Department of Economic History
Master Programme in Economic Demography

Alcoholics and workaholics

Premature male mortality as a reaction to economic crisis

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Abstract

From the recent mortality trends in Central and Eastern Europe, it is clear that in the former socialist countries the economic transition had a different effect on male and female mortality: premature death became much more frequent among males, and the gender mortality gap increased as a result. The psycho-social stress hypothesis (Cornia and Paniccia, 2001) explains the Eastern European experience, suggesting that an increase in the gender gap may be a sign of economic and social crisis, as male mortality sometimes reacts to economic uncertainties more strongly. To my knowledge, no previous studies have examined if there is a similar relationship between economic crisis and gender gap elsewhere.

The present study focuses on the economic crisis – gender mortality gap relationship in a broader context. While the starting point is the Eastern European experience, the focus is on looking at other examples, outside of the Soviet bloc, where high unemployment and economic uncertainty may have caused similar mortality reactions. Firstly, I review a large number of studies which report some information on gender-specific mortality during crisis. Secondly, to examine the unemployment - gender mortality gap relationship, I have prepared five case studies, for countries where there has been an economic crisis recently: Russia, Germany, South Korea, Argentina and Spain. For each country I have calculated gender mortality rate ratios by cause before and during crisis and correlations of differenced unemployment and gender gap time series. Thirdly, I look at the effect of Great Depression on mortality on individual level, using the Utah Population Database. I check if there was any difference in the mortality reactions of males and females using interactions in a Cox model.

The results make it likely that the increase in premature male mortality is not a usual consequence of economic crisis. In none of the countries I have examined could I link statistically the movements of the gender mortality gap to fluctuations in unemployment. Although there was a smaller increase in the relative risk of dying among the middle aged during 1930 in Utah, there were no significant sex differences in the increase of relative risk. On the other hand the literature review and the case studies show, that behavioural differences and changes (like changes in the relative prevalence of smoking and drinking) are much more important in shaping the gender mortality gap than psychosocial stress even in the short run.

Key words: mortality, crisis, gender, sex mortality differences, psychosocial stress, unemployment

Preface

I am grateful for Carl Hampus Lyttkens who introduced me to health economics and helped a lot in crystallising the idea of the paper, Luciana Quaranta, who never gave up the hope of explaining me how interactions work in Stata, Tommy Bengtsson for his valuable comments on an early draft of the paper, and Jo Jacobs who was so kind to review the English usage in the draft. The ICPSR summer course at University of Michigan (Longitudinal Analysis of Historical Demographic Data) provided very useful input to this paper, including access to an extract of the Utah dataset. Thanks for Ken Smith for his advice and for allowing access to the dataset, and Susan Hautaniemi Leonard and George Alter for their excellent introduction to longitudinal methods.

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"Resolution #2: Will find nice sensible boyfriend and stop forming romantic attachments to any of the following: alcoholics, workaholics..."
Helen Fielding: Bridget Jones's Diary

1 Introduction:

My friends who became engineers often tease me saying that the university I went to is on the other side of the river from theirs, meaning that social science is not a true science, as it is not based on firm mathematical grounds like for example physics. There is some truth in this statement: oddly, the Technical University and the University of Economics lie at the opposite sides of the river Danube in Budapest. But otherwise, while I agree that it is difficult to do social science well, I think it is worth giving it a try.

While social science inevitability has its elusiveness and softness, this problem can be overcome with good methodology. As Durkheim showed in his landmark study in 1897, it is possible to build up a strong case by focusing on a simple but hard statistical fact or evidence. By examining that evidence from several angles, in different social groups and situations it is possible to illuminate important aspects of the functioning of a society. For Durkheim this hard fact was suicide; for the present study, it is gender mortality gap, the difference (or the ratio) of female and male mortality.

So I am focusing on dying, but not because it is one of the few things that "can be done just as easily laying down", as Woody Allen said. No. I am going to argue that while gender mortality gap can be accurately and easily measured, it tells an interesting story about society: about gender roles, work-related stress, risk taking and social cohesion. For example, the female advantage in life expectancy was 14 years in Russia in 1994, while at about the same time it was less than 2 years between Bavarian Monks and Nuns (Luy, 2003). Several interesting studies have already examined, the possible reasons behind the variations of gender mortality gap in space and time. But it is perhaps even more interesting to examine what happens with the gender gap in times of economic crisis, when hidden problems of the society come to surface.

From the recent mortality trends in Central and Eastern Europe, it is very clear that in the former socialist countries the economic transition had a different effect on male and female mortality: premature death became much more frequent among males, and the gender mortality gap increased as a result. (Cornia and Paniccia, 2001) It has been estimated that in Russia alone, the number of avoidable premature death between 1992 and 2001 amounted to 2.1 million males and 0,6 million females (Men et al, 2003). [1] The epidemiological crisis in the Central European members of the former communist bloc was less drastic, but it lasted over a longer period (from the mid 1960s- until the mid 1990s), and its effects were similarly devastating.

[1] This has been calculated assuming constant mortality after 1991 instead of the drastic worsening that has occurred in two waves after the economic transition.

The psycho-social stress hypothesis (Cornia and Paniccia, 2001) explains the Eastern European experience, suggesting that an increase in the gender gap may be a sign of economic and social crisis, as male mortality sometimes reacts to economic uncertainties more strongly. To my knowledge, no previous studies have examined if there is a similar relationship between economic crisis and gender gap elsewhere.

The present study focuses on the economic crisis – gender gap relationship in a broader context. While the starting point is the Eastern European experience, the focus is on looking at other examples, outside of the Soviet bloc, where high unemployment and economic uncertainty may have caused similar mortality reactions. I am curious to find out if the recent mortality reaction of the ex-communist countries is a unique, unprecedented one, or other examples can be found for this pattern. I am focusing on the short-term effects of modern economic crisis during the 20th century, the effects of crises in later life, and historic aspects of the topic are out of scope.

Firstly, I review a large number of studies which report some information on gender-specific mortality during crisis. Secondly, to examine the unemployment - gender mortality gap relationship, I have prepared five case studies, for countries where there has been an economic crisis recently: Russia, Germany, South Korea, Argentina and Spain. For each country I have calculated gender mortality rate ratios by cause before and during crisis and correlations of differenced unemployment and gender gap time series. Thirdly, I look at the effect of Great Depression on mortality on individual level, using the Utah Population Database. I check if there was any difference in the mortality reactions of males and females using interactions in a Cox model.

The author of this study is one of those who believe in the notion that our mental state, including work-related stress affects our health. This study started off as an attempt to extend the psychosocial stress theory developed in a Central-Eastern European context, to other countries, but instead it ended up finding a number of limitations to its applicability. The results make it likely that any direct link between cardiovascular mortality and psychosocial stress is weak, and behavioural differences and changes (like changes in the relative prevalence of smoking and drinking) are much more important in shaping the gender mortality gap then psychosocial stress, even in the short run.

1.1 Background: Mortality patterns during the economic transition of the formal Soviet Bloc countries

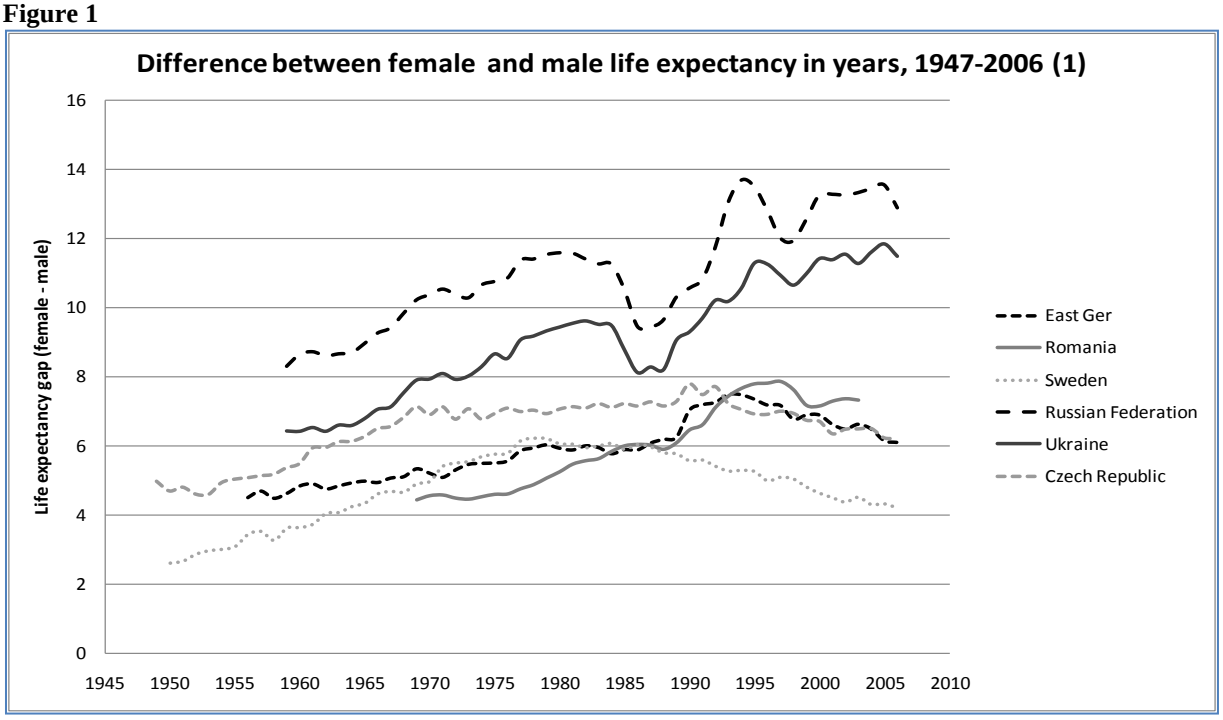
Starting from the mid 1960s, a special mortality pattern developed in Eastern Europe. This pattern was similar in most countries belonging to the Soviet Bloc, although there were variations in its timing and intensity. The improvement of female mortality slowed down, while male mortality worsened or stagnated. The worsening was most pronounced among working age males, and was mainly due to cardiovascular disease, external causes, and liver disease (Kruger and Nesse 2007, Kopp et al 2006). The youngest and oldest generations were hardly effected, often their mortality continued to improve (Nolte et al 2004). The relative rate of mortality increase was the highest in young working age males, primarily due to external causes. But the decline of male life expectancy was mainly caused by the increase of

cardiovascular and alcohol-related mortality in the late working age generations. Higher social status and marriage provided some protection for males. On the other hand the mortality increase was the worst among divorced, widowed and low-income males. (Cornia and Paniccia, 2001, Watson 1995, Hajdu et al 1995, Nolte et al 2004)

Arguably, late working age males were also the group which was worst affected by the economic transition, as their skills were often de-valued and they had little hope to re-integrate into a changed economic system. This suggests a link between economic crisis and mortality, indicating that changes in the gender gap reflect the intensity of the economic crisis. In countries like Czech Republic and East Germany, where the transition was more gradual, the gender gap did not move as hectically as it did in countries where shock therapy was applied, like Russia.

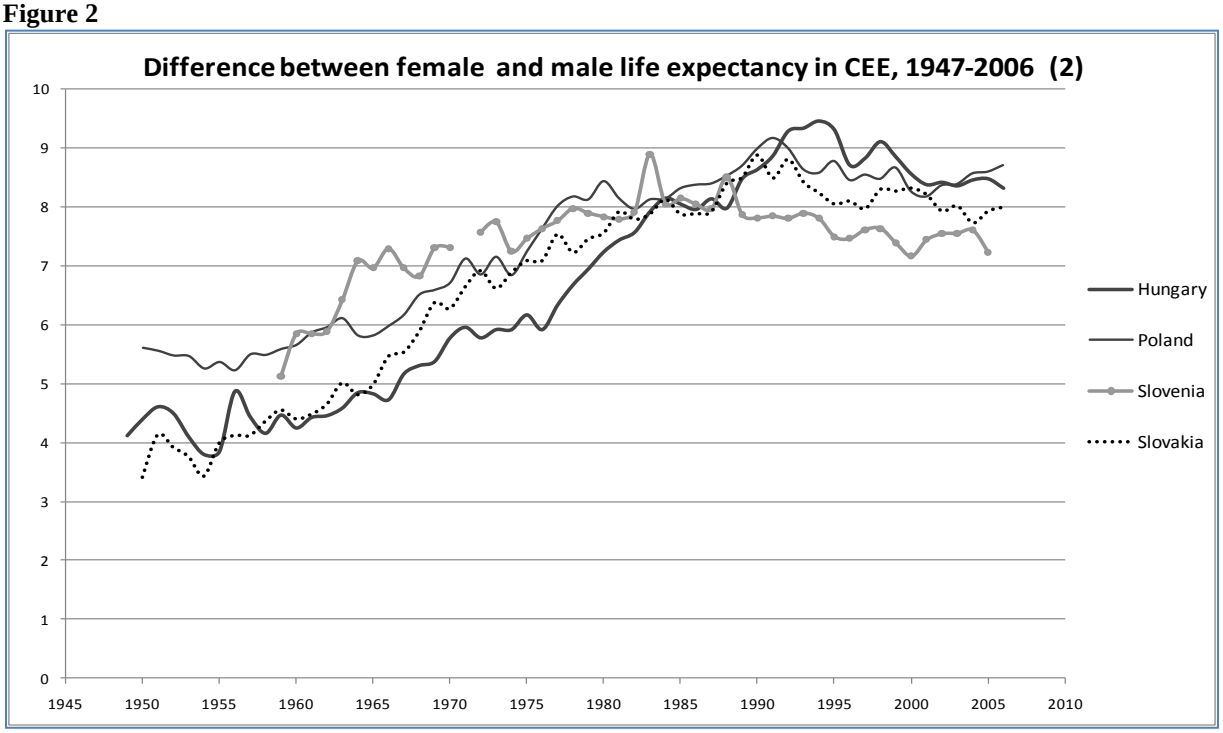
I have calculated and plotted the gender mortality gap in several countries of the region (together with Sweden), over a longer period (1947-2006), using life expectancy data from Eurostat and the Human Mortality Database. In the first group of countries (Figure 1), and primarily in Russia and Ukraine, around the date of transition there was a break in trend.[2] In the second group of countries (Hungary, Poland, Slovenia and Slovakia, Figure 2), the previous trends appear to continue, until about mid 90's, when a gradual improvement started. In the CIS countries, the improvement started later.

Figure 1



[2] Cornia and Paniccia (2000) tested if the trend before 1989 explains, what happened after the transition, using time series analysis, separately for males and females, and they arrived at similar result: a break in mortality trends was shown for Russia and Ukraine, but not for Poland and Hungary. (pg 21-22)

Figure 2


Difference between female and male life expectancy in CEE, 1947-2006 (2)
10
9
8
7
6
5
4
3
2
1
0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Hungary
Poland
Slovenia
Slovakia

1.2 The measurement of gender differences in mortality

There are two main methods to measure the gender mortality gap: by calculating the life expectancy gap and by calculating sex mortality ratios.

Gender life expectancy gap: When I refer to the "gender mortality gap" or "gender gap" in this text, I simply mean the difference in life expectancies at birth between males and females. This measure summarizes in one figure, what is the difference between the overall mortality experiences of the two sexes in a given society. Some articles decompose this difference by various age groups and cause of death.

Male to Female Mortality Ratio (M:F MR): The other approach is to calculate standardised or age-specific death rates for both sexes and calculate the ratio of the two. This latter method can also be used to show, which causes and which age groups have high sex mortality differences. For some causes and age groups the result is striking: male mortality is often twice, but sometimes for example six times, higher than that of the corresponding female group (see also section 3).

2 Literature review

2.1 Introduction to the methods and structure of the paper

The primary method I am using throughout the paper is literature review. While our investigation has a special viewpoint, there are many papers which contain some useful information regarding the economic crisis – gender gap relationship. I think that the topic requires that I review a large number of countries, and that was only feasible by relying on the work of other researchers.

I have searched for relevant articles using Pubmed queries and cross-references between articles. Unfortunately, I could not meet two methodological criteria of a systematic literature review: I had selected the articles and books subjectively, after reading the synopsis of many works, and the methods used in the articles are too versatile to enable direct comparison. However, I have done what I could do to make my review more transparent and objective: I have grouped similar articles together, and reviewed them systematically, using a number of standard questions. The main questions were these: what do we know about the factors behind gender gap, and on this basis, what changes can we expect in the gender gap in times of economic problems?

I have identified about one hundred articles and books which are relevant. I have grouped the selected articles into four groups: A, B, C, and D.

Group A: Historic papers. While the present paper is focusing on modern economic crisis during the 20th century, I think that some understanding of earlier mortality crises is helpful. So I start with the review of historic articles in section 2.2.

Group B: Economic cycles and mortality. Several papers use econometric methods to investigate the link between economic crisis and mortality. These articles are comparable, and they often estimate effects by males and females separately, I just had to look at their results. I found eleven articles, and compared their results in a systematic way, focusing on gender. This is done in section 2.3. While the results show that male mortality was often a bit more sensitive to economic fluctuation in developed countries, the difference tends to be small, and in developed countries mortality tends to improve in recessions.

Group C: Causes behind gender differences in mortality. The articles above contain the viewpoint of historians and economists, but it is also important to integrate the insights of demographers, sociologists, psychologists and epidemiologists. I am reviewing a large number of different articles, which help to understand the causes behind the gender mortality gap. (section 2.4) I argue that in developed countries the gender gap is unlikely to change quickly, as it is mainly determined by slow-moving social processes, like gender roles, smoking habits, and employment rates. The theories are summarised in a graph (section 2.5)

The rest of the literature was used in the result sections.

Group D: Country crisis studies. Economic crises are complex, and have different features in South America, Asia and in Europe. These complexities can be best addressed using case

studies. Using the articles about crisis mortality in specific countries (group D), I could ensure a relatively broad coverage, while keeping the amount of work manageable. It was possible to apply a systematic review combined with some of my own data collection and analysis. Typically, the authors included a table by sex containing cause-specific mortality rates before and during crisis, but did not calculate gender ratios from that. In addition to calculating the gender mortality ratios, I have collected unemployment and mortality data from other sources, plotted them and undertook a simple correlation analysis to see if there is any relationship between unemployment and the gender gap. (section 3.1) Surprisingly, the case study results show little similarity with Eastern Europe - the gender gap was not sensitive to the hectic movement of unemployment in Argentina, Spain and South Korea.

2.2 The history of gender mortality gap

2.2.1 Demographic transition, epidemiological stages and gender gap

Female advantage in life expectancy is a relatively new phenomenon. Before the demographic transition woman tended to have so high mortality at childbearing ages that it counter-balanced their advantage in other ages. Excess female mortality therefore was not unusual in the 19th century. (Bengtsson, Campbell and Lee 2009). Following the demographic transition, life expectancy tended to improve continuously. While Omran's theory of epidemiological stages assumed that improvements will slow down as human life expectancy reaches a ceiling, up to this date the data do not confirm this idea. Best practice life expectancy follows a linear trend. (Omran, 1971; Oeppen and Vaupel 2002) Initially, life expectancy advanced through sanitation and vaccination, which contributed to better control of infectious deceases. While these improvements were continuous, the driving forces and age patterns of improvements changed, so we may speak about several epidemiological stages or waves. In the first wave mainly infant and child mortality declined, and only in the second wave did improvements gradually penetrate adult ages. In the 1960s-1970s in developed countries, there was no further room for improvement in external causes, and improvements in circulatory disease became the driving force (third wave).

While life expectancy tends to improve with GDP, there are large differences between countries which cannot be explained with economic factors. Soares (2007) argues that these differences can be explained by the diffusion of health technologies. The nature of these technologies is different in each wave of health transition. Technologies that helped reductions in mortality from infectious diseases had a strong public good component: most measures were only efficient if no one was excluded. On the other hand diffusion of technologies and lifestyle changes that help to reduce circulatory decease has a more private nature. As a result, we may expect an increase in health inequalities during the third wave - both between individuals and countries.

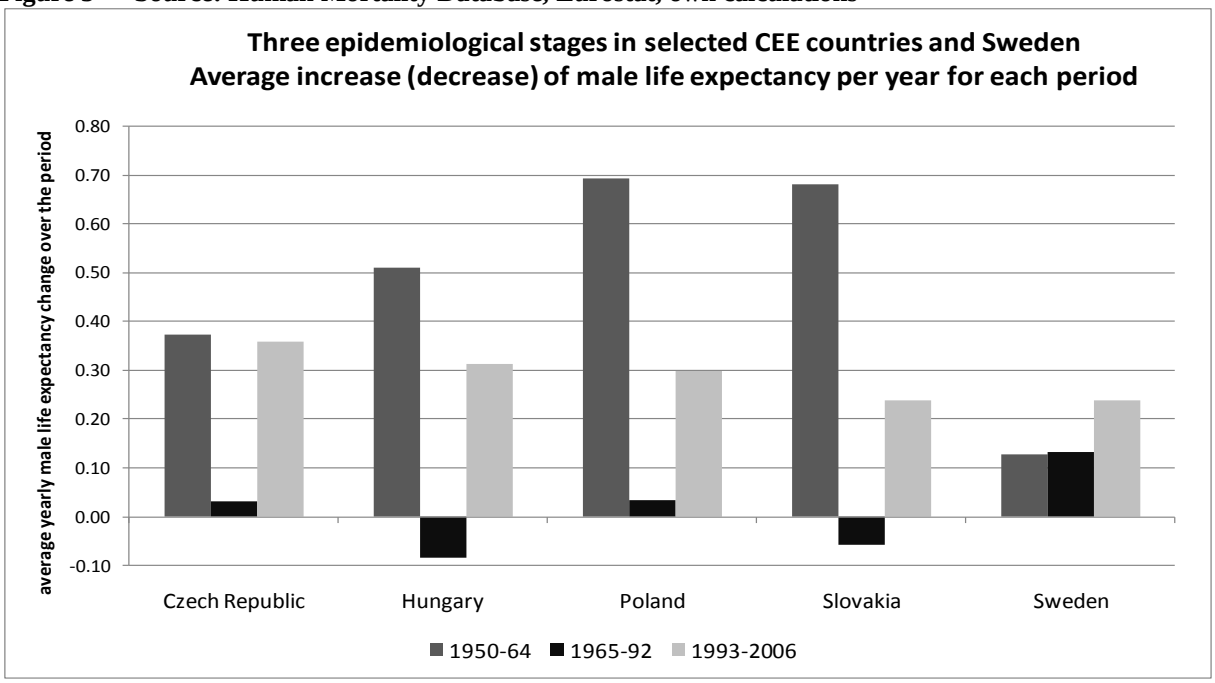
After the demographic transition has started in a country, the decline of mortality tends to continue and we very rarely see a reversal in this trend. One of the few exceptions is the divergence of Soviet bloc countries after the mid 1960s. Their entry to the third wave of mortality decline has been delayed compared to the level of economic development, and their

mortality stagnated or, especially for males, worsened for about three decades (Bongaarts an Bulato 2000; Cornia and Paniccia 2001).

The gender mortality gap also reflected the divergence in health between Eastern and Western Europe (Watson 1995). In Western Europe mortality improvement continued, the share of circulatory disease declined, and a gradual decline started in gender mortality gap as well. At the same time, in Eastern Europe the gradual increase of gender mortality gap signalled a chronic health crisis during the 1965-1989 period, and an acute health crisis shortly after the transition. While the chronic crisis was similar throughout the soviet bloc, the severity of the acute crisis differed. Russia, Ukraine and the Baltic states experienced the most severe transition mortality crisis, while, for example, East Germany a milder crisis. The gender gap may be regarded as an indicator of the severity of the social crisis caused by the transition.

As the transition crisis abated, usually during the mid 1990s, mortality started to improve, and period of convergence started. The examples of Czech Republic, Hungary and Slovakia may be used to illustrate the three waves of epidemiological development described above. In Figure 3 the yearly increase in male life expectancy is compared with Sweden over three different stages of epidemiological development.

Figure 3 --- Source: Human Mortality Database, Eurostat, own calculations



Besides the unfavourable difference compared to Sweden in the 1965-92 period, it is also noticeable that the post war increase was 3-5 times faster in Eastern Europe than in Sweden.

Worsening of male morality and the opening of the gender gap were two sides of the same coin. The gender gap in life expectancy reached 12-13 years in Russia during the post-transition crisis, in Slovakia it was above 8 in the 80s and 90s, while the Swedish level was 4-6 years.

2.2.2 Economic crisis and mortality in pre-industrial societies

Malthus (1803) argued that while humans have a tendency to multiply beyond their means, positive checks (mortality increase at times of food shortage) and preventive checks (later marriage, increase in celibacy) keep population growth within the limits of agricultural production. His ideas were later referred to as 'the Malthusian trap' (Bengtsson 1992).

Recent research indicates that until about 1800 in the UK, the idea of the 'Malthusian trap' was correct: there were strong mortality reactions to food price changes, which followed a remarkable stable pattern, even in cross-country comparison. Later, as a result of industrial revolution, productivity growth could exceed population growth, and it became possible to break out of the Malthusian trap. In Western Europe the breakout happened some time during the 19th century (Bengtsson 1998; Galloway 1988; Lee 1981, 2003).

The method used for studying the effects of short term economic shocks on mortality has been worked out by Galloway and Lee. It involves the examination of food prices (or real wages) versus mortality and fertility over a longer period of time (like a century or more) using distributed lag models. After de-trending the series the authors examine if mortality fluctuations and food price fluctuations are related to each-other with a certain delay.

Distributed lag methods have also been applied for contemporary populations in third world countries. Lee (1990) contrasts the results on historic Europe and some current developing countries. He finds that the immediate effect of the crisis is much more severe in developing countries, but it is more lasting in historic Europe. Lee's explanation of these patterns is that in Europe, famines weakened some people who died later due to other causes, while in current developing countries crises are more severe and leave less weakened survivors.

The studies above usually do not handle male and female populations separately. An exception is the book 'Life Under Pressure' (Bengtsson, Campbell and Lee 2009), which devotes a separate chapter to gender differences in mortality reaction to economic crisis (Alter, Manfredini and Nystedt 2009). The authors take pre-industrial Belgian, Chinese, Italian, Japanese and Swedish populations, and compare the gender specific reactions to economic pressure in their case. They conclude that they "can not point to a single pattern" (pg 341). Various differences have been measured both among locations and among age groups. Economic roles and unequal distribution of resources probably played an important role, but there have been many different patterns in this respect. For example, some populations preferred breadwinner males in times of food shortage, but there are also indications that this privilege has been lost in more severe food shortages. Some households sent out adult male members as temporary migrants to search for work, and the mortality among the labour migrants could have been higher.

The conclusion for our study is that in pre-industrial populations' mortality often reacted very strongly to economic crisis, but the gender gap has probably not followed a clear pattern.

2.3 Economic fluctuations and mortality in industrialised countries

While in pre-industrial societies economic crisis (food shortage) had a clearly identifiable effect to increase mortality, in industrial societies both the direction and the measurement of the effect are controversial.

An economic approach of the mortality-income curve may help to understand why we are getting controversial results. Laporte (2004) argues that the mortality-income curve is convex, and higher income countries are situated at the part where it is less steep, where the income elasticity of mortality is lower. For this reason the fluctuations of mortality are expected to be milder in high income countries. The smaller absolute size of the effects may lead to even small methodological differences giving rise to different results. This is likely the reason why researchers often find contradicting results in studies.

In his seminal study Harvey Brenner (1979) argued that recession mainly affects disadvantaged low-income groups, and for these groups the effects may be lasting, continuing even during economic upturns. For disadvantaged groups, recession may be a starting point of downward mobility, because many of the unemployed may lose their ability to return to the labour market as their skills are not demanded due to changed technologies. The victims of this process may develop a chronic illness, which may eventually lead to premature mortality. It is difficult to measure this process as the exact time lag is not known. (The study of effect of early life factors on later life mortality is a separate research area, and considered out of scope for this paper, as I am studying short term effects.)

While Brenner was probably correct regarding the effect of unemployment on health at the individual level, his econometric methods have received severe criticism as he disregarded the time series properties (potential stationarity) of the macro data series he used (Laporte 2004; Gerdtham and Johanesson 2005).

The majority of recent studies suggest that in developed countries the short run effect of economic fluctuations on mortality is pro-cyclical: “crisis is good for health”.

I have identified 11 studies which examine the relationship between economic fluctuations and mortality over a longer time period, using advanced econometric methods. The studies have been selected using “Pubmed” queries and by reviewing cross-references in the leading papers. Out of the 11 studies three concluded that the effect on mortality is counter-cyclical (re Sweden, Spain and Australia), two had inconclusive results (EU-26), and six concluded that the effect is pro-cyclical for all-cause mortality (US, Germany, OECD, Japan). We may note that the case of Sweden is probably special due to strong safety net, and the Australia study can be probably disregarded as it is an old study that applies the same controversial methods as Brenner(1979) did. Considering this, a consensus seems to emerge that the short term effect of economic fluctuations is pro-cyclical in high income developed countries.

The reasons behind the negative health effects of economic upturns are not entirely understood. According to Grossman’s economic theory it is plausible, that people allocate more time to health-enhancing leisure activities during economic depressions, as the opportunity cost of market time is lower (Grossman 1972). It is also hypothesized that the

business cycle induces changes in lifestyle factors through different budget constraints. During economic upturns people can afford to drive more and eat more fats, buy more cigarettes and drink more alcohol (Tapia Granados 2008).

While in pre-industrial societies and developing countries the mortality effect of the crisis comes from the fact that disadvantaged people are crossing the absolute poverty, in high-income developed societies this is less frequent. The key short term risk factor is not poverty any more, but instead risky lifestyle and occupational stress. For example Ruhm (2000) decomposed the cyclical fluctuation of death rates as predicted by his model, and estimated that 48% of the fluctuation was due to preventable causes (this includes circulatory decease) and 22% to car accidents and other external causes, while the fluctuation of cancer mortality was minimal. This gives more room to gender differences, as males are usually more prone to risky behaviour.

While none of the studies focused on gender differences, most of them included gender-specific estimates. Out of the 11 studies only 8 addressed the gender aspect. Six of these indicated that males are more sensitive to economic fluctuations, one was inconclusive, and one showed that females reacted more strongly (Neumeuer 2004, regarding Germany). Based on this result it is likely that in most high-income societies, males react slightly more strongly to economic fluctuations, giving rise to increasing gender differences in mortality.

Further research is needed to make a more confident statement, because in the selected studies the significance of difference between the gender-specific coefficients was often not tested. In addition, there were also some results which weaken the above argument: (1)In the US there is some indication that in the last two decades the sensitivity of male mortality to economic fluctuations is decreasing, especially among whites (Tapia Grandos 2005). (2) In some studies the sex differences in the sensitivity of all-cause mortality are small, probably insignificant, and the higher male sensitivity is only apparent in some special causes or age groups. For example Stuckler et al (2009) reports for the EU-26 countries, males are more susceptible to ischaemic heart disease at times of high unemployment, but only in the 30-44 age group.

It is interesting to compare the results of these studies with the transition mortality experience. The observation that male mortality is more sensitive to economic fluctuations appears to be true both in Western and in Eastern Europe. The direction of the reaction is the opposite in most cases: recession is likely to decrease the gender gap in Western Europe based on these results. The reaction of male mortality is also much milder in Western Europe, while it is also concentrated in similar age groups (working ages) and behaviour-related causes (circulatory disease, motor vehicle accidents). It may be noted however, that the transition to a market economy was not a simple recession, but a deeper crisis which created chaos and breakdown of social cohesion.

The following table summarises the studies, focusing on any evidence of gender-specific impact of economic fluctuations.

Table 1

Study	Covers	Method	Mortality is	Result by gender	Results on gender impact
Bunn A. R. 1979 Ischaemic heart disease mortality and the business cycle in Australia. American journal of public health 69 (8), 772-81	Australia 1921-1975	macro series for unemployment IHD mortality is correlated with lags	counter-cyclical	N/A	none
Gerdtham U. and Johannesson M. 2005. Business cycles and mortality: results from Swedish micro data. Social science & medicine 60 (1), 205-18	Sweden 1981-1996	probit regression for mortality using individual data of 40000 persons observed over 10-16 years, and 6 different business cycle indicators	counter-cyclical for males, insignificant for females	M++	One standard deviation increase in "GDP change" decreases mortality risk by 8% for males, while there is no signif. effect on females. The result is similar for other indicators (except unemployment due to trend change). The effect is stronger for working age males, and was found for all cause, cardiovascular and cancer mortality as well. The authors tested the gender difference using interactions, and for four out of six measures it was significant.
Gerdtham U. and Ruhm C. 2006. Deaths rise in good economic times: evidence from the OECD. Economics and human biology 4 (3), 298-316	OECD 1960-1997	fixed effects linear regression of log mortality rate and unemployment rate, controlling for age and sex distribution and country-specific linear time trends	pro-cyclical	N/A	none
Kondo N. et al. 2008. Economic recession and health inequalities in Japan: analysis with a national sample, 1986-2001. Journal of epidemiology and community health 62 (10), 869-75	Japan 1986-2001	Survey results on self-related health are compared before (1986-89) and after the crisis (1998-2001). Odds ratios of reporting poor health by occupation and income groups were calculated.	improvements continued during crisis	M+	In Japan, absolute health status improved in spite of the crisis in the 1990s. However, the relative disparity increased between top and middle occupational groups in men, but not in woman. Males showed a slightly steeper income gradient in self-related health.

Study	Covers	Method	Mortality is	Result by gender	Results on gender impact
Laporte, A. 2004. Do economic cycles have a permanent effect on population health? Revisiting the Brenner hypothesis. Health economics 13 (8), 767-79	US 1948-1996	Time series analysis (ECM) using US macro data for 1948-1996. Explanatory variables: unemployment, real per capita GDP and total health expenditure.	pro-cyclical	N/A	
Neumayer, Eric. 2004. Recessions lower (some) mortality rates - evidence from Germany. Social Science & Medicine 58: 1037–1047	Germany by state 1980-2000	Fixed effect panel regression of mortality rate with unemployment and control variables. 1. Static fixed effect model 2. Dynamic model, allowing for more lags for unemployment effect	pro-cyclical	FM+	Overall effect was highly significantly pro-cyclical in both models. In the static model, all cause mortality and cardiovascular mortality had very similar highly significant (-) coefficients for both sexes. In the dynamic model, the overall effect becomes insignificant for males, but remains significant for females. For cardiovascular mortality, effects for both sexes are still similar. Overall, mortality of German woman seams to be slightly more sensitive to economic fluctuations, but it is not clear if the difference is significant or not. One percentage increase in state unemployment rate causes 1.27% mortality decrease for males and 0.91% decrease for males.
Reher D.S., Sanz-Gimeno A. 2000. Mortality and Economic Development over the Course of Modernization: An Analysis of Short-Run Fluctuations in Spain, 1850-1990. Population Studies, Vol. 54, No. 2 pp. 135-152	Spain 1850-1990	distributed lag models for GDP and mortality	counter-cyclical	M++	Males showing far greater sensitivity then females to economic fluctuations. In the Central pain sample over 1850-1960, adult male mortality had signif. negative elasticity at lag 0 and 1, while for females the elasticities are not significant.

Study	Covers	Method	Mortality is	Result by gender	Results on gender impact
Ruhm, C. 2000. Are recessions good for your health? Quarterly Journal of Economics	US, 1972-1991, by state	Fixed effects linear regression of mortality rates by cause, with unemployment and income macrodata by state. Micro data analysis is added.	pro-cyclical	M+	No gender-specific modelling, but the study shows that the pro-cyclical variation is mainly due to avoidable causes of death (pg 645), and females have significantly lower propensity to engage in such behaviour. Females are less likely to smoke, drink or be overweight, and eat more vegetables. The only underperform males in the amount of exercise. (pg 648)
Stuckler D, Basu S, Suhrcke M, Coutts A, McKee M. 2009. The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. The Lancet 374 (9686), 315-23	EU 26, 1970-2007	fixed effects linear regression of mortality rate and unemployment rate, controlling for country-specific linear time trends	insignificant for all cause; suicide incr. with unemployment; road accidents decreased	M+	Effect on all cause mortality is insignificant for both sexes. Effect of unemployment on iscaemic heart disease mortality is significantly positive for males (but only for 30-44 age group), and insignificant for females.
Tapia Granados J. A. 2005 Increasing mortality during the expansions of the US economy, 1900-1996. International journal of epidemiology 34 (6), 1194-1202 (Dec 2005)	US 1920-1999	Time series analysis of macro data: mortality rates with GDP, Unemployment, manufacturing hours weekly. 1. Correlation of time series after de-trending 2. Regression of differenced series.	pro-cyclical except suicide	mixed	Gender-specific mortality coefficients were pro-cyclical overall, but their strength was changing in time. In the 1945-1970 period male mortality reacted more strongly to fluctuations. In the 1971-1996 period the result became different for whites and non-whites. The pro-cyclical variation became insignificant for whites for both sexes. In the same period for non-whites the pro-cyclical effect remained narrowly significant for males, while strongly significant for females.

Study	Covers	Method	Mortality is	Result by gender	Results on gender impact
Tapia Granados J. A. 2008. Macroeconomic fluctuations and mortality in post-war Japan. Demography 45 (2), 323 - 343	Japan 1955-2002	Time series analysis of macro data: mortality rates with GDP, Unemployment, Labour force participation and lagged GDP. 1. Correlation of time series after de-trending using HP Filter. 2. Regression of differenced series.	pro-cyclical	M+	In the correlation analysis, results are similar for both sexes. In the regression analysis the coefficients are slightly higher for males for some disease: stroke, transport accidents, and suicide. Stroke and transport accidents are pro-cyclical, and suicide is counter-cyclical for both sexes, but for males with slightly larger amplitude. Interactions by sex were not tested by the author, but based on the SEs I believe that for the above three causes the coefficients are significantly different by sex.

Legend:
The result by gender was coded as follows:
M+ some evidence that males react more strongly to economic fluctuations
M++ strong evidence for the same;
FM+ females react more strongly;
mixed - inconclusive,
N/A the study did not estimate effects separately by sex

2.4 Sensitivity of factors behind gender inequality in mortality

We may observe hectic movements in the gender mortality gap during the transition mortality crisis, the most extreme example being Russia where it jumped from 10,3 years to 13,7 years over five years after 1989. But this is rather an exception, then the rule. Some of the factors affecting the gender gap are fixed, some others are slowly changing but probably unaffected by short term economic fluctuations, and again others are likely to change in crisis. I am going to review these in turn using the literature.

There are a very large number of papers that one would like to review. A single aspect of this problem, like gender differences in smoking and mortality, has a huge literature. A Pubmed search for (gender) and (mortality) brought up 12995 results. For (sex) AND (mortality) AND (smoking) I still got 4401 results. [3] To keep the review focussed, I ask these two questions: what do we know about the factors behind gender gap, and on this basis, what changes can we expect in the gender gap in times of economic problems?

I used the classic review articles of Nathanson(1984) and Watson(1995) to identify the main factors that affect gender mortality gap. I have used additional evidence from other literature to classify the factors as stable factors, long term determinants, and short term determinants. But before turning to the factors, I would like to introduce the methods used in the literature.

2.4.1 Review of the methods

The types of studies and the methods the quoted articles use can be summarised as follows.

Long term country studies on gender mortality gap

These studies show, what is behind the development of gender mortality gap for a given country over a longer period, like 80 years. The sex ratio of cause-specific mortality is plotted with time, or the changes in the gender life expectancy gap are de-composed by cause of death. Time series analysis is sometimes applied to regress the trend with explanatory variables.

Demographic decomposition studies

Some studies decompose gender mortality gap by cause, age group or by marital status. Although the result is, strictly speaking, only descriptive and not causal, it can help to generate theories.

Gender gap in special populations

It is often not possible to filter out the effect of some factors in normal populations, as explanatory variables may be collinear. Luckily, there are some special populations that make this nevertheless possible, because some factors affecting the gender gap may be entirely or mainly missing in their case. For example the study of cloistered populations shows that by filtering out the effect of some gender-specific social roles, such as work-related stress and drinking, the gender gap becomes much smaller. Two studies among Israeli Jews (Staetsky and Hinde 2009) and Seventh Days Adventists (Berkel and de Waard 1983) also show a much lower gender gap, as males have more healthy lifestyles on religious grounds. Later in the

[3] (Pubmed accessed on :2010.05.04)

results section the study of the Utah population may help to examine an economic crisis situation where males do not drink alcohol, partly due the prohibition and partly due to the Mormon religion.

Demographic comparison studies (mortality before, during and after crisis)
A number of studies try to assess the impact of economic crisis by comparing mortality in detail during the crisis, and before or after it. While these studies do not concentrate on sex differences, and are primarily descriptive, the published data often allow calculating gender rate ratios by age group for the main causes of death, to see if the gender gap increased or decreased. I am also going to apply this method in the results section.

Causal studies for individual factors
Causality can be best established in longitudinal mortality follow-up studies. These may relate the individual characteristics, like social ties, behaviour, diet, unemployment, and perceived health to later mortality. The classic example is the Alemada county study in the US (Nathanson 1984). There are now a large number of such studies, applying epidemiological methods – and some of them relate to sex differences in mortality. Without aiming for completeness I try to include some of the most interesting ones.

Having introduced the types of studies I am using, I now turn to the main factors affecting the gender gap, grouping them according to their sensitivity to economic crisis.

2.4.2 Stable factors

Biological differences:
The biological constitution of man and woman lead to different risks. It is probable that woman have a natural advantage in lifespan potential. Warldon (1983), reviewing the genetic factors that may cause mortality difference by sex, concludes that they mainly affect mortality by interacting with social factors, which makes them difficult to measure separately. Månsdotter estimates that biological factors explain 2,5 to 5 years of the total gender difference, and the rest is due to societal factors. (Månsdotter et al, 2004) Another estimate may come from cloistered populations, because nuns and monks have similar lifestyles, sheltered from societal stress factors, and free from many elements of the traditional gender roles. The gender gap in life expectancy between Bavarian nuns and Monks was 1,6 in the 1960-1990 period, much smaller than the comparable figure for the German population (ca. 5,5 years). This was due to the comparatively low mortality of the monks. We may note that German monks were not completely free from all harmful habits: smoking was common among them after WW II, and we know little about their alcohol consumption (Luy, 2003). This makes it possible that the stable genetic core of life expectancy difference is below 1 year.

2.4.3 Long-term determinants

My argument is that the gender mortality gap is mainly determined by long-term changes in society. The main factors affecting it are parts of slow-moving social change processes; we may expect changes in them over decades, but usually not from one year to another. Let us look at these factors in turn.

Health technology, epidemiological stages

As we have seen in section 2.1, the epidemiological stages affect the gender gap. The progress depends on income and the spread of health technologies. For example, improved medical treatment of hypertension and ischemic heart disease benefited both man and woman, but it resulted in a larger absolute gain for men, due to the higher prevalence of these diseases among them (Waldron 1993, Hemström 1999). These are slow-moving processes, which are unlikely to cause abrupt changes in the gender gap, and probably not very closely related to short-term economic cycles.

Socio-economic differences

Human capital theory may be expanded to explain the demand for health. Grossman (1972) argued that health can be viewed as a special type of human capital. The stock of health determines the amount of healthy life, the time that we may use to produce earnings and commodities. Healthy time is used to work more (and to produce even more income), or to enjoy some free time or family activity. The relationship between health and income is complex in this model, but in essence, it explains why higher income individuals tend to have better health.

The positive relationship between income and health is confirmed in many studies(Gerdtham et al 2004, Gravelle and Sutton 2009, Leigh and Jencks 2007). In most advanced societies females have a disadvantage in most areas, for example, lower income then males, so the above logic would suggest that males should also live longer. In terms of life expectancy, the opposite is true, and some researchers explain it with the "gender system" theory.

Gender system

Several researchers believe that the gender differences in mortality are related to the "gender system". Based on sex, a societal structure exists, organizing human activities and relations, assigning different health-related behaviours to woman and men. Men more frequently engage in health-damaging behaviours as a means of demonstrating masculinity. As gender differences gradually decrease in modern societies, the role models and behaviour of males and females become more similar, so the gender mortality gap decreases. This is what we call "convergence hypothesis" (Walron 1993, Månsdotter et al, 2006). This hypothesis have been confirmed in recent US and Swedish research.

Differences in risky behaviour may be regarded as a part of the gender system. Women's movement towards economic equality and higher labour force participation has a gradual effect on the gender gap. The long term trend of gender gap is mainly explained with changes in the prevalence of smoking. Hemström (1999) plots cigarette consumption and excess male mortality over the 1945-1990 period in Sweden, showing that the two trends are strikingly similar and the differenced series are significantly correlated. The recent decrease in gender gap, which started in Anglophone countries and Northern and Western Europe around 1980, may be clearly attributed to changes in relative smoking prevalence among males and females (Waldron 1993). On the other hand, it is debated how much the gender gap can be linked to other aspects of gender role convergence. For example Warldon(1993) argues that increasing labour force participation of women has probably not decreased the gender gap, while studies

from the Nordics argue that it probably has done so, as it narrowed the differences in gender behaviour (Helweg-Larsen and Juel 2000; Hemström 1999).

Interestingly, the higher equality of woman may impact male mortality as well, as changes in the family roles may be stressful, or to the contrary, may solve a stressful role conflict within the family. Kawachi et al (1999) have carried out a cross-sectional analysis of mortality gap for 50 US states. They reported that a smaller wage gap between women and men was associated with lower female mortality rates. But interestingly, states with higher wage gap and lower female autonomy were also detrimental for men's health.

Researchers in Sweden have examined the gender system hypothesis using individual data. This research also had the virtue that it could separate the effects of equality in the domestic and in the public sphere. The results show that in the public sphere, traditionally unequal woman have decreased health risk, while traditionally unequal men have increased health risk compared to their equal counterparts. In the domestic sphere both sexes have higher health risks, if they are unequal (Månsdotter et al, 2006). A recent Swedish study, comparing municipalities found that gender equality was generally correlated with poorer health for both men and women. The authors speculate that equality in Sweden has reached a stage where it can not be extended further without large conflicts: woman take too high a burden while men lose their privileges (Backhans, Lundberg and Månsdotter 2007). In Eastern Europe it was found that marriage had a strong protective effect for males, a large part of mortality increase in the 1965-1990 occurred among single males, and the selection effect only partly explains this (Watson 1995; Hajdu et al 1995).

Summary

Most factors that affect the gender gap are determined by slowly moving social tendencies, like gender equality, smoking habits, and adoption of health technologies. It is not surprising that the trend of the gender mortality gap is usually quite stable and that large changes from one year to another are rare.

2.4.4 Short-term determinants

There is a lot of controversy regarding the short term determinants of gender mortality differences. Economic fluctuations evidently affect risk-taking behaviour and harmful consumption, but the aggregate effect can be either positive, or negative (see section 2.3). Large economic and social changes may cause "acute psychosocial stress", but in my view the evidence for this is only indirect. Moreover, the psychosocial stress argument leads to the idea that unemployment has a differential effect on male and female mortality. While this argument makes sense, I could only find very limited direct scientific evidence for it, and almost no evidence supports it outside of Eastern Europe. Let us look at these arguments in detail.

Risk-taking behaviour and economic fluctuations

During recessions people are likely to reduce their spending on foodstuff and alcohol, and consumption is likely to decrease. This may mean that people eat less meat and fats, and turn to more healthy vegetables, as Ruhm (2000) argues. Unfortunately, people often make compromises on quality instead. Stuckler (2009) notes that during the 2009 recession the

turnover of the fast food chains increased in the US. In Russia alcohol consumption probably increased during the transition crisis (Cornia and Paniccia 2001), and the budget constraint caused people to drink harmful spirits from unchecked sources, for example aftershaves with 95% ethanol (Stuckler, 2009). Peggy Watson (1995) argues that while eastern Europeans do not smoke more, the dose-response relationship for them may be steeper than in the West.

While probably all researchers agree that smoking and drinking explains at least a part of mortality gap, some researchers argue that behavioural factors explain a very substantial part. Martin Bobak (2003) shows that mortality rate ratios in 32 European countries are strongly correlated with the gender gap due to tobacco ($r=0,61$ $p<0,001$). In other words estimated prevalence of smoking explains a large part of cross-country variation of gender mortality rate ratios. Kubik et al (1995) collected cigarette consumption statistics for the Central-Eastern European region, and contrasted it with the rising trends of lung cancer. The result shows that indeed, there was a large increase in smoking during the 1960-1989 period in Hungary (50% increase on the 1960 level), Bulgaria(38%), East Germany(63%) and Poland (40%), while Slovakia (25-30%) and the Czech Republik (10-20%) showed a milder increase.

The other factors of risky behaviour are driving and violence. In Western Europe, studies tend to record decreases in accidents during recessions (see chapter 2.3 and 3.3). During the transition mortality crisis, however, accidents and homicides showed a large increase during the economically chaotic years, and this contributed to the increase of gender gap, although it was not the main factor. Accidents and violence are often the leading cause of gender mortality gap at young ages (e.g. in the 15-25 age group) (Nathanson 1984). While the male-female ratio of adults (aged 25-64) in mortality due to injuries and violence is around three in Western Europe, it was about five in both CIS and CEE in 2000. This is attributed to various factors: drunken driving, the mixture of old and new vehicles in traffic, and homicides due to the breakdown of government control (Nolte 2004).

So while risky behaviour is evidently a “male thing”, it may depend on the circumstances, if recessions will increase or decrease it. What is more, harmful consumption of food and tobacco is unlikely to have an immediate effect on individual health. Alcohol consumption however may possibly have a short term effect on gender gap. In the next section I am looking at that in detail.

Alcohol consumption and its health effects

Drinking, and especially binge drinking largely explains both the size and the hectic movements of the gender gap in Eastern Europe. The Great Depression hit the US at the time when the Prohibition was in place, and alcohol was hard to come by. Mortality rates actually fell during the 1929-33 crisis by about 10%, and there was no large change in the gender gap. In Russia, on the other hand, alcohol was available when the crisis hit, and there was a culture of heavy drinking. A study based on 1190 interviews has shown that in Moscow males not only drink much more than females, but the way they drink is also much more harmful. Binge drinking (drinking less often, but then until intoxication, using strong distilled spirits) is also associated with economic problems for males (OR 1,78) but not for females (OR 0,71),

showing that for males alcohol consumption may be a coping mechanism in the Russian culture. (Jukkala 2008) The gender gap in Russia rose to 13 years during the transition crisis.

It is clear that the heavy fluctuations of the gender gap in Russia and Ukraine were at least partly related to the Gorbachov's alcohol ban. After 1990 the state could not control the alcoholic drinks market any more, and although the official statistics could not show it, due to the relatively lower price and improved availability of alcoholic drinks, consumption increased throughout the region. (Zaridze et al 2008, Cornia and Paniccia 2001)

The health effect of alcohol is such that a small quantity daily may even improve health, but binge drinking, drinking a large amount in irregular intervals, is harmful (Hemström 1999, Jukkala et al. 2008). There is a direct causal relationship between the gender gap increase of cirrhosis mortality and drinking, and with a number of other causes, like accidents - but it is difficult to establish similar link between alcohol and CVD. It has been estimated that in Russia 32,5% of the 1990-1994 mortality rise, and in Poland 27,6% of the 1989-1991 mortality rise may be attributed to alcohol (Cornia and Paniccia 2001 pg 100).

The mystery regarding alcohol and CVD mortality

Binge drinking is also known elsewhere in Eastern Europe, in Hungary a folksong says: "I make my sorrow drawn in wine". But the idea of masculinity includes heavy drinking in other countries, where the gender gap is lower, so this cultural factor alone does not explain everything. There is an argument that alcohol drinking cannot be the main explanation of male excess mortality, due to its weak link with CVD mortality, and due to the fact that alcohol consumption and gender gap often move independently. For example in East Germany no increase in alcohol consumption was recorded during the 1989 peak in gender gap. (Cornia and Paniccia 2001)

However, two studies suggest some pathways which may indicate a stronger link between alcohol and excess mortality than previously thought. Zaridze et al (2008) present evidence from the review of 24836 autopsy records for the 1990-2006 period in Russia. They note that although the excess mortality was mainly due to cardiovascular causes, within that category mostly only "other forms of chronic ischaemia" were growing, while rates of myocardial infarction were relatively constant. A very high proportion of the autopsies which fell to this "other" category, have shown a lethal concentration of ethanol in blood. This indicates that many of alcohol related deaths may have been classified incorrectly as CVD deaths. Medical research suggest that the effects of binge drinking maybe much worse than that of moderate regular drinking, because it may cause arrhythmia and thrombosis, while the positive effects on lipoproteins is missing. (McKee and Britton 1998) This means that both administrative and medical mechanisms may link binge drinking to CVD, and the actual share of alcohol in the mortality increase may be much higher than the 30-40% estimate above, because that estimate only attributed 15% of CVD mortality increase to alcohol.

For the purposes of this paper, smoking and drinking is regarded as a "proximate determinant", as I am more interested in the relationship between economic development and health. In other words I believe that behind both smoking and drinking there are more

important socio-economic reasons, which are referred to in the literature as "psychosocial stress".

Psychosocial stress

Most papers addressing the problem of premature male mortality in the formal Soviet bloc attribute it to a special psychological and sociological state of the society, which was unique to the period of transition to market economy. While using different terms and emphasis, they tend to agree that consumption factors were of secondary importance. Cornia and Paniccia (2001) write about a period of chronic psychosocial stress (1965-1989) and acute psychosocial stress (after 1989). They emphasize the fact that a new situation arose, for which the appropriate coping behaviour was not known, resulting in a psychosocial stress which may cause sudden death due to cardiovascular problems, and may also interact with other risk factors, causing accidents and cirrhosis. Watson (1995) explaining the more gradual first phase (chronic crisis) stresses the feeling of relative deprivation, which was related to the growing inability of socialist system to meet the expectations of the citizens. Sigriest (2002) stresses the harmful psychological consequences of effort-reward imbalance.

In spite to the agreement between researchers regarding the main factors, this line of theory has some major weaknesses. As Carlson (2001) argues in his book review, the trends for premature male mortality started well before the transition, around 1965, so labelling it as "crisis" may not be appropriate. He also argues that the concept of psychosocial stress needs refinement.

The two pillars of psychosocial stress theory

The psychosocial stress theory rests on two pillars: (1) psychosocial stress leads to higher CVD mortality risk and (2) males experience stress more often or they are more vulnerable to such stress.

But is the view that disease is a direct reflection of mental state largely folklore, or does it have some strong underpinning? [4] While the biomedical community tends to be sceptical, behavioural scientists have gathered more and more evidence. A review article concludes that taken as a whole, evidence for a psychological and social impact on CVD morbidity and mortality is convincing (Kranz and McKeney, 2002).

Does stress increase the chance of CVD mortality?

Maria Kopp and her partners (Kopp et al 2008) published a research report which links together interview results abut stress factors with regional cardiovascular mortality data for 150 Hungarian sub-regions.

They have shown that high weekend workload, low social support at work and low control at work are correlated to the variation in male premature cardiovascular mortality rates. Although the pair-wise correlation between psychological explanatory variables and CVD mortality was high, due to multicollinearity between socio-economic factors and

[4] The authors of "Mortality Crisis in Transition Economies" themselves recognise that "direct evidence is lacking". Marmot and Bobak article in Cornia and Paniccia 2001, pg 136.

psychological factors, and due to the fact that the study can only analyse regional aggregates, a causal relationship could not be convincingly established.

Example correlation coefficients with male CV mortality (all are significant at 0,01 level):

Education	-0,60
Personal income	-0,51
Anomie	+0,34
Depression	+0,35
Control at work	-0,26
Social support of friends	-0,37

Research regarding Russia also linked together economic uncertainty, stress and mortality. Gavrilova and Semyonova (2000) carried out a regional analysis of the 1992-1994 mortality decline in Russia and shown that the regional differences may not be explained by traditional measures like unemployment and income, or alcohol consumption. On the other hand loss of social capital, growing inequality, and stress of adoption has played a significant role in the mortality increase. The mortality crisis affected middle aged people the most, especially those who were near pension age, because upon losing their jobs they had little hopes to find alternative source of income. (Gavrilova – Semyonova 2000)

Cornia and Paniccia (2001, pg 70-76) modelled the change in standardized mortality rates for all causes, CVD, and external causes between 1989 and 1994 for 47 oblasts (regions) of Russia. Socio-economic stress has been measured by region by extracting the first principal components of three variables: labour turnover, unemployment and family instability. The authors found a significant relationship between change in stress and mortality increase, and the effect for males was 2,5 times more pronounced than for females.

Daniel Kruger and Nesse (2007) wrote a comprehensive article, examining the psychological factors behind the demographic developments in Eastern Europe. They have computed male:female mortality rates (M:F MR) for 14 Eastern European nations, for three different periods: pre-transition(1985-1989), transition (1990-1994) and post-transition (1995-1999). They show that gender mortality gap (M:F MR) has increased in these countries as a result of the transition, predominantly in case of young adults, reflecting shift towards riskier behaviour, and middle adulthood, indicating a greater psychological susceptibility to stress. But why are males more prone to take risks and engage in unhealthy behaviour? Kruger and Nesse provide an evolutionary psychological explanation. The reproductive success of males largely depends on their ability to compete for mating opportunities. Men who control more resources, who have higher status are more likely to mate and have offspring. Natural selection reinforces risk-taking behaviour in males. Human male competition includes direct physical and status competition, as well as competition for resources that make them more attractive for females. Females, however, have bigger role in protecting their offspring. They are more likely to follow “tend-and-befriend” and “huddle and hide” strategies.

While the explanation of Kruger and Nesse is interesting, it is not more than a hypothesis because it is not based on empirical data analysis.

Peggy Watson (1995) in her excellent essay gives a somewhat similar hypothesis: she points out that the "frustrations of state socialism" had important influences on health, and the coping mechanism of females were probably better due to their household roles and broader social networks. The failure of the system put a larger emphasis on family, both to ensure access to non-market favours, and to ensure psychological well-being. Hajdu et al (1995) pointed out that a large part of premature male mortality in Hungary occurred among divorced and widowed males, and they argue that the difference is so large that it can only be partly due to selection effect. In Hungary, divorce had an impoverishing effect on males, often leaving children with the mother, and ordering a 20-50% deduction from salaries as maintenance payment.

Finally, Stuckler et al (2009) showed in his hotly debated recent study in the Lancer, that the mortality crisis was deeper in those countries which followed the advice of the IMF and World Bank and implemented shock therapy and mass privatisation, while it was milder in those which implemented a more gradual approach with fewer lay-offs. Stuckler argues that in the countries that pursued mass privatisation, like Kirgizstan and Russia, unemployment increased more radically, and these countries have seen more severe health effects, than other countries which implemented a more gradual approach to privatisation, like Albania and Bulgaria. A panel regression at the country level between working age male mortality and privatisation measures supports this view. This study provoked a debate in Lanset, with critics arguing that the results are not robust to the privatisation index used.(Earle 2010)

As we have seen, the above studies are based on regional analysis or literature review, and strictly speaking they do not prove that there is a causal relationship between stress and mortality. So let us turn to individual level studies now.

Stress, unemployment and mortality on individual level

In individual studies there is a clear statistical relationship between unemployment and mortality. However, it is subject to debate if the measured relationship is causal, or due to selection.

In a recent review article Jin, Shah and Svoboda (1995), after reviewing 46 articles the authors concluded that while the association between unemployment and adverse health outcomes is strong, and that further research is needed to prove that this is a causal relationship, as it is difficult to control for all important confounding factors.

For example a Polish study by Zagozdzon et al (2008) has shown that unemployment status has significantly increased mortality risk and was associated with a two times greater risk of death in men than in women: hazard ratio (HR) 2.02, 95% CI 1.33–3.08. However, the authors in this study could not control for socioeconomic position and initial health status.

A Swedish study by Gerdtham and Johannesson (2003) controlled for initial health status, education and income, and found that unemployment significantly increases the risk of suicides and the risk of dying from "other diseases", but not from cardiovascular disease and cancer.

Clinical research regarding the connection between stress and CVD shows that acute and chronic risk factors are a bit different, and they combine to reach threshold for clinical cardiac events. Controlled animal experiments with monkeys and dogs have convincingly demonstrated the effects of social stress and social status on the development of organic disease like atherosclerosis[5], cardiac arrhythmias and sudden death. Results on humans seem to confirm this (Krantz and McKeney 2002).

Individual studies often find that social factors affect mortality of men and women differently. An epidemiological follow-up study in Finland has shown that having more social connections reduces the risk of mortality for males, but not for females. (Kaplan et al 1988) A US mortality follow-up study using the PSID has shown that increasing spousal income raises man's odds of dying, while the opposite is true for women (Mcdonough et al 1999)

In spite of all the above, I could not find much evidence that psycho-social stress had a strong gender-specific mortality impact anywhere outside of Eastern Europe. A recent study about the Karelian Finns is an interesting exception. Saarela and Finnas (2009) have shown that Finn males who were originally born in Karelia, have suffered more than a 20% mortality increase, mainly due to cardiovascular mortality, during the perestroika (1988-1990). Female mortality and the mortality of the main population have not been significantly affected. During this period, there was much uncertainty regarding the outcome of a debate regarding the possible restitution of Karelia, their homeland, to Finland. The Karelian Finns, having evacuated from Karelia in the 1940-45 period, have completely assimilated to the Finnish society. Before and after the crisis their mortality was highly similar to that of the main population. This means that psycho-social stress is the only possible explanation for their temporary mortality increase.

2.5 Summary of theories

The mechanisms affecting the gender mortality gap can be best summarised using a graph. (Figure 1.) Based on the literature, economic crisis may affect mortality through three different mechanisms.

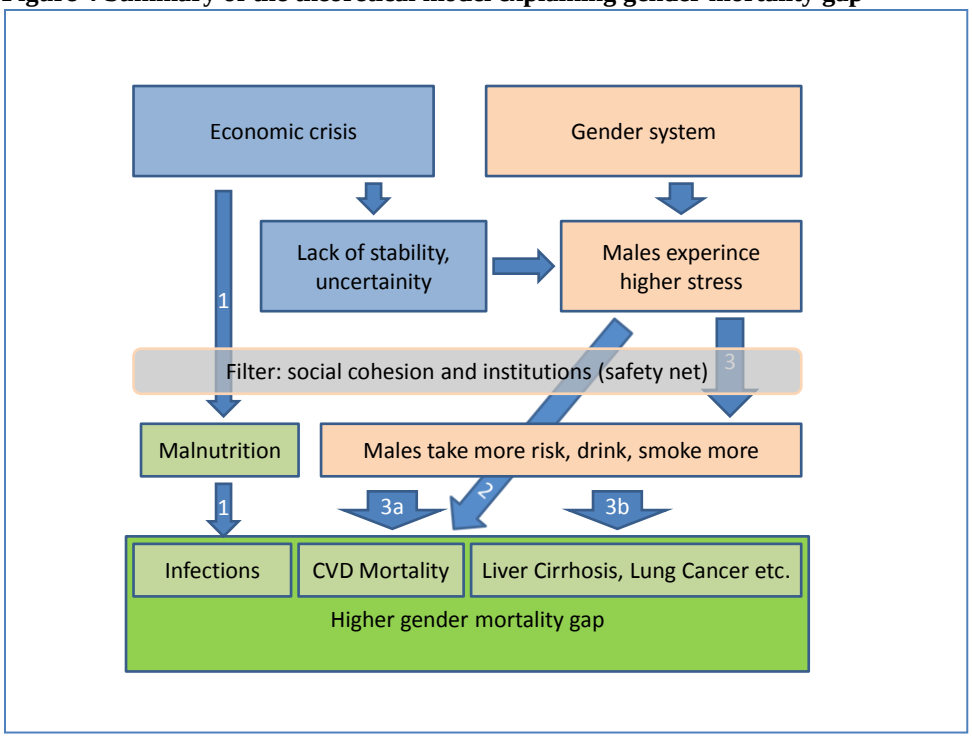
1. In developing societies and historic Europe, economic problems caused food shortages, and malnutrition made the population more susceptible to infections disease. Depending on the social norms, in some societies this may lead to higher male then female mortality. Mortality crisis of this kind tend to affect the young and old generations more.
2. Economic problems create uncertainty, and as a result some individuals experience stress. Coping mechanisms of males and females tend to be different, and at least in some societies males experience higher stress then females. According to some, but not all researchers, this may lead to higher CVD mortality for males.
3. Even if there is not a direct mechanism between stress and mortality, there is a broad agreement in the literature that males drink and smoke more, and tend to increase other risky behaviour, probably using this as a way to cope with stress. Smoking and

[5] Atherosclerosis: the condition in which an artery wall thickens as the result of a build-up of fatty materials such as cholesterol.

drinking, (especially binge drinking) increase the risk of cardiovascular mortality, and also mortality due to a number of other disease tends to increase.

As we have seen, economic crisis often does not increase the gender gap. This can be explained by the existence of a filtering mechanism in modern societies. Both the family and institutions have an important role. Social cohesion or religious rules may keep males from taking too many risks, and safety nets may reduce stress for the unemployed. (Kondo et al 2008, Stuckler 2009) According to this view, the economic transition in Central and Eastern Europe was unique, because high economic uncertainty and the collapse of social protection mechanisms happened simultaneously (Figure 4).

Figure 4 Summary of the theoretical model explaining gender mortality gap



Based on the above theoretical framework I hypothesise that other examples may be found when the gender mortality gap increased as a result of economic crisis.

In the rest of the paper I am looking for such examples, and try to see if the mortality pattern shows any similarity to that of the transition mortality crisis in Central Eastern Europe. Is there any evidence that male risk-taking increased, and the gender mortality gap widened as a reaction to economic crisis in other countries?

3 Crisis scoreboard (short case studies)

3.1 Research question for this section: does unemployment change affect the gender gap?

We have seen in the theory section that the key explanation for the short-term increase in gender gap is psycho-social stress, in other words the unfavourable health effects of

adaptation to economic change. While the idea of psycho-social stress is complex and difficult to measure, most researchers of the field would probably agree, that with some simplification it can be led back to the unemployment change – gender gap relationship. Cornia and Paniccia (2000, pg 31-32) argues that what really matters for mortality is not the level of unemployment, but the sudden and large changes in that. The authors propose an 'adaptation hypothesis', which links the standard death rate to change in unemployment in period t, t-1 and t-2. The model is written as follows (pg. 32):

$$SDR_t = (\alpha_1 \Delta U_t + \alpha_2 \Delta U_{t-1} + \alpha_3 \Delta U_{t-2}) + \sum \beta_i X_i + \varepsilon \qquad (1)$$

Where t is time, SDR is standardised death rate, U is unemployment and X is a set of other regressors. Cornia and Paniccia (2000) suggests that in the above model $\alpha_2 > \alpha_1 >> \alpha_3$, meaning that a rise of unemployment has the highest effect in the year that follows, but later people adopt to this change, and even if unemployment remain high, the effect on mortality remains only temporary.

Interestingly however, I could not find a paper which tests the unemployment – gender gap relationship in this way, because the authors are more often using cross-sectional approach, where unemployment level is part of a composite index, and the effect of change is not measured. In addition, no paper attempted to test this hypothesis outside of the formal Soviet bloc.

Therefore even my largely descriptive approach will progress the knowledge in this area. In this section I present a "crisis scoreboard" for five countries. I have selected such countries where there has been a major rise in unemployment recently, and I am going to examine, if that had any effect on the gender gap.

3.2 Data and Method

Using a recent review article by Falagas et al (2009), and my own literature list, I have selected five articles which address the issue of mortality and economic crisis, and publish similar information, that enable me to calculate gender mortality ratios. The sources are summarised in Table 2.

Table 2 Sources used in the Crisis Scoreboard

Country	Specific source (detailed mortality data and background information)	Life expectancy and unemployment data
Argentina	Cornia and Paniccia 2001 (pg 328- 351); Myriam and Munn 2005	For all countries: Human Mortality Database: http://www.mortality.org World Bank: http://databank.worldbank.org
Germany	Nolte, Shkolnikov and McKee 2000 (1), (2) Riphahn and Zimmermann 1998	
Russia	Cornia and Paniccia 2001 Gavriova 2000	
South Korea	Khang 2005; Khang and Lynch 2005	
Spain	Reher and Sanz-Gimeno 2000 + WHO data collected by the author for cause-specific mortality rates	

The first four studies enabled me to calculate gender mortality rate ratios (F:M MR) for the main causes that are known to be affected by economic crisis: cardiovascular mortality, suicides, traffic accidents, and liver disease. The study for Spain had a different structure, and I have collected data for from Eurostat to fill the gap. Knowing that in Eastern Europe the late working age generation was the most severely affected, I have selected that age group where it was possible. I show using standard graphs, how did the crisis affect gender mortality gap by cause in each case.

Additionally, as the relationship between unemployment and gender mortality gap is a key question of the current study, for the selected five countries I have collected yearly unemployment data from the World Bank database for both sexes for the post WWII period, and life expectancy data from the Human Mortality and World Bank databases.

Besides plotting these two series for the selected five countries, I have also calculated correlations using the first differenced series, assuming 0, and 1 years lag. I have adopted the methods of Tapia Granados (2008), which is also in line with equation (1): I am trying to relate changes in mortality to changes in unemployment in period t and t-1. As the unemployment data usually start from around 1980, it is possible to calculate correlations for about 25 year period, which is not too long, but still, it adds some objectivity to the results.

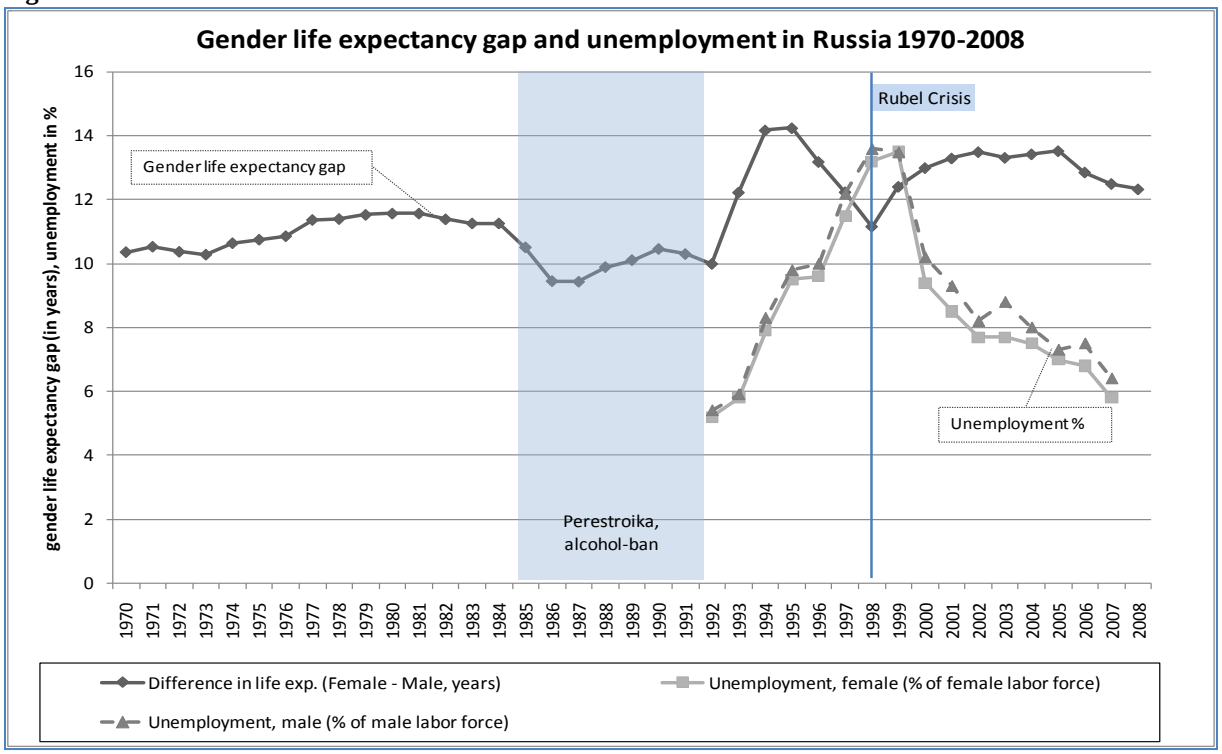
While this investigation will not provide conclusive evidence, it will enable a thorough comparison of the demographic reaction to economic crisis. If there is any similarity between the mortality patterns of ex-socialist bloc with that of other selected countries, we will be able to point that out.

3.3 Results

3.3.1 Russia

In Russia, we see a large fluctuation in the gender gap. This partly due to the availability of alcohol: it has been restricted in the Gorbachov era, but abundant from 1992, as the liberalised market started to shed cheap drinks. There were two major shocks: the collapse of the Soviet Union in 1991, and the Rubel crisis in 1998. It is clear that after both of these shocks the gender gap started to increase (Figure 5). However, it should be noted that the gender gap has traditionally been very high in Russia, probably reflecting the traditional norms of masculinity.

Figure 5



The crisis scorecard compares the two crisis years (1991 and 1998) with third year that followed the crisis (1994 and 2001) especially for adults in the 35-69 age group (Figure 6). In case of Russia this is not the best way of comparison, as the effects were cumulative and delayed. All cause mortality increased after the crisis in both cases, and gender ratios were very high, but no marked increase can be seen specifically in crisis years. The cause-specific ratios have some surprises: The gender ratio of ischaemic heart disease stagnated. Liver disease showed a relative increase among females, and the sex ratio is not too high. It is more according to the expectations that suicide shows a marked increase for both sexes, but for males more.

The conclusion is that we see here an accumulation of unfavourable effects on mortality. The new waves of the crisis came before the wound of the previous one could have been healed. There were evidently some traditions which affected male mortality more adversely. It is

perhaps mistaken to concentrate on the economic side of the crisis, as it was a more complex social process.

Figure 6 Crisis scoreboard for Russia

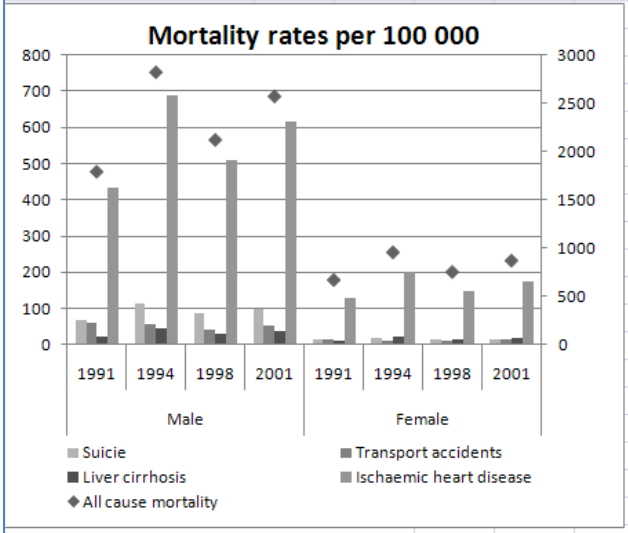
Russia

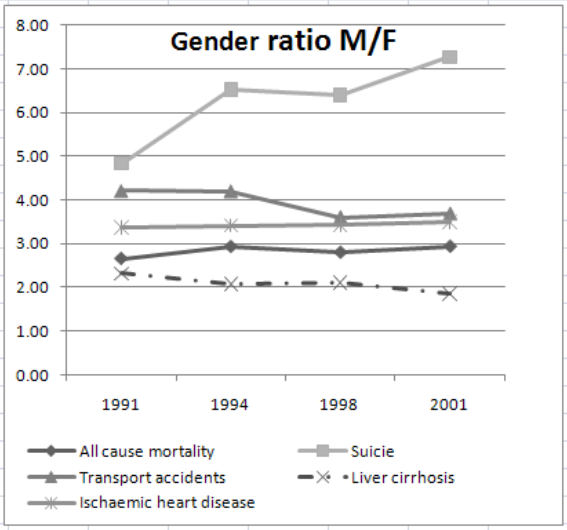
Cause-specific mortality rates per 100 000 and calendar-year mortality rate ratios among males and females (standardised to world population)

Crisis: 1998

Age group: 35-69

	Male				Female				Gender rate ratio M/F			
	1991	1994	1998	2001	1991	1994	1998	2001	1991	1994	1998	2001
All cause mortality	1789	2814	2117	2566	674	959	756	873	2.65	2.93	2.80	2.94
Suicie	67.2	114.9	88.3	96.8	13.9	17.6	13.8	13.3	4.83	6.53	6.40	7.28
Transport accidents	60.6	55.1	41.1	52	14.4	13.1	11.4	14.1	4.21	4.21	3.61	3.69
Liver cirrhosis	22	43.8	31.7	38.1	9.5	21.1	15	20.5	2.32	2.08	2.11	1.86
Ischaemic heart disease	433.2	688.9	508.6	616.3	128.4	202	148	176	3.37	3.41	3.44	3.50





Note: all cause mortality is on the right hand scale.

3.3.2 South Korea

The financial crisis of South Korea started in the Autumn 1998, and lasted until 2001. After enjoying a long period of high GDP growth (5-10% yearly), in 1998 the GDP fell with 6,7%, and unemployment had jumped from the previous 2-3% to 6-7% in 1999. South Korea received an emergency loan from IMF. The crisis caused a restructuring in the economy, for example employment became more flexible.

Mortality had a stable declining trend before the crisis, and all cause mortality continued to decline steadily during the crisis, for both sexes. While clearly there was no absolute increase in mortality, some authors argue that compared to the previous trend excess mortality can be observed, while some others doubt this. Kim et al (2004) estimated mortality from pre-crisis years using ARIMA trend, and reported a worrying excess mortality compared to that trend. However, Khang et al(2005) criticised the methods applied to estimate the trend, and concluded that the excess mortality estimated by Kim et al is way too high to be correct. The analysis of Kim et al(2005) (which is probably more correct in my view) shows, that while age-standardised mortality rates from most causes continued to improve during the crisis, ischemic heart disease rates increased for both sexes, as well as suicide. Both of these causes are more frequent among men.

Figure 7

Figure 7 shows that while there was no major increase in the gender gap, its decline halted during the worst two years of crisis. But even if the crisis had affected the gender gap, this effect was only minor and it did not last very long, from 1999 the decline continued.

Figure 8 Crisis scoreboard for South Korea - source: my calculation from the published data of Khang et al (2005)

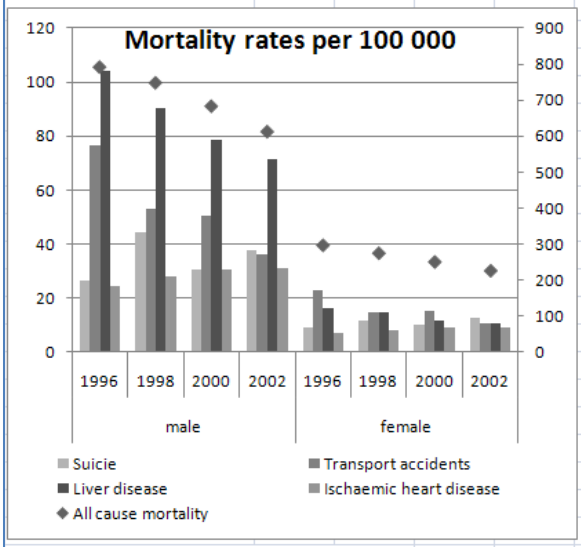
South Korea

Cause-specific age-standardized (to 2000 world population) mortality rates per 100 000 and calendar-year mortality rate ratios among males and females

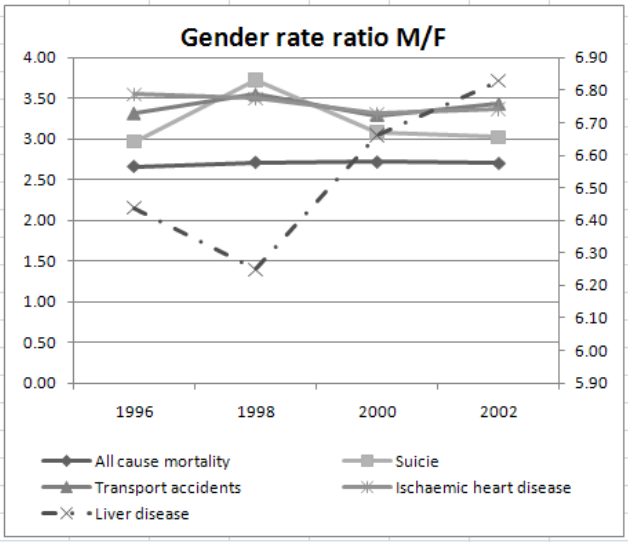
Crisis: 1998-2000

Age group: 35-64

	male				female				Gender rate ratio M/F			
	1996	1998	2000	2002	1996	1998	2000	2002	1996	1998	2000	2002
All cause mortality	791.2	747.7	682.9	612.3	297.4	275.5	251.3	226.8	2.66	2.71	2.72	2.70
Suicie	26.4	44.3	30.5	37.8	8.9	11.9	9.9	12.5	2.97	3.72	3.08	3.02
Transport accidents	76.5	52.9	50.3	36.4	23.1	14.9	15.3	10.6	3.31	3.55	3.29	3.43
Liver disease	104.3	90.6	78.6	71.7	16.2	14.5	11.8	10.5	6.44	6.25	6.66	6.83
Ischaemic heart disease	24.5	28	30.8	31.3	6.9	8	9.3	9.3	3.55	3.50	3.31	3.37



Note: all cause mortality is on the right hand scale.



Note: liver desease mortality is on the right hand scale.

In Figure 8 we see that in spite of the crisis, mortality continued to improve in South Korea. We compare mortality in the 35-64 age group, in crisis years (1998-2000) and two reference years before and after, 1996 and 2002.

All cause gender rate ratio remained fairly constant, and we see only a very slight increase. The crisis left the gender mortality gap largely unaffected. Liver disease mortality is more than six times higher among males, and this ratio worsened in the wake of the crisis. The disadvantage of males in suicide and transport accidents slightly increased during the first year of crisis, but returned to "normal" later. Ischaemic heart disease mortality increased slightly for both sexes, but it has a far lower share then what we usually see in Europe, and the gender ratio was not sensitive to the crisis.

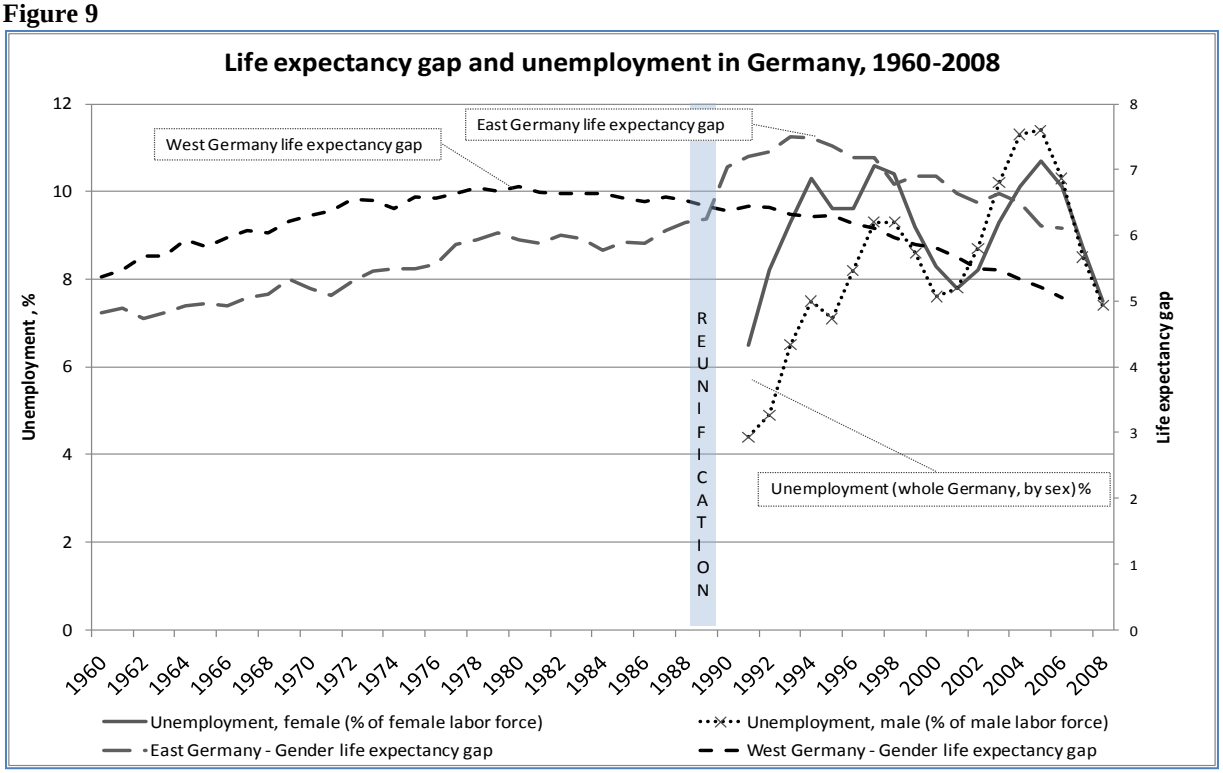
The conclusion is that while mortality continued to improve, there is some evidence that males increased their risk-taking behaviour in South Korea during and shortly after the crisis, and this temporarily halted the decrease of gender mortality gap.

3.3.3 Germany

I have included Germany, because the possibility to look at the effects of reunification is very interesting. As Nolte at al (2000) noted, East Germany has always been somewhere half-way between east and west in terms of mortality, and after unification there has been a quick improvement, which reduced the East German gender gap faster than in other Central-Eastern European countries. This may be explained by a rapid change in diet (fruits and vegetables becoming more available) and the extension improvement in health care.

While I could calculate the gender gap separately, I could only find Germany-wide unemployment data, but we of course know that unemployment was much higher in the "Neue Lander" after unification. What we see on the graph is that only the East German gender gap increased after Unification, by about one year over a four year period (from 6,2 to 7,5), but it continued to decline afterwards, in both East and West Germany, even though unemployment had a second peak around 2005. This suggests that only a very major economic and political change affects the gender gap, and it is driven by long term factors otherwise. (Figure 9)

Figure 9



The crisis scoreboard for Germany compares mortality for all ages, shortly after Unification in 1992 ("a crisis year"), with mortality five years later, in 1997. The graph shows, that in line with the adoption hypothesis, after reunification there was a reduction in sex ratios, particularly for Eastern Germany. The reduction was especially large in causes related to risk-taking behaviour, like transport accidents (Figure 10). We may note however, that unemployment was much higher in 1997 than in 1992, so the gender gap decreased in spite of raising unemployment.

Figure 10

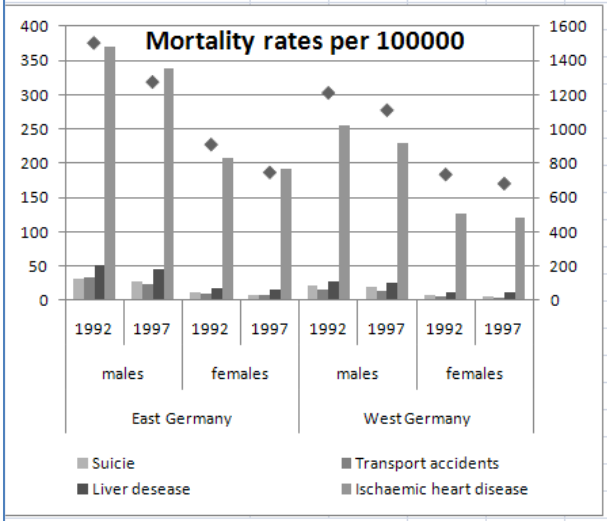
Germany

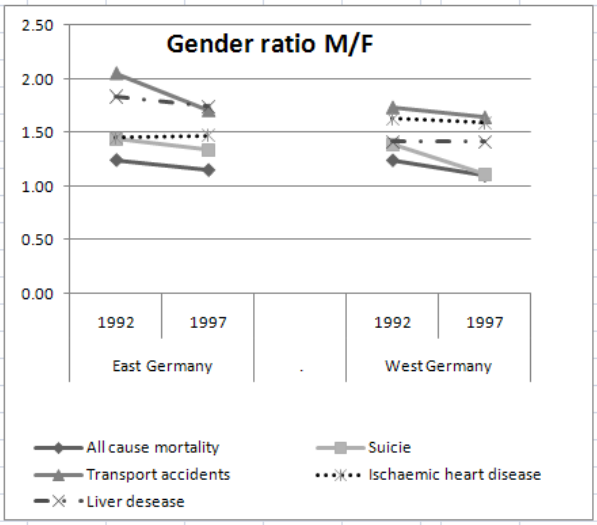
Cause-specific mortality rates per 100 000 and calendar-year mortality rate ratios among males and females (standardised to European population)

Crisis: 1992

Age group: all

	East Germany				West Germany				Gender rate ratio M/F			
	males		females		males		females		East Germany	.	West Germany	
	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997
All cause mortality	1505	1277	911	748	1213.3	1111.6	736	682.4	1.24	1.15	1.24	1.10
Suicie	32	27.4	10.85	7.51	22.28	20.5	7.83	6.77	1.44	1.34	1.39	1.11
Transport accidents	33.89	24.01	10.18	7.6	16.52	14.06	5.87	4.63	2.05	1.71	1.73	1.64
Liver desease	51.71	44.83	17.37	15.54	28.22	25.75	12.29	11	1.83	1.74	1.41	1.41
Ischaemic heart disease	370.62	338.92	207.77	191.68	255.43	230.06	127.51	120.61	1.45	1.47	1.63	1.59





Note: all cause mortality is on the right hand scale.

3.3.4 Argentina

The Cornia-Paniccia book brings up Argentina, a possible example where psycho-social stress effected mortality, during the period of extensive privatisation and economic restructuring over the 1990s. During this period there has been a large rise in unemployment and economic inequality increased in Argentina (Cornia and Paniccia 2000, Chapter 14). The main evidence the authors provide is a panel regression for the 1990-1995 period for 23 provinces. Although their results show that the effect of unemployment change on male mortality change is significant, the regression is only presented for the 15-25 age group (pg 347).

My figure, based on World Bank data shows that the life expectancy gap had a stable trend, and was not affected by the rise in unemployment (Figure 11). (I have tried to check the life expectancy data, as there might be an artificial reason for this stability, for example it is possible that the statistical office estimated the female series from the male one, but I could not find a secondary source yet. On the whole I believe that the World Bank data are reliable. On a larger scale the gender gap graph does show some fluctuation.)

Figure 11

Figure 12

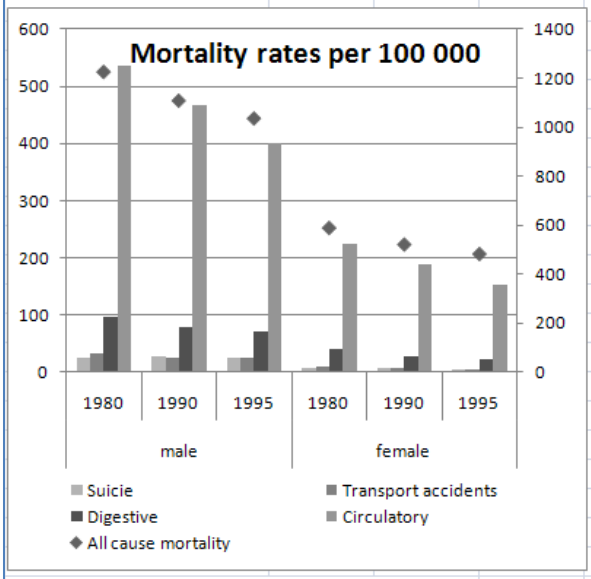
Argentina

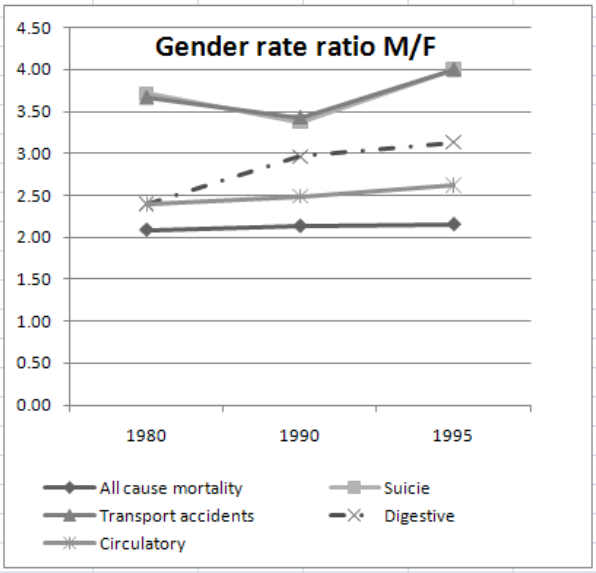
Cause-specific age-standardized (to age structure of 1980 population) mortality rates per 100 000 and calendar-year mortality rate ratios among males and

Crisis: 1998-2000

Age group: 40-64

	male			female			Gender rate ratio M/F		
	1980	1990	1995	1980	1990	1995	1980	1990	1995
All cause mortality	1228	1110	1037	588	520	481	2.09	2.13	2.16
Suicie	26	27	24	7	8	6	3.71	3.38	4.00
Transport accidents	33	24	24	9	7	6	3.67	3.43	4.00
Digestive	96	80	72	40	27	23	2.40	2.96	3.13
Circulatory	537	468	401	224	188	153	2.40	2.49	2.62





Note: all cause mortality is on the right hand scale.

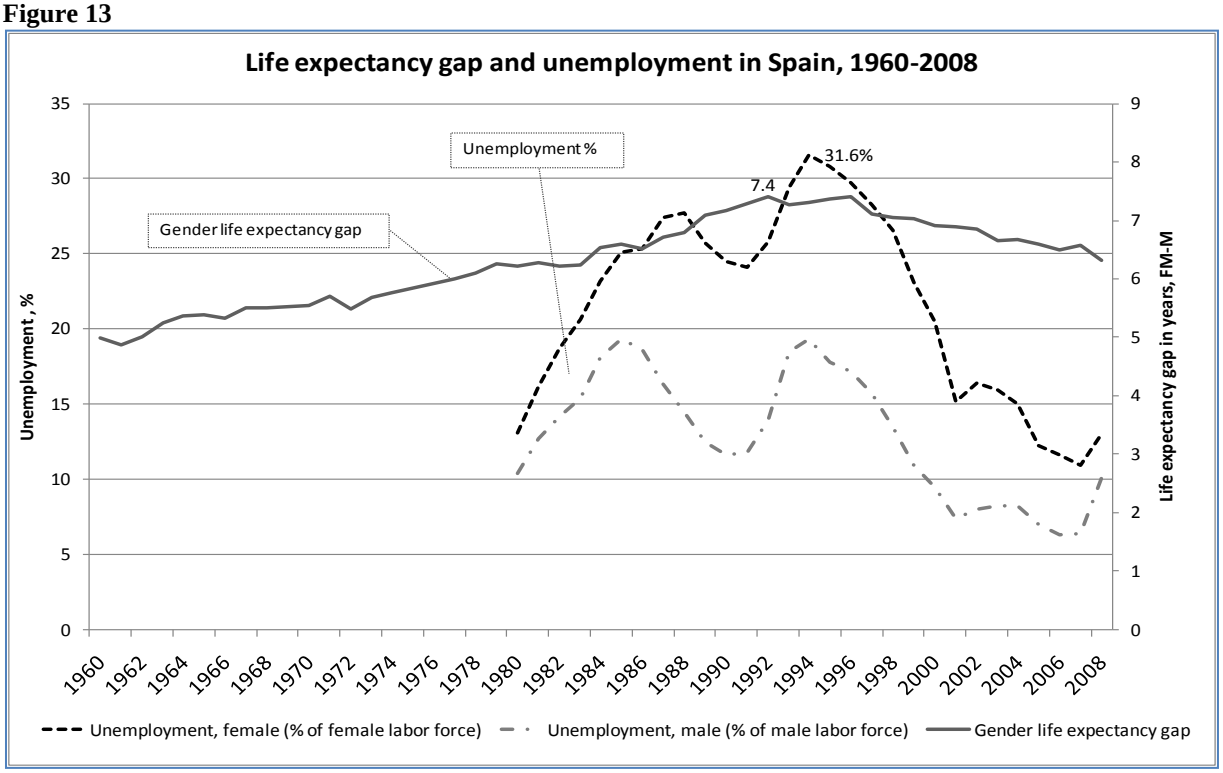
The crisis scoreboard (Figure 12) compares two normal years (1980 and 1990) with a crisis year (1995), for the late working age group (40-64). Mortality continued to improve during the crisis. In all cause mortality the gender ratio is stable, it remains around 2,1. However, it appears that the crisis reversed the decreasing trend in the gender ratio of suicide and transport accidents.

3.3.5 Spain

I have included Spain because an interesting study by Reher and Sanz-Gimeno (2000) indicated that the traditional Malthusian link between economic development and mortality still existed in Spain for quite long, until about 1960: mortality worsened when GDP dropped. The sensitivity of mortality to economic fluctuations in spite of the overall improvement in health is explained by income inequality: the presence of disadvantaged groups in the society, who are living near to absolute poverty limits.

In the 1980s and 1990s Spain experienced rising unemployment in two waves, reaching 31,6% for females. In spite of this from Figure 13 it appears that the gender gap followed a stable long term trend, and most probably it was not sensitive to the fluctuations of unemployment.

Figure 13



The crisis scoreboard (Figure 14) compares two crisis years (1994 and 1995) with two normal years year (2001-2002), for those below 65, using Eurostat data. Contrary to the psychosocial stress hypothesis, the gender ratio of all cause mortality is quite stable, and gender ratio of ischaemic heart disease mortality was also not higher during the crisis, then afterwards. Only suicide mortality had higher gender ratio in the crisis years.

Figure 14

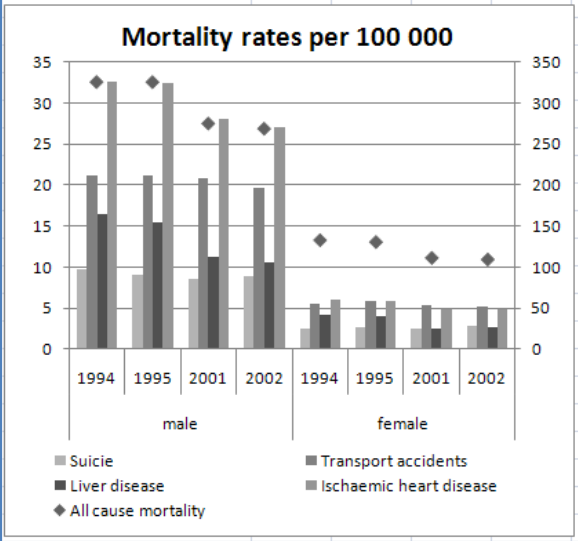
Spain

Cause-specific age-standardized (to 2000 world population) mortality rates per 100 000 and calendar-year mortality rate ratios among males and females

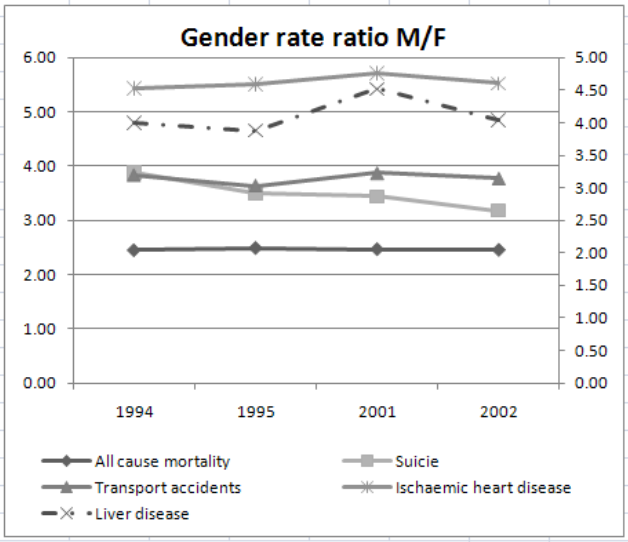
Crisis: 1994-1995

Age group: under 65

	male				female				Gender rate ratio M/F			
	1994	1995	2001	2002	1994	1995	2001	2002	1994	1995	2001	2002
All cause mortality	326	325.9	275.4	269.1	133.3	131	111.7	109.7	2.45	2.49	2.47	2.45
Suicie	9.7	9.1	8.6	8.9	2.5	2.6	2.5	2.8	3.88	3.50	3.44	3.18
Transport accidents	21.1	21.1	20.9	19.6	5.5	5.8	5.4	5.2	3.84	3.64	3.87	3.77
Liver disease	16.4	15.5	11.3	10.5	4.1	4	2.5	2.6	4.00	3.88	4.52	4.04
Ischaemic heart disease	32.6	32.5	28	27.1	6	5.9	4.9	4.9	5.43	5.51	5.71	5.53



Note: all cause mortality is on the right hand scale.



Note: liver desease mortality is on the right hand scale.

3.3.6 Correlations between differenced unemployment and gender gap series

In order to do a more objective check, the following table shows the correlations of differenced unemployment and gender gap series based on the data plotted earlier. None of the correlations were significant, even at 20% level.

It is possible, that the lack of correlation is due to aggregation, and the fact that the series are short. While I can not exclude this possibility entirely, as an experiment I have done a much more focused calculation in case of one country, Spain, where I had the longest series and this continues to give insignificant result. I am looking at the gender gap in circulatory disease for Spain, focusing on the sex mortality ratio in the 45-54 age group. (Table 3) The result is still insignificant at 10% level (r=0,3 p=0,11 at lag 0).

These results do not confirm the hypothesis that male mortality reacts more strongly to changes in unemployment than female mortality.

Table 3

Pearson correlation coefficients of differenced life expectancy gap and differenced male unemployment series by country

	time period	unemployment lag	correlation (r)	N	p (two-tailed)
Russia	1992-2007	t	-0.031	15	0.914
		t-1	0.030	14	0.919
East Germany	1991-2006	t	0.221	15	0.428
		t-1	0.232	16	0.386
West Germany	1991-2006	t	0.041	15	0.885
		t-1	0.313	16	0.237
Argentina	1987-2008	t	0.168	21	0.467
		t-1	0.194	21	0.399
Spain	1980-2008	t	-0.100	28	0.614
		t-1	0.244	28	0.211

Data source: World Bank

Note: corr(Δlifeexpgap(t) ; Δunepl_male(t)) and corr(Δlifeexpgap(t) ; Δunepl_male(t-1))

Person correlation coefficients of differenced circulatory disease male:female mortality rate ratio in the **45-54 age group** and differenced male unemployment series

	time period	unemployment lag	correlation (r)	N	p (two-tailed)
Spain	1980-2005	t	0.322	25	0.116
		t-1	0.017	25	0.935

Data source: Who mortality database, tables
http://apps.who.int/whosis/database/mort/table1.cfm

Note: corr(ΔcirculatoryM:FMR_age45-54(t) ; Δunepl_male(t)) and
corr(ΔcirculatoryM:FMR_age45-54 (t) ; Δunepl_male(t-1))

3.3.7 Summary of the case study results

The case study results make it likely that the increase in premature male mortality is not a usual consequence of economic crisis. Although there was a large crisis in South Korea, in Argentina, and in Spain, we do not see a large increase in the gender gap there. A further difference is that if there was a small increase in the gender gap, it was only temporary, while in Russia the high gender mortality gap was lasting. The probable reason is that the gender difference had deeper social roots and the economic crisis probably only made it a bit worse.

Some smaller elements of the crisis scoreboards show more similarities. Suicide mortality and alcohol-related mortality was often higher in the crisis year. But the sex mortality ratio for all-cause mortality was stable in South Korea, Argentina, and Spain as the main mortality causes did not show a gender-specific reaction to the crisis.

Even in East Germany and Russia, unemployment and gender gap often do not move together, so if there was a link, it was not direct. It is possible, that a more sophisticated approach would be needed to make that link visible. Although the tools I have used are simple, because previous research results are all in line with each other, it leads one to think that the explanatory power of the psychosocial stress theory is weak in most situations.

4 Mortality in Utah (US) during the Great Depression

4.1 Introduction

A recent study by Tapia Granados (2005) has come up with the counter-intuitive result that mortality improved during the Great Depression for both males and females. The authors use aggregate data. This is surprising because one would think that the Great Depression would lead to similarly large economic uncertainty, as the post-Soviet transition did.

Therefore I am re-examining the Great Depression using individual data in the results section, using the Utah Population Database (UPDB). The results show that although mortality indeed improved, it worsened in the 40-60 age group during the first two years of the crisis. The worsening was somewhat stronger for males than for females. As smoking and alcohol drinking was probably rare in this particular population, this indicates that psycho-social stress may have been causing higher mortality during the Great Depression as well, but only in certain age group, and the effects were much less dramatic and did not last long. (section 3.2)

4.2 Data and Method

The Utah Population database is one of the largest genealogical datasets of the world. It contains 1.6 Million individuals, and I am using an extract of ca. 200 thousand records of people who were born before 1900. The dataset reflects the history of a special population, people who mainly lived in Utah, and about half of them belong to the Church of Jesus Christ of Latter-day Saints (LDS or Mormons) and it is not representative to the US population as a whole. The advantage of the dataset is that records are linked, so it is possible to identify

families through several generations (Smith et al, 2009). To my knowledge, it has not been used yet to research the mortality impact of the Great Depression.

The analysis in the paper takes the following approach. I look at all people in the sample, who were born before 1900, and I observe their mortality before, during and after the crisis. New observations are not added, so in essence we are observing the survival of the same group of people throughout the period. I am only observing people aged 40-60, who lived any time during the period 1924-1938, the rest of the data are dropped or censored.

4.2.1 Covariates and controls

The Utah dataset is rich in life event and family composition variables, but not very rich in other explanatory variables. For example we do not know if a person became unemployed or if his employment status has changed as a result of the crisis. We also do not know the place of residence within Utah.

The main purpose of the paper is to do short-term comparison between the pre-crisis years and crisis years, and as we are observing the same large cohort of people, only mortality from one year to another changes their compositions slightly. For this reason in my view controls are not very important.

Table 4 shows the control variables I could select from the dataset. An earlier study by Ken Smith et al (2009) based on a similar extract from the UTAH database have shown that these variables are important covariates in modelling mortality.

Table 4

Variable	Description
LDS	LDS or not (is ego an active Mormon)
NPSES	Nam Powers SES code (if record linked to a Utah Death Certificate)
farmer	Is the ego a farmer? (0 if not, 1 if yes)
sibnum	Number of siblings in this dataset as determined by having a common mother (ego)
deathofmother20	Dad died before ego was 20
deathoffather20	Mom died before ego was 20
parity_krank	Parity of the ego (sequence nr. of birth)
number_of_children	Number of children of the ego. The size of family may have en effect on exposure to the crisis.

The use of Utah Population database is partly justified by the idea, that religion prohibits Mormons to use alcohol and to smoke (Alexander 1996), so the result will show the short-term effect of economic crisis on mortality, when males have less possibility to engage in health-damaging behaviour. But I should also note the gender mortality gap was much lower around 1930 than at the end of the century because the disease environment was very different. In spite of this I think it is very interesting to examine the effect of Great Depression on mortality using a large and detailed dataset.

4.3 Method

4.3.1 Death rates and sex ratios by age group and year

Knowing the birth dates and death dates of all individuals in the sample, I could calculate detailed mortality statistics. To achieve this I have declared the data as longitudinal in Stata (stset), I split the observations to episodes by age groups and calendar years, re-calculating the durations for each record. After this, I tabulated the durations (time at risk) and death counts by sex, calendar year and age group. Dividing the death counts by the time at risk, I could calculate the death rates.[6]

The bonus of having calculated so many death rates is, that it is now possible to calculate sex ratios by age group, and draw up a trend for the observed period. The graph will make visible any major change in the gender mortality rate ratio during the Great Depression. Although this is a descriptive approach to our research question, because I do not specify what constitutes a major deviation, it is enough to provide an overview of the mortality impact of the crisis, and make sure that the more sophisticated analysis that will follow is on the right track. The results can be compared with the results of Tapia Granados (2009) for the whole US.

4.3.2 Cox regression

Using these data, it is also possible to model the mortality risk by gender and time period. For this purpose I use survival analysis, and specifically, Cox proportional hazard method:

$$h_i(a) = h_0(a)e^{X_i\beta}$$

where $h_i(a)$is the hazard rate, i is an index by person, a is age, X is the matrix of covariates, and β represents regression parameters. (Cleves et al 2008)

I observe persons from the age of 40 until death or censoring (age of 60). X includes a number of yearly dummy variables to signal the calendar years: the coefficients of these dummies will show, if mortality is significantly higher during the crisis or not.

Name of period dummy	Calendar year
Period 1	1924-1928
Period 2	1929
Period 3	1930
Period 4	1931
Period 5	1932
Period 6	1933
Period 7	1934-1939

The analysis time is age, meaning that time is ticking for each individual according to his or her own age. The period dummies are used as time-dependent covariates, their values signal, if we observe an individual during a crisis year, or not.

[6] I have used Cleves et al (2008) and a series of lecture notes and sample Stata do files by Susan Hautaniemi Leonard and George Alter.

4.3.3 Graphing the cumulative hazard estimates by sex

Before running Cox regression, I have used a non-parametric method to show the mortality experience by sex and period. I used Nelson-Aalen cumulative hazard estimates. The cumulative hazard curve is expected to move upwards in the crisis years (Period 2-6), especially in late working ages, and move up more for males then for females.

4.3.4 Cox model versions

While keeping the basic idea, I run the models in the following versions.

A Without controls, separately for males and females – in theory, the controls which do not change in time are not important, when we compare mortality between the years, as we are observing the same people.

B/1 With additional covariates as controls, separately for males and females. The addition of controls cuts the sample size, due to missing values. For example in many cases the age of the egos mother is not known, and then the given observation is dropped.

B/2 Same as B1, but with fewer control variables.

C With interactions for sex and being a Mormon. (to test if the effect of sex and religion is significant)

I have used Schoenfeld residuals (Cleves et al 2008, pp 200-203) to test the proportionality assumption. I could accept the specification in case of Model A, but the test indicated a problem with the proportionality of some control variables in model B/1. After dropping the problematic control-variables, the model (B/2) was again accepted, and the result was essentially unchanged.

4.4 Results

4.4.1 A slight, and temporary increase in death rates, no change in sex ratios

The following two figures (Figure 15, Figure 16) show the changes of age-specific death rates that I calculated from the Utah population sample, for the period between the two world wars (1918-1938). The calculation is based on 77707 deaths and 3,9 million man-years at risk. In one category (formed by one sex and age group and year) the count of deaths was around 50-150.

We may say that the Great Depression started with "Black Tuesday", October 29, in 1929, so the first full crisis year was 1930. From the graphs we may observe that there was no major mortality increase during the great depression. On the other hand for most age groups 1930 was a local maximum in the curve, a relative peak, and this is especially true for males aged 50-54 we see a major increase in the 1929-30 period.

Figure 15

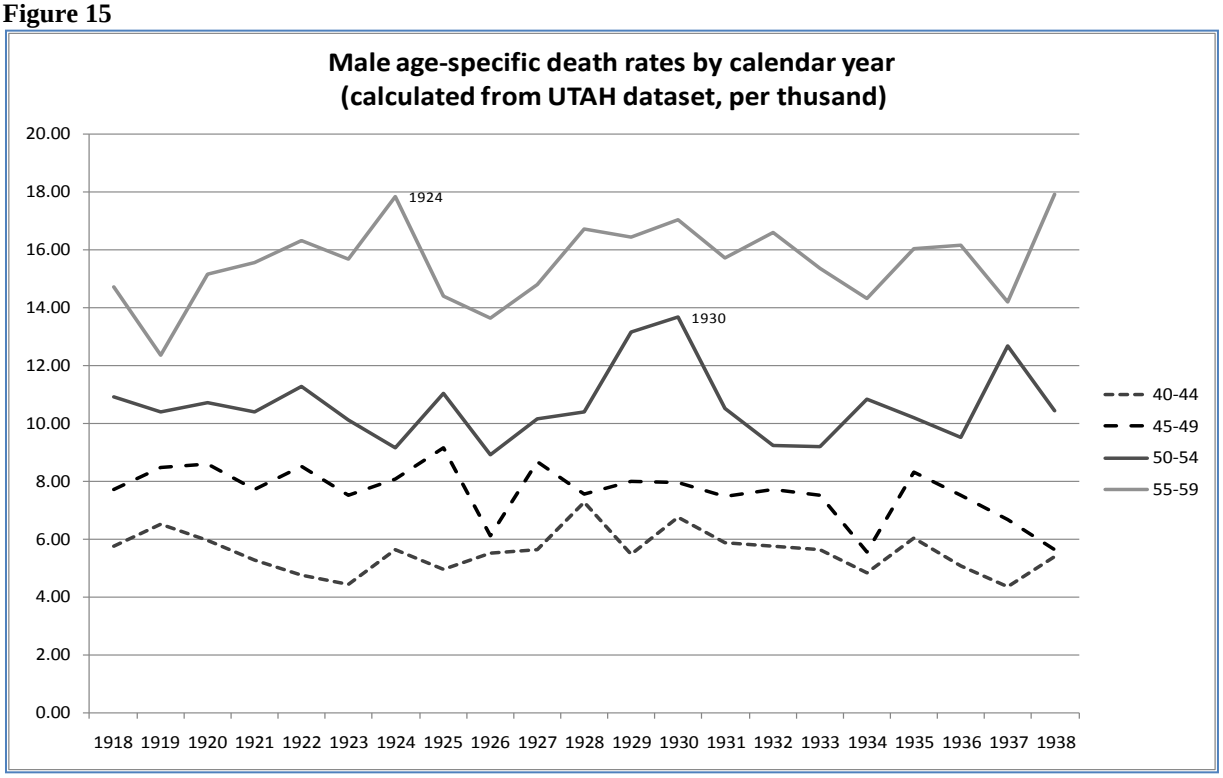
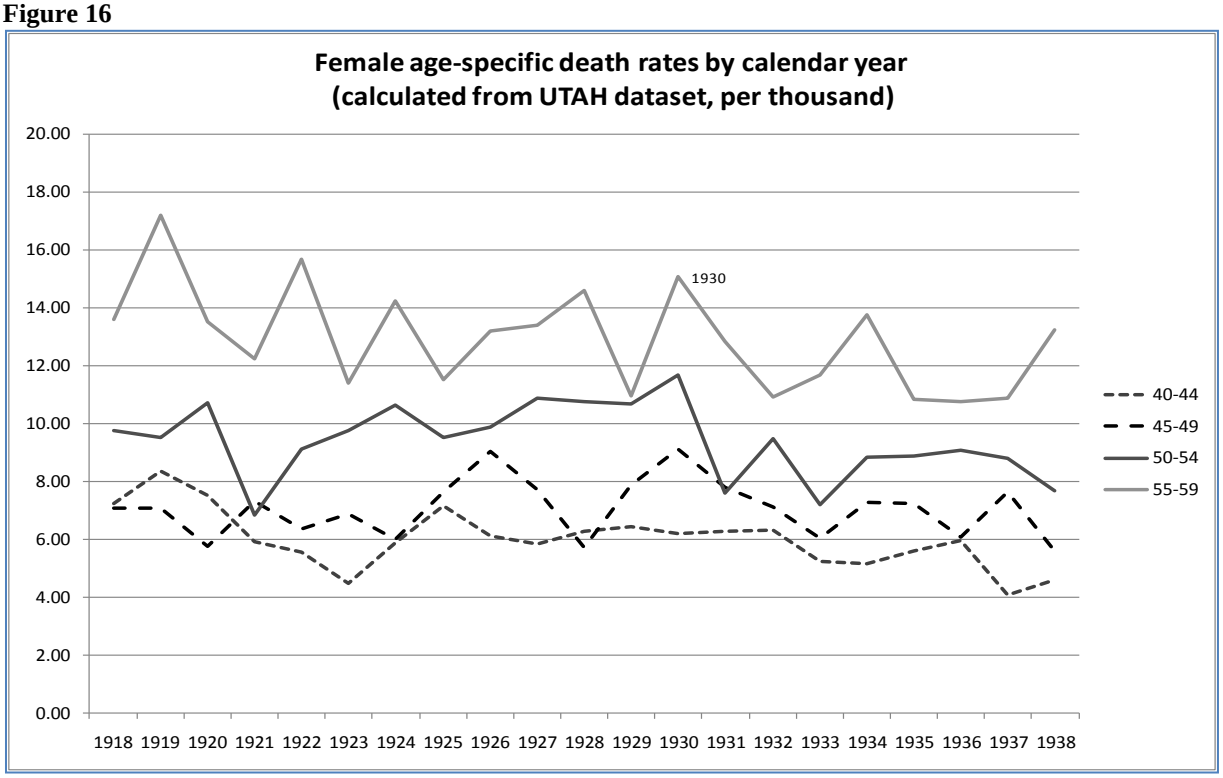


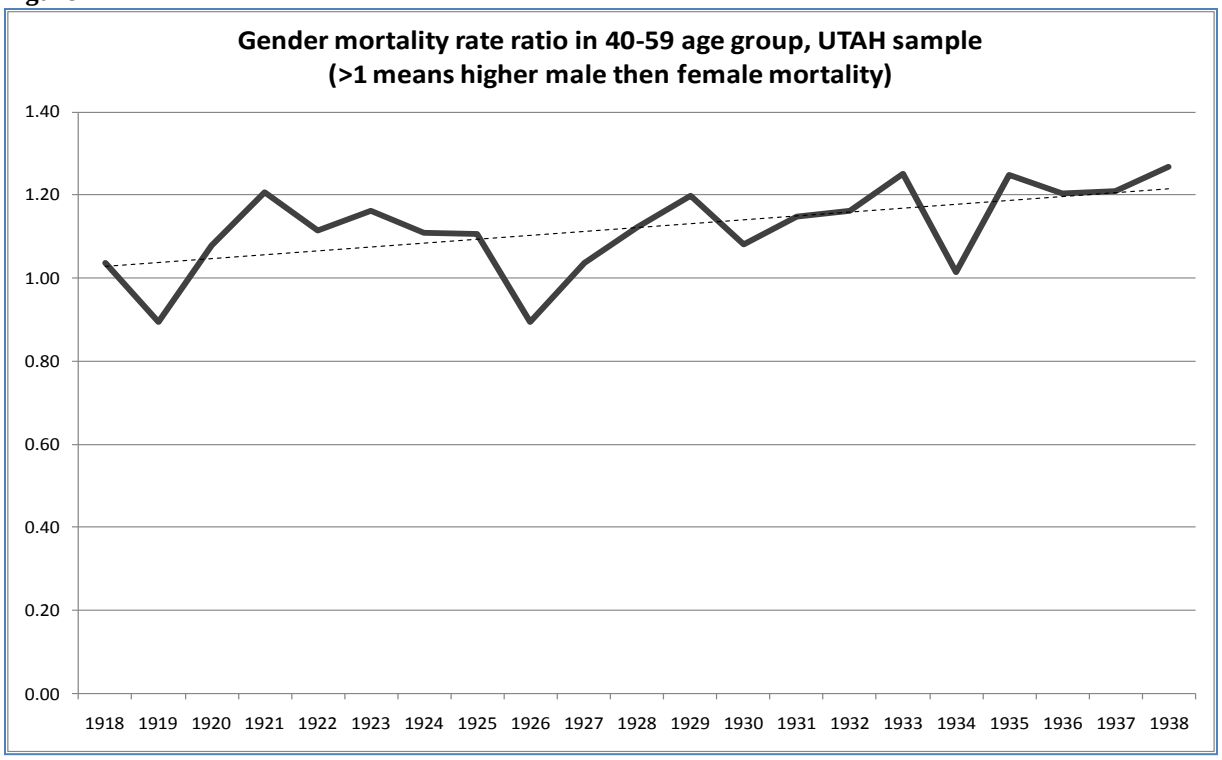
Figure 16



The gender ratio would show high random fluctuation by age group, so it is better to calculate it for the whole 40-59 age group. The result indicates that the relative gender gap followed an increasing trend over the whole period (because female mortality in these age groups was improving, while male mortality was not), but we do not see any major deviation from the

trend during the crisis years. Even in 1930, when we see a male peak, the 40-59 gender ratio "stays calm". (Figure 17)

Figure 17



4.4.2 Nonparametric analysis: slightly increased risk of dying in 1930, but "back to normal" afterwards

To compare the mortality experience in the years during, before and after the crisis, I have also calculated Nelson- Aalen Cumulative Hazard estimates. (Figure 18, Figure 19)

The x axis on these graphs shows the analysis time, which starts at the age of 40, so 10 means the age of 50. The lines show, how the mortality hazard accumulated over the years for an "average person" after the age of 40. The solid line is the base period, 1924-28, it shows less random fluctuation as it uses the data of more years.

We may see from the graph that mortality increased in 1929 and 1930 for both males and females, but mainly only after the age of 50. Otherwise, male mortality was similar in all years examined, while female mortality showed an improvement, especially after the crisis. Female mortality at older ages (after 53) improved even during the crisis from 1931, while the improvements halted in earlier ages. Male mortality was stagnating with the exception of the temporary increase in 1929-30.

Figure 18

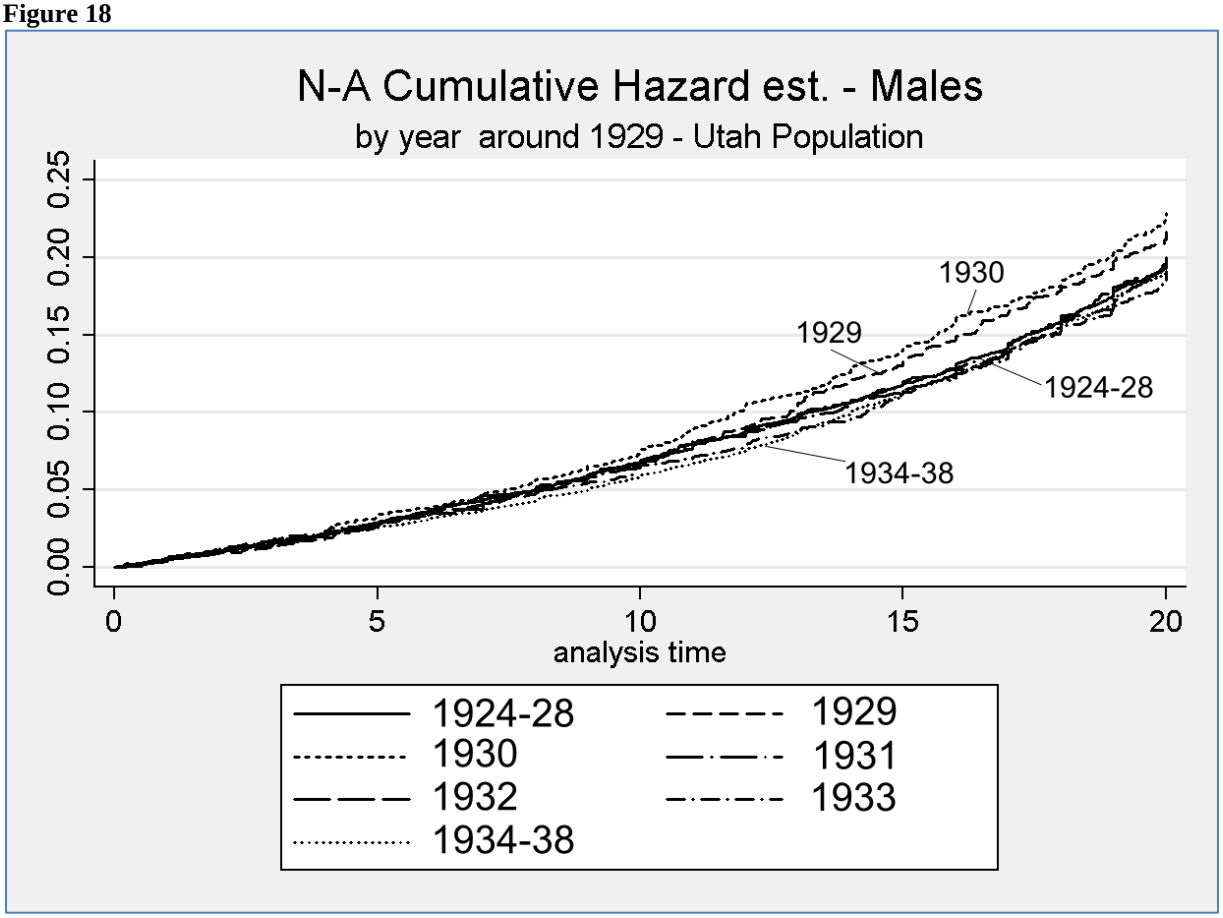
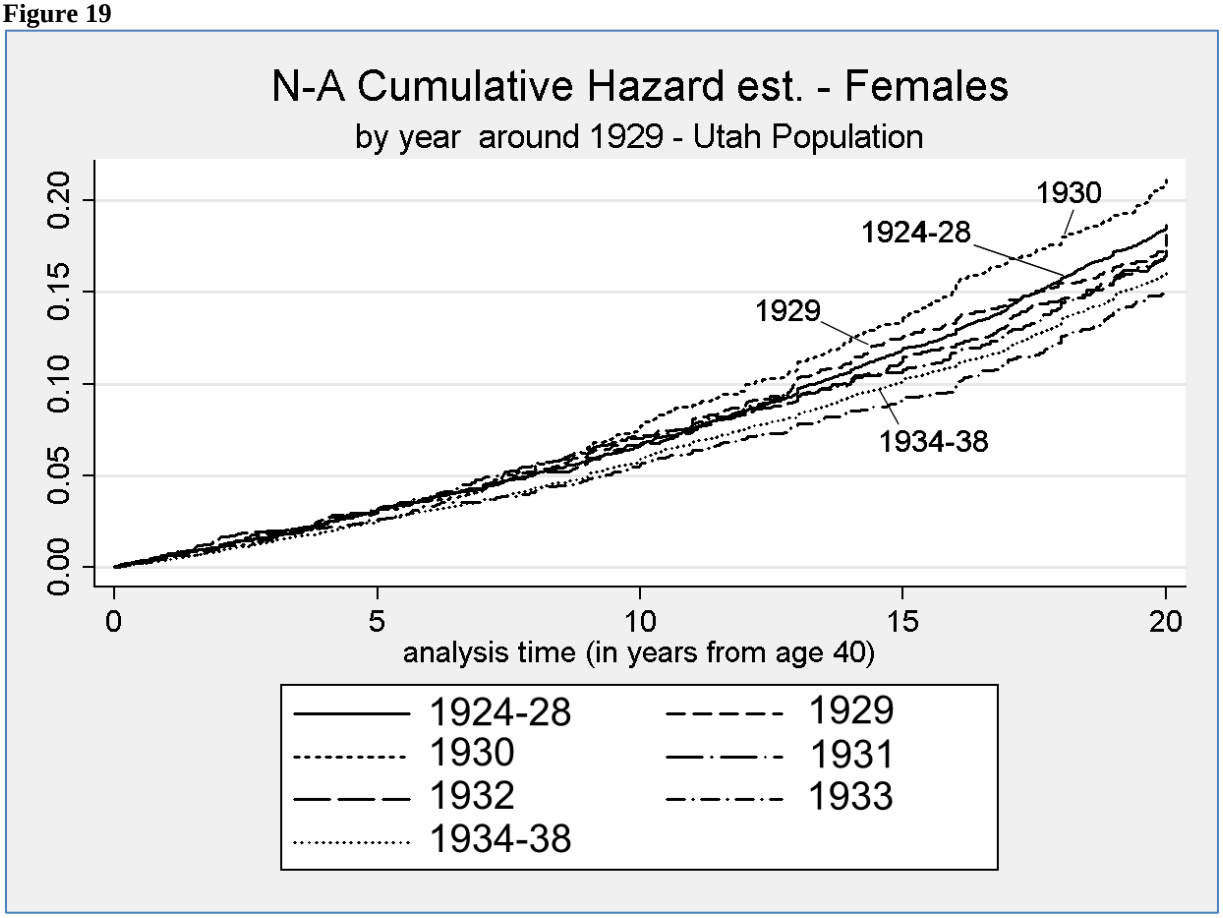

N-A Cumulative Hazard est. - Males
by year around 1929 - Utah Population
0.00 0.05 0.10 0.15 0.20 0.25
0
5
10
15
20
analysis time
1930
1929
1924-28
1934-38
1924-28
1929
1930
1931
1932
1933
1934-38

Figure 19



4.4.3 Cox regression: the increase in 1930 was significant, but gender differences were insignificant

Model A

In this section I am using Cox regression models to show, that the risk of dying is significantly higher in 1930 for the Utah population in the 40-60 age group, than it was before. Model A estimates only the relative risk for the yearly dummies, selecting the five years before the crisis as base period. Most periods are not significantly different in terms of mortality risk, but 1930 (the first full crisis year) is. In 1930 the hazard ratio is 1,17 for males and 1,21 for females, showing 17% higher risk of dying for males and 22% for females. On the other hand in 1933 there is a significant decrease of mortality risk for females compared to base period. A test using Schoenfeld residuals has been carried out, and it shows that both male and female models met the proportionality assumptions.

Model A - Relative risk of dying during the Great Depresion in the UTAH sample - simple model by sex, age group: 40-60

	Males			Females		
Reference period: 1924-1928	Haz. Ratio		*Std. Err*	Haz. Ratio		*Std. Err*
period2 (1929)	1.1085	*	*0.0633*	1.0594		*0.0675*
period3 (1930)	1.1797	**	*0.0651*	1.2179	**	*0.0722*
period4 (1931)	1.0261		*0.0597*	1.0112		*0.0647*
period5 (1932)	1.0136		*0.0587*	0.9945		*0.0634*
period6 (1933)	0.9787		*0.0569*	0.8726	**	*0.0585*
Nr of individuals	63668			59245		
Nr of failures	4889			4056		
Overall chi-sq test significance	0.04			0.00		
Proportionality test significance	0.99			0.47		

Note: ** significant at 5% level, * significant at 10% level

Model B

Although the introduction of controls cuts the number of observations, the basic result remains the same: we see a significant increase in 1930, and a reversal for females only in 1933. As the test rejected the assumption of proportionality for model B1, some control variables have been dropped in model B2, but this again does not change the main result.

Model B - Relative risk of dying during the Great Depresion in the UTAH sample - simple model by sex

	Model B1						Model B2					
	Males			Females			Males			Females		
Reference period: 1924-1928	Haz. Ratio		*Std. Err*	Haz. Ratio		*Std. Err*	Haz. Ratio		*Std. Err*	Haz. Ratio		*Std. Err*
period2 (1929)	1.1365		*0.0931*	1.0055		*0.0838*	1.0992		*0.0778*	1.0834		*0.0769*
period3 (1930)	1.2862	**	*0.1001*	1.1902	**	*0.0915*	1.1650	**	*0.0801*	1.2158	**	*0.0810*
period4 (1931)	1.0190		*0.0876*	0.9859		*0.0819*	1.0547		*0.0753*	0.9802		*0.0712*
period5 (1932)	0.9880		*0.0849*	0.9562		*0.0792*	1.0153		*0.0731*	1.0029		*0.0712*
period6 (1933)	0.9708		*0.0832*	0.8417	**	*0.0729*	0.9673		*0.0705*	0.8654	*	*0.0649*
LDS religion	0.8944	**	*0.0389*	0.9370		*0.0394*	0.7511	**	*0.0276*	0.8712	**	*0.0319*
SES (Socioecon. Status)	1.0007		*0.0010*	0.9953	**	*0.0014*						
Ego i a farmer	0.9935		*0.0445*	1.3798	**	*0.1685*						
Number of siblings	0.9200	**	*0.0094*	0.9263	**	*0.0092*	0.9892		*0.0083*	0.9961		*0.0084*
Death of mother before ego turns 20	5.6317	**	*0.2940*	6.6573	**	*0.3430*						
Death of father before ego turns 20	6.2956	**	*0.2999*	7.9709	**	*0.3788*						
Number of children of ego	0.9907		*0.0070*	0.9958		*0.0063*	0.9877	**	*0.0057*	0.9960		*0.0055*
Parity (birth order) of ego	1.1911	**	*0.0096*	1.1900	**	*0.0093*	1.0069		*0.0067*	0.9977		*0.0065*
Nr of individuals	30857			39104			40557			48637		
Nr of failures	2295			2461			3153			3234		
Overall chi-sq test significance	0.00			0.00			0.00			0.00		
Proportionality test significance	0.00			0.00			0.68			0.71		

Note: ** significant at 5% level, * significant at 10% level; age group: 40-60; LDS religion 0: not religious, 1 yes.

Both males and females belonging to the LDS religion had significantly lower mortality risk. In model B2, their relative risk is 25% lower for males and 17% lower for females.

Model C – test of interactions

Finally, it is time to ask the question: was the gender mortality gap was affected by the crisis? This question can be translated to a test of interactions between the yearly dummies and sex.

This is done in model C. The interaction term is not significant, which means that the UTAH dataset does not show a significant difference in the 1930 mortality increase. More exactly, the estimated coefficients show, that the risk of dying for males in 1930 relative to 1924-1928 period is 1.1534, and for females it is slightly, but not significantly higher (1.1534*1.0638=1,227). Looking at the sex ratio on Figure 17, we see that in 1929 this small sex difference was in the other direction, so taking the two years (1929 and 1930) together we can say with even more certainty that there was no significant change in the gender mortality gap.

I have also tested the interactions with religion, to check if a protective effect of the health-conscious Mormon religion can be seen.

Model C - Relative risk of dying during the Great Depresion in the UTAH sample - model with interactions

	Interactions with sex			Interactions with religion		
Reference period: 1924-1928	Haz. Ratio		*Std. Err*	Haz. Ratio		*Std. Err*
Sex (reference cat.: male)	0.9027	**	*0.0235*			
period3 (1930)	1.1534	**	*0.0787*			
sex*period3	1.0638		*0.1003*			
LDS religion (ref: not LDS)				0.8087	**	*0.0218*
period3 (1930)				1.1685	**	*0.0876*
LDS*period3(1930)				1.0324		*0.0993*
period2 (1929)	1.0914	*	*0.0547*	1.0924	*	*0.0548*
period4 (1931)	1.0163		*0.0517*	1.0166		*0.0518*
period5 (1932)	1.0085		*0.0510*	1.0085		*0.0510*
period6 (1933)	0.9149	*	*0.0478*	0.9147	*	*0.0478*
LDS religion	0.8090	**	*0.0210*			
Number of siblings	0.9924		*0.0059*	0.9929		*0.0059*
Number of children of ego	0.9925	*	*0.0040*	0.9924	*	*0.0040*
Parity (birth order) of ego	1.0023		*0.0047*	1.0021		*0.0047*
Nr of individuals	89194			89194		
Nr of failures	6387			6387		
Overall chi-sq test significance	0.00			0.00		

Note: ** significant at 5% level, * significant at 10% level

Although we have seen above that the LDS religion reduces mortality risk significantly for both males and females, it does not seem to cause any difference for the rise in 1930 as the term LDS*period3 is not significant.

I have done the interactions in several different forms, for example by moving the reference period to 1930, but the results were similar, so I do not report all of them.

4.5 Evaluation of the Utah results

The above investigation is not enough to prove that there was a causal relationship between the Great Depression and the mortality increase ***among the middle aged*** [7] in 1929-1930. We would need to have more variation in the data in order to be able to establish a causal relationship: for example information about some groups that were sheltered from the effects of crisis or some data about individual unemployment spells. With the current dataset, I had no possibility to meet this requirement. However, no other explanation seems obvious, looking at the way the cumulative hazard curve moves up from middle ages in the first years of the crisis, and then goes back to normal.

But the essential point for the current paper is not to establish causality, but to check, if there is any similarity in the mortality pattern with that of the transition mortality crisis. Was there premature male mortality, and increasing gender gap as a reaction to the Great Depression in Utah? The answer to this is clearly no. The mortality increase was only temporary, and there were no significant gender differences in that. Although there is some similarity in the fact that the late middle aged were more badly affected, but there were no gender differences, and no lasting deterioration, as we have seen in case of transition countries.

Relying on the figure summarising the theory section (Figure 5), there are two possible reasons why the Great Depression did not trigger premature male mortality. Firstly, in the US prohibition was introduced a decade earlier (Stuckler, 2009), which decreased the availability of alcohol, while in the Utah population there was a culture of avoiding alcohol due to the Mormon religion (Alexander 1996). In contrast, the liberalisation of the alcohol trade made alcoholic drinks more easily available in CEE transition countries (Stuckler 2009, Cornia and Paniccia 2001). Secondly, in the US social and institutional protective mechanisms were still in place, while in Russia the whole society had to learn to live according to completely different norms, and the state temporarily collapsed. Further research would be needed to find out more exactly what social and institutional mechanisms were protecting people in the US during the Great Depression from more severe mortality consequences.

I think that this paper made an interesting contribution by showing, that in spite of the improvements in the aggregate mortality statistics in the US during the Great Depression, in a special population there were some clear signs of worsening mortality among the middle aged.

[7] I have calculated life expectancy at the age of 40 in 1928 and 1930 for both males and females. The calculations show a slight increase for males 70.9 (1928) and 71.1 (1930), and a slight decrease for females 72.4 versus 72.1. The difference is probably within error limit, so it is better to conclude that thee was no change in life expectancy at the age of 40. This indicates that the mortality increase was limited to the middle aged group, and taken together with older age groups no worsening life expectancy is apparent.

5 Discussion

5.1 The transition mortality experience is unique

The transition mortality crisis in CEE countries increased the gender mortality gap. The objective of the paper was to search for similar examples in other countries. The main conclusion is that I could not find any example of an increasing gender gap due to economic crisis outside of the CEE counties. The results suggest that premature male mortality is not a usual consequence of economic crisis; the problem is probably unique to some countries which have undergone a major socio-economic transition.

To me this result was surprising at first, but as my understanding progressed gradually, it became self-evident.

Economic downturns may increase poverty for some, but they may also relieve work-related stress for some others. These two impacts have the opposite effect on mortality. The final effect of economic fluctuations depends on the living standards and work-related practices of a country. For example, if overtime and high work-related stress is frequent, but poverty is minimal, then the positive effects of the economic downturn will prevail. In high income countries, like the US and Japan, this is what we actually see. So among these countries, the crisis mortality pattern is certainly different, premature male mortality is more frequent during booming periods.

As we have seen in section (2.2) in developing countries we may expect mortality to fluctuate counter-cyclically, both for males and females. The impoverishing effect of economic downturns may cause malnutrition among the poorest; it may make people more sensitive infectious decease. However, such mortality impacts are usually seen in the traditional vulnerable groups, in the young and the oldest generations, and not working age males. So this pattern is also different.

As we have seen in case of Argentina and South Korea, there are a number of countries where mortality shows a very strong improvement in the long run, and economic crisis is more likely to slow down the improvements in mortality. We do not see absolute worsening in middle aged male mortality, as it was typical in CEE countries. So this pattern is again different.

The Utah example was the last hope to find a similar pattern. The size of economic problems and the degree of uncertainty experienced by working age males was probably similar, and the gender roles were still traditional in the US, meaning that unemployment was similarly "unacceptable" for males. However, mortality got worse only temporarily, and this affected both sexes similarly.

This means that the elevated mortality of the Karelian Finns during the perestroika is the only similar example that I could identify. It suggests that the psycho-social stress theory may work in other contexts as well, but in itself probably not enough to prove that economic crisis may increase the gender gap through psychological mechanisms.

5.2 The critique of the psycho-social stress theory

In my opinion, the result of this review also casts some doubt on the theory, which suggests that psycho-social stress has a direct effect on cardiovascular mortality. In Figure 5 this effect is indicated with arrow 2.

It is difficult to understand, that if such effect exists, why it would be a Central-Eastern European speciality. We have seen that the gender gap was not sensitive to the uncertainty resulting in the economic crisis in Spain, Argentina, and in the Utah example, and CVD mortality is pro-cyclical in most high-income countries. Moreover, in the CEE countries the unemployment-gender gap link could not be clearly established. Neither the graphs, nor from the correlations of differenced unemployment and gender gap time series for Russia and East Germany confirmed that unemployment increases the gender gap.

The evidence that behavioural factors, particularly smoking and binge drinking influenced the gender gap is strong. In the countries worst effected by premature male mortality, long term increase in male smoking and the presence of binge drinking was shown. Both smoking and binge drinking was a "male thing", and the medical mechanism for how this may lead to mortality appears to be clear. Previous counter-arguments, that drinking may not cause CVD mortality have been weakened by recent research results, which partly say that binge drinking may cause circulatory problems, and partly refer to incorrect classification of alcohol-related death as CVD.

On the other hand in my view the evidence for the causal link between psychosocial stress and mortality is still rather weak. Most evidence is presented from macro level cross-sectional studies, which may suffer from unobserved heterogeneity. It has not been yet established on individual level if there is a causal link between unemployment and mortality, and if unemployment has a differential effect on the health of males compared to females. In many of the CEE countries there was no trend break in mortality in 1989, the increase in the gender gap can often be explained with previous tendencies in male risk taking behaviour. In CIS countries, on the other hand, an alternative explanation of gender gap fluctuations exists: the enforcement and later release of Gorbachov's alcohol ban.

It appears that the transition crisis was strictly speaking not an economic crisis. There were longer term social processes, which have created the necessary conditions: it was an acute crisis, which brought a long, hidden illness to the surface.

The literature review has shown that there are a number of mechanisms which may cause unemployment and economic uncertainty to increase stress, and stress in turn to result in premature male mortality. However, the case studies have not provided strong support for this idea. The gender mortality gap is determined by medium and long term factors in most social contexts, and only a large collapse of social cohesion mechanism and institutions may have allowed a short term effect to take shape in the counties of Central and Eastern Europe during the transition to market economy.

I would summarize the results as follows: there is a clear causal link between smoking, drinking and gender gap, which probably explains the larger part of premature male mortality,

but not everything. The remaining part of the fluctuation may be due to psycho-social stress, or to other factors.

5.3 Policy recommendations

Can the problem of premature male mortality appear again in the future in other countries? Although I have not found an exactly matching example, economic crises often have negative consequences on health. We must note, that an unfortunate coincidence of several factors have caused the mortality crisis in CEE countries, and the impact could have been less severe if some of the factors could have been avoided or prevented. The comparison with the Great Depression in the US shows, that the ability of the state (or religious groups) to control access to alcohol during the worst period of crisis can probably mitigate the impact on health. The East German experience indicates that maintenance or improvement of the health care system also reduces the impact of crisis, primarily thorough the better treatment and prevention of cardiovascular decease. Many authors stress, that the collapse of the social sphere, and over-reliance on the family made eastern European males more vulnerable, especially after divorce. Conversely, as the example of Israel shows, premature male mortality is less likely to threaten a highly cohesive society, where males have broader social contacts.

5.4 Resolution 3

And finally, as a middle aged Eastern European male I make my resolution in Helen Fielding's style:

> *Resolution #3: Will join as many friendships, clubs, associations as possible, but will avoid taking up the habits of any of the following: alcoholics, workaholics...*

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7 Appendix

The appendix contains some additional analysis which does not belong to the core part of the paper, but gives some interesting additional insights.

7.1 Two way MANOVA: are those dying during the crisis different?

It is an interesting question, if the persons who died during the crisis had different qualities than those who died before the crisis. For example, the Russian mortality pattern suggests that people dying during the crisis were more often males, were generally younger and had lower social status, than in "normal years". This question is important, because we should also be able to detect (as much as our variables allow it), if there was any special tendency, for example an epidemic in 1929-1930, which coincided with the crisis, and would give an alternative explanation to the mortality increase.

I limit the observations to those who died in 1927-28 and 1929-30, having one record again per person in the database. (2411 records) This dataset includes now all deaths in the given years, without any further limitation. We have four groups: crisis death, non-crisis death; male, female. Each person has a number of qualities (explanatory variables) which are measured in the dataset. The above question in statistical terms is to ask, if the multivariate averages of the four groups are the same, or not. We may use a two-way multivariate analysis of variance (MANOVA) model to answer this question, which looks as follows:

$$X_{ijk} = \mu + \tau_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk}$$

The dependent variable (X) is a vector, consisting of the variables listed in Table 4. The vector is modelled as a sum of a general average μ, an additional factor depending on sex τ_i , another depending on the time of dying (crisis or not) β_j, an interaction term γ_{ij} (time of dying and sex), and a residual term ε_{ijk}.

I expect that the sex term will be significant, meaning that males and females who die have different qualities, (eg. die at an older age, have more children), the crisis variable will be insignificant (although more people die during the crisis, they have the same qualities). The most interesting is the interaction term: it will show, if the crisis has different effect on males and females. Based on the Cox results, I expect that the interaction term will be insignificant in the ANOVA model as well.

7.2 Results

The two-way Manova result shows, that people dying in 1927-28 versus those dying in 1929-30 did not differ significantly in terms of those variables, which are listed in Table 4. For example Wilks' Lambda for "crisisdeath" is 0,991, which is insignificant (at 5 or 10%). The variable "sex" is significant, as expected, males and females mainly differ in occupation and age at death.

The multivariate test shows that crisisdeath*sex interaction is not significant at 5% level. This means that although males and females had different qualities these differences were about the same before and during the crisis. Two individual variables constitute an exception: number of children and age of death, which have individually significant crisisdeath*sex

interactions. The death age of women decreased in the crisis years, while the death age of man increased a bit, the average difference growing from 0,3 to 1,6 years. The result indicates that the crisis effected woman worse, causing earlier death in their case, and this difference is significant in a individual (ANOVA) test. The other variable which had individually significant sex-crisisdeath interaction is the number of children. We may regard it as a measure of poverty at this time. On average, woman who died in the crisis years had less children (6,3 before and 5,7 during crisis), but men who died in the crisis years had more children (5,6 versus 5,9) than before. This may either indicate more female death in childbearing ages, or it may indicate that a larger family had protective effect for females, but not for males. To clarify the relationship between family size and mortality in various age groups would require further research. (see able 6 and 7 for detailed results)

What is important for the present study is the fact, that those dying during the crisis were not significantly different in the multivariate test. This seems to indicate that mortality did not have a very different social structure, even if it was a bit higher in some middle aged groups.

Table 5 MANOVA Result

Test if the persons dying in a crisis year (1929-30) had different qualities then those dying before (1927-28) interacting with sex, using two-way Manova model for dependent variables listed in Table 4 (religion(lds), status(npses), sibnum, ego is a farmer, age at death, deathofmother20, deathoffather20, parity_krank, number of children, ageofmotheratbirth, ageoffatheratbir

MANOVA Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.994	19132,600[a]	11	1295	.000
	Wilks' Lambda	.006	19132,600[a]	11	1295	.000
crisisdeath	Pillai's Trace	.009	1,108[a]	11	1295	.351
	Wilks' Lambda	.991	1,108[a]	11	1295	.351
sex	Pillai's Trace	.660	228,480[a]	11	1295	.000
	Wilks' Lambda	.340	228,480[a]	11	1295	.000
crisisdeath * sex	Pillai's Trace	.012	1,458[a]	11	1295	.141
	Wilks' Lambda	.988	1,458[a]	11	1295	.141

a. Exact statistic

b. Design: Intercept + crisisdeath + sex + crisisdeath * sex

Figure 20

Estimated Marginal Means

crisisdeath * sex

Dependent Variable	crisisdeath	sex	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Bound
lds	,00	1	.606	.029	.550	.662
		2	.591	.027	.538	.644
	1,00	1	.571	.026	.520	.622
		2	.630	.027	.577	.683
npses	,00	1	45.784	.955	43.910	47.658
		2	4.821	.892	3.071	6.570
	1,00	1	44.307	.870	42.600	46.014
		2	3.973	.899	2.210	5.735
sibnum	,00	1	5.178	.132	4.918	5.438
		2	5.116	.124	4.874	5.359
	1,00	1	5.142	.121	4.905	5.379
		2	5.227	.125	4.983	5.472
ego is a farmer	,00	1	.421	.022	.378	.464
		2	.048	.021	.007	.088
	1,00	1	.460	.020	.421	.500
		2	.033	.021	-.007	.074
dage	,00	1	51.027	.333	50.374	51.681
		2	50.739	.311	50.128	51.349
	1,00	1	51.954	.303	51.359	52.549
		2	50.380	.313	49.765	50.995
deathofmother20	,00	1	.774	.025	.725	.823
		2	.776	.023	.731	.822
	1,00	1	.744	.023	.700	.789
		2	.761	.023	.715	.807
deathoffather20	,00	1	.634	.028	.579	.688
		2	.669	.026	.618	.719
	1,00	1	.645	.025	.595	.694
		2	.691	.026	.640	.742
parity_krank	,00	1	4.579	.167	4.251	4.907
		2	4.313	.156	4.007	4.620
	1,00	1	4.324	.152	4.025	4.623
		2	4.285	.157	3.976	4.593
number_of_children	,00	1	5.627	.191	5.252	6.001
		2	6.316	.178	5.967	6.666
	1,00	1	5.906	.174	5.565	6.247
		2	5.655	.180	5.302	6.007
ageofmotheratbirth	,00	1	28.808	.393	28.037	29.580
		2	28.549	.367	27.829	29.269
	1,00	1	28.438	.358	27.735	29.140
		2	27.906	.370	27.180	28.632
ageoffatheratbirth	,00	1	35.760	.568	34.646	36.875
		2	35.678	.530	34.637	36.718
	1,00	1	34.517	.517	33.502	35.532
		2	34.418	.534	33.370	35.467

Note: Crisisdeath = 0 means before crisis (1927-28) ; sex=1 is male.

Figure 21

MANOVA - additional results

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	lds	,635[a]	3	.212	.880	.451
	npses	539136,356[b]	3	179712.119	674.490	.000
	sibnum	2,306[c]	3	.769	.150	.930
	ego is a farmer	53,134[d]	3	17.711	125.275	.000
	dage	468,204[e]	3	156.068	4.817	.002
	deathofmother20	,218[f]	3	.073	.400	.753
	deathoffather20	,625[g]	3	.208	.927	.427
	parity_krank	16,936[h]	3	5.645	.692	.557
	number_of_children	99,516[i]	3	33.172	3.117	.025
	ageofmotheratbirth	136,842[j]	3	45.614	1.010	.387
	ageoffatheratbirth	510,628[k]	3	170.209	1.806	.144
Intercept	lds	468.447	1	468.447	1948.108	.000
	npses	796207.621	1	796207.621	2988.301	.000
	sibnum	34768.775	1	34768.775	6784.226	.000
	ego is a farmer	75.443	1	75.443	533.619	.000
	dage	3391975.403	1	3391975.403	104700.647	.000
	deathofmother20	759.968	1	759.968	4195.829	.000
	deathoffather20	566.660	1	566.660	2523.038	.000
	parity_krank	24939.607	1	24939.607	3054.953	.000
	number_of_children	44983.066	1	44983.066	4227.094	.000
	ageofmotheratbirth	1052681.677	1	1052681.677	23319.895	.000
	ageoffatheratbirth	1604486.630	1	1604486.630	17026.452	.000
crisisdeath	lds	.001	1	.001	.006	.940
	npses	440.390	1	440.390	1.653	.199
	sibnum	.456	1	.456	.089	.766
	ego is a farmer	.049	1	.049	.348	.556
	dage	26.237	1	26.237	.810	.368
	deathofmother20	.166	1	.166	.917	.338
	deathoffather20	.092	1	.092	.409	.523
	parity_krank	6.544	1	6.544	.802	.371
	number_of_children	11.903	1	11.903	1.119	.290
	ageofmotheratbirth	83.708	1	83.708	1.854	.174
	ageoffatheratbirth	510.002	1	510.002	5.412	.020
sex	lds	.159	1	.159	.660	.417
	npses	538173.117	1	538173.117	2019.854	.000
	sibnum	.045	1	.045	.009	.925
	ego is a farmer	52.161	1	52.161	368.942	.000
	dage	282.564	1	282.564	8.722	.003
	deathofmother20	.028	1	.028	.153	.696
	deathoffather20	.536	1	.536	2.386	.123
	parity_krank	7.542	1	7.542	.924	.337
	number_of_children	15.621	1	15.621	1.468	.226
	ageofmotheratbirth	50.871	1	50.871	1.127	.289
	ageoffatheratbirth	2.683	1	2.683	.028	.866
crisisdeath * sex	lds	.451	1	.451	1.874	.171
	npses	32.242	1	32.242	.121	.728
	sibnum	1.757	1	1.757	.343	.558
	ego is a farmer	.232	1	.232	1.644	.200
	dage	134.444	1	134.444	4.150	.042
	deathofmother20	.016	1	.016	.090	.764
	deathoffather20	.010	1	.010	.043	.835
	parity_krank	4.171	1	4.171	.511	.475
	number_of_children	72.165	1	72.165	6.781	.009
	ageofmotheratbirth	6.045	1	6.045	.134	.714
	ageoffatheratbirth	.021	1	.021	.000	.988

a. R Squared = ,002 (Adjusted R Squared = ,000)
b. R Squared = ,608 (Adjusted R Squared = ,607)
c. R Squared = ,000 (Adjusted R Squared = -,002)
d. R Squared = ,224 (Adjusted R Squared = ,222)
e. R Squared = ,011 (Adjusted R Squared = ,009)
f. R Squared = ,001 (Adjusted R Squared = -,001)
g. R Squared = ,002 (Adjusted R Squared = ,000)
h. R Squared = ,002 (Adjusted R Squared = -,001)
i. R Squared = ,007 (Adjusted R Squared = ,005)
j. R Squared = ,002 (Adjusted R Squared = ,000)
k. R Squared = ,004 (Adjusted R Squared = ,002)