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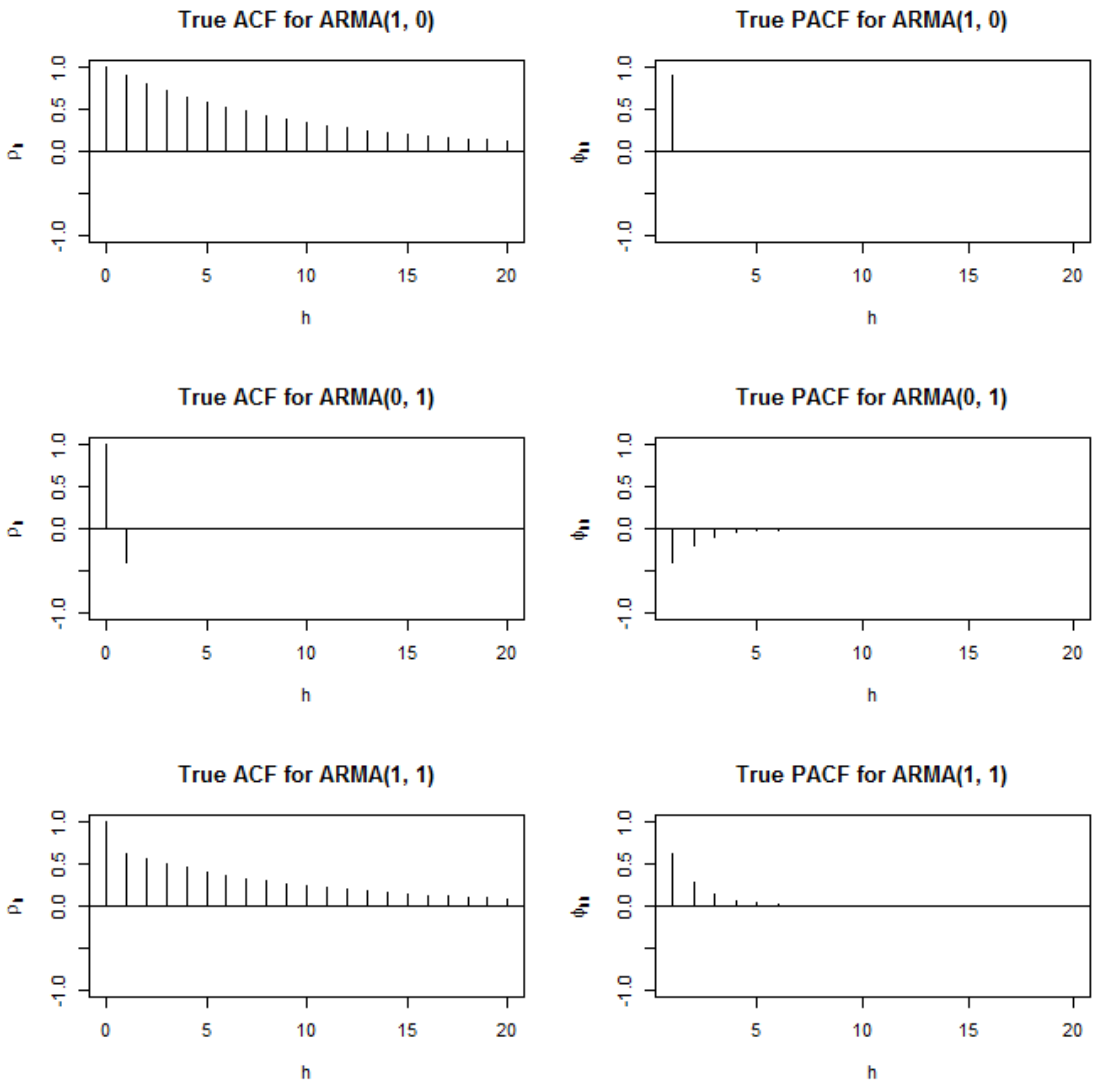
Appendix – A: Ageing population dataset

Year	Aging Population (in '000)	Year	Aging Population (in '000)	Year	Aging Population (in '000)
1950	409	1972	817	1994	1184
1951	419	1973	841	1995	1199
1952	430	1974	856	1996	1212
1953	437	1975	856	1997	1226
1954	453	1976	872	1998	1244
1955	305	1977	888	1999	1258
1956	313	1978	900	2000	1264
1957	319	1979	917	2001	1738
1958	327	1980	936	2002	1770
1959	337	1981	986	2003	1793
1960	346	1982	1008	2004	1795
1961	354	1983	1022	2005	1814
1962	365	1984	1036	2006	1834
1963	621	1985	1052	2007	1852
1964	643	1986	1067	2008	1870
1965	658	1987	1083	2009	1893
1966	686	1988	1099	2010	1909
1967	690	1989	1113	2011	1930
1968	706	1990	1129	2012	2521
1969	728	1991	1141	2013	2548
1970	743	1992	1152	2014	2571
1971	807	1993	1167	2015	2593
				2016	2623

Appendix – B: Theoretical autocorrelation and partial autocorrelation plots for AR(1), MA(1) and ARMA(1,1)



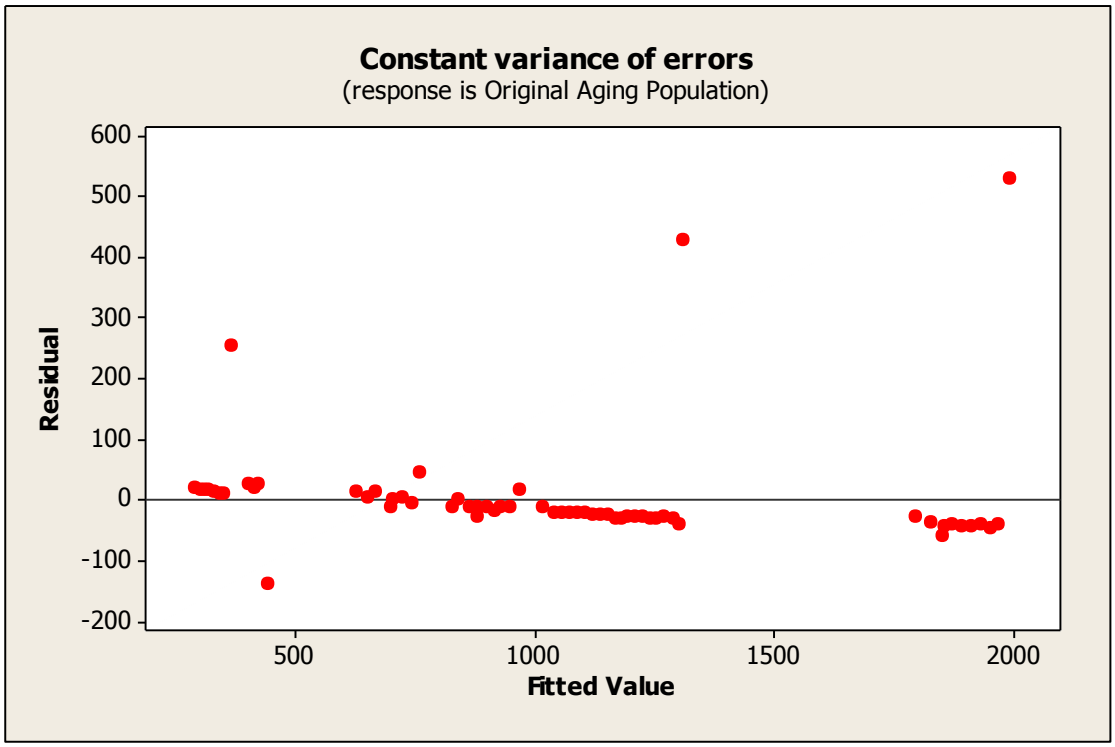
Appendix – C: Diagnostic checks of residuals of ARIMA(0,2,1) model

Q statistics

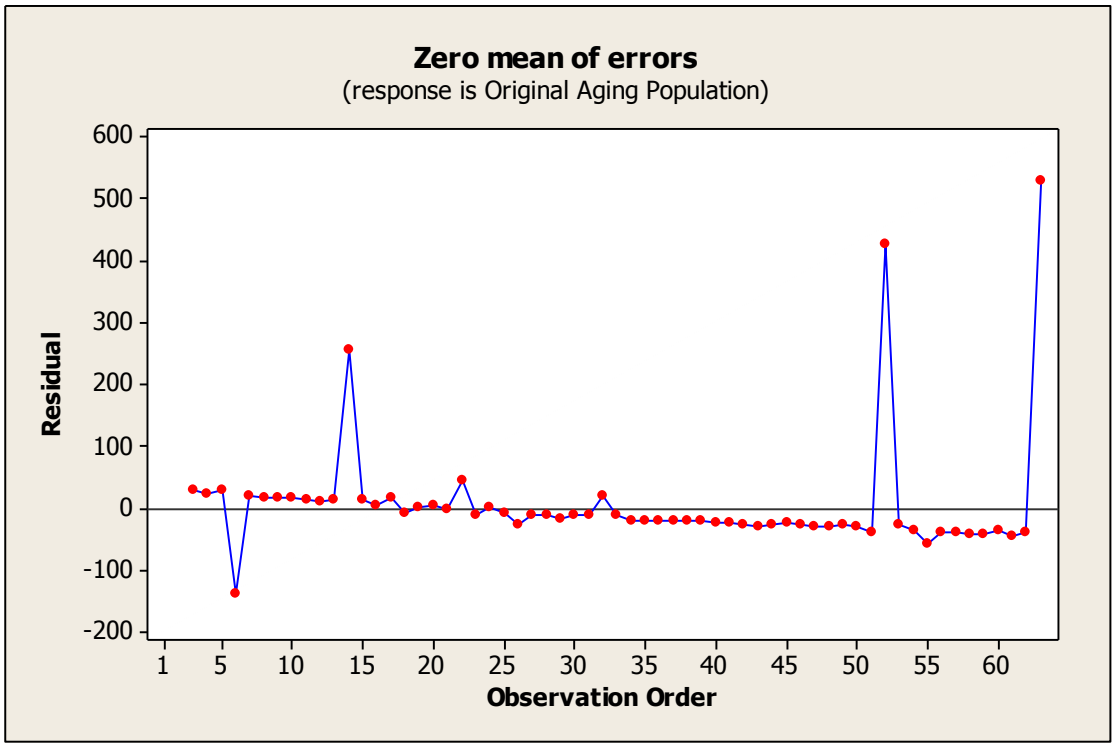
Date: 05/04/17 Time: 22:59
Sample: 1950 2012
Included observations: 61
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.037	-0.037	0.0859	
. | . |	. | . |	2	-0.044	-0.045	0.2115	0.646
. | . |	. | . |	3	-0.048	-0.052	0.3668	0.832
. | . |	. | . |	4	-0.054	-0.060	0.5619	0.905
. | . |	. | . |	5	-0.047	-0.057	0.7167	0.949
. | . |	. | . |	6	-0.047	-0.061	0.8728	0.972
. | . |	.*| . |	7	-0.049	-0.067	1.0442	0.984
.*| . |	.*| . |	8	-0.112	-0.135	1.9461	0.963
. | . |	.*| . |	9	-0.059	-0.096	2.2054	0.974
. | . |	.*| . |	10	-0.040	-0.087	2.3256	0.985
. |*** |	. |*** |	11	0.401	0.371	14.701	0.143
. | . |	. | . |	12	-0.025	-0.025	14.748	0.194
. | . |	. | . |	13	-0.014	-0.009	14.764	0.255
. | . |	. | . |	14	-0.013	-0.013	14.777	0.321
. | . |	. | . |	15	-0.017	0.001	14.800	0.392
. | . |	. | . |	16	-0.029	-0.024	14.873	0.461
. | . |	. | . |	17	-0.013	-0.000	14.887	0.533
. | . |	. | . |	18	-0.004	0.015	14.889	0.603
. | . |	. |*. |	19	-0.010	0.079	14.897	0.669
. | . |	. | . |	20	0.009	0.058	14.904	0.729
. | . |	. | . |	21	-0.020	0.014	14.943	0.780
. | . |	**| . |	22	-0.018	-0.215	14.976	0.824
. | . |	. | . |	23	-0.026	-0.025	15.042	0.860
. | . |	. | . |	24	-0.021	-0.034	15.088	0.891
. | . |	. | . |	25	-0.022	-0.025	15.139	0.917
. | . |	.*| . |	26	-0.046	-0.071	15.372	0.932
. | . |	. | . |	27	-0.025	-0.019	15.442	0.949
. | . |	. | . |	28	-0.020	-0.037	15.487	0.962

Results of constant variance of ARIMA (0,2,1) model



Results of zero mean of ARIMA (0,2,1) model



Appendix – D: Calculating initial values for level and trend in double exponential smoothing using Minitab

According to Minitab technical support document (2010) Minitab calculates back to the initial observation, using data from later observations:

$$p_2 = 2x_3 - x_4 - (MA_1 * e_3) - (MA_2 * e_4)$$

$$e_2 = x_2 - p_2$$

$$p_1 = 2x_2 - x_3 - (MA_1 * e_2) - MA_2 * e_3$$

$$e_1 = x_1 - p_1$$

Where:

pi = the predicted value of the i[th] smoothed observation

xi = the value of the i[th] observation in your time series

ei = the value of the i[th] residual, stored from the ARIMA

Minitab calculates the initial value for level (L_1) according to this formula:

$$L_1 = p_1 + w_1 * (e_1)$$

Minitab calculates the initial value for trend (T_1) according to this formula:

$$T_1 = p_2 - L_1$$

Appendix – E: Percentage Errors for training dataset (DES model)

Year	Ageing Population	Fitted through DES	% Errors	Year	Ageing Population	Fitted through DES	% Errors
1950	409	417.27	-2.02	1982	1008	1005.02	0.30
1951	419	428.55	-2.28	1983	1022	1028.17	-0.60
1952	430	435.94	-1.38	1984	1036	1042.24	-0.60
1953	437	446.65	-2.21	1985	1052	1055.98	-0.38
1954	453	453.37	-0.08	1986	1067	1071.73	-0.44
1955	305	469.02	-53.78	1987	1083	1086.56	-0.33
1956	313	319.98	-2.23	1988	1099	1102.36	-0.31
1957	319	321.97	-0.93	1989	1113	1118.21	-0.47
1958	327	327.70	-0.21	1990	1129	1132.06	-0.27
1959	337	335.59	0.42	1991	1141	1147.85	-0.60
1960	346	345.57	0.12	1992	1152	1159.69	-0.67
1961	354	354.62	-0.18	1993	1167	1170.40	-0.29
1962	365	362.64	0.65	1994	1184	1185.10	-0.09
1963	621	373.63	39.83	1995	1199	1201.96	-0.25
1964	643	631.25	1.83	1996	1212	1216.91	-0.40
1965	658	662.33	-0.66	1997	1226	1229.77	-0.31
1966	686	677.73	1.21	1998	1244	1243.57	0.03
1967	690	705.62	-2.26	1999	1258	1261.43	-0.27
1968	706	709.83	-0.54	2000	1264	1275.43	-0.90
1969	728	725.23	0.38	2001	1738	1281.23	26.28
1970	743	747.11	-0.55	2002	1770	1757.66	0.70
1971	807	762.19	5.55	2003	1793	1806.35	-0.74
1972	817	826.32	-1.14	2004	1795	1829.72	-1.93
1973	841	837.89	0.37	2005	1814	1831.02	-0.94
1974	856	861.57	-0.65	2006	1834	1848.65	-0.80
1975	856	876.65	-2.41	2007	1852	1867.94	-0.86
1976	872	876.32	-0.50	2008	1870	1885.31	-0.82
1977	888	891.54	-0.40	2009	1893	1902.63	-0.51
1978	900	907.36	-0.82	2010	1909	1925.01	-0.84
1979	917	919.18	-0.24	2011	1930	1940.56	-0.55
1980	936	935.90	0.01	2012	2521	1960.92	22.22
1981	986	954.82	3.16				

Appendix – F: Percentage Errors for training dataset (Growth model)

Year	Ageing Population	Forecasted	% Errors	Year	Ageing Population	Forecasted	% Errors
1950	409	361.2	11.70	1982	1008	914.4	9.28
1951	419	371.8	11.26	1983	1022	941.4	7.89
1952	430	382.8	10.99	1984	1036	969.1	6.46
1953	437	394.0	9.83	1985	1052	997.6	5.17
1954	453	405.6	10.46	1986	1067	1027.0	3.75
1955	305	417.6	-36.91	1987	1083	1057.3	2.38
1956	313	429.9	-37.34	1988	1099	1088.4	0.96
1957	319	442.5	-38.73	1989	1113	1120.5	-0.67
1958	327	455.6	-39.32	1990	1129	1153.5	-2.17
1959	337	469.0	-39.17	1991	1141	1187.5	-4.07
1960	346	482.8	-39.54	1992	1152	1222.4	-6.11
1961	354	497.0	-40.41	1993	1167	1258.4	-7.84
1962	365	511.7	-40.19	1994	1184	1295.5	-9.42
1963	621	526.8	15.18	1995	1199	1333.7	-11.23
1964	643	542.3	15.67	1996	1212	1372.9	-13.28
1965	658	558.2	15.16	1997	1226	1413.4	-15.28
1966	686	574.7	16.23	1998	1244	1455.0	-16.96
1967	690	591.6	14.26	1999	1258	1497.9	-19.07
1968	706	609.0	13.73	2000	1264	1542.0	-21.99
1969	728	627.0	13.88	2001	1738	1587.4	8.66
1970	743	645.4	13.13	2002	1770	1634.2	7.67
1971	807	664.5	17.66	2003	1793	1682.3	6.17
1972	817	684.0	16.28	2004	1795	1731.9	3.52
1973	841	704.2	16.27	2005	1814	1782.9	1.72
1974	856	724.9	15.31	2006	1834	1835.4	-0.08
1975	856	746.3	12.82	2007	1852	1889.5	-2.02
1976	872	768.3	11.90	2008	1870	1945.1	-4.02
1977	888	790.9	10.94	2009	1893	2002.4	-5.78
1978	900	814.2	9.54	2010	1909	2061.4	-7.98
1979	917	838.2	8.60	2011	1930	2122.1	-9.95
1980	936	862.8	7.82	2012	2521	2184.6	13.34
1981	986	888.3	9.91				

Appendix – G: Percentage Errors for training dataset (ARIMA 0,2,1)

Year	Ageing Population	Forecast	% Error	Year	Ageing Population	Forecast	% Error
1950	409			1982	1008	1019.07	-1.10
1951	419			1983	1022	1042.13	-1.97
1952	430	402.46	6.40	1984	1036	1056.94	-2.02
1953	437	415.62	4.89	1985	1052	1071.72	-1.87
1954	453	424.61	6.27	1986	1067	1088.54	-2.02
1955	305	442.79	-45.18	1987	1083	1104.30	-1.97
1956	313	292.25	6.63	1988	1099	1121.08	-2.01
1957	319	302.22	5.26	1989	1113	1137.83	-2.23
1958	327	310.08	5.18	1990	1129	1152.50	-2.08
1959	337	319.93	5.06	1991	1141	1169.21	-2.47
1960	346	331.80	4.11	1992	1152	1181.78	-2.59
1961	354	342.58	3.23	1993	1167	1193.32	-2.25
1962	365	352.28	3.49	1994	1184	1208.94	-2.11
1963	621	365.02	41.22	1995	1199	1226.61	-2.30
1964	643	629.67	2.07	1996	1212	1242.21	-2.49
1965	658	653.42	0.70	1997	1226	1255.73	-2.42
1966	686	669.93	2.34	1998	1244	1270.26	-2.11
1967	690	699.76	-1.41	1999	1258	1288.89	-2.46
1968	706	704.86	0.16	2000	1264	1303.39	-3.12
1969	728	722.27	0.79	2001	1738	1309.65	24.65
1970	743	745.81	-0.38	2002	1770	1797.19	-1.54
1971	807	762.11	5.56	2003	1793	1829.80	-2.05
1972	817	828.76	-1.44	2004	1795	1853.13	-3.24
1973	841	839.80	0.14	2005	1814	1854.86	-2.25
1974	856	865.22	-1.08	2006	1834	1874.07	-2.18
1975	856	881.33	-2.96	2007	1852	1894.31	-2.28
1976	872	881.99	-1.15	2008	1870	1912.49	-2.27
1977	888	899.08	-1.25	2009	1893	1930.66	-1.99
1978	900	916.14	-1.79	2010	1909	1953.96	-2.36
1979	917	929.06	-1.32	2011	1930	1970.06	-2.08
1980	936	947.10	-1.19	2012	2521	1991.30	21.01
1981	986	967.16	1.91				