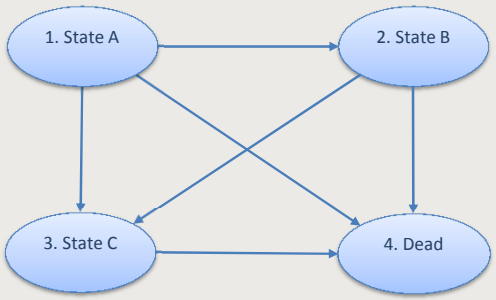
Supplementary file to accompany Jones, Epstein, Garcia-Mochon "A procedure for deriving formulas to convert transition rates to probabilities for multi-state Markov models"

Model 2. Four-state model with forward transitions only



Matrix Q

	State A	State B	State C	Dead
State A	-0.006	0.0030	0.0006	0.0023
State B	0	-0.054	0.0532	0.0010
State C	0	0	-0.02	0.02
Dead	0	0	0	0

Matrix D

	State A	State B	State C	Dead
State A	-0.006	0	0	0
State B	0	-0.0542	0	0
State C	0	0	-0.0200	0
Dead	0	0	0	0

Matrix U

	State A	State B	State C	Dead
State A	1	0.0029957	0.000	0.000
State B	0	-0.0483	-0.0003	0.000
State C	0	0	-0.0003	0.000
Dead	0	0	0	0.000

Matrix U^(-1)

	State A	State B	State C	Dead
State A	1	0.062	-0.792	-0.270
State B	0	-20.723	20.726	-0.002
State C	0	0	-3799.755	3799.755
Dead	0	0	0	3102.472

	Transition rates									*Transition probabilities*					
	From State A to …				From State B to …			From State C to Dead		From State A to …				From State B to …	
	State A	State B	State B	Dead	State B	State C	Dead	State C	Dead	State A	State B	State C	Dead	State B	State C
Cycle	a	b	c	d	f	g	h	-i	i						
0															
1	-0.0059	0.0030	0.0006	0.0023	-0.054	0.0532	0.0010	-0.001	0.001	0.9941	0.0029	0.0007	0.0023	0.9472	0.0518
2	-0.0072	0.0037	0.0008	0.0027	-0.059	0.0574	0.0018	-0.001	0.001	0.9929	0.0036	0.0009	0.0027	0.9425	0.0557
3	-0.0084	0.0044	0.0009	0.0030	-0.063	0.0603	0.0024	-0.001	0.001	0.9917	0.0042	0.0011	0.0030	0.9392	0.0584
4	-0.0095	0.0051	0.0011	0.0034	-0.065	0.0624	0.0031	-0.001	0.001	0.9905	0.0049	0.0013	0.0034	0.9367	0.0603
5	-0.0107	0.0057	0.0013	0.0037	-0.068	0.0640	0.0038	-0.001	0.001	0.9894	0.0055	0.0015	0.0037	0.9345	0.0618
6	-0.0119	0.0064	0.0015	0.0040	-0.070	0.0654	0.0046	-0.001	0.001	0.9882	0.0061	0.0017	0.0040	0.9323	0.0632
7	-0.0132	0.0071	0.0017	0.0044	-0.072	0.0668	0.0055	-0.001	0.001	0.9869	0.0068	0.0019	0.0044	0.9302	0.0644
8	-0.0145	0.0078	0.0019	0.0048	-0.075	0.0683	0.0064	-0.001	0.001	0.9856	0.0075	0.0021	0.0048	0.9280	0.0658
9	-0.0159	0.0086	0.0021	0.0053	-0.077	0.0696	0.0073	-0.001	0.001	0.9842	0.0082	0.0024	0.0052	0.9259	0.0670
10	-0.0174	0.0093	0.0023	0.0057	-0.079	0.0708	0.0082	-0.001	0.001	0.9828	0.0089	0.0026	0.0057	0.9241	0.0680
11	-0.0189	0.0100	0.0026	0.0062	-0.081	0.0715	0.0091	-0.001	0.001	0.9813	0.0096	0.0029	0.0062	0.9226	0.0686
12	-0.0204	0.0108	0.0029	0.0068	-0.082	0.0717	0.0100	-0.001	0.001	0.9798	0.0102	0.0032	0.0067	0.9216	0.0688
13	-0.0220	0.0115	0.0032	0.0073	-0.082	0.0713	0.0109	-0.001	0.001	0.9783	0.0109	0.0035	0.0073	0.9211	0.0684
14	-0.0236	0.0123	0.0035	0.0079	-0.082	0.0705	0.0117	-0.001	0.001	0.9766	0.0116	0.0039	0.0079	0.9211	0.0677
15	-0.0254	0.0130	0.0038	0.0085	-0.082	0.0693	0.0126	-0.001	0.001	0.9749	0.0124	0.0042	0.0085	0.9213	0.0665
16	-0.0272	0.0138	0.0042	0.0092	-0.081	0.0680	0.0135	-0.001	0.001	0.9732	0.0131	0.0046	0.0092	0.9217	0.0652
17	-0.0291	0.0145	0.0046	0.0100	-0.081	0.0665	0.0146	-0.001	0.001	0.9713	0.0138	0.0050	0.0100	0.9222	0.0638
18	-0.0312	0.0153	0.0050	0.0109	-0.081	0.0651	0.0157	-0.001	0.001	0.9693	0.0145	0.0054	0.0108	0.9224	0.0625
19	-0.0333	0.0160	0.0054	0.0118	-0.081	0.0638	0.0170	-0.001	0.001	0.9672	0.0152	0.0058	0.0118	0.9224	0.0613
20	-0.0357	0.0168	0.0059	0.0130	-0.081	0.0628	0.0185	-0.001	0.001	0.9649	0.0158	0.0063	0.0129	0.9220	0.0602
21	-0.0382	0.0175	0.0064	0.0143	-0.082	0.0620	0.0201	-0.001	0.001	0.9625	0.0165	0.0068	0.0142	0.9211	0.0595
22	-0.0410	0.0182	0.0070	0.0158	-0.084	0.0618	0.0219	-0.001	0.001	0.9598	0.0171	0.0074	0.0157	0.9198	0.0592
23	-0.0439	0.0188	0.0077	0.0174	-0.086	0.0619	0.0237	-0.001	0.001	0.9570	0.0176	0.0081	0.0173	0.9180	0.0593
24	-0.0470	0.0192	0.0085	0.0193	-0.088	0.0623	0.0257	-0.001	0.001	0.9541	0.0180	0.0089	0.0191	0.9158	0.0596
25	-0.0504	0.0196	0.0094	0.0213	-0.091	0.0631	0.0278	-0.001	0.001	0.9509	0.0182	0.0098	0.0211	0.9131	0.0603
26	-0.0540	0.0198	0.0106	0.0237	-0.095	0.0648	0.0300	-0.001	0.001	0.9475	0.0183	0.0109	0.0233	0.9096	0.0618
27	-0.0578	0.0198	0.0118	0.0262	-0.100	0.0673	0.0324	-0.001	0.001	0.9438	0.0183	0.0121	0.0258	0.9051	0.0640
28	-0.0619	0.0197	0.0133	0.0289	-0.106	0.0709	0.0348	-0.001	0.001	0.9399	0.0182	0.0135	0.0284	0.8996	0.0673
29	-0.0663	0.0195	0.0149	0.0319	-0.113	0.0757	0.0375	-0.001	0.001	0.9359	0.0179	0.0151	0.0312	0.8929	0.0716
30	-0.0709	0.0192	0.0166	0.0351	-0.122	0.0818	0.0403	-0.001	0.001	0.9315	0.0174	0.0168	0.0343	0.8850	0.0770
31	-0.0759	0.0187	0.0185	0.0386	-0.133	0.0893	0.0432	-0.001	0.001	0.9270	0.0169	0.0186	0.0375	0.8758	0.0836
32	-0.0811	0.0181	0.0207	0.0424	-0.145	0.0984	0.0463	-0.001	0.001	0.9221	0.0162	0.0207	0.0411	0.8653	0.0916
33	-0.0868	0.0173	0.0230	0.0465	-0.159	0.1091	0.0495	-0.001	0.001	0.9169	0.0153	0.0229	0.0449	0.8533	0.1009
34	-0.0929	0.0163	0.0256	0.0509	-0.174	0.1215	0.0528	-0.001	0.001	0.9113	0.0143	0.0254	0.0490	0.8401	0.1114
35	-0.0994	0.0150	0.0286	0.0558	-0.192	0.1355	0.0562	-0.001	0.001	0.9054	0.0130	0.0281	0.0535	0.8256	0.1232
36	-0.1063	0.0134	0.0319	0.0609	-0.211	0.1514	0.0596	-0.001	0.001	0.8991	0.0115	0.0312	0.0582	0.8098	0.1364
37	-0.1137	0.0114	0.0358	0.0665	-0.232	0.1695	0.0629	-0.001	0.001	0.8925	0.0096	0.0347	0.0632	0.7926	0.1511
38	-0.1218	0.0089	0.0403	0.0726	-0.257	0.1904	0.0662	-0.001	0.001	0.8853	0.0074	0.0386	0.0686	0.7737	0.1679

Matrix Exp(D)

	State A	State B	State C	Dead
State A	0.994070947	0	0	0
State B	0	0.947241	0	0
State C	0	0	0.980199	0
Dead	0	0	0	1.000000

Matrix P(1) = U * Exp(D) * U^(-1)

	State A	State B	State C	Dead	
State A	0.9941	0.0029	-0.0130	0.0161	1.00000
State B	0	0.947241	0.032962	0.019797	1.00000
State C	0	0	0.980199	0.019801	1.00000
Dead	0	0	0	1.000000	1.00000

	From State C to ...	
Dead	**State C**	**Dead**
0.0010	0.9990	0.0010
0.0018	0.9990	0.0010
0.0024	0.9990	0.0010
0.0030	0.9990	0.0010
0.0037	0.9990	0.0010
0.0045	0.9990	0.0010
0.0053	0.9990	0.0010
0.0062	0.9990	0.0010
0.0071	0.9990	0.0010
0.0079	0.9990	0.0010
0.0088	0.9990	0.0010
0.0096	0.9990	0.0010
0.0105	0.9990	0.0010
0.0113	0.9990	0.0010
0.0121	0.9990	0.0010
0.0130	0.9990	0.0010
0.0140	0.9990	0.0010
0.0151	0.9990	0.0010
0.0164	0.9990	0.0010
0.0178	0.9990	0.0010
0.0193	0.9990	0.0010
0.0210	0.9990	0.0010
0.0228	0.9990	0.0010
0.0246	0.9990	0.0010
0.0266	0.9990	0.0010
0.0287	0.9990	0.0010
0.0308	0.9990	0.0010
0.0331	0.9990	0.0010
0.0355	0.9990	0.0010
0.0380	0.9990	0.0010
0.0405	0.9990	0.0010
0.0432	0.9990	0.0010
0.0458	0.9990	0.0010
0.0485	0.9990	0.0010
0.0512	0.9990	0.0010
0.0538	0.9990	0.0010
0.0562	0.9990	0.0010
0.0585	0.9990	0.0010

State transition model (Markov trace)				
State A	**State B**	**State C**	**Dead**	*Check*
1	0	0	0	1.00
0.994	0.003	0.001	0.002	1.00
0.987	0.006	0.002	0.005	1.00
0.979	0.010	0.003	0.008	1.00
0.969	0.014	0.005	0.011	1.00
0.959	0.019	0.007	0.015	1.00
0.948	0.023	0.010	0.019	1.00
0.935	0.028	0.013	0.023	1.00
0.922	0.033	0.017	0.028	1.00
0.907	0.038	0.021	0.033	1.00
0.892	0.043	0.026	0.039	1.00
0.875	0.048	0.032	0.044	1.00
0.857	0.054	0.038	0.051	1.00
0.839	0.059	0.045	0.058	1.00
0.819	0.064	0.052	0.065	1.00
0.799	0.069	0.060	0.073	1.00
0.777	0.074	0.068	0.081	1.00
0.755	0.079	0.076	0.090	1.00
0.732	0.084	0.085	0.099	1.00
0.708	0.088	0.094	0.109	1.00
0.683	0.093	0.104	0.120	1.00
0.657	0.097	0.114	0.132	1.00
0.631	0.100	0.125	0.144	1.00
0.604	0.103	0.136	0.158	1.00
0.576	0.105	0.147	0.172	1.00
0.548	0.106	0.159	0.187	1.00
0.519	0.107	0.171	0.203	1.00
0.490	0.106	0.184	0.220	1.00
0.460	0.105	0.198	0.237	1.00
0.431	0.102	0.212	0.256	1.00
0.401	0.097	0.227	0.274	1.00
0.372	0.092	0.242	0.294	1.00
0.343	0.086	0.258	0.313	1.00
0.315	0.078	0.274	0.333	1.00
0.287	0.070	0.291	0.352	1.00
0.260	0.062	0.307	0.371	1.00
0.233	0.053	0.323	0.390	1.00
0.208	0.044	0.339	0.408	1.00
0.184	0.036	0.354	0.425	1.00

Intermediate variables

U=					
1	b	j	k	l	m
	0.00300	-0.00019	0.00032	-0.04826	-0.00026
	0.00369	-0.00026	0.00042	-0.05207	-0.00035
	0.00438	-0.00032	0.00052	-0.05438	-0.00044
	0.00505	-0.00039	0.00062	-0.05590	-0.00053
	0.00572	-0.00045	0.00073	-0.05709	-0.00062
	0.00640	-0.00052	0.00083	-0.05816	-0.00071
	0.00710	-0.00059	0.00095	-0.05918	-0.00081
	0.00782	-0.00067	0.00108	-0.06018	-0.00092
	0.00856	-0.00075	0.00122	-0.06105	-0.00104
	0.00930	-0.00084	0.00137	-0.06163	-0.00116
	0.01004	-0.00092	0.00152	-0.06173	-0.00128
	0.01078	-0.00100	0.00167	-0.06127	-0.00139
	0.01153	-0.00108	0.00181	-0.06020	-0.00150
	0.01228	-0.00115	0.00194	-0.05859	-0.00160
	0.01303	-0.00121	0.00208	-0.05656	-0.00169
	0.01379	-0.00128	0.00222	-0.05428	-0.00178
	0.01454	-0.00133	0.00236	-0.05191	-0.00187
	0.01529	-0.00139	0.00252	-0.04962	-0.00196
	0.01604	-0.00146	0.00269	-0.04749	-0.00206
	0.01678	-0.00153	0.00290	-0.04554	-0.00218
	0.01750	-0.00161	0.00314	-0.04390	-0.00231
	0.01816	-0.00170	0.00343	-0.04263	-0.00247
	0.01876	-0.00181	0.00376	-0.04169	-0.00265
	0.01924	-0.00194	0.00414	-0.04099	-0.00287
	0.01957	-0.00208	0.00458	-0.04059	-0.00312
	0.01976	-0.00227	0.00511	-0.04080	-0.00343
	0.01982	-0.00250	0.00576	-0.04184	-0.00383
	0.01975	-0.00279	0.00655	-0.04385	-0.00432
	0.01954	-0.00315	0.00751	-0.04694	-0.00495
	0.01920	-0.00358	0.00866	-0.05120	-0.00572
	0.01872	-0.00411	0.01006	-0.05674	-0.00669
	0.01810	-0.00475	0.01174	-0.06360	-0.00789
	0.01731	-0.00552	0.01377	-0.07184	-0.00936
	0.01631	-0.00642	0.01619	-0.08142	-0.01116
	0.01504	-0.00749	0.01905	-0.09232	-0.01333
	0.01343	-0.00874	0.02243	-0.10464	-0.01594
	0.01141	-0.01022	0.02643	-0.11866	-0.01910
	0.00892	-0.01199	0.03125	-0.13485	-0.02300

			Uinverse											
n	o	p		q	r	s	u	v	w	x	y	z	expa	expff	exp-i
0.00032	-0.00026	0.00032	1	0.06208	-0.79236	-0.26972	-20.72307	20.72556	-0.00249	-3799.75550	3799.75550	3102.47190	0.99407095	0.94724065	0.9990005
0.00042	-0.00036	0.00042	1	0.07082	-0.78543	-0.28539	-19.20503	18.93809	0.26694	-2783.13729	2783.13729	2354.51763	0.99285614	0.9424813	0.9990005
0.00052	-0.00045	0.00052	1	0.08045	-0.78708	-0.29337	-18.38773	17.96153	0.42620	-2199.59051	2199.59051	1905.70650	0.99167207	0.93918115	0.9990005
0.00062	-0.00055	0.00062	1	0.09036	-0.79067	-0.29969	-17.88864	17.31412	0.57452	-1818.80538	1818.80538	1603.13281	0.99051239	0.93666058	0.9990005
0.00073	-0.00065	0.00073	1	0.10025	-0.79357	-0.30667	-17.51617	16.77965	0.73653	-1543.16950	1543.16950	1378.33875	0.98935506	0.93445473	0.9990005
0.00083	-0.00075	0.00083	1	0.11005	-0.79521	-0.31484	-17.19413	16.29043	0.90370	-1328.38212	1328.38212	1199.39162	0.98816993	0.93233788	0.9990005
0.00095	-0.00087	0.00095	1	0.11991	-0.79568	-0.32422	-16.89632	15.82986	1.06645	-1152.63920	1152.63920	1050.33271	0.98692592	0.9302101	0.9990005
0.00108	-0.00099	0.00108	1	0.12990	-0.79544	-0.33446	-16.61679	15.39808	1.21871	-1005.77020	1005.77020	923.84436	0.98560935	0.92804477	0.9990005
0.00122	-0.00113	0.00122	1	0.14014	-0.79502	-0.34512	-16.37977	15.01820	1.36157	-883.84974	883.84974	817.48814	0.98422849	0.92593791	0.9990005
0.00137	-0.00128	0.00137	1	0.15088	-0.79466	-0.35622	-16.22713	14.72364	1.50349	-784.26256	784.26256	729.70736	0.98279768	0.92406099	0.9990005
0.00152	-0.00142	0.00152	1	0.16260	-0.79511	-0.36748	-16.19861	14.54595	1.65266	-703.89981	703.89981	658.28787	0.98132567	0.92257685	0.9990005
0.00167	-0.00156	0.00167	1	0.17595	-0.79719	-0.37876	-16.32211	14.50205	1.82006	-639.16068	639.16068	600.38035	0.9798104	0.92158266	0.9990005
0.00181	-0.00170	0.00181	1	0.19146	-0.80100	-0.39046	-16.61234	14.59599	2.01635	-586.82411	586.82411	553.32255	0.97825012	0.92110053	0.9990005
0.00194	-0.00184	0.00194	1	0.20953	-0.80619	-0.40334	-17.06872	14.81678	2.25194	-543.56086	543.56086	514.24418	0.9766302	0.9210565	0.9990005
0.00208	-0.00197	0.00208	1	0.23039	-0.81232	-0.41808	-17.68159	15.14645	2.53514	-506.63721	506.63721	480.74012	0.974934	0.92132585	0.9990005
0.00222	-0.00211	0.00222	1	0.25397	-0.81896	-0.43501	-18.42275	15.55371	2.86904	-473.98098	473.98098	450.95983	0.97315569	0.92174018	0.9990005
0.00236	-0.00225	0.00236	1	0.28005	-0.82541	-0.45464	-19.26292	16.00070	3.26223	-444.19177	444.19177	423.64859	0.9712932	0.92215671	0.9990005
0.00252	-0.00241	0.00252	1	0.30812	-0.83091	-0.47721	-20.15422	16.43831	3.71591	-415.72094	415.72094	397.39535	0.96932599	0.92240425	0.9990005
0.00269	-0.00258	0.00269	1	0.33778	-0.83502	-0.50276	-21.05782	16.83325	4.22456	-387.47080	387.47080	371.19614	0.96721662	0.92235869	0.9990005
0.00290	-0.00278	0.00290	1	0.36850	-0.83726	-0.53124	-21.95722	17.17375	4.78347	-359.23412	359.23412	344.87155	0.9649359	0.92197543	0.9990005
0.00314	-0.00302	0.00314	1	0.39859	-0.83714	-0.56145	-22.78076	17.41925	5.36151	-330.89326	330.89326	318.31833	0.96247711	0.92114142	0.9990005
0.00343	-0.00330	0.00343	1	0.42604	-0.83425	-0.59179	-23.45535	17.53503	5.92032	-302.71785	302.71785	291.79970	0.95984449	0.91978236	0.9990005
0.00376	-0.00363	0.00376	1	0.44996	-0.82873	-0.62123	-23.98852	17.54378	6.44474	-275.57874	275.57874	266.15473	0.95704994	0.91797392	0.9990005
0.00414	-0.00400	0.00414	1	0.46927	-0.82013	-0.64914	-24.39441	17.46606	6.92835	-249.89600	249.89600	241.79952	0.95408749	0.91576738	0.9990005
0.00458	-0.00444	0.00458	1	0.48212	-0.80808	-0.67404	-24.63491	17.29451	7.34040	-225.28811	225.28811	218.38568	0.95089598	0.91306939	0.9990005
0.00511	-0.00497	0.00511	1	0.48431	-0.79135	-0.69296	-24.50758	16.92557	7.58201	-201.33523	201.33523	195.51949	0.9474628	0.90958093	0.9990005
0.00576	-0.00561	0.00576	1	0.47368	-0.76931	-0.70437	-23.89995	16.30678	7.59317	-178.30607	178.30607	173.46517	0.94380519	0.90513009	0.9990005
0.00655	-0.00639	0.00655	1	0.45033	-0.74203	-0.70831	-22.80746	15.44170	7.36576	-156.59993	156.59993	152.61525	0.93993881	0.89961733	0.9990005
0.00751	-0.00733	0.00751	1	0.41626	-0.71048	-0.70578	-21.30456	14.37716	6.92741	-136.46440	136.46440	133.21890	0.93585662	0.8929441	0.9990005
0.00866	-0.00847	0.00866	1	0.37493	-0.67640	-0.69854	-19.52999	13.19308	6.33691	-118.08384	118.08384	115.46546	0.93153828	0.88504101	0.9990005
0.01006	-0.00985	0.01006	1	0.32996	-0.64153	-0.68842	-17.62537	11.96677	5.65860	-101.52959	101.52959	99.43538	0.92695478	0.87582682	0.9990005
0.01174	-0.01152	0.01174	1	0.28455	-0.60735	-0.67719	-15.72243	10.76597	4.95646	-86.82699	86.82699	85.16424	0.92207464	0.86525372	0.9990005
0.01377	-0.01352	0.01377	1	0.24093	-0.57466	-0.66627	-13.92069	9.63714	4.28355	-73.94552	73.94552	72.63276	0.91686668	0.85331314	0.9990005
0.01619	-0.01592	0.01619	1	0.20030	-0.54384	-0.65646	-12.28267	8.61002	3.67265	-62.81416	62.81416	61.78127	0.91131114	0.84005627	0.9990005
0.01905	-0.01876	0.01905	1	0.16290	-0.51492	-0.64797	-10.83181	7.69653	3.13528	-53.30743	53.30743	52.49570	0.90540493	0.8255597	0.9990005
0.02243	-0.02211	0.02243	1	0.12833	-0.48771	-0.64063	-9.55669	6.88947	2.66723	-45.22844	45.22844	44.59062	0.89914506	0.80981488	0.9990005
0.02643	-0.02609	0.02643	1	0.09613	-0.46198	-0.63415	-8.42720	6.17115	2.25605	-38.33397	38.33397	37.83342	0.89249488	0.79263067	0.9990005
0.03125	-0.03087	0.03125	1	0.06613	-0.43762	-0.62851	-7.41541	5.52388	1.89153	-32.38959	32.38959	31.99844	0.8853464	0.77365395	0.9990005