

Seasonality in the Cambodian Consumer Price Index

Working Paper 13

Ung Bunleng



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CAMBODIA DEVELOPMENT RESOURCE INSTITUTE

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January 2000

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Abstract

Preliminary results from a seasonal adjustment of Cambodia's official consumer price index (CPI) indicate significant seasonality in the series. Although the seasonal factors mirror the country's main food production cycle, the original series has itself been volatile in recent years, and because of the procedures used in its compilation, it is particularly sensitive to exchange rate fluctuations. The inflationary momentum abated substantially in 1999, with inflation towards the end of the year running at a quarterly annualised rate of 6.6 percent, compared to 17.2 percent in the same period the previous year.

Foreword

The Cambodia Development Resource Institute had the pleasure of welcoming Ung Bunleng, a Senior Analyst in the Economics Department at the Reserve Bank of New Zealand, as a Visiting Research Fellow in May–June 1999. Building on his previous experience from a project in the National Bank of Cambodia, he decided to devote the few weeks of his stay to exploring seasonality in the Cambodian consumer price index. In the process, he was able to familiarise CDRI researchers with the latest software package available for this purpose, conducting regular tutorials on the use of the X-12-Arima model.

As a result, his work had two outputs. One is this working paper, more technical than previous papers in this series, and oriented towards the specialist rather than the general reader. Its recommendations should be of interest to specialists, particularly in the National Bank of Cambodia, the Ministry of the Economy and Finance, and the National Institute of Statistics. The other output is the interest aroused in a number of CDRI researchers in the use of this model: it is likely that they will take the author's advice and experiment with it further, including forecasts, exploration of the seasonality of CPI sub-groups, and investigation of seasonality in other official series, such as airport arrivals and the NBC monetary aggregates. The work on modelling and forecasting for the Cambodian economy currently under way in CDRI will certainly benefit from Bunleng's input.

*Martin Godfrey, Research Coordinator
January 2000*

Seasonality in the Cambodian Consumer Price Index¹

The removal of seasonal influences from time series, where statistically significant, is a long established practice among statistical agencies overseas. The presence of seasonality tends to mask a series' central tendency, complicates intra-year comparisons of the underlying trend, and makes turning point detection difficult.

In common with similar indices compiled overseas, the Cambodian consumer price index (CPI) appears affected by fixed, time invariant seasonality, even though the National Institute of Statistics (NIS) has yet to publish an official seasonally corrected series. A basic minimum number data points, however, do now exist to meet the requirements of one major statistical software package.² Previous analyses of the CPI series, such as those by the National Bank of Cambodia (NBC) and the International Monetary Fund (IMF) have used moving averages to smooth out irregularities in the series. The NBC extracts a trend by fitting a three-month moving average. Such an approach fails to account for seasonality apart from other factors; interpretation of data during politically volatile periods, such as 1997 and 1998, is therefore hampered. Following earlier CDRI studies of price indices, this working paper reports the results of an exercise using X-12-Arima.³

1) Seasonal Decomposition

Given a monthly series, seasonality is often defined as a month-specific effect that causes a series to deviate from its long-term central tendency. In an empirical model, such as that followed by the US Bureau of the Census X-11 method, the components of a time series $Y(t)$ are defined as:

$$Y(t) = C(t).S(t).I(t)$$

where $C(t)$ is the trend cycle, $S(t)$ the seasonal factor and $I(t)$ the irregular component. In such a representation, while $I(t)$ has a random impact on $Y(t)$, the influence of $S(t)$ is "predictable" over the course of a year. $S(t)$ includes effects associated with national festivals, normal climatic variations in a calendar year, or regulatory events such as periodic tax drains on liquidity. Trend $C(t)$ captures longer-term fluctuations due to structural changes in the economy

¹ Ung Bunleng is a Senior Analyst in the Economics Department at the Reserve Bank of New Zealand. He can be contacted via the Reserve Bank of New Zealand, PO Box 2498, Wellington, New Zealand. The author expresses his gratitude to CDRI colleagues for the hospitality offered, and to Long Vou Piseth for his assistance with the data series.

² X11, in contrast, requires a minimum of three years of data.

³ US Bureau of the Census, X-12-Arima Reference Manual, Version 0.2.3 (12 March 1999).

(such as demographic, institutional or technological change). Seasonal adjustment removes $S(t)$, leaving the corrected series: $Y'(t) = C(t).I(t)$.

The nature of the series usually indicates whether a pre-determined seasonal pattern can be expected. The seasonality that affects food price indices are usually fixed, associated with the weather patterns affecting supply over any given year. Stochastic seasonality evolves in time and is often associated with regulatory changes.⁴ Flow series may be further affected by the so-called “trading day effect,” in which the number of working days can affect the original series. In sophisticated financial systems, for example, and before the arrival of automated teller machines (ATMs), the total expenditure on credit cards varied with the number of Saturdays and Sundays in each month, because consumers tended to use their cards more often at the weekend when banks were closed.

Most statistical software packages now offer the widely used X-11 as a standard, non-parametric adjustment program. Developed in the 1960s, X-11 is an iterative procedure that applies various centred moving average filters, taking into account outliers defined by a given standard deviation band. An initial long-term trend is calculated and removed from the original series. An estimation of the seasonal factors is then made on the remainder using short-term centred moving averages, leading to preliminary estimates for $S(t)$ and $I(t)$. After accounting for trading day effects, the whole process is repeated to obtain final estimates for S , I and C .

X-12-Arima (X-12-A) is the latest X-11 variant that incorporates a Box-Jenkins Arima time series model. This helps overcome the asymmetrical weights applied at series end-points in X-11. Under X-12-A, an Arima model is fitted to the data to provide forecasts to the original series before it is passed to the X-11 seasonal correction module. X-12-A also incorporates a number of useful options, including the regression of level or temporary shifts in the data prior to carrying out the seasonal adjustment.

The amount of Cambodian CPI data available at this stage (54 observations from 1995 to mid-1999) satisfies the basic requirement of X-11, but is insufficient to yield an appropriate identification of the fitted Arima model. The use of quality control procedures available in X-12-Arima is also impaired.⁵ The Arima-based projections in this working paper are therefore preliminary and may lead to unstable estimates of monthly changes in the series. Notwithstanding these data limitations, the presence of strong and stable seasonality is nevertheless reasonably evident, and the general pattern of seasonality is unlikely to be revised when new observations become available.

2) Results

The specifications listed in Appendix One were used to seasonally adjust the series “CPI (all groups; including rent).” Figure 1 plots the original observations against the seasonally adjusted series and the estimated seasonal factors for the series up to June 1999.

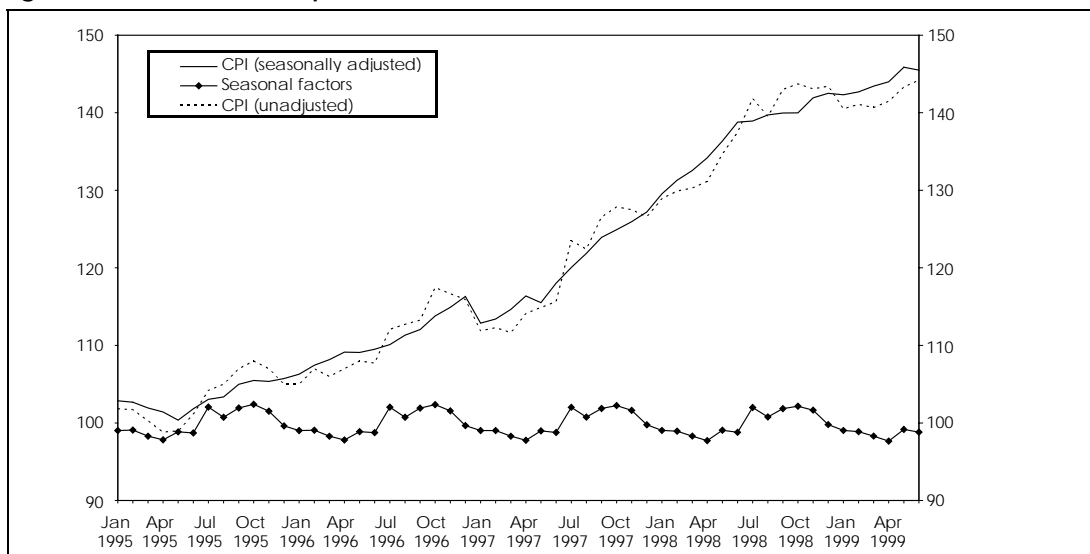
Figure 2 reproduces the seasonal factors of the CPI, the CPI excluding rent (CPIX), and the food, beverage and tobacco (FBT) sub-group for the data up to March 1999. For the last two indices, the seasonals were obtained using default X-11 options with no Arima modeling. Under current compilation procedures, the price index derived for imputed rental value of owner-occupied housing is calculated in January and July (see the housing and utilities index, Appendix Two, Figure A9). The treatment of rent appears to have little consequence on the seasonal factors of CPIX (see Figure 2) compared with those of the CPI. All seasonal

⁴ Stochastic seasonality can affect some series, notably financial and monetary indicators, where changes to the tax regime or financial regulations can cause seasonal patterns to evolve over time.

⁵ These procedures include analyses of sliding spans and estimates of the historical stability of end points, all of which require a greater number of observations.

factors are standardised (with a base of 100 in July–September 1994). Values of 100 in any month indicate that seasonality has no impact on the original series at that time of the year.

Figure 1. CPI Series Decomposition



Appendix Three contains a selection of tables from X-12-A program output for data up to June 1999. Of particular interest are the following:

- A1 - Original data series
- D10 - Final seasonal factors
- D11 - Seasonally adjusted series
- D12 - Trend cycle
- E6 - Monthly percentage changes of D11

Figure 2. Estimated Seasonal Factors for CPI, CPIX and FBT

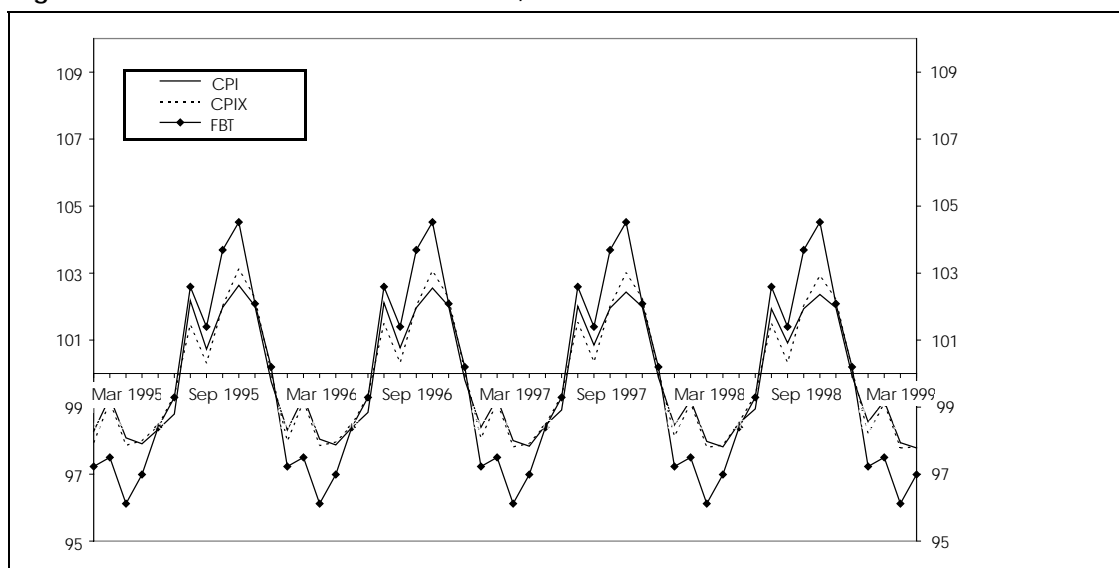
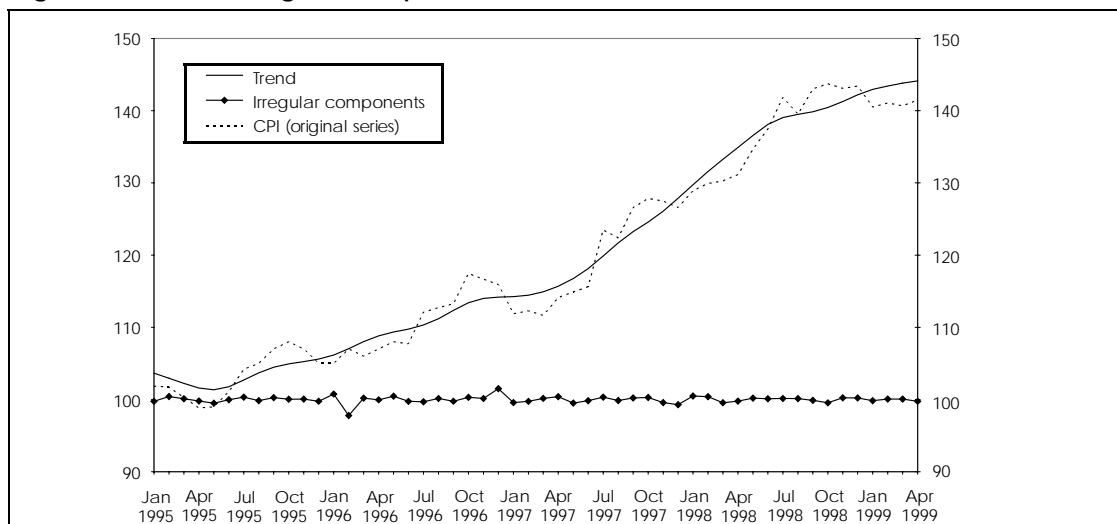


Figure 3 shows the trend and irregular components of the CPI. Irregulars are one-off disturbances to the series and fluctuate around 100. The trend-line is obtained using a centred nine-term moving average.

Figure 3. Trend and Irregular Components



3) Discussion

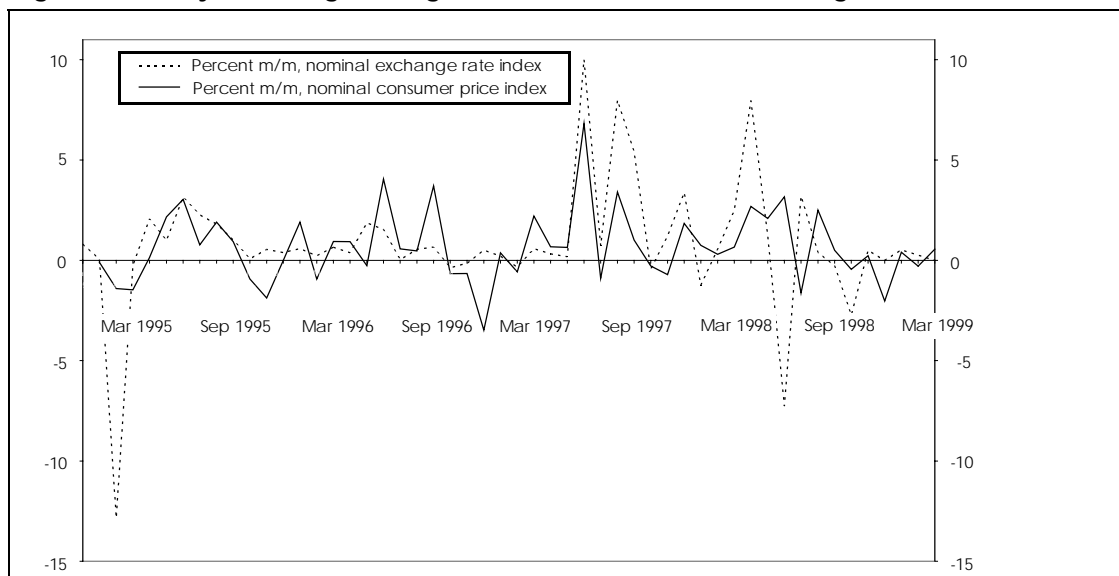
3.1. Seasonal Patterns

The correspondence between the seasonal component and the original series is visually evident in Figure 1 above. The CPI's seasonal cycle in Figure 2 matches almost month for month with that for the FBT sub-group. The broad similarity between the CPI's seasonality and Cambodia's main food production cycle was expected, given the large (46 percent) weight of the FBT sub-group. The first half of the calendar year is marked by deflationary influences. The opposite is true from July until October. The arrival of the new rice crop and fish harvest starts a downward effect on the price level from November.

The recurrent February seasonal spike in the CPI contrasts with the trough in April, even though each of these months corresponds to a major festival (the Chinese and Khmer New Year celebrations, respectively). Equally noticeable is the differential effect that the two festivals have on the CPI and FBT: the Chinese New Year festival has a larger impact on overall CPI than on FBT, implying greater influence on the price of non-food items. The reverse seems to hold for the Khmer New Year, with FBT more affected than the CPI. The local trough in August for the CPI has no obvious explanation, though it coincides with the so-called "little" dry season.

The differential effect on price levels between the two major festivals can be explained by two intertwined factors: the exclusively urban coverage of the CPI, and the index compilation procedure. Cambodians of Chinese or Vietnamese descent make up an influential minority in urban areas, and their purchasing power is in conspicuous display during the February celebration. Supply bottlenecks emanating from Vietnam, where the lunar new year is also celebrated, further aggravate import prices of both durable and non-durable items in this month. On the other hand, the consumption of food items characterises Khmer New Year celebrations in April, with prices in these items affected accordingly.

Figure 4. Monthly Percentage Changes in Nominal CPI and the Exchange Rate Index



The second factor is widespread dollarisation, which explains the tendency for non-food items to be routinely quoted in dollars. Although food items almost invariably retail in riels, non-food items, especially at the more expensive end of the scale, are priced in dollars. Exchange rate fluctuations will tend to immediately feed through into the CPI, regardless of merchandise inventory levels.

In a simple Laspeyres index of the form $CPI(t) = (1+e) \cdot A \cdot Y(t-1) + B \cdot Z(t)$, where Y = prices of CPI imports quoted in dollars, e = exchange rate depreciation between t and $t-1$, Z = prices of CPI items quoted in riels, and A and B their relative weights. The immediate change to the CPI for an increment of e , holding all else equal, is given by $d(CPI) = A \cdot Y \cdot d(e)$. In this simple representation, the price index is directly affected by the extent of the depreciation and weighting scheme, but not by the local riel-priced items nor their weights.

The direct impact of exchange rate fluctuations in the nominal CPI is illustrated in Figure 4, where a correspondence exists between swings in the nominal exchange rate index (as compiled by CDRI), with movements in the CPI.

It is evident in Figure 4 that the appreciation or depreciation of the riel feeds into the CPI almost instantaneously, though there are apparent exceptions.

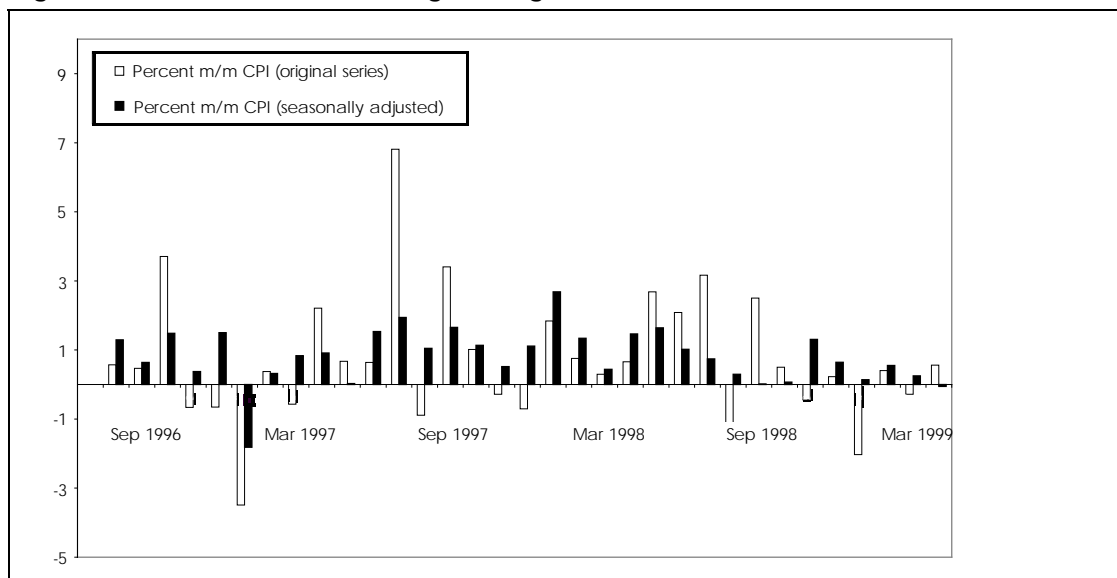
Elsewhere, the imputed rental value of owner-occupied housing is calculated in January and July, and modified over the intervening months by taking account of fluctuations in the exchange rate (see Appendix Two, Figure 9). This compilation procedure results in a step-like, irregular impact on the index in these two months, and may have caused the unusual drop in the CPI in January 1997 (see Figure 5). Although rent accounts for 19.5 percent in weight, its impact on the July 1997 CPI's irregular component seems to have been completely swamped by political factors.

3.2. Adjusted Data and Trends—Monthly Changes

The seasonally adjusted data over the past two years present some interesting reading (see Figure 5). The crisis in July 1997 was not the total shock to consumers that the non-adjusted CPI series seems to indicate. A burst of inflation is evident in the June adjusted data, as well as over the following months. In the run-up to the July 1998 national election, the pressure on prices grew from April, but dissipated rapidly in August. The non-adjusted data, in contrast, point to a peak in July and a sharp drop in the month that followed. The annualised quarter-

on-quarter growth rates in Table A1 (Appendix Two), which provide an indication of inflationary momentum, fell away quickly by the end of 1998, and appeared to have bottomed out in April 1999.

Figure 5. Month-on-Month Percentage Changes



Compare the use of seasonally adjusted data with data transformed via a moving average scheme as used by the NBC. As Figures 6 and 7 illustrate, a simple three-month moving average will always lag the seasonally adjusted series and as a result provide a misleading reading of current conditions.

Figure 6. CPI (Seasonally Adjusted) and Three-Month Moving Averages

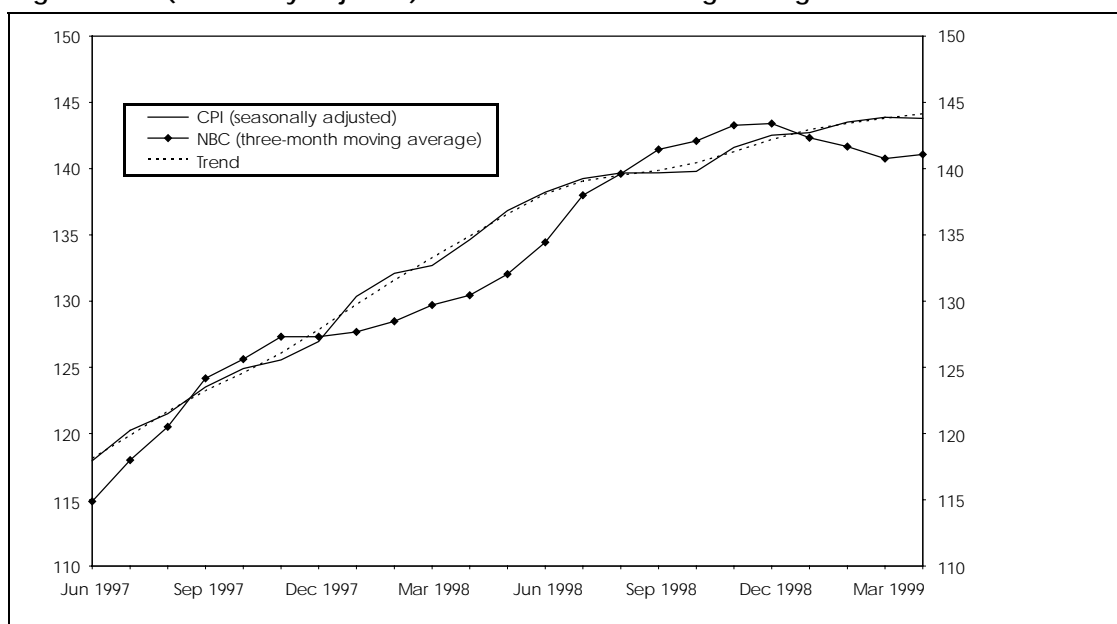
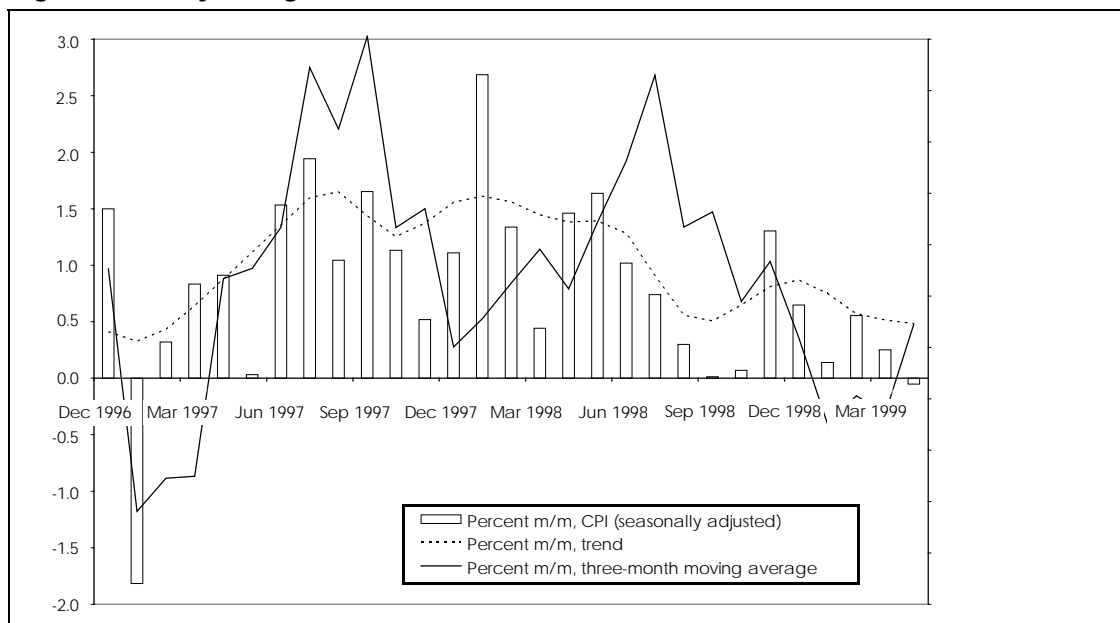
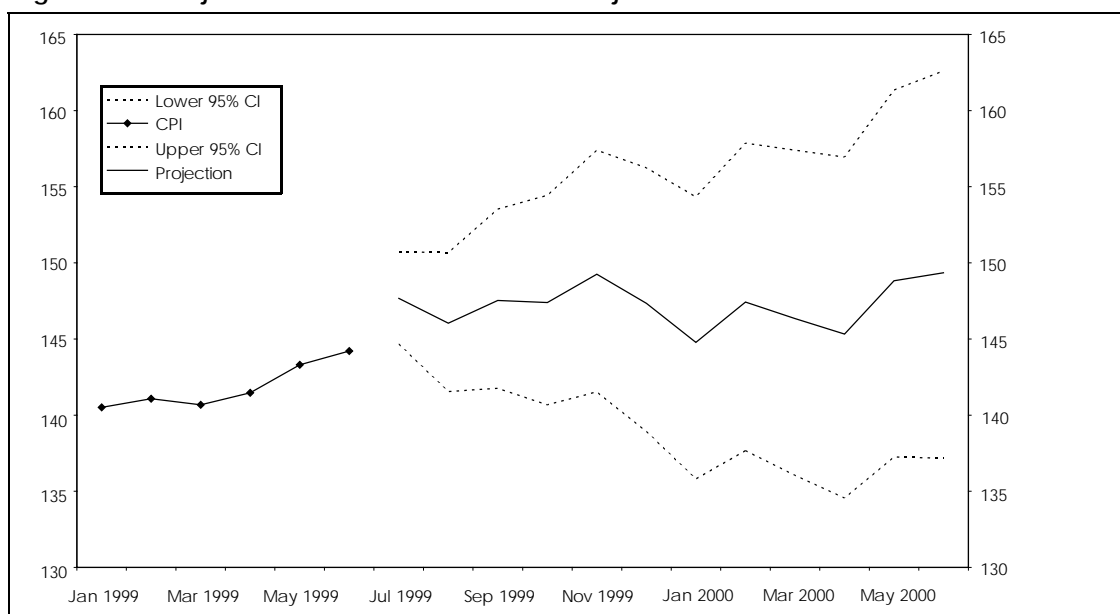


Figure 7. Monthly Changes in CPI



X-12-A also provides projections for the value of the CPI based on the specified Arima model (see Figure 8), along with a 95-percent confidence interval. As noted above, X-12-A uses these projections to supplement calculations at the series end point. Pioneered by Dagum, the technique improves the stability of seasonal estimates when new observations are added to the series.⁶ The Arima projections are, however, sensitive to the model chosen. A correctly specified model leads to a smaller number of revisions to the adjusted numbers and trends as new data become available.

Figure 8. CPI Projections Assumed under Current Adjustment



⁶ Estela B. Dagum (1980), *The X-11-Arima Seasonal Adjustment Method* (Cat. No. 12-564E, Statistics Canada).

The chosen Arima model, based on estimates using data up to June 1999, indicates a rise in the CPI to 148 in July 2000, peaking at 149 in November 2000. If recent conditions hold, the year-on-year increase in the CPI is expected to be one of the lowest rates seen since the beginning of the series, of between 3 and 5 percent per year by the end of the year. The confidence interval is, however, so wide as to render the projections of little benefit beyond a rough, indicative estimate.

4) Conclusion

The presence and strength of seasonality in the CPI provide a case for using a consistent adjustment procedure such as X-12-A. Such a procedure adds more confidence when interpreting shorter term movements of the CPI. It is suggested, however, that CDRI:

- publish monthly percentage changes in the seasonally adjusted CPI series, using the appended specifications and noting the non-official nature of the results;
- produce forward seasonal factors which are likely to remain relatively robust;
- provide a three- to six-month forward indicative outlook on the official CPI, using the same X-12-A specifications or some revised model;
- pursue further work on the seasonality of CPI sub-groups, especially on the core Food and FBT sub-groups, because of their wider relevance;
- Compare results in this working paper with those from a composite adjustment approach on the CPI sub-groups;
- Investigate seasonality in other official series, such as airport arrivals and the NBC monetary aggregates.

Appendix One

X-12-Arima Options Used for the CPI

Given the limited number of observations, AUTOMDL was used to allow automatic selection of a seasonal model from a range listed in file X12A.mdl. Although the seasonal model (0,1,2)(1,0,0)12 was suggested on the basis of lowest in-sample error, the auto-correlation and partial correlation functions of the raw series suggest an AR(1) process, which is used here (despite the non-asymptotic ACF).

Trading day effects appear statistically significant and have been regressed with a level shift in January 1997. The sigma limits for the treatment of outlying observations have been set to default. For consistency, it may be useful to leave these parameters unchanged until a review of all specifications and settings could be performed as new data points come to light.

All numbered M's diagnostics (see Appendix Three, Table A???) are within acceptable limits, as is the weighted Q value. Finally, a comparison between the spectra of the original with the adjusted series shows no visually significant seasonality or trading day effect left. The spectrum of the irregular term also appears acceptable.

Spec File

```
line #
-----
series{
  title="CPI All Groups (inc Rent)"
  period=12
  start=1995.1
  file='0.txt'
}
transform{function=log}
regression{variables=(tdnolpyear LS1997.Jan)}
aictest=(tdnolpyear )}
arima {model=(1,1,0)(1,0,0)12}
estimate{}
outlier{}
check{maxlag=36}
forecast{exclude=0 maxlead=12 save=(transformed variances forecasts)}
x11{sigmalim=(1.5 2.5)appendfcst=yes print=(adjorigplot seasonalplot seasadjplot)}
```

X-12-A Settings

```
Series Title- CPI All Groups (inc Rent)
Series Name- a
10/16/99 19:23:45.35

-Period covered- 1st month, 1995 to 6th month, 1999
-Type of run- multiplicative seasonal adjustment
```

- sigma limits for graduating extreme values are 1.5 and 2.5
- 3x3 moving average used in section 1 of each iteration
- 3x5 moving average in section 2 of iterations B and C
- moving average for final seasonal factors chosen by Global MSR
- spectral plots generated for selected series

Appendix Two

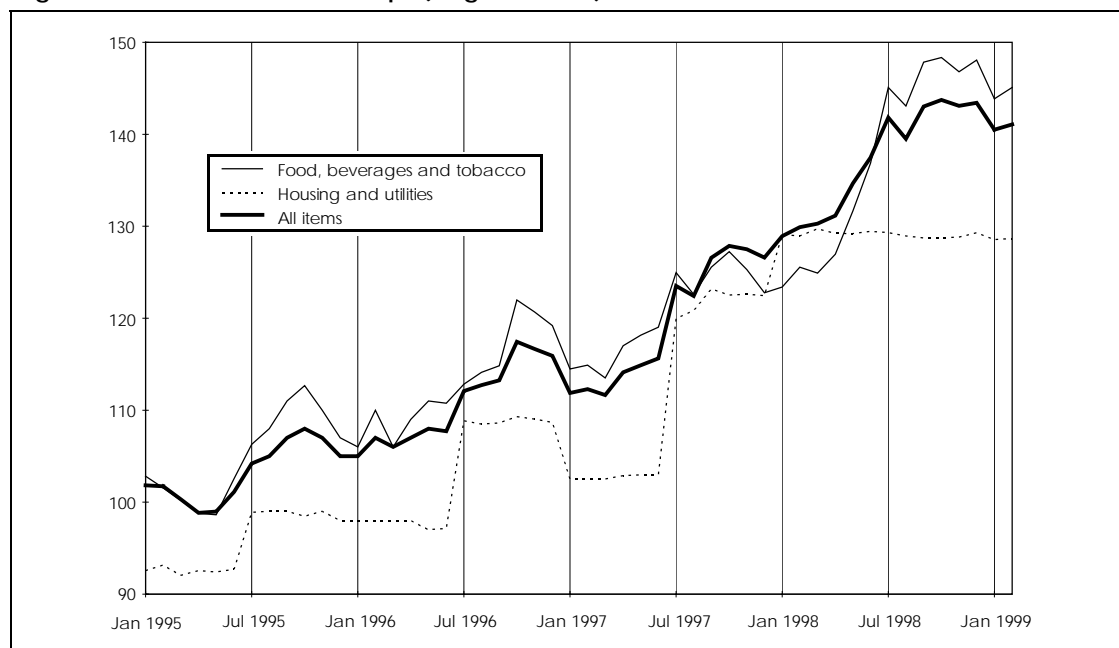
Seasonally Adjusted CPI Series

Table A1. Seasonally Adjusted CPI Series

Month	CPI	CPI (adjusted)	Percentage, m/m (adjusted)	Three-month avg. (annualised)
Jan 1995	101.83	102.90		
Feb 1995	101.73	102.70	-0.2	
Mar 1995	100.30	101.90	-0.7	
Apr 1995	98.83	101.40	-0.5	
May 1995	98.97	100.40	-1.0	
Jun 1995	101.12	101.80	1.5	-4.9
Jul 1995	104.19	103.00	1.2	-1.0
Aug 1995	105.00	103.40	0.3	6.1
Sep 1995	107.00	105.00	1.6	10.7
Oct 1995	108.00	105.50	0.4	11.8
Nov 1995	107.00	105.40	-0.1	10.2
Dec 1995	105.00	105.70	0.3	6.8
Jan 1996	105.00	106.30	0.6	4.6
Feb 1996	107.00	107.40	1.1	4.7
Mar 1996	106.00	108.20	0.7	6.9
Apr 1996	107.00	109.10	0.9	9.6
May 1996	108.00	109.10	0.0	9.0
Jun 1996	107.72	109.50	0.4	7.4
Jul 1996	102.08	110.10	0.6	5.0
Aug 1996	112.72	111.30	1.1	5.7
Sep 1996	113.25	112.00	0.6	7.2
Oct 1996	117.45	113.80	1.6	10.7
Nov 1996	116.67	114.90	1.0	12.4
Dec 1996	115.91	116.30	1.2	14.6
Jan 1997	111.87	112.90	-3.0	8.5
Feb 1997	112.29	113.40	0.5	2.2
Mar 1997	111.65	114.60	1.1	-4.7
Apr 1997	114.12	116.40	1.5	0.4
May 1997	114.89	115.50	-0.8	4.7
Jun 1997	115.63	118.00	2.2	11.0
Jul 1997	123.51	120.10	1.7	11.1
Aug 1997	122.41	121.90	1.5	16.4
Sep 1997	126.58	123.90	1.7	19.5
Oct 1997	127.86	124.90	0.8	20.8
Nov 1997	127.50	125.90	0.8	17.5
Dec 1997	126.60	127.20	1.0	14.1

Jan 1998	128.93	129.50	1.8	13.6
Feb 1998	129.90	131.30	1.4	14.9
Mar 1998	130.29	132.60	1.0	17.2
Apr 1998	131.15	134.20	1.2	16.4
May 1998	134.67	136.30	1.6	16.4
Jun 1998	137.48	138.80	1.8	17.2
Jul 1998	141.83	138.90	0.1	17.1
Aug 1998	139.52	139.70	0.6	15.0
Sep 1998	143.01	140.00	0.2	9.4
Oct 1998	143.73	140.00	0.0	5.5
Nov 1998	143.09	141.90	1.4	4.3
Dec 1998	143.42	142.50	0.4	5.7
Jan 1999	104.51	142.30	-0.1	6.9
Feb 1999	141.08	142.70	0.3	5.4
Mar 1999	140.68	143.40	0.5	3.8
Apr 1999	141.47	144.00	0.4	3.2
May 1999	143.31	145.90	1.3	5.6
Jun 1999	144.21	145.50	-0.3	6.6

Figure 9. Selected CPI Sub-Groups (Original Series)



Appendix Three

Excerpts from X-12-A Output

MODEL DEFINITION

Transformation
Log(y)

Regression Model
Trading Day + LS1997.Jan

ARIMA Model
(1,1,0)(1,0,0)12

regARIMA Model Span
From 1995.Jan to 1999.Jun

MODEL ESTIMATION/EVALUATION

Exact ARMA likelihood estimation	
Max total ARMA iterations	200
Max ARMA iter's w/in an IGLS iterati	40
Convergence tolerance	1.00E-05

Likelihood statistics for model with tdnolpyear

Likelihood Statistics

Effective number of observations (nefobs)	53
Number of parameters estimated (np)	10
Log likelihood	164.1633
Transformation Adjustment	-253.6645
Adjusted Log likelihood (L)	-89.5012
AIC	199.0024
AICC (F-corrected-AIC)	204.2405
Hannan Quinn	206.5792
BIC	218.7053

Likelihood statistics for model without tdnolpyear

Likelihood Statistics

Effective number of observations (nefobs)	53
Number of parameters estimated (np)	4
Log likelihood	149.1258
Transformation Adjustment	-253.6645
Adjusted Log likelihood (L)	-104.5386
AIC	217.0773
AICC (F-corrected-AIC)	217.9106
Hannan Quinn	220.1080
BIC	224.9584

***** AICC (with aicdiff= 0.00) prefers model with tdnolpyear *****

OUTLIER DETECTION

From 1995.Jan to 1999.May

Observations 53

Types AO and LS

Method add one

Critical |t| for AO outliers 3.68

Critical |t| for LS outliers 3.68

No AO or LS outliers identified

Largest outlier t-value : -2.88953 (AO1997.May)

Average absolute percentage error in within-sample forecasts:

Last year: 4.39 Last-1 year: 3.40 Last-2 year: 3.05

Last three years: 3.61

Estimation converged in 12 ARMA iterations, 95 function evaluations.

Regression Model

Variable	Parameter Estimate	Standard Error	t-value
Trading Day			
Mon	-0.0055	0.00149	-3.68
Tue	0.0081	0.00171	4.71
Wed	-0.0049	0.00166	-2.98
Thu	0.0053	0.00146	3.63
Fri	0.0007	0.00151	0.49
Sat	-0.0010	0.00160	-0.61
*Sun (derived)	-0.0027	0.00158	-1.71
LS1997.Jan	-0.0413	0.00814	-5.07

*For full trading-day and stable seasonal effects, the derived parameter estimate is obtained indirectly as minus the sum of the directly estimated parameters that define the effect.

Chi-squared Tests for Groups of Regressors

Regression Effect	df	Chi-Square	P-Value
Trading Day	6	61.57	0.00

ARIMA Model: (1,1,0)(1,0,0)12

Nonseasonal differences: 1

Parameter	Estimate	Standard Errors
Nonseasonal AR		
Lag 1	0.2355	0.12305
Seasonal AR		
Lag 12	0.7978	0.06788
Variance	0.94878E-04	

Likelihood Statistics

Effective number of observations (nefobs)	53
Number of parameters estimated (np)	10
Log likelihood	164.1633
Transformation Adjustment	-253.6645
Adjusted Log likelihood (L)	-89.5012
AIC	199.0024
AICC (F-corrected-AIC)	204.2405
Hannan Quinn	206.5792
BIC	218.7053

Sample Autocorrelations of the Residuals

	-1.0	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8	1.0
	+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+										
1						X					-0.050
2					.	X	.				0.042
3					.	XX	.				0.088
4					XXX						-0.133
5					.	X	.				0.032
6					.	XXXX	.				0.148
7					.		.				0.011
8					.	XXXXXX	.				0.221
9					.	X	.				0.025
10					.	XXXX	.				0.176
11					X						-0.028
12	- - - - -			XXXXXX			.	- - - - -			-0.223
13				XX			.				-0.068
14				.	X		.				0.024
15				.			.				0.016
16				.	XX		.				0.098
17				.			.				-0.019
18				.			.				-0.002
19				XXXX			.				-0.147
20				XXX			.				-0.116
21				.			.				-0.014
22				X			.				-0.041
23				X			.				-0.033
24	- - - - -				XX		.	- - - - -			0.091
25				.			.				-0.004
26				.			.				0.002
27				XXX			.				-0.112
28				.			.				-0.008
29				XXXXXX			.				-0.181
30				XX			.				-0.081
31					XX		.				0.086
32					X		.				0.030
33				XX			.				-0.083
34					XX		.				0.068
35				XXX			.				-0.113
36	- - - - -						.	- - - - -			-0.018

FORECASTING

Origin 1999.Jun
Number 12

Confidence intervals with coverage probability (0.95000)
On the Original Scale

Date	Lower	Forecast	Upper
1999.Jul	144.68	147.67	150.72
1999.Aug	141.55	146.04	150.67
1999.Sep	141.77	147.53	153.53
1999.Oct	140.68	147.40	154.44
1999.Nov	141.53	149.26	157.40
1999.Dec	138.94	147.34	156.25
2000.Jan	135.82	144.78	154.34
2000.Feb	137.68	147.43	157.86
2000.Mar	136.06	146.34	157.40
2000.Apr	134.56	145.32	156.95
2000.May	137.26	148.82	161.36
2000.Jun	137.17	149.35	162.61

B 1.A Forecasts of (prior adjusted) original series
 From 1999.Jul to 2000.Jun
 Observations 12

	Jan Jul	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	TOTAL
1999	147.	146.	147.	148.	149.	147.	884.
2000	146.	146.	146.	146.	149.	148.	882.

D 8.A F-tests for seasonality

Test for the presence of seasonality assuming stability.

	Sum of Squares	Dgrs.of Freedom	Mean Square	F-Value
Between months	120.7586	11	10.97806	71.503**
Residual	6.4484	42	0.15353	
Total	127.2070	53		

**Seasonality present at the 0.1 per cent level.

Nonparametric Test for the Presence of Seasonality Assuming Stability

Kruskal-Wallis Statistic	Degrees of Freedom	Probability Level
47.6446	11	0.000%

Seasonality present at the one percent level.

Moving Seasonality Test

	Sum of Squares	Dgrs.of Freedom	Mean Square	F-value
Between Years	0.5097	3	0.169905	1.397
Error	4.0124	33	0.121587	

No evidence of moving seasonality at the five percent level.

COMBINED TEST FOR THE PRESENCE OF IDENTIFIABLE SEASONALITY

IDENTIFIABLE SEASONALITY PRESENT

D 10 Final seasonal factors

From 1995.Jan to 1999.Jun
 Observations 54
 Seasonal filter 3 x 5 moving average

	Jan Jul	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	AVGE
1995	99.0 102.0	99.1 100.7	98.3 101.9	97.8 102.4	98.8 101.5	98.7 99.6	100.0
1996	99.0 102.0	99.1 100.7	98.3 101.9	97.8 102.3	98.9 101.5	98.7 99.7	100.0
1997	99.0 102.0	99.0 100.8	98.3 101.9	97.8 102.2	99.0 101.6	98.8 99.7	100.0
1998	99.0 102.0	98.9 100.8	98.3 101.8	97.7 102.2	99.1 101.7	98.8 99.8	100.0
1999	99.0	98.9	98.3	97.7	99.1	98.8	98.6
AVGE	99.0 102.0	99.0 100.8	98.3 101.9	97.7 102.3	99.0 101.6	98.8 99.7	

Table Total- 5391.92 Mean- 99.85 Std. Dev.- 1.53
 Min - 97.65 Max - 102.41
 Test for the presence of residual seasonality.

No evidence of residual seasonality in the entire series at the
1 per cent level. F = 0.37

No evidence of residual seasonality in the last 3 years at the
1 per cent level. F = 0.41

No evidence of residual seasonality in the last 3 years at the
5 per cent level.

Note: sudden large changes in the level of the adjusted series will
invalidate the results of this test for the last three year period.

D 12 Final trend cycle
(LS outliers included)
From 1995.Jan to 1999.Jun
Observations 54
Trend filter 9-term Henderson moving average
I/C ratio 0.28

	Jan Jul	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	TOTAL
1995	103. 103.	102. 104.	102. 105.	102. 105.	101. 106.	102. 106.	1240.
1996	106. 110.	107. 111.	108. 112.	109. 114.	109. 115.	110. 116.	1328.
1997	113. 120.	114. 122.	114. 124.	115. 125.	117. 126.	118. 128.	1435.
1998	129. 139.	131. 140.	133. 140.	134. 141.	136. 142.	138. 142.	1645.
1999	143.	143.	143.	144.	145.	145.	863.
AVGE	119. 118.	119. 119.	120. 120.	121. 121.	122. 122.	123. 123.	
Table Total-	6511.48		Mean-	120.58	Std. Dev.-	14.84	
			Min -	101.45	Max -	145.10	
	CPI All Groups (inc Rent) PAGE 16, SERIES a						

F 2. Summary Measures

F 2.B: Relative contributions to the variance of the percent change
in the components of the original series

Span in months	E3 I	D12 C	D10 S	A2 P	D18 TD&H	TOTAL	RATIO (X100)
1	2.76	38.33	58.54	0.36	0.00	100.00	86.50
2	1.11	57.12	41.22	0.55	0.00	100.00	97.37
3	0.57	64.71	34.08	0.64	0.00	100.00	101.50
4	0.26	69.11	29.94	0.69	0.00	100.00	106.90
5	0.16	70.81	28.31	0.73	0.00	100.00	116.81
6	0.13	75.84	23.24	0.79	0.00	100.00	115.29
7	0.09	82.53	16.51	0.87	0.00	100.00	114.34
8	0.09	89.24	9.72	0.95	0.00	100.00	108.64
9	0.05	93.73	5.21	1.01	0.00	100.00	105.96
10	0.04	96.51	2.40	1.05	0.00	100.00	103.81
11	0.04	97.87	1.01	1.08	0.00	100.00	103.26
12	0.04	98.85	0.00	1.11	0.00	100.00	100.97

F 2.I:	Statistic	Prob. level
F-test for stable seasonality from Table B 1.	: 19.305	0.00%
F-test for stable seasonality from Table D 8.	: 71.503	0.00%
Kruskal-Wallis Chi Squared test		
for stable seasonality from Table D 8.	: 47.645	0.00%
F-test for moving seasonality from Table D 8.	: 1.397	26.09%

F 3. Monitoring and Quality Assessment Statistics

All the measures below are in the range from 0 to 3 with an
acceptance region from 0 to 1.

- The relative contribution of the irregular over three months span (from Table F 2.B). M1 = 0.058
- The relative contribution of the irregular component to the stationary portion of the variance (from Table F 2.F). M2 = 0.048

- | | |
|--|------------|
| 3. The amount of month to month change in the irregular component as compared to the amount of month to month change in the trend-cycle (from Table F2.H). | M3 = 0.000 |
| 4. The amount of autocorrelation in the irregular as described by the average duration of run (Table F 2.D). | M4 = 0.042 |
| 5. The number of months it takes the change in the trend-cycle to surpass the amount of change in the irregular (from Table F 2.E). | M5 = 0.000 |
| 6. The amount of year to year change in the irregular as compared to the amount of year to year change in the seasonal (from Table F 2.H). | M6 = 0.144 |
| 7. The amount of moving seasonality present relative to the amount of stable seasonality (from Table F 2.I). | M7 = 0.280 |

*** ACCEPTED *** at the level 0.12

*** O (without M2) = 0.13 ACCEPTED.

G.0 10*LOG(SPECTRUM) of the differenced, transformed Outlier Adjusted Data
(Table A11). Spectrum estimated from 1995.Jan to 1999.Jun.

[illegible]

G.1 10*LOG(SPECTRUM) of the differenced, transformed seasonally adjusted data (Table E2). Spectrum estimated from 1995.Jan to 1999.Jun.

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+++++I+++++I
-34.69I      *      I      -34.69
      I      *      I
      I      *      I
      I      *      I
-35.81I      *      I      -35.81
      I      *      I
      I      *      I
      I      *      I
-36.93I      *      *      I      -36.93
      I      *      *      I
      I      *      *      I
      I      *      *      I
-38.05I      *      *      *      I      -38.05
      I      *      *      *      I
      I      *      *      *      I
      I      *      *      *      I
-39.17I      *      *      *      *      I      -39.17
      I      *      *      *      *      I
      I      *      *      *      *      I
      I      *      *      *      *      I
-40.29I      *      *      *      *      *      I      -40.29
      I      *      *      *      *      *      I
      I      *      *      *      *      *      I
      I      *      *      *      *      *      I
-41.41I      *      *      *      *      *      *      I      -41.41
      I      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      I
-42.53I      *      *      *      *      *      *      *      I      -42.53
      I      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      I
-43.65I      *      *      *      *      *      *      *      *      I      -43.65
      I      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      I
-44.77I      *      *      *      *      *      *      *      *      *      I      -44.77
      I      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      I
-45.89I      *      *      *      *      *      *      *      *      *      *      I      -45.89
      I      *      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      I
-47.01I      *      *      *      *      *      *      *      *      *      *      *      I      -47.01
      I      *      *      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      *      I
-48.13I      *      *      *      *      *      *      *      *      *      *      *      *      I      -48.13
      I      *      *      *      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      *      *      I
      I      *      *      *      *      *      *      *      *      *      *      *      I
-49.26I      *      *      *      *      *      *      *      *      *      *      *      *      *      I      -49.26
+++++I+++++I

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S=SEASONAL FREQUENCIES, T=TRADING DAY FREQUENCIES

All Groups - Including RENT

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Seasonality in the Cambodian Consumer Price Index

Preliminary results from a seasonal adjustment of Cambodia's official consumer price index indicate significant seasonality in the series. Although the seasonal factors mirror the country's main food production cycle, the original series has itself been volatile in recent years, and because of the procedures used in its compilation, it is particularly sensitive to exchange rate fluctuations. The inflationary momentum abated substantially in 1999, with inflation towards the end of the year running at a quarterly annualised rate of 6.6 percent, compared to 17.2 percent in the same period the previous year.

This working paper, for the specialist rather than the general reader, uses the latest techniques for a seasonal adjustment of Cambodia's official consumer price index. As might be expected, the index is strongly affected by seasonal factors, and the adjustment procedure explored in this paper is recommended for future use. An interesting incidental finding of the paper is the strong direct impact of exchange rate fluctuations on the consumer price index.

Ung Bunleng is a Senior Analyst in the Economics Department at the Reserve Bank of New Zealand. He prepared this paper based on work undertaken as a Research Fellow at the Cambodia Development Resource Institute from May to June 1999.