Cause-of-Death Contribution to the Female-Male Gap in Mortality in the United States

DRAFT

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Abstract

The improvement in life expectancy at birth in the last half a century was characterized by different patterns for both sexes in the United States. While the female advantage in life expectancy was increasing until the 1970s, males were catching up since then. In this study we are interested to describe the contribution of different age groups and causes to the sex mortality difference in the years 1968–2004. Differences between the sexes in life expectancy at birth have been decomposed into the contribution of selected age groups and four groups of causes of death as proposed by Rutstein et al. (1976): causes amenable to medical intervention, conditions preventable by health policy, Ischeamic Heart Disease and other causes.

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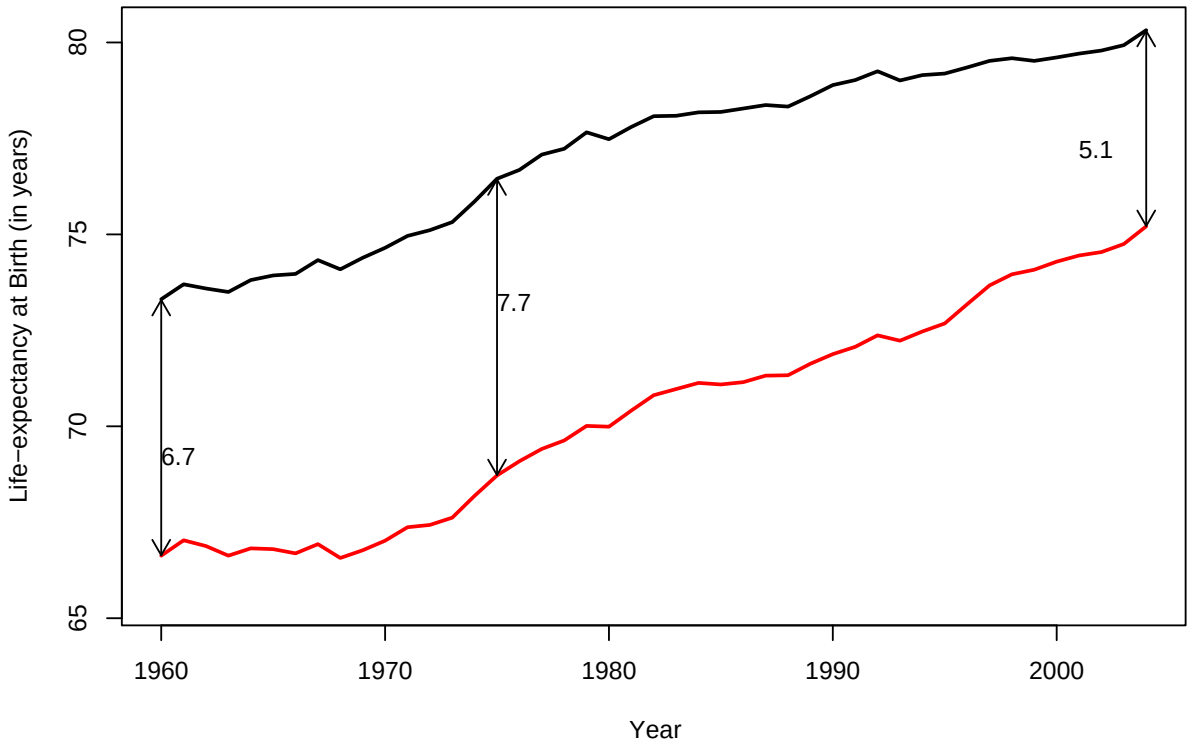
1 Introduction

Women live longer than men. In the last decades, however, in most of the developed countries, improvements in the mean duration of life were faster for men than for women. There was an almost universal pattern of change with a rapid increase in the sex-gap in life expectancy at birth followed by a decrease (Glei and Horiuchi, 2007). Similar in the United States, since the mid-1970 life expectancy at birth has been improving faster for males than females, resulting in a narrowing gap between the two (Figure 1). In particular, since 1984 reductions in the female mortality have been small (Meslé, 2006). The largest difference of 7.7 years in 1975 in the sex-gap in life-expectancy decreased to 5.1 years in 2004. Altogether, in the last half a century, life expectancy at birth in the United States has improved by a similar number of years for both sexes: Between 1960–2004 it increased by 9.3 years for women and 9.8 years for men.

The widening gap in mortality between the two sexes until the last decades of the twentieth century resulted from both women's growing advantage in survival and men's increasing excess mortality. First, it was only the decrease of maternal mortality and mortality at young ages, as a result of control over infectious diseases, that women could fully benefit from their biological survival advantage (Vallin, 2006). Among the biological differences between the sexes that guarantee the female advantage are: A genetic advantage of additional X-chromosome (Christensen et al., 2001), estrogens that protect against circulatory diseases until menopause (Roeters van Lennep et al., 2002), an advantage to store and eliminate food reserves that make them better fit to endure overfeeding and easier to adjust to existing living conditions (Seely, 1990). As far as infant mortality is concerned, with the shift from the predominance of deaths from infectious diseases to perinatal conditions, girls benefited more from the epidemiological transition than boys (Drevenstedt et al., 2008).

On the other hand, the male growing excess mortality is often discussed as a result of differences in behavioural patterns between the sexes that exposed men to a greater extent to mortality risks. Those behaviours include "..smoking, drinking, driving, and violence" (Nathanson,

Figure 1: Life Expectancy at Birth, 1960–2004



Source: HMD

1984, p. 204). It is also women's growing involvement in this type of risky behaviours that is usually brought forward to explain the narrowing differences in life-expectancy between the sexes (e.g. Case and Paxson, 2005; Pampel, 2002; Preston and Wang, 2006; Vallin et al., 2006; Wingard, 1984) with the predominant role of smoking: "smoking fully explains the recent narrowing of sex differential" (Pampel, 2002, p.96).

An explanation that is not often brought to demographic studies, however, is that at adult ages both sexes benefit differently from the advancement in medicine and new medical technologies and the benefits for men might be greater than those for women. Despite the fact that women more often consult a doctor in general, "for life-threatening illnesses or illnesses that interfere with normal activities men may be as predisposed as women to seek medical care" (Waldron, 1983, p. 1117). Due to the differences in socio-economic status and types of health insurance

between the two sexes (Chulis et al., 1993), it is very probable that men in the United States have better acccess to expensive procedures and medicines. In the United States the type of insurance is often claimed to determine type and quality of treatment and medications received (??, Hur; Blustein, 1995; Pezzin et al., 2007; Shi, 2000). Furthermore, the biological differences between men and women also require variation in the diagnosis and treatment (Henry, 2005; Oda et al., 2006). Those two might currently be insufficiently tailored to the women's physiological needs (Gregg et al., 2007).

Following the argument of differential benefits from health care, in this study we make an attempt to explain the narrowing gap in life-expectancy between the sexes by separating causes that are amenable to medical treatment from causes mainly related to behavioral factors and other conditions. Deaths from IHD were separated from other causes and formed a separate group, as they could be prevented by both medical intervention and public health and cannot be classified to one of these cathegories (James et al., 2007a). We decompose the sex-gap in the mean duration of life between ages 0 and 75 into four categories of the underlying cause of death and study change in the importance of these causes for life expectancy of both sexes and changes in the sex-gap in the years 1968–2004.

2 Methods and Data

2.1 Method

Following the argument that the benefits of men at adult ages from medical development are greater than those of women, we study the sex-gap in mortality, distinguishing those causes of death that we believe could have been prevented by medical intervention. The selection of the second group of causes distinguished in this study (health policy amenable) is based on the argument that the differences in mortality between the sexes are a result of behavioural differences. Deaths from Ischemic Heart Disease form a separate group, as they are preventable by both medical intervention and public health (James et al., 2007a). The selection of the above

groups follows the list of amenable causes of death as proposed by Rutstein et al. (1976).

In 1976 Rutstein et al. proposed a method of measuring the quality of medical care by an index based on a list of conditions resulting in disease, disability or death, that could have been otherwise treated or prevented by health care system. This indicator of amenable mortality is often used to assess performance of health care systems, in particular in international comparisons (Douglas and Mao, 2002; Mackenbach et al., 1990; Nolte and McKee, 2003, 2008). Following the original classification, other authors distinguish between causes of death amenable to medical intervention (treatable conditions) and those amenable to inter-sectoral health policies (preventable conditions), as well as, separate Ischemic Heart Disease (IHD) from other conditions (Andreev et al., 2003). That means that deaths amenable to medical care are those that could be prevented after the condition developes, and deaths amenable to public health policies are caused by conditions that could have been otherwise prevented from occurring. As deaths from Ischemic Heart Disease could be prevented by both medical intervention and public health (James et al., 2007a), deaths from IHD are separated from other causes of death. When deaths from IHD are included in the medically amenable and policy amenable groups, due to their significant number, the importance of other causes of deaths in those groups is concealed (Nolte et al., 2002).

The causes considered to be amenable to public health are: HIV, lung cancer, skin cancer, chronic obstructive pulmonary disease, liver cirrhosis and motor vehicle accidents. The number of causes amenable to medical care is considerably larger. The most notable causes are many infectious diseases, cerebrovascular diseases, respiratory diseases like pneumonia, influenza or asthma, and several cancers such as breast cancer or leukaemia.

Coding of causes of death across various ICD revisions is notoriously problematic. We used the articles by Hem et al. (2007) and James et al. (2007b) to guide us through the coding of the four cause-categories from ICD-8 to ICD-9 (James et al., 2007b) and from ICD-9 to ICD-10 (Hem

et al., 2007). In section 4 (page 20), we give the complete list of codes we have used.

We disregard deaths that occured after age of 74 years, as deaths above this age are less likely to be preventable. In addition, certification of causes above this age is claimed to be less acurate that for deaths at younger ages (James et al., 2007a; Nolte and McKee, 2008). Decomposition of life expectancy by age and groups of causes of death is based on the discreate method as proposed by Arriaga (1984). As we set the upper age limit for amenable causes of death to 74, we limit in our study the contribution of the the four groups of causes to the ages 0-74. In addition, due to the fact that the reasons for the excess male mortality at adult ages are different from those for the infants, we repeat the same analyses for the ages 1-75.

Over the study period woman's breast cancer was responsible for 14% (in 1968) – 26% (in 1991) of deaths resulting from causes classified in our study to be amenable to medical intervention. For ages 1-75, these figures equal to 17% and 28%. At the same time, the number of deaths from cancers typical for males (i.e. testicular cancer) was relatively low over the study period. Hence, we decided in the next step to study causes of death amenable to medical intervention excluding the breast cancer from those causes, but we disregarded typical male cancers.

In Table 1 (page 6), we show that more than 78 mio deaths have been recorded in the United States between 1968 and 2002. About one one quarter of all deaths among women and men were due to ischaemic heart disease. Among women about 30% of all female deaths belong to the category "amenable to medical care" whereas the corresponding proportion of men is about 19%. Deaths from the category "amenable to public health" are more common among men with 16% than among women (9.5%).

Table 1: Numbers of Death by Category, Females and Males, United States, 1968–2002

Cause	Women		Men		Total	
	Count	%	Count	%	Count	%
IHD	9,405,870	25.27	11,005,112	26.71	20,410,982	26.03
Medical Care	11,034,146	29.65	7,740,268	18.79	18,774,414	23.94
Public Health	3,544,922	9.52	6,740,416	16.36	10,285,338	13.12
Rest	13,232,284	35.55	15,715,849	38.14	28,948,133	36.91
$\sum$	37,217,222	100.00	41,201,645	100.00	78,418,867	100.00

2.2 Data

Multiple cause of death data on the individual level have been compiled by the National Center for Health Statistics (NCHS). We obtained those data from the National Bureau of Economic Research which provides a website to download these records for free.[1] Although the data are available for the years 1959–2005 we restricted our analysis to the years 1968–2002. The reason to choose the end of the 1960s instead of the end of the 1950s is related to the "International Classification of Diseases" which is the general standard to code causes of deaths. Between 1959 and 1967, the seventh revision ("ICD-7") was used in the United States. This version of the coding scheme did not contain any category for ischaemic heart disease which is one of our main causes of interest. ICD-8 was used in the US from 1968 until 1978. The longest part of our observation window was covered by ICD-9 (1979–1998) and since 1999 ICD-10 has been employed. Because of some minor problems we discovered in our analysis for the year 2003 and 2004, we decided to stop in 2002.

The corresponding population data have been downloaded from the Human Mortality Database (University of California, Berkeley (USA), and Max Planck Institute for Demographic Research, Rostock, (Germany), 2008).

3 Preliminary Results

In Figure 2 we present the sex-gap in life expectancy at birth in the calendar period 1968–2004. In the same figure we compare the difference in the expected number of years lived between ages 0 and 75 (e075)and for ages 1 to 75 (e175), in the calendar period 1968–2004. Over the studied years the sex difference in e075 closely resembled the pattern of steady decline in the gap in the life expectancy at birth. The decrease in the expected number of years lived between

[1] The URL of the website is: `http://www.nber.org/data/vital-statistics-mortality-data-multiple-cause-of-d` `html`.

age 1 and 75 had been not as sharp as the above two. The slower decrease in the gap for e175 as compared to e075 in years 1968-1995, stands for the faster improvement in infant mortality for boys than for girls. In the last decade the difference between e075 and e175 remains at similar level as a result of the fact that speed of improvements in infant mortality has been similar for both sexes.

In the next step, the sex-gap in the expected number of years lived for ages 0-75 and the gap for ages 1-75 have been decomposed according to the contribution of the four groups of causes. The results for selected years are presented on Figure 5. The major difference between the two lies in the contribution of causes amenable to medical care. In the year 1968 causes amenable to medical care accounted for about 5 months of the gap in e075, while for e175 the contribution of these causes was close to zero. That means that the difference of about 5 months in the number of years lived between men and women in 1968 can be attributed to the excess infant male mortality. In the later years, the contribution of the medical causes to the gap for ages 0-75 decreases to the maximum of 1.5 months, and after the exclusion of the age 0 the contribution becomes negative (except the last year presented here, where it equals zero). The negative contribution of this group of causes stands for the fact that the number of lives lost, because of these causes, is higher among women than among men. It is equivalent to the statement that in comparison to men, women (above age 0) benefit to a lesser extent from medical developments. In the year 2004 the gap resulting from medical conditions is negligible. Except the group of conditions amenable to medical intervention, the difference between the results for ages 0-75 and 1-75 is insignificant. Hence, in the next paragraph we concentrate only on the results for the expected number of years lived between age 0 and 75.

In the year 1968 the largest contribution to the gap was of IHD with men living on average 2 years and 7 months shorter than women as a result of excess deaths from this cause. The weight of IHD for the sex-gap has been decreasing since then, with the lowest contribution of less then 11 months in 2004. Similar decrease in the importance of the contribution was of

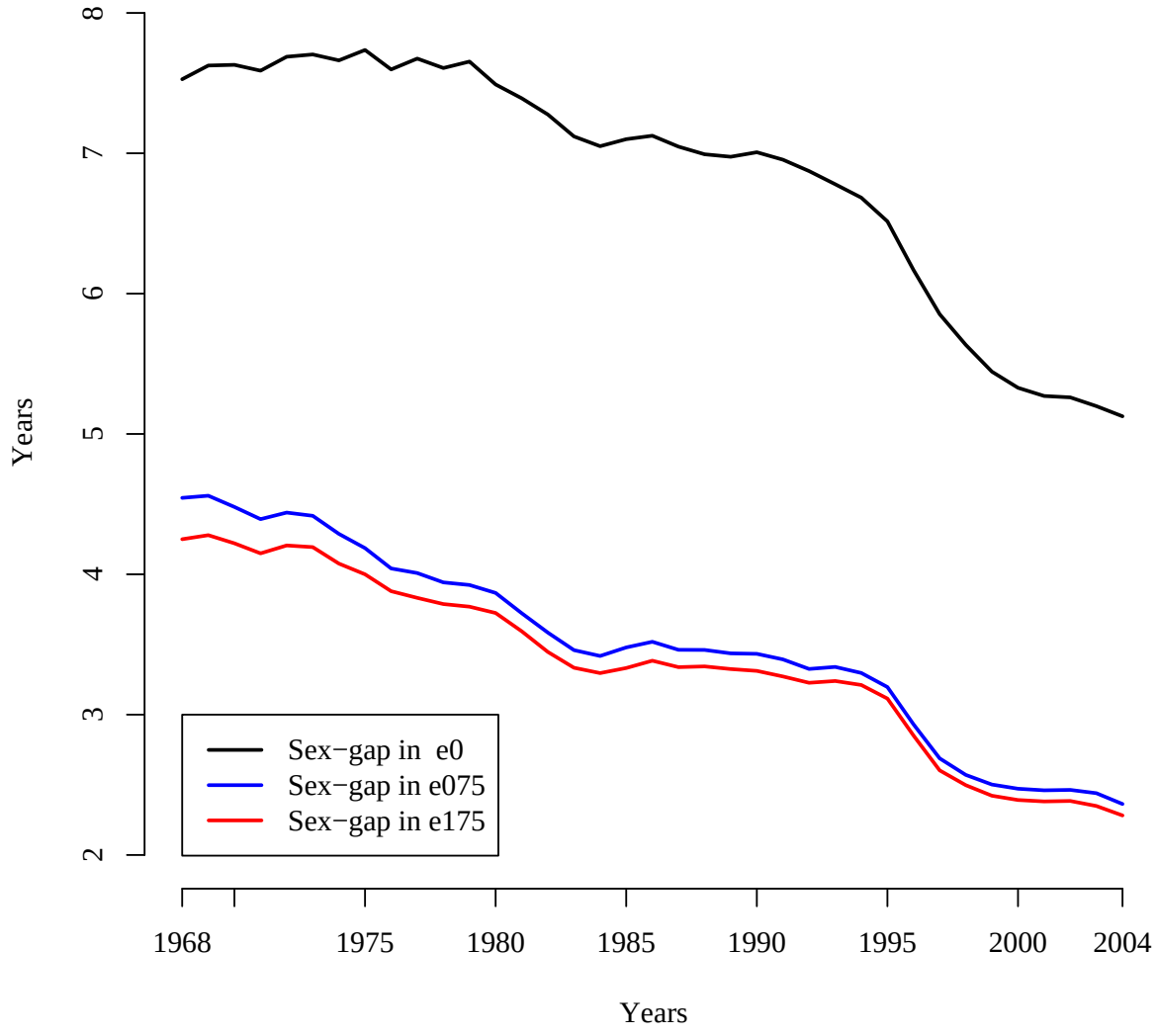
causes of death amenable to public policy interventions. The gap in e075 related to causes of death interpreted in this study as resulting from different behavioral pattern between the genders (amenble by public policy interventions) dropped from contribution of 1 year and 8 months to 1 year in 2004. The importance of the remaining group of other causes of death has been one of the highest over the entire period, with the peak of 2 years and 8 months in 1985. It was mostly deaths from "other" causes that are responsible for the sex-gap in mortality at the end of the studied period. We expect, however, that there is a strong age dependence for the importance of the four groups of causes.

The contribution of the four groups of causes of death for the sex-gap in e075 has been further decomposed by age. In Figure 3, we present selected results of this decomposition for the years 1968,1985 and 2004. As we can see on the top panel of the Figure, in year 1968 causes amenable to medical care disadvantaged male infants versus female ones. The difference between e075 for females and males resulting from excess infant male mortality in 1968 equaled 5 months. At ages 25-59 it is men who benefit more from medical care than women. The contribution at these ages of medically amenable causes of death to the male minus female gap in e075 is negative. At older ages (55–74 years) it is women who benefit more again and the contribution of medically amenable deaths to the gap is positive. The importance of ischemic heart disease for the existing gap grows with age, up to 5.8 months at ages 60-64. As far as causes amenable by health policy interventions and the group of "other" causes are concerned, in 1968 one can observe two peaks in the age distribution of the sex-gap: at young adult ages and around age 60. The first peak of excess male mortality results from higher incidence among men of violent deaths, car accidents, and other causes of death related to higher level of testosterone among men (Nathanson, 1984). Similar pattern of two dominant values can be also observed in the other two years studied here (in 1985 and 2004). Despite its lower level, in the years 1985 and 2004, also the age distributions of sex-gap in e075 due to causes amenable to medical intervention and the IHD resemble their equivalent distributions in 1968. The disadvantage of men as an outcome of excess infant mortality reduces to 1.5 months in 1985 and less then a month in

2004. On the other hand, the disadvantage of women in relation to medically amenable causes in 1985 concentrates at ages 25-69, and in 2004: at ages 25-59 years. In total, the disadvantage of women due to medically amenable causes of death at ages 25–59 contributes to the total of 1 year and 9 months in 1968, in 1985 and at ages 25–69 to the total disadvantage of women is of 1 year and 7 months, and in 2004 it equals to 4 months. The disadvantage of women due to medically amenable conditions at those ages is a result of high mortality from breast cancer. When we exclude deaths from breast cancer from the group of medically amenable conditions (as respresented by green bars on Figure 4), the disadvantage of women, as the remaining causes in the group are concerned, dissapears. The contribution of remaining causes to the sex-gap in life expectancy remains at similar level in the studied years. It means that we were not able to prove our initial hypothesis that the narrowing gap in life expectancy between men and women is a result of the fact that women benefit to a lesser extent from medically amenable conditions. In order to disprove this hypothesis, we need to study not only death rates from medically amenable conditions, but also incidence rates of these diseases.

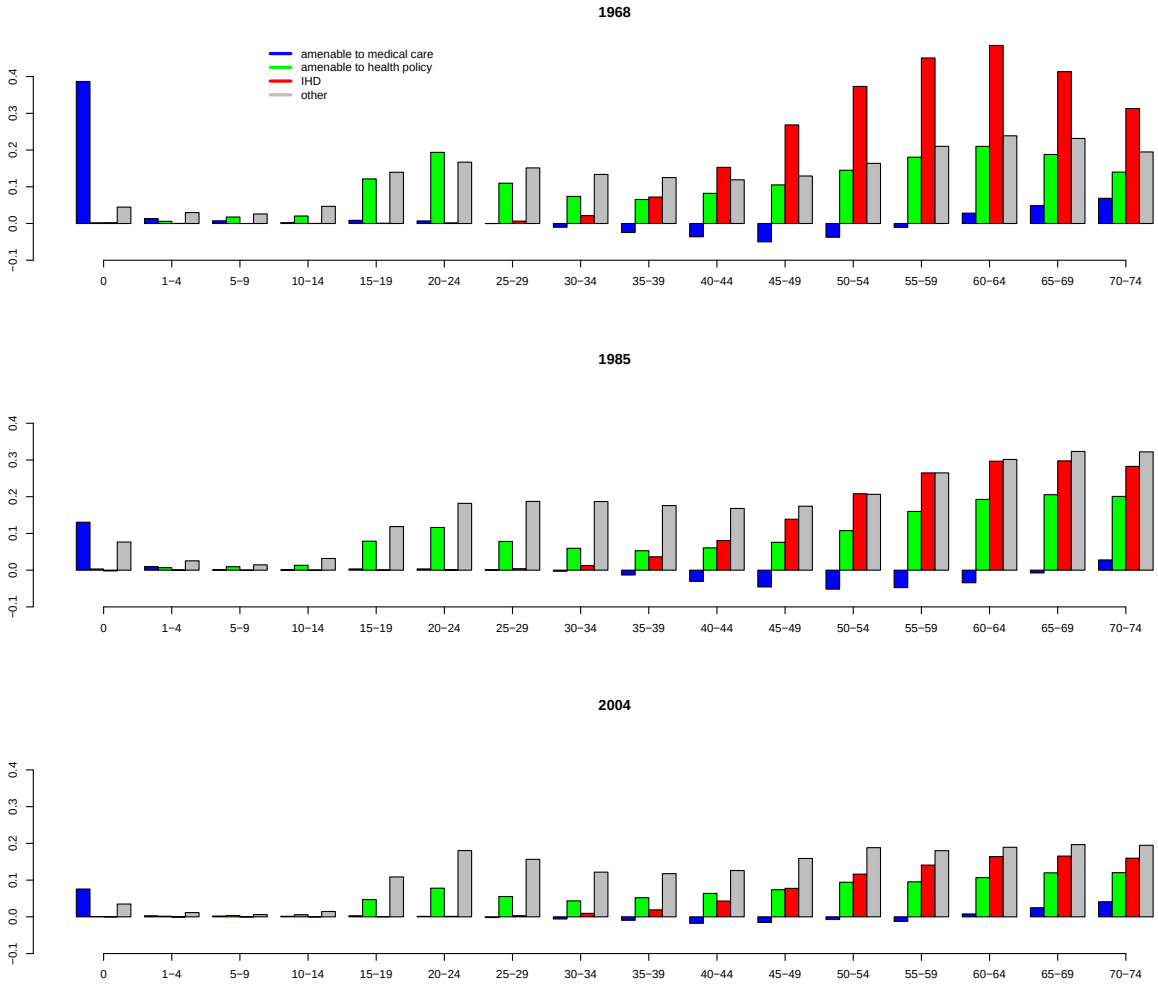
As the next part of our analysis focuses on change, separately for each sex, we study dynamics in the contribution of the four groups to the growth in life expectancy (Figure 5). Following the discusion on importance of medical intervention for differences in the infant mortality between the two sexes, we add an additional bar illustrating contribution of change in the deaths amenable to medical care at age 0. In the first half of the studied period, both male and female e075 increased by almost 2 years due to improvements in medical interventions. For males about 50% of the change occured at age 0 and for females: 40%. Improvement in the next two decades (1985–2004) in medical conditions have not had anymore such a great impact on the improvements in e075 as in the previous years. On contrary, at ages 35-74 medically amenable causes of death shifted the sex-gap in life-expectancy upwards (Figure 6).

Figure 2: Sex-gap in life expectancy at birth and sex-gap in the mean number of lives lived ages 0-75, and ages 1-75, 1968–2004



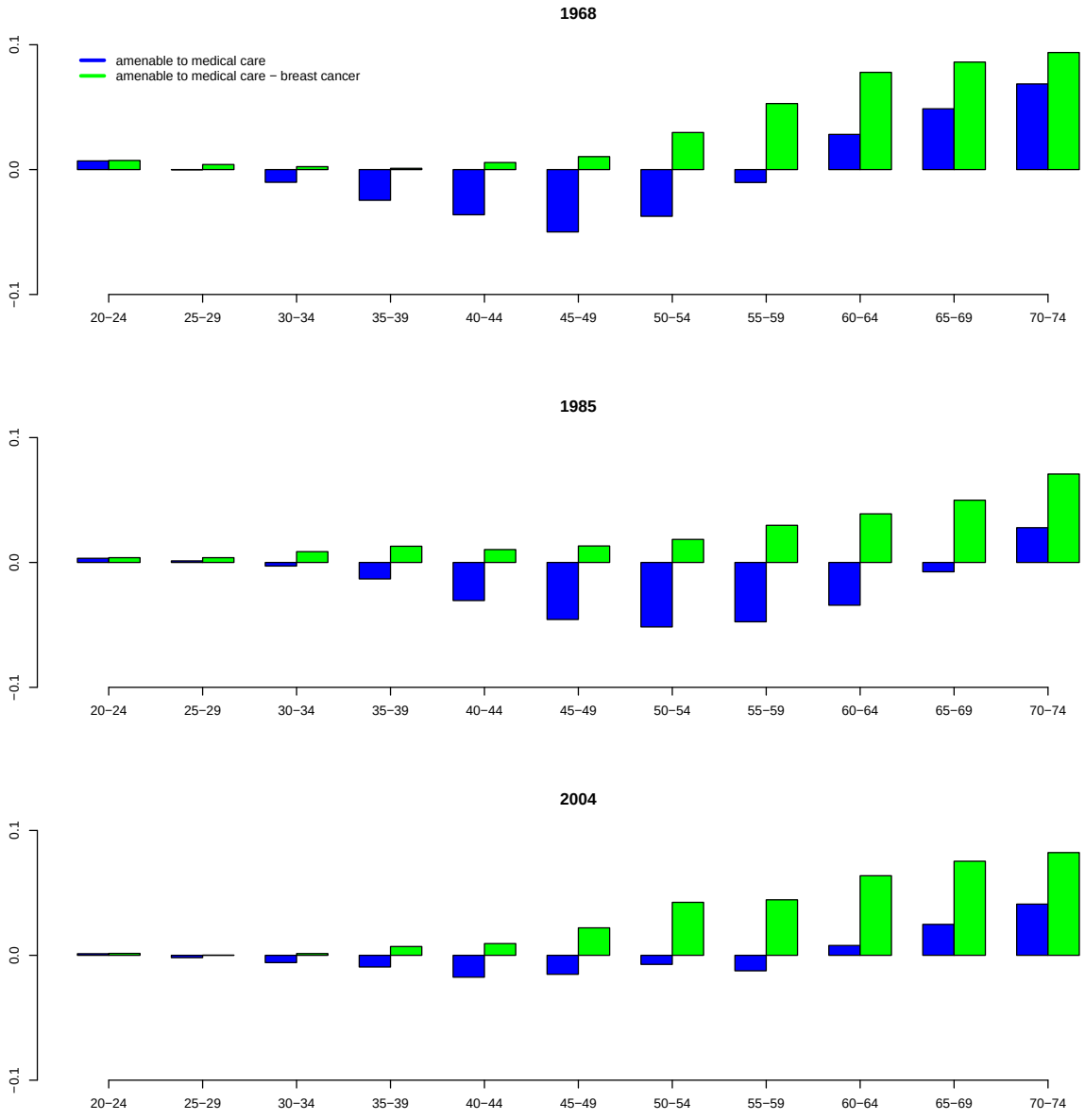
Source: HMD

Figure 3: Age- and cause specific contributions to the sex-gap in the mean number of years lived between age 0 and 75 years, calendar years: 1968, 1985, 2004



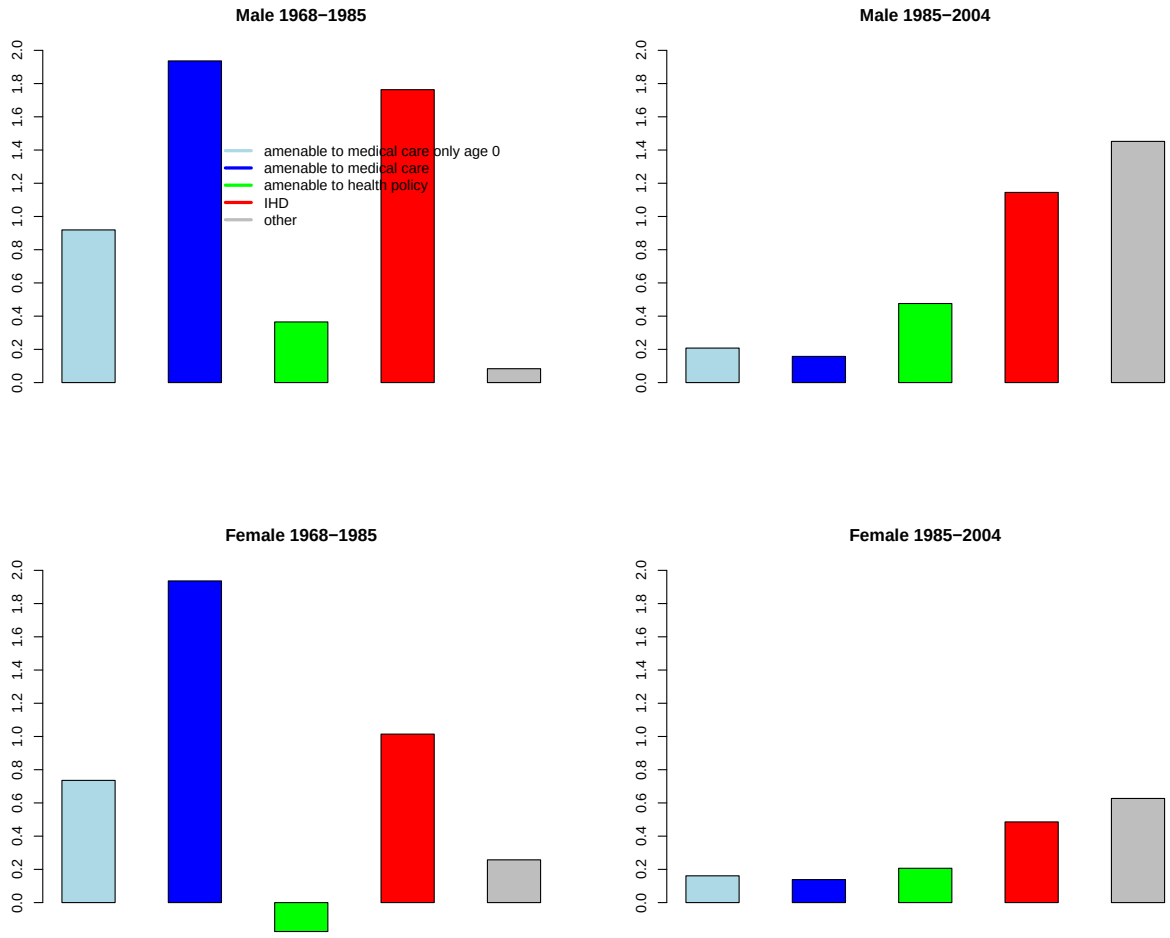
Source: authors' estimation, data derived from HMD

Figure 4: Age- and cause specific contributions to the sex-gap in the mean number of years lived between age 0 and 75 years, causes amenable to medical care and causes amenable to medical care excluding breast cancer, calendar years: 1968, 1985, 2004



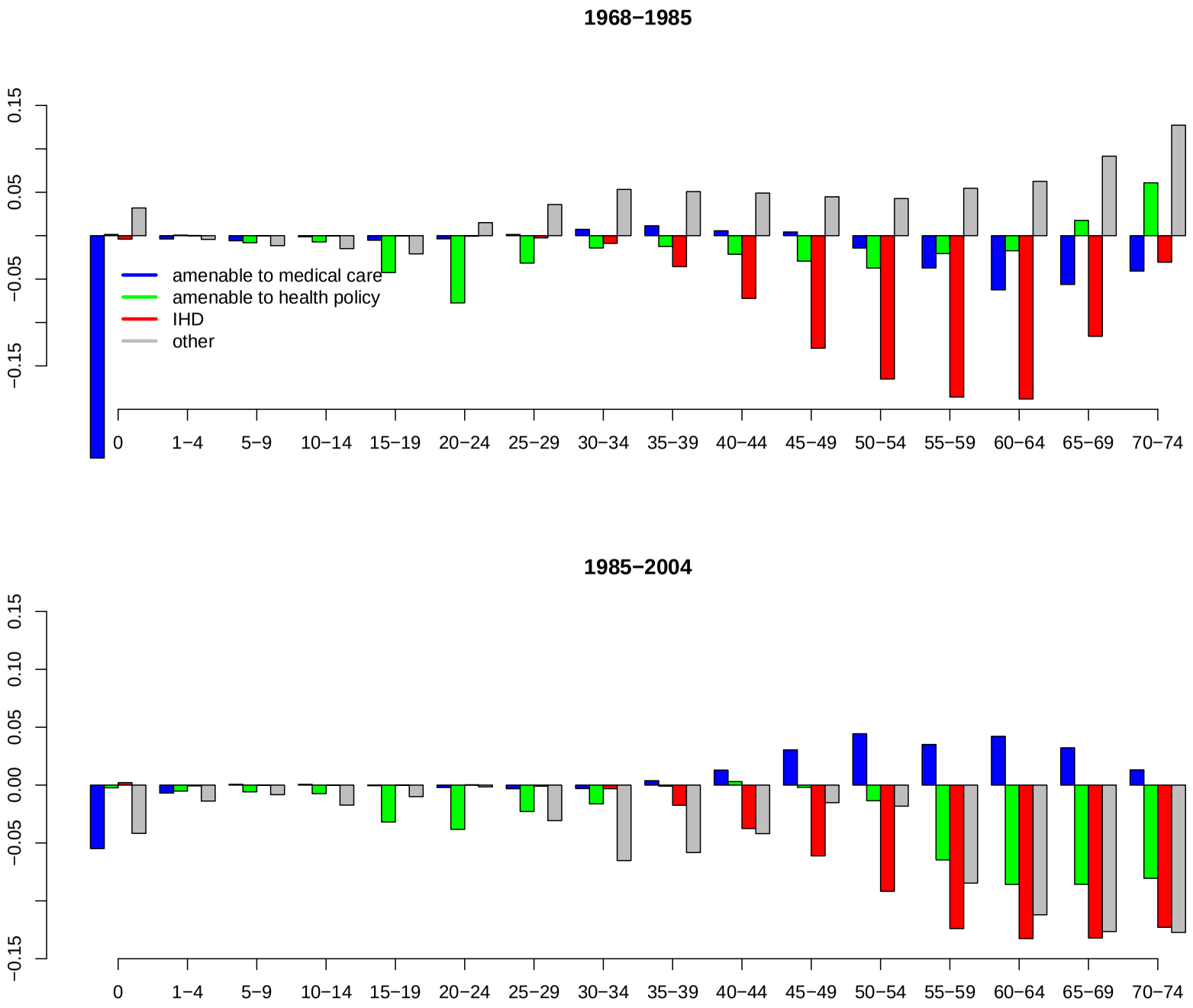
Source: authors' estimation, data derived from HMD

Figure 5: Cause specific contributions to the change in the expected number of years lived between ages 0–75 years, both sexes separately



Source: authors' estimation, data derived from HMD

Figure 6: Contribution of shift in age-specific mortality in the four groups of causes to the change in the sex-gap in the expected number of years lived between age 0 and 75 years



Source: authors' estimation, data derived from HMD

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4 Code Listing

Ischaemic Heart Disease:

ICD-8: 410 411 412 413 414

ICD-9: 410 411 412 413 414

ICD-10: I20 I21 I22 I23 I24 I25

Amenable to Public Health:

ICD-8: 162 173 490 491 492 571 810 811 812 813 814 815 816 817 818 819 820 821 822 823

ICD-9: 042 162 173 490 491 492 496 571 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825

ICD-10: B20 B21 B22 B23 B24 C34 C43 C44 J40 J41 J42 J43 J44 K70 K71 K74 V02 V03 V04 V09 V12 V13 V14 V19 V20 V21 V22 V23 V24 V25 V26 V27 V28 V29 V30 V31 V32 V33 V34 V35 V36 V37 V38 V39 V40 V41 V42 V43 V44 V45 V46 V47 V48 V49 V50 V51 V52 V53 V54 V55 V56 V57 V58 V59 V60 V61 V62 V63 V64 V65 V66 V67 V68 V69 V70 V80 V81 V82 V83 V84 V85 V86 V87 V88 V89

Amenable to Medical Care:

ICD-8: 000 001 002 003 004 005 006 007 008 009 010 011 012 013 014 015 016 017 018 019 020 021 022 023 024 025 026 027 028 029 030 031 032 033 034 037 038 040 041 042 043 044 055 090 091 092 093 094 095 096 097 174 180 182 186 201 204 205 206 207 240 241 242 243 244 245 246 250 280 281 320 345 381 382 383 390 391 392 393 394 395 396 397 398 400 401 402 403 404 430 431 432 433 434 435 436 437 438 460 461 462 463 464 465

466 470 471 472 473 474 480 481 482 483 484 485 486 493 531 532 533 534 540 541 542 543 550 551 552 553 560 574 575 580 581 582 583 584 590 595 600 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 680 681 682 683 684 685 686 710 720 746 747 750 751 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779

ICD-9: 001 002 003 004 005 006 007 008 009 010 011 012 013 014 015 016 017 018 019 020 021 022 023 024 025 026 027 028 029 030 031 032 033 034 037 038 045 055 090 091 092 093 094 095 096 097 137 174 179 180 182 186 201 204 205 206 207 208 240 241 242 243 244 245 246 250 280 281 320 321 322 345 381 382 383 390 391 392 393 394 395 396 397 398 401 402 403 404 430 431 432 433 434 435 436 437 438 460 461 462 463 464 465 466 480 481 482 483 485 486 487 493 531 532 533 534 540 541 542 543 550 551 552 553 560 574 575 576 580 581 582 583 584 585 586 587 588 589 590 595 600 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 680 681 682 683 684 685 686 711 730 745 746 747 750 751 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779

ICD-10: A00 A01 A02 A03 A04 A05 A06 A07 A08 A09 A15 A16 A17 A18 A19 B90 A33 A35 A36 A37 A40 A41 A80 B05 C18 C19 C20 C21 C44 C50 C53 C54 C55 C62 C81 C91 C92 C93 C94 C95 E00 E01 E02 E03 E04 E05 E06 E07 E10 E11 E12 E13 E14 G40 G41 I05 I06 I07 I08 I09 I10 I11 I12 I13 I15 I60 I61 I62 I63 I64 I65 I66 I67 I68 I69 J00 J01 J02 J03 J04 J05 J06 J07 J08 J09 J10 J11 J12 J13 J14 J15 J16 J17 J18 J20 J21 J22 J23 J24 J25 J26 J27 J28 J29 J30 J31 J32 J33 J34 J35 J36 J37 J38 J39 J40 J41 J42 J43 J44 J45 J46 J47 J48 J49 J50 J51 J52 J53 J54 J55 J56 J57 J58 J59 J60 J61 J62 J63 J64 J65 J66 J67 J68 J69 J70 J71 J72 J73 J74 J75 J76 J77 J78 J79 J80 J81 J82 J83 J84 J85 J86 J87 J88 J89 J90 J91 J92 J93 J94 J95 J96 J97 J98 J99 K25 K26 K27 K35 K36 K37 K38 K40 K41 K42 K43 K44 K45 K46 K80 K81 N01 N02 N03 N04 N05 N06 N07 N17 N18 N19 N25 N26 N27 N40 O00 O01 O02 O03 O04 O05

O06 O07 O08 O09 O10 O11 O12 O13 O14 O15 O16 O17 O18 O19 O20 O21 O22 O23 O24 O25 O26 O27 O28 O29 O30 O31 O32 O33 O34 O35 O36 O37 O38 O39 O40 O41 O42 O43 O44 O45 O46 O47 O48 O49 O50 O51 O52 O53 O54 O55 O56 O57 O58 O59 O60 O61 O62 O63 O64 O65 O66 O67 O68 O69 O70 O71 O72 O73 O74 O75 O76 O77 O78 O79 O80 O81 O82 O83 O84 O85 O86 O87 O88 O89 O90 O91 O92 O93 O94 O95 O96 O97 O98 O99 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 P00 P01 P02 P03 P04 P05 P06 P07 P08 P09 P10 P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29 P30 P31 P32 P33 P34 P35 P36 P37 P38 P39 P40 P41 P42 P43 P44 P45 P46 P47 P48 P49 P50 P51 P52 P53 P54 P55 P56 P57 P58 P59 P60 P61 P62 P63 P64 P65 P66 P67 P68 P69 P70 P71 P72 P73 P74 P75 P76 P77 P78 P79 P80 P81 P82 P83 P84 P85 P86 P87 P88 P89 P90 P91 P92 P93 P94 P95 P96