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Seasonality in the Cambodian Consumer Price Index

Working Paper 13

Ung Bunleng

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Contents

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 Index[1]

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.

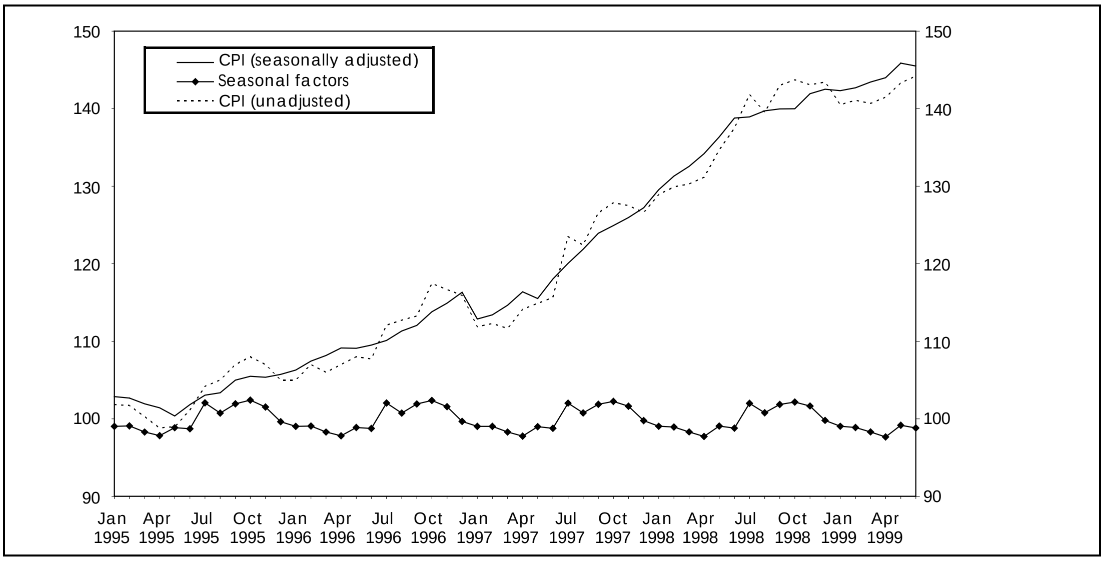
Figure 2 reproduces the seasonal factors of the CPI, the CPI excluding rent (CPIX), and the food, beverage and tobacco (FBT) sub-group for the data up to March 1999. For the last two indices, the seasonals were obtained using default X-11 options with no Arima modelling. Under current compilation procedures, 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

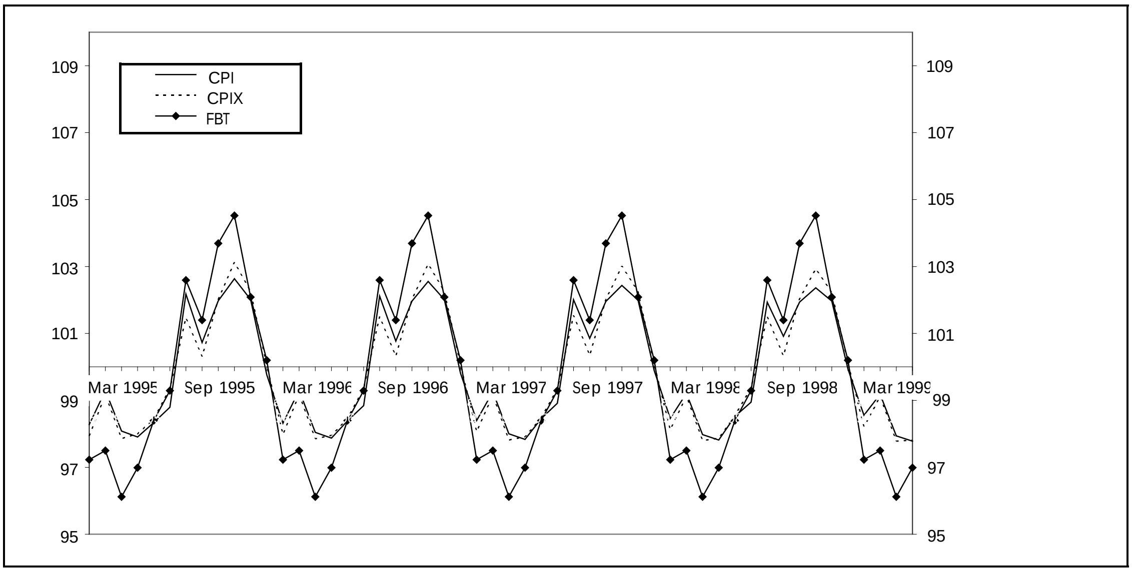
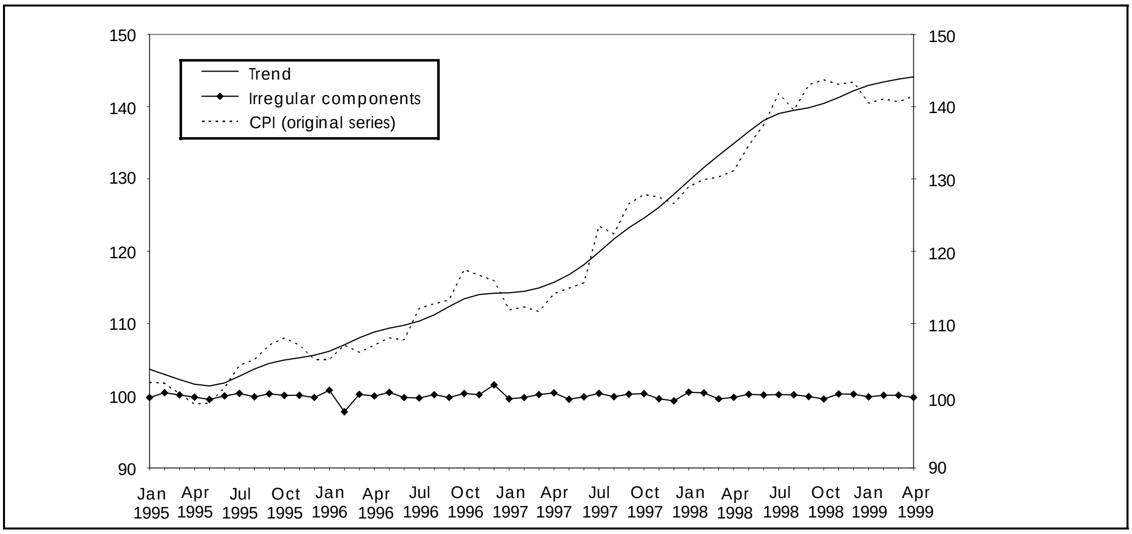


Figure 3 shows the trend and irregular components of the CPI. Irregulars are one-off disturbances to the series and fluctuate around 100. The trend-line is obtained using a centred nine-term moving average.

Figure 3. Trend and Irregular Components



3) Discussion

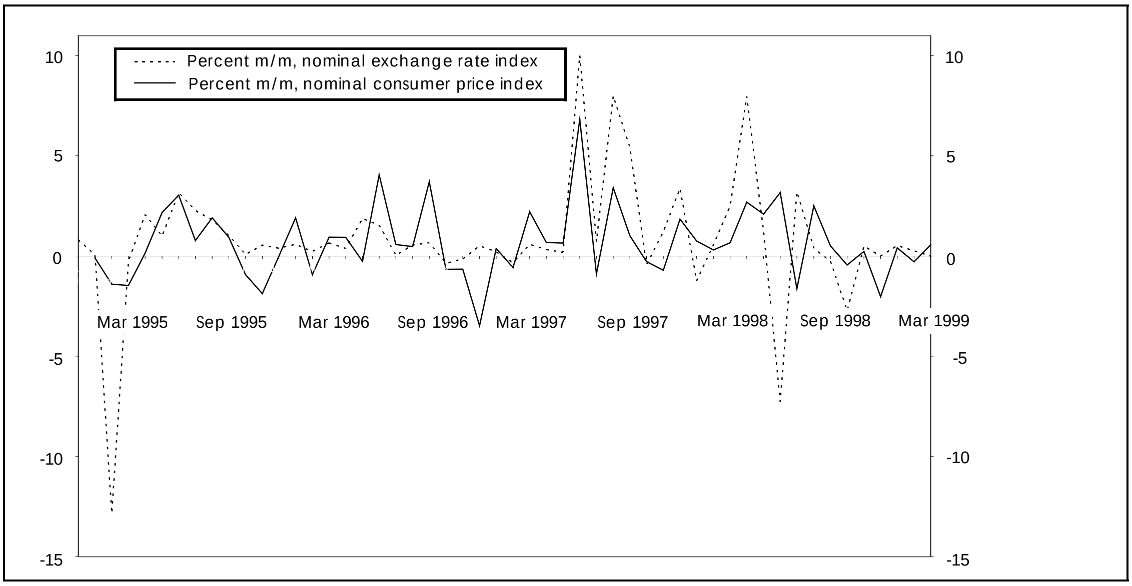
3.1. Seasonal Patterns

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*).A.Y(t-1) + B.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.Y.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.

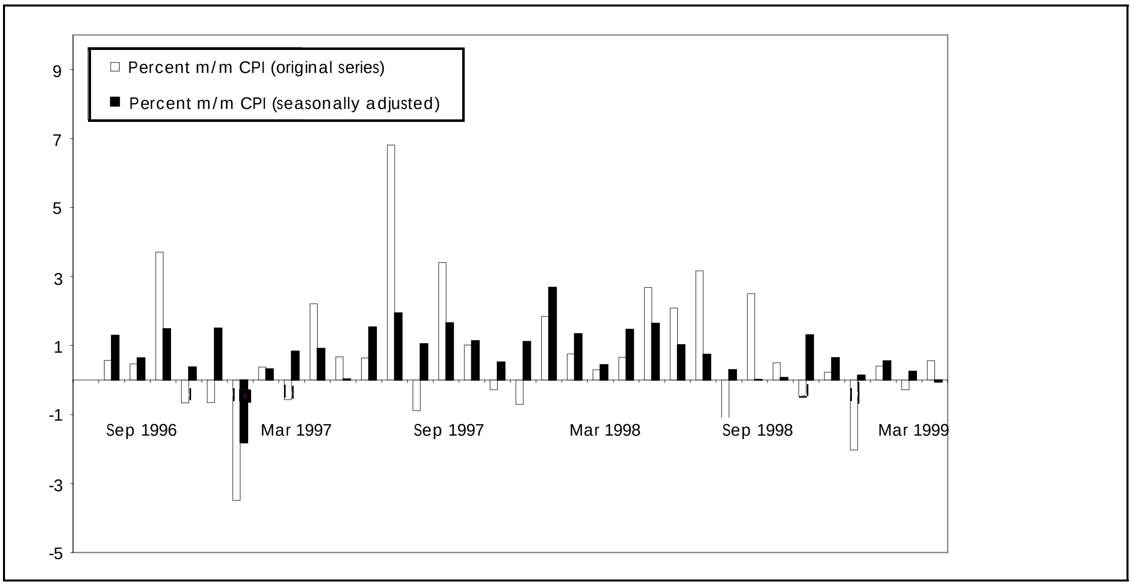
It is evident in Figure 4 that the appreciation or depreciation of the riel feeds into the CPI almost instantaneously, though there are apparent exceptions.

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

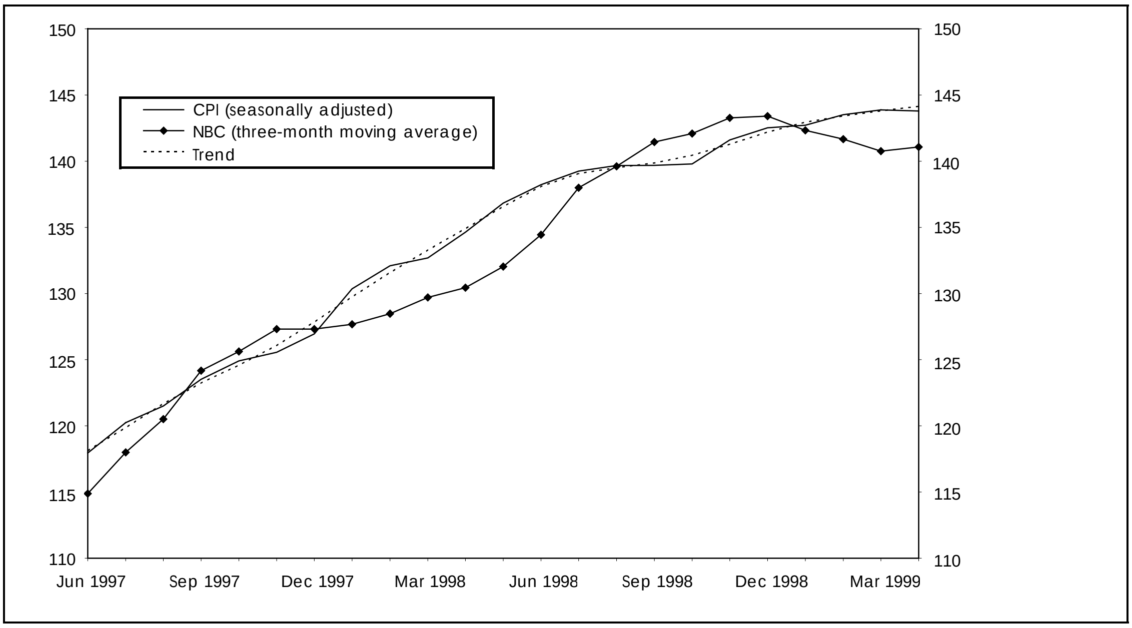
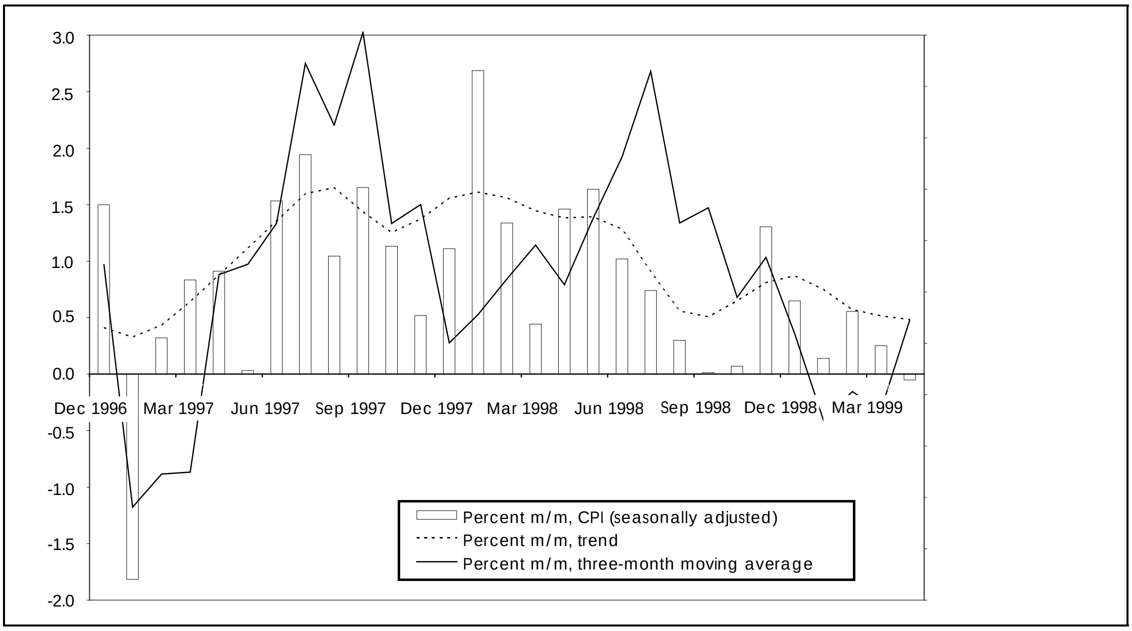
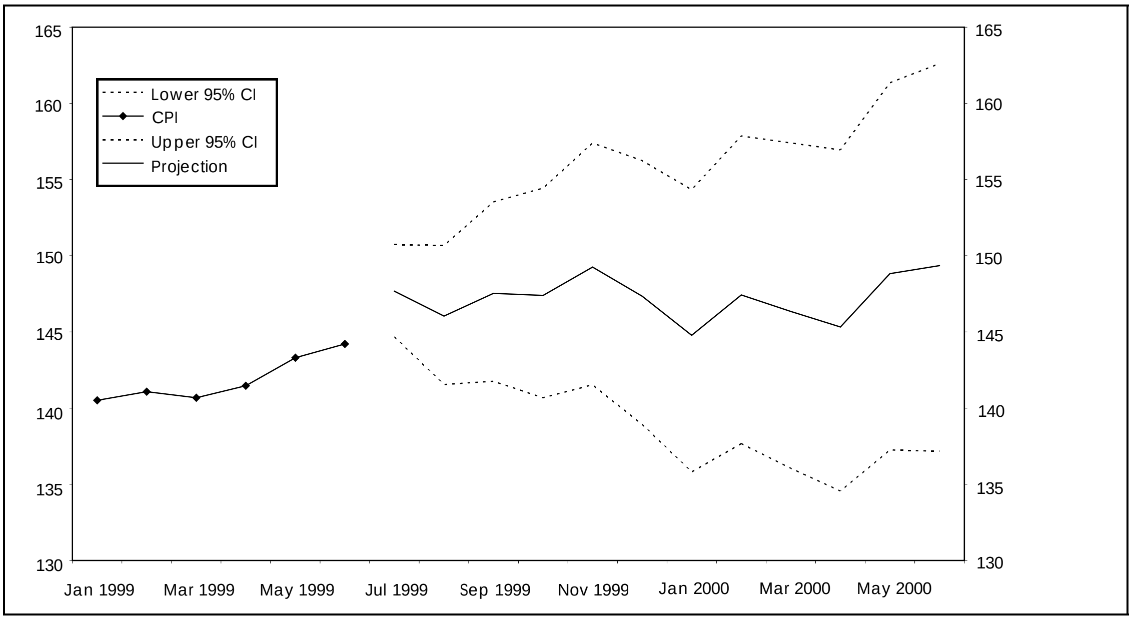


Figure 7. Monthly Changes in CPI



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

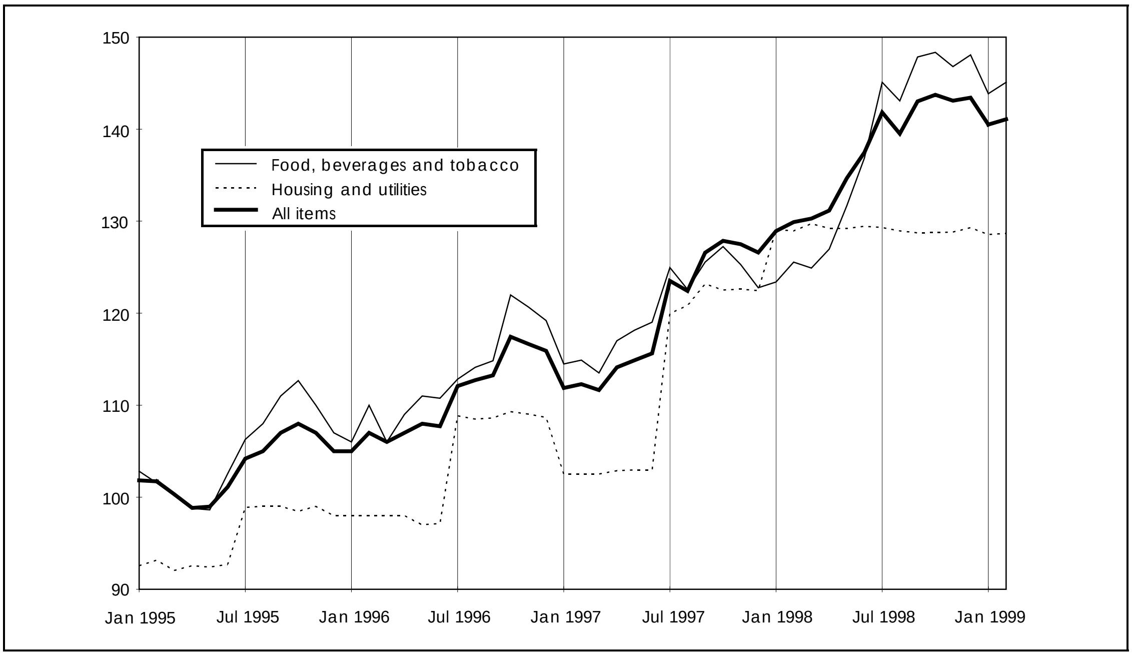
Seasonally Adjusted CPI Series

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
-------------------------------------------------------------------
                            Parameter        Standard
Variable                     Estimate           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
                                             Standard
Parameter                    Estimate          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                        .  XXXXX|       .                  -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	99.1	98.3	97.8	98.8	98.7	
	102.0	100.7	101.9	102.4	101.5	99.6	100.0
1996	99.0	99.1	98.3	97.8	98.9	98.7	
	102.0	100.7	101.9	102.3	101.5	99.7	100.0
1997	99.0	99.0	98.3	97.8	99.0	98.8	
	102.0	100.8	101.9	102.2	101.6	99.7	100.0
1998	99.0	98.9	98.3	97.7	99.1	98.8	
	102.0	100.8	101.8	102.2	101.7	99.8	100.0
1999	99.0	98.9	98.3	97.7	99.1	98.8	
							98.6
AVGE	99.0	99.0	98.3	97.7	99.0	98.8	
	102.0	100.8	101.9	102.3	101.6	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      Feb      Mar      Apr      May      Jun
              Jul      Aug      Sep      Oct      Nov      Dec        TOTAL
-----------------------------------------------------------------------------
 1995         103.     102.     102.     102.     101.     102.
              103.     104.     105.     105.     106.     106.        1240.

 1996         106.     107.     108.     109.     109.     110.
              110.     111.     112.     114.     115.     116.        1328.

 1997         113.     114.     114.     115.     117.     118.
              120.     122.     124.     125.     126.     128.        1435.

 1998         129.     131.     133.     134.     136.     138.
              139.     140.     140.     141.     142.     142.        1645.

 1999         143.     143.     143.     144.     145.     145.
                                                                        863.

 AVGE         119.     119.     120.     121.     122.     123.
              118.     119.     120.     121.     122.     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     E3      D12      D10      A2     D18            RATIO
    months   I        C        S        P     TD&H    TOTAL   (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.

   1. The relative contribution of the irregular over three        M1  = 0.058
      months span (from Table F 2.B).

   2. The relative contribution of the irregular component         M2  = 0.048
      to the stationary portion of the variance (from Table
      F 2.F).
```

```
   3. The amount of month to month change in the irregular       M3  = 0.000
      component as compared to the amount of month to month
      change in the trend-cycle (from Table F2.H).

   4. The amount of autocorrelation in the irregular as          M4  = 0.042
      described by the average duration of run (Table F 2.D).

   5. The number of months it takes the change in the trend-     M5  = 0.000
      cycle to surpass the amount of change in the irregular
      (from Table F 2.E).

   6. The amount of year to year change in the irregular as      M6  = 0.144
      compared to the amount of year to year change in the
      seasonal (from Table F 2.H).

   7. The amount of moving seasonality present relative to       M7  = 0.280
      the amount of stable seasonality (from Table F 2.I).

         *** ACCEPTED *** at the level   0.12

         *** Q (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.
++++++++++I+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++I
    -27.52I          *                                                  I    -27.52
          I          S                                                  I
          I          S                                                  I
          I          S                                                  I
    -28.81I          S                                       *          I    -28.81
          I          S                                       S          I
          I          S                                       S          I
          I          S                               *       S          I
    -30.10I          S                             * T       S          I    -30.10
          I          S                             S T       S          I
          I          S                             S T       S          I
          I          S*                            S T       S          I
    -31.40I          S*                            S T       S          I    -31.40
          I          S*                            S*T*      S          I
          I          S*                            S*T*      S          I
          I          S*                            S*T*      S*         I
    -32.69I          S*                            S*T*      S*         I    -32.69
          I          S*                            S*T*      S*         I
          I          S*                  *         S*T*      S*         I
          I          S*                  S         S*T*      S*         I
    -33.98I          S*                  S        *S*T*      S*         I    -33.98
          I          S*                  S        *S*T*     *S*         I
          I          S*                  S        *S*T*     *S*        *I
          I          S*                  S        *S*T*     *S*        SI
    -35.27I   *      S*                  S        *S*T*     *S*     *  SI    -35.27
          I   *      S*                  S        *S*T*     *S*     *  SI
          I   *     *S*    *             S        *S*T*     *S*     *  SI
          I   *     *S*   **             S        *S*T*     *S*    ** *SI
    -36.56I   *     *S*   **             S        *S*T*     *S*    ** *SI    -36.56
          I   *     *S*   **             S*       *S*T*     *S*    ****SI
          I  **     *S**  **             S*       *S*T*     *S*    ****SI
          I  **     *S**  ***           *S*       *S*T*    **S*    ****SI
    -37.85I  **     *S**  ***           *S*       *S*T*    **S*    ****SI    -37.85
          I  **     *S** ****           *S*       *S*T*    **S*    ****SI
          I  **     *S** *****          *S*       *S*T*    **S*    ****SI
          I  **     *S*********         *S*       *S*T*    **S*    ****SI
    -39.14I  **     *S*********         *S*       *S*T**   **S**   ****SI    -39.14
          I  **     *S**********    **  *S*       *S*T**   **S*T   ****SI
          I  **    **S*********S    ** **S*       *S*T**   **S*T   ****SI
          I  **    **S*********S    ** **S*      **S*T**  ***S*T   ****SI
    -40.44I  **    **S*********S   ******S*      **S*T**  ***S*T  *****SI    -40.44
          I  **    **S*********S*  ******S**     **S*T**  ***S*T  *****SI
          I  ***   **S*********S*  ******S**     **S*T**  ***S*T  *****SI
          I  ***   **S*********S*********S**     **S*T**  ***S*T  *****SI
    -41.73I  ***   **S*********S*********S**     **S*T*******S*T  *****SI    -41.73
          I  ***  ***S*********S*********S**     **S*T*******S*T  *****SI
          I ****  ***S*********S*********S**     **S*T*******S*T* *****SI
          I ****  ***S*********S*********S**     **S*T*******S*T*******SI
    -43.02I ****  ***S*********S*********S***   ***S*T*******S*T*******SI    -43.02
          I *********S*********S*********S***   ***S*T*******S*T*******SI
          I**********S*********S*********S***   ***S*T*******S*T*******SI
          I**********S*********S*********S****  ***S*T*******S*T*******SI
    -44.31I**********S*********S*********S*********S*T*******S*T*******SI    -44.31
++++++++++I+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++I
           S=SEASONAL FREQUENCIES, T=TRADING DAY FREQUENCIES
```

```
G.1  10*LOG(SPECTRUM) of the differenced, transformed seasonally adjusted
     data (Table E2).  Spectrum estimated from 1995.Jan to 1999.Jun.
++++++++++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  ** **    *   ****     **  *     **     *T           *   ** I    -40.29
          I  ** **    *   ****     ** **     **     *T           *   ** I
          I  *****    *   ****     ** **     **     *T           *   ** I
          I  *****    *   ****     ** **     **     *T           *   ***I
    -41.41I  *****    *   ****     ** **    ***     *T           *   **SI    -41.41
          I  *****    *  *****     ** **    ****    *T           *   **SI
          I  *****    *  *****     *****    ****    *T           *   **SI
          I ******   **  *****     ******   ****    *T           *  ***SI
    -42.53I ******   S** *****     ******   ****    *T           ** ***SI    -42.53
          I ******   S** *****     ******   ****    *T          *** ***SI
          I ******   S** *****    *******   ****    *T          *** ***SI
          I ******   S** *****    *******  *****    *T          *** ***SI
    -43.65I ******   S** *****    *******  *****    *T          *** ***SI    -43.65
          I ******   S** *****    *******  *****    *T       *  *******SI
          I*******   S********    ******** *****    *T   *   S  *******SI
          I*******   S********    *******S******    *T   *   S* *******SI
    -44.77I*******   S*********   *******S******    *T   *  *S*********SI    -44.77
          I*******   S*********   *******S******   **T   *  *S*T*******SI
          I*******   S*********   *******S******   S*T   ** *S*T*******SI
          I*******   S*********   *******S******   S*T   ** *S*T*******SI
    -45.89I*******   S*********   *******S******   S*T* *****S*T*******SI    -45.89
          I*******   S*********   *******S*******  S*T* *****S*T*******SI
          I********  S*********   *******S*******  S*T* *****S*T*******SI
          I********  S*********   *******S*******  S*T* *****S*T*******SI
    -47.01I********  S*********   *******S*******  S*T* *****S*T*******SI    -47.01
          I********  S*********   *******S*******  S*T*******S*T*******SI
          I******** *S*********   *******S*******  S*T*******S*T*******SI
          I******** *S*********  ********S*******  S*T*******S*T*******SI
    -48.13I******** *S*********  ********S*********S*T*******S*T*******SI    -48.13
          I******** *S********** ********S*********S*T*******S*T*******SI
          I**********S*********S ********S*********S*T*******S*T*******SI
          I**********S*********S ********S*********S*T*******S*T*******SI
    -49.26I**********S*********S*********S*********S*T*******S*T*******SI    -49.26
++++++++++I+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++I
           S=SEASONAL FREQUENCIES, T=TRADING DAY FREQUENCIES
       All Groups - Including RENT            PAGE  25, SERIES a1
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3) Kannan, K. P. (January 1997), *Economic Reform, Structural Adjustment and Development in Cambodia* (Working Paper No. 3) (out of print)
4) Chim Charya, Srun Pithou, So Sovannarith, John McAndrew, Nguon Sokunthea, Pon Dorina & Robin Biddulph (June 1998), *Learning from Rural Development Programmes in Cambodia* (Working Paper No. 4) $7.50
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12) Chan Sophal, Toshiyasu Kato, Long Vou Piseth, So Sovannarith, Tia Savora, Hang Chuon Naron, Kao Kim Hourn & Chea Vuthna (September 1999), *Impact of the Asian Financial Crisis on the SEATEs: The Cambodian Perspective* (Working Paper No. 12) $4.50

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.

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