EXAMINATIONS OF THE HONG KONG STATISTICAL SOCIETY

HIGHER CERTIFICATE IN STATISTICS, 2010

MODULE 7 : Time series and index numbers

Time allowed: One and a half hours

Candidates should answer **THREE** *questions.*

Each question carries 20 marks.
The number of marks allotted for each part-question is shown in brackets.

Graph paper and Official tables are provided.

Candidates may use calculators in accordance with the regulations published in the Society's "Guide to Examinations" (document Ex1).

The notation log *denotes logarithm to base* ***e****.*
Logarithms to any other base are explicitly identified, e.g. $\log_{10}$.

Note also that $\binom{n}{r}$ *is the same as* ${}^{n}C_{r}$.

This examination paper consists of 5 printed pages **each printed on one side only**.
This front cover is page 1.
Question 1 starts on page 2.

There are 4 questions altogether in the paper.

1. (i) A time series Y can be decomposed, either additively or multiplicatively, into three main components, C (trend), S (seasonal) and I (irregular). For each type of decomposition, write the equation for Y in terms of these components, and state in each case what transformation, if any, should be applied to the data before seasonal adjustment. Explain briefly, with the aid of examples, how you would decide which type of decomposition to use. Give the equation for the seasonally adjusted estimate and explain briefly how it is achieved.

(8)

(ii) The timing of Easter varies between late March and late April. Explain how this variation can cause problems in interpreting movements in seasonally adjusted time series, how the Easter effect can be tested for and, if found, how it can be estimated and removed. Name one other calendar related effect affecting seasonal adjustment.

(5)

(iii) The following table represents automatic output from the regression analysis part of a seasonal adjustment of a monthly series measuring total overseas visits to the UK. Explain this output. What actions would you take when seasonally adjusting this series? What is the fundamental difference between adjusting for Easter and for outliers?

(7)

Regression Model

Variable	Parameter Estimate	Standard Error	t-value
AO-2004.Oct	-0.1519	0.07257	-2.09
AO-2005.August	-0.1963	0.07274	-2.70
Easter	0.0740	0.123	0.60

Note: AO stands for additive outlier.
Critical value at 5% significance level is 1.96.

2. (i) Explain how moving averages can be used to extract the seasonal and trend components from a time series.

(5)

(ii) The table below shows the production *y* of a certain commodity in each quarter for the years 2005 to 2007 (Q1 denotes quarter 1). Add an extra row giving the 5-point simple symmetric moving average of *y*. What are the implications of using a *symmetric* moving average and how can they be dealt with, in particular at the end of the series (where data users have most interest)?

(9)

Production of commodity, *y*

Period	2005 Q1	2005 Q2	2005 Q3	2005 Q4	2006 Q1	2006 Q2	2006 Q3	2006 Q4	2007 Q1	2007 Q2	2007 Q3	2007 Q4
Production	50.0	36.5	43.0	44.5	38.9	38.1	32.6	38.7	41.7	41.1	40.5	33.8

(iii) Discuss why symmetric moving averages with unequal weights may be preferred to simple (equally-weighted) moving averages when estimating trend.

(4)

(iv) What are the advantages and disadvantages of increasing the length of a moving average?

(2)

3. (i) Suppose that we have a Laspeyres price index for each of the first 3 months of 2010, in each case with January 2010 as the base period. Derive, in terms of prices and quantities in the appropriate periods, a formula for the growth of the index from February to March (i.e. the ratio of the March index to the February index).

(4)

(ii) The formula derived in part (i) is a Lowe price index, denoted P_{Lo}(February, March; January) where February is the base period, March is the current period and January is the quantity period. Show that this Lowe price index is a weighted arithmetic mean of price relatives whose base period is February. Identify and describe the weights.

(5)

(iii) Derive, in terms of prices and quantities in the appropriate periods, a formula for the growth of the Paasche price index from February to March, using January as the base period.

(2)

(iv) Show that the formula derived in part (iii) is the growth in value divided by a volume index. What is the name of the volume index?

(4)

(v) Derive, in terms of value growth and other indices, a formula for the growth of the Fisher price index from February to March, using January as the base period.

(5)

4. In an application of index numbers to human fertility, in any particular year the birth rate (number of live births per woman) is analogous to prices for economic index numbers, the number of women is analogous to quantity and the number of live births is analogous to value.

(i) State the formulae for Laspeyres and Paasche birth rate indices where period 0 is the base period and period t is the current period, simplifying where appropriate.

(4)

Age group	*Number of women in 2008*	*Number of live births in 2008*	*Number of women in 2009*	*Number of live births in 2009*
15–17	3095	30	2985	28
18–21	4056	439	4027	401
22–29	7483	984	7514	975
30–39	10247	426	10473	453
40–49	9835	37	9626	52

(ii) Using data from the table above relating to a small province, calculate the Laspeyres, Paasche and Fisher birth rate indices for this province in 2009, using 2008 as the base period.

(12)

(iii) What would an index for number of women quantify? Calculate the Laspeyres index for number of women.

(4)