CORRESPONDENCE.

ROYAL EXCHANGE ASSURANCE. MORTALITY EXPERIENCE, 1721–1830.

To the Editors of the Journal of the Institute of Actuaries.

SIRS,—When the Royal Exchange was destroyed by fire on the night of 10 January 1838 the records of the Royal Exchange Assurance were unfortunately destroyed, and it is only during the last few days that we had any idea that any life statistics prior to that date were available.

There has just been discovered among some old papers a letter, which is here photographically reproduced, from Mr. A. De Morgan, dated 31 August 1850, along with a document which is undoubtedly the mortality experience of the Corporation for the years 1721–1830, as graduated by Mr. Finlaison by his own hand.

The letter is endorsed "Mr. De Morgan's, morning's work on the old R.E.A. experience." From the interesting explanations given in the letter it is clear that it was Mr. Finlaison's morning's work.

The document gives the detailed arithmetical work of the graduation, and a summary of the results for all ages is appended in Table I, which gives the ages, exposed to risk, the q_x grouping, and the final graduated q_x.

The graduation adopted was two summations of q_x in fives divided by 25 except at the end of the table, when two summations in fours divided by 16, two summations in threes divided by 9, and two summations in twos divided by 4 were employed.

Mr. Finlaison apparently was not satisfied to adopt the rough q's without modification, and in certain groups, as shown in the tables, he substituted the average q of the group for the q at each age. There is no note to show how the exposed to risk was arrived at.

It should be remarked that when the Royal Exchange first started life business, the type of policy issued was a short-term cover, and I believe I am correct in stating that the period was one, five, or seven years. The age at entry was, it is believed, limited to 45 or 50, and the premium was in every case £5 per-cent per annum. In consequence, the amount of business written was exceedingly small, the premiums being a matter of only a few hundreds a year. A graduated table of premiums was adopted in 1783, and the premium income immediately rose, and in 1830 had increased to £150,000 per annum. As an indication of the distribution of the data a note is appended of the premium income in each tenth year from 1790 to 1830.

It would appear safe to say that the experience, although starting in 1721, is largely the experience of the last few years of the 18th century and the first 30 years of the 19th century.

Yours faithfully,

T. F. ANDERSON,
Actuary.

Royal Exchange Assurance,
Royal Exchange, London.
15 *November* 1927.

In the year 1831 a small manuscript was lent to me for a few days, pertaining to contain the experience of the Royal Exchange Assurance office. This was lent, by whom I forget, with a strict charge not to copy it. While it was in my possession, Mr Finlaison, Actuary of the National Debt Office, came to breakfast with me, to look over some matters connected with the Amicable Society, in the affairs of which we were then jointly advising. On my showing this book to Mr Finlaison, he desired to examine it at his own house, which I told him he could not do. He then proposed to make an examination on the spot, for the purpose of forming an idea of the general character of its results. This I agreed to, on condition that he should not carry away the results, or any written memoranda of them. He then sat down, and before breakfast, to my amusement, and astonishment at the short time in which he did it, equalized the whole of the experience by the method described in his Report on the Government Annuitants Friendly Societies. And the above paper is the result; from which this experience is therefore recoverable.

I always thought I had destroyed this paper. and when I heard of the fire at the Royal Exchange, and the loss of the manuscript, I always held it useless to make any search. But this day, in sorting a bundle of papers connected with the Amicable investigation, I find this paper folded in one of them, in which I dare say it has lain hid since the day it was written. And I accordingly hand it over to the R. Exchange Assurance Office, to which it properly belongs

7 Camden Street
Camden Town
August 31/50

A. De Morgan

Mr De Morgan's
Answer's work on
Re of R. E. Experience

Premiums received in the Life Branch of the Royal Exchange Assurance.

(N.B.—Prior to 1780 the premiums never exceeded £1,000 in any one year.)

Year to 30 April	Premiums
1790	£18,890
1800	£27,615
1810	£76,945
1820	£145,710

Table II is added which gives the values of l_x and e_x derived from Mr. Finlaison's graduated values of q_x. The difficulty encountered at the older ages owing to Mr. Finlaison having terminated his table at age 90 was surmounted by regraduating the data and joining on Mr. Finlaison's q_x to the expectation at age 90 derived from the regraduated data. The regraduation was performed by the method of moments and the formula adopted was

$$\text{colog}_{10}\, p_x = \text{A} + \text{B}c^x + \text{D}c^{-x}$$

The value of log c was ·036 and the values of the constants A, B and D, found by equating the first, second and third summations of the function $\text{E}_x \times \text{colog}_{10}\, p_x$ (graduated) to the first, second and third summations of the same function ungraduated, were as follows:

A ... ·00475
B ... ·000079695
D ... ·00306

The results are given in Tables III and IV.

In comparing the values of q from the formula with Mr. Finlaison's values it should be noted that while Mr. Finlaison's results derived from the average of the data for ages 11 and 12 are placed opposite age 12, the formula is arranged so that they belong to an age half a year earlier; and the same for other ages.

T. F. A.

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press

Royal Exchange Assurance. Mortality Experience, 1721–1830.

TABLE I.

Age in Manuscript	Exposed to Risk E_x	Deaths d_x	$\frac{d_x + d_{x-1}}{E_x + E_{x-1}}$	Figures substituted by Mr. Finlaison in certain groups	Mr. Finlaison's Graduation of q_x
11	69	0	...	...	...
12	88	2	·012739	...	...
13	91	0	·011173	...	·011335
14	104	2	·010257	...	·011849
15	108	3	·023585	·013594	·012612
16	126	1	·017094	·013594	·0131043
17	144	1	·007407	·013594	·0134677
18	174	1	·006289	·013594	·0138075
19	230	5	·014852	...	·0140609
20	320	3	·014545	...	·0140907
21	345	7	·015038	·013857	·0140407
22	332	5	·017725	·013857	·0139075
23	450	4	·011509	·013857	·0136272
24	536	7	·011156	·013857	·0132398
25	649	9	·013502	...	·0127845
26	763	8	·012039	...	·0122772
27	865	9	·010442	...	·0118079
28	970	12	·011444	...	·0115737
29	1056	16	·013820	·011163	·0115511
30	1170	9	·011231	·011163	·0117322
31	1319	12	·008437	·011163	·0123429
32	1392	23	·012910	...	·0130845
33	1541	19	·014320	...	·0138335
34	1678	33	·016154	·015562	·0145634
35	1754	30	·018357	·015562	·0151579
36	1809	19	·013753	·015562	·0156172
37	1909	33	·013986	·015562	·0159312
38	1979	32	·016718	...	·0161869
39	2010	35	·016796	·016578	·0163809
40	2057	35	·017212	·016578	·0166301
41	2076	30	·015727	·016578	·0169133
42	2167	39	·016262	...	·0173252
43	2154	38	·017820	...	·0179246
44	2115	43	·018974	...	·0185952
45	2114	35	·018444	...	·0193158
46	2163	54	·020809	...	·0201430
47	2132	39	·021653	...	·0209251
48	2119	49	·020701	...	·0215204
49	2125	47	·022620	...	·0220636
50	2097	50	·022975	...	·0224940
51	2085	50	·023912	...	·0228825
52	1982	41	·022375	...	·0235215
53	1923	46	·022279	...	·0244333
54	1873	43	·023446	...	·0256350
55	1831	55	·026458	...	·0273123
56	1775	65	·033278	...	·0290437
57	1701	39	·029919	...	·0305221
58	1643	65	·031101	...	·0320398
59	1537	50	·036164	...	·0334771
60	1467	44	·031292	...	·0347402
61	1424	61	·036320	...	·0365754
62	1333	45	·038447	...	·0390649
63	1252	53	·037911	...	·0418153
64	1151	54	·044528	...	·0451426

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press

Royal Exchange Assurance. Mortality Experience, 1721–1830 —*continued.*

Age in Manuscript	Exposed to Risk E_x	Deaths d_x	$\frac{d_x + d_{x-1}}{E_x + E_{x-1}}$	Figures substituted by Mr. Finlaison in certain groups	Mr Finlaison's Graduation of q_x
65	1070	58	·050428	...	·0491289
66	976	56	·055719	...	·0532359
67	914	47	·054497	...	·0568207
68	823	54	·058146	...	·0603143
69	734	54	·069364	...	·0638810
70	649	45	·071584	...	·0670089
71	572	32	·063063	...	·0700848
72	512	42	·068266	...	·0744799
73	448	35	·080208	...	·0798614
74	369	33	·083231	...	·0848375
75	320	30	·091437	...	·0901763
76	270	31	·103390	...	·0965864
77	208	20	·106695	...	·1045363
78	161	14	·092135	...	·1139696
79	131	17	·106164	...	·1265289
80	108	16	·138075	...	·1419773
81	77	18	·183784	·182210	·1580904
82	52	10	·217054	·182210	·1739377
83	34	4	·162791	·182210	·1896415
84	25	7	·186441	·201328	·2046493
85	12	1	·216216	·201328	·2179629
86	7	1	·105263	·254386	·2308686
87	5	0	·083333	·254386	·2707120
88	3	0	·000000	·254386	·2976650
89	3	2	·333333	·254386	·3372320
90	1	1	·750000	·254386	·4407895
91	0	0	1·000000	...	...

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press

TABLE II.

Age x	FINLAISON'S GRADUATION		Age x	FINLAISON'S GRADUATION	
	l_x	e_x		l_x	e_x
13	100000	39·435	52	54577	17·345
4	98867	38·888	3	53293	16·763
15	97694	38·354	4	51991	16·182
6	96463	37·843	55	50658	15·608
7	95198	37·347	6	49274	15·047
8	93916	36·856	7	47843	14·497
9	92619	36·373	8	46383	13·953
20	91317	35·891	9	44897	13·415
1	90031	35·405	60	43394	12·880
2	88767	34·908	1	41886	12·343
3	87533	34·401	2	40354	11·812
4	86340	33·876	3	38778	11·292
25	85196	33·330	4	37157	10·785
6	84107	32·762	65	35480	10·294
7	83073	32·169	6	33737	9·826
8	82092	31·554	7	31940	9·379
9	81143	30·924	8	30125	8·944
30	80205	30·285	9	28308	8·518
1	79265	29·644	70	26500	8·099
2	78287	29·015	1	24724	7·681
3	77263	28·399	2	22992	7·260
4	76194	27·798	3	21279	6·844
35	75084	27·208	4	19580	6·438
6	73947	26·627	75	17919	6·035
7	72791	26·050	6	16303	5·633
8	71632	25·470	7	14728	5·235
9	70473	24·890	8	13189	4·846
40	69319	24·305	9	11686	4·470
1	68166	23·715	80	10207	4·117
2	67013	23·123	1	8757·9	3·799
3	65852	22·531	2	7373·4	3·512
4	64673	21·942	3	6090·9	3·251
45	63470	21·357	4	4935·8	3·012
6	62244	20·778	85	3925·7	2·787
7	60990	20·206	6	3070·1	2·564
8	59713	19·638	7	2361·3	2·333
9	58429	19·069	8	1722·1	2·199
50	57140	18·500	9	1209·5	2·131
1	55855	17·925	90	801·6	2·215

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press

Table III.

Regraduation by $A + Bc^x + Dc^{-x} = colog_{10} p_x$

$A = \cdot00475$

$B = \cdot000079695$

$D = \cdot00306$

$log_{10} c = \cdot036$

Age x	$colog_{10} p_x$	q_x	e_x	Age x	$colog_{10} p_x$	q_x	e_x
11	·00618	·01413	39·974	61	01728	·03901	12·145
12	610	1395	39·548	62	1837	4142	11·638
13	602	1377	39·107	63	1934	4356	11·140
14	596	1363	38·653	64	2082	4681	10·648
15	591	1352	38·187	65	2219	4981	10·170
16	586	1340	37·709	66	2370	5311	9·703
17	583	1333	37·222	67	2534	5668	9·248
18	579	1324	36·725	68	2712	6054	8·804
19	576	1318	36·218	69	2905	6470	8·371
20	575	1315	35·701	70	3115	6921	7·950
21	574	1313	35·177	71	3343	7409	7·541
22	573	1311	34·645	72	3591	7936	7·144
23	574	1313	34·105	73	3860	8504	6·760
24	575	1315	33·559	74	4152	9118	6·389
25	577	1320	33·007	75	4470	9781	6·030
26	579	1324	32·448	76	4815	·10494	5·683
27	583	1333	31·884	77	5190	·11264	5·350
28	586	1340	31·315	78	5597	·12092	5·029
29	591	1352	30·740	79	6039	·12982	4·720
30	596	1363	30·162	80	6520	·13940	4·425
31	602	1377	29·579	81	7043	·15029	4·142
32	610	1395	28·989	82	7611	·16075	3·871
33	618	1413	28·399	83	8228	·17259	3·612
34	627	1433	27·806	84	8898	·18526	3·366
35	637	1456	27·211	85	9626	·19880	3·131
36	648	1481	26·613	86	·10416	·21324	2·908
37	660	1508	26·013	87	·11275	·22865	2·696
38	674	1540	25·411	88	·12209	·24506	2·495
39	689	1574	24·809	89	·13223	·26249	2·305
40	706	1612	24·206	90	·14324	·28095	2·126
41	724	1653	23·603	91	·15521	...	1·956
42	743	1696	22·999	92	·16822	...	1·796
43	765	1746	22·396	93	·18234	...	1·646
44	789	1800	21·794	94	·19769	...	1·505
45	814	1857	21·194	95	·21437	...	1·373
46	843	1922	20·595	96	·23249	...	1·249
47	873	1990	19·999	97	·25217	...	1·133
48	907	2067	19·405	98	·27355	...	1·025
49	943	2148	18·814	99	·29678	...	·924
50	983	2238	18·227	100	·32202	...	·831
51	1025	2333	17·645	101	·34944	...	...
52	1073	2440	17·066	102	·37923	...	...
53	1124	2555	16·493	...	...	...	...
54	1179	2678	15·925	...	...	...	...
55	1239	2813	15·363	...	...	...	...
56	1305	2960	14·808	...	...	...	...
57	1376	3119	14·260	...	...	...	...
58	1453	3290	13·719	...	...	...	...
59	1537	3477	13·186	...	...	...	...
60	1629	3681	12·660	...	...	...	...

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press

TABLE IV.

Regraduation by colog $p_x = A + Bc^x + Dc^{-x}$.
Comparison of Actual and Expected Deaths.

Age Group	Exposed to Risk	Expected Deaths	Actual Deaths	Actual − Expected	Accumulated Deviation
11–15	460	6·4	7	·6	.6
16–20	994	13·1	11	− 2·1	− 1·5
21–25	2312	30·4	32	1·6	·1
26–30	4824	64·8	54	−10·8	−10·7
31–35	7684	108·9	117	8·1	− 2·6
36–40	9764	150·9	154	3·1	·5
41–45	10626	186·1	185	− 1·1	− ·6
46–50	10636	220·4	239	18·6	18·0
51–55	9694	247·8	235	−12·8	5·2
56–60	8123	267·1	263	− 4·1	1·1
61–65	6230	272·5	271	− 1·5	− ·4
66–70	4096	245·8	256	10·2	9·8
71–75	2221	186·0	172	−14·0	− 4·2
76–80	878	103·3	98	− 5·3	− 9·5
81–85	200	32·9	40	7·1	− 2·4
86–90	19	4·4	4	− ·4	− 2·8

VALUATION OF REVERSIONS FOR ESTATE DUTY.

This question, which was discussed with the Inland Revenue Authorities in 1900 (see *J.I.A.*, vol. 36, p. 81), has recently received further consideration by the Council, and the following letter was addressed to the Secretary of the Estate Duty Office on the 13 October 1927.

THE INSTITUTE OF ACTUARIES,
STAPLE INN HALL,
HOLBORN, W.C.
13 *October* 1927.

THE SECRETARY,
Estate Duty Office,
Somerset House, W.C.2.

DEAR SIR,

VALUATION OF REVERSIONS FOR ESTATE DUTY.

We have recently had occasion to consider the question of the valuation of reversions for Estate Duty, and our attention has been drawn to the fact that there seems to be a difference of opinion in the Actuarial Profession as to the proper allowance to be made for expenses in such valuations.

This question was discussed between this Institute and the

https://doi.org/10.1017/S0020268100031875 Published online by Cambridge University Press