

FHS Mathematics and Statistics Part B 2011

Examiners' Report

Part I

A. Statistics

1. Numbers and percentages in each class

The figures in Table 1 are for Mathematics and Statistics. For comparison, Table 2 gives the corresponding figures for Mathematics.

Class	Number					Percentage				
	2011	2010	2009	2008	2007	2011	2010	2009	2008	2007
1	12	(12)	(10)	(13)	(9)	34.3	(25.5)	(33.3)	(32.5)	(24.3)
2(i)	12	(22)	(16)	(17)	(18)	34.3	(46.8)	(53.3)	(42.5)	(48.6)
2(ii)	9	(9)	(2)	(9)	(8)	25.7	(19.2)	(6.7)	(22.5)	(21.6)
3	2	(4)	(1)	(1)	(2)	5.7	(8.5)	(3.3)	(2.5)	(5.4)
Pass	0	(0)	(1)	(0)	(0)	0	(0)	(3.3)	(0)	(0)
Fail	0	(0)	(0)	(0)	(0)	0	(0)	(0)	(0)	(0)
Total	35	(47)	(30)	(40)	(37)	100	(100)	(100)	(100)	(100)

Table 1: Numbers and percentages of Mathematics and Statistics candidates in each class.

Class	Number					Percentage				
	2011	2010	2009	2008	2007	2011	2010	2009	2008	2007
1	54	(55)	(61)	(53)	(61)	36.2	(35.7)	(36.1)	(34.2)	(35.9)
2(i)	66	(61)	(76)	(74)	(79)	44.3	(39.6)	(45.0)	(47.7)	(46.5)
2(ii)	20	(28)	(23)	(22)	(25)	13.4	(18.2)	(13.6)	(14.2)	(14.7)
3	7	(9)	(5)	(5)	(4)	4.7	(5.8)	(3.0)	(3.2)	(2.4)
Pass	2	(0)	(3)	(1)	(1)	1.3	(0)	(1.8)	(0.7)	(0.6)
Fail	0	(1)	(1)	(0)	(0)	0	(0.7)	(0.6)	(0)	(0)
Total	149	(154)	(169)	(155)	(170)	100	(100)	(100)	(100)	(100)

Table 2: Numbers and percentages of Mathematics candidates in each class.

2. Vivas

There are no vivas in Mathematics and Statistics.

3. Marking of scripts

The following were double-marked: 3 BSP projects (in mathematics). The remaining scripts were single-marked according to detailed pre-agreed mark schemes. The checking process for scripts and mark entry was the same as that used as in all parts of Mathematics/Mathematics and Statistics (see Part II, Section A).

B. New examining methods and procedures

The methods of assessment for the new option BSP Structured Project (in mathematics) included oral presentation and peer review – see the Mathematics Part B report.

C. Suggested changes in examining methods and procedures

With effect from Part B 2012, written exam USMs will mostly be reported for each half-unit (though BS1 is an exception and will still have a single USM for the whole unit). This follows the corresponding change in Part C 2011. The change will lead to more information being available to candidates on their performance and will also allow simpler operation of the Strong Paper Rule.

D. Notice of examination conventions to candidates

Candidates were given details of the examining conventions in the Notices to Candidates that were sent out by the Examiners. These notices also reminded candidates about the department's Examination Conventions document.

Part II

A. General comments on the examination

1. The internal examiners record their thanks to:
 - the external examiners, Professor Bowman (Statistics external) and Professor Clarkson (Mathematics external)
 - all assessors, particularly the actuarial assessor Professor Jacka
 - the administrative staff of the Department of Statistics, particularly Jan Boylan, and the Mathematical Institute administrative staff, particularly Helen Lowe
 - Waldemar Schlackow for managing the exam database
 - the graduate students who acted as checkers for the scripts and mark entry.
2. Course lecturers were appointed as assessors and provided draft questions, which were then checked by nominated checkers before being considered by the examiners. Lecturers also marked the questions on their course.

The external examiners scrutinised the draft questions and provided helpful input which was incorporated into the final versions. (The Statistics external looked at the questions on statistics courses, the Mathematics externals looked at the questions on mathematics courses.) The actuarial assessor scrutinised and commented on papers BS3 and BS4.

Mark processing and checking was carried out according to the usual procedures: scripts were checked to ensure that all work had been marked and that all marks had been correctly totalled and recorded. In this way a small number of errors were corrected and each change was signed-off by one of the examiners.

3. For both Parts B and C this year, in common with Mathematics, instructions to setters were rewritten in an attempt to ensure that there was sufficient basic/straightforward material on which weaker candidates in particular could gain marks. We think this was successful and recommend similar instructions be used for 2012.
4. There were some excellent performances this year. More than 10% of candidates had average USMs above 80. The performance of the top candidate in particular was outstanding. The percentage of candidates getting Firsts this year was considerably higher than last year, though somewhat unfortunately it was the percentage of 2(i)s that decreased rather than the whole cohort's performance moving upwards relative to last year's. Although the results profile of the (relatively small) Mathematics and Statistics cohort shows fluctuations from year to year, once combined with the Mathematics the corresponding profile is fairly stable. There is no evidence (in 2011 data, nor in 2007–11 cumulative data) for departure from a model in which classification (1/2(i)/...) and subject (Mathematics/Mathematics and

Statistics) are independent. The profile of the Mathematics and Statistics cohort in Part B this year is in line with how this cohort performed in Part A last year.

Determination of University Standardised Marks

The Examiners followed the established procedures, outlined below, to determine the University standardised marks (USMs). When doing this the Examiners took note of:

- the Examiners' reports from Parts A and B 2010
- guidance from the MPLS Division passed on by the Statistics Academic Committee (and similarly from the Mathematics Teaching Committee) on the percentage of candidates that might be expected in each class
- reports from assessors on the standard of the work they had marked, including their estimates of where they considered class boundaries might fall for the scripts they had marked.

The scaling process described below was not used for a small number of units that were marked directly to the USM scale (this year, just 3 BSP projects). For all other units, raw marks were converted to USMs by scaling; each half-unit was scaled separately, and if a candidate took both halves of a unit their USM for the unit was the average of the USMs for each half. (Different half-units have different scalings to allow for differences in difficulty.) For the purpose of determining the scaling, Mathematics, and Mathematics and Statistics candidates are not distinguished, they are treated as a single cohort. The algorithm used to provide a starting point for the Examiners' deliberations on scaling is as follows. It uses the average USM from Part A.

The initial map from raw mark r to USM has four segments. Suppose that for some particular half-unit, n_{70} (n_{60}) of the candidates had a USM of 70 (60) or above in Part A. Then a USM of 70 (60) is set at the raw mark, r_{70} (r_{60}) say, of the n_{70} 'th (n_{60} 'th) ranked candidate on that half-unit. Take the straight line through the two points $(r_{60}, 60)$ and $(r_{70}, 70)$ and truncate it at points P_1 and P_2 where it meets the lines USM = 72 and USM = 57 respectively. A line segment joins P_1 to $(50, 100)$, and another joins P_2 to $(0, 20)$. But the latter segment is broken, at P_3 , where it intersects the line USM = 37, and the final segment of the map is from P_3 to $(0, 0)$. So the initial map from raw mark r to USM is the four segments joining $(0, 0)$, P_3 , P_2 , P_1 , $(50, 100)$. (Note that the raw mark for a half-unit is out of a maximum of 50, while the USM is scaled to a maximum of 100.)

For a well-set paper taken by a large number of candidates, this algorithm yields a piecewise linear map which is close to linear, usually with a somewhat steeper first and last segment. If the paper is too easy or too difficult, or is taken by only a few candidates, then the algorithm can yield anomalous results. For all papers, changes to the initial maps are considered: usually these changes are made by adjusting the position of the points P_1 , P_2 , P_3 by hand so as to produce a fair map for each half-unit. As in past years, a preliminary meeting of examiners was held (earlier in the week of the

Final Examiners' Meeting) to assess the results produced by the algorithm and to make changes if necessary, so that the starting point for day 1 of the final meeting was a set of USM maps yielding a tentative class list with class percentages roughly in line with historic data.

Day 1 of the Final Examiners' Meeting began with an overview of the methodology and of this year's data, followed by a review of the mathematics and statistics papers taken by a large number of candidates. For each half of these papers, the data and initial scaling were scrutinised in turn, and the USM maps were adjusted as deemed appropriate. As usual, the Statistics external examiner was present for this session with the Mathematics examiners (who included the Chairman of Mathematics and Statistics) in order for him to get an overview of this year's exams, to observe the discussion of mathematics papers and thereby achieve consistency when participating in the discussion of the statistics papers.

The meeting then adjourned to allow the external examiners to look at scripts before reconvening to complete the task of adjusting USM maps for all papers. As usual, the Mathematics and Statistics examiners who were not Maths examiners joined the Maths examiners at the reconvened meeting, observing the adjusting and finalising of the USM maps for mathematics papers in order to achieve consistency when participating in the adjusting and finalising of the USM maps for statistics papers which followed. During this process the positions of borderlines and the operation of the Strong Paper Rule were considered.

At their final meeting the following afternoon, the Mathematics and Statistics examiners checked the positions of borderlines for their cohort, taking account of the operation of the Strong Paper Rule. Candidates near borderlines were considered in detail. The Examiners made a small number of final changes in order to arrive at a class list which, in their academic judgement, was in line with the candidates' performance.

The final positions of P_1 , P_2 , P_3 for the units/half-units taken by at least two Mathematics and Statistics candidates are given in Table 3. For the corresponding information for the remaining mathematics units/half-units, see the Examiners' Report on Mathematics Part B.

Paper	P_3	P_2	P_1
BS1	(16, 37)	(55.8, 57)	(76.8, 72)
BS2a	(15.3, 37)	(32, 57)	(42, 72)
BS3a	(11.9, 37)	(26, 57)	(41, 72)
BS3b	(11.7, 37)	(25.4, 57)	(40, 72)
BS4a	(10.9, 37)	(23.7, 57)	(40.2, 72)
BS4b	(12, 37)	(19.1, 57)	(38.6, 72)
B8a	(7.5, 37)	(16.4, 57)	(34.4, 72)
B10a	(10.6, 37)	(23.1, 57)	(42.6, 72)
B10b	(12, 37)	(23.8, 57)	(42, 70)
B11a	(12, 37)	(23.1, 57)	(42.6, 72)

Table 3: The points P_1 , P_2 , P_3 used for scaling. Note that the raw mark for each paper is out of 50, except BS1 which is out of 100.

Table 4 gives the rank of candidates by weighted average USM at the end of Part B.

Av USM	Rank	Candidates with this USM or higher	%
93	1	1	2.86
86	2	2	5.71
84	3	3	8.57
83	4	4	11.43
78	5	5	14.29
74	6	7	20
72	8	9	25.71
71	10	12	34.29
69	13	15	42.86
68	16	17	48.57
67	18	18	51.43
66	19	19	54.29
65	20	20	57.14
64	21	22	62.86
60	23	24	68.57
59	25	25	71.43
58	26	26	74.29
57	27	27	77.14
53	28	28	80
52	29	31	88.57
51	32	32	91.43
50	33	33	94.29
46	34	34	97.14
42	35	35	100

Table 4: Number and percentage of candidates scoring a given USM or higher at the end of Part B.

B. Equal opportunities issues and breakdown of the results by gender

Table 5 shows the numbers and percentages of male and female candidates in the various classes. There were similar numbers of male and female candidates this year, and they achieved a similar standard of results.

Class	Female	Male
1	6	6
2(i)	4	8
2(ii)	6	3
3	0	2
Pass	0	0
Fail	0	0
Total	16	19

Table 5: Breakdown of results by gender.

C. Detailed numbers on candidates' performance in each part of the examination

The performance of candidates is summarised below. The detailed question data is for Mathematics and Statistics candidates only.

Paper BS1 Applied Statistics

Number of candidates: 35 Average raw mark: 66.91 Average USM: 66.74
(Number of Maths candidates: 1)

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	14.66	14.78	4.12	32	1
Q2	12.5	12.5	5.60	10	0
Q3	11.76	12.03	4.59	28	2
Q4	15.18	15.18	5.21	32	0
Q5	15.5	18.33	6.02	3	1
PR	24.74	24.74	3.88	35	0

Note that the individual question marks are out of 22 and the practical component (PR) is out of 34.

Paper BS2a Foundations of Statistical Inference

Number of candidates: 17 Average raw mark: 39.35 Average USM: 73.29
(Number of Maths candidates: 0)

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	20.13	20.13	5.12	15	0
Q2	12.6	12.6	6.84	5	0
Q3	20.62	21.71	4.27	14	2

Paper BS3 Stochastic Modelling

Number of candidates: 32

BS3a: Av raw 33.56, Av USM 65.56, BS3b: Av raw 33.16, Av USM 65.88

(Number of Maths candidates: 5

BS3a: Av raw 38.4, Av USM 72.8, BS3b: Av raw 35.2, Av USM 69.6)

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	15.82	15.88	4.46	25	3
Q2	15.8	15.78	4.64	28	2
Q3	19.15	21.36	7.08	11	2
Q4	17.85	17.85	6.32	28	0
Q5	10.57	11.33	7.22	15	4
Q6	18.90	19.55	5.28	20	1

Paper BS3a Applied Probability

Number of candidates: 3 Average raw mark: 33.67 Average USM: 64.67)

(Number of Maths candidates: 64 Average raw mark: 34.12 Average USM: 65.75)

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	15	15	1.41	2	0
Q2	12.33	16.5	7.23	2	1
Q3	19	19	1.41	2	0

Paper BS4 Actuarial Science

Number of candidates: 29

BS4a: Av raw 31.24, Av USM 64.31, BS4b: Av raw 26.69, Av USM 60.28

(Maths: Number of candidates: 44

BS4a: Av raw 31.89, Av USM 65.23, BS4b: Av raw 28.02, Av USM 64.16)

Question	Average mark		StDev	Number of attempts	
	All	Used		Used	Unused
Q1	15.22	15.22	5.51	27	0
Q2	12.11	15.50	7.57	6	3
Q3	16.08	16.08	4.37	25	0
Q4	13.92	14.04	5.85	23	1
Q5	10.52	10.41	5.94	22	3
Q6	13.94	17.08	6.86	13	4

Paper B8a Mathematical Ecology and Biology

Number of candidates: 8 Average raw mark: 21.5 Average USM: 59.38
 (Maths: Number of candidates: 45 Average raw mark: 23.73 Average USM: 62.64)

Paper B10 Martingales Through Measure Theory and Mathematical Models of Financial Derivatives

Number of candidates: 3
 B10a: Av raw 34.67, Av USM 67.67, B10b: Av raw 32.33, Av USM 66.67
 (Maths: Number of candidates: 15
 B10a: Av raw 37.93, Av USM 71.93, B10b: Av raw 35.53, Av USM 68.33)

Paper B10a Martingales Through Measure Theory

Number of candidates: 2 Average raw mark: 37.5 Average USM: 79
 (Maths: Number of candidates: 5 Average raw mark: 36 Average USM: 70.8)

Paper B10b Mathematical Models of Financial Derivatives

Number of candidates: 23 Average raw mark: 29.74 Average USM: 60.43
 (Maths: Number of candidates: 59 Average raw mark: 32.97 Average USM: 64.03)

Paper B11a Communication Theory

Number of candidates: 10 Average raw mark: 25.6 Average USM: 56.4
 (Maths: Number of candidates: 33 Average raw mark: 32.15 Average USM: 64.06)

D. Comments on papers and individual questions

The following comments on statistics papers BS1–BS4 were submitted by assessors; for comments on mathematics papers, see the Examiners' Report on Mathematics Part B. The comments relate to all candidates taking these papers, not just Mathematics and Statistics candidates.

BS1a Applied Statistics I

In comparison with previous years, the 2011 BS1a paper put relatively more emphasis on data analysis [model building and interpretation (1b,c;2;3a), choosing and carrying out tests (1d;2bi-ii;3b,c), computing confidence intervals (2ci-iii) and evaluating evidence for goodness of fit (1c,f;2bii;3d)] with relatively fewer marks available for reproducing and developing the statistical theory (1a,e;2cii;3e) in the course. There was a little too much ANOVA, from the first 3 weeks of the course, and this explains the popularity of Questions 1 and 3. However, this has to be weighed with relatively fewer marks for ANOVA in the assessed practicals.

Students were obliged to assimilate a relatively large amount of information. The text of each 40 minute question ran over two pages. Although there was some evidence for time being a factor (good answers stopping short) there was a wide spread of marks: a fair number of students were able to provide two near-complete answers, and low marks were associated with a basic ignorance of central ideas in the course.

Question 1 was popular and generally well done. There was some inaccuracy counting the dimension of categorical variables and setting up notation for indicator variables (in 1b). Students focused their remarks on GOF on the qqplots and failed to comment on correlation between fitted values and residuals. Just a handful of scripts identified the symmetry in the data that is the key to Question 1(e).

Question 2 was unpopular but the few responses seemed to show a similar spread of marks to the other two questions. Questions 2a and 2b are of a standard type and were well done. Question 2c was less familiar, and 2cii, which is related to the material on the iteratively reweighted least squares algorithm, is fairly challenging in this setting, though there were a couple of near-perfect answers.

Question 3 was popular. The majority of students were able to count the dimension of the interaction terms and compute the residual sum of squares for H_0 from the ANOVA table. There were few correct suggestions on comparison of H_0 and H_0 -bar, which are not nested. Like 1(e), 3(e) needed a little imagination, and tended to be answered correctly by the same students.

BS1b Applied Statistics II

Most students opted for the first question, which was similar in style to questions about rank-based testing in previous years, with only very few answering the second, mixed question and /or both questions.

The quality of answers was quite high in the rank-test question. Most students could solve the latter two parts but sometimes had trouble with the definitions in the first two sub-questions (i.e. the null hypothesis was often defined as the random variable D being equal to 0 instead of its expected value).

The phrasing of the question about the probability $P(W \leq w)$ in b) was misleading for only very few students, who wrongly used this to calculate the p-value instead of $P(W > w)$. This part was marked generously.

The second question was answered satisfactorily, with only one student experiencing problems with the interpretation of the GCV value.

BS1 Practicals

Practical 1: The students fared relatively well in this practical. The average was 18/25 and so was the median. The only issues that appeared frequently, concern the variable selection in the third question and the final model interpretation in the last question. Although all of them answered those two parts, the majority could have put some more details in their answers. Regarding the variable selection part, most of them used the stepAIC function and then simply compared the output model with the initial one using the anova function. Very few tried to use anova without previously using stepAIC or try backward selection beginning with the full model. The interpretation of the final model was, in general, poor where most of them simply stated which variables are important and wrote down the coefficients of the model.

Q1: Overall, EDA was good. Almost all of them figured out the issue with age (over/under 20 y.o). Q2: No problems creating the new data frame. Q3: Very few tried to transform the response before fitting the model. Almost everybody used Box-Cox transformation during the model selection process (usually choosing square root). Also most of them introduced and included in the model, the indicator variable for age (i_{20}). Problems with model selection are detailed above. There was no major issue with the residual diagnostics. Q4: Questions 4(a) and 4(b) were mostly answered while working on the model selection. Most did not do specific tests but they justified their answers based on the work they did for Q3 which was fine in most cases. Issues with model interpretation are detailed above.

Practical 2: One of the most problematic parts was the goodness of fit consideration, which the majority of students have either ignored or done incorrectly by using residual deviances for Bernoulli data. As expected parts 2(a) and 2(d) were found to be the most difficult with only a few full answers to (d). Also most of the students have ignored that they have paired data without giving any explanation/reason as to why this can be done. As for the easier (and more basic) parts of the assignment, generally good understanding of the theory is shown and good results have been obtained.

Practical 3: Problem 1: (b) Sometimes considered Lot as a continuous variable, which will result in wrong results. GoF sometimes incomplete, missing plots. (e) Interpretation not always detailed. (f) Often concluded that the test proved that the outliers are of no concern. Problem 2: Answers were usually similar (eg in d, all reproduced the MC-Chi-Sq plot), possibly due to the problem being similar to a previous practical. (d) Gave wrong value for p. Reason why Chi-Sq fails not mentioned.

Practical 4: The students did well in general. Very few seem to have problems with the subjects of the practical. No-one had any issues with the first question. The most common mistake in the second question was that many students provided one-sided confidence intervals. They had no reason, whatsoever, to assume that since the exercise subsequently asks to comment on the length of those C.I.'s; length makes no sense for one-sided intervals. In the third question many tried to improve the fit of the ordinary

linear model by removing outliers and then based their further analyses on that fitted model (affecting ex.4 as well). That was not the point. The outliers were needed in order to see the effect of L1 regression. In the fourth exercise they did not have any issues with the bootstrap. Everybody wrote and applied a code in R. They had some problems with the interpretation though. They mostly focused on the sample variance of the bootstrap sample instead of the mean. They were not penalised for that. Also very few used histograms to show their bootstrap samples. Instead they used scatter-plots which is visually much less informative than the histogram. The last part proved the most tricky with very few providing interesting suggestions on how to address the problem of dependence.

BS2a Foundations of Statistical Inference

Q1. This question was attempted by most candidates and was generally well done. Common errors were: (a) not deriving the Negative Binomial distribution from a probabilistic argument. (b) Forgetting the Jacobian when transforming the prior for theta to the prior for omega. (d) Not evaluating the Beta integral occurring in the denominator of the Bayes' factor.

Q2. This question was not attempted by most candidates, even though much of it was bookwork. (a) There was possibly a reluctance to do the algebra needed in completing the square in the Bayesian calculation of finding the posterior for mu in a Normal sample when the mean has a prior normal distribution. (b), (c) Reasonably done. (d) An unseen application, done by almost no candidates.

Q3. This was attempted by most candidates. (a) Bookwork, done well. (b) Candidates often could not complete the algebraic calculation to get the Bayes' risk answer, even if they knew what was required.

BS3a Applied Probability

Q1: This question was popular and was generally done well. In (b)(i) several candidates gave a version of the Markov property for a birth process which was incorrect as a statement of the Markov property for the birth-and-death process asked about in this question. Most candidates reached the end of (d)(i): many dropped some marks along the way, but most did these parts of the question fairly well. Many attempts made errors in (d)(ii), and few students were able to (d)(iii) fully.

Q2: This was also a popular question. Quite a few candidates lost marks as they thought the queueing process described was an $M/M/1$ queue (which it is not). Parts (a)–(c) were generally done well, though many did not explain (d) sufficiently well for full marks and few could do (e). In (d), the question asks for a brief explanation, which some answers did not attempt: many candidates stated ergodic theorems and gave a yes/no answer, but failed to give a reason for their yes/no.

Q3: This question was the least popular, but those who did it generally did it well. The bookwork in (c) was generally done well, though some attempts lost several marks here. Some candidates lost marks in the calculations in (e), and some lost marks in (e)

as they made no comment at the end of their answer: candidates were asked for both a comparison of (e)(i) and (e)(ii) which most did – they were also asked for a comment which some did not do (i.e. a comment relating to the inspection paradox/size-biasing).

BS3b Statistical Lifetime Models

Overall, I felt that the students had a good understanding of the material in general. The results were within the range that I expected.

Q4: Most students attempted this question. The majority of the students did well in the technical aspects of the question. The final part of the question caused some difficulty. (a) All students (with a few exceptions) scored very well in this question (b) Most students were capable of recognising the correct characteristics here. (c) The majority of students answered this question perfectly. There were some exceptions for certain ages where censoring occurs. (d) This question caused difficulty for some students. This was due to the fact that they were not able to remember or derive the formula needed.

Q5: Most students did well in the second part of the question (which had not been covered in lectures) but many faltered in the final part of the question. (a) This part was not well answered overall with students failing to give accurate definitions. (b) Students did well in general here. The majority of students who answered this question seemed to have a very good understanding of what was required here. (c) A small number of students did very well here but many students did not recognise the relationship between the parameters.

Q6: Students who attempted this question did well in most parts. (a) All students did well in the first part here. Many students did not answer the second part accurately (or at all in many cases). (b) This was generally answered well. Students had a good understanding of the material. (c) This part of the question was answered perfectly by the majority of students. (d) This final part of Question 6 was also answered well by most students.

BS4a Actuarial Science I

Questions 1 and 3 were the most popular, with a substantial minority choosing question 2.

Question 1 was generally well answered, although some students did not correctly state which of the two formulae in question (c) (i) was the prospective formula and which was the retrospective. Only a small number of students realised that the yield for Contract A was the same as that for Contract B.

Many students struggled either with part (a) or part (b) of question 2, with few students correctly answering (a) (iii) or (b)(iii). Some students were not sufficiently precise in answering a (iv).

Many students were not sufficiently clear in answering question 3 part (a)(ii). Parts (c) (ii) and (d) were generally answered poorly.

BS4b Actuarial Science II

Q4. This question was popular, well-answered by many candidates with a high number of excellent answers. The lowest marks were mainly on incomplete scripts, some candidates ran out of time, others were blocked by the wrong cash flow in (c), forgetting the random amount of interest due at time 1. In (e), most candidates lost some marks for not identifying the parameters of the log-normal distributions, particularly for $1 + Y_B$, but partial marks were given for appropriate general statements about log-normal distributions, even when students derived means and variances, which were not required here, but the formulas would have been useful in (f), which was often not completed by such candidates. In (f), many candidates missed the different signs in cash flows A and B that make the time-0 payments cancel. This had knock-on effects on the expectations of random yields.

Q5. This question was very popular with few incomplete attempts, but with just a handful of excellent answers, quite poorly done by many. A sizeable number of students lost marks for incomplete bookwork in (b). Others lost time (but no marks) by proving rather than just stating that no arbitrage implies the Law of One Price. A disappointingly high number of students could not do (c), although it is essentially the most basic no-arbitrage argument. Many others lost a mark for assuming that there is a bank account with a constant force of interest, while zero-coupon bonds take this role here. These problems persisted in (d). Part (e) was often poorly done with many students only scoring one or two marks for a definition of DMT and an incomplete attempt at calculating it. Many students incorrectly included the purchase price of the bond in the cash flow, which clearly destroys the interpretation as an average term weighted by discounted cash flows. This interpretation is also a key to the last parts, to guide the bounding and passing to limits, marks that were rarely claimed.

Q6. This question was not as popular as the other two, but still done by more than half of the students. Most low marks were for incomplete scripts, where students very clearly did not have the time for a serious attempt. Virtually all serious attempts scored more than half the marks available, with a large number of good answers and a handful of excellent ones. Single marks here or there were quite regularly lost in (a) for not giving an expression in terms of one-year death probabilities, in (b) for not separating the two principles and the application to the specific product, in (c) for being vague about the reasons for reserves in this extreme case of an endowment assurance, which is closer to a regular saving scheme than to a stream of one-year assurance premiums (this said, rather than singling out the end-of-term benefit payment, all that was required here for full marks was the statement that parts of earlier premium payments need to be set aside for later benefit payments, because expected benefits are increasing, while premiums are level). For (d), there was a variety of correct algebraic derivations, some more elegant than others, the general reasoning part was done quite well, although a few candidates fudged it by just rewriting the formula in words; the distinction of expected death benefit and expected reserve was the key. Many had some problems with the time- n benefit payment in (e), probably because they tried to force the equation of (d) to still hold, while it does not. (f) was not well-done apart from a few notable exceptions,

and this was usually not in any apparent way due to the typos confounding k and n , and the inaccuracy about the mortality model which was intended to specify q_x not just for $x = 50$; marks were nevertheless given generously for attempts.

E. Comments on the performance of identifiable individuals and other material which would usually be treated as reserved business

[Removed in web version]

F. Names of members of the Board of Examiners

Examiners: Prof A Bowman (External), Prof P Clarkson (External), Dr E Gaffney, Dr N Laws (Chairman), Dr A Muench, Dr M Winkel.

Assessors for Papers BS1–BS4: Dr O Burke, Mr D Clarke, Prof R Griffiths, Prof S Jacka, Dr N Meinshausen, Dr G Nicholls.

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