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Abstract. Given the highly kurtotic and positively skewed characteristics of the cross-sectional distribution of price, asymmetric trimmed-mean is the best approach in extracting the statistical medium-term trend of inflation.

This paper uses asymmetric trimmed-mean approach to measure core inflation in Indonesia. This measure, as compared with headline inflation, is more correlated with the growth of money supply in the past. Additionally, it is a reliable indicator of inflation trend.

JEL classifications : C43; E31; E52

Keywords: stochastic approach; inflation; core inflation; monetary policy

1. Preface.

Motivated by the difficulties faced in implementing monetary policy using either exchange rate peg or some monetary aggregates as intermediate targets, some developed countries have adopted a monetary policy framework, which is known later as inflation targeting. This monetary policy framework was aimed to reach and maintain a low and stable inflation, and also the accountable and transparent monetary policy (Mason 1997).

These developments were then followed by many researches, especially as to how to define and to measure the inflation that is relevant with the formulation, communication and accountability of the monetary policy; so-called core inflation. There have been so many methods proposed to measure the core inflation. Some of them are exclusion method, structural VAR, specific adjustment, trimmed-mean, etc.

Researches about core inflation describe how useful it is as a policy tool. Core inflation measure, compared to the headline inflation, can be a better guidance for the policy today and in the future. In addition, core inflation will be more controllable than the headline inflation.

Ideally, a measure of core inflation should be (Hogan *et al.* 2001):

1. a good indicator for the trend of the inflation today and in the future; and
2. a measure of inflation which is practically able to be used as the target of monetary policy.

Bank Indonesia did the first research about the core inflation in Indonesia (Hutabarat 1999). The result has been used by the Bank Indonesia as the measure of core inflation. They used asymmetric trimmed-mean method resulting 80% trimmed-mean centered on the 77^{th} percentile as the best indicator of core inflation. They did another research in 2001 even with the stronger conclusion that this indicator is the best among some alternatives of approaches (Majardi 2001).

Unfortunately, some inconsistencies in the process lead to a methodological failure. Consequently, the result cannot be used as the core inflation indicator in Indonesia.

This paper uses the same approach used by Hutabarat, *et. al.* in terminology, but it is based more on a consistent estimation process in accordance with the asymmetric trimmed-mean method meant by Bryan, Cecchetti and Roger (Bryan *et al.* 1997; Roger 1995).

The data comprises of monthly cross-sectional individual price indices, which are grouped into 337 sub-components for the period April 1990–December 1997 (1987 constant price).

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The hypothesis that will be tested is that core inflation measured with asymmetric trimmed-mean approach, as opposed to headline inflation, is:

1. an inflation indicator that more correlated with the growth of money supply in the past; and
2. a better indicator of the trend of inflation.

2. Literature Survey.

2.1. Core Inflation Concepts. One key issue in an inflation targeting monetary policy framework is how to differentiate between demand pull and cost push inflation. It is extremely important because all central banks – even the explicitly inflation targeting – still has to worry about the output stability, as they worry about the inflation's per see.

In the case of an unanticipated demand shock, a monetary policy that is intended to stabilize inflation would also stabilize output. The story will be the opposite if we are dealing with a supply shock. In the case of negative supply shock for example, an inflation stabilization monetary policy would even worsen the recession and destabilizes both inflation and output. What appears is a conflict between inflation stabilization and the output stabilization in the short-run (Roger 1998). At this stage, we can safely conclude that it is the demand driven inflation (not the supply driven inflation) to which a central bank should react to by conducting a monetary policy: which is called core inflation.

Despite the important role played by the core inflation concept in formulating the monetary policy, there has not been any strong agreement as to what method should be used to measure it. Most of the proposals emphasis on how to measure rather than what components should a measure cover (Roger 1998).

At least we can divide them into two broad types of approaches: (1) proposals that regard the core inflation as the persistent component of inflation and (2) proposals that regard it as the generalized components of inflation. Both of them associate core inflation with the expected inflation or specifically demand driven inflation (Roger 1998). From this point forward, this paper will use the second approach.

2.2. Necessary Conditions for a Core Inflation indicator. In addition to some criteria proposed by some economists for a core inflation measurement method (Wynne 1999), Marques and Mota propose three necessary conditions for a core inflation indicator (Marques and Mota 2000).

1. If inflation, Π_t, is I(1), then core inflation, Π_t^* has to be I(1) as well and both of them are co-integrated with coefficient 1, i.e. $(\Pi_t - \Pi_t^*)$ has to be a stationary variable with zero mean. If inflation, Π_t, is I(0), then it is sufficient if $E(\Pi_t - \Pi_t^*) = 0$.
2. There has to be an error correction mechanism which is given by $z_{t-1} = (\Pi_{t-1} - \Pi_{t-1}^*)$ for $\Delta\Pi_t$:

$$\Delta\Pi_t = \sum_{j=1}^{m} \alpha_j \Delta\Pi_{t-j} + \sum_{j=1}^{n} \beta_j \Delta\Pi_{t-j}^* - \gamma(\Pi_{t-1} - \Pi_{t-1}^*) + \varepsilon_t \tag{1}$$

3. Π_t^* has to be strongly exogenous for the parameters in equation (1).

2.3. Asymmetric [Weighted] Trimmed-Mean.

2.3.1. Theoretical background. Let us assume that the economy consists of two types of price setters. The first type price setters adjust their prices flexibly in response to any shocks in the economy, while the second group set their prices infrequently and face a relatively significant readjustment cost; significantly high as compared with the benefit from those adjustments. In setting their prices, these Neo-Keynesian behaved firms are bounded by contracts and have to consider any ex-post unexpected events and anticipate the upcoming trends.

As regard to measuring core inflation, the first group would produce *noise* to the generalized price changes; their price movement would exhibits a large transitory fluctuations. Because they can frequently and easily adjust their prices, there is no need for them to worry about the long-term inflation or even the growth in money supply.

In contrast, the second group would exhibit a smoother price movement because any wrong decision will be costly for them. In searching the generalized component of price changes, we should then focus our attention on this group.

These firms do not adjust their prices for any shock but only if the desired adjustment would optimize the loss function they are facing. As described in figure 1, these firms will have inaction bands, within which they will not make any adjustment in response to a shock, in a distribution of shocks (Ball and Mankiw 1994).

The effect of relative price shock on aggregate inflation will depend on the distribution of the shock (Ball and Mankiw 1995). If the distribution is symmetric (Panel A), the effect in average will be zero. While if the distribution is skewed, the aggregate inflation will be higher (lower) if it is positively skewed as on panel B (negatively skewed as on panel C). As the result, in short term, there will be some transitory movements around the long-term aggregate inflation rate.

To be more specific and more related to monetary policy, we are assuming that money supply is growing exogenously in a constant rate, $dM/dt = \mathbf{m}$, velocity is constant and output growth is normalized to zero (Bryan and Cecchetti 1994).

Bearing in mind this environment, in each period, firm will set the change of their price equals to $\mathbf{m}$, so that inflation would be merely monetary phenomena. Then the core inflation can be expressed as:

$$\Pi^C = \mathbf{m} \tag{2}$$

As explained before, each firm is experiencing shock, θ, either on the demand or on their production cost. This shock is serially uncorrelated and $E(\theta_t) = 0$. Having realized the shock, firms whose value of their shocks lie outside the inaction band will adjust their price further. Price change for the i^{th} firm in this category can be expressed as:

$$\pi_i = \mathbf{m} + \theta_i. \tag{3}$$

If we are assuming that all of the inaction bands is symmetric and similar across firms, $|\theta_l| = \theta_h = \varepsilon$, then aggregate inflation can be expressed as:

$$\Pi = \mathbf{m} + \frac{1}{n}\sum_{i=1}^{n} \theta_i \times \frac{\max(|\theta_i| - \varepsilon, 0)}{|\theta_i|\varepsilon} \tag{4}$$

When the distribution is symmetric, the second part on the right hand will be zero; but if it is positively (negatively) skewed, the aggregate inflation will be higher (lower) than the core inflation.

Because the gap between the core inflation and the aggregate inflation comes from the tails of the shock distribution, it is proposed to measure the core inflation by eliminating these outliers. This is the basic idea of using trimmed-mean estimator as the core inflation indicator.

2.3.2. Symmetric vs. Asymmetric Trimmed-Mean: Statistical theory. Symmetric trimmed-mean is an indicator which average the middle part of a sample. Set $x = \{x_1, x_2, \ldots, x_n\}$ as a sample of a price changes population that is sorted from the lowest to the highest, and $w = \{w_1, w_2, \ldots, w_n\}$ is the weight, and $W_i = \sum_{j=1}^{i} w_j$ is the cumulative weight from 1 to i. If I_α is the untrimmed range, $(\alpha/100) < W_i < (1 - \alpha/100)$, then a $2\alpha\%$ symmetric trimmed-mean is

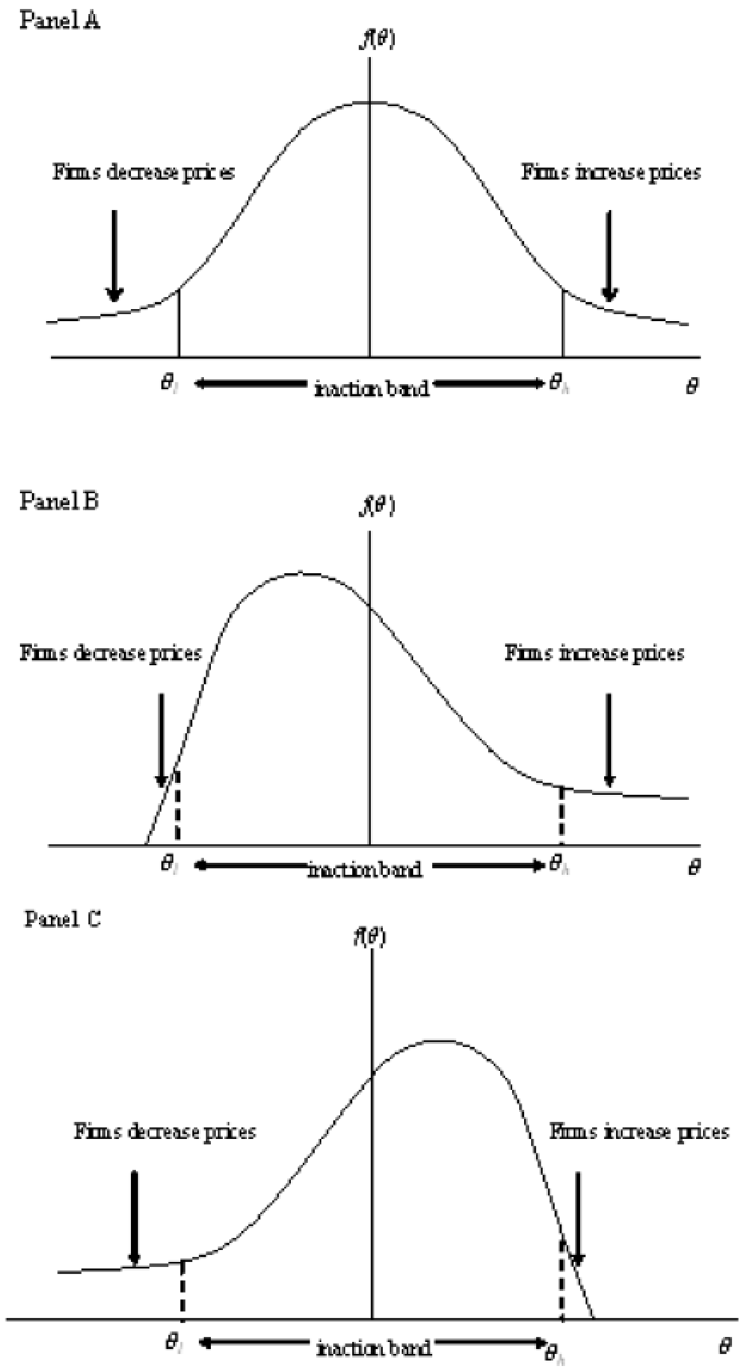
$$x_\alpha = 1/(1 - 2\alpha/100)\sum_{i \in I_\alpha} w_i x_i, \tag{5}$$

with $\alpha\%$ trimming from both left and right tail of the distribution and 50^{th} percentile as the centre of trimming. Median and mean are two extreme cases with 100% and 0% trimmed-mean respectively.

If the distribution is Normal, median, mean and mode will coincide and each of these central tendencies can be picked as the generalized inflation, i.e. core inflation. However, if the distribution is positively skewed, then mean > median > mode.

For a symmetric distribution but high kurtosis, mean would be still the unbiased estimator; but much less efficient than median (Roger 2000). Bryan and Checcetti proposed to use median as the core

Figure 1: Price Adjustment & Distribution of Relative Price Shocks



inflation indicator, but revised it three years later that it should have been [symmetric] trimmed-mean (Bryan et al. 1997).

Before Bryan, Checcetti and Wiggins II proposed [symmetric] trimmed-mean, Roger had found that all [symmetric] limited-influence estimators (including median and symmetric trimmed mean) are biased indicators for core inflation in New Zealand. Having realized that price changes distribution in New Zealand is always chronically skewed, Roger found that asymmetric trimmed-mean (trimming centered on any i^{th} percentile other than 50^{th} percentile) is the unbiased one (Roger 1995). This result is then applied to some countries: Australia (Kearns 1998), Ireland, Portugal (Marques and Mota 2000) and Belgium (Aucremanne 2000).

The raison d'être lies on the trade-off between gaining the efficiency and the unbiasedness in conducting a symmetric trimming on an asymmetric distribution.[1] When the distribution is skewed, the efficiency focused trimming would loose the unbiasedness of the estimator. For example, in a positively skewed distribution, the effect of $\alpha\%$ highest prices on the aggregate inflation would be higher than the effect of $\alpha\%$ lowest prices. That is why a symmetric trimming would produce a systematically under-estimated estimator of core inflation. To avoid it, we should centre the trimming on the rightward of 50^{th} percentile. For example, for a $2\alpha\%$ asymmetric trimmed-mean centered on β^{th} percentile we are trimming $\frac{2\alpha\beta}{100}\%$ from left tail and $\frac{2\alpha(100-\beta)}{100}$ % from the right tail of the distribution.

2.3.3. Weighted vs. Unweighted.. Bank Indonesia calculates the core inflation by using CPI data in Indonesia by using [unweighted] asymmetric trimmed-mean. The result is (77;40) trimmed-mean which means trimming 20% from the tails of the distribution centered at the 77^{th} percentile, as the core inflation estimator. They do the same thing to kurtosis and skewness coefficients.

Both theoretically and empirically, unweighted mean, kurtosis and skewness will be very different from their weighted counterparts. They do not provide the true information about the distribution in question.

Using unweighted mean was first pioneered by Jevon in 1884. As Classical economics does, he assumed that "...increases in the supply of money increased all the prices proportionately except for random fluctuations" (Diewert 1998). This assumption is clearly misleading. For an increase in money supply, it is the desired price that would proportionally increase; not the actual price. It takes time for prices to adjust.

Even if the assumption was right, it is still hard to accept another implicit assumption behind it, i.e. all price changes are equally important. Why that would an increase in price of lettuce, be as important as the same increase in price of rice while a household's expenditure on rice is 70,100 times larger than on lettuce in Indonesia. When a central bank wants to stabilize the inflation, it is not for the sake of the inflation figure itself. One of the main objectives is to stabilize the purchasing power of the households to increase their welfare.

3. Distribution Of Price Changes In Indonesia.

The data for the estimation process is the monthly individual price indices in Consumer Price Index (CPI) comprises of 337 sub-commodities from April 1990 to December 1997, with 1987 as the base year. The main consideration in choosing this period is the stationarity of the data; the economic crises hit Indonesian economy in late 1997. The weights are the proportion of household's expenditure on each sub-commodity based on Cost of Living Survey 1987/1988.

Those price indices are calculated by using Laspeyres-Dutot index (Diewert 1995). Then the sub-commodity inflation rates are the rates of change of these indices, which results in a distribution of rates of price changes. To eliminate the seasonal effect on the individual prices, we are simply using 12-month horizon, i.e. year on year inflation. Consequently, mean, skewness coefficient and kurtosis coefficient are calculated by using the implicit time varying weights, which will be explained later.

[1] If Π_t and Π_t^* are the headline and the core inflation estimator in period t, then Π_t^* is unbiased if $u_t = \Pi_t - \Pi_t^*$ in average equals to zero and stationary. While to increase efficiency means to decrease the variance of the core inflation estimator caused by the outliers of the distribution.

Specifically, price level in period t, $\mathbf{P}_t$, is defined as:

$$\mathbf{P}_t = \sum_{i=1}^{n} w_{i0} p_{it}. \tag{6}$$

where p_{it} is the price index for good i in period t, and
w_{i0} is the fixed weight of good i in base year, with

$$\sum_{i=1}^{n} w_{i0} = 1.$$

Then the year-on-year inflation rate in month t can be expressed as:

$$\frac{\mathbf{P}_t - \mathbf{P}_{t-12}}{\mathbf{P}_{t-12}} = \Pi_t = \sum_{i=1}^{n} w_{it} \pi_{it}, \tag{7}$$

where $\pi_{it} = (p_{it}/p_{it-12}) - 1$ and $w_{it} = w_{i0}(p_{it-12}/\mathbf{P}_{t-12})$ is the time-varying weight of good i in month t.

If the k^{th} moment of the cross sectional distribution of the price changes is

$$m_{kt} = \sum_{i=1}^{n} w_{it}(\pi_{it} - \Pi_t)^k, \tag{8}$$

then skewness (S_t) and kurtosis (K_t) coefficients can be expressed as follows:

$$S_t = \frac{m_{3t}}{(m_{2t})^{3/2}} \tag{9}$$

$$K_t = \frac{m_{4t}}{(m_{2t})^2}. \tag{10}$$

Using these statistics, we can see that similar to what is found in many other countries, the distribution of price changes in Indonesia is characterized by a chronic positive skewness and high kurtosis.

Table 1: Summary of distribution of year on year price changes in Indonesia

(April 1990 – December 1997; 337 sub-commodities)

	Mean	**Median**	**STD**
Inflation	8.40	8.97	1.74
Standard Deviation	9.81	9.22	3.06
Mean percentile	59.61	59.58	3.36
Skewness coefficient	2.24	1.45	2.63
Kurtosis coefficient	25.18	12.98	34.19

4. Core Inflation In Indonesia. For any weighted distribution, clearly we can compute an unlimited trimmed-means. To be more efficient, we will firstly define the relevant percentiles. From the previous section, we know that mean in average lies at more or less 59^{th} percentile and it never lie below 50^{th} percentile. Considering these, we confine the relevant range is 50^{th}-65^{th} percentiles.

Nevertheless, there are still unlimited trimmed-means within this range. Anyway, the neighboring trimmed-means are statistically equal. Following Marques and Mota .....(Marques and Mota 2000), we choose to use those percentiles that are integers and average of the successive integers in the relevant range. By so doing, the relevant percentiles would be {50; 50,5; 51; ... ; 65}. Using the same raison d'être we choose the trimming levels {5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%}. For example, trimmed-mean (51;5), which is abbreviated as TM (51;5), represents the weighted average of 5% around 51^{st} percentile.

Before computing the core inflation, there is another important issue: the behaviour of the skewness over time. If trimmed-mean computing is conducted by assuming a constant asymmetry, while in fact it is time-varying, then the computed core inflation will not be co-integrated (in case of I(1) inflation) or statistically has the same mean (in case I(0) inflation) with the aggregate inflation. Testing the asymmetry's behaviour can be done by testing the stationarity of the mean percentile. For the sample, it is stationary.[2] The next steps would be following the aforementioned three necessary conditions.

Test 1: Unbiasedness of Core Inflation

The aggregate inflation 1991:04 – 1997:12 is stationary,[3] I(0). Because inflation, Π_t, is stationary, it is not possible to be co-integrated with core inflation, Π_t^*. Even though, we can require that $E[\Pi_t - \Pi_t^*] = 0$. This condition is a hypothesis that both of them have the same mean. Core inflation indicators that pass this test are unbiased estimators. Econometrically, we are testing the restrictions $\beta_0 = 0$; $\beta_1 = 1$ on regression $\Pi_t = \beta_0 + \beta_1 \Pi_t^* + u_t$. Among 218 data sets, 96 pass this test.

Test 2: Core inflation as attractor for inflation

Condition 2 in section 2.2. requires that core inflation, Π_t^*, as the attractor for the actual inflation, Π_t, and requires an error-correction mechanism that describe the long-term causality relationship from Π_t^* to Π_t. The approach than can be used for this test is by specify a model like in equation (1) and test the hypothesis $\gamma = 0$. The practical question would be how many lags we should use. I set the number of lags based on Akaike Information Criterion (AIC), which balances between goodness of fit with the parsimonious of the model.

As the result, 7 datasets, i.e. TM(59,5;10), TM(60;10), TM(59;15), TM(59,5;15), TM(58;20), TM(58,5;20) and TM(59;20), fulfil the requirement as the leading indicator for the actual inflation.

Test 3: Strong Exogeneity of the Core Inflation

The third necessary condition is the strong exogeneity of the candidate. This condition guarantee that the movement in core inflation, Π_t^*, is not determined by past actual inflation, Π_{t-j}. This means that in error-correction model for Π_t^*,

$$\Delta\Pi_t^* = \sum_{j=1}^{r} \delta_j \Delta\Pi_{t-j}^* + \sum_{j=1}^{s} \theta_j \Delta\Pi_{t-j} - \lambda \left(\Pi_{t-1}^* - \Pi_{t-1}\right) + \eta_t, \tag{11}$$

the hypothesis $\lambda = \theta_1 = \ldots = \theta_s = 0$ has to be accepted.

Standard F-test for restricted least square is used to test this condition. Again, AIC is used as to decide the number of lags. As the result, all of the datasets that passed test 2 also pass test 3.

As discussed before, actually, there are unlimited core inflation datasets that can pass those three conditions; but they would be statistically equal. Each of those seven datasets that have passed the necessary conditions can be used as core inflation indicator. They exhibit a very similar movements as we can see in figure 2 for TM(58;20) and TM(58,5;20).

Because they are relatively similar, we can just choose the smoothest one, which will exhibit the smallest short-term volatility and make it easier to interpret the movement in inflation. As the final result, we choose TM(58;20) which has the smallest relative variance.

To say that TM(58;20) is the core inflation indicator means that only 40% centered at 58^{th} of the price changes distribution represents the generalized movement of inflation; and the remaining 60%

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[2] For the sample 1991:04 – 1997:12,

$$\underset{}{\Delta MP_t} = \underset{(7.34666)}{36.00016} - \underset{(0.123232)}{0.602718 MP_{t-1}} + \underset{(0.117658)}{0.145317 \Delta MP_{t-1}}$$

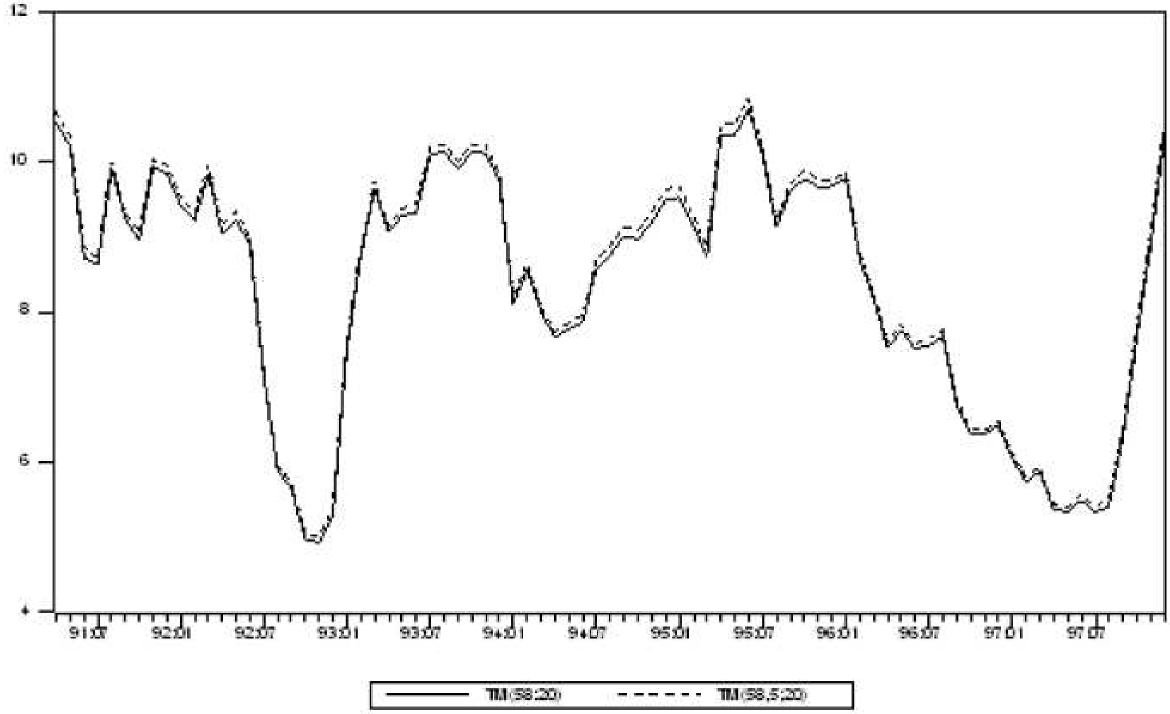
with level of significance 1%, null hypothesis for the existence of unit root is rejected.

[3] For the sample 1991:04 – 1997:12,

$$\Delta\Pi_t = \underset{(0.40722)}{1.247390} + \underset{(0.04787)}{-0.146664 \Pi_{t-1}} + \underset{(0.103677)}{0.495194 \Delta\Pi_{t-1}}$$

with level of significance 5%, null hypothesis for the existence of unit root is rejected.

Figure 2: Figure 2. TM(58;20) and TM(58,5;20)



represents the supply shocks. This conclusion has to be carefully interpreted. It does not mean that 60% of the price changes are not important because they do not represent the trend; actually, the trend was calculated by using the complete data (100% of the price changes).

5. Hypothesis Testing.

5.1. Core Inflation and Money Supply Growth. Besides being associated with demand and expectation driven inflation, core inflation is also associated with the medium to long-term inflation, which does not correlate with output. Because in long-term inflation would be always monetary phenomena, then we can expect that core inflation would be more correlated to the money supply growth than the headline would.

We will test this hypothesis by:

1. calculating the coefficient of correlation between the inflation measures and the growths on M0, M1 and M2 for 1 until 24 lags; and

2. measuring the ability of the past money supply growths in forecasting each of inflation measures.

Surprisingly, both inflation measures are not correlated with the past money supply growths. Small but higher correlation is shown by M1, while for M2 (not shown) up to the 48^{th} lag never show a positive correlation. For the data, the growth rates of M0 and M1 are both stationary while M2 is not.

Following Bryan and Checcetti (Bryan and Cecchetti 1994), we do the second test by using this equation

$$\Pi_t = \alpha + \sum_{i=1}^{n} \beta_i m_{t-i} \tag{12}$$

where Π_t is the inflation measure on month t, α is a constant, β is the coefficients and m_t is the money supply growth rates on month t. The number of lags is set based on AIC and the data availability.

Table 2: Coefficients of correlation between lagged money supply growth with Core and Headline Inflation

Lag	**M0**		**M1**	
	Headline	**Core**	**Headline**	**Core**
12	0.19	0.17	0.16	0.21
14	0.19	0.19	0.27	0.29
15	0.20	0.21	0.31	0.34
16	0.23	0.20	0.35	0.37
17	0.18	0.16	0.31	0.34
18	0.15	0.12	0.24	0.28
19	0.11	0.09	0.24	0.28
20	0.04	0.00	0.18	0.22
21	-0.09	-0.13	0.09	0.14
22	-0.28	-0.31	-0.02	0.01
23	-0.36	-0.35	-0.13	-0.10
24	-0.43	-0.43	-0.15	-0.14

Table 3: Summary Statistic of estimation of equation (12)

		Headline	**Core**
Adjusted-R^2	M0	0.965170	0.981030
	M1	0.885315	0.983012
	M2	0.624928	0.840582
Akaike IC	M0	-1.489604	-2.284578
	M1	-0.297909	-2.394930
	M2	0.887024	-0.155901
Prob(F-statistic)	M0	0.032094	0.017600
	M1	0.102089	0.015775
	M2	0.298959	0.139210

The result is convincing that core inflation (rather than headline) is explained better by the past money supply growths especially M0 and M1. While for M2, again, the result is not conclusive; its p-value indicate that the null hypothesis that says all of the coefficients are equal to zero is not rejected.

The fitted regression of equation (12) is then used to forecast both core and headline inflation for period 1996:05 – 1997:12, and then their root-mean-square-error (RMSE) will be compared.

Table 4: RMSE for forecasting core and headline inflation

Forecasted period	M0		M1		Average inflation rate	
	Headline	Core	Headline	Core	Headline	Core
1996:05	0.16	1.22	0.11	0.67	7.82	7.75
1996:05 – 1996:06	0.13	1.22	1.20	0.59	7.71	7.63
1996:05 – 1996:07	0.64	1.90	1.69	1.20	7.64	7.61
1996:05 – 1996:08	2.65	2.20	1.71	0.99	7.60	7.62
1996:05 – 1996:09	3.52	2.31	1.61	0.93	7.49	7.45
1996:05 – 1996:10	3.52	2.31	1.49	0.90	7.37	7.27
1996:05 – 1996:11	3.91	2.46	1.47	0.87	7.31	7.14
1996:05 – 1996:12	4.29	2.57	1.75	1.07	7.23	7.06
1996:05 – 1997:01	4.41	2.50	2.33	1.35	7.04	6.95
1996:05 – 1997:02	4.18	2.37	2.73	1.58	6.82	6.83
1996:05 – 1997:03	4.01	2.28	2.85	1.71	6.69	6.74
1996:05 – 1997:04	3.95	2.45	2.87	1.86	6.56	6.63
1996:05 – 1997:05	4.10	2.80	2.88	1.95	6.44	6.53
1996:05 – 1997:06	4.22	3.22	2.99	2.13	6.34	6.45
1996:05 – 1997:07	4.77	3.55	3.15	2.28	6.25	6.38
1996:05 – 1997:08	5.34	3.89	3.23	2.34	6.21	6.32
1996:05 – 1997:09	5.48	4.26	3.23	2.34	6.25	6.32
1996:05 – 1997:10	5.42	4.33	3.17	2.30	6.38	6.39
1996:05 – 1997:11	5.28	4.30	3.15	2.30	6.57	6.52
1996:05 – 1997:12	5.17	4.19	3.13	2.28	6.81	6.71

Forecasting core inflation (start from 4 months ahead) by using the past money supply growths result in the smaller RMSE as compared to forecasting headline inflation using the same information. The past money supply growths forecast the core inflation better than the headline inflation; or similarly, we can say that core inflation is more correlated to the past money supply growths than the headline is.

5.2. Core Inflation as the trend of inflation.

5.2.1. Core Inflation and Noise. If we regard the core inflation as the generalized components of the inflation, i.e. inflation trend, then any price changes, which do not follow the trend, represent the noise; mainly come from supply side. This noise can be either transitory (for example the price changes of tomato, chilli, rice, etc.) or persistent (for example the price change because of a change in production technology); but their impact on inflation would be temporary or even be followed by a reversal price change. With these characteristics, we can expect that in average, noise will equal to zero (Hogan et al. 2001).

Using the idea above, TM(58;20) as the core inflation indicator will be tested by using the equation below:

$$(\Pi_{t+h} - \Pi_t) = \alpha + \beta(\Pi_t^* - \Pi_t). \tag{13}$$

Π_t and Π_{t+h} are headline inflation in a period t and $t + h$ respectively, Π_t^* is the core inflation in period t, α is constant and β is coefficient. For each h equals to 6, 12, 18 and 24, the tested null hypothesis is $\alpha = 0$ and $\beta = 1$. Using the standard F-test with 5% level of significance, all of the null hypothesis except for h=18 is not rejected. P-values for h equals to 6, 12, 18 and 24 are 0.425, 0.299, 0.027 and 0.220 respectively. As the conclusion, TM(58;20) can be used as inflation trend indicator.

5.2.2. Superiority of Core Inflation in forecasting the inflation movement. If TM(58;20) is the inflation trend indicator, then it has to be superior to the headline inflation in forecasting the headline inflation itself. This superiority can be simply tested by using this equation below (Bryan and Cecchetti 1994):

$$\Pi_t = \rho + \sum_{i=1}^{n} \gamma_i \Pi_{t-i} \tag{14}$$

$$\Pi_t = \lambda + \sum_{i=1}^{n} \kappa_i \Pi^*_{t-i} \tag{15}$$

λ, ρ, γ, and κ are coefficients, while n is the number of lags. The sample is 1991:04 – 1996:04. The fitted regressions will be used to forecast the headline inflation in period 1996:05 – 1997:12.

Core inflation is superior to headline inflation if the adjusted-R^2 in equation (15) is bigger than in equation (14). Additionally, RMSE of the forecast using equation (15) has to be less than of the forecast using equation (14). The result for these models is summarized in table 5 below[4].

Table 5: Summary Statistic for equation (14) and (15)

equation	**(14)**	**(15)**
Lag	25	26
Adjusted-R^2	0.755889	0.809982
DW Statistic	2.381912	2.331616
Akaike IC	1.429901	1.104814
Prob(F-statistic)	0.004353	0.004716

6. Conclusion.

By assuming that the price change requires some adjustment costs, core inflation can be computed by focusing our attention on the generalized components of price changes in CPI by using the asymmetric trimmed-mean approach.

The distribution of price changes in Indonesia exhibits the similar characteristics with many other countries. Based on what implicitly predicted by Ball-Mankiw model as to the relative price movements, it makes it possible for us to resort to the asymmetric trimmed-mean approach in measuring the core inflation in Indonesia.

The hypothesis that core inflation indicator measured by using the asymmetric trimmed-mean approach, compared with the headline inflation, is:

1. the inflation indicator that is more correlated with the past money supply growth; and
2. a better indicator of inflation trend,

is not rejected.

6.1. Limitations of this approach. The asymmetric trimmed-mean approach requires a long enough time series data. If not, it is very risky to conclude that the observed characteristics are persistent.

In the case of the existence of structural change in an economy like economic crises, this approach – like other approaches – has to be carefully used. If the inflation were not a stationary process – as in case of crisis period in Indonesia – the optimal trimmed-mean possibly would be different.

[4]Using 26 lags on equation (14) decreases its adjusted-R^2 to 0.728988, increases its AIC to 1.459861, and its p-value to 0.016187.

Table 6: RMSE for forecasting Headline inflation by using equation (14) and (15)

Forecasted period	(14)	(15)	Average inflation rate
1996:05	0.56	0.39	7.82
1996:05 – 1996:06	1.51	0.93	7.71
1996:05 – 1996:07	1.95	1.12	7.64
1996:05 – 1996:08	2.04	1.51	7.60
1996:05 – 1996:09	2.20	1.74	7.49
1996:05 – 1996:10	2.42	1.86	7.37
1996:05 – 1996:11	2.51	1.82	7.31
1996:05 – 1996:12	2.61	1.83	7.23
1996:05 – 1997:01	2.83	2.11	7.04
1996:05 – 1997:02	3.11	2.44	6.82
1996:05 – 1997:03	3.37	2.72	6.69
1996:05 – 1997:04	3.50	2.83	6.56
1996:05 – 1997:05	3.57	2.85	6.44
1996:05 – 1997:06	3.61	2.92	6.34
1996:05 – 1997:07	3.68	2.99	6.25
1996:05 – 1997:08	3.76	3.00	6.21
1996:05 – 1997:09	3.73	2.96	6.25
1996:05 – 1997:10	3.64	2.88	6.38
1996:05 – 1997:11	3.54	2.81	6.57
1996:05 – 1997:12	3.49	2.78	6.81

6.2. Implications and proposed further researches. The main implication of this research is on the relevant core inflation indicator for Indonesia. Accordingly, this paper claims that the asymmetric trimmed-mean core inflation indicator used by Bank Indonesia is methodologically wrong.

TM(58;20), in further research can be used as the inflation trend or even as the intermediate target of monetary policy in Indonesia. Another possible further research is to test whether this core inflation indicator can perform well in specifying the short-run Phillips Curve model. If TM(58;20) is the best indicator for core inflation, then the gap of actual inflation from core inflation would be a good estimator for the supply shock. The challenge would be extending the research to cover the up to date data including the crisis period.

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