murakami and Shirota wrote the paper. All authors had approved the final version.

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