Regional Inflation Persistence Analysis:
A Case Study in Surabaya

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ABSTRACT

This study aims to determine the behavior of regional inflation in Surabaya by looking at its persistence, namely the speed of inflation returns to its equilibrium after a shock. Using monthly data on general inflation, commodity groups and commodity goods and services, then the persistency is calculated utilizing Autoregressive Method. Furthermore, inflation cause is estimated by NKPC Hybrid Model. The results showed that the general inflation in Surabaya tends to be persistent as evidenced by the persistence value of 0.98. Whereas commodities with high persistence value are dominated by commodities of volatile food and administered prices.Meanwhile, the cause of the high inflation persistence in Surabaya is produced by a combination of backward-looking inflation expectations and dominated by forward looking inflation expectations.

Keywords: *Surabaya, Persistence, Inflation, Commodity Groups, Goods, Services, hybrid NKPC*

1. INTRODUCTION

Inflation control is important to do because low and stable inflation is an effort to realize the welfare of society. Inflation in a region will affect the economic growth of the region concerned, because it's stability will affect the certainty of business and investment. Thus, low and stable inflation in the long term will support sustainable economic growth. Inflation that is too low even to the level of deflation will suppress economic growth. Similarly, the too high of it will reduce the purchasing ability of the people so that it inhibits the wheels of the economy.

Many studies have been conducted on the inflation persistence before. On the European Continent, it takes more than 1 year for monetary policy to have the maximum effect on inflation [1]and there is a tradeoff between inflation persistence and flexibility of inflation assumptions in the long run [2]. In Indonesia, inflation persistence is quite high when using a sample from 1990 to 2006. However, if the crisis period during 1998 - 1999 is controlled, inflation in Indonesia tends to have low persistence [3]. Meanwhile, the average inflation persistence of various regions in Indonesia is relatively high, including in DKI Jakarta Province [4], North Sumatera [5], Central Java [6], and West Papua [7].

Various studies previously conducted above show that general inflation persistence in Indonesia is remaining high. The national inflation is formed by almost 81% of regional inflation (outside Jakarta), so this research will focus on one of the regions at the Regency / City level, namely Surabaya City. Surabaya City is the Capital City of East Java Province which is one of the regions that does not form a Regional Inflation Control Team (TPID). Through interviews in the media, Surabaya major Tri Rismaharini stated that the formation of the TPID will only add to the budget burden, so that the function of regional inflation control activities is directly within the relevant agencies. On the other hand, over the past 10 years the city of Surabaya has the highest average inflation compared to other CPI districts / cities in East Java [8].

The average inflation in Surabaya is the highest compared to other regions in East Java[8]. This could be because the position of the City of Surabaya is the provincial capital which is the center of economic activity in the province of East Java. From 2006 to 2018, inflation in the city of Surabaya is often in a highest position in East Java Province. In addition, the city of Surabaya has the second highest city inflation weight in Indonesia after DKI Jakarta based on the 2012 Cost of Living Survey as mentioned in [9].

Based on some of the reasons mentioned above, it is important to research how inflation behavior in the city of Surabaya by looking at the persistence of inflationand its causes. The importance of a study of persistence at the district / city level is because each region has different inflation characteristics, so it

is necessary for each region to be well acquainted with the inflation behavior in the region. This is done to support the region concerned so that it can take more effective and targeted policy measures in accordance with the characteristics and behavior of inflation in the region.

2. LITERATURE REVIEW

2.1. Persistence of Inflation

Marques[2]defines inflation persistence as the speed of inflation to return to its equilibrium level after the onset of shock. While Angeloni[10]defines inflation persistence as a tendency to slow the movement of inflation toward its long-term value when there is a shock in the economy. A similar definition is also stated by Willis in [11] which defines inflation persistence as the time needed for inflation to return to baseline after a shock. Inflation persistence is a long-term effect of shocks on inflation. Therefore, inflation persistence is fast or slow inflation to return to its natural value when there is a shock.

The high degree of inflation persistence indicates the slow rate of inflation returning to its natural level. Conversely a low degree of persistence indicates the rapid rate of inflation to return to its natural level. Shock referred to include government policies, distribution disruptions, natural disasters, and weather changes. Studies on inflation persistence are important to improve the ability to forecast inflation, obtain clarity of the dynamic effects of exogenous price shocks, provide information / guidance and improve monetary policy, and to assess whether different monetary policy regimes will produce different persistence [11].

Batini[1]provides a more detailed explanation by distinguishing 3 types of inflation persistence. The first type is positive serial correlation in inflation. Second is the time lag between systematic monetary policy action and its effect on inflation. Third is the slow response from inflation to an unsystematic monetary policy. The first type of persistence is a reduced form of inflation that simultaneously manifests the underlying price-setting process, the implementation of monetary policy, and the process of establishing price-setting expectations. Changes in one of these three factors will affect the nature of inflation autocorrelation. However, various studies show that persistence measured by this definition tends to decrease over time, especially after the onset of a monetary regime with strong anti-inflation credential.

Type 2 inflation persistence refers to the number of periods needed to make changes in monetary policy in order to have a maximum effect on inflation. Batini and Nelson [12] examine the time lag between monetary policy actions and the inflation response using UK and US data in the period 1953-2001 on rates of monetary growth, inflation and interest rates, as well as annual data on money growth and inflation. They assert that it takes more than a year before the monetary policy taken has a peak effect on inflation both in the US and in the UK even

though there have been many changes in monetary policy settings in both countries.

Type 3 of inflation persistence is related to the amount of delay needed for inflation to respond to policy shocks. This type of persistence is often the only one that economic modelers consult when validating a model dealing with the dynamics of the process of making data in the real world. In conclusion, as discussed in Batini and Nelson [12], type 2 inflation persistence is the most relevant type for monetary policy making because this type of persistence determines the cost of disinflation. Knowing the lag between policy action and its peak effect on inflation informs monetary policy makers about how early they should be when responding to private sector shocks by helping to minimize the variability gap in output costs from price stabilization.

2.2. Causes of Inflation Persistence

The cause of inflation persistence can be seen through the New Keynesian Phillips Curve (NKPC) equation which was built by Gali and Gatler in [18]. Maical [13]argues that the development of the Hybrid NKPC model begins with the Phillips curve which is an empirical study by Phillips [14]of the British economy in 1861 – 1957.He found a decrease in the unemployment rate (or an increase in output growth) would be followed by an increase in inflation. Research by [15]and [16]argue that the tradeoff between the inflation rate and the unemployment rate will only occur in the short term. Whereas in the long term, the tradeoff will not happen because the unemployment rate tends to be at its natural level, so the prevailing monetary policy will only affect the inflation rate. Empirical facts that support the opinion of Friedman and Phelps are stagflation experienced by industrialized countries in the 1970s. This stagflation is at the same time the cause of the collapse of the Phillips curve in the 1970s and 1980s[17].

In the latest macroeconomic model developed by New Keynesian economists, the Phillips curve now shows a positive correlation between the inflation rate and the output level (Gali and Gertler). The relationship between the inflation rate and the output level is then called the New Keynesian Phillips Curve (NKPC).Furthermore, the New Keynesian Phillips Curve model has received some criticism which shows that the model is not optimal for analyzing the phenomena of the Phillips curve. Related to these criticisms, Gali and Gatler [18] developed a hybrid model of the New Keynesian Phillips Curve, a model that includes the effect of inflation lags by entering the backward looking inflation rate as a rule of thumb in determining prices.

Constructing and estimating the structural model of the Hybrid New Keynesian Phillips Curve, Gali and Gertler included the real marginal cost variable to measure the impact of increased productivity from inflation proxy by the output gap and the division of labor income. It also included elements of backward looking and forward looking expectation. The results obtained from this study indicate that the New Phillips Curve model

containing forward looking elements is able to explain the dynamics of inflation (dominant).

Based on the explanation above, the causes of inflation persistence according to the New Keynesian Phillips Curve hybrid model, are as follows:

1. *Extrinsic persistence* associated with persistence in marginal costs or output gaps

2. *Intrinsic persistence* related to inflation dependencies on previous period inflation (backward looking expectation)

3. *Expectations-based* persistence related to the formation of inflation expectations based on forward looking conditions

4. *Error term persistence* due to the effect of supply side shock or inflation shock that occurs.

3. METHODS

Inflation persistence is estimated using the univariate autoregressive (AR) time series model analysis method. Autoregressive is a model that includes the lag of the dependent variable as an independent variable [19]. The choice of the AR model is because the AR model is a fairly good measure of inflation persistence [2]. With the AR model, the level of inflation persistence is measured from the sum of the coefficients of the dependent variable lag. From several studies that have been carried out, such as those of [2],[3],[4], the univariate autoregressive (AR) time series model is the most prevalent approach in empirical research. The AR formula with the order ρ can be described as follows:

General Autoregressive Model:

$$......(1)$$

Or it can be written as:

Where :

	=	monthly inflation rate at time *t*
	=	constants from the results of the estimation process, as a control - on average inflation
	=	number of AR coefficients
	=	random error term or residual

From the estimation results of the equation, the inflation persistence level is calculated by adding up the AR coefficient as follows:

$$\alpha_j..(2)$$

According to Andrews and Chen [20], the method of adding coefficients is the best way to measure the persistence scale. Inflation persistence is said to be high if the current inflation rate is strongly influenced by the lag value, so the coefficient is close to 1. In this case, inflation is said to be close to the unit root process. In line with this Dosschee&Everaert[21] states that if the value of ρ ≤0.5 then inflation has low persistence. For estimation ρ, determine the appropriate number of dependent variable lag using Akaike Information Criterion (AIC) and or Schwarz Bayesian Information Criterion (SBIC). Meanwhile, to find out how long it takes for inflation to return to the initial balance or its natural value after the shock [16] :

$$\overline{\quad\quad}..(3)$$

Where h is the time needed for inflation to absorb 50% of the shock that occurs before returning to its average value and ρ is the result of an estimated degree of inflation persistence.

To see the causes of inflation persistence, the New Keynesian Phillips Curve hybrid model by Gali and Gatler[18] is used as follows:

Note :π_tInflation on time period*t ;*   Inflation in the past *t-1 (backward looking);*   )Inflation expectations on time *t+1*with time conditions t *(forward looking);*   Output Gap;ε Error term; $\gamma_b, \gamma_{f, \lambda}$Coefficient

The Model will then be estimated using the Ordinary Least Square (OLS) method. To get the BLUE (Best Linear Unlimited Estimator) of estimation results, it is necessary to do a classic assumption test which includes Normality, Autocorrelation, Heteroscedasticity, and Multicollinearity Tests [22].

Meanwhile, to determine the inflation expectation variable in the NKPC hybrid equation, it is done by predicting or forecasting inflation using the AR Forecasting method. This is done because the city of Surabaya has no inflation target or target that can be used to describe inflation expectations. The reason for the use of AR Forecasting is that Surabaya City inflation is still adaptive, that is, inflation that is formed based on observed inflation or follows the previous inflation.

The output gap variable is obtained by calculating the difference between the actual output and its potential output. Potential output is the maximum amount of goods and services that an economy can produce in the most efficient condition. Potential output is the level of output that is consistent with inflation statistics and to calculate the method the Hodrick-Prescott Filter is used. HP filters are used to find potential GDP trends based on actual GDP data. This technique minimizes size combinations around potential GDP trend fluctuations and the rate of change in GDP trends for the entire sample. The output gap shows the degree of tightness and slackness of aggregate demand and supply. This indicator is used to assess pressure on price changes.

4. RESULT AND DISCUSSION

The measurement of the degree of persistence of inflation in Surabaya is carried out on the General Inflation variable, the variable in the CPI Spending Group, as well as the variable in commodity goods and services. Commodities of goods and services are chosen based on the average of the largest inflationary contributions during the study period, then the 20 biggest contributors to inflation in the period were taken. The data used in this study are secondary data obtained from the publication of the Central Statistics Agency and Bank Indonesia from 2010 to 2018. To see the cause of inflation persistency, the annual inflation data (year on year) and Gross Domestic Product (GDP) of Surabaya are used.

4.1. Results and Analysis the Persistence of General Inflation and Commodity Groups

After knowing the estimation results of the autoregressive model (AR), then the AR coefficient on each variable is added to determine the degree of inflation persistence. The results of calculating the degree of persistence of general inflation and commodity groups are presented in Table 1.

TABLE 1
PERSISTENCE OF GENERAL INFLATION
AND COMMODITY GROUPS

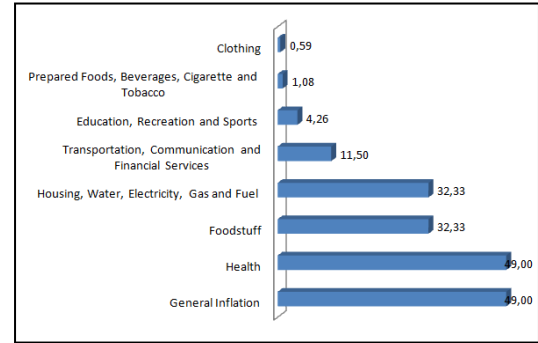| No.	Variable	Degree of Persistence
	General Inflation	0,98
	Commodity Group	
1	Foodstuff	0,97
2	Prepared Food, Beverages, Cigarettes and Tobacco	0,52
3	Housing, Water, Electricity, Gas and Fuel	0,97
4	Clothing	0,37
5	Health	0,98
6	Education, Recreation and Sports	0,81
7	Transportation, Communication and Financial Services	0,92

Fig. 1. Time Returns to Average Values (months) for General Inflation and Commodity

The results of measuring the degree of inflation persistence indicate that the general inflation variable has a high persistence, which is equal to 0.98. This means that the general inflation behavior in Surabaya tends to be persistent. This is reflected in the length of time needed to absorb 50% of the shock that occurs before returning to its natural level, which is 49 months. This finding is in line with various previous studies which stated that on average the general inflation behavior in various provinces in Indonesia tends to be persistent.

The next analysis is to measure the level of persistence of the commodity groups that compile the CPI. Persistence in the CPI-forming commodity group also showed a high average. The Health group had the highest persistence value compared to 6 other groups, which amounted to 0.98. The time needed to return to the average value is 49 months. Meanwhile the Foodstuffs Group which has high volatility because it is susceptible to shock has a persistence value of 0.97 which means it is very persistent. Most of the food supplies in the city of Surabaya come from outside the region [23], so that it depends on the production and distribution of the supplier area. The Housing, Water, Electricity, Gas and Fuel group also has the same persistence value of 0.97. The high persistence in these two groups could be because the commodity in the group is dominated by commodities whose prices are regulated by the government (Administered Price) which causes prices to stiffen so that it is not easy to return to their average values during a shock. Both of these commodities need 32 months to absorb 50% of shocks before returning to their natural values.

The next commodity groups that also have high persistence value are the Transportation, Communication and Financial Services group as well as the Education, Recreation and Sports group respectively 0.92 and 0.81, where commodity prices in the two groups are also largely regulated by the government. The time needed to return to the natural value after absorbing 50% of shock 11 months and 4 months, respectively. Meanwhile, there are 2 commodity groups showing a low degree of persistence, namely the Food, Beverage, Cigarettes and Tobacco group and clothing groups respectively 0.52 and 0.37. These two expenditure groups are not included in the volatile food category or administered prices, meaning that

based on inflation disaggregation the two commodity groups are not included as non-core inflation. The time needed to return to its natural level after absorbing 50% of the shocks was also relatively short, i.e. 1 month and half a month respectively. Based on the explanation above, it can be concluded that the commodity group that has a high degree of inflation persistence is the commodity group in the administered price category followed by the volatile food category in which both categories are disaggregated by inflation including non-core inflation. This is because commodity prices that are administered prices tend to be rigid and are more difficult to change depending on government policy. The implication of this is that in setting policies in the field of prices, the government must be careful and pay attention to the right time and not in a hurry. Whereas the volatile food commodity group tends to be more susceptible to disruptions in production, distribution and domestic and international price developments. Therefore, there is a need for stronger coordination between local governments and Bank Indonesia in controlling inflation in the city of Surabaya.

Meanwhile it is known that most of the food supply in the city of Surabaya comes from other regions. Thus, the shock or shock that needs to be watched out not only happens in the city of Surabaya, but also happens in the area of food suppliers. This was done as an effort to suppress the high degree of inflation persistence.

4.2. Results and Analysis of Goods and Services Commodity Persistence

The persistence calculation is done up to the level of commodities and services forming the basket of the Surabaya City Consumer Price Index. The selection of 20 commodity goods and services is based on the largest average contribution to inflation formation during the study period. Measurement of the degree of persistence to the level of commodity goods and services needs to be done so that it is known what commodities tend to be persistent so that the application of policies can be better targeted because it leads directly to the root of the problem.

TABLE 2
PERSISTENCE OF COMMODITIES IN GOODS
AND SERVICES

| No.	Commodity	Degree of Persistence
1	Air transport	0,97
2	Rice	0,97
3	Gold Jewelry	0,97
4	Inter-City Transportation	0,96
5	Fuel	0,96
6	Electric Tariff	0,96
7	Car	0,95
8	KAI rates	0,95
9	Garlic	0,94
10	Artisan Not a Foreman	0,94
11	Shallot	0,93
12	Broiler Chicken Meat	0,93
13	Cayenne pepper	0,91
14	Kretek Cigarettes / Filters	0,89
15	Red chili	0,39
16	RT Fuel	0,37
17	Vegetable Tomatoes	0,37
18	Noodles	0,36
19	Broiler Chicken Eggs	0,34
20	Carrot	0,25
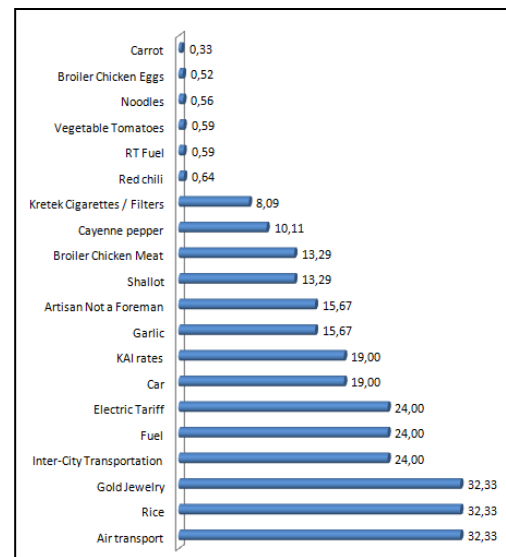
Fig. 2. Time Returns to Average Value (months)

Commodity of Goods and Services

Air Transport, Rice and Gold Commodity Commodities have the highest persistence value compared to other commodities, each at 0.97%. The high level of persistence in Air Transport is due to government interference in setting the upper and lower limits of airplane ticket prices, so prices will be rigid. Meanwhile, Rice is a volatile food commodity where the formation of rice prices in Indonesia still gets government intervention through the determination of HET (Highest Retail Price) which always experiences an increase every year. The time needed for the prices of the three commodities to absorb 50% of the shock that occurs before returning to its natural level is 32.33 months.

The second highest degree of persistence were commodities of Inter-City Transportation, Gasoline, and Electricity Tariffs amounting to 0.96. When examined, these three commodities are commodities whose prices are regulated by the government (Administered Price) so that the prices of these three commodities become more rigid. This persistent commodity behavior is reflected in the length of time needed by the three commodities to absorb 50% of shock before returning to the average value after a shock, which is 24 months. Meanwhile the Car and Railway Fares commodities had the third highest degree of persistence, each by 0.95%. While the time needed for the two commodities to absorb 50% of shock before returning to its natural level after a shock that causes price changes is 19 months.

The high demand for non-foreman artisans is inseparable from the position of the city of Surabaya, which is the center of East Java's largest economy, so development has also increased rapidly. The degree of persistence of Non Foreman Artisan is also relatively high, which is 0.94. In addition, the commodity Garlic which includes volatile food also has a high persistence of 0.94. The time needed for the two commodities to absorb 50% of shock before returning to their natural level after a shock is 15.67 months.

Meanwhile commodities that have low persistence include Red Chili, Household Fuels, Vegetable Tomatoes, Noodles, Broiler Chicken Eggs, and Carrots. This means that the five commodities have non-persistent behavior and quickly adjust to natural levels after a shock. The time needed for these commodities to return to their natural level is also quite short. Red Chillies Commodity takes 0.64 months (days), Household Fuel 0.59 months (days), Vegetable Tomatoes 0.59 months (days), Noodles 0.56 months (days), Chicken Eggs 0.52 month (day), and Carrot 0.33 month (day). Overall it takes less than 1 month for the five commodities to return to their natural levels after a shock has affected prices.

4.3. Results and Analysis the Causes of Inflation Persistence

The estimation results of the Hybrid NKPC Model using OLS are explained in the following Table:

TABLE 3. NKPC Hybrid Model OLS Regression Estimation Results

Variable	Coef.	Std. error	t-stat	Prob
Inflation t-1	0,3876	0,1624	2,3868	0,0317**
Inflation $t+1$	0,6962	0,1255	5,5459	0,0001***
Output Gap	6,96	0,0001	0,0503	0,9606
C	-0,9057	1,6151	-0,5608	0,5838
R^2		0,7236		
Adjusted R^2		0,6644		
F-statistic		12,2201		

*** α =1% ** α =5%

Estimation results show the coefficient of the variable t-1 inflation or inflation in the previous period has a positive and significant effect. This means that an increase in t-1 inflation by 1% will increase inflation by 0.3876. Whereas the coefficient of the Inflation Expectation variable also has a positive and significant effect, where an increase of 1% Inflation Expectation will increase Inflation by 0.6962%. Meanwhile the Output Gap coefficient has a positive but not significant effect. The constant value (C) indicates if the inflation variable t-1, inflation expectations, and the output gap is zero, the inflation rate is -0.9057%. The coefficient of determination R2 is 0.72, meaning that 72 %% of the inflation rate can be explained by the t-1 inflation variable, inflation expectations, and the output gap. While the remaining 28% is explained by other variables not included in the model. The OLS estimation results above have passed the classic assumption test which includes the normality test, autokorelasi, heteroskedastisitas, dan multikolinearitas.

Based on the estimation results of the New Keynesian Phillips Curve hybrid model shows that the cause of inflation in the city of Surabaya is the influence of backward looking or looking at inflation in the previous period and forward-looking expectation. However, the forward-looking inflation behavior is more dominant in the formation of inflation in Surabaya, which is reflected in the magnitude of the coefficient compared to backward looking behavior. Meanwhile the output gap does not have a significant influence on the dynamics of inflation in the city of Surabaya. The level of economic output that is above its potential output will increase inflation. However, if the level of economic output is below potential output it will reduce inflation. A positive Output Gap value means that unemployment in Surabaya is below its natural value, which causes workers to demand higher wages which results in further increases in production costs.

This phenomenon also occurs in Indonesia as [24] found that forward looking behavior is more dominant in Indonesia than backward looking. In line with this, several regions in Indonesia also experienced similar phenomena, including DKI Jakarta [4] and West Sumatra [25].However, forward looking behavior in Surabaya is still adaptive, meaning that it is inseparable from backward looking behavior. This explains that the people and economic players of the City of Surabaya basically also still see the experience of past inflation as a reference for future inflation.

The behavior that tends to see past inflation as a reference will affect commodity prices contributing to inflation, causing inflation to tend to be more persistent. Inflation behavior that tends to be persistent will certainly complicate economic management [4].Thus, the length of time needed by inflation to return to the average value will also complicate economic actors and require greater effort for the government to return the inflation rate to its natural value.

The implication of this finding is the important role of government policy through controlling regional inflation in an effort to overcome persistent inflation. Inflation behavior that is still adaptive in the city of Surabaya needs to be explored further, one of which is by changing the view that still refers to backward looking to purely forward looking through setting government inflation targets in the regions. In Indonesia, the government and Bank Indonesia have been implementing the Inflation Targeting Framework since 2005 to change the mindset of economic actors so that they are more in line with the inflation target set by the government. The dominance of the forward-looking effect in the city of Surabaya is one of the loopholes for the regional government and Bank Indonesia to immediately set regional inflation targets to keep inflation low and stable.

5. CONCLUSION

The results of the calculation of the degree of general inflation persistence in the city of Surabaya gave a high result, amounting to 0.98 The high degree of persistence took 49 months to absorb 50% of the shock that occurred before returning to its natural level.

Based on expenditure groups, the highest degree of persistence is in the Health commodity group, while the lowest persistence degree is the Clothing commodity group. Meanwhile, the high degree of persistence in the commodity group was in the categories of administered prices and volatile foods.

Based on the commodity of goods and services, the highest persistence is commodity in Air Transport, Rice, and Gold Jewelry. While the commodity with the lowest persistence is Carrots.

Thus, the regional government together with Bank Indonesia through regional inflation control policies to be more vigilant when there is an increase or decrease in the price level of commodities that have high persistence value.

Causes of Persistence Inflation in the city of Surabaya is influenced by backward looking and forward looking inflation.

Foward looking behavior is more dominant than backward which means that although economic actors still use past inflation experience as a reference.However, if obtained information that affects inflation in the future, economic actors will immediately change their behavior. The output gap does not have a significant effect on inflation formation in the city of Surabaya. Thus the government does not need to over-apply GDP to overcome unstable inflation.

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