Hong Kong Monetary Authority

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A SIMPLE MEASURE OF UNDERLYING INFLATION: ESTIMATES FOR HONG KONG AND THE MAINLAND

Key Points:

- *Monitoring and assessing inflation developments is an essential task for any monetary authority or central bank. While estimates of the trend rate of inflation can easily be made by considering changes of price level over some period of time, turning points of inflation are less easily determined in a timely manner.*

- *Inflation measured over twelve months lags behind changes in the monthly inflation rate, which, however, is too variable to be easily interpretable because of price-level shocks and measurement errors.*

- *A simple measure, based on a statistical model, is developed to separate the underlying inflation from price-level shocks and measurement errors in the monthly inflation rate. The underlying inflation reveals turning points more promptly.*

- *The simple measure of underlying monthly inflation suggests that deflation in Hong Kong was over in the second half of 2003, but inflation has not yet taken hold. On the other hand, it suggests that inflation pressures are rising on the Mainland.*

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INTRODUCTION

Monitoring and assessing inflation developments, in particular changes in the inflation environment, is an essential task for any monetary authority or central bank. While estimates of the trend rate of inflation can easily be made by considering changes of the price level over some period of time, turning points of inflation are less easily determined in a timely manner. This issue is of particular importance in Hong Kong, where the strengthening of economic activity and the fact that monthly changes of several price indices have been close to zero in the second half of 2003 raise the question whether the years of deflation have come to an end. Given the close and growing relationship between Hong Kong and the Mainland, where monthly changes of its main price indices have been positive since mid-2003, it is also of interest to consider whether the inflation environment has changed on the Mainland as well.

While the concept of the rate of inflation is simple, it is quite difficult to measure it in practice. There are two reasons for that. First and most importantly, central banks typically make a distinction between inflation, which is defined as an *ongoing change* in the price level, and *once-off shocks* to the level of prices. These may be caused by a range of factors, including changes in administratively set prices, taxes, exchange rate changes as well as energy and food prices. Attention is typically focussed on the former, since once-and-for-all changes in the price level only impact temporarily on inflation. Secondly, the absolute level of prices is measured with some error, which induces volatility in price indices and measures of inflation constructed from those indices.

Because of price-level shocks and measurement errors, monthly changes in price indices are for these reasons typically too variable to be easily interpretable. Many central banks therefore measure inflation by the twelve-month change in the price level, which is typically much less volatile than the monthly change. Graphs 1 and 2, which contain plots of the (annualised) rate of change of prices over one and twelve months in Hong Kong and the Mainland, demonstrate the sharp difference in volatility between these two measures of inflation.[1]

However, inflation measured over twelve months is, by construction, equal to the average monthly change in prices during the last year. This measure of inflation therefore lags behind changes in the monthly inflation rate. Graph 1, for example, shows that the twelve-month inflation rate in Hong Kong declined much more gradually than month-to-month inflation in 1998. Furthermore, twelve-month inflation changed much

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[1] For Hong Kong, we use the composite consumer price index adjusted for special one-off factors and seasonal effects. Of course, other price level shocks may still remain. For Mainland China, we use the consumer price index adjusted for seasonal effects.

less than month-to-month inflation during and after the SARS episode in 2003. This suggests that it is difficult to use inflation computed as the change in prices over twelve months to judge whether deflation has subsided since last summer. Alternative measures of inflation are needed.

A SIMPLE MEASURE OF UNDERLYING INFLATION

Next we develop a simple measure of underlying inflation, which is based on a statistical model. The model assumes that inflation consists of two components. The first of these is the underlying rate of inflation and the second captures price-level shocks and measurement errors. These latter disturbances impact permanently on prices but raise inflation only for one month. It is further assumed that the rate of inflation varies randomly from month to month. The statistical problem is to decompose the monthly changes in the price index into (a) the underlying rate of inflation and (b) the effects of price-level shocks and measurements errors. Of course, since these are unobserved, one cannot do so perfectly, that is, there will be some estimation error. However, the extent of this error can be calculated.

The statistical model is given by:

$$\pi_t = \mu_t + \varepsilon_t - \varepsilon_{t-1} \tag{1}$$

$$\mu_t = \mu_{t-1} + \eta_t \tag{2}$$

where π_t denotes the monthly change of a price index and μ_t the underlying inflation measured on a month-to-month basis. The ε_t-shocks, which capture price-level shocks and measurement errors, and the innovations in underlying inflation, η_t, are assumed to be independently, identically distributed with $N(0,\sigma_\varepsilon^2)$ and $N(0,\sigma_\eta^2)$ respectively.

To estimate underlying inflation, the above model is written in state-space form in order to utilise the Kalman filter to extract an estimate of underlying inflation. To do so, let X_t denote the vector of unobserved state variable that is to be estimated:

$$\mathrm{X}_t^T = \begin{bmatrix} \mu_t & \varepsilon_t & \varepsilon_{t-1} \end{bmatrix} \tag{3}$$

where X_t^T denotes the transpose of X_t. Next define the vector A as:

$$A = \begin{bmatrix} 1 & 1 & -1 \end{bmatrix}. \tag{4}$$

We then have that:

(5) $$\pi_t = A\mathrm{X}_t .$$

Equation (5) states that the monthly change of a price index is a linear combination of the unobserved underlying inflation and the price-level shocks and measurement errors. To proceed further, a law of motion for X_t is needed. Without loss of generality, it is assumed that:

(6) $$\mathrm{X}_t = B\mathrm{X}_{t-1} + \upsilon_t$$

where the transition matrix, which governs the evolution over time of the state variables in the X_t vector, is given by:

(7) $$B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}.$$

The vector of disturbances can then be written as $\upsilon_t^T = [\eta_t \quad \varepsilon_t \quad 0]$. It is also assumed that the covariance matrix of the disturbances Ω is diagonal. This assumption implies that innovations to the underlying inflation are unrelated to the shocks to the price level.

To estimate the model, which is given by the measurement equation (5) and the transition equation (7), the likelihood function is formed:

(9) $$\log L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_1^T \log|F_t| - \frac{1}{2}\sum_1^T v_t^T F_t^{-1} v_t ,$$

where T, v_t and F_t denote the sample size, the prediction errors and the mean square matrix of the prediction errors, respectively. Estimates of the model can then be obtained by numerically maximising the likelihood function, using the Kalman filter. Since the monthly inflation series is non-stationary, in estimating the model we follow the suggestions of Harvey (1993. p. 88) and assume that the prior state vector is a random variable and has a diffuse distribution, that is, its covariance matrix is given by κI with $\kappa \to \infty$. This is tantamount to assuming that nothing is known about the initial state.

EMPIRICAL RESULTS

Table 1 presents the estimates of the variances of the price-level shocks and the innovations of the underlying inflation.

Table 1. Maximum Likelihood Estimates
(Estimation period: March 1992 to December 2003)

Model	Hong Kong		Mainland China	
Parameters	Estimates	Asymptotic t-values	Estimates	Asymptotic t-values
$\sigma_\varepsilon^2 \times 1000$	0.57	7.06	0.33	9.39
$\sigma_\eta^2 \times 1000$	0.18	4.03	1.16	5.53
Log Likelihood	231.83		179.27	
Akaike info. Criterion	-3.26		-2.52	
Schwarz Criterion	-3.22		-2.47	

Graph 3 shows the resulting estimate of the underlying rate of monthly inflation of Hong Kong, together with a 95% confidence band and the monthly change in prices. It is important to note that it is not necessarily sensible to focus on the point estimate of underlying inflation (since it is subject to estimation error). Instead, it seems appropriate to ask whether the 95% confidence band is above or below zero. Strikingly, the graph shows that while the underlying rate of inflation has clearly been negative since 1998 (except possibly for a brief episode in late 2000 and early 2001), in recent months the confidence band includes zero. In fact, it is centred close to zero (but just below, as indicated by the point estimate, which is –0.5%). Overall, the results suggest that while the episode of deflation is over, the economic environment has not yet turned inflationary. If the underlying rate of inflation does not change in the coming months, one would therefore expect months of positive and negative changes in prices to be roughly equally common.

Graph 4 depicts the resulting estimate of the underlying rate of monthly inflation of the Mainland, together with a 95% confidence band and the monthly change in prices. Interestingly, the graph shows the underlying rate of inflation of the Mainland has been close to zero since 1997.[2] However, in the recent months, the underlying inflation has been rising significantly above zero. Overall, the results suggest a rapid increase in inflation since July 2003.

[2] In particular, the confidence band includes zero.

Finally, Graphs 5 and 6 show the "standard" measure of inflation over twelve-months of the two economies, together with the new statistical measure of underlying monthly inflation. The graphs indicate that underlying inflation varies more over time in response to short-term economic developments than inflation measured over twelve months. Furthermore, as discussed above, the twelve-month rate of inflation typically lags behind underlying inflation, which suggests that using the rate of price change over twelve months to judge whether deflation is over is hazardous.

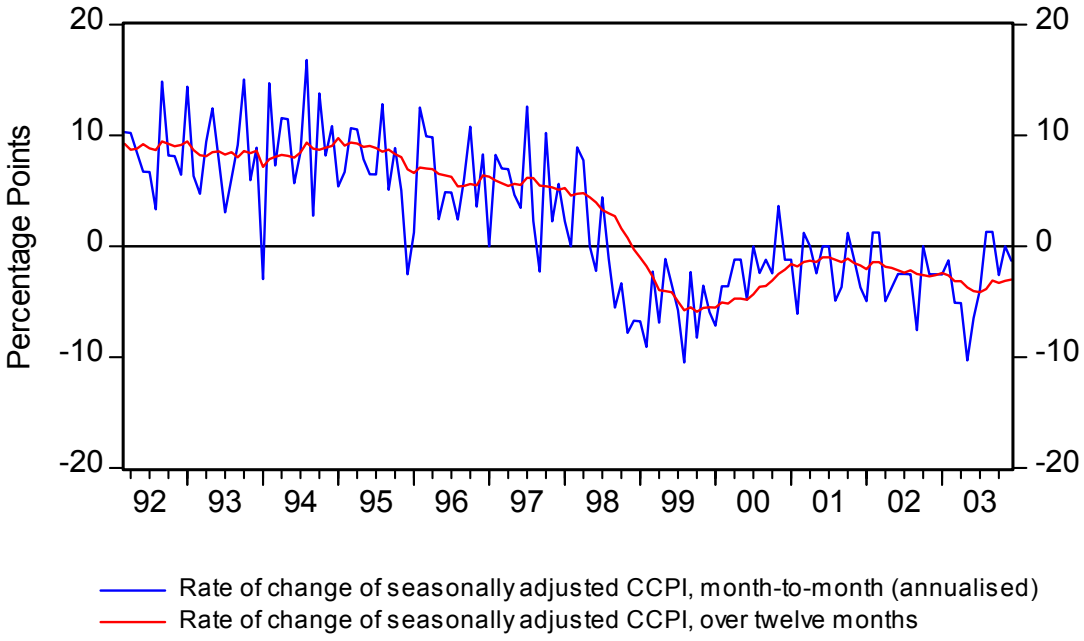
CONCLUSION

The statistical model proposed in this paper provides a simple measure of underlying monthly inflation, which is designed to be useful for indicating the changes of inflation in a timely manner. For Hong Kong, the proposed measure suggests that deflation is over, but inflation has not yet taken hold. By contrast, for the Mainland, the measure of inflation indicates that inflation pressures are rising.

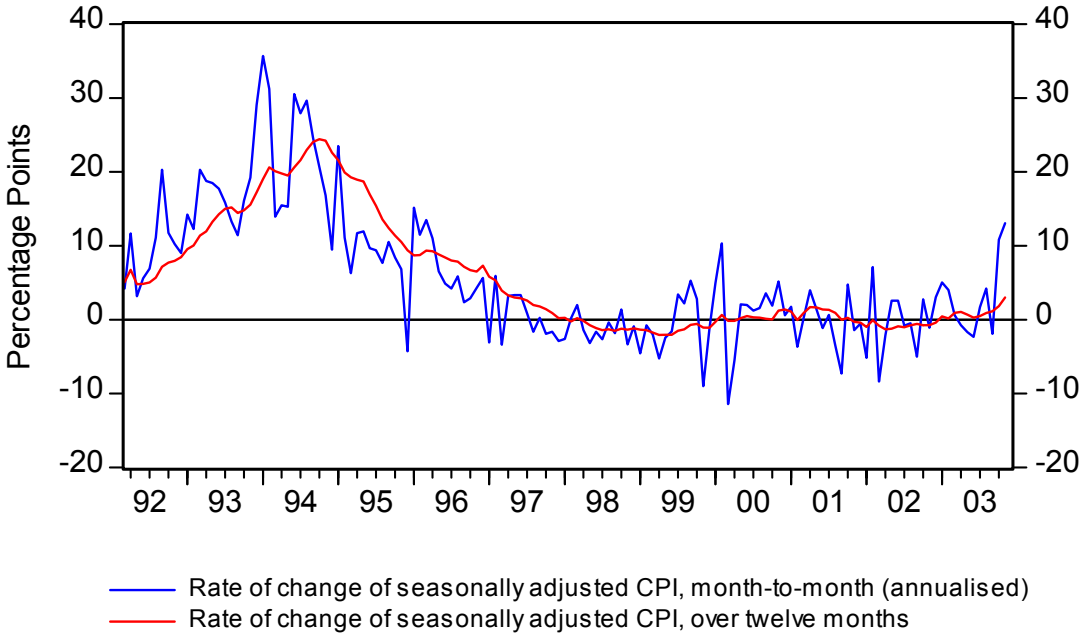
REFERENCE:

Harvey, A.C. (1993), Time Series Models, 2nd ed. MIT Press, Cambridge

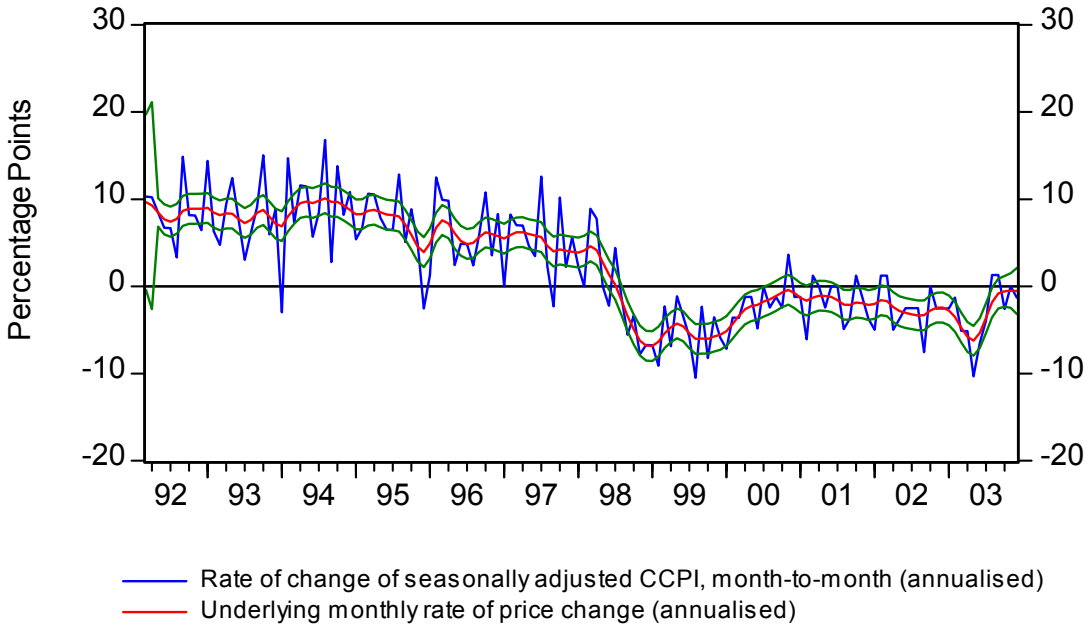
Graph 1: Hong Kong



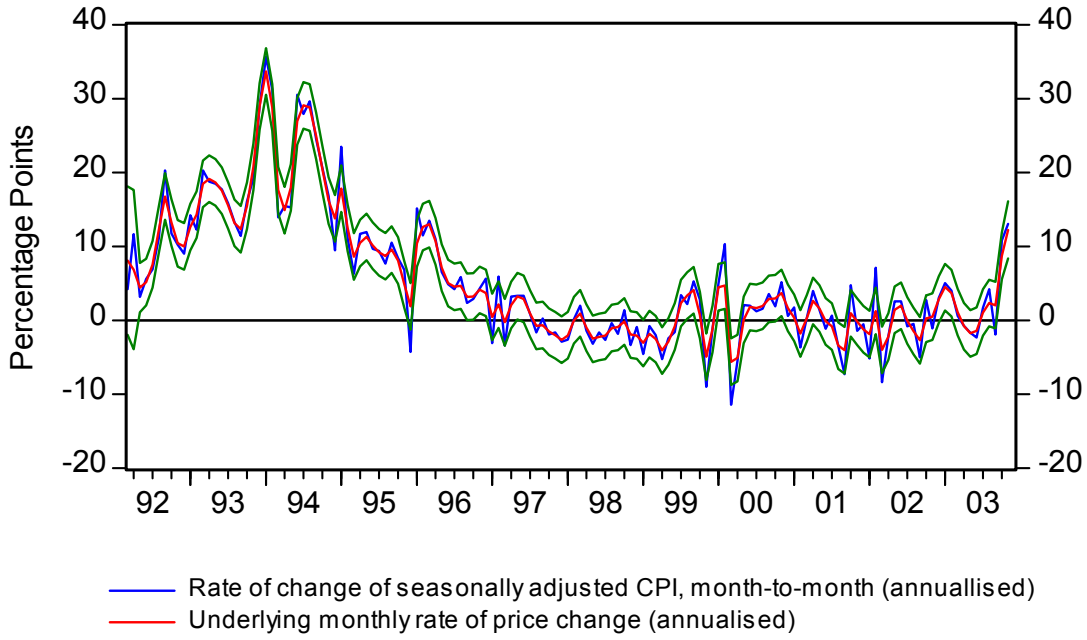
Graph 2: Mainland China



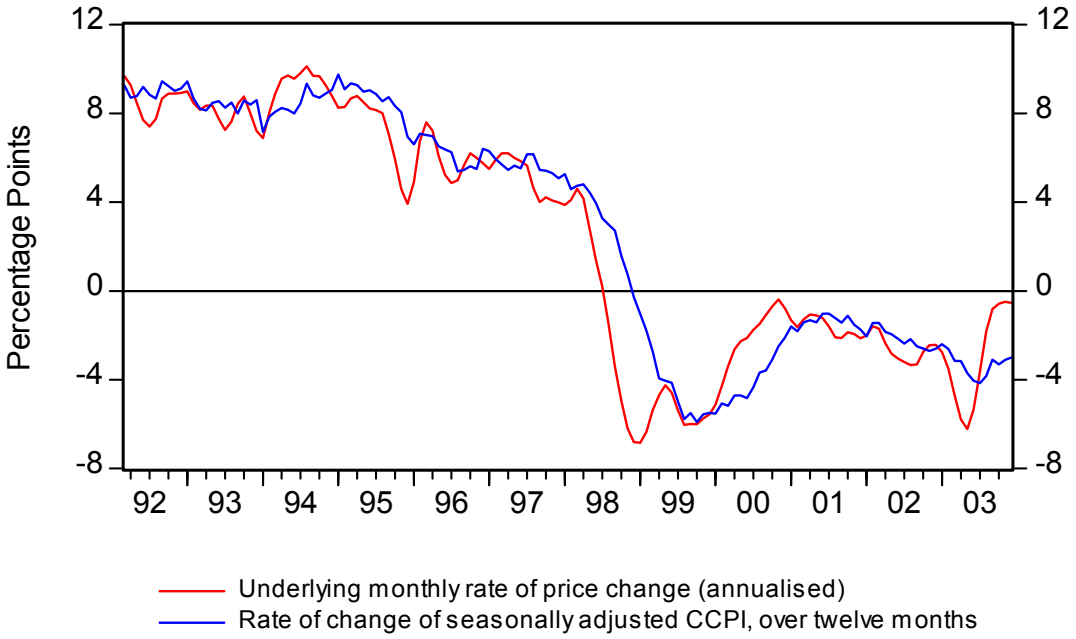
Graph 3: Hong Kong



Graph 4: Mainland China



Graph 5: Hong Kong



Graph 6: Mainland China