Identification and comparison of characteristics of inflation rate in cities in Indonesia in the period of 2009–2014 with the period of 2014–2019

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ABSTRACT

This study aims to identify the characteristics of the MoM inflation rate in cities in Indonesia. In addition, it also compares the distribution of the monthly inflation rate for the 2009–2014 period with the 2014-2019 period in cities in Indonesia. The method used to identify the characteristics of the MoM inflation rate is by using summary of statistics, while to compare the distribution of the monthly inflation rate for the 2009–2014 period and the 2014–2019 period, the two-sample Kolmogorov-Smirnov test is used. Characteristics of the month to month (MoM) inflation rate in cities in Indonesia for the period October 2009 to March 2019 was presented. Furthermore, the comparison of the characteristics of the MoM inflation rate from October 2009 to September 2014 (period 1) and the period from October 2014 to March 2019 (period 2) was also shown. The cities of Banda Aceh, Kendari, Yogyakarta, Jakarta and Sorong had an average characteristic of inflation each month which tended to be low in February, March, April and September. Six cities had significantly different characteristics during period 2 inflation rate compared to period 1.

Keywords: city weight in national inflation, K-S test 2 samples, MoM inflation.

1. Introduction

Every month, the Central Bureau of Statistics (BPS) issues the Consumer Price Index (CPI) which is used to calculate the month to month (MoM) inflation. CPI is calculated based on the commodity price index of various goods and services in 82 cities in Indonesia. The inflation weight of cities is determined based on SBH (Survei Biaya Hidup - Living Cost Survey) which is held every 5 years, including the years of 2007 and 2012. For example, in the inflation calculation starting in January 2014, the cities of Jakarta, Surabaya, Bandung, Bekasi and Tangerang were included as the cities that had relatively high weights for the inflation rate nationally. The inflation weights were 19.23, 5.65, 4.87, 4.78 and 3.75 percent, respectively. Each city of 82 cities in Indonesia has CPI for each commodity (around 225 to 462 commodities per city) for each month and the city weight on national/Indonesian inflation.

Research on inflation and inflation modeling has been carried out (Yolanda, 2017; Živkov *et al.*, 2020). However, there has been no research on the characteristics of inflation for the cities used in calculating the national inflation rate. In this study, we will discuss how the characteristics of the MoM inflation rate for each city is used in calculating inflation in Indonesia. Are there significant differences in the characteristics of the inflation rate per MoM in the period of 2009–2014 and 2014–2019? In this study, because only 66 cities were used to determine the national inflation rate in the 2009–2014period, only 66 cities were used in the comparison of the characteristics of the MoM inflation rate in the period 2009–2014 and 2014–2019.

Since early 2000s, along with the enactment of Law No. 23 of 1999, concerning Bank Indonesia, the Policy Framework for Inflation Target, better known as the Inflation Targeting Framework, has been implemented in Indonesia. Within this framework, monetary policy is set transparently and consistently to achieve the sole objective of achieving and maintaining the stability of the rupiah value or controlling inflation as low as possible, as stated in article 7 concerning the objectives of Bank Indonesia. The low inflation rate is believed to be one of the important factors in creating a conducive climate for achieving sustainable economic growth (Rachman, 2016). Meanwhile, the source of inflationary pressure can rise not only from the demand side that can be managed by Bank Indonesia, but also from the supply side related to the real sectors or production. Therefore, in managing inflation, Bank Indonesia initiated the formation of the National Inflation Monitoring and Control Team (TPIN) at national level and the Regional Inflation Control Team (TPID) at the regional level. Knowing the characteristics of the MoM inflation rate, is useful in decision making by the inflation control team at the national and regional levels.

2. Literature Review & Theory

In the review literature and theory, the Consumer Price Index and the MoM inflation rate are presented. In statistics, to summarize the data, the minimum score, maximum score, mean, median, standard deviation, median absolute deviation (MAD), skewness, excess kurtosis and index of dispersion are used. The index of dispersion of the data is defined as the variance of the data divided by the average data. Another summary of data used in the analysis is boxplot, empirical cumulative distribution function and estimation of the kernel density function estimation. The estimates of kernel density functions are used to provide a description of the location and distribution/distribution of data (more information about estimating kernel density functions can be seen in Gramacki (2018) and Scott (2015)).

The MoM inflation rate or also known as the percentage change in MoM CPI can be calculated by the following formula:

$$M_n = \left(\frac{I_n}{I_{n-1}} - 1\right) \times 100, \tag{1}$$

where In = the n-th month CPI and In-1 = the (n-1)-th month CPI. To provide an overview of the use of this formula can be explained below. Suppose that it is known that the CPI in February 2019 and March 2019 for the city of Jakarta are 135.93 and 136.12, respectively. The MoM inflation rate for March 2019 is thus

$$M_n = \left(\frac{I_n}{I_{n-1}} - 1\right) \times 100 = \left(\frac{136.12}{135.93} - 1\right) \times 100 = 0.14, \tag{1}$$

in percent. For more information, we can see Fahlevi *et al.* (2020).

To compare the data characteristics of a time period with the characteristics of other time period data, Kolmogorov–Smirnov (K-S) 2 sample samples were used (Hesse *et al.*, 2020). This test compares whether there is a significant difference between the empirical cumulative distribution

function of the MoM inflation rate in period 1 (sample 1) with the period 2 empirical cumulative distribution function (sample 2). If there are significant differences indicated by the *p*-values which are smaller than the level of significance chosen, there is a significant difference between the two samples. In this case, the *t* test can not be used because by using a sample K-S test, not all samples obtained are normally distributed (for information about the K-S One Sample Test, please see Hesse *et al*. (2020)).

3. Research Methods

MoM inflation data in all cities was obtained from Official News of Statistics (BRS) from West Java Province Central Bureau of Statistics which contains complete data on MoM inflation and CPI. Data were used from October 2009 to March 2019. Data on MoM inflation rates from October 2009 to December 2013 were determined based on 66 cities. The weight of each city was based on 2007 Living Cost Survey whereas from January 2014 to December 2018, the MoM inflation rate was determined based on 82 cities, and the weight of each city is based on the 2012 Living Cost Survey. However, only 66 cities are used to determine national inflation in the 2009–2014 period. In this study, only 66 cities were used to compare the characteristics of inflation from October 2009 up to September 2014, and from October 2014 to March 2019. Previously, the characteristics of Indonesia's MoM inflation rate for the period of October 2009 to March 2019 was presented.

4. Results and Discussion

In March 2019 the MoM inflation rate was 0.11 percent. Out of the 82 cities used in calculating inflation (as measured by the Consumer Price Index - CPI), 51 cities experienced inflation and 31 cities experienced deflation (BPS, 2019). Indonesia's national MoM inflation rate during the period of October 2009 to March 2019 had minimum value, median, average, standard deviation, MAD, dispersion index and maximums as –0.45, 0.27, 0.39, 0.52, 0.40, 0.68 and 3.29, respectively. Therefore, it can be seen that the data used has a dispersion index smaller than 1. This means that the inflation rate is more accumulate. From October 2009 to September 2014 period, the minimum value, median, mean, standard deviation, MAD, dispersion index and maximum successive values were –0.35, 0.32, 0.45, 0.56, 0.44, 0.70 and 3.29, while for the October 2014 period up to March 2019 were –0.45, 0.23, 0.33, 0.46, 0.36, 0.64 and 2.46, respectively. It can be seen that the averages and medians for the two periods do not differ greatly for the dispersion index. Furthermore, if the K-S 2 sample test is used, the two will not be significantly different. This means that in the period of October 2009 to September 2014, there was an empirical distribution that was not different from the empirical distribution in the period of October 2014 to March 2019.

Table 1. The summary of statistics from the inflation rate data for the cities of Banda Aceh, Kendari, Yogyakarta, Jakarta, Tarakan, Ambon, Pangkal Pinang and Sorong.

City	Min	Median	Mean	Max	Standard deviation	MAD	Dispersion index
Banda Aceh	−1.92	0.29	0.28	2.19	0.70	0.64	1.75
Kendari	−2.98	0.17	0.31	4.85	0.97	0.61	3.02
Yogyakarta	−0.45	0.28	0.37	2.58	0.45	0.31	0.55
Jakarta	−0.41	0.27	0.39	3.16	0.48	0.31	0.59
Tarakan	−2.08	0.45	0.51	2.91	0.88	0.70	1.53
Ambon	−3.82	0.44	0.44	4.79	1.25	0.87	3.58
Pangkal Pinang	−2.11	0.38	0.48	3.79	1.21	0.78	2.92
Sorong	−4.28	0.27	0.37	6.47	1.18	1.17	3.99

Arithmetic mean, median, standard deviation, MAD and the smallest dispersion index of the MoM inflation rate of the 66 cities that were of concern in the period of October 2009 to March 2019 were achieved by the cities of Banda Aceh, Kendari, Yogyakarta, Jakarta and Yogyakarta. The largest values of these statistics were, successively achieved by the cities of Tarakan, Tarakan, Ambon, Pangkal Pinang and Sorong. In more detail, a summary of the statistics from the inflation rate data of each city is presented in Table 1 and the boxplot is presented in Figure 1.
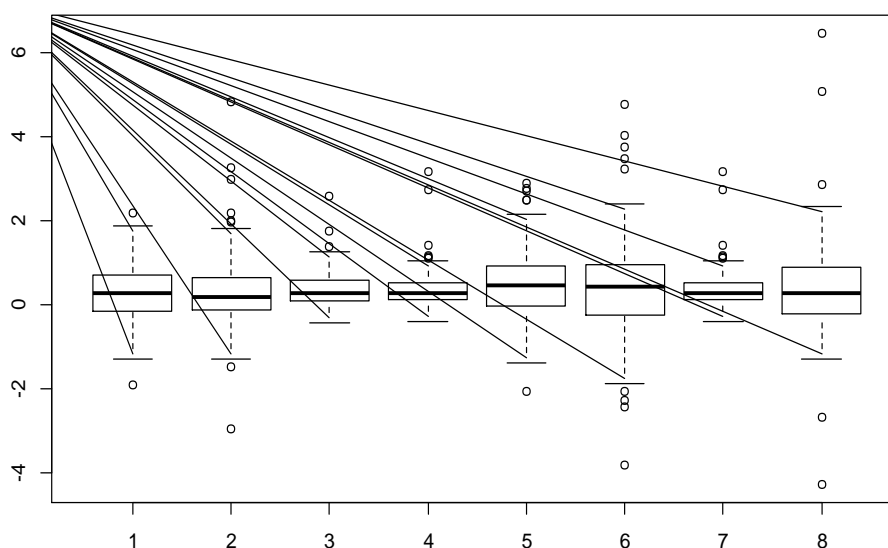

Figure 1. Boxplot from the inflation rate data for the cities of Banda Aceh, Kendari, Yogyakarta, Jakarta, Tarakan, Ambon, Pangkal Pinang and Sorong respectively from left to right.

From Figure 1, it can be seen that in the city of Banda Aceh, even though the average inflation rate is 0.28, the dispersion index is 1.75. It means that the MoM inflation rate data tends to spread more widely or tend to be more fluctuating than the city of Yogyakarta, which has an average inflation rate of 0.37 MoM. That means that the inflation rate of the city of Yogyakarta tends to not fluctuate more compared to the city of Banda Aceh. Even though the average MoM inflation rate of Kendari city is relatively smaller compared to other cities' inflation rates as seen in Table 1, the dispersion index of inflation rate is 3.02. Thus, it can be said that Kendari's inflation rate fluctuates more than the city of Yogyakarta and the city of Jakarta. Furthermore, the cities of Sorong and Ambon have large dispersion indices, which are 3.58 and 3.99 respectively. It can be said that the two cities in the Eastern Part of Indonesia tend to have more fluctuating inflation rates from month to month. In other words, the MoM inflation rate data spread more widely compared to the MoM inflation rate data of other cities in Indonesia. It is also supported by the standard deviation and madness that is greater than other cities. The boxplot in Figure 1 also supports this, as seen from the more widespread inflation rate data for the cities of Ambon and Sorong.

Figure 2 presents the scatter plot between the standard deviation value and the depressive index of each city. It appears that there is a close relationship between the standard deviation value and the dispersion index and it is also supported by the Pearson correlation coefficient between the two at 0.96 so it is significant for the level of significance of 5% with the boundary of 0.24. That means that the city has large standard deviations and will also tend to favor large dispersion indices. In contrast, the cities with a small standardized inflation rate will also tend to have a small dispersion index. Likewise, the top right of Figure 2 illustrates the scatter diagrams between the value of MAD and the disperse index and there is a linkage between the MAD with the dispersion

index and it has a Pearson correlation coefficient of 0.79. Thus, it is significant. Furthermore, the bottom left of Figure 2 shows the scatter diagram between the variation coefficient value and the disperse index. There is also a correlation between the variation coefficient value and the dispersion index and the Pearson correlation coefficient is 0.97. So, it is significant. In this study, more interpretations only use the dispersion index. Finally, the bottom right image states the schematic diagram between the value of MAD and the coefficient of variation in each city so that there is an association between the value of MAD and the coefficient of variation. It is also supported by the data which have a significant Pearson correlation coefficient of 0.71.
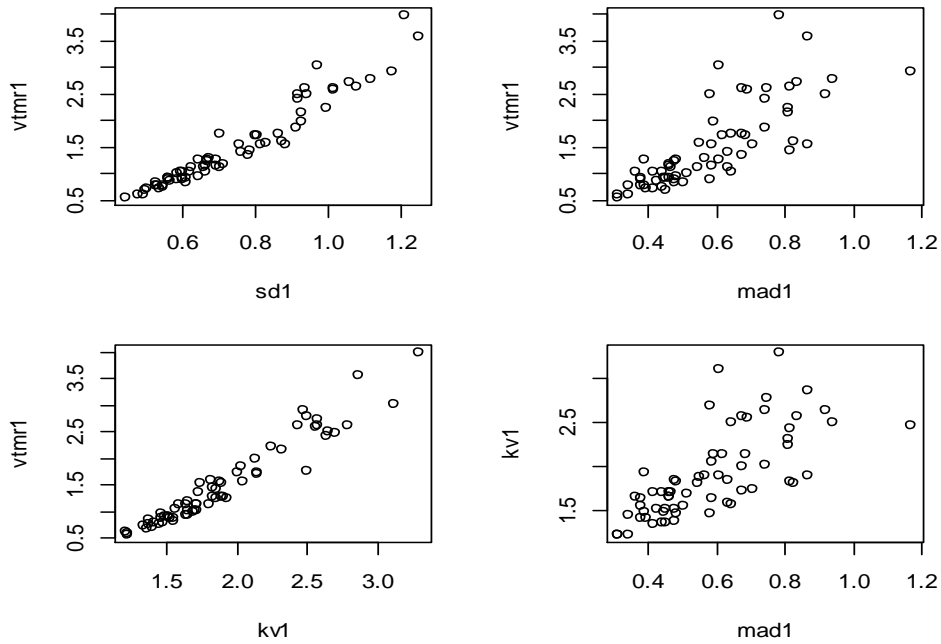
Figure 2. The upper left picture shows a scatter plot between the standard deviation values and the dispersion index of each city. The upper right picture states the scatter diagram between the MAD value and the dispersion index. The lower left image shows the scatter diagram between the coefficient of variation and the dispersion index of each city. The lower right image shows the scatter diagram between MAD values with the coefficient of variation for each city.
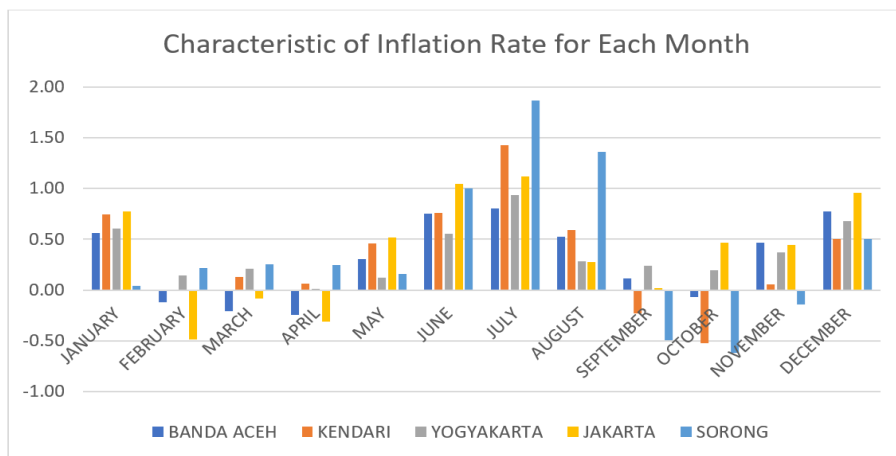
Figure 3. Characteristics of monthly inflation rates for the cities of Banda Aceh, Kendari, Yogyakarta, Jakarta and Sorong.

Figure 3 shows the characteristics of the city inflation rate in Table 1 for each month from January to December. It can be seen that in February, March, April, September and October, MoM inflation tends to be low. Some cities even tend to experience deflation, while in June and July MoM inflation tends to be high. That is, probably because in June and July many students are looking for schools, so the need to pay for school fees.

To compare the characteristics of the MoM inflation rate for the period of October 2009 to September 2014, and the period of October 2014 to March 2019, the t test cannot be used because not all cities had the same variance for both periods. For this reason, 2 sample K-S were used in an effort to test whether the empirical distribution function of the samples in the two periods had significant differences or not. Using a significance level of α = 5%, it was found that the cities of Maumere, Mataram, Tarakan, Pontianak, Kediri and Sumenep gave significant differences between the functions of the empirical distribution of the two periods, the p-values obtained were 0.0059, 0.0136, 0.0185 , 0.0264, 0.0296 and 0.0463, respectively. This is also supported by Figure 4.
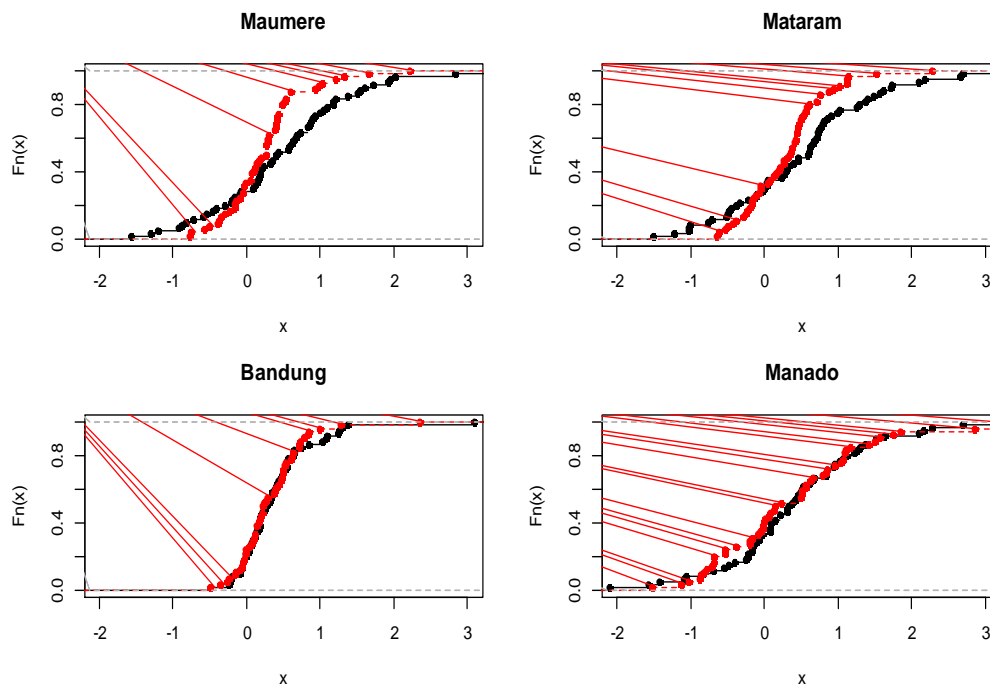

Figure 4. The empirical cumulative distribution function of the sample of period 1 and period 2 MoM inflation rates for the cities of Maumere, Mataram, Bandung and Manado.

It can be seen that the empirical distribution function of period 1 inflation rate is very different from the empirical distribution function of period 2 MoM inflation for the cities of Maumere and Mataram. Other cities such as Bandung and Manado did not have a significant difference. Thus, it can be seen that the empirical distribution function of the period 1 MoM inflation did not differ greatly from the empirical distribution function of the period 2 MoM inflation for the two cities. We can also see the comparison of the estimated kernel density in the MoM inflation rate in period 1 (black) and period 2 (red) can also be seen. It was shown that the period 1 MoM inflation rate spread more widely compared to the period 2 MoM inflation rate in the cities of Maumere and Mataram. However, it did not apply to the cities of Bandung and Manado. Figure 5 supports the results obtained in Figure 4. The estimated kernel density based on the period 1 and period 2 inflation rates differed significantly for the cities of Maumere and Mataram while for the cities of Bandung and Manado, they did not differ significantly.
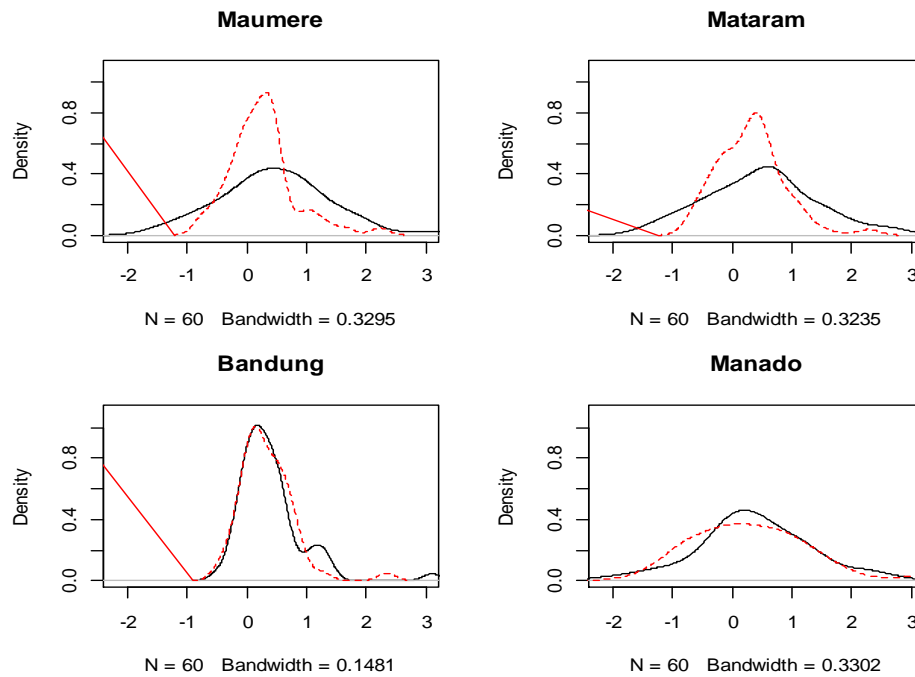
Figure 5. The kernel density function of the samples of period 1 MoM inflation rate (black and solid lines) and period 2 (red and dotted lines) for the cities of Maumere, Mataram, Bandung and Manado.

Table 2 presents the summary of period 1 and period 2 MoM inflation statistics in the cities of Maumere, Mataram, Tarakan, Pontianak, Kediri, Sumenep, Bandung and Manado. The standard deviation and MAD declined sharply in period 2 compared to period 1 in the cities of Maumere and Mataram while in the cities of Bandung and Manado, the standard deviation and MAD tended not to decline.

Table 2. Summary of the statistics from MoM inflation rates in the cities of Maumere, Mataram, Bandung and Manado in period 1 and period 2.

City	Min	Median	Mean	Max	Standard deviation	MAD	Dispersion index
Maumere (1)	−1.57	0.42	0.49	3.56	0.97	0.86	1.93
Maumere (2)	−0.77	0.27	0.25	2.22	0.56	0.40	1.23
Mataram (1)	−1.51	0.60	0.54	4.55	1.06	0.96	2.08
Mataram (2)	−0.66	0.35	0.31	2.27	0.56	0.56	1.01
Tarakan (1)	−2.08	0.59	0.64	2.91	0.97	1.11	1.47
Tarakan (2)	−1.40	0.32	0.36	2.71	0.76	0.25	1.58
Pontianak (1)	−1.66	0.66	0.55	3.36	0.97	0.80	1.69
Pontianak (2)	−1.06	0.32	0.40	2.28	0.76	0.58	1.45
Kediri (1)	−0.71	0.36	0.43	3.26	0.61	0.50	0.85
Kediri (2)	−0.83	0.21	0.24	2.52	0.50	0.31	1.02
Sumenep (1)	−1.44	0.48	0.43	3.84	0.79	0.61	1.46
Sumenep (2)	−0.56	0.27	0.28	2.60	0.50	0.41	0.87
Bandung (1)	−0.49	0.28	0.39	3.10	0.56	0.38	0.77
Bandung (2)	−0.49	0.23	0.33	2.34	0.45	0.38	0.63
Manado (1)	−2.10	0.36	0.43	3.96	1.04	0.82	2.52
Manado (2)	−1.52	0.19	0.39	3.83	1.09	1.07	3.03

The characteristics of the MoM inflation in the two periods can be compared in the cities of Maumere, Mataram, Bandung and Manado. The comparison can be seen in Figure 5. The characteristics of the MoM inflation rate for each month in period 1 appeared to be different compared to the characteristics of the inflation rate every month in period 2 for the cities of Maumere and Mataram, while analogous conclusions can be applied for the cities of Bandung and Manado.

The Inflation Control Team was formed at the national, provincial and district/city level based on the Republic of Indonesia's Presidential Decree Number 23 of 2017 to maintain a low and stable inflation rate as a prerequisite for sustainable economic growth. This team consists of the Central Inflation Control Team, the Provincial Regional Inflation Control Team and the Regency/City TPID. The city of Maumere is the capital of Sikka Regency, which is located on Flores Island, East Nusa Tenggara. So far, even though there is no clear information about the TPKA district TPID but there are significant differences in the characteristics of period 1 and period 2 MoM inflation, it can be said that the Sikka district TPID has succeeded in reducing the inflation rate. The city of Mataram is the provincial capital of West Nusa Tenggara, which is located in the island of Lombok. Based on this study, it appears that Mataram city TPID has succeeded in lowering the average inflation rate for period 2 when compared to period 1. It can be seen, from the average inflation rate, which decreased from 0.54% per month to 0.31% per month (more information about the TPID of Mataram city can be seen on Ban-humas (2019)). Tarakan City is mostly located in Tarakan Island, North Kalimantan province, which is the youngest province in Indonesia. The dispersion index for the two periods is still above 1 so the MoM inflation rate of the city of Tarakan is quite fluctuative from month to month. This possibility is caused by the city of Tarakan, which is located in a small island and the commodity distribution (transportation) routes of daily necessities are relatively difficult (Sangga, 2019). Kediri city TPID is the best TPID in Java and Bali in 2018. In this study, it has been proven to have succeeded in reducing the average inflation rate of MoM from 0.43% per month to an average inflation rate of 0.24% MoM per month. In the information, it was also obtained information that the TPID of the city of Kediri sought to maintain 4K starting from the adequacy of the supply of food commodities, the affordability of food prices, the smooth distribution and effective public communication.

Table 3. Summary of the statistics from MoM inflation rates in the cities of Maumere, Mataram, Bandung and Manado in period 1 and period 2.

Year	Target YoY (%)	Actual YoY (%)	Target MoM (%)	Actual MoM (%)
2009	4.5 ± 1	2.78	0.38 ± 0.08	0.23
2010	5 ± 1	6.76	0.42 ± 0.08	0.56
2011	5 ± 1	3.79	0.42 ± 0.08	0.32
2012	4.5 ± 1	4.30	0.38 ± 0.08	0.36
2013	4.5 ± 1	8.38	0.38 ± 0.08	0.70
2014	4.5 ± 1	8.36	0.38 ± 0.08	0.70
2015	4 ± 1	3.35	0.33 ± 0.08	0.28
2016	4 ± 1	3.02	0.33 ± 0.08	0.25
2017	4 ± 1	3.61	0.33 ± 0.08	0.30
2018	3.5 ± 1	3.13	0.29 ± 0.08	0.26
2019	3.5 ± 1	Not yet determined	0.29 ± 0.08	Not yet determined

As stated above, Bank Indonesia announces future inflation targets for certain periods or known as inflation targeting strategies. Table 3 states the inflation target from 2009 to 2018 is the period of concern in this study. It can be concluded that the actual value of yoy (year-on-year) inflation in 2012, 2015, 2016, 2017 and 2018 is in the inflation target while in 2009 and 2011 it is below the

inflation target. Furthermore, for the years 2010, 2013 and 2014 were above the inflation target. This means that even though there is no significant difference in Indonesian national inflation in the empirical cumulative distribution of period 1 and period 2, in period 2, 2015, 2016, 2017 and 2018 the yoy inflation rate has reached the inflation target as expected by Bank Indonesia while in period 1, namely 2009 and 2011 were below the target. However, the inflation targets of the years of 2010, 2013 and 2014 were above the inflation target. Indonesia's national inflation target for the second period is achieved, one of which is helped by the world crude oil price which is relatively lower compared to the previous one.
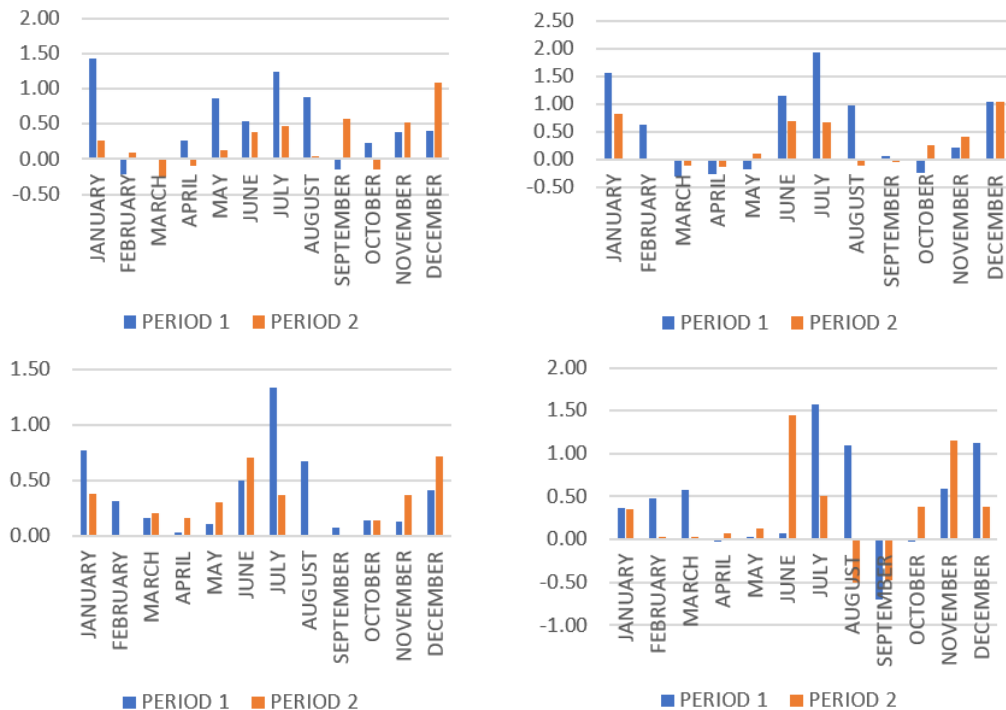

Figure 6. The characteristics of MOM inflation for each month in the cities of Maumere (left top), Mataram (right top), Bandung (left bottom) and Manado (right bottom).

5. Conclusion and Remarks

Based on the explanation above, it can be concluded that for the cities of Banda Aceh, Kendari, Yogyakarta, Jakarta and Sorong, the characteristics of the inflation rate of MoM each month tend to be low in February, March, April, September and October while in June and July, they tend to be high. Based on the MoM inflation rate data it can be found that there are 6 cities that differ significantly in the characteristics of the period 2 MoM inflation rate compared to period 1, they are Maumere (the initial average was 0.49, and it became 0.25 and the p-value is 0.0264), Mataram (the inivial average was 0.54, and it became 0.31 and the p-value 0.0136), Tarakan (the initial average was 0.64, and it became 0.36 and the p-value 0.0185) , Pontianak (the initial average was 0.55, and it became 0.40 and the p-value 0.0246), Kediri (the initial average was 0.43, and it became 0.24 and the p-value 0.0296) and Sumenep (the initial average was 0.43, and it became 0.28 and the p-value 0.0463). This research can be developed using yoy inflation rate data and spatial statistical analysis using Moran index statistics, Gerry index, LISA index and Getis Ord index. In addition, this research can also be extended to the relationship between inflation, government expenditure and economic Growth (Mandala, 2020).

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