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Measuring Underlying Inflation in Papua New Guinea

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Abstract

This paper assesses the value of the Bank of Papua New Guinea's underlying inflation measures: exclusion-based and trimmed mean. Results indicate that whilst the exclusion-based measure is an unbiased estimator of CPI inflation, the trimmed mean has a small and negative bias with respect to CPI inflation. Evidence also suggests that when a gap emerges between CPI inflation and underlying inflation, CPI inflation tends to adjust toward both underlying inflation measures and also towards a constant rate of inflation. It was additionally observed that whilst underlying inflation did not adjust toward CPI inflation, both measures tended to adjust toward a constant rate of inflation. The paper concludes that both underlying inflation measures are good indicators of CPI inflation and that, at present, the trimmed mean measure is preferred over the exclusion-based.

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1. Introduction

Underlying or 'core' inflation is a concept used to describe inflation measures that attempt to capture the medium-term trend in inflation. The construction of core inflation involves manipulating the headline inflation measure to remove data, which is considered to be inconsistent with trend inflation. In Papua New Guinea (PNG) the headline inflation measure is the Consumer Price Index (CPI). Central banks consider measures of underlying inflation to be essential inputs into monetary policy decision-making.

Underlying inflation as a concept has been used in the past but a proper and formal measurement of it is relatively new in PNG. The first measure of underlying inflation was the exclusion-based inflation measure and it was introduced in the Bank of Papua New Guinea's (BPNG) biannual Monetary Policy Statement (MPS) in July 2001. Beginning July 2002 BPNG began publishing, in addition to the exclusion-based measure, a trimmed mean measure of underlying inflation.

This paper aims to assess the value of BPNG's current underlying inflation measures; specifically to assess whether they are unbiased estimators of CPI inflation and whether underlying inflation has some value in predicting CPI inflation.

The evidence considered in this paper suggests that exclusion-based inflation is unbiased with respect to CPI inflation and that trimmed mean inflation has a small and negative bias with respect to CPI inflation. The negative bias is due to the construction of the trims associated with the measure. Evidence also suggests that CPI inflation tends to adjust toward both underlying inflation measures and a constant rate of inflation and that whilst both measures of underlying inflation did not, on average, adjust toward CPI inflation, they did tend to adjust toward a constant rate of inflation.

The rest of the paper is set out as follows. Section 2 provides a brief description of BPNG's underlying inflation measures. Section 3 discusses statistical properties that are desirable for underlying inflation measures to have whilst section 4 presents the results. Section 5 concludes.

2. Measures of underlying inflation

Exclusion-based and *trimmed mean* inflation are the two underlying inflation measures used by the BPNG. The CPI is divided into 7 groups, which are sub-divided into 23 sub-groups. The calculation and composition of each measure is described below.

Exclusion-based

The exclusion-based inflation measure is calculated by zero-weighting sub-groups that are historically volatile and those which are largely determined by non-market forces; namely sub-groups that are subject to excise or price control. Out of the total 23 sub-groups, 9 sub-groups are excluded from the calculation of this measure. The sub-groups that are zero-weighted are: Fruit and vegetables; Betelnut; Alcoholic drinks; Cigarettes and tobacco; Council charges; Fuel and Power; Airline, bus and public motor vehicle (PMV) fares; Telephone and postal charges; and medical and health care. These sub-groups are excluded every quarter.

Trimmed mean

The trimmed mean inflation measure is calculated by excluding sub-groups with the most extreme price changes in each quarter. The distribution of price changes is arranged in ascending order from lowest to highest and its tail ends trimmed such that 33 percent and 27 percent is taken off the lower and higher ends of the distribution respectively. The sub-groups included in the trimmed mean measure will differ each quarter depending on whether they fall within the cut-off points.

3. Desirable Statistical Properties of underlying inflation

Two main statistical properties are desirable in an underlying inflation measure. The first is that the measure for underlying inflation is unbiased with respect to CPI inflation. We can informally assess bias by comparing the average of underlying inflation with that of CPI inflation over a specified period and can test whether the bias is statistically significant by estimating the equation:

$$\pi_t = \alpha + \beta\pi*_t + \varepsilon_t \tag{1}$$

where:

π_t is CPI inflation at time period *t*;

$\pi*_t$ is a measure of underlying inflation; and

ε_t is the error term.

The estimated equation should test the joint null hypothesis that $\alpha = 0$ and $\beta = 1$.

We would like to accept the null hypothesis because doing so would imply that movements in underlying inflation equate to movements in CPI inflation and as such there would be no bias between the two measures. The existence or extent of bias may also depend on the sample period over which the calculation is performed. This is because changes in the distribution of sub-group price changes over time can result in an underlying inflation measure being unbiased in one sample period and biased in another sample period.

The second desirable property is the direction of causality, that is, 'underlying inflation should Granger cause CPI inflation and that Granger causality should not run in the opposite direction '(Roberts: 2005). The Granger causality test helps to determine the direction of a relationship and is used to test for predictive ability, that is, whether one time series is useful in forecasting another.

We want to see whether the independent variable, underlying inflation, $\pi*_t$ Granger causes the dependent variable, CPI inflation π_t. If it does, we can use past values of underlying inflation to predict future CPI inflation. So, $\pi*_t$ is said to Granger cause π_t if it can be statistically proven that lagged values of underlying inflation are significant in the regression of CPI inflation on lagged values of underlying and CPI inflation.

Granger causality is one way of looking at the predictive ability of underlying inflation, but there are others. A situation may arise when we want to test the predictive ability of an underlying inflation measure when underlying and CPI inflation diverge at a given point in time. In doing this we would like to establish whether the gap is likely to be closed in the next period. We might see in the next period that CPI inflation moves towards underlying inflation or that underlying inflation moves towards CPI inflation. To test this we estimate the two equations below:

$$\Delta\pi_t = \gamma_{10} + \gamma_{11}(\pi_{t-1} - \pi^*_{t-1}) + \varepsilon_{1t} \quad (2)$$

$$\Delta\pi^*_t = \gamma_{20} + \gamma_{21}(\pi_{t-1} - \pi^*_{t-1}) + \varepsilon_{2t} \quad (3)$$

where:

$\Delta\pi_t$ is the change in CPI inflation at time *t*;

$\Delta\pi^*_t$ is the change in underlying inflation at time *t*;

π_{t-1} is CPI inflation lagged one period; and

π^*_{t-1} is underlying inflation lagged one period.

There are several conclusions that can be drawn from the above equations depending on whether the estimated regression coefficients are either positive or negative.

In Equation (2), assuming that $\hat{\gamma}_{21}$ is equal to zero, if $\hat{\gamma}_{11}$ is significantly less than zero and the fixed term $(\pi_{t-1} - \pi^*_{t-1})$ is either positive or negative then the conclusion would be that CPI inflation adjusts towards underlying inflation, but not vice versa. This is a desirable property for an estimator to possess because it indicates that when there is a gap between the underlying and CPI inflation measures, CPI inflation will tend to adjust toward underlying inflation and as such using past values of underlying inflation would be useful in predicting future CPI inflation. Alternatively, if $\hat{\gamma}_{11}$ is positive then the conclusion is that CPI inflation tends to move away from underlying inflation.

In Equation (3) assuming that $\hat{\gamma}_{11}$ is equal to zero, if $\hat{\gamma}_{21}$ is significantly less than zero and the fixed term $(\pi_{t-1} - \pi^*_{t-1})$ either positive or negative, the conclusion that can be reached is that underlying inflation tends to move away from CPI inflation. If $\hat{\gamma}_{21}$ is positive then underlying inflation tends to move towards CPI inflation. Lastly, if both parameters $\hat{\gamma}_{11}$ and $\hat{\gamma}_{21}$ are both significantly less than zero, then it is likely that the underlying inflation measures being tested is only a rough approximation to the underlying trend in inflation that it is supposed to estimate. (Roberts: 2005) These tests are referred to as 'gap' tests because they test the statistical significance of the gap between underlying inflation and CPI inflation when the two measures diverge.

Another test which is an extension of the above two equations is the augmented gap test. It can be used to test whether CPI inflation is adjusting toward underlying inflation or towards a constant rate of inflation, which could be any constant rate including an inflation target or the inflation mean.

The augmented gap test can be estimated by the following equation:

$$\Delta\pi_t = \alpha_0 + \alpha_1(\pi_{t-1} - \pi^*_{t-1}) + \alpha_2(\pi_{t-1} - \bar{\pi}) + \varepsilon_t \qquad (4)$$

where $\bar{\pi}$ is a constant rate of inflation.

Like the gap tests there are several conclusions that can be drawn from Equation (4) depending on whether the estimated regression coefficients and the fixed terms $(\pi_{t-1} - \pi^*_{t-1})$ and $(\pi_{t-1} - \bar{\pi})$ are either positive or negative.

In the first part of Equation (4) assuming that $\hat{\alpha}_2$ is zero if $\hat{\alpha}_1$ is significantly less than zero and the fixed term $(\pi_{t-1} - \pi^*_{t-1})$ is either positive or negative, then CPI inflation adjusts towards a particular measure of underlying inflation. Alternatively, if $\hat{\alpha}_1$ is positive, then CPI inflation tends to move away from underlying inflation. In the second part of the equation assuming that $\hat{\alpha}_1$ is zero, if $\hat{\alpha}_2$ is significantly less than zero and the fixed term $(\pi_{t-1} - \bar{\pi})$ is either positive or negative then CPI inflation adjusts towards some constant rate $\bar{\pi}$. If $\hat{\alpha}_2$ is positive then CPI inflation tends to move away from the constant rate $\bar{\pi}$.

We can further test this equation by substituting CPI inflation with underlying inflation as the dependent variable and as an independent term:

$$\Delta\pi^*_t = \beta_0 + \beta_1(\pi_{t-1} - \pi^*_{t-1}) + \beta_2(\pi^*_{t-1} - \bar{\pi}) + \varepsilon_t \qquad (5)$$

In the first part of Equation (5) assuming that $\hat{\beta}_2$ is zero, if $\hat{\beta}_1$ is significantly less than zero and the fixed term $(\pi_{t-1} - \pi^*_{t-1})$ is either positive or negative, then underlying inflation is moving away from CPI inflation. Alternatively, if $\hat{\beta}_1$ is positive then underlying inflation tends to move towards CPI inflation. In the second part of the equation assuming that $\hat{\beta}_1$ is zero, if $\hat{\beta}_2$ is significantly less than zero and the fixed term $(\pi^*_{t-1} - \bar{\pi})$ is either positive or negative then underlying inflation adjusts towards some constant rate of inflation $\bar{\pi}$. Alternatively, if $\hat{\beta}_2$ is positive, then underlying inflation tends to move away from a constant rate of inflation.

Unadjusted quarterly inflation data for all three measures: headline CPI, exclusion-based and trimmed mean are used for estimation. Two sample periods are chosen. The longer sample covers the period from 1990:Q1 to 2005:Q3, with 63 observations and the shorter sample period from 1994:Q4 to 2005:Q3 with 44 observations. The start period of 1990:Q1 coincides with the beginning of the underlying inflation series whilst the period 1994:Q4 was chosen to coincide with the floating of the kina in October 1994. The Ordinary Least Squares (OLS) method was used to estimate the above equations.

4. Assessing the measures of underlying inflation

4.1 Average Inflation and Bias

This section assesses whether the measures of underlying inflation are unbiased with respect to CPI inflation. Table 1 presents the estimation results for exclusion-based and trimmed mean inflation. Equation 1 and the joint null and alternative hypotheses are reproduced below.

Test Equation 1: $\pi_t = \alpha + \beta\pi^*_t + \varepsilon_t$

Joint Null Hypothesis: $H_0 : \alpha = 0, \beta = 1$

Joint Alternative Hypothesis: $H_1 : \alpha \neq 0$ or $\beta \neq 1$

Table 1: Underlying Inflation – Assessment of Bias				
Quarterly percent change				
		Coefficients		**p-values**
Sample	**Inflation Indicator**	$\hat{\alpha}$	$\hat{\beta}$	
1990:Q1 - 2005:Q3				
	Exclusion-based	0.21	0.88	0.36
	Trimmed mean	-0.12	1.18	0.08*
1994:Q4 - 2005:Q3				
	Exclusion-based	0.27	0.88	0.53
	Trimmed mean	-0.23	1.23	0.12

Note: The p-values in the last column are for the F-statistics relating to the test of the joint null hypothesis. * denotes the rejection of the null hypothesis at the 10 percent significance level.

Source: Author's calculations.

We look at the probability (*p*) values in the last column of Table 1 to decide whether to reject or accept the null hypothesis. Looking at the sample period 1990:Q1 to 2005:Q3 the p-value for exclusion-based inflation concludes that it is an unbiased measure with respect to CPI inflation at the 5, 10 and even 30 percent significance levels. By contrast, the decision to accept or reject the null hypothesis is less clear for trimmed mean. Its p-value accepts the null hypothesis of unbiasedness at 5 percent significance but rejects the null hypothesis at 10 percent significance. The rejection of the null hypothesis implies that there is a bias associated with the trimmed mean. The bias can be best illustrated by assuming that the value for the trimmed mean inflation variable is a constant at 1 percent. When substituted into the equation we find that a 1 percentage point change in trimmed mean inflation will result in 1.18 percentage point change in CPI inflation[1].

A negative bias was also found in trimmed mean when examining descriptive statistics of the inflation measures. Descriptive statistics in Table 2 show that average trimmed mean inflation is lower than average CPI inflation by 0.25 and 0.29 percentage points in the longer and shorter sample periods respectively.

[1] This is for illustrative purposes only and is not meant to indicate causation.

Table 2. Descriptive Statistics				
Sample	Statistics	Headline	Trimmed mean	Exclusion-based
1990:Q1 2005:Q3				
	Mean	2.17	1.92	2.21
	Standard deviation	2.39	1.67	2.18
1994:Q4 2005:Q3				
	Mean	2.58	2.29	2.62
	Standard deviation	2.70	1.80	2.41
Source: Author's calculations.				

The negative bias in trimmed mean inflation is the result of the construction of the trimmed mean excluding too much of the right tail relative to the left tail of the distribution of quarterly price changes. This bias can be easily corrected given a revision of the respective weights.

For sample period 1994:Q4 to 2005:Q3 it was found that both underlying inflation measures are unbiased with respect to CPI inflation. However, the small sample size could bias these estimation results. As such, these tests should be conducted in future. The trimmed mean is an unbiased measure of CPI inflation in this sample period, however it can be seen that compared to the longer sample period, the results are fairly close. That is, the p-value of trimmed mean is 0.12 whilst in the longer sample period it was 0.08. So, the trimmed mean is on the borderline of being an unbiased estimator of CPI inflation depending on the level of tolerance for error.

4.2 Granger Causality

We look at the Granger causality test to examine whether CPI inflation Granger - causes underlying inflation or whether the opposite occurs. The Granger causality test was applied to PNG inflation data for the two sample periods. Different lags were used for each of the underlying inflation measures. This was done because the results for causality were mixed between lags and between measures.

Table 3. Granger Causality Results: 1990:Q1 to 2005:Q3							
	Lags	1	2	3	4	5	6
Measure	Null Hypothesis	p-values					
Exclusion-based	Exclusion does not Granger-cause Headline	0.00***	0.00***	0.00***	0.00***	0.00***	0.00**
	Headline does not Granger-cause Exclusion	0.07*	0.16	0.18	0.34	0.47	0.23
Trimmed mean	Trimmed does not Granger-cause Headline	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	Headline does not Granger-cause Trimmed	0.34	0.02**	0.02**	0.04**	0.07*	0.10
Source: Author's calculations.							

Table 4. Granger Causality Results: 1994:Q4 to 2005:Q3							
	Lags	1	2	3	4	5	6
Measure	Null Hypothesis	p-values					
Exclusion-based	Exclusion does not Granger-cause Headline	0.00***	0.00***	0.00***	0.00***	0.01**	0.01**
	Headline does not Granger-cause Exclusion	0.09*	0.21	0.19	0.32	0.44	0.16
Trimmed mean	Trimmed does not Granger-cause Headline	0.01***	0.00***	0.00***	0.00***	0.01**	0.03**
	Headline does not Granger-cause Trimmed	0.38	0.06*	0.05**	0.08*	0.21	0.30
Note: The probability (p)-values are given in tables 3 and 4 and relate to the test of the null hypotheses. ***, ** and * denote the rejection of the null hypothesis at the 1, 5 and 10 percent significance levels, respectively.							
Source: Author's calculations.							

Table 3 and 4 show the results of the Granger causality test for sample periods 1990:Q1 to 2005:Q3 and 1994:Q4 to 2005:Q3.

The results for both sample periods show strong evidence that both underlying inflation measures Granger-cause CPI inflation on all six lags of underlying inflation used. However, results also showed that in the longer sample period CPI inflation Granger-caused trimmed mean inflation on the second to fourth lag. At this stage, the reason for this behaviour is unclear.

4.3 'Gap' Tests

Table 5 presents the results of the gap tests, described in section 3, which aim to determine whether CPI inflation adjusts towards underlying inflation. We are interested in this test because there are instances when CPI inflation and underlying inflation diverge. From this test, we can determine whether the gap in the next period is likely to be closed by either CPI inflation adjusting toward underlying inflation, underlying inflation adjusting toward CPI inflation or neither measure adjusting towards the other. The test equations and their respective null and alternative hypotheses are reproduced here.

Test Equation 2: $\Delta\pi_t = \gamma_{10} + \gamma_{11}(\pi_{t-1} - \pi^*_{t-1}) + \varepsilon_{1t}$

Null Hypothesis: $H_0 : \gamma_{11} = 0$

Alternative Hypothesis: $H_1 : \gamma_{11} \neq 0$

Test Equation 3: $\Delta\pi^*_t = \gamma_{20} + \gamma_{21}(\pi_{t-1} - \pi^*_{t-1}) + \varepsilon_{2t}$

Null Hypothesis: $H_0 : \gamma_{21} = 0$

Alternative Hypothesis: $H_1 : \gamma_{21} \neq 0$

In Equation (2) a decision to reject the null hypothesis with $\hat{\gamma}_{11} < 0$ would imply that CPI inflation tends to adjust towards a particular measure of underlying inflation whilst in Equation (3) rejection of the null with $\hat{\gamma}_{21} < 0$ indicates that underlying inflation tends to move away from CPI inflation.

Table 5: 'Gap' Tests				
Indicator	1990:Q1 2005:Q3 (63 observations)		1994:Q4 2005:Q3 (44 observations)	
	$\hat{\gamma}_{11}$	$\hat{\gamma}_{21}$	$\hat{\gamma}_{11}$	$\hat{\gamma}_{21}$
Exclusion-based	-1.29 (0.00)***	-0.16 (0.38)	-1.35 (0.00)***	-0.21 (0.33)
Trimmed mean	-1.47 (0.00)***	-0.22 (0.10)	-1.54 (0.00)***	-0.26 (0.12)
Note: The p-values relate to the test of the null hypothesis and are in parentheses below the estimated coefficients. ***, ** and * denote the rejection of the null hypothesis at the 1, 5 and 10 percent significance levels, respectively.				
Source: Author's calculations.				

For each sample the estimates of $\hat{\gamma}_{11}$ and $\hat{\gamma}_{21}$ of equations (2) and (3) are presented. The results show that the null hypothesis for $\hat{\gamma}_{11}$ is rejected at the 1 percent level. The estimated coefficient $\hat{\gamma}_{11}$ is significantly less than zero for both underlying measures of inflation and across both sample periods. From this we can easily conclude that the gap between CPI inflation and underlying inflation is likely to be closed in the next period by CPI inflation adjusting towards underlying inflation. In both cases, it is equally clear that the estimated coefficient $\hat{\gamma}_{21}$ is statistically insignificant. That is, underlying inflation does not adjust towards CPI inflation. In fact, the negative sign attached to $\hat{\gamma}_{21}$ indicates that the underlying inflation measures appear to be moving away from CPI inflation.

So, if CPI inflation tends to adjust toward underlying inflation but underlying inflation might be moving away from CPI inflation then where is underlying inflation going? To gain a better understanding of this question we estimate Equation (4) and (5) to perform the augmented gap test.

4.4 Augmented Gap Test

Test Equation 4 and its relevant hypotheses tests are presented.

Test Equation 4: $\Delta\pi_t = \alpha_0 + \alpha_1(\pi_{t-1} - \pi^*_{t-1}) + \alpha_2(\pi_{t-1} - \bar{\pi}) + \varepsilon_t$

Null Hypothesis 1: $H_0 : \alpha_1 = 0$

Alternative Hypothesis 1: $H_1 : \alpha_1 \neq 0$

Null Hypothesis 2: $H_0 : \alpha_2 = 0$

Alternative Hypothesis 2: $H_1 : \alpha_2 \neq 0$

There are two null and alternative hypotheses to be tested. The first relates to the estimated coefficient $\hat{\alpha}_1$. A decision to reject the null hypothesis with $\hat{\alpha}_1 < 0$ would imply that CPI inflation tends to adjust towards a particular measure of underlying inflation. Meanwhile a rejection of the null hypotheses relating to the estimated coefficient $\hat{\alpha}_2$ with $\hat{\alpha}_2 < 0$ would indicate that CPI inflation tends to adjust towards a constant rate of inflation. Here we define the constant rate of inflation, $\bar{\pi}$ to be the average CPI inflation over the sample period. Average CPI inflation is 2.17 percent and 2.58 percent for the longer and shorter sample periods respectively. Alternatively, the rejection of both null hypotheses would suggest that CPI inflation adjusts towards both an underlying inflation rate and the CPI mean.

Table 6 presents the results for the estimated coefficients for $\hat{\alpha}_1$ and $\hat{\alpha}_2$. Looking first at the longer sample period 1990:Q1 to 2005:Q3 there is strong evidence which indicates that both coefficients for both underlying inflation measures are significantly less than zero at the 1 percent significance level. This implies that when a gap emerges between CPI inflation and the underlying inflation measures, CPI inflation has tended to adjust toward the underlying measures and the CPI inflation mean of 2.17 percent in the following quarter.

Table 6. Augmented Gap test CPI Inflation

	1990:Q1 – 2005:Q3		1994:Q4 - 2005Q3	
	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_1$	$\hat{\alpha}_2$
Exclusion-based	-0.89 (0.00)***	-0.54 (0.00)***	-0.91 (0.00)***	-0.58 (0.00)***
Trimmed mean	-1.05 (0.00)***	-0.33 (0.05)**	-1.07 (0.01)***	-0.36 (0.10)

Notes: The p-values for each of the estimated coefficients are shown in parenthesis and relate to the test of the null hypothesis. ***, ** and * denotes significance at the 1, 5 and 10 percent levels respectively.

Source: Author's calculations.

The shorter sample 1994:Q4 to 2005:Q3 shows a slightly different picture. For exclusion-based inflation, CPI inflation adjusts towards both exclusion-based and the CPI inflation mean. However, for trimmed mean, CPI inflation adjusts only towards trimmed mean although the estimated coefficient of $\hat{\alpha}_2$ is on the edge of being significant at the 10 percent level.

Test Equation 5 applies the augmented gap test to the underlying inflation measures. Table 7 presents the results.

Test Equation 5: $\Delta\pi^*_t = \beta_0 + \beta_1(\pi_{t-1} - \pi^*_{t-1}) + \beta_2(\pi^*_{t-1} - \overline{\pi}) + \varepsilon_t$

Null Hypothesis 1: $H_0 : \beta_1 = 0$

Alternative Hypothesis: $H_1 : \beta_1 \neq 0$

Null Hypothesis 2: $H_0 : \beta_2 = 0$

Alternative Hypothesis: $H_1 : \beta_2 \neq 0$

There are two null and alternative hypotheses to be tested. For estimated coefficient $\hat{\beta}_1$ a decision to reject the null hypothesis with $\hat{\beta}_1 < 0$ would imply that underlying inflation tends to adjust away from CPI inflation whilst a rejection of the null for $\hat{\beta}_2$ with $\hat{\beta}_2 < 0$ implies that underlying inflation tends to adjust toward the CPI mean.

Table 7. Augmented Gap test: Underlying Inflation

	1990:Q1 – 2005:Q3		1994:Q4 - 2005Q3	
	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_1$	$\hat{\beta}_2$
Exclusion-based	0.19 (0.28)	-0.48 (0.00)***	0.19 (0.38)	-0.52 (0.00)***
Trimmed mean	0.25 (0.17)	-0.38 (0.00)***	0.30 (0.20)	-0.43 (0.00)***

Notes: The p-values for each of the estimated coefficients are shown in parentheses and relate to the test of the null hypothesis. ***, ** and * denotes significance at the 1, 5 and 10 percent levels respectively.

Source: Author's calculations.

The results show that for both underlying inflation measures and across both sample periods, the estimated coefficient $\hat{\beta}_1$ is statistically insignificant. This implies that both exclusion-based and trimmed mean inflation do not adjust toward CPI inflation. By contrast, the estimated coefficient $\hat{\beta}_2$ for these measures is statistically significant at the 1 percent level across both samples. This provides strong evidence that underlying inflation is moving toward the CPI mean. Use of the average rates for exclusion-based and trimmed mean inflation instead of the CPI mean in place of $\bar{\pi}$ did not alter the conclusion reached above.

5. Conclusion

Two main statistical properties are desirable in underlying inflation measures. Firstly, a particular measure of underlying inflation must be unbiased with respect to CPI inflation and secondly past values of that particular underlying inflation measure should help to predict CPI inflation.

Several tests were conducted to assess the value of BPNG's two underlying inflation measures: exclusion-based and trimmed mean. In meeting the first desirable property, it was found that exclusion-based inflation is unbiased with respect to CPI inflation whilst the trimmed mean has a small negative bias with respect to CPI inflation. This bias is associated with the construction of the measure which trims too much of the right tail relative to the left tail of the distribution of quarterly price changes. By contrast the conclusion over the shorter time period found both underlying inflation measures to be unbiased with respect to CPI inflation. However, the results for the trimmed mean across both sample periods were close to the 10 percent significance level.

The gap tests found that when a gap emerges between CPI inflation and underlying inflation, CPI inflation tends to adjust toward both underlying inflation measures. This reinforces the Granger causality tests, which found that both underlying inflation measures Granger-caused CPI inflation and that causality ran in this direction only. The augmented gap tests revealed that in addition to adjusting toward underlying inflation, CPI inflation also tends to adjust toward a constant rate of inflation given by the CPI mean. However whilst it was observed that both underlying inflation measures did not adjust toward CPI inflation, which is a desirable property, they did tend to move toward a constant rate of inflation, which is a feature that needs further investigation.

So which measure is the better indicator of underlying inflation trends?

The statistical tests of bias indicate that both measures are good estimators of CPI inflation and from the tests overall it was clear that the exclusion-based inflation measure outperformed the trimmed mean measure. However, we are currently inclined to prefer the trimmed mean over the exclusion-based because it has been more informative over recent years relative to the exclusion-based measure. Despite this there will be cases when in future both measures produce different outcomes and in these situations it is always useful to use both underlying inflation measures to assess where trends are.

Areas of further research include an investigation into the trims used to cut-off the distribution of price changes for the calculation of the trimmed mean inflation measure. Additionally, until more data is gathered a revisitation of all the tests on the shorter sample period should be conducted to confirm whether current results still hold.

References

Dewan, E., Hussein, S. and Morling, S., 1999. *Modelling inflation processes in Fiji*, 1999/02, Reserve Bank of Fiji, Suva.

Dewan, E., Gokal, V. and Hussein, S., 2003. *Measurement of underlying inflation in Fiji*, Working Paper 2003/04, Reserve Bank of Fiji, Suva.

Halloway, J. *Underlying inflation in China*, Technical Note, Reserve Bank of Australia, Sydney.

Heath, A., Roberts, I. and Bulman, T. *Inflation in Australia: Measurement and Modelling*, Reserve Bank of Australia, Sydney.

Mankikar, A. and Paisley, J., 2004. *Core inflation: a critical guide*, Working Paper No. 242, Bank of England, London.

Roberts, I., 2005. *Underlying inflation: Concepts, measurement and performance*, Research Discussion Paper 2005-05, Reserve Bank of Australia, Sydney.

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