INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

April 2016 (with mark allocations)

Subject CT5 – Contingencies
Core Technical

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton
Chair of the Board of Examiners
June 2016

A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Contingencies subject is to provide a grounding in the mathematical techniques which can be used to model and value cashflows dependent on death, survival, or other uncertain risks.

2. CT5 introduces the fundamental building blocks that stand behind all life insurance and pensions actuarial work.

3. Credit is given to students who produce alternative viable numerical solutions. In the case of descriptive answers credit is also given where appropriate valid points are made which do not appear in the solutions below.

4. In questions where definitions of symbols and then formulae are requested, a different notation system produced by a student to that used by the Examiners is acceptable provided it is used consistently, is relevant and is properly defined and used in the answer.

5. Students should note that for long questions reasonable credit is given if they can describe the right procedures although to score high marks reasonably accurate numerical calculation is necessary.

B. General comments on *student performance in this diet of the examination*

1. The general performance was slightly lower than usual this session compared to previous ones although it was felt that this paper was roughly of the same standard..

2. Many well prepared students gained very high marks but there were some concerns that some students had just not prepared for the examination satisfactorily and scored very minimal marks overall

3. Questions that were done less well were 4, 9, 11 and 12 part (ii). The Examiners hope that the detailed solutions given below will assist students with further revision.

4. However most of the short questions 1–8 and 10 were very straightforward where an answer could be produced quickly and this is where many successful candidates scored particularly well.

C. Pass Mark

The Pass Mark for this exam was 60%.

Solutions

Q1 $${}_{0.5}p_{90.25} = 1 - \frac{0.5q_{90}}{1 - 0.25q_{90}}$$

$$= 1 - \frac{0.5 \times 0.20465}{1 - (0.25 \times 0.20465)}$$

$$= 0.892158$$

[2 for formula, 1 for result]
[TOTAL 3]

A very straightforward question which was generally done very well.

Q2 (i) The net premium retrospective reserve will be equal to the net premium prospective reserve if:

The retrospective and prospective reserves are calculated on the same basis [1]
and,
This basis is the same as the basis used to calculate the premiums used in the reserve calculation. [1]

(ii) In practice these conditions rarely hold since:

The assumptions which are appropriate for the retrospective calculation (based on the experienced conditions over the duration of the contract up to the valuation date) are not generally appropriate for the prospective calculation (based on assumptions considered suitable for the remainder of the term) [1]
and,
The assumptions considered appropriate at the time the premium was calculated may not be appropriate for the retrospective or prospective reserves some years later [1]
[TOTAL 4]

A bookwork question answered well by students who had prepared satisfactorily for the examination.

Q3 (a) $${}_{25}p_{30} = \frac{l_{55}}{l_{30}} = \frac{9557.8179}{9925.2094} = 0.962984$$ [½]

(b) $$\ddot{a}^{(4)}_{[40]:\overline{15}|} = \ddot{a}^{(4)}_{[40]} - v^{15} \times \frac{l_{55}}{l_{[40]}} \times \ddot{a}^{(4)}_{55} = \ddot{a}_{[40]} - 0.375 - v^{15} \times \frac{l_{55}}{l_{[40]}} \times (\ddot{a}_{55} - 0.375)$$

$$= 19.634 - 0.55526 \times \frac{9557.8179}{9854.3036} \times 15.498 = 11.287$$ [2]

(c) $$A^{1}_{50:\overline{20}|} = A_{50} - v^{20} \times \frac{l_{70}}{l_{50}} \times A_{70}$$

$$= 0.32907 - 0.45639 \times \frac{8054.0544}{9712.0728} \times 0.60097 = 0.10162$$ [1½]

[TOTAL 4]

> Generally well done. The main issue was with part (ii) where often students did not perform the quarterly adjustment properly.

Q4 For those currently paying contributions the decrements of interest are death, withdrawal and retirement. For those receiving benefit or entitled to a deferred benefit the only decrement of interest is death.

The mortality of those who retired early (but in good health) or at normal retirement age is likely to be lower than that of ill-health retirement pensioners. This is an example of class selection. [1]

The mortality of ill-health retirement pensioners is likely to depend on duration since retirement for a few years following the date of retirement, and subsequently only on age attained. This is an example of temporary initial selection. [1]

Underwriting at the date of joining a scheme tends to be very limited, e.g. actively at work, and so there tends to be only very slight temporary initial selection. [1]

Different sections of a large scheme, e.g. works and staff, may exhibit different levels of mortality. This is an example of class selection. [1]

Among the active members of the scheme ill-health retirement acts as a selective decrement, resulting in lighter mortality among the remaining active members. This is sometimes termed the "healthy worker" or the "active lives mortality" effect. [1]

Withdrawal from a scheme is associated with voluntary or compulsory termination of employment (changing jobs or redundancy). If voluntary resignation is the cause this tends to select those with lighter mortality (and ill-health retirement) rates. If redundancy is the cause withdrawal rates tend to vary markedly over time as economic conditions vary. This is an example of time selection. [1]

Marks were awarded for additional examples, e.g. class selection between males and females, or time selection of the mortality rates.

[MAX 6]

> All other reasonable comments were credited. In general this question was poorly answered. Many students described the selection processes in the abstract without properly relating them to a pension scheme environment. To score well there needed to be a strong linkage demonstrated between the various types of selection and the operation of such schemes.

Q5 (i)

Age	*Population*	*Number of deaths*	*Standard q_x*	*Expected deaths*
60	9,950	52	0.01392	138.50
61	8,020	68	0.01560	125.11
62	6,997	73	0.01749	122.38
Total	24,967	193		385.99

[2 for whole table]

$$\text{The SMR} = \frac{\sum_x E^c_{x,t}\, m_{x,t}}{\sum_x E^c_{x,t}\ {}^s m_{x,t}} = \frac{\text{Actual deaths in population}}{\text{Expected deaths in population}}$$

$= 193/385.99 = 0.500$ [2]

[Total 4]

(ii) An SMR less than 1 indicates a population with mortality lighter than that in the standard population, allowing for the distribution by age and sex in the observed population. [1]

A value of 0.5 indicates that population has half the number of expected deaths. [1]

[Total 2]

[TOTAL 6]

> Part (i) was very straightforward and generally done well.
>
> Often however students gave only one of the statements in part (ii), usually the former.

Q6 (i)

$$\bar{A}_{x:\overline{n}|} = \int_0^n \mu e^{-(\mu+\partial)t}dt + e^{-(\mu+\partial)n} = \mu\bar{a}_{x:\overline{n}|} + e^{-(\mu+\partial)n}$$

But $\bar{a}_{x:\overline{n}|} = \int_0^n e^{-(\mu+\partial)t}dt = \dfrac{1-e^{-(\mu+\partial)n}}{\mu+\partial}$ so $e^{-(\mu+\partial)n} = 1-(\mu+\partial)\bar{a}_{x:\overline{n}|}$

Thus $\bar{A}_{x:\overline{n}|} = \mu\bar{a}_{x:\overline{n}|} + 1-(\mu+\partial)\bar{a}_{x:\overline{n}|} = 1-\partial\bar{a}_{x:\overline{n}|}$ as required

[1 mark for each line]
[Max 3]

(ii) In this case we need to calculate $10000\bar{P}_{40:\overline{20}|}$.

From the formula given in (i) by dividing throughout by $\bar{a}_{x:\overline{n}|}$ we can deduce for age and term that:

$$\bar{P}_{40:\overline{20}|} = \frac{1}{\bar{a}_{40:\overline{20}|}} - \partial$$

In this case $\mu = .01$ and $\partial = \ln(1.05) = .048790$.

Thus $10000\bar{P}_{40:\overline{20}|} = 10000\times\left[\dfrac{.01+.048790}{1-e^{-20(.01+.048790)}} - .048790\right]$

$$= 10000\times\left[\frac{.058790}{.691428} - .048790\right]$$

$$= £362.4$$

[1 for line 3, ½ for line 4, 2 for line 5 and ½ for result]
[Max 4]
[TOTAL 7]

Part (i) overall was poorly done. The most common error was to omit the $e^{-(\mu+\partial)n}$ term which of course leaves a term assurance function and not an endowment.

Although the question asked for a proof using a constant force of mortality some students offered a generalised proof involving random variables. If done correctly this method was credited.

Part (ii) was better answered.

Q7 (i) As this unit linked policy produces negative cash flows after the initial funding, these can be zeroised by establishing reserves from earlier cash flows. [1]

(ii) It is prudent that once sold and funded at outset, a policy should be self-supporting financially. This implies that the profit signature has a single negative value (funds are provided by the insurance company) at policy duration zero. [1]

(iii) To calculate the expected reserves at the end of each year we have (utilising the end of year cash flow figures):

$$p_{63} = 0.988656 \quad p_{62} = 0.989888 \quad p_{61} = 0.990991 \quad p_{60} = 0.991978$$
$$\Rightarrow {}_4p_{60} = 0.962062$$

$${}_3V = \frac{192.05}{1.035} = 185.556$$
$${}_2V \times 1.035 - p_{62} \times {}_3V = 267.57 \Rightarrow {}_2V = 435.990$$
$${}_1V \times 1.035 - p_{61} \times {}_2V = 321.06 \Rightarrow {}_1V = 727.654$$

[3]

The revised cash flow for year 1 will become:

$$751.25 - p_{60} \times 727.654 = 29.433$$

[1]

Revised profit vector becomes (29.43, 0, 0, 0, 201.75) and

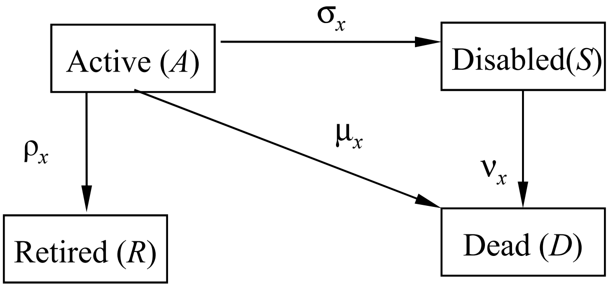
Net present value of profits = $\dfrac{29.433}{1.06} + {}_4p_{60} \times \dfrac{201.75}{1.06^5} = 27.77 + 145.04 = 172.81$

[1]

[TOTAL 7]

This straightforward bookwork and application question was generally well done.

Q8 (i)



[Max 4]

(ii) The expected present value is given by the following expression:

$$20,000\times 0.5\times \int_0^{65-x} \frac{s_{x+t}}{s_x} e^{-\delta t}\, {}_t p_x^{AA}\, \sigma_{x+t}\, a_{x+t}^{*}\, dt \qquad [1]$$

with s_{x+t} being proportionate to the current annual rate of salary at exact age $x+t$,

$${}_t p_x^{AA} = \exp\left[-\int_{r=0}^{t} \left(\rho_{x+r} + \mu_{x+r} + \sigma_{x+r}\right) dr\right]$$

Where the integral is limited to the normal retirement age of 65. [½]

${}_t p_x^{AS} = e^{-\int_0^t {}_s p_x^{AA} \sigma_{x+s} ds}$ is the probability that an Active life age x is Disabled at age $x + t$ [1]

${}_t p_x^{AA}$ is the probability that an Active life age x is still Active at age $x + t$ [½]

a_{x+t}^{*} is the expected present value at age $x + t$ of an annuity to a disabled life [½]

$\frac{s_{x+t}}{s_x}$ denotes the increase in salary for the period from age x to age $x + t$ [½]

Alternatively

$$\frac{20{,}000\times 0.5}{s_{x-½}\, l_x}\times\left[s_x\, v^{½}\,\bar{a}^{i}_{x+½}\, i_x + s_{x+1}\, v^{1½}\,\bar{a}^{i}_{x+1½}\, i_{x+1} + \cdots + s_{64}\, v^{64½-x}\,\bar{a}^{i}_{64½}\, i_{64}\right]$$

is acceptable in pension summation form

[Max 3]
[TOTAL 7]

> Most students offered satisfactory diagrams and had some idea about the correct formulae. Most marks were lost for not specifying the bases.

Q9 Firstly calculate μ^d for each age from q_x as it is the constant force required.

For age 63-64 $u^d = -\ln p_{63} = -\ln(1-q_{63}) = 0.01985$
For age 64-65 $u^d = -\ln p_{64} = -\ln(1-q_{64}) = 0.02224$

$$(aq)^s_x = \frac{\sigma}{\mu+\sigma}\left(1-e^{-(\mu+\sigma)}\right)$$

$$(aq)^d_x = \frac{\mu}{\mu+\sigma}\left(1-e^{-(\mu+\sigma)}\right)$$

[2]

Age	*t*	μ	σ	$(aq)^d_x$	$(aq)^s_x$	${}_{t-1}(ap)_x$
63	1	0.01985	0.03	0.019363	0.029265	1
64	2	0.02224	0.03	0.021669	0.029230	0.951372

[2 for multiple decrements, ½ for $(ap)_x$]

Assume benefits payable uniformly through year of age so discount factors = $v^{t+½}$ [1]

Age	${}_{t-1}(ap)_x$	*Salary*	*Benefit*	*Discount factors*	*Present value*
63	1	50,000	250,000	0.975900	7,140
64	0.951372	51,500	257,500	0.929429	6,655
					13,795

[2 for complete table, ½ for result]
[TOTAL 8]

> This rather challenging question was poorly done overall. Most students did not realise that an equivalent constant force of mortality needed to be first calculated and used the varying force instead .

> Some students used the old formula approach $(aq)^d = q^d \times (1 - \frac{1}{2}q^s)$ etc. which is no longer used in this course. The Examiners decided to allow this approach.

Q10 Value of lump sum death benefit

$$50000\bar{A}^{1}_{55:\overline{10}|} = 50000 \times (1.04)^{0.5} \times A^{1}_{55:\overline{10}|}$$

$$A^{1}_{55:\overline{10}|} = A_{55} - v^{10} \times \frac{l_{65}}{l_{55}} \times A_{65}$$

As

$$A_x = 1 - d\ddot{a}_x$$

then

$$A_{65} = 1 - \frac{.04}{1.04} \times 13.666 = 0.474385$$

Hence value of death benefits $= 50000 \times (1.04)^{0.5} \times \left(0.332154 - v^{10} \times \frac{9647.797}{9904.805} \times 0.474385\right)$

$= 1019.4$ [3]

Value of survival benefit

Let P be the annual premium, then value is:

$$0.25 \times 5 \times P \times v^{10} \times {}_{10}p_{55}$$

$$= 1.25 \times P \times v^{10} \times \frac{9647.797}{9904.805}$$

$$= .82254P$$ [1½]

Value of reversionary annuity

$$5000\ddot{a}^{(12)}_{50|55} = 5000(\ddot{a}^{f}_{50} - \ddot{a}^{f\ m}_{50:55})$$

$$= 5000\times(19.539-16.602)$$

$$= 14685 \qquad [2]$$

Value of premiums

$$P\ddot{a}_{55:\overline{5}|} = P\left(\ddot{a}_{55} - v^5\times {}_5p_{55}\times\ddot{a}_{60}\right)$$

$$= P\left(17.364 - v^5\times\frac{9826.131}{9904.805}\times 15.632\right)$$

$$= 4.61769P \qquad [2]$$

Equation of value is

$$4.61769P = 1019.4 + 0.82254P + 14685$$

$$\Rightarrow P = 4138 \qquad [½ \text{ for result}]$$

[TOTAL 9]

This fairly standard style premium valuation question was well done by fully prepared students.

Q11 Reserves at the end of the 3rd policy year:

- Where both lives are alive:

$$75000\times 1.04^{0.5}\times\left(1-\frac{\ddot{a}_{\overline{68^m:63^f}}}{\ddot{a}_{\overline{65^m:60^f}}}\right)$$

$$= 75000\times 1.04^{0.5}\times\left(1-\frac{12.412+15.606-11.372}{13.666+16.652-12.682}\right) = 4293.52 \qquad [1½]$$

- Where the male life is alive only:

$$75000\bar{A}_{68^m} - P\ddot{a}_{68^m}$$

$$75000\times 1.04^{0.5}\times\left(1-\frac{0.04}{1.04}\times 12.412\right) - 1395.11\times 12.412 = 22656.29 \qquad [1]$$

- Where the female life is alive only:

$$75000\bar{A}_{63^f} - P\ddot{a}_{63^f}$$

$$75000\times1.04^{0.5}\times\left(1-\frac{0.04}{1.04}\times15.606\right)-1395.11\times15.606=8804.38$$ [1]

Mortality Profit = Expected Death Strain – Actual Death Strain

(a) Both lives die during 2014 = 2 actual claims.

Mortality Profit

$$=\left(5997\times q_{67^m}\times q_{62^f}-2\right)\times\left(75000\times1.04^{0.5}-4293.52\right)$$
$$=(5997\times0.008439\times0.002885-2)\times(72191.77)=-133843.10$$ [2]

(b) Males only die during 2014 = 12 actual deaths (and therefore we need to change reserve from joint life to female only surviving).

Mortality Profit

$$=\left(5997\times p_{62^f}\times q_{67^m}-12\right)\times(8804.38-4293.52)$$
$$=(5997\times0.997115\times0.008439-12)\times(4510.86)=173499.75$$ [2]

(c) Females only die during 2014 = 8 actual deaths (and therefore we need to change reserve from joint life to male only surviving).

Mortality Profit

$$=\left(5997\times p_{67^m}\times q_{62^f}-8\right)\times(22656.29-4293.52)$$
$$=(5997\times0.991561\times0.002885-8)\times(18362.77)=168117.38$$ [2]

Hence overall total mortality profit

$$=-133843.10+173499.75+168117.38=£207774.03$$ [½]

[TOTAL 10]

This question proved to be the most challenging on the paper and was generally not answered well.

The most common error was to use only the situation where both lives were alive thus ignoring the other two states.

Also many students failed to calculate the reserves correctly.

Credit was given for the correct method where calculations were inaccurate.

Q12 (i) Let P be the monthly premium for the contract. Then:

EPV of premiums (valued at 6%) is:

$$12P\ddot{a}^{(12)}_{[45]:\overline{40|}} = 170.928P$$

where

$$\ddot{a}^{(12)}_{[45]:\overline{40|}} = \ddot{a}^{(12)}_{[45]} - v^{40}\,{}_{40}p_{[45]}\ddot{a}^{(12)}_{85} = \left(\ddot{a}_{[45]} - \frac{11}{24}\right) - v^{40}\,{}_{40}p_{[45]}\left(\ddot{a}_{85} - \frac{11}{24}\right)$$

$$= \left[(14.855 - 0.458) - 0.09722 \times \frac{3385.2479}{9798.0837} \times (4.998 - 0.458)\right] = [14.397 - 0.153] = 14.244$$

[2]

EPV of death benefits:

$$150{,}000\bar{A}_{[45]} @ i' = 42{,}597.65$$

where

$$\bar{A}_{[45]} = (1.06)^{0.5} \times A^{@i'\%}_{[45]} = 1.029563 \times 0.27583$$ [2]

EPV of expenses:

$$0.65 \times 12P + 0.05 \times 12P\ddot{a}^{6\%}_{[45]:\overline{40|}} = 7.8P + 0.6P \times 14.687 = 16.6122P$$

where:

$$\ddot{a}_{[45]:\overline{40|}} = \ddot{a}_{[45]} - v^{40}\,{}_{40}p_{[45]}\ddot{a}_{85}$$

$$= \left[14.855 - 0.09722 \times \frac{3385.2479}{9798.0837} \times 4.998\right] = 14.687$$ [2]

Equation of value gives:

$$170.928P = 42{,}597.65 + 16.6122P$$

$\Rightarrow P = £276.04$ [1]

[Total 7]

(ii) Sum assured and attaching bonuses at 1 March 2015
$= 150{,}000(1.02)^{18} = 214{,}236.94$ [½]

Gross prospective policy reserve immediately before alteration is given by (valued at 6%):

$$214{,}236.94\bar{A}_{63} - 276.04 \times 12\ddot{a}^{(12)}_{63:\overline{22}|} = 48{,}078.29$$

where

$$\bar{A}_{63} = (1.06)^{0.5} \times A_{63} = 1.029563 \times 0.37091 = 0.38188$$

$$\ddot{a}^{(12)}_{63:\overline{22}|} = \ddot{a}^{(12)}_{63} - v^{22}\,{}_{22}p_{63}\ddot{a}^{(12)}_{85} = \left(\ddot{a}_{63} - \frac{11}{24}\right) - v^{22}\,{}_{22}p_{63}\left(\ddot{a}_{85} - \frac{11}{24}\right)$$

$$= \left[(11.114 - 0.458) - 0.27751 \times \frac{3385.2479}{9037.3973} \times 4.998 - 0.458\right]$$

$$= [10.656 - 0.4719]$$

$$= 10.1841$$ [3]

Let S be the revised sum assured after alteration. Value of gross prospective policy reserve immediately after alteration (valued at 6%) is given by:

$$S\bar{A}_{63} = S \times 0.38188$$ [1]

Allowing for cost of alteration, and equating reserves before and after alteration, we have:

$$0.38188S + 175 = 48{,}078.29$$

$$\Rightarrow S = 125{,}440.69$$

i.e. the sum assured is reduced to £125,441 [1½]

[Total 6]

[TOTAL 13]

Part (i) was generally done well.

Part (ii) caused greater problems. In many cases students did not understand the process of equating before and after reserves so were not able to develop a satisfactory solution.

Q13 (i) If P is the annual office premium, the gross future loss random variable ($GFLRV$)

$$= v^{K_{[56]}+1}(140{,}000 + 20{,}000 \times K_{[56]}) + 275 + 55a_{\overline{K_{[56]}}|} - P\left(.975\ddot{a}_{\overline{K_{[56]}+1}|} - 0.275\right)$$

$$for\ K_{[56]} < 4$$

$$or$$

$$= 275 + 55a_{\overline{3}|} + 0.5 \times 4Pv^4 - P\left(.975\ddot{a}_{\overline{4}|} - 0.275\right)$$

$$for\ K_{[56]} \geq 4$$

[Total 3]

(ii) If $E(GFLRV) = 0$ then we have:

$$P(0.975\ddot{a}_{[56]:\overline{4}|} - 0.275) = 120{,}000A^{1}_{[56]:\overline{4}|} + 20{,}000(IA)^{1}_{[56]:\overline{4}|} + 0.5 \times 4Pv^4\,{}_4p_{[56]} + 275 + 55[\ddot{a}_{[56]:\overline{4}|} - 1]$$

$$\Rightarrow P(0.975 \times 3.648 - 0.275) = 120{,}000 \times 0.01927 + 20{,}000 \times 0.051424 + 2P \times 0.774228 + 275 + 55 \times 2.648$$

$$\Rightarrow P = \frac{3761.52}{1.733344} = 2170.09$$ [3]

where

$$A^{1}_{[56]:\overline{4}|} = A_{[56]:\overline{4}|} - v^4\,{}_4p_{[56]} = 0.79350 - 0.79209 \times \frac{9287.2164}{9501.4839}$$

$$= 0.01927$$

and

$$(IA)^{1}_{[56]:\overline{4}|} = (IA)_{[56]} - v^4\,{}_4p_{[56]}[4A_{60} + (IA)_{60}]$$

$$= 5.29558 - 0.774228[4 \times 0.32692 + 5.46572]$$

$$= 0.051424$$ [1]

[Total 4]

(iii) Decrement table

x	t	q_x^d	$p_{[x]+t-1}$	$_{t-1}p_{[x]}$
56	1	0.003742	0.996258	1.0000000
57	2	0.005507	0.994493	0.9962580
58	3	0.006352	0.993648	0.9907716
59	4	0.007140	0.992860	0.9844782

[½]

Cash flows for the policy:

Yr	*Prm*	*Exp*	*Interest*	*Death claim*	*Mat claim*	*Profit vector*
1	P	$0.3P+275$	$0.042P–16.50$	523.88	0.00	$0.742P–815.38$
2	P	$0.025P+55$	$0.0585P–3.3$	881.12	0.00	$1.0335P–939.42$
3	P	$0.025P+55$	$0.0585P–3.3$	1143.36	0.00	$1.0335P–1201.66$
4	P	$0.025P+55$	$0.0585P–3.3$	1428.00	$1.98572P$	$–0.95222P–1486.30$
	[½]	[½]	[½]	[½]	[½]	[½]

Yr	*Profit vector*	$_{t-1}p_{[x]}$	*Profit signature*	*Discount factor*	*PVFNP*
1	$0.742P–815.38$	1.0000000	$0.742P–815.38$	0.943396	$0.7P–769.23$
2	$1.0335P–939.42$	0.9962580	$1.02963P–935.90$	0.889996	$0.91637P–832.95$
3	$1.0335P–1201.66$	0.9907716	$1.02396P–1190.57$	0.839619	$0.85974P–999.63$
4	$–0.95222P– 1486.30$	0.9844782	$–0.93744P–1463.23$	0.792094	$–0.74254P–1159.02$
			[½]	[½]	[½]

Total PVFNP = $1.73359P – 3760.83 = 0$

$$=> P = \frac{3760.80}{1.73359} = 2169.40$$ [1]

[Total 6]

(iv) (a) If reserves are established, profit is deferred but the PVFNP will be the same as the earned interest rate on reserves is equal to the discount rate. [1]

(b) Again, if reserves are established, profit is deferred but now the PVFNP will be lower as the earned interest rate on reserves is lower than the discount rate. The premium would therefore have to be increased to achieve the same profit criteria. [2]

[Total 3]

[TOTAL 16]

Well prepared students made very good progress with this question.

The main area of problems were in part (i). Part (ii) was done well.

Credit was given in part (iii) for the correct method even if the calculations were inaccurate.

END OF EXAMINERS' REPORT