WP. 6
26 September 2007

ENGLISH ONLY

UNITED NATIONS STATISTICAL COMMISSION and ECONOMIC COMMISSION FOR EUROPE

STATISTICAL OFFICE OF THE EUROPEAN COMMUNITIES (EUROSTAT)

CONFERENCE OF EUROPEAN STATISTICIANS

Joint Eurostat/UNECE Work Session on Demographic Projections
(Bucharest, 10-12 October 2007)

Agenda item 5: Mortality

MORTALITY RATES IN POPULATION PROJECTIONS: A STOCHASTIC APPROACH TO INFERENCE

Invited Paper

Submitted by Statistics Sweden[1]

ABSTRACT

At Statistics Sweden population projections are made for regions such as counties and municipalities. The size of the future population in one region depends on variables such as fertility, mortality and migration. Before making a population projection it is essential to determine whether the mortality in the region is the same or significantly different from the mortality in the whole country. This is done by comparing the observed number of deaths in the region (D) to the number of deaths that would be expected if the region would have the same mortality as the whole country (E). An often-used test statistic, referred to as the Standard Mortality Rate (SMR), is given by the ratio D/E. For regions with the same mortality as the whole country the expected value of SMR should be close to 1.

It is obvious that the values of both D and E are stochastic, but the method in use at Statistics Sweden today assumes that E is deterministic. In this paper two different approaches that does not restrict E to be deterministic are suggested: The first, and perhaps most obvious approach, is to determine the distribution of D/E under parametric assumptions. Using illustrating examples it will be shown that this approach provides shorter confidence intervals than the method in use today. The second approach suggested is to use the empirical distribution of the data. The value of the SMR as it is used in population projections today is based on deaths over a period of time, often several years. However, by constructing SMR for *each year* we get a number of observations that inference can be applied to. As can be seen in the illustrating examples this approach results in shorter confidence intervals in some cases but not over all.

---

[1] Prepared by Gustaf Strandell and Therese Karlsson, Department of Population and Welfare Units of Method and Population.

1. INTRODUCTION

Statistics Sweden provides the public with a national population projection updated every year. However the interest of population projections is maybe even greater from smaller regions in Sweden that use population projections for economical decisions. Sweden has a total number of 21 counties. Most of them do some kind of population projection using the statistics provided by Statistics Sweden.

When making a population projection on a regional level the mortality is assumed to follow the same *pattern* as the projected national mortality. However, the *level* of mortality in a region is adjusted based on a comparison between the number of deaths observed (D) and the number of deaths expected (E). The expected number of deaths is simply what one would expect if the region would have the same mortality as the whole country given the population structure of the region. The comparison between D and E is given by the ratio D/E which is referred to as the Standard Mortality Rate (SMR). If a region has the same mortality as the whole country, the SMR should be close to 1. The ratio is used in population projections when adjusting the level of mortality in the region but can also be used for comparing mortality between regions.

The need of inference applied to the SMR is obvious because the numbers of deaths is stochastic. The inference done today at Statistics Sweden is based on the assumption that D is stochastic while E is deterministic. The aim of the authors of this paper is to find other approaches that do not restrict E to be deterministic. The results of the approaches suggested in this paper will be compared to the results of the method in use today using population statistics from 1969 to 2006.

The first approach considered is to find the distribution of D/E under parametric assumptions. The second approach is to use the empirical distribution of the data. A brief summary of how the SMR is used in the regional population projections at Statistics Sweden is presented in Section 2. The method in use today will be described in Section 3. In Section 4 the two approaches suggested are presented and in Section 5 illustrated using population statistics from 1969 to 2006. In Section 6 the results of the inference is presented in tables.

2. INTRODUCTION TO THE SMR

The SMR is given by D/E where D is the observed number of deaths in the region over a specific period of time and E is the expected number during the same period. D is easily observed while E is calculated using the probability of death in the nation and the mean population in the region. Hence, E is the expected number of deaths in the region if the region would have the same mortality as the whole country.

The SMR can be calculated for any period of time. In the regional population projections done today at Statistics Sweden the time period 1997-2006 is used. The SMR can also be used in any age constellation. At Statistics Sweden the SMR for males and females in the ages 20-64 and 65-90 years are calculated for each county. For the population younger than 20 or older than 90 years the SMR is not of interest when making a regional population projection because the number of deaths in these age groups is often low for small regions. However, due to the ageing population, Statistics Sweden is considering applying the SMR to the population older than 90 years.

When applying inference to the SMR a 95 percent confidence level is used when calculating confidence intervals and a one percent significance level is used in the significance tests.

We need to fix some notation and make some assumptions:

Let T_{gh} denote the mean population in the region g, $(g = 1,2,\ldots,G)$ that belongs to the age group h, $(h = 1,2,\ldots,H)$ during the time period considered. Further, let X_{gh} denote the number of persons in the region g belonging to age group h who died during the time period considered.

Our basic assumption is that $X_{gh} \sim Po(l_{gh})$ for each g and h and that X_{gh} and $X_{g'h'}$ are independent if $g \neq g'$ or $h \neq h'$. The total number of persons who died in the region g during the time period is denoted by X_g, that is, $X_g = \sum_{h=1}^{H} X_{gh}$ and $X_g \sim Po(l_g)$ where $l_g = \sum_{h=1}^{H} l_{gh}$.
The expected number of deaths in the region g during the time period is denoted by Y_g and is calculated as

$$Y_g = \sum_{h=1}^{H} \left(\frac{T_{gh}}{\sum_{g'=1}^{G} T_{g'h}} \sum_{g'=1}^{G} X_{g'h} \right).$$

If we let $w_{gh} = \frac{T_{gh}}{\sum_{g'=1}^{G} T_{g'h}}$ then an alternative expression of Y_g is given by

$$Y_g = \sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} X_{g'h}.$$

The SMR for the region g is now defined as $SMR = \frac{X_g}{Y_g}$.

3. METHOD IN USE TODAY

The perhaps easiest way to apply inference to the SMR for a region g is to assume that D_g is the outcome of a random experiment described by the stochastic variable X_g and that the stochastic variable Y_g is identically equal to its observation E_g (which we calculate in the same way as we calculate the variable Y_g but with observed mean populations and observed numbers of dead people). Hereby the problem of applying inference to the variable SMR_g reduces to the easier problem of applying inference to the variable X_g which we have assumed has the Poisson distribution with parameter l_g.

A significance test for the expected value of SMR_g can be put up as follows. With the hypothesis

$$H_0: \quad E(SMR_g) = 1 \quad \Leftrightarrow \quad \frac{E(X_g)}{E_g} = 1 \quad \Leftrightarrow \quad l_g = E_g$$

$$H_a: \quad E(SMR_g) \neq 1 \quad \Leftrightarrow \quad \frac{E(X_g)}{E_g} \neq 1 \quad \Leftrightarrow \quad l_g \neq E_g.$$

Since X_g is assumed to be Poisson distributed with mean l_g the test statistic for this test becomes

$$z_g = \frac{\hat{l}_g - E_g}{\sqrt{s^2_{\hat{l}_g}}} = \frac{D_g - E_g}{\sqrt{D_g}}.$$

If l_g is large enough z_g can be regarded as an observation of a stochastic variable which is approximately standard normal distributed. The critical values when applying a one percent significance level is therefore $-2{,}58$ and $2{,}58$. The result of this test applied to data for all counties in Sweden for the time period 1969-2006 can be found in the appendix.

If $l_g \geq 10$, X_g can be approximately seen as having a normal distribution. A 95 % confidence interval for the expected value of X_g, i.e. for l_g is therefore estimated by

$$\hat{l}_g \pm 1{,}96\sqrt{s^2_{\hat{l}_g}} = D_g \pm 1{,}96\sqrt{D_g}.$$

To receive the confidence interval for SMR_g both the upper and lower limit of the interval above needs to be divided by E_g. Therefore the interval is given by

$$\frac{\hat{l}_g \pm 1{,}96\sqrt{s^2_{\hat{l}_g}}}{E_g} = \frac{D_g \pm 1{,}96\sqrt{D_g}}{E_g}.$$

Confidence intervals for the SMR using this method can be found in Section 5 and in the appendix.

4. SUGGESTED APPROACHES

In this section we present two approaches that do not restrict E to be deterministic.

4.1. Inference under stochastic assumptions

As before we want to apply inference to $SMR_g = \frac{X_g}{Y_g}$. This time however we will not assume that $Y_g = \sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} X_{g'h}$ is a constant variable. Instead we assume that all components in the SMR which describes number of people dying, i.e. the X's, are stochastic variables and that all components which describe mean populations, i.e. the *w*'s, are just numbers. Besides this we make the same assumptions as in Section 2.

Taylor series expansion of SMR_g about $E(X_g), E(Y_g)$ gives us the following expression:

$$SMR_g \approx \frac{E(X_g)}{E(Y_g)} + \frac{1}{E(Y_g)}\left[X_g - E(X_g)\right] - \frac{E(X_g)}{E(Y_g)^2}\left[Y_g - E(Y_g)\right]$$
$$= \frac{E(X_g)}{E(Y_g)} + \frac{1}{E(Y_g)}\left(X_g - \frac{E(X_g)}{E(Y_g)}Y_g\right)$$

Thus

$$V(SMR_g) \approx V\left\{\frac{1}{E(Y_g)}\left[X_g - \frac{E(X_g)}{E(Y_g)}Y_g\right]\right\}$$
$$= \frac{1}{E(Y_g)^2}\left[V(X_g) + \frac{E(X_g)^2}{E(Y_g)^2}V(Y_g) - 2\frac{E(X_g)}{E(Y_g)}C(X_g, Y_g)\right].$$

We now want to construct an unbiased estimator for $V(SMR_g)$. For Y_g the following holds

$$E(Y_g) = E\left(\sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} X_{g'h}\right) = \sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} E(X_{g'h}) = \sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} l_{g'h}$$

and

$$V(Y_g) = V\left(\sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} X_{g'h}\right) = \sum_{h=1}^{H} w_{gh}^2 \sum_{g'=1}^{G} V(X_{g'h}) = \sum_{h=1}^{H} w_{gh}^2 \sum_{g'=1}^{G} l_{g'h}\ .$$

Unbiased estimators for $E(Y_g)$ and $V(Y_g)$ is therefore given by $\sum_{h=1}^{H} w_{gh} \sum_{g'=1}^{G} D_{g'h} = E_g$ and $\sum_{h=1}^{H} w_{gh}^2 \sum_{g'=1}^{G} D_{g'h}$ respectively.

Further it holds that

$$E(X_gY_g) = E\left[\left(\sum_{h=1}^{H} X_{gh}\right)\left(\sum_{h'=1}^{H} w_{gh'} \sum_{g'=1}^{G} X_{g'h}\right)\right]$$

$$= E\left(\sum_{h=1}^{H} w_{gh} X_{gh}^2 + \sum_{h=1}^{H} w_{gh} X_{gh} \sum_{\substack{g'=1 \\ g'\neq g}}^{G} X_{g'h} + \sum_{\substack{h=1 \\ h'\neq h}}^{H} \sum_{h'=1}^{H} w_{gh'} X_{gh} \sum_{g'=1}^{G} X_{g'h'}\right)$$

$$= \sum_{h=1}^{H} w_{gh}\left(l_{gh} + l_{gh}^2\right) + \sum_{h=1}^{H} w_{gh}\, l_{gh} \sum_{\substack{g'=1 \\ g'\neq g}}^{G} l_{g'h} + \sum_{\substack{h=1 \\ h'\neq h}}^{H} \sum_{h'=1}^{H} w_{gh'}\, l_{gh} \sum_{g'=1}^{G} l_{g'h'}$$

and

$$E(X_g)E(Y_g) = \left(\sum_{h=1}^{H} l_{gh}\right)\left(\sum_{h'=1}^{H} w_{gh'} \sum_{g'=1}^{G} l_{g'h})\right)$$

$$= \sum_{h=1}^{H} w_{gh}\, l_{gh}^2 + \sum_{h=1}^{H} w_{gh}\, l_{gh} \sum_{\substack{g'=1 \\ g'\neq g}}^{G} l_{g'h} + \sum_{\substack{h=1 \\ h'\neq h}}^{H} \sum_{h'=1}^{H} w_{gh'}\, l_{gh} \sum_{g'=1}^{G} l_{g'h'}$$

why

$$C(X_g, Y_g) = E(X_gY_g) - E(X_g)E(Y_g) = \sum_{h=1}^{H} w_{gh}\, l_{gh} \; .$$

An unbiased estimator for $C(X_g, Y_g)$ is therefore givenby $\sum_{h=1}^{H} w_{gh} D_{gh}$.

If the Taylor approximation above is good, an unbiased estimator of it can be used as estimator for $V(SMR_g)$. We suggest the estimator

$$\hat{V}(SMR_g) = \frac{1}{E_g{}^2}\left(D_g + \frac{D_g{}^2}{E_g{}^2} \sum_{h=1}^{H} w_{gh}^2 \sum_{g'=1}^{G} D_{g'h} - 2\frac{D_g}{E_g} \sum_{h=1}^{H} w_{gh} D_{gh}\right).$$

Using $\frac{D_g}{E_g}$ as an estimator for $E(SMR_g)$ an approximate 95 percent confidence interval can be constructed as

$$\frac{D_g}{E_g} \pm 1{,}96\sqrt{\hat{V}(SMR_g)}.$$

The hypothesis in the significance test are

$$H_0 : E(SMR_g) = 1$$
$$H_a : E(SMR_g) \neq 1.$$

As test statistic the following expression is used

$$z = \frac{\frac{D_g}{E_g} - 1}{\sqrt{\hat{V}\left(SMR_g\right)}}$$

where we assume that the test statistic z is approximately standard normal distributed. Confidence intervals and results of the significance test for the SMR using this method can be found in Section 5 and in the appendix.

4.2. Distribution of the data

In this approach the SMR is calculated for each year, age group and sex. If we assume that the SMR for each year are independent we have, for each age group and sex, the independent and random sample: $smr_1, smr_2, \ldots, smr_n$.
As an estimator of the SMR we use the mean of the observations

$$\overline{smr} = \frac{\sum_{i=1}^{n} smr_i}{n}$$

where $n = 1,2,\ldots$ are the years in the considered time period.

The estimator is approximately normal distributed according to the Central Limit Theorem if the observations are random independently and no fewer than 30.

The confidence interval for the SMR is given by

$$\overline{smr} \pm 1{,}96\sqrt{\frac{\hat{V}(SMR)}{n}}.$$

In the significance test we have the hypothesis

$$H_0 : E(SMR) = 1$$
$$H_a : E(SMR) \neq 1$$

where

$$z = \frac{\overline{smr} - 1}{\sqrt{\frac{\hat{V}(SMR)}{n}}}$$

is used as test statistic.
The critical values when applying a one percent significance level is $-2{,}58$ and $2{,}58$. See Section 5 and the appendix for results.

5. ILLUSTRATING EXAMPLES

As an illustrating example of the suggested approaches we calculate the SMR for men in the age groups 20-64 and 65-90 years. The difference in the confidence intervals can be seen in the graphs. The point estimates, lower and upper level of the confidence intervals can also be seen in the tables of the Appendix in section six. Point estimates marked with (*) indicates a significant difference from 1.

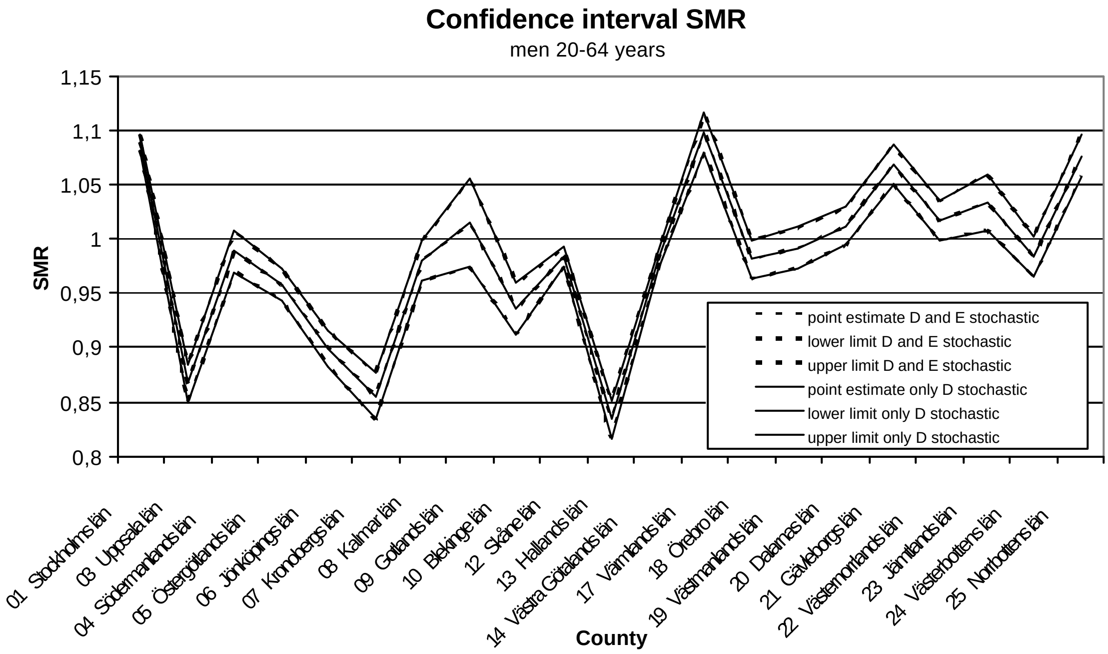
The illustrating examples show that the first approach suggested provides shorter confidence intervals than the old method. This is an argument why the confidence interval calculations should be performed using the distribution of D/E instead of, as in the old method, only using the distribution of D.

The second approach provides shorter confidence intervals in some cases but cannot be seen as an over all better approach.

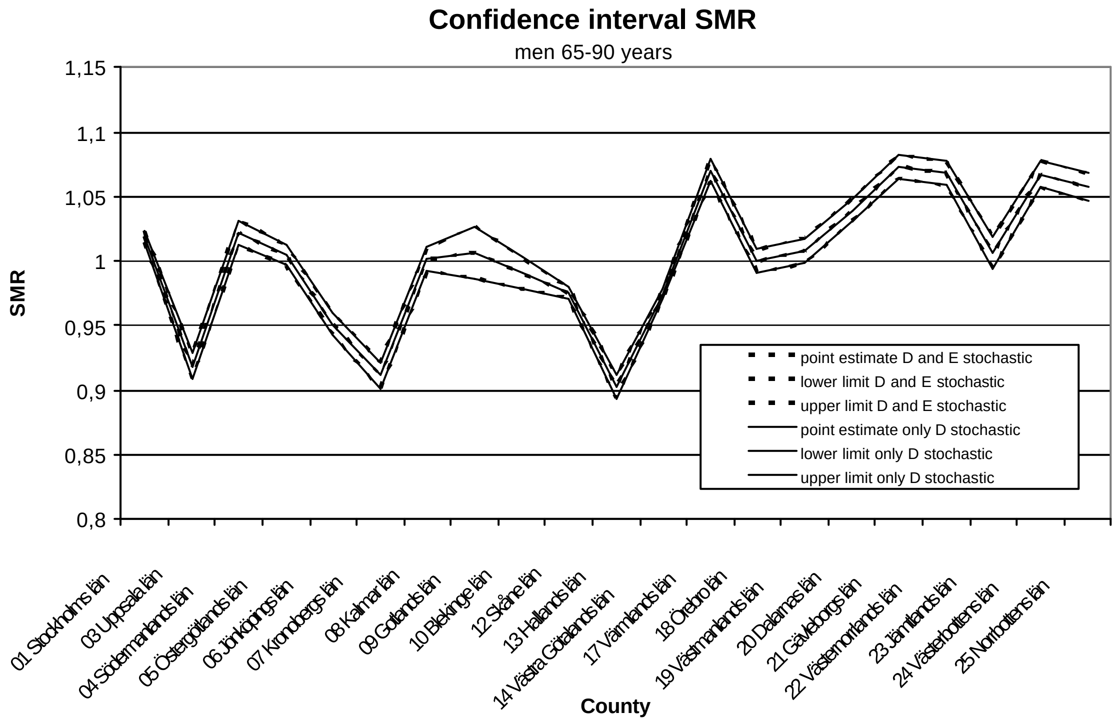
5.1. Using the inference under stochastic assumptions

The confidence intervals are calculated using the methods presented in section three and four. Over all we see shorter confidence intervals when assuming both D and E to be stochastic compared to the method when only D is assumed to be stochastic.

Graph 1

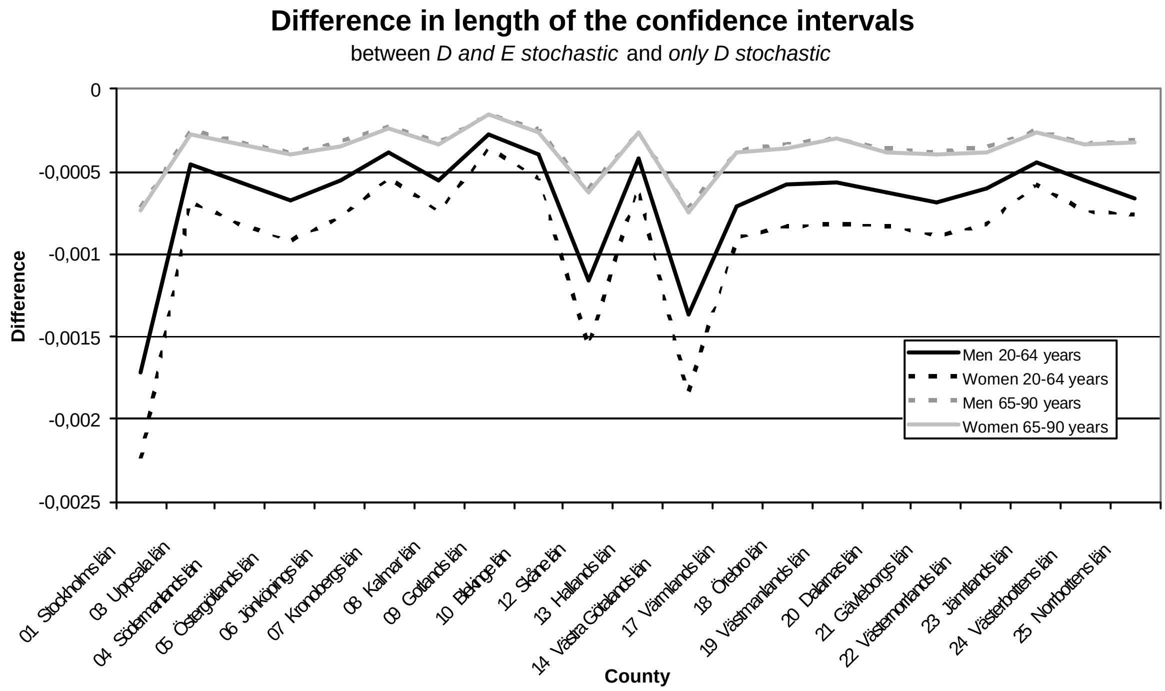


Graph 2



The difference between the confidence intervals is more obvious when comparing the difference in length.

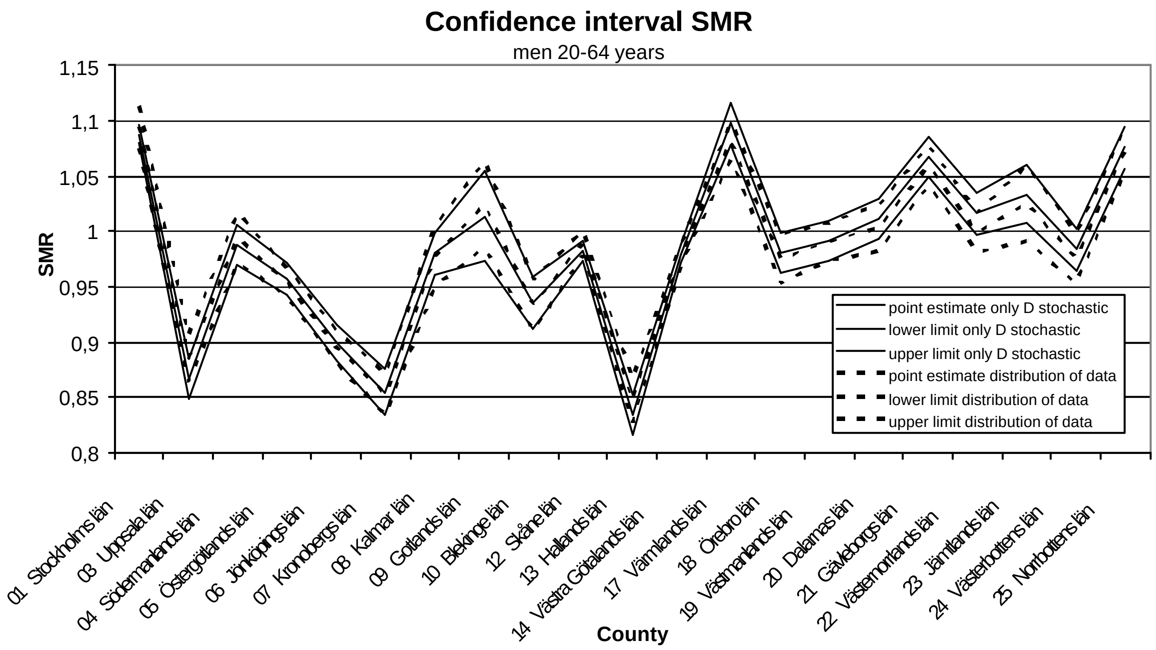
Graph 3



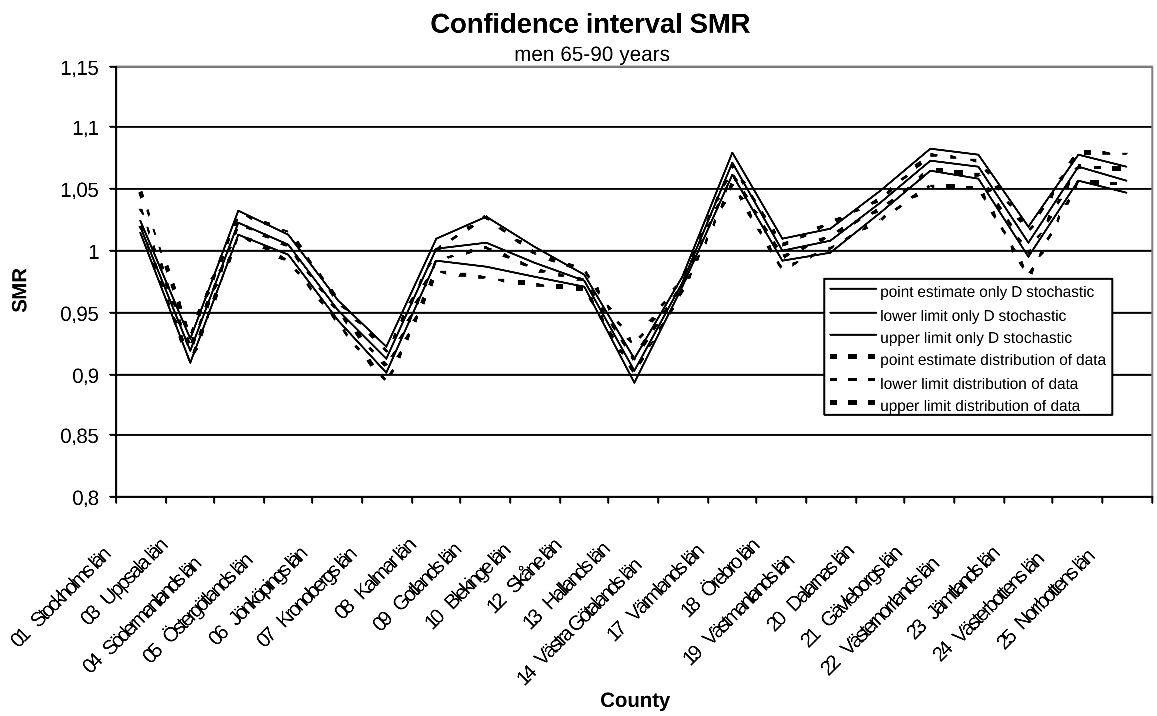
5.2. Using distribution of data

The confidence intervals are calculated using the methods presented in section three and four. The lengths of the confidence intervals when using the distribution of the data are not always smaller than the length of the confidence intervals calculated under the assumption that only D is stochastic. 22 out of 84 confidence intervals are shorter when using the distribution of the data.

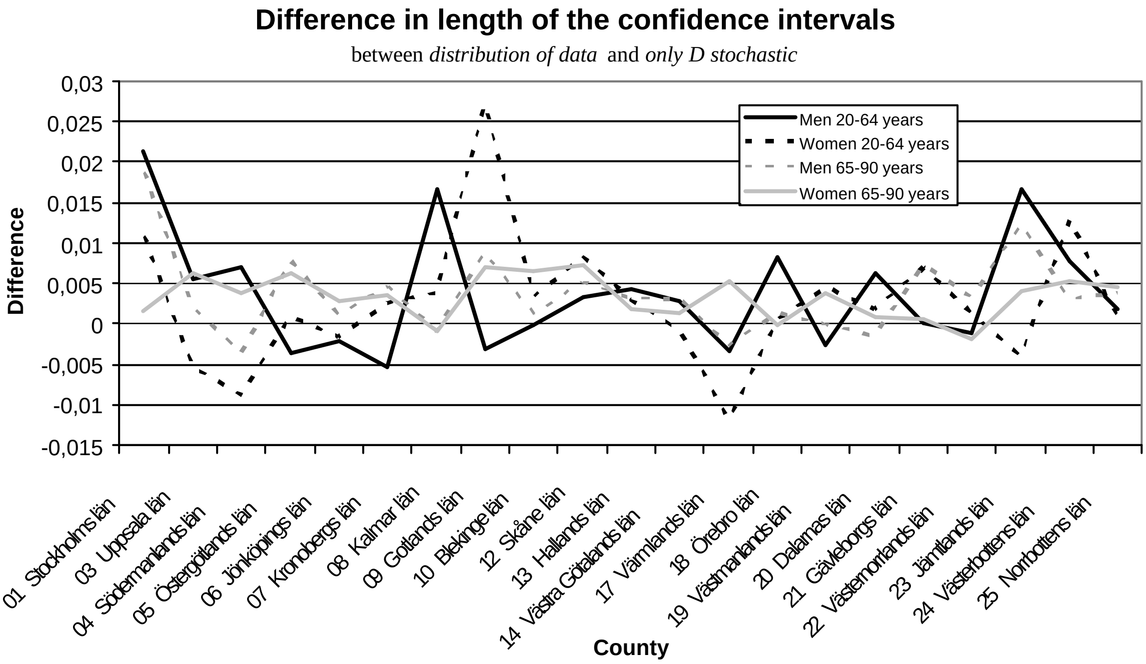
Graph 4



Graph 5



Graph 6


Difference in length of the confidence intervals
between *distribution of data* and *only D stochastic*
Men 20-64 years
Women 20-64 years
Men 65-90 years
Women 65-90 years
Difference
0,03
0,025
0,02
0,015
0,01
0,005
0
-0,005
-0,01
-0,015
01 Stockholms län
03 Uppsala län
04 Södermanlands län
05 Östergötlands län
06 Jönköpings län
07 Kronobergs län
08 Kalmar län
09 Gotlands län
10 Blekinge län
12 Skåne län
13 Hallands län
14 Västra Götalands län
17 Värmlands län
18 Örebro län
19 Västmanlands län
20 Dalarnas län
21 Gävleborgs län
22 Västernorrlands län
23 Jämtlands län
24 Västerbottens län
25 Norrbottens län
County

6. Appendix

SMR for men							
1969-2006	Method:	D and E - stochastic	confidence - interval	only D- stochastic	confidence - interval	distribution of data	confidence interval
region (conty)	age group	SMR	(SMR +/-)	SMR	(SMR +/-)	SMR	(SMR +/-)
Stockholm	20-64	1,08834*	0,00706	1,08834*	0,007915	1,0948*	0,018655
Uppsala	20-64	0,86685*	0,01781	0,86685*	0,01804	0,88507*	0,020785
Södermanland	20-64	0,98817	0,018465	0,98817	0,018745	0,99466	0,02227
Östergötland	20-64	0,95769*	0,01451	0,95769*	0,014845	0,95401*	0,01307
Jönköping	20-64	0,899*	0,01586	0,899*	0,016135	0,89583*	0,01506
Kronoberg	20-64	0,85488*	0,020945	0,85488*	0,021135	0,85273*	0,018505
Kalmar	20-64	0,98008	0,018805	0,98008	0,01908	0,97777	0,02744
Gotland	20-64	1,01432	0,04071	1,01432	0,040845	1,02463	0,039235
Blekinge	20-64	0,93577*	0,02316	0,93577*	0,02336	0,93344*	0,02333
Skåne	20-64	0,98297*	0,008635	0,98297*	0,009215	0,98999	0,01092
Halland	20-64	0,83401*	0,017455	0,83401*	0,017665	0,84701*	0,01976
V. Götaland	20-64	0,97945*	0,00726	0,97945*	0,00794	0,98055*	0,00936
Värmland	20-64	1,09778*	0,01811	1,09778*	0,018465	1,08234*	0,01672
Örebro	20-64	0,98115	0,017715	0,98115	0,018005	0,97557	0,02211
Västmanland	20-64	0,99193	0,018295	0,99193	0,018575	0,99104	0,01731
Dalarna	20-64	1,01161	0,01746	1,01161	0,01777	1,00347	0,020945
Gävleborg	20-64	1,06836*	0,01766	1,06836*	0,018005	1,05985*	0,01811
Västernorrland	20-64	1,01644	0,018125	1,01644	0,018425	0,99935	0,01791
Jämtland	20-64	1,03382	0,02579	1,03382*	0,02601	1,02598	0,034365
Västerbotten	20-64	0,98382	0,01871	0,98382	0,018985	0,97587	0,022855
Norrbotten	20-64	1,0762*	0,018735	1,0762*	0,019065	1,07388*	0,019965
Stockholm	65-90	1,01922*	0,00416	1,01922*	0,00452	1,03401*	0,01393
Uppsala	65-90	0,91844*	0,00973	0,91844*	0,009855	0,91929*	0,010905
Södermanland	65-90	1,02202*	0,00972	1,02202*	0,00988	1,022*	0,008085
Östergötland	65-90	1,00436*	0,007615	1,00436	0,007805	1,00322	0,011735
Jönköping	65-90	0,95133*	0,008095	0,95133*	0,008255	0,94999*	0,00884
Kronoberg	65-90	0,91147*	0,010425	0,91147*	0,01054	0,90513*	0,01285
Kalmar	65-90	1,00114	0,00909	1,00114	0,00925	0,99228	0,00879
Gotland	65-90	1,00695	0,020205	1,00695	0,02028	1,00261	0,024695
Blekinge	65-90	0,99056	0,011875	0,99056	0,011995	0,98483	0,01261
Skåne	65-90	0,97538*	0,004435	0,97538*	0,00474	0,97609*	0,00733
Halland	65-90	0,90284*	0,009155	0,90284*	0,009285	0,91159*	0,01087
V. Götaland	65-90	0,97426*	0,003725	0,97426*	0,004085	0,97374*	0,005665
Värmland	65-90	1,07065*	0,00886	1,07065*	0,009045	1,06188*	0,00769
Örebro	65-90	1,0001	0,00887	1,0001	0,009035	0,99455	0,00971
Västmanland	65-90	1,00805	0,00987	1,00805	0,01002	1,01241	0,010015
Dalarna	65-90	1,03947*	0,008705	1,03947*	0,008885	1,03351*	0,008155
Gävleborg	65-90	1,07337*	0,00886	1,07337*	0,00905	1,06516*	0,01266
Västernorrland	65-90	1,068*	0,009335	1,068*	0,00951	1,06175*	0,01117
Jämtland	65-90	1,00695	0,011985	1,00695	0,01211	0,99693	0,018265
Västerbotten	65-90	1,06727*	0,010275	1,06727*	0,01044	1,06776*	0,011985
Norrbotten	65-90	1,05715*	0,010385	1,05715*	0,01054	1,06603*	0,012465

SMR for women							
1969-2006	Method:	D and E - stochastic	confidence - interval	only D- stochastic	confidence - interval	distribution of data	confidence interval

region (county)	age group	SMR	(SMR +/-)	SMR	(SMR +/-)	SMR	(SMR +/-)
Stockholm	20-64	1,05831*	0,009205	1,05831*	0,010325	1,06312*	0,015775
Uppsala	20-64	0,93558*	0,02488	0,93558*	0,02522	0,95117*	0,022525
Södermanland	20-64	1,04067	0,025585	1,04067*	0,025995	1,03974*	0,021615
Östergötland	20-64	0,97409*	0,019715	0,97409	0,020175	0,97207*	0,020655
Jönköping	20-64	0,93061*	0,02175	0,93061*	0,02214	0,92621*	0,021325
Kronoberg	20-64	0,91186*	0,02972	0,91186*	0,02999	0,91392*	0,031315
Kalmar	20-64	0,99639	0,02581	0,99639	0,02618	0,99202	0,028135
Gotland	20-64	0,99736	0,05474	0,99736	0,05492	1,00201	0,06849
Blekinge	20-64	0,93257*	0,031505	0,93257*	0,031775	0,93311*	0,03345
Skåne	20-64	0,97338*	0,0115	0,97338*	0,01228	0,97925	0,016455
Halland	20-64	0,86578*	0,02418	0,86578*	0,02448	0,8778*	0,025955
V. Götaland	20-64	0,98504*	0,009845	0,98504*	0,010765	0,9843*	0,0104
Värmland	20-64	1,05694*	0,02412	1,05694*	0,02457	1,05043*	0,01866
Örebro	20-64	1,02256	0,024325	1,02256	0,02474	1,018	0,025
Västmanland	20-64	1,03356*	0,025345	1,03356*	0,025755	1,03126	0,02804
Dalarna	20-64	1,00576	0,023675	1,00576	0,02409	0,99651	0,025005
Gävleborg	20-64	1,04645*	0,023775	1,04645*	0,02422	1,0413*	0,027715
Västernorrland	20-64	1,02313	0,02468	1,02313	0,02509	1,00922	0,025725
Jämtland	20-64	1,02944	0,03551	1,02944	0,0358	1,02004	0,03381
Västerbotten	20-64	0,98007	0,025455	0,98007	0,025825	0,97342	0,032245
Norrbotten	20-64	0,98971	0,0249	0,98971	0,02528	0,9888	0,02559
Stockholm	65-90	0,96303*	0,003805	0,96303*	0,004175	0,96443*	0,00492
Uppsala	65-90	0,9433*	0,0104	0,9433*	0,010535	0,94339*	0,01369
Södermanland	65-90	1,0368*	0,010405	1,0368*	0,01057	1,04168*	0,0125
Östergötland	65-90	1,02487	0,00809	1,02487*	0,00829	1,02666*	0,01145
Jönköping	65-90	0,97685*	0,008795	0,97685*	0,00897	0,97918*	0,01037
Kronoberg	65-90	0,93657*	0,011695	0,93657*	0,011815	0,93178*	0,013605
Kalmar	65-90	1,02363*	0,009995	1,02363*	0,01016	1,01938*	0,00967
Gotland	65-90	1,02175*	0,021955	1,02175	0,02203	1,01924	0,02548
Blekinge	65-90	1,00521	0,012745	1,00521	0,012875	0,9992	0,016095
Skåne	65-90	0,93752*	0,004425	0,93752*	0,004735	0,93575*	0,008355
Halland	65-90	0,90037*	0,00994	0,90037*	0,01007	0,90892*	0,010955
V. Götaland	65-90	0,98167*	0,003925	0,98167*	0,0043	0,98051*	0,005015
Värmland	65-90	1,09488*	0,009625	1,09488*	0,00982	1,08933*	0,01247
Örebro	65-90	1,03581*	0,009585	1,03581*	0,009765	1,03141*	0,00973
Västmanland	65-90	1,02085*	0,010655	1,02085*	0,010805	1,03191*	0,01275
Dalarna	65-90	1,09009*	0,009615	1,09009*	0,00981	1,08845*	0,01022
Gävleborg	65-90	1,10843*	0,0096	1,10843*	0,0098	1,10288*	0,01016
Västernorrland	65-90	1,11186*	0,01022	1,11186*	0,01041	1,10786*	0,009475
Jämtland	65-90	1,05604*	0,013845	1,05604*	0,013975	1,04766*	0,01603
Västerbotten	65-90	1,10048*	0,011555	1,10048*	0,01172	1,1126*	0,014375
Norrbotten	65-90	1,06444*	0,01144	1,06444*	0,0116	1,07601*	0,01392

* indicates significant difference from 1 on a 1 percent significance level.

7. References

[1] Statistics Sweden (SCB) (2007) Livslängden i Sverige 2001-2005. Livslängdstabeller för riket och länen, Demografiska rapporter 2007:1.

[2] Silcocks, P. Estimating confidence limits on a standardised mortality ratio when the expected number is not error free. J Epidemiol Community Health. 1994 Jun;48(3):313-7.

[3] Joseph Beyene and Rahim Moineddin. Methods for confidence interval estimation of a ratio parameter with applications to location quotients. BMC Medical Research Methodology. 2005, 5:32.

*****