Life Expectancy during the Great Depression in Eleven European Countries

Tim A. Bruckner[1]

Andrew Noymer[2]

Ralph A. Catalano[3]

[1] Public Health & Planning, Policy and Design

University of California, Irvine

Irvine, CA 92697, USA

[2] Department of Sociology and Program in Public Health

University of California, Irvine

Irvine, CA 92697, USA

and World Population Program, IIASA, Laxenburg, Austria

[3] School of Public Health

University of California at Berkeley

Berkeley, California 94720, USA

Corresponding author:

Tim A. Bruckner, Ph.D.

Email: tim.bruckner@uci.edu

Telephone: 949 824 5797

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ABSTRACT

The global economic recession has renewed interest in knowing whether a declining economy affects population health. Understanding the extreme case of the Great Depression, the worst economic downturn in the 20th century, may inform the current debate as well as theory regarding biological and behavioral adaptations to unwanted economic change. We test the hypothesis, recently suggested in the literature, that period life expectancy at birth *improved* during the Great Depression. We applied time-series methods to annual period life expectancy data of the civilian population from eleven European countries: Denmark, England and Wales, Finland, France, Iceland, Italy, the Netherlands, Norway, Scotland, Sweden, and Switzerland. Our methods control for trends and other forms of autocorrelation in life expectancy that could induce spurious associations. We find that period life expectancy at birth during the Great Depression generally remains within the interval forecasted from historical values. Additional analyses using an automated, rule-based methodology also indicate no perturbation in life expectancy. During the most crippling phase of the Great Depression, period life expectancy in eleven European countries generally did not rise above expected levels.

Key words: Great Depression, economic decline, mortality, life expectancy, life table, Europe

Abbreviations: ARIMA- autoregressive integrated moving average

INTRODUCTION

The global recession has reinvigorated the longstanding yet unresolved debate over the association between macroeconomic change and population health (Catalano 2009; Bezruchka 2009; Ruhm 2007; Edwards 2005; Tapia Granados 2005). One element of this debate focuses on the consequences of economic crises such as the Great Depression (Stuckler et al. 2009). The Great Depression refers to the period after a calamitous crash on October 29, 1929 of the United States stock market. This unprecedented downturn, which reverberated across the Atlantic to Europe, led to record high unemployment rates, a fall in real income and assets, and declines in economic productivity (Kindleberger 1986).

Scholars have argued that measuring the potential health effects of the extreme case of the Great Depression may inform both contemporary population health as well as theory regarding behavioral adaptations to unwanted economic change (Tapia Granados and Diez Roux 2009; Elder 1974). Although extensive research finds that more subtle fluctuations in the national economy covary with population mortality, societies may react to extreme events in ways not anticipated by mere extrapolation of responses to these small fluctuations (Brenner 1979; Catalano and Serxner, 1992; Neumayer 2004; Ruhm 2007; Tapia Granados 2005). Moreover, historians such as Elder have noted that " . . . it is generally agreed that the Great Depression was a crisis . . . more generally in industrialized, Western societies; to study crises of this sort is to explore the incipient process of adaptation and change (Elder p.9)." These circumstances imply that a focus on mortality responses to the extreme case of the Great Depression deserves closer scrutiny by scholars concerned with macroeconomic fluctuations and health.

In a recent analysis of mortality during the Great Depression, Tapia Granados and Diez Roux (2009) examine the relation between Gross Domestic Product and period life expectancy in the United States from 1920 to 1940. The authors find that life expectancy improved during the Great Depression (1930-33) but stagnated when the economy expanded (1934-36). Descriptive reports during the 1930s in the U.S. also noted declines in mortality during the Great Depression (Weihl 1935; Sydenstricker 1933).

While these findings may have implications for the debate over the health effects of US economic policy, their external validity and, therefore, their meaning for theories of population health remain unclear. Many European countries (e.g., Great Britain) had strong ties to the U.S. economy and witnessed sharp rises in unemployment, falls in Gross Domestic Product, and decline in real wages (Saint-Etienne 1984). Countries relatively less integrated with the U.S. economy (e.g., France, Scandinavian countries) experienced economic downturns of similar magnitude which began around 1931, slightly after the start of the Great Depression in the U.S. (Mitchell 1980; Hodne and Grytten 2002; Krantz 2002). The ripple effect on Western European economies seemed inevitable, as the U.S. economy represented 42.5% of global manufacturing output from 1925-1929 (Saint-Etienne 1984). The shared experience of the Great Depression suggests that by examining life expectancy in European societies, researchers could assess how well the U.S. experience pertains to other countries.

We test whether period life expectancy in European countries rose above expected values during the initial and most economically perturbing phase of Great Depression (1930-1934). Our test populations include residents of eleven countries that kept high-quality registration of mortality data from at least 1878 and experienced stark economic downturns. We analyze males and females separately because the sexes exhibit different temporal variation in life expectancy and also may respond differently to economic downturns.

Our analysis builds upon previous reports in two ways. First, we use mortality data that have been calculated with consistent demographic conventions to allow comparability over time and across societies. Second, we employ time series methods that remove temporal patterns in period life expectancy before examining the effect of the Great Depression.

Our approach intends to move beyond inferential statements regarding whether or not life expectancy increased or decreased during the Great Depression. In historical perspective, life expectancy time series have been characterized as highly variable (White 2002). For this reason, an increase (or decrease) in life expectancy in a given year may not permit simple interpretation in substantive terms. The same case holds for two or more consecutive years of increases or decreases. To use a crude analogy, in repeated coin flips, four heads in a row does not provide persuasive evidence of an unfair coin. The time-series method we employ here allows us to examine whether the changes seen in period life expectancy during the Great Depression are unusual given the past history of the time series we examine.

METHODS

Variables and Data

Period life expectancy serves as a cross-sectional summary of the mortality experience at all ages. We used as the dependent variable annual period life expectancy for the civilian (i.e., non-military) population, separately for males and females. We acquired these data from the Human Mortality Database (HMD) (www.mortality.org). The HMD includes countries only if their census and vital registration systems meet basic quality standards for accurate reporting. We refer the reader to the Human Mortality Database Methods Protocol which describes the methodology for calculating period life expectancy (Wilmoth et al. 2010).

Interrupted time-series methods, described below, require 50 consecutive observations prior to the interruption (Box, Jenkins, and Reinsel 1994). Researchers typically characterize the onset of the Great Depression as occurring in late 1929 or 1930. We selected countries for analysis only if the HMD includes period life expectancy at birth for at least 50 years before the Great Depression (i.e., from 1878 or earlier). This selection criterion yielded the following eleven countries for analysis: Denmark, England and Wales, Finland, France, Iceland, Italy, the Netherlands, Norway, Scotland, Sweden, and Switzerland. All of these countries experienced stark economic decline during the Great Depression (Mitchell 1980; Hodne and Grytten 2002; Krantz 2002; Villa 1995).

The exact timing of the Great Depression varied from country to country, and economists continue to debate the year of its onset (Temin 1993; Eichengreen and Sachs 1985). We used a basic decision rule to define the start and end year of the Great Depression on a country-by-country basis. We defined the start year for each country as the first year after the U.S. stock market crash in late 1929 in which national GDP per head fell below the value from the previous year. This start window adheres to the operational definition used in the literature (Tapia Granados and Diez Roux 2009). We defined the end of the Great Depression as the first subsequent year in which the GDP per head exceeded that country's pre-depression level, or the year 1934, whichever came first. We retrieved GDP data from the Maddison database (2010).

We use Sweden to illustrate our decision rule. The first year after 1929 with a negative change in GDP per head was 1931. The first year in which GDP per head returned to pre-1930 levels was 1934. Thus, for Sweden, we date the Great Depression as 1931-33, inclusive. Iceland serves as the only test country with no publicly available GDP data over this time period. We, therefore, assumed the same timing of the Great Depression in Iceland as in Sweden and Norway.

Analyses

Our test turns on whether the observed values of period life expectancy differ from the values expected under the null hypothesis of no perturbation in life expectancy during the Great Depression. Life expectancy in the late 19th and early 20th centuries trends upward and exhibits the tendency to remain elevated or depressed or to oscillate after high or low values. These patterns, typically referred to as autocorrelation, complicate hypothesis tests because the expected value of an autocorrelated series is often not its mean.

We used methods that address this problem by identifying temporal patterns and expressing them as an effect of earlier values in the dependent variable itself (Box, Jenkins, and Reinsel 1994). This data-driven time-series approach, referred to as Autoregressive, Integrated, Moving Average (ARIMA) modeling, identifies and removes autocorrelation from the dependent variable series such that (1) the expected value of the residuals is 0, and (2) the residual annual observations are statistically independent of one another.

We believe that much of the divergence in research into the association between contracting economies and mortality arises from differences in method. The field has not adopted a convention for measuring the association between economic and mortality time series although candidates for such a convention have been proposed in the last decade (De Gooijer and Hyndman 2006; Mélard and Pasteels 2000; Tran and Reed 2004; Valenzuela et al. 2004). This circumstance raises the question of whether researchers choose methods that yield results they favor. We tried to address this problem by using two analytic routines. First, we, as all authors have in this field, used our judgment in identifying and modeling autocorrelation in the mortality time series. Second, we applied a more automated, rule-based approach that uses relatively little researcher discretion and can be replicated exactly by any researcher with access to the data and the software.

The approach that uses relatively more researcher discretion implements strategies devised by Dickey and Fuller (1979) as well as Box and Jenkins (1994) to identify and model patterns in annual period life expectancy for the 50 years prior to 1929. The Dickey-Fuller routines detect non-stationarity. Box and Jenkins methods model trends by differencing a series (i.e., subtracting the values of each year from those of the next year). The Box and Jenkins approach also uses autoregressive (AR) and moving average (MA) parameters to model other forms of autocorrelation. AR parameters best describe the tendency for high or low values to exhibit "memory" into subsequent periods, whereas MA parameters parsimoniously describe the tendency for high or low values to exhibit an "echo" into following periods but last for a shorter duration than do autoregressive patterns. Integrated patterns indicate a non-stationary mean.

For each country and separately for each sex, we identified and estimated models of period life expectancy for the 50 years prior to 1929. Next, we added to this model the Great Depression variable for years from 1930 to 1934, inclusive (depending on the country). We then repeated our time-series estimations for the 60 year time span that includes the Great Depression (i.e., 1878 to 1937).

Outliers in period life expectancy other than any associated with the Great Depression may inflate standard errors and induce a type II error. In the 50 years prior to 1929, several events in Europe (e.g., the worldwide 1918 influenza pandemic and civilian deaths during World War I in Europe) may have perturbed period life expectancy in the civilian population sufficiently to create outlying values. To control for potential outliers, we added a binary variable for the 1918 Influenza pandemic to the final equations and applied iterative outlier detection and adjustment routines to the residuals (Chang, Tiao, and Chen 1988).

The steps described above required that we estimate, separately for each country and each sex (i.e., 11 countries X 2 sexes = 22 tests), the following equation:

$$\Delta_d e^0{}_t = c + \left(\omega_0 + \omega_1 B + \omega_2 B^2 + \omega_3 B^3 + \omega_4 B^4\right)\Delta_d I_t + \omega_4 \Delta_d F_t + \frac{\left(1-\theta B^q\right)}{\left(1-\phi B^p\right)} a_t \qquad [1]$$

Δ_d is the difference operator that indicates the variable has been differenced at order d (i.e., value at time t subtracted from value at time t+d). With annual time series, a detected difference operator typically is of order one (d=1).

$e^0{}_t$ is period life expectancy of the synthetic cohort during year t.

c is a constant

I_t is the binary “Great Depression” variable scored 1 for the start year and 0 otherwise.

B^n is the value of the variable at year t+n.

ω_0 to ω_4 are the estimated parameters for the Great Depression variable (from 1930 to 1934, depending on the country’s circumstance).

F_t is the binary Flu pandemic variable scored 1 for 1918 and 0 otherwise.

ω_4 is the estimated parameter for the 1918 Flu pandemic variable.

θB^q, or "moving average" parameter, implies that a proportion (estimated by θ that is always less than 1) of the error term at year t of the model is "remembered" into t+p.

ϕB^p or "autoregressive" parameter, implies that a proportion (estimated by ϕ that is always less than 1) of the estimated value of y at year t is "remembered" into t+q.

a_t is the error term at year t.

As noted above, we conducted a second test that requires no researcher discretion in the application of ARIMA modeling rules. More specifically, we apply widely disseminated software that uses decision rules agreed among time-series analysts to detect and model autocorrelation. We used Scientific Computing Associates time-series analysis software (Oak Brook, IL, USA) because of its wide availability and automated implementation of expert-system univariate identification and modeling as well as of outlier detection routines (Chang, Tiao, and Chen 1988; Liu 2009). The literature includes several interrupted time-series tests that use this software (Cunningham and Liu 2008; Cunningham, Liu, and Muramoto 2008).

The automated approach identifies the best fitting ARIMA model for period life expectancy of males and females for each of our populations for the years 1878 through 1928. The software also uses Chang's, Tiao's, and Chen's outlier detection routines (1988) to discover any years from 1878 through 1934 in which the observed values fell outside the 95% confidence interval (2-tailed test) of the expected values. If the Great Depression induced salutary behavior and improved period life expectancy, we would find outliers above the 95% confidence level some time between 1930 and 1934. We refer the reader to the Appendix for a detailed description of the procedure.

RESULTS

Table 1 shows the mean, standard deviation, and range of period life expectancy over the test years. In all countries, mean life expectancy for females exceeds that of males. From 1878 to 1928, period life expectancy exhibits an upward trend for most countries (Figures 1 and 2). The well-documented rise in period life expectancy over time required that we difference most (i.e., 18 of the 22) of the series to render them stationary in their mean. For 16 of the 22 series, period life expectancy also exhibits autocorrelation best modeled by autoregressive and/or moving average parameters. Figures 3 and 4 plot the unexpected (i.e., residual) annual values for male and female period life expectancy after we identified and removed autocorrelation using Box-Jenkins routines. The residual series exhibit variation around their expected value (i.e., 0). Iceland shows the largest variation. We also observe a mean reduction of 8.8 years (males) and 7.45 years (females) of period life expectancy statistically attributable to the 1918 "Spanish" flu pandemic.

Table 2 displays the outlier-adjusted results in which we applied our judgment in implementing the Box-Jenkins rules. The column for each country contains coefficients for years that coincided with the Great Depression in that country. The well-documented rise in period life expectancy over time required that we difference most (i.e., 18 of the 22) of the series to render them stationary in their mean. In 1930, period life expectancy for females in Italy and France and for males in England and Wales rises above expected levels. The greatest gain occurs in 1930 among males in England and Wales (coef. = 2.09 years; standard error [SE] = .734, p<.01). Among females in Italy, we also observe a rise in life expectancy in 1934. In the other 19 tests, period life expectancy during the Great Depression remains within intervals expected from history.

We further performed a joint test of significance, separately for each country and sex, for the block of years that coincided with the Great Depression. This joint test turns on whether period life expectancy for the set of years during the Great Depression (e.g., 1931-33 in Sweden, 1930-34 in Italy) differed from values expected from history. The joint test differs slightly from the approach shown in Table 2 in that we estimate the Great Depression coefficient for a block of years rather than separately for individual years. As with the original test, females in Italy show a rise in life expectancy during the Great Depression (coef. = 1.41 years; SE = .60, p<.05). Two of the other 21 series indicate a positive relation between the Great Depression years and period life expectancy, but the results do not reach conventional levels of significance (females in France, coef: 1.20 years, SE = .62; Switzerland females, coef: 1.11 years, SE = .58). None of the 22 tests suggest a reduction in life expectancy during the Great Depression (full results available upon request).

We tested the possibility that our decision rule using changes in GDP per head to define the time frame of the Great Depression may have excluded adjacent years that experienced similar economic downturns. For example, a high unemployment rate in Denmark in 1931 may have preceded declines in GDP in 1932. We, therefore, repeated all analyses and examined coefficients for 1930-1934 inclusive for all test countries. Statistical inference for all Great Depression coefficients shown in Table 2 did not change, nor did we discover any novel associations with life expectancy from 1930-1934.

Using the rule-based ARIMA approach, the expert system software finds lower than expected period life expectancy for men and women in each of our test societies except Iceland and Denmark for either or both 1918 or 1919. The procedure also detects lower than expected values of civilian life expectancy during several war years for many of the belligerent counties in World War I. The routines, however, find no outliers for either men or women in any country for the years 1930 through 1934. The first author can provide tabulated ARIMA models and identified outliers to interested readers.

DISCUSSION

We examine population-level mortality in eleven European countries to determine if the observation from the U.S. that period life expectancy improved during the Great Depression applies also in other societies. Among females, 2 of the eleven test countries (Italy and France) exhibit unexpected gains in period life expectancy in 1930, a year in which France's economy arguably showed prosperity but Italy's economy experienced a precipitous decline (Saint-Etienne 1984; Mattesini and Quintieri 1984). Among males, only one society (England and Wales) yields an increase in period life expectancy in 1930, the first calendar year of Britain's Great Depression (Saint-Etienne 1984). The remaining 19 tests show no perturbation in period life expectancy. Taken together, results do not support the hypothesis that life expectancy improved above expected values during the Great Depression.

In none of our analyses do we observe unexpected falls in period life expectancy from 1930 to 1934. This finding seems to conflict with individual-level research reporting a countercyclical relation between the economy and morbidity among those put out of work or suffering true impoverishment (Eliason and Storrie 2009; Sullivan and Wachter 2009; Gallo et al. 2006). We infer that the mechanisms suggested by Tapia Granados and Diex-Rouz (2009) as well as others as constraints on risk taking during economic recessions probably reduced mortality among those not losing jobs or suffering severe economic shock (Ruhm 2005; Ruhm 2007; Edwards 2008). These averted deaths may have counterbalanced any increase in mortality attributable to job loss and impoverishment, but also may have remained too few to yield a net reduction in population mortality.

An intuitive response to our findings may be to assume that the eleven European countries we studied suffered much milder depressions than did the U.S., thereby rendering comparisons across countries inappropriate. All the countries we studied, however, experienced a sharp rise in unemployment as well as a decline in productivity at some point from 1930 to 1934 that rivaled the magnitude of the Great Depression in the U.S. For example, economists have described Norway as a country that underwent a “mild” Great Depression relative to the U.S. (Hodne and Grytten 1980). Norway, however, shows an 8.4 percent decline in GDP per head from 1930-1931 and an unemployment rate of 22 percent in 1931, which rivals the U.S. case in its magnitude (e.g., 9.0% GDP reduction from 1929-1930; maximum unemployment rate of 22.9% in 1932).

Strengths of our analysis include that we use life expectancy data from a database constructed to ensure comparability of life expectancy over time and across societies. Second, our time-series methods remove autocorrelation in the dependent variable — which could bias correlational tests towards a type I error — before examining the effect of the Great Depression. Third, we test the robustness of the results by using a rule-based methodology that researchers can replicate with available software. In all 22 tests, the rule-based approach discovered no perturbation in period life expectancy from 1930 to 1934.

Limitations of our study involve the lack of data on cause-specific mortality or on specific welfare support provided by each country. This information would permit a more detailed comparative analysis of the population mortality response to the Great Depression in the U.S. relative to Europe. It remains possible, for instance, that a larger welfare support structure in European countries allowed these populations to withstand the Great Depression with less social disruption than in the U.S. case. For example, maintenance of relative social stability or federal support programs in Europe during the Great Depression may have resulted in fewer changes in health behaviors that Tapia Granados and Diez Roux (2009) propose as causes of mortality decline in the U.S. We encourage closer inspection of country differences in social and political structure to explain these divergent findings. In addition, the United States does not have national mortality data available prior to 1900. Absent fifty consecutive years of life expectancy data, we could not apply our time-series routines to the United States.

Examination of life expectancy for both sexes in eleven populations required estimation of coefficients for 22 tests. A limitation of our analysis, therefore, involves the increased likelihood of a type I error (i.e., falsely rejecting the null) due to multiple tests. In all but three tests, however, we do not reject the null (i.e., no perturbation in period life expectancy). The rule-based methodology, moreover, indicates a null result for all 22 tests, which precludes this potential error introduced by multiple testing.

Although much research tests the relation between macroeconomic conditions and mortality, less work has examined the population consequences of extreme economic downturns. Investigation of the Great Depression indicates that period life expectancy in Europe generally does not differ from expected levels. Our findings suggest that contemporary explanations that connect economic downturns to improvements in life expectancy do not generalize to European societies forced to adapt to the most extreme economic crisis in the 20th century.

APPENDIX

The rule-based approach applies widely disseminated decision rules developed by time-series analysts to implement the logic described above. This analysis can be repeated exactly by any researcher with access to the Human Mortality Database and to state-of-the-art software that implements these decision rules. The software uses rules devised by Box and Jenkins (1994) and others (De Gooijer and Hyndman 2006; Mélard and Pasteels 2000; Tran and Reed 2004; Valenzuela et al. 2004) to identify best fitting ARIMA models and those offered by Chang, Tiao, and Chen (1988) to discover outliers. None of the authors of this paper contributed to the development of this software or benefit in any way from its dissemination.

We used the software to first identify the best fitting ARIMA model for period life expectancy of men and women for each of our societies for the years 1878 through 1928. We then allowed the software to use these models to estimate expected values for the years 1878 through 1934 and to use Chang's, Tiao's, and Chen's (1988) outlier detection routines to discover any years in which the observed values fell outside the 95% confidence interval (2-tailed test) of the expected values. We anticipated, for example, that the "Spanish Flu" may have yielded outliers in 1918 and or 1919 below the 95% confidence interval, and that those countries most involved in World War I may exhibit lower than expected period life expectancy during one of more of the war years. If the theory that the Great Depression induced salutary behavior were correct, we would also find outliers below the 95% confidence level sometime between 1929 and 1934. Readers can obtain the commands for our analyses from the first author.

Essentially our method searched for two patterns of outliers. We refer to these changes as spikes and decay. Spikes are outliers in which the observed value for a single year falls above or below the 95% confidence interval of the expected value. Decay alludes to outliers in which the initial spike decays geometrically such that at least one subsequent value remains outside the 95% confidence interval.

A spike would be specified in equation 1 as follows.

$$\Delta_d e^0{}_t = \theta_0 + \omega I_t + \frac{\left(1 - \theta_1 B - \theta_2 B^2 - \ldots - \theta q B^q\right)}{\left(1 - \phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p\right)} a_t \qquad [1]$$

I_t is a binary variable scored 0 for all years before the outlier, 1 for the year of the outlier, and 0 afterward.

ω is the estimated parameter for the binary outlier variable.

Δ_d is the difference operator that indicates the variable has been differenced at order d (i.e., value at time t subtracted from value at time t+d). With annual time series, a detected difference operator typically is of order one (d=1).

$e^0{}_t$ is period life expectancy of the synthetic cohort during year t.

θB^q, or "moving average" parameter, implies that a proportion (estimated by θ that is always less than 1) of the error term at year t of the model is “remembered” into t+p.

ϕB^p or "autoregressive" parameter, implies that a proportion (estimated by ϕ that is always less than 1) of the estimated value of y at year t is "remembered" into t+q.

Decay would be specified as follows.

$$\Delta_d e^0{}_t = \theta_0 + \frac{\omega I_t}{(1-\delta B)} + \frac{(1-\theta_1 B - \theta_2 B^2 - ... - \theta q B^q)}{(1-\phi_1 B - \phi_2 B^2 - ... - \phi_p B^p)} a_t \quad [2]$$

δ is the proportion of I_t carried into the next year.

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Table 1. Mean, standard deviation, and minimum as well as maximum values for period life expectancy, 1878-1937, for the eleven societies analyzed.

	Mean	Std. Dev.	Minimum	Maximum
Period Life Expectancy				
Females				
Denmark	56.35	.75	45.72	65.18
England and Wales	53.77	.82	44.58	64.55
Finland	49.34	.70	38.94	59.94
France	51.12	.72	42.98	62.16
Iceland	54.06	1.12	18.83	66.38
Italy	45.01	.97	28.33	58.17
Netherlands	54.33	1.03	41.81	67.72
Norway	58.04	.69	48.48	67.70
Scotland	52.02	.66	44.82	61.20
Sweden	57.45	.68	47.98	66.08
Switzerland	53.61	.89	41.77	65.42
Males				
Denmark	53.98	.76	43.82	63.04
England and Wales	40.74	.79	41.05	60.45
Finland	45.54	.67	26.32	54.77
France	46.83	.66	33.84	56.15

Iceland	48.91	1.14	16.76	61.89
Italy	43.37	.95	23.50	55.57
Netherlands	52.10	1.10	38.95	66.22
Norway	55.08	.70	46.24	64.70
Scotland	48.96	.60	42.22	57.48
Sweden	54.91	.71	45.36	63.84
Switzerland	50.52	.85	39.17	61.50

Table 1 (continued)

Figure 1. Female Period Life Expectancy (in Years) for Eleven European Societies, 1878 to 1938.

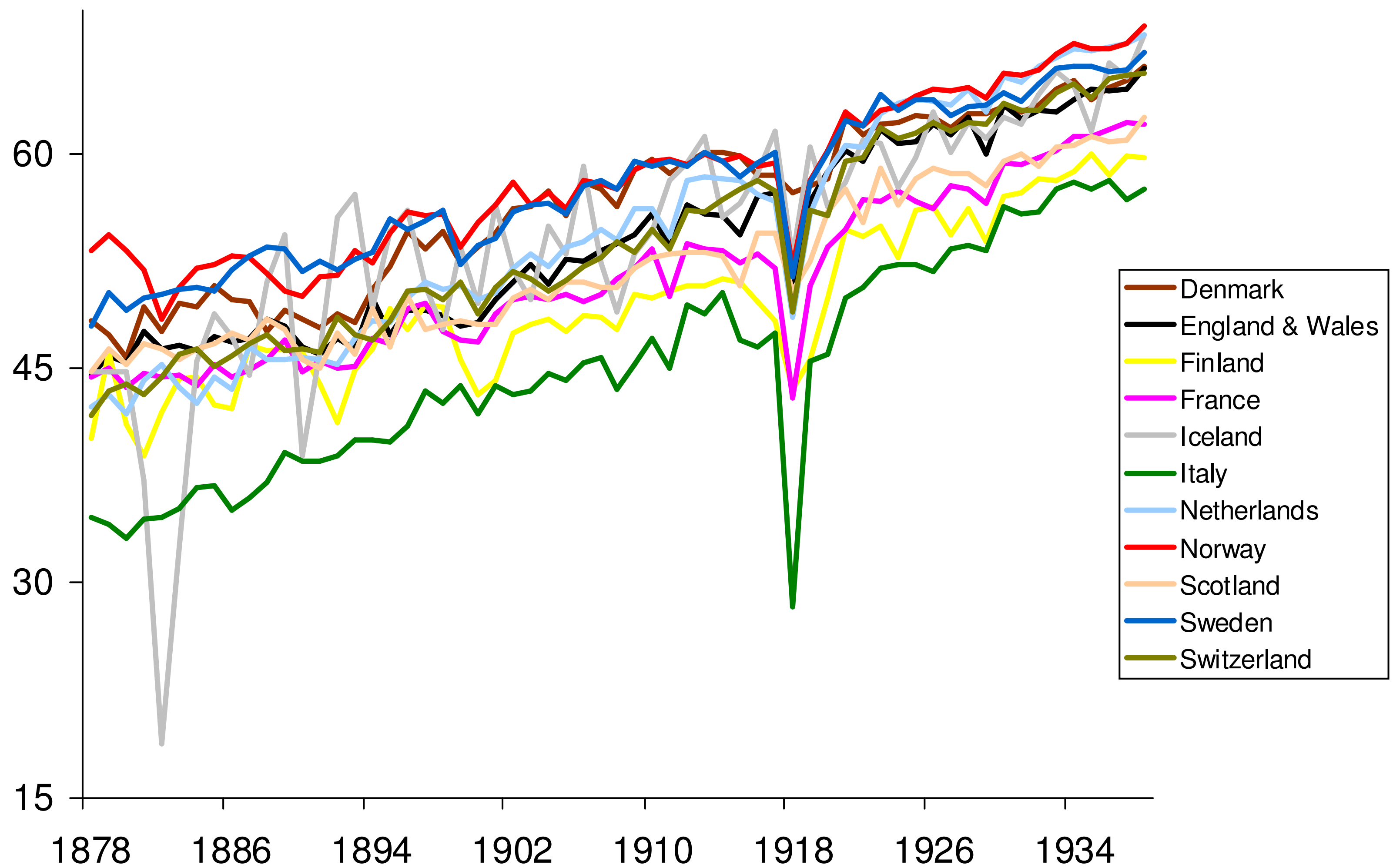

Figure 2. Male period life expectancy (in years) for eleven European societies, 1878 to 1938.

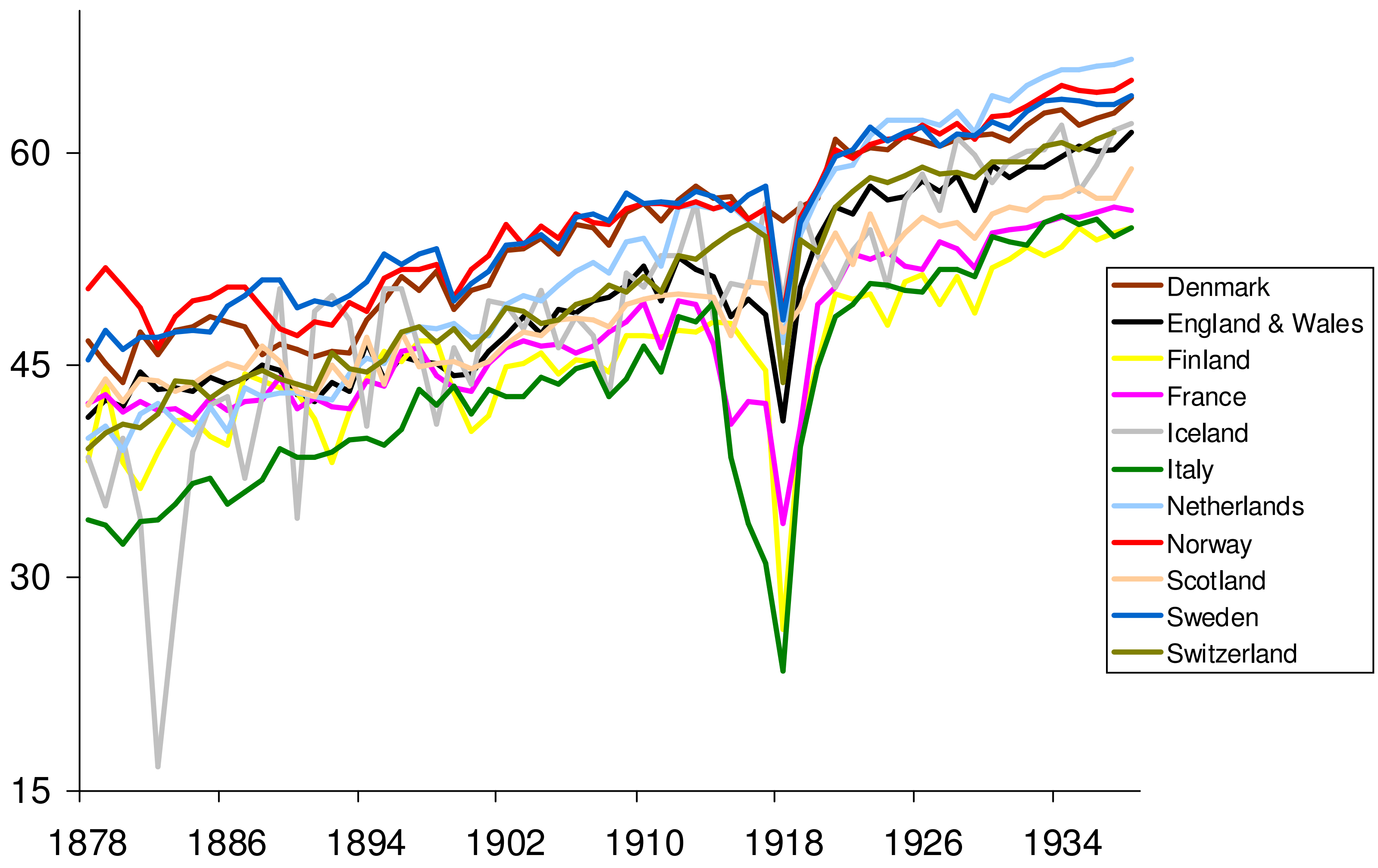

Figure 3. Residual values of female period life expectancy (in years) after removal of autocorrelation, 1878 to 1938.

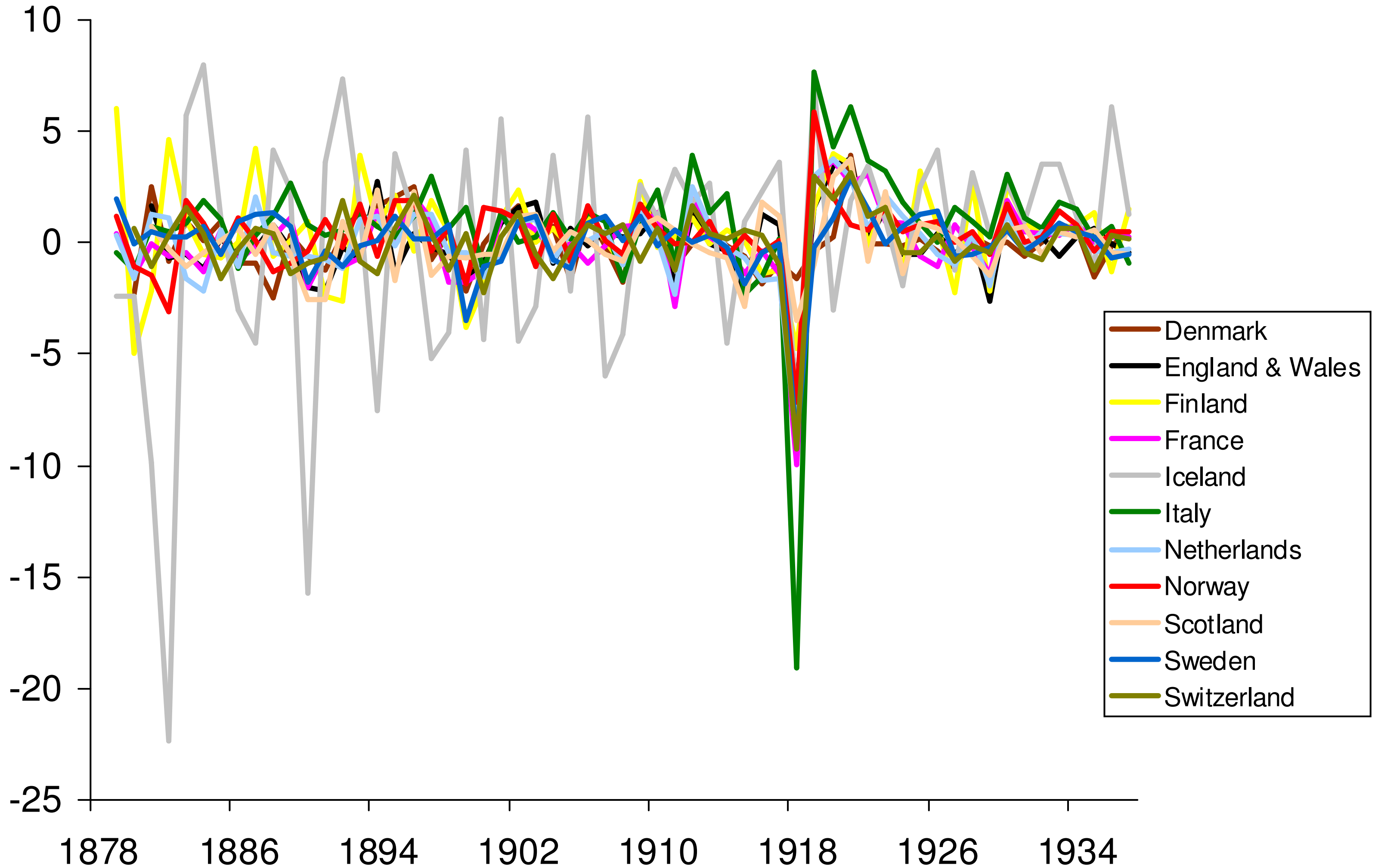

Figure 4. Residual values of male period life expectancy (in years) after removal of autocorrelation, 1878 to 1938.

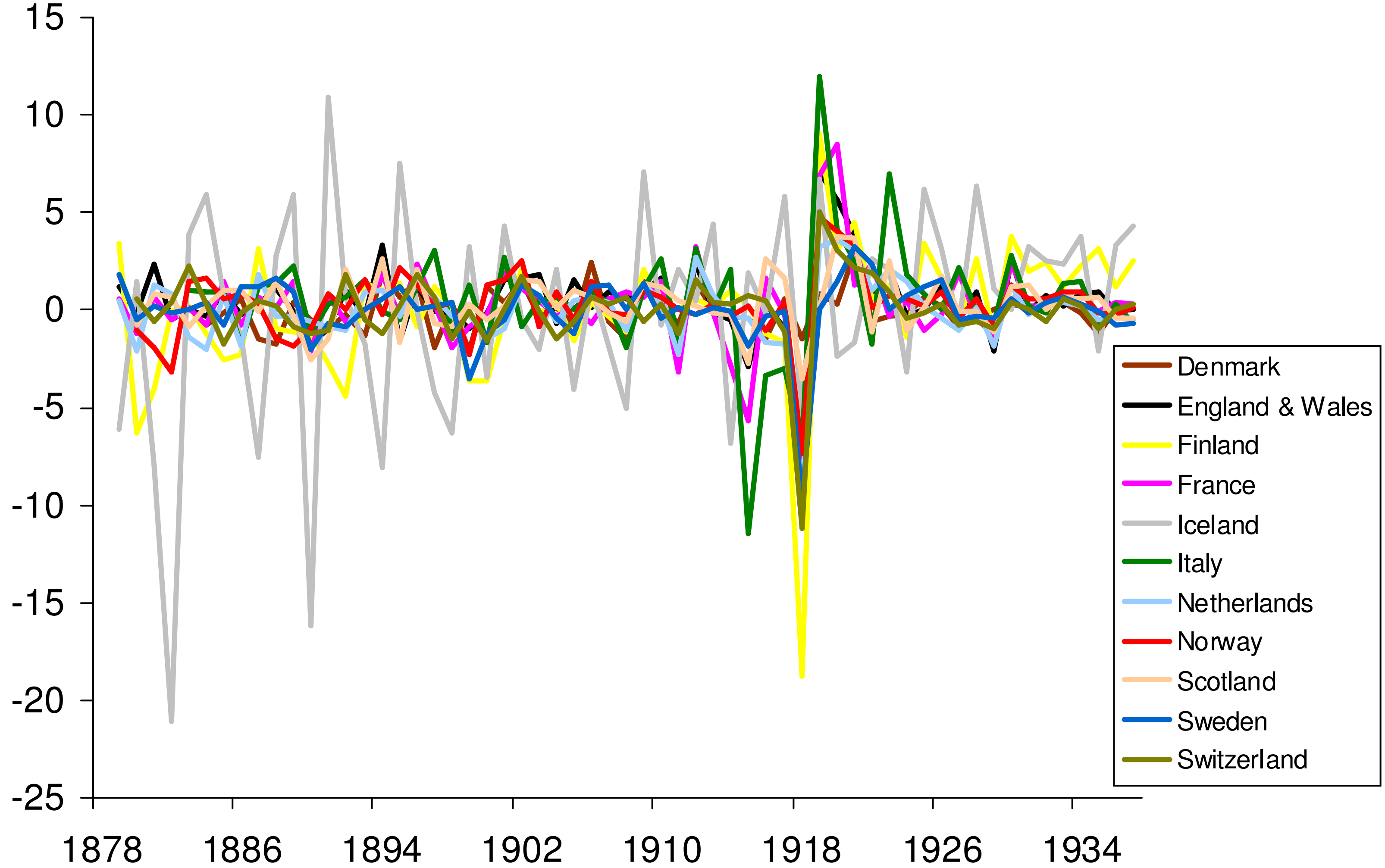

Table 2. Outlier-adjusted equations for male and female period life expectancy in eleven European societies as a function of the Great Depression, the 1918 Flu, and autocorrelation (n=60 years beginning 1878; SEs in parentheses).

	Denmark		**England and Wales**		**Finland**	
	Males	Females	Males	Females	Males	Females
Differencing	First Differences	First Differences	First Differences	First Differences	--	First Differences
Constant	.269 (.059)**	--	.352 (.048)**	.411 (.062)**	46.725 (1.708)**	--
1918 Influenza	-.637 (.552)	-1.024 (.735)	-8.792 (.703)**	-7.650 (.580)**	-18.551 (.925) **	-2.447 (1.183)*
Great Depression:						
1930	--	--	2.093 (.734)**	1.209 (.644)	2.199 (1.168)	1.456 (1.745)
1931	--	--	.401 (.755)	.581 (.653)	1.825 (1.426)	2.049 (2.263)
1932	.156 (.577)	-.462 (.749)	.457 (.756)	.145 (.653)	1.762 (1.425)	1.410 (2.275)
1933	.787 (.582)	.710 (.747)	-.145 (.735)	-.301 (.642)	.275 (1.167)	-.071 (1.719)
1934	--	--	--	--	--	--
MA Parameters	--	--	B^1= .573 (.125)**	--	--	B^3 = .413 (.142)**
AR Parameters	B^1= -.314 (.140)*	--	--	B^1 = -.565 (.124)**	B^1 = .879 (.060)**	--
	B^5= -.293 (.138)*					

*p<0.05; two- tailed test; **p<0.01; two- tailed test

[Table 2 continued]

	France		Iceland		Italy	
	Males	Females	Males	Females	Males	Females
Differencing	First differences	First differences	--	--	First differences	First differences
Constant	--	.415 (.101)**	51.01 (.889)**	58.09 (1.42)**	--	.360 (.051)**
1918 Influenza	-7.80 (.657)**	-9.64 (.640)**	-6.34 (2.17)**	-8.00 (2.836)**	-8.86 (.943)**	-18.12 (.725)**
Great Depression:						
1930	1.71 (.883)	1.85 (.809)*	--	--	2.07 (1.14)	1.94 (.756)*
1931	1.33 (1.11)	1.05 (.948)	.767 (2.49)	.005 (3.33)	1.13 (1.33)	.943 (.786)
1932	1.22 (1.21)	.784 (.985)	.532 (2.78)	1.99 (3.76)	.392 (1.40)	.543 (.796)
1933	.956 (1.13)	-.531 (.933)	-.243 (2.49)	2.76 (3.32)	1.35 (1.33)	1.49 (.785)
1934	.525 (.893)	.799 (.774)	--	--	1.29 (1.13)	1.55 (.754)*
MA Parameters	--	B^1 = .119 (.151)	--	--	--	B^1= .537 (.126)**
AR Parameters	B^5= -.135 (.159)	--	B^1 = .600 (.054)**	B^1 = -.658 (.059)**	B^1 = -.175 (.148)	--

*p<0.05; two- tailed test; **p<0.01; two- tailed test

[Table 2 continued]

	The Netherlands		Norway	
	Males	Females	Males	Females
Differencing	First differences	First differences	First differences	First differences
Constant	.466 (.142)**	.447 (.141)**	.330 (.133)*	.349 (.124)**
1918 Influenza	- 7.77 (.736)**	-7.61 (.732)**	-7.23 (.696)**	-6.64 (.650)**
Great Depression				
1930	1.79 (.951)	1.79 (.945)	--	--
1931	.763 (1.20)	.647 (1.20)	-.392 (.852)	-.625 (.795)
1932	1.13 (1.28)	.980 (1.27)	-.365 (.984)	-.750 (.918)
1933	1.06 (1.20)	.893 (1.19)	-.137 (.852)	-.265 (.795)
1934	.813 (.951)	.817 (.945)	--	--
MA Parameters	--	--	--	--
AR Parameters	--	--	--	--

*$p<0.05$; two- tailed test; **$p<0.01$; two- tailed test

[Table 2 continued]

	Scotland		**Sweden**		**Switzerland**	
	Males	Females	Males	Females	Males	Females
Differencing	First Differences	First Differences	First Differences	First Differences	First Differences	First Differences
Constant	.316 (.059)**	.358 (.059)**	.266 (.057)**	.303 (.027)**	.273 (.095)**	.297 (.084)**
1918 Influenza	-4.38 (.604)**	-4.78 (.609)**	-9.22(.575)**	-8.91 (.583)**	-10.18 (.493)**	-7.77 (.571)**
Great Depression:						
1930	.0063 (.670)	.197 (.698)	--	--	.758 (.637)	1.00 (.681)
1931	1.002 (.697)	.952 (.697)	-.649 (.619)	-.815 (.600)	.507 (.806)	.215 (.785)
1932	-.3015 (.697)	-.803 (.698)	.193 (.645)	.161 (.604)	.125 (.854)	-.109 (.825)
1933	.4051 (.695)	.405 (.697)	.516 (.619)	.878 (.600)	.943 (.806)	.770 (.785)
1934	--	--	--	--	.872 (.637)	1.10 (.679)
MA Parameters	--	--	B^1= .392 (.134)**	B^1 = .692 (.106)**	--	--
AR Parameters	B^1= -.827 (.081)**	B^1 = -.834 (.078)**	--	--	--	B^1 = -.205 (.142)

*p<0.05; two- tailed test; **p<0.01; two- tailed test