Two centuries of Swiss demographic history

Graphic album of the 1860–2050 period

Including CD-ROM

Office fédéral de la statistique
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Author **Gérard Calot**
Observatoire démographique européen, Paris

with assistance from **Alain Confesson and Jean-Paul Sardon**
Observatoire démographique européen, Paris

Erminio Baranzini, Stéphane Cotter and Philippe Wanner
Swiss Federal Statistical Office

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Preface

In 1798, exactly two centuries ago, the leaders of the Helvetic Republic, influenced by France, conducted the first population census in the eighteen cantons that constituted the Switzerland of the day. In a country in the throes of political unrest and war, an operation of this kind was far from simple. But its completion marked the end of the "pre-statistical era" of the Old Confederation (cf. "The Swiss Population around 1800", publ. Swiss Federal Statistical Office, 1988). Bearing in mind the five territories which were not yet part of Switzerland, it is estimated that the country then had some 1.7 million inhabitants. In 1850, two years after the Swiss Federal State came into being, Stefano Franscini, a Federal Councillor from Ticino who was also a statistician, organized the first federal Population Census. At that time, there were 2.4 million inhabitants, 44% up on the 1798 figures.

The data of the 1850 Census could not be analyzed in depth due to lack of human and financial resources. 1860 saw the founding of the Federal Statistical Office which was subsequently to conduct and analyze population censuses on a professional basis, in conformity with international standards. The same year, a population census was held and provided basic data for establishing annual population statistics. The annual population data by age and gender reconstituted by the Federal Statistical Office for the purpose of this study also date back to 1860.

Following the 1870 population census, vital statistics were standardized at national level. From 1871 onwards, Federal Statistical Office archives contain several thousand tables presenting an exhaustive record of the natural population movement of Switzerland, its cantons and even some of its districts and communes. In 1992, work began on transferring the lion's share of these archives (some 15 000 tables) to electronic media, adding the necessary information. This work is almost complete and, for the first time, the database subsequently compiled has been made accessible for scientific analyses in order to carry out this study.

This publication, which marks the 150th anniversary of the Swiss Federal State and the Bicentenary of the Helvetic Republic, is the fruit of close cooperation between Swiss and French statisticians and demographers. It augurs well. Mr. Gérard Calot, Director of the «Observatoire démographique européen» (ODE) and Inspector-General of the INSEE (Institut national de la statistique et des études économiques) kindly directed the presentation and commentary of the data. The ODE plans to conduct comparative studies on population movement in the various countries and regions of Europe. The study on Switzerland is the first to present a country's demographic history in detail using the methods and visualization techniques developed by Gérard Calot. The remarkable, constant quality of Switzerland's demographic data from the outset played a major role in its being chosen to launch this new series of studies.

Historical series have been linked to the findings of the Swiss Federal Statistical Office's latest demographic scenarios (cf. "Les scénarios de l'évolution démographique de la Suisse, 1995–2050", Swiss Federal Statistical Office, Berne, 1996), making it possible to extrapolate the study results to bring out the impact of past developments in the very long term.

The present publication is a kind of encyclopaedia of commented data which displays a substantial amount of information in graphic form. All the data used for this study are available on CD-ROM to allow further analytical work, making it a unique tool for analyzing and interpreting Switzerland's demographic history while placing it in an international context.

This study would not have been possible without the commitment

– of our predecessors at the Federal Statistical Office who compiled population statistics year after year, for more than a century,

– of those responsible for transferring the historic hard-copy tables to electronic media, and

– of those who worked on this publication, both in the Swiss Federal Statistical Office and in the Observatoire démographique européen,

and I take this opportunity to thank them.

Swiss Federal Statistical Office

Werner Haug

Executive Summary

This study portrays changes in the population of Switzerland from 1860 to 2050 using a combination of historical data from censuses and annual statistics of natural population change, and demographic projections to the year 2050 for future trends. The broad demographic trends are depicted and commented on in a series of charts.

Between 1860 and 1997, the total population of Switzerland has increased from 2.5 to 7.1 million people, an average growth of 0.8% a year. It has not grown at a steady rate: rapid increases during the periods 1890-1910 and 1945-1970 have alternated with slower growth from 1860 to 1880 and between the two World Wars; it was negative only in 1918 and from 1975 to 1977. This irregular growth rate is essentially attributable to the net balance from international migration. It was negative from 1872 to 1887, then positive during the economic boom which ended in 1910, becoming negative again up to the 1930s. Disregarding exceptional periods, Switzerland's migration balance has been firmly positive from World War Two down to the present day. The normally high gross rate of natural increase has begun to decline as a result of the ageing of the population and low fertility, the combined effect of which has been an increase in deaths and decrease in births. Deaths could start to exceed births in the coming decades.

The age structure of the population has changed since the mid-19th century through a process of demographic ageing, i.e., a fall in the proportion of young people and a rise in the proportion of elderly persons. This trend is projected to continue in the coming decades. In 1995, the population aged 60 and over was 3.3 times larger than it was in 1930; that aged 80 and over has multiplied tenfold. By the year 2050, the former group will be a further 1.6 times larger, and the latter 2.7 times. Ageing changes the dependency ratio (between the working and retired populations) and the excess of females over males amongst the elderly and very elderly.

The study examines the different factors which have influenced Switzerland's population size and structure.

The first marriage rate has shown a contrasting picture since World War Two: mean age at first marriage declined steadily up to around 1970, and rose sharply thereafter. The proportion of women already married at 25 years of age rose from 35% in 1930 to nearly 60% in 1970, falling back to 25% in 1996. This rise in age at first marriage has been accompanied by a turning away from legally-constituted marriages. The proportion of ever-married persons at age 50, which has long hovered around 80%, is likely to decline among women of cohorts born after 1960, at least if recent trends remain constant.

As the total first marriage rate has declined, so the divorce rate has increased rapidly since 1965: 30% of the marriages celebrated in 1970 will end in divorce against 10% for those celebrated 50 years earlier. The risk of divorce is highest between the 10th and 15th year of marriage.

Fertility has been in a long-term decline since the mid-19th century, interspersed by four decades of high fertility (1938-1978). The total fertility rate has fallen from 4.4 children per woman in 1875 to no more than 1.5 today, where it is projected to remain for the next half century. Fertility decline has been moderate in birth orders 1 and 2, and considerably more pronounced in orders 3 and higher.

Mean age at childbirth has fallen from 30.6 among women born around 1910 (with an average parity little more than 2) to 26.8 among those born around 1945. Motherhood has become increasingly delayed among subsequent cohorts such that mean age at childbirth is expected to return to around thirty years of age before long.

Mortality has fallen dramatically, especially at the start of life - the infant mortality rate has been divided by 40 from 120 years ago, falling from 20% (one in five babies did not survive to their first birthday in 1875) to 0.5% now. At adult ages, mortality decline is slower, but still significant. Life expectancy at birth has nearly doubled from 39.5 years in 1876 to 76.0 years in 1996 for men, and from 52.5 to 82.0 years for women. At other ages, the increase in average longevity has risen commensurately. The only – albeit recent - exception to this general fall in death rates is persons aged between 20 and 40, due to the rise of accidental and AIDS-related deaths.

The analysis of daily and monthly variations of vital events reveals interesting phenomena, like the bunching of marriages on Fridays and the lower frequency of weekend births attributable to induced labour and caesarian sections.

Births remain distributed fairly evenly throughout the year, notwithstanding improved fertility control methods which should enable couples to choose the month of birth. There is a discernible birth surge each year from the end of August to the end of September. This is explained by the increase in Christmas and New Year conceptions, being the time of year when the number of couples kept apart, especially by work, is at its lowest. Marriages are increasingly taking place between May and September, while deaths, from being largely concentrated in the winter months, are now tending to even out over the year.

The analysis of daily and monthly variations in vital events reveals a number of period-specific events. So, the entry into force of the new Nationality Act in January 1992 was preceded by an increase in the number of marriages in November and December 1991. There was also a sudden upsurge in marriages on 8.8.88, particularly in the German-speaking regions.

Particular episodes in Swiss demographic history are described, notably the mortality peaks during the influenza epidemic and their effect on the birth rate nine months later. The world wars also had demographic consequences, especially on nuptiality. The lower rate of wartime marriages was followed by a decline in fertility.

The study concludes with a comparison of Swiss demography and that of its European neighbours. It reveals, among other things, proportionately more but later marriages in Switzerland, a lower proportion of premarital conceptions and a broadly better health situation.

L’essentiel en bref

La présente étude porte sur l’évolution de la population de la Suisse de 1860 à 2050. Elle repose à la fois sur les données passées, fournies par les recensements successifs et par la statistique annuelle du mouvement naturel, et sur les scénarios démographiques à l’horizon 2050 pour ce qui est du futur. Des graphiques commentés brossent les grands traits de cette évolution.

Entre 1860 et 1997, l’effectif de la population de la Suisse est passé de 2,5 à 7,1 millions d’habitants, soit une croissance moyenne de 0,8% l’an. Ce rythme de croissance n’a pas été uniforme : rapide au cours des périodes 1890-1910 et 1945-1970, la croissance a été plus lente de 1860 à 1880 et entre les deux guerres mondiales ; elle n’a été négative qu’en 1918 et de 1975 à 1977. L’irrégularité des taux de croissance est due essentiellement au solde des migrations avec l’étranger. Celui-ci a été négatif de 1872 à 1887, puis positif durant la période de prospérité économique qui a pris fin en 1910. Il a été ensuite de nouveau négatif jusque dans les années 1930. Après la Seconde Guerre mondiale et jusqu’aux années récentes, le solde migratoire de la Suisse a été très fortement positif, si on met à part quelques périodes exceptionnelles. Le taux brut d’excédent naturel, longtemps élevé, diminue en raison du vieillissement de la population et de la basse fécondité, dont l’effet conjugué est d’augmenter le nombre de décès et de diminuer celui des naissances. L’excédent naturel pourrait devenir négatif au cours des prochaines décennies.

La composition par âge de la population s’est modifiée depuis le milieu du XIXe siècle dans le sens du vieillissement démographique, c’est-à-dire de la diminution de la proportion des jeunes et l’augmentation de celle des personnes âgées. Cette tendance au vieillissement devrait se poursuivre au cours des prochaines décennies. De 1930 à 1995, l’effectif du groupe 60 ans ou plus a été multiplié par 3,3, celui du groupe 80 ans ou plus par 10. D’ici à 2050, l’effectif du premier groupe sera encore multiplié par 1,6, et celui du second par 2,7. Le vieillissement modifie l’équilibre entre le nombre d’actifs et le nombre de retraités et influe sur la féminisation du troisième et du quatrième âges.

L’analyse se poursuit par une étude des différents facteurs qui ont conditionné l’évolution de la taille et de la structure de la population de la Suisse.

La primo-nuptialité a enregistré, depuis la Seconde Guerre mondiale, une évolution contrastée, marquée jusque vers 1970 par un rajeunissement de l’âge au premier mariage, puis par un très fort vieillissement. La proportion de femmes déjà mariées à 25 ans est ainsi passée de 35% en 1930 à près de 60% en 1970 pour revenir à 25% en 1996. Ce vieillissement du calendrier du premier mariage a été accompagné par une désaffection pour le mariage légal. La proportion de non célibataires à 50 ans, longtemps voisine de 80%, devrait diminuer pour les femmes des générations nées après 1960, du moins si les tendances récentes se poursuivent.

Alors que le mariage des célibataires est en baisse, le divorce progresse rapidement depuis 1965. 30% des mariages célébrés en 1970 seront dissous par divorce contre 10% pour les mariages célébrés 50 ans plus tôt. C'est entre 10 et 15 ans de mariage que le risque de divorcer est le plus élevé.

L'évolution de la fécondité depuis le milieu du XIXe siècle a été caractérisée par une baisse à long terme, entrecoupée par quatre décennies de forte fécondité (1938-1978). Alors qu'en 1875, l'indicateur conjoncturel de fécondité était de 4,4 enfants pour une femme, aujourd'hui, il ne dépasse pas 1,5, niveau qui ne devrait guère varier durant le prochain demi-siècle. La baisse de la fécondité a été modérée aux rangs de naissance 1 et 2 et considérablement plus marquée pour les rangs 3 ou plus.

L'âge moyen à la maternité, qui atteignait 30,6 ans chez les femmes nées vers 1910 (qui ont eu à peine plus de 2 enfants en moyenne), s'est abaissé jusqu'à 26,8 ans chez celles nées vers 1945. Dans les générations suivantes, la fécondité est devenue de plus en plus tardive et l'âge à la maternité devrait prochainement retrouver des valeurs voisines de trente ans.

La mortalité s'est caractérisée par un recul prodigieux, notamment au début de la vie puisque le taux de mortalité infantile a été divisé par 40 en 120 ans, passant de 20% (un bébé sur cinq n'atteignait pas son premier anniversaire vers 1875) à 0,5% actuellement. Aux âges adultes, la baisse de la mortalité a été moins rapide, mais cependant considérable. L'espérance de vie à la naissance a presque doublé, passant de 39,5 ans en 1876 à 76,0 ans en 1996 pour les hommes, et de 52,5 à 82,0 ans pour les femmes. Aux autres âges, la durée moyenne restant à vivre a augmenté dans des proportions comparables. La seule exception, au demeurant récente, à cette baisse générale de la mortalité concerne les âges compris entre 20 et 40 ans ; elle est liée à la montée des décès par accident et des décès par sida.

L'analyse des fluctuations journalières et mensuelles des événements démographiques fait apparaître des phénomènes intéressants, comme la concentration du mariage le vendredi et la moindre fréquence des naissances le week-end, qui résulte de l'augmentation de la part des accouchements à déclenchement provoqué et des césariennes.

Les naissances se répartissent de manière sensiblement uniforme tout au long de l'année, malgré la maîtrise accrue de la fécondité qui devrait permettre aux couples de choisir le mois de la naissance. On note un regain de naissances chaque année à partir de fin août jusqu'à fin septembre. Ces naissances s'expliquent par une recrudescence des conceptions au voisinage de Noël et du Nouvel An, période de l'année où la proportion des couples séparés, notamment pour des motifs professionnels, est la plus faible. Les mariages se célèbrent de plus en plus entre mai et septembre, tandis que les décès, autrefois assez fortement concentrés dans les mois hivernaux, tendent à se répartir de manière de plus en plus uniforme.

L'analyse des variations journalières et mensuelles des nombres d'événements montre quelques événements conjoncturels particuliers. Ainsi, l'entrée en vigueur, en janvier 1992, de la nouvelle loi sur la nationalité a été précédée par une augmentation du nombre des mariages en novembre et décembre 1991. Le 8.8.88 a correspondu à une soudaine augmentation du nombre des mariages, principalement dans les régions alémaniques.

Différents épisodes particuliers de l'histoire démographique suisse sont décrits, notamment les pointes de mortalité dues à la grippe et leur association, décalée de neuf mois, avec la fécondité. Les guerres mondiales ont également eu des conséquences démographiques, en particulier sur la nuptialité. La diminution de la nuptialité durant les guerres a été suivie d'une diminution de la fécondité.

L'étude se termine par une comparaison de la démographie suisse avec celle de ses voisins européens, faisant apparaître notamment une nuptialité plus élevée en Suisse, mais aussi plus tardive, une plus faible proportion des naissances hors mariage et une situation sanitaire dans l'ensemble plus favorable.

Das Wichtigste in Kürze

Diese Studie ist der Bevölkerungsentwicklung in der Schweiz von 1860 bis 2050 gewidmet. Die zur Beschreibung der Vergangenheit verwendeten Daten stammen aus den verschiedenen Volkszählungen sowie aus der Statistik der natürlichen Bevölkerungsbewegung, jene zur Beschreibung der Zukunft aus den Bevölkerungsszenarien bis 2050. Kommentierte Grafiken zeichnen die Entwicklung in grossen Zügen nach.

Zwischen 1860 und 1997 nahm der Bevölkerungsstand in der Schweiz von 2,5 auf 7,1 Millionen Einwohner zu. Dies entspricht einem jährlichen Anstieg von 0,8% pro Jahr, wobei zu sagen ist, dass das Wachstum nicht regelmässig verlaufen ist. Den Phasen starker Zunahme von 1890-1910 und von 1945-1970 stehen Perioden langsamen Anstiegs von 1860 bis 1880 und zwischen den zwei Weltkriegen gegenüber; ein negatives Wachstum gab es nur gerade 1918 und von 1975 bis 1977 zu verzeichnen. Diese Schwankungen sind hauptsächlich auf den Wanderungssaldo mit dem Ausland zurückzuführen, der von 1872 bis 1887 negativ, während des wirtschaftlichen Aufschwungs bis 1910 hingegen positiv war. Danach folgte wiederum eine negative Phase, die in den 30er Jahren endete. Nach dem Zweiten Weltkrieg bis in die neuere Zeit hinein war der Wanderungssaldo der Schweiz mit dem Ausland abgesehen von wenigen Ausnahmen deutlich positiv. Der sich lange auf einem hohen Stand bewegende Bruttogeburtenüberschuss ist aufgrund der Alterung der Bevölkerung und der geringen Geburtenhäufigkeit rückläufig. Dies bedeutet eine Zunahme der Anzahl Todesfälle und einen Rückgang der Anzahl Geburten, womit der Geburtenüberschuss in den kommenden Jahrzehnten negativ werden könnte.

Die Altersstruktur der Bevölkerung spiegelt seit Mitte des 19. Jahrhunderts die zunehmende Alterung der Bevölkerung wider, die sich in der Verkleinerung des Anteils der Jungen und der Vergrösserung des Anteils der älteren Personen äussert. Dieser Trend dürfte sich in den kommenden Jahrzehnten fortsetzen. Zwischen 1930 und 1965 wuchs die Altersgruppe der 60jährigen und Älteren um das 3,3fache, jene der 80jährigen und Älteren um das zehnfache. Bis ins Jahr 2050 dürfte in diesen Altersgruppen noch eine Vervielfachung um den Faktor 1,6 respektive 2,7 eintreten. Die Alterung verändert das Verhältnis zwischen der Anzahl Erwerbspersonen und der Anzahl Rentner und lässt den Frauenanteil in den oberen Altersgruppen immer mehr ansteigen.

Die Analyse wendet sich anschliessend den verschiedenen Faktoren zu, welche die Grösse und die Struktur der Schweizer Bevölkerung geprägt haben.

Die wechselvolle Entwicklung der Erstheiraten seit dem Zweiten Weltkrieg zeichnet sich bis 1970 durch einen Rückgang, danach durch einen starken Anstieg des Alters bei der ersten Heirat aus. So erhöhte sich der Anteil der im Alter von 25 Jahren verheirateten Frauen von 35% im Jahr 1930 auf knapp 60% im Jahr 1970, um 1996 wieder auf 25% zu sinken. Diese Verschiebung der Erstheirat in spätere Lebensabschnitte wurde von einer vermehrten Abkehr von der standesamtlichen Heirat begleitet. Bei einer Fortsetzung der gegenwärtigen Tendenzen dürfte sich der Anteil der im Alter von 50 Jahren verheirateten Personen - er bewegte sich lange um 80% - für die Frauen der Geburtsjahrgänge nach 1960 verringern.

Während einerseits die Heirat zwischen ledigen Personen seltener wird, ist andererseits eine starke Zunahme der Scheidungen seit 1965 festzustellen. 30% der 1970 geschlossenen Ehen dürften geschieden werden, verglichen mit 10% der 50 Jahre zuvor eingegangenen Ehen. Nach zehn bis fünfzehn Ehejahren ist das Scheidungsrisiko am höchsten.

Die Entwicklung der Geburtenhäufigkeit seit Mitte des 19. Jahrhunderts zeichnet sich langfristig durch einen Rückgang aus, der jedoch durch vier Jahrzehnte starker Geburtenhäufigkeit unterbrochen wird (1938-1978). Während die zusammengefasste Geburtenziffer 1875 4,4 Kinder je Frau betrug, bewegt sie sich heute um 1,5 Kinder je Frau, ein Wert, der sich in den nächsten fünfzig Jahren kaum verändern dürfte. Die Zahl der Frauen mit einem oder zwei Kindern ist nur mässig, jene mit drei und mehr Kindern jedoch deutlich zurückgegangen.

Das mittlere Alter bei der Geburt des Kindes, das sich bei den um 1910 geborenen Frauen auf 30,6 Jahre belaufen hatte (sie hatten durchschnittlich rund zwei Kinder), sank bei den um 1945 geborenen Frauen auf 26,8 Jahre. Die Frauen in den nachfolgenden Geburtsjahrgängen warteten mit dem Mutterwerden immer länger zu, wodurch das Alter bei der Geburt des Kindes bald wieder um die 30 Jahre betragen dürfte.

Die Sterblichkeit zeichnet sich insbesondere in den ersten Lebensmonaten durch einen starken Rückgang aus, reduzierte sich doch die Säuglingssterblichkeitsrate innerhalb von 120 Jahren um das 40fache und sank von 20% (d.h. einer von fünf Säuglingen starb 1875 vor seinem ersten Geburtstag) auf heute 0,5%. Immer noch beträchtlich, wenn auch weniger spektakulär, ist der Rückgang der Erwachsenensterblichkeit. Mit einer Steigerung von 39,5 Jahren (1876) auf 76,0 Jahre (1996) für die Männer und von 52,5 Jahren auf 82,0 Jahre für die Frauen hat sich die Lebenserwartung bei der Geburt fast verdoppelt. Ähnlich verhält es sich auch mit der mittleren verbleibenden Lebenszeit in den übrigen Altersgruppen. Die einzige Ausnahme - übrigens jüngeren Datums - innerhalb dieses allgemeinen Rückgangs der Sterblichkeit bildet die Altersgruppe der 20- bis 40jährigen; sie steht im Zusammenhang mit der gestiegenen Anzahl unfall- oder AIDS-bedingter Todesfälle.

Die tages- oder monatsbezogene Analyse der demografischen Ereignisse zeitigte einige interessante Ergebnisse, so zum Beispiel die Konzentration von Heiraten auf den Freitag oder die geringere Geburtenhäufigkeit am Wochenende, die auf die zunehmende Zahl von künstlich eingeleiteten Geburten oder von Kaiserschnitten zurückzuführen ist.

Die Geburten verteilen sich trotz der zunehmenden Möglichkeiten zur Empfängnisverhütung - die es den Paaren eigentlich ermöglichen sollte, den Geburtsmonat ihres Kindes zu bestimmen - ziemlich gleichmässig auf das ganze Jahr. Dennoch ist jedes Jahr ein Anstieg der Geburtenzahl von Ende August bis Ende September festzustellen. Dieser geht auf eine erhöhte Zahl von Zeugungen in der Weihnachts- und Neujahrszeit zurück, eine Periode, in der die Paare oft mehr Zeit füreinander haben. Eheschliessungen finden immer häufiger zwischen Mai und September statt, während sich die Todesfälle, die früher in den Wintermonaten verstärkt auftraten, immer gleichmässiger auf das Jahr verteilen.

Die tages- oder monatsbezogene Analyse der Anzahl demografischer Ereignisse ergibt einige saisonbedingte Sonderfälle. So nahm zum Beispiel im November und Dezember 1991, das heisst im Vorfeld der Einführung des neuen Bürgerrechtsgesetzes im Januar 1992, die Zahl der Eheschliessungen zu. Weiter stieg am 8.8.88 die Zahl der Eheschliessungen hauptsächlich in der deutschen Schweiz sprunghaft an.

Die Studie beschreibt einige herausragende Etappen der demografischen Geschichte der Schweiz, so die Sterblichkeitsrekorde aufgrund der Grippeepidemie und deren Auswirkungen, neun Monate danach, auf die Geburtenhäufigkeit. Die Weltkriege haben ebenfalls ihre demografischen Spuren hinterlassen, was sich in erster Linie bei der Heiratshäufigkeit bemerkbar machte. Und auf den Rückgang der Heiratshäufigkeit in den Kriegsjahren folgte ein Rückgang der Geburtenhäufigkeit.

Die Studie schliesst ab mit einem Vergleich der schweizerischen Demografie mit jener in den europäischen Nachbarländern und weist dabei insbesondere auf die hierzulande höhere Heiratshäufigkeit, dann aber auch auf die später erfolgenden Eheschliessungen, die geringere Zahl von Geburten unverheirateter Mütter und die generell besseren Bedingungen im Gesundheitsbereich hin.

Chapter 1: Population dynamics

From 2.5 to 7.1 million inhabitants between 1860 and 1997: an average growth of 0.8% per annum

In its first census of modern times – December 10, 1860 – Switzerland had a population of two and a half million. Since then, an average annual growth of 0.8% has all-but tripled the Confederation's population (Figure 1.1) to 7 million inhabitants today (7.08 million at January 1, 1997). A half-century hence, the population size may not be so very different from what it is now: 7.4 million in 2050 according to SFSO scenario A[1]; scenario B puts it higher (8.4 million) after a steady increase, whereas scenario C posits an early *decline* (from 2002) falling to just 5.9 million by 2050, thus returning to its mid-1960s value.

Demographic growth (Figures 1.2 and 1.3) since the mid-19th century has not proceeded at a uniform pace: rapid during the periods 1890-1910 and 1945-1970, with average annual rates of around + 1.2%, slower from 1860 to 1880 and between the two world wars (+ 0.5% over the period 1920-1945), *negative* population growth has occurred only in certain very specific years: in 1918 (- 0.4%) because of the very high *mortality* caused by the flu epidemic; from 1975 to 1977 (- 0.6% in 1975 and 1976, – 0.1% in 1977) because of high surplus *emigration*. Conversely, the growth rate was exceptionally high in 1961 (+ 2.7%) and, to a lesser extent, in 1962 (+ 2.3%) and 1963 (+ 1.9%), particularly as a result of surplus *immigration*.

Net migration

Barring exceptional circumstances – such as 1918 – irregular annual population growth is far more attributable to net migration with other countries than net natural population change, i.e., the balance of births and deaths.

Relative net migration, averaging + 1.2 per thousand since 1860, was *negative* from 1872 to 1930 apart from in the economic boom period of 1888 to 1910: Switzerland has long been a country of *net emigration*. But, since the end of the Second World war, Switzerland's net migration (averaging + 3.7 per thousand during the period 1946-1996) has been almost continuously positive, the only notable exceptions occurring in the years 1970 and 1975 to 1977.

In five years only was relative net migration significantly higher than that of surrounding years: 1961 to 1963 (+ 18, + 15 and + 10 per thousand, respectively), 1990 (+ 8 per thousand) and 1991 (+ 9 per thousand); in two, relative net migration was significantly less: 1975 and 1976 (- 9 per thousand). In 1995, relative net migration was + 3.5 per thousand. SFSO scenarios A, B and C project a very slight net migration surplus by 2050 (between 0 and + 0.5 per thousand).

[1] In the figures showing the results of Swiss Federal Statistical Office (SFSO) scenarios A, B and C by 2050, the clear field shows the interval between scenarios A and B, the dark field that between scenarios A and C.

During the half-century from January 1, 1946 to December 31, 1995, the algebraic sum of net migration was just over one million (1.06 million). But the effect of this net immigration on current population size considerably exceeds this total, because, while deaths of migrants must be subtracted from it, births to those migrants must be added to it, and these are comparatively high due to a markedly younger age distribution than that of the Swiss population.

Working on the assumption of *identical* annual fertility and mortality between migrants and non-migrants of the same sex and age from 1946 to 1995, a rough estimation can be made up to January 1, 1996 of the population resident in Switzerland on January 1, 1946 as it *would have* developed with *zero* net migration each year at each age, but with the annual fertility and life tables *actually* observed. This approximation, which *understates* the migration effect because migrant fertility is higher than that of nationals, gives a population of 5.23 million instead of the 7.06 actually observed. The effect of migration over the fifty years 1946-1995 has thus been to increase the country's population by (at least) 35%. For the generation born in 1960 (aged 35 completed years on January 1, 1996), the increase rises to 60% for males and females alike (Figures 1.4 and 1.5). Note that migration checked the increase in ageing of the population (see the lower pyramid of figure 1.5).

The effect of migration in the fifty preceding years (7.06 – 5.23 = 1.83 million) on Switzerland's population size at January 1, 1996 breaks down algebraically into two almost equally important *positive* elements: the algebraic sum of annual net balances for the period (1.06 million, predominantly females aged around 20, males aged around 30: see the upper part of figure 1.4) and total births to these migrants (0.90 million additional births in Switzerland), and one *negative* element: total deaths of migrants or children of migrants (0.13 million additional deaths in Switzerland).

The lower part of figure 1.4 shows the effect of migration in the period 1946-1975 on the age structure of the population at January 1, 1976, each generation being classed by age in completed years at January 1, 1996, while the upper curve shows the complete fifty year migration effect on the population at January 1, 1996. This makes clear the effect of *return* migration between 1976 and 1995 for the cohorts aged 50 and over on January 1, 1996.

Crude rate of natural increase, birth and death rates

The *crude rate of natural increase* (figure 1.3), which averaged + 6.5 per thousand between 1860 and 1996, was below average in 1870-1871, from 1915 to 1941 (except 1921-1923) and *constantly* since 1971; in 1995, it was + 2.3 per thousand. SFSO scenarios A, B and C project a continued decline in the crude rate of natural increase, bringing it by the middle of the next century to - 2.5 per thousand in scenario A, + 0.5 and - 7.5 per thousand in scenarios B and C.

The *crude birth rate* of around or over 30 per thousand of population in the 1870s declined virtually throughout the 20th century, the most rapid decreases being those of 1901-1917 (from 29 to 18 per 1000), 1920-1937 (from 21 to 15 per 1000) and 1965-1978 (from 19 to 11 per thousand). The periods during which the crude birth rate increased are chiefly 1940-1945 (from 15 to 20 per 1000) and 1954-1964 (from 17 to 20 per 1000). In 1995, it fell to 12 per thousand. SFSO scenarios A, B and C project a continuing but slowing decline, the 2050 values being 10, 11 and 8 per thousand, respectively.

The *crude death rate* has declined far more regularly than the crude birth rate since 1861, the only notable exception being in 1918 – the year of the Spanish influenza epidemic. Around 1870, it was about 25 per thousand of population. In the following fifty years, it fell sharply, standing at just 13 per thousand in 1921. The rate of decline slowed thereafter, bringing it to 9 per thousand by the end of the 1970s, where it has more or less remained ever since.

Significantly, despite the ageing of the population, the crude death rate has never increased in the past: the increase in the crude death rate which the ageing of the population should bring has been more than offset by the downward pressure of increased average life expectancy. This will probably not hold true in the future: SFSO scenarios A, B and C all project an increase to 12, 10.5 and 15.5 per thousand by 2050.

SFSO scenarios A, B and C for 2050

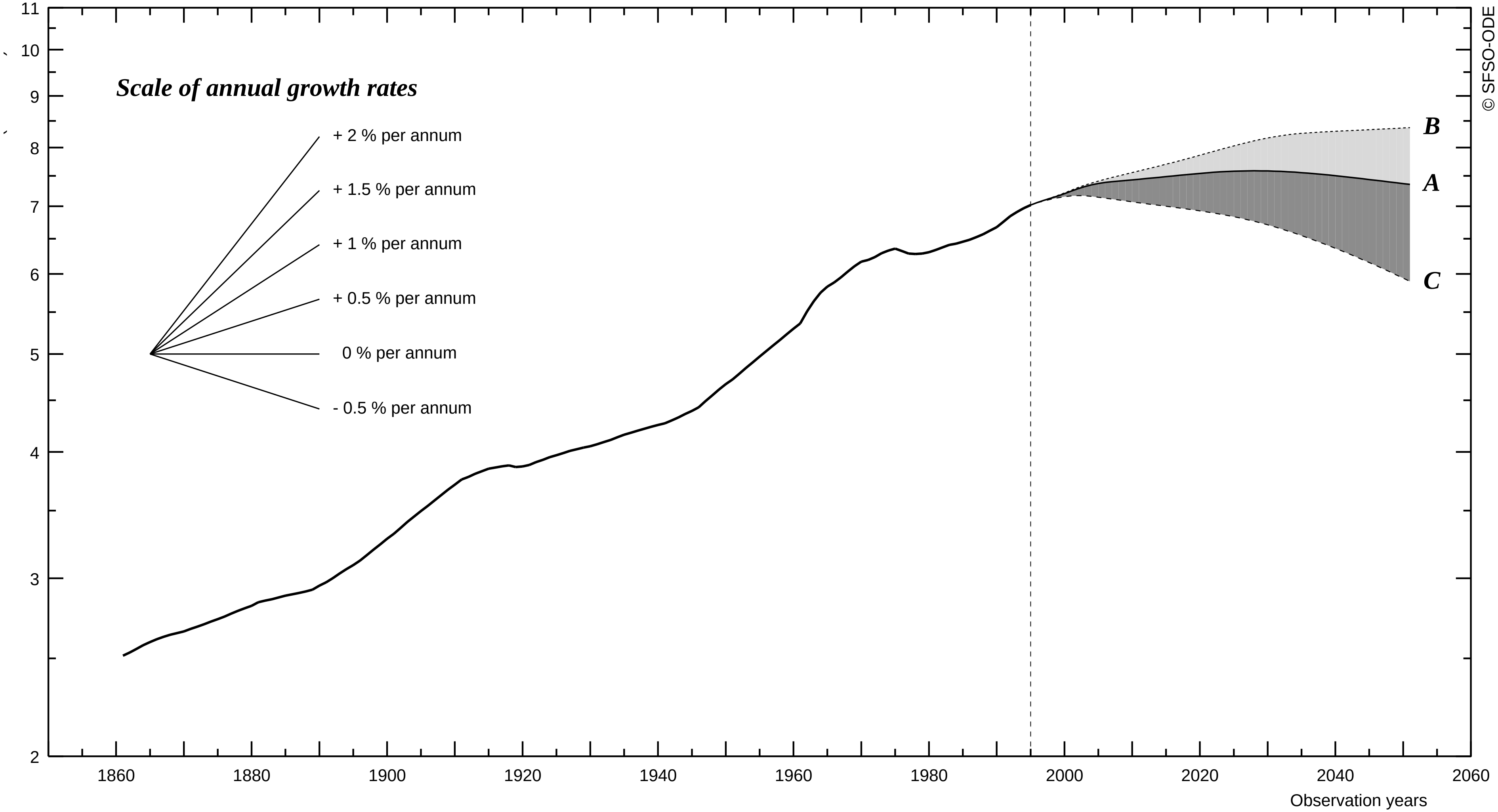
The Swiss Federal Statistical Office regularly publishes scenarios of Swiss population trends based on consistent and plausible pre-defined assumptions about fertility, mortality and migration. The last such projections were made in 1995.

The SFSO does not map out a single age-sex specific forecast for the resident population, but rather several alternative scenarios based on a mix of alternative hypotheses. The three scenarios referred to in this publication are set in different economic and political contexts:

- Scenario A – the *trend* scenario – assumes moderate economic growth and negotiations with the European Union leading to the introduction of freedom of movement for persons between Switzerland and the European Economic Area from 2000. The population process would not be disturbed by any economic or demographic shock (high migration pressure for example). This is regarded as the most plausible scenario, at least in the medium term.
- Scenario B – the *positive dynamics* scenario – postulates a greater economic and social opening-up, leading to more sustained population growth than scenario A.
- Scenario C – the *negative dynamics* scenario – posits a significantly less vigorous population process than scenario A, with very low fertility and population expansion checked by increasing longevity.

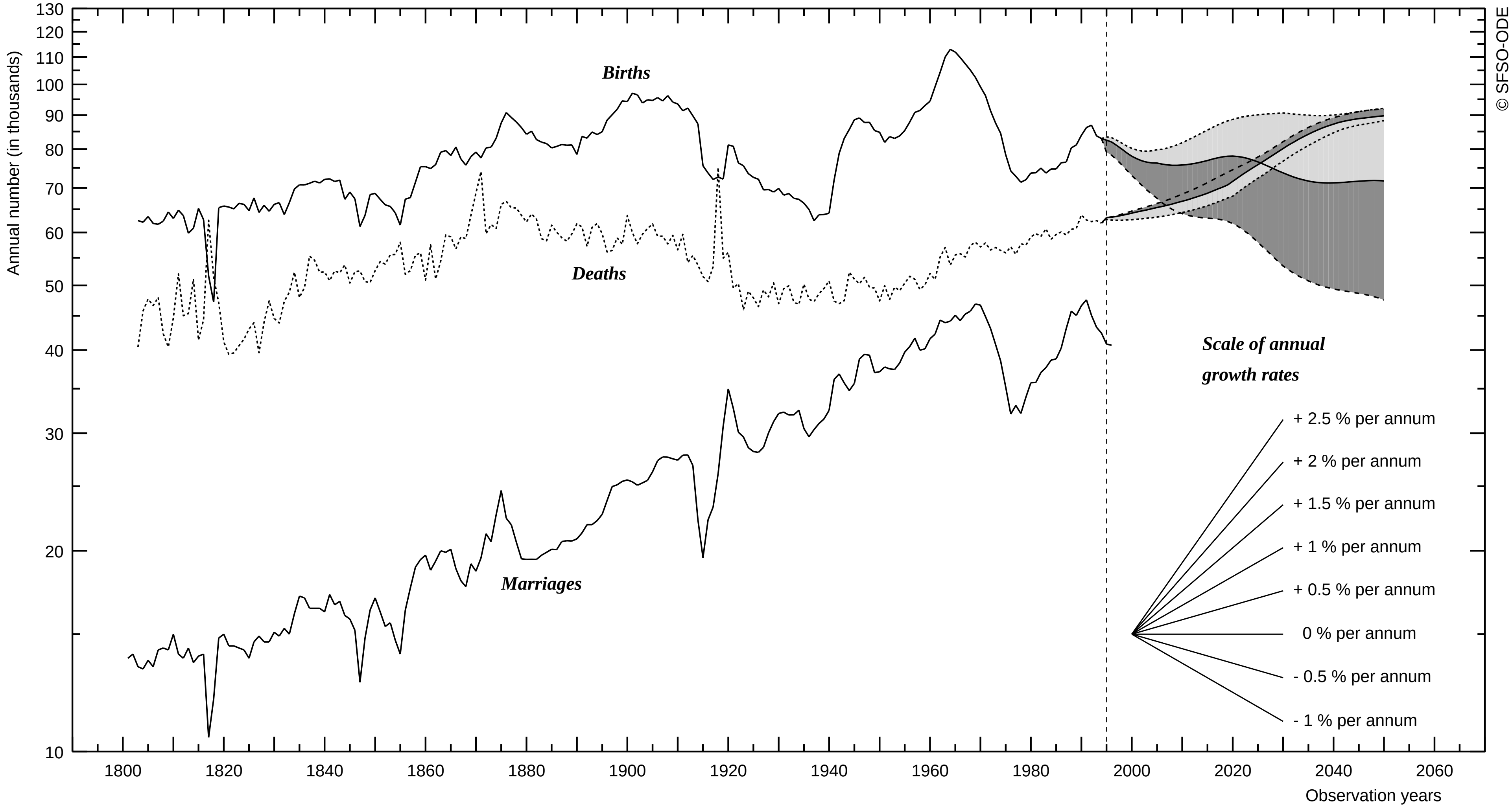
Interested readers can find more detailed information on both the assumptions and the results of the various scenarios in the SFSO publication "Les scénarios de l'évolution démographique de la Suisse, 1995-2050", Office Fédéral de la Statistique, Berne, 1996.

Figure 1.1 SWITZERLAND, 1860-2050
Total POPULATION SIZE at January 1 of the year
SFSO A, B and C scenarios from 1995
Logarithmic ordinate scale



The logarithmic ordinate scale shows the relative changes: the annual rate of population growth is constant when the curve varies linearly

Figure 1.2 SWITZERLAND, 1800-2050
Annual numbers of births, death and marriages since 1800
SFSO A, B and C scenarios from 1995
Logarithmic ordinate scale



The logarithmic ordinate scale shows the relative changes

Figure 1.3 SWITZERLAND, 1861-2050
SFSO A, B and C scenarios from 1995
Annual RATE of CHANGE of total POPULATION SIZE
Crude rate of NATURAL INCREASE and relative net MIGRATION
Crude birth and death rates

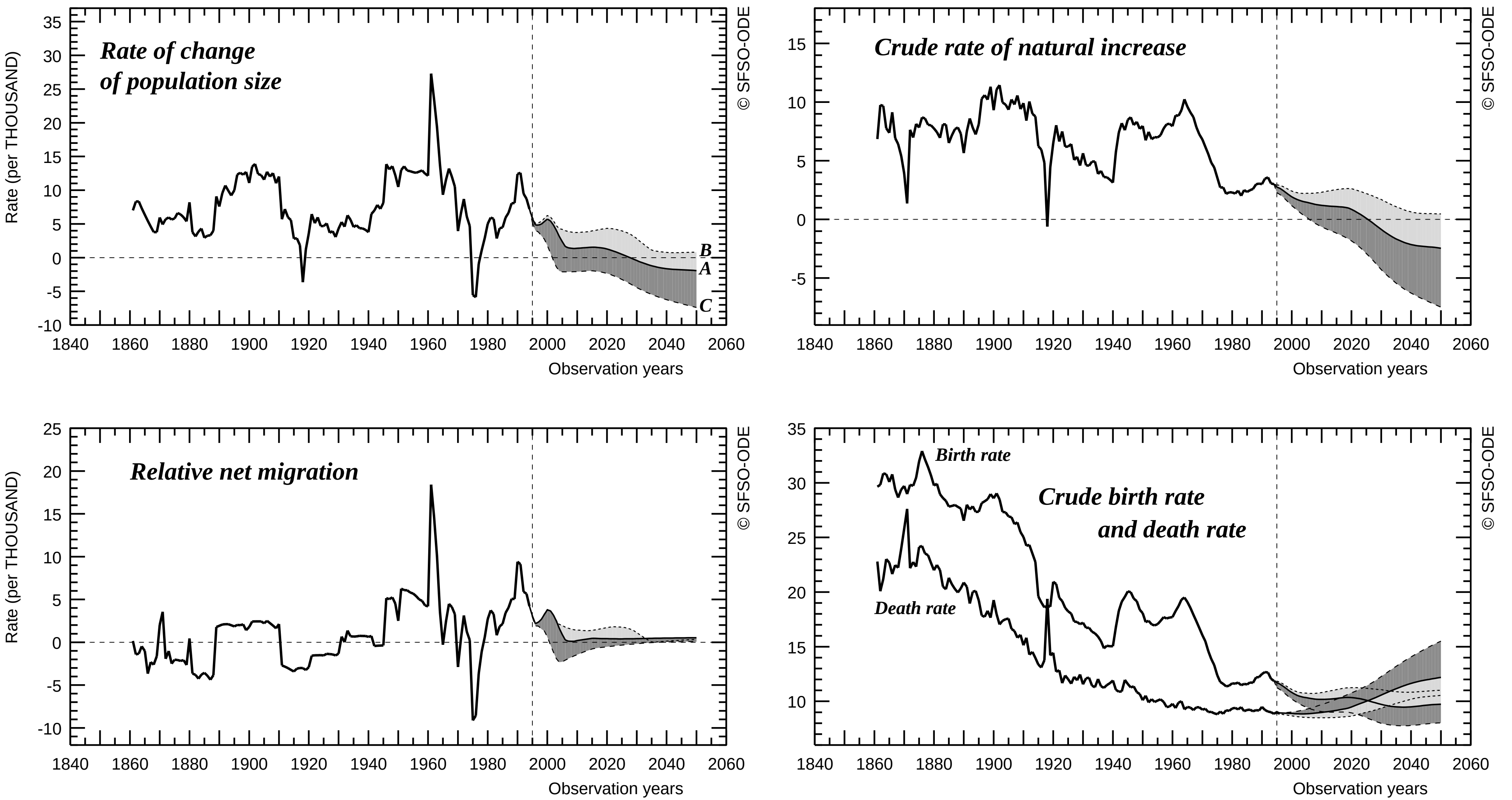


Figure 1.4 SWITZERLAND, Migration, 1946-1995
Upper part: Age-sex-specific cumulative net migration in the period
Lower part: Estimated increase in each age group
resulting from migration, assuming that migrants and non-migrants
of the same sex and age had identical fertility and mortality each year of the period

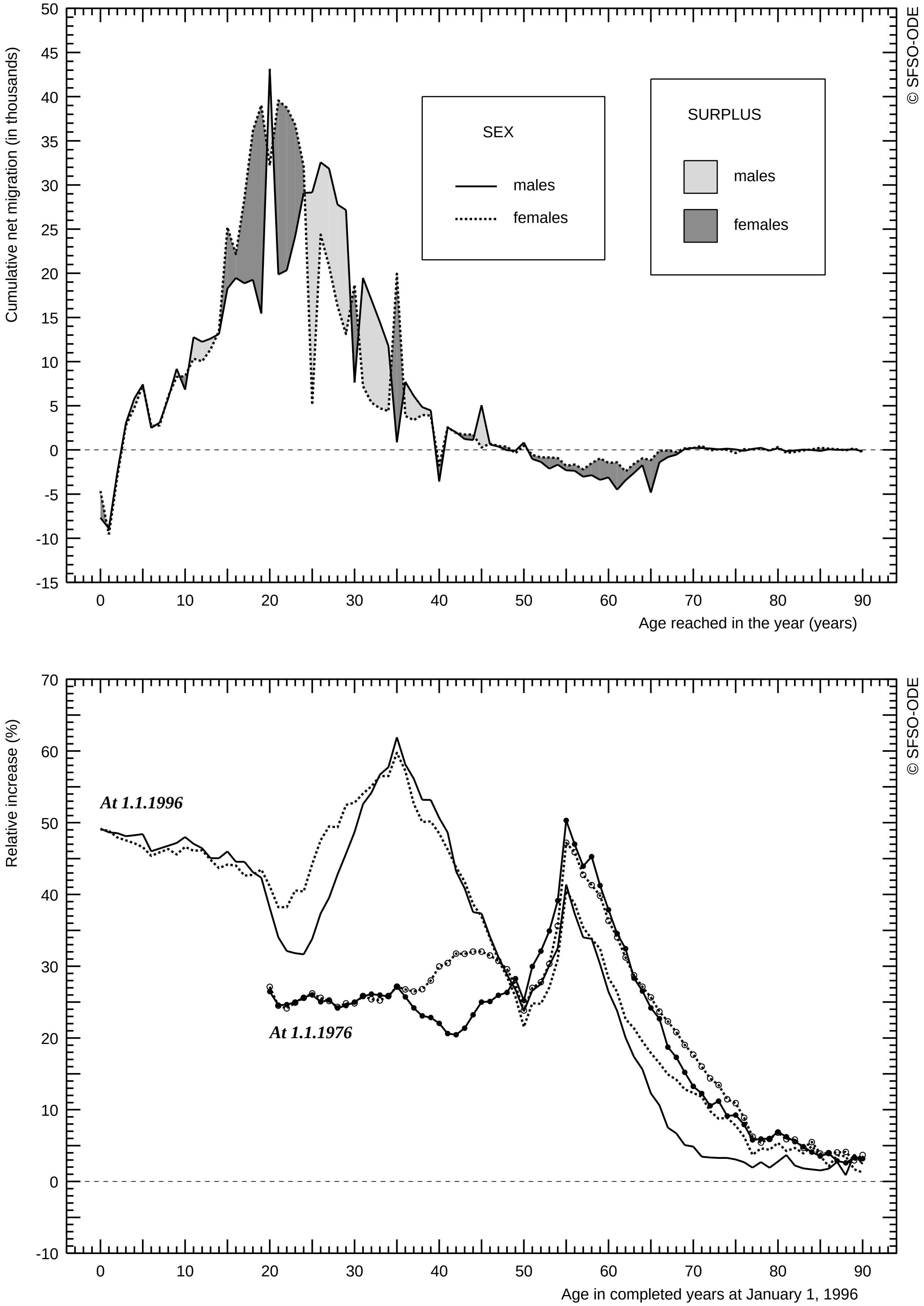
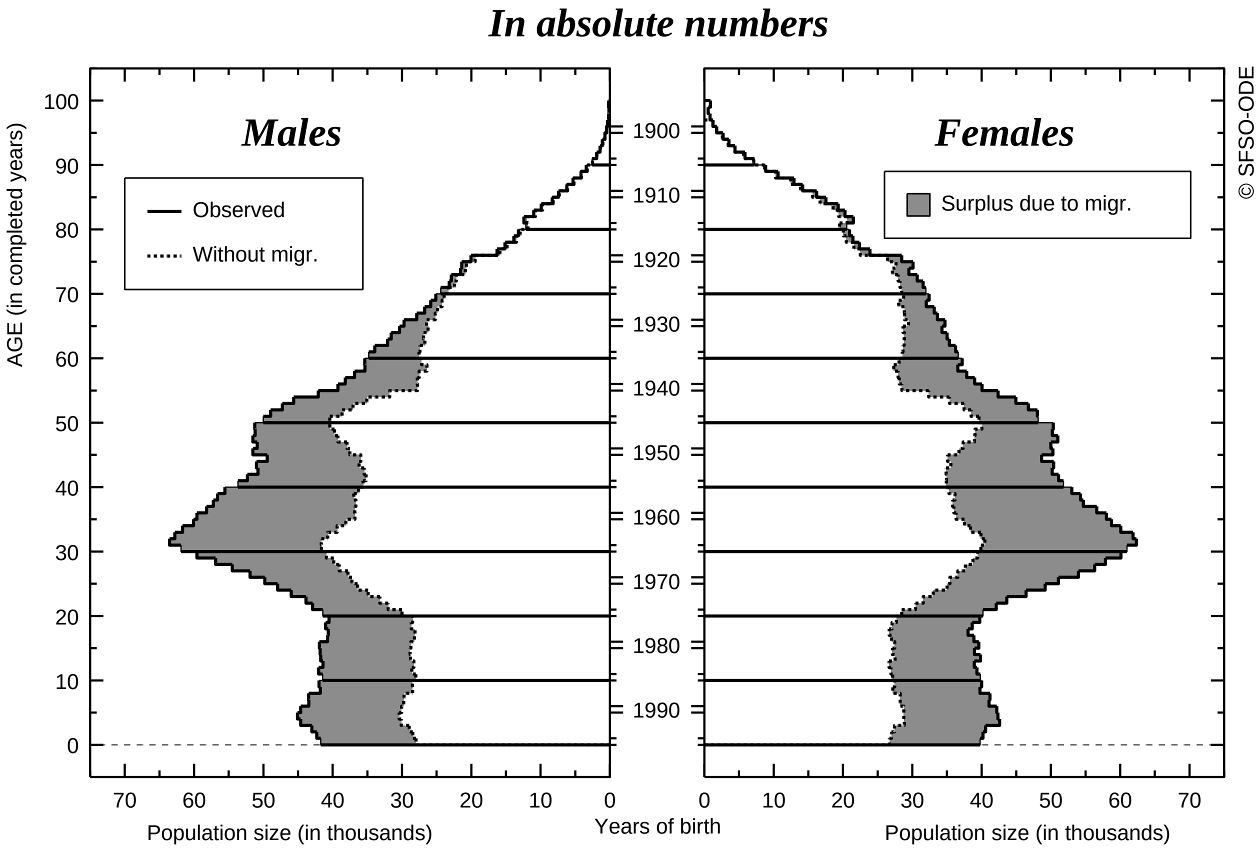
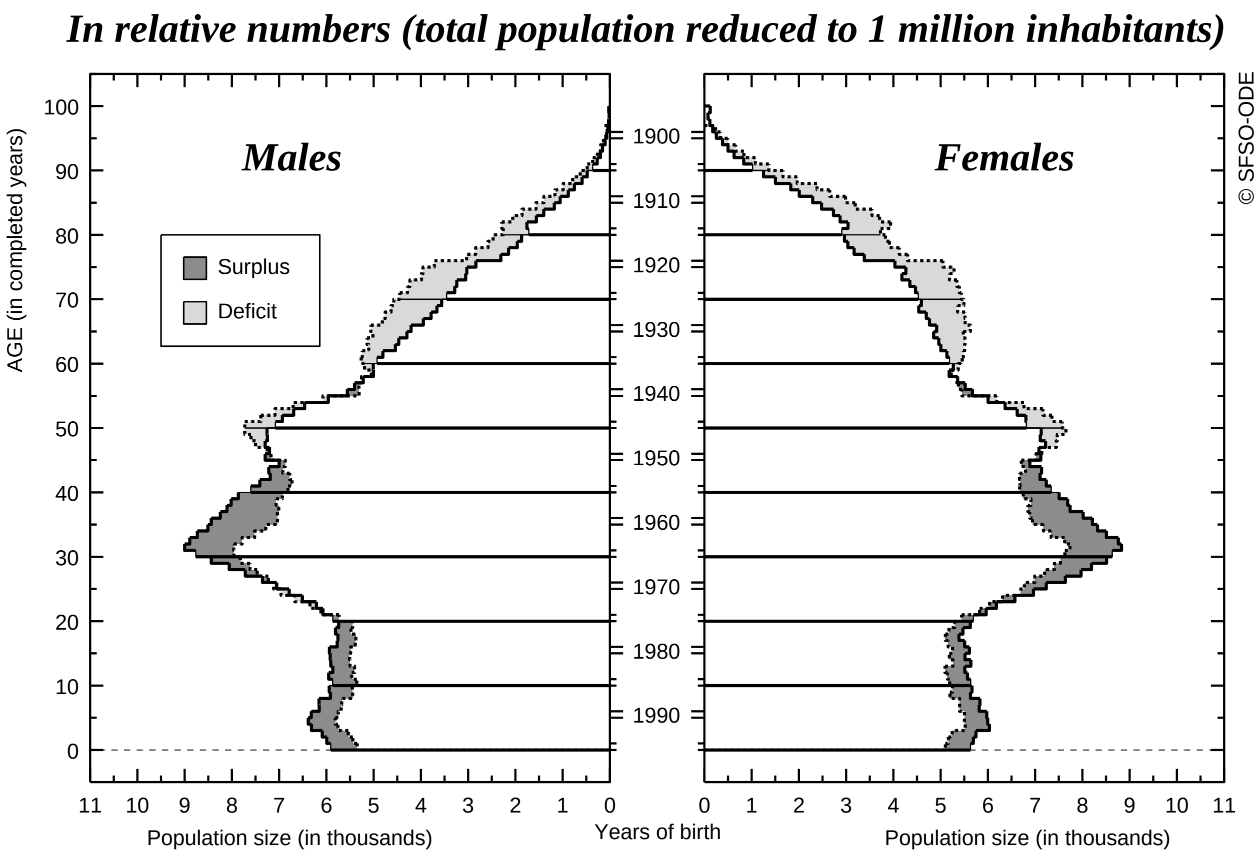


Figure 1.5 SWITZERLAND, January 1, 1996
Observed age-sex structure and age-sex structure that would have been observed with no migration since 1946
assuming identical fertility and mortality, each year,
between migrants and non-migrants of the same sex and age





Chapter 2: Age-sex structure of the population

An ageing population that will continue to grow older

The age structure of the population has gradually changed since the mid-19th century. Switzerland has an *ageing population*: the proportion of young people has declined, marked by the contracting base of the population pyramid, while that of older people has increased (Figure 2.1). The future age pyramids (Figure 2.2) tend to be formed, as one moves up the age scale, by fairly constant age groups up to the age of 80, declining rapidly thereafter.

Exceptional birth rate and net migration levels also leave their mark on the later population structures for several decades after. So, in the age structures from the 1970s to 2010, the largest generations are the 1965 cohorts, when Switzerland's birth rate was high, but also when a significant number of immigrants were born (abroad).

Figure 2.3 shows the trend in four broad age groups: under 20, 20-64, 65 and over, under 50. Overall, the size of the under-20 population has changed relatively little since the mid-19th century. The increase in the 20-64 age group broadly tracked that of the total population, rising more or less threefold from 1.55 to 4.4 million people between 1890 and today. But that of the 65 and over age group multiplied sevenfold, from 0.15 to 1.06 million.

In the future, even assuming a population increase (SFSO scenario B), the under-50 age group will remain more or less its present size, while the size of the 65 and over population will continue to increase rapidly up to 2030 (1.06 million now, 1.78 to 1.86 million in 2030 in SFSO scenarios).

Figure 2.4 is similar to figure 2.3. but shows the trend in the *percentage* of the total population instead of the *total number*. The general trend towards ageing is very clear: a decline in the proportion of young people (under 20) *offset almost exactly* by the increase in the proportion of older people (65 and over), the central age group (20-64) representing a constant 55 to 60% of the total population at all times.

The changes in the population age structure became perceptible only around 1910: prior to that, the age structure had remained fairly invariant. The ageing of the population – the product of a long-term decline in fertility and mortality – is therefore a process that has been going on for approximately eighty years. It is not a new phenomenon, therefore, but will undoubtedly see a significant increase when the 1940 to 1970 baby boom birth cohorts reach 65.

A rapid increase in the number of elderly and especially very elderly

The general characteristic of the ageing population is that the increase in the older population has been and will be more rapid in the higher age groups.

Figure 2.5 shows the population changes in age groups 60 and over, 65 and over, ..., 95 and over. The number of very elderly in particular is rising at an extremely rapid pace: from 1930 to 1995, the size of the 60 and over group being multiplied by 3.3, that of the 70 and over group by 4.9, that of the 80 and over group by 10, that of the 90 and over group by 24, that of the 95 and over age group by 35.

While there is no doubt that the health of the coetaneous population has improved considerably since 1930 and will continue to do so in the future, these rates of increase in the oldest old population will in all likelihood entail a rapid increase in the number of the *dependent* elderly.

By 2050, the size of the 60 and over age group will have multiplied by 1.6 according to SFSO scenario A (1.8 and 1.5 in scenarios B and C), that of the 70 and over age group by 2.0 (2.2 and 1.7), that of the 80 and over age group by 2.7 (3.1 and 2.2), that of the 90 and over age group by 4.3 (5.7 and 3.1), that of the 95 and over age group by 5.0 (8.1 and 3.0).

An increasing ageing amounting to twenty year between 1910 and 2050

The degree of ageing of the population around a given age over a period can be quantified by determining the age which, at the *end* of the period, divides the population into two parts (older and less old) *identically* to the relevant age at the *beginning* of the period. It can, for example, be said that the age of 37.5 in 1910 and the age of 50 in 1995 are equivalent because the proportion of the total population above age 37.5 in 1910 is the same (31.2%) as that above age 50 in 1995. In other words, the age above which 31.2% of the total population are found rose from 37.5 to 50 between January 1, 1910 and January 1, 1995, i.e., over a period of 85 years, an ageing of 12.5 years occurred at what is now age 50.

Figure 2.6 shows the trend from 1861 to 2051 of the equivalent ages of 50, 55, 60, ..., 95 at January 1, 1995. Around what are ages 50, 60 or 70 today, an ageing of 22 years occurs over the 140 year period between 1910 and 2050. Around age 80 today, it is still 19 years, around 90 it is 15 years, around 95 it is 11 years.

The effect of ageing on the working/pen-sio-nable age population balance

Figure 2.7 (left-hand side) shows the trend from 1861 to 2051 of the equivalent age of 60 in 1995 within the population *aged 20 and over*. This age is that which divides the population aged 20 and over into two sizes of the same ratio as does the age of 60 at January 1, 1995. The right-hand side of this figure refers to the age of 65 rather than 60.

In a very simplified model of a pay-as-you-go pension system, where *all* those – but only those – in an age bracket between age 20 and age *x* were working, and where all those – but only those – aged *x* or over were retired, age *x* is the age at separation from the labour force (presumed identical for all individuals in the same birth cohort) which preserves an *invariable* ratio between the total pensionable age population and the total working population, that ratio being equal to the value it had on January 1, 1995 with age 60 or 65, respectively[2], as the age at separation from the labour force. Figure 2.7 shows that, to maintain this ratio, the retirement age must be raised by approximately *ten* years by 2040, regardless of whether the current benchmark is taken as 60 or 65 years.

It will be observed that between 1910 and 1995, the equivalent increase was only eight years at age 60 and nine years at age 65. It should be noted that, during the period 1980-1995, the equivalent ages of 60 or 65 at January 1, 1995 varied almost not at all: there was a *pause* in the effect of ageing on the ratio between the working and pensionable age populations, but the reaching of retirement age of the post-1935, and especially post-1940, birth cohorts will have a significant effect on future years.

Gender differentials among the aged and elderly

At present (1997), at all ages below 60, the sex structure of the population is broadly *equal* (Figure 2.8). There is, however, a slight surplus of male infants due to the excess of male births (approximately 105 male to 100 female newborns), then a surplus of females aged 22 to 29 years due to the higher rate of young adult female immigration, followed again by a male surplus in the 30 to 53 age bracket. From age 54, however, the population becomes increasingly predominantly female due to excess male mortality. In the 95 and over age group, there are just 30 men to every 100 women: the oldest old are mostly females.

This pattern has varied little over time (Figure 2.9), although in the latter half of the 19th century, the sex structure was somewhat more equal at all ages. It was from 1920, with the increase in excess male mortality, that the very old population became predominantly female. In future, this feminization phenomenon should occur only at increasingly advanced ages.

[2] Taking age 65 instead of age 60 gives virtually identical results: raising retirement age by ten years offsets the ageing set to occur by 2040 (see right-hand side of figure 2.7).

Figure 2.1 SWITZERLAND. AGE-SEX STRUCTURES
at January 1 of each year from 1861 to 1997
(total population size reduced to 1 million persons)

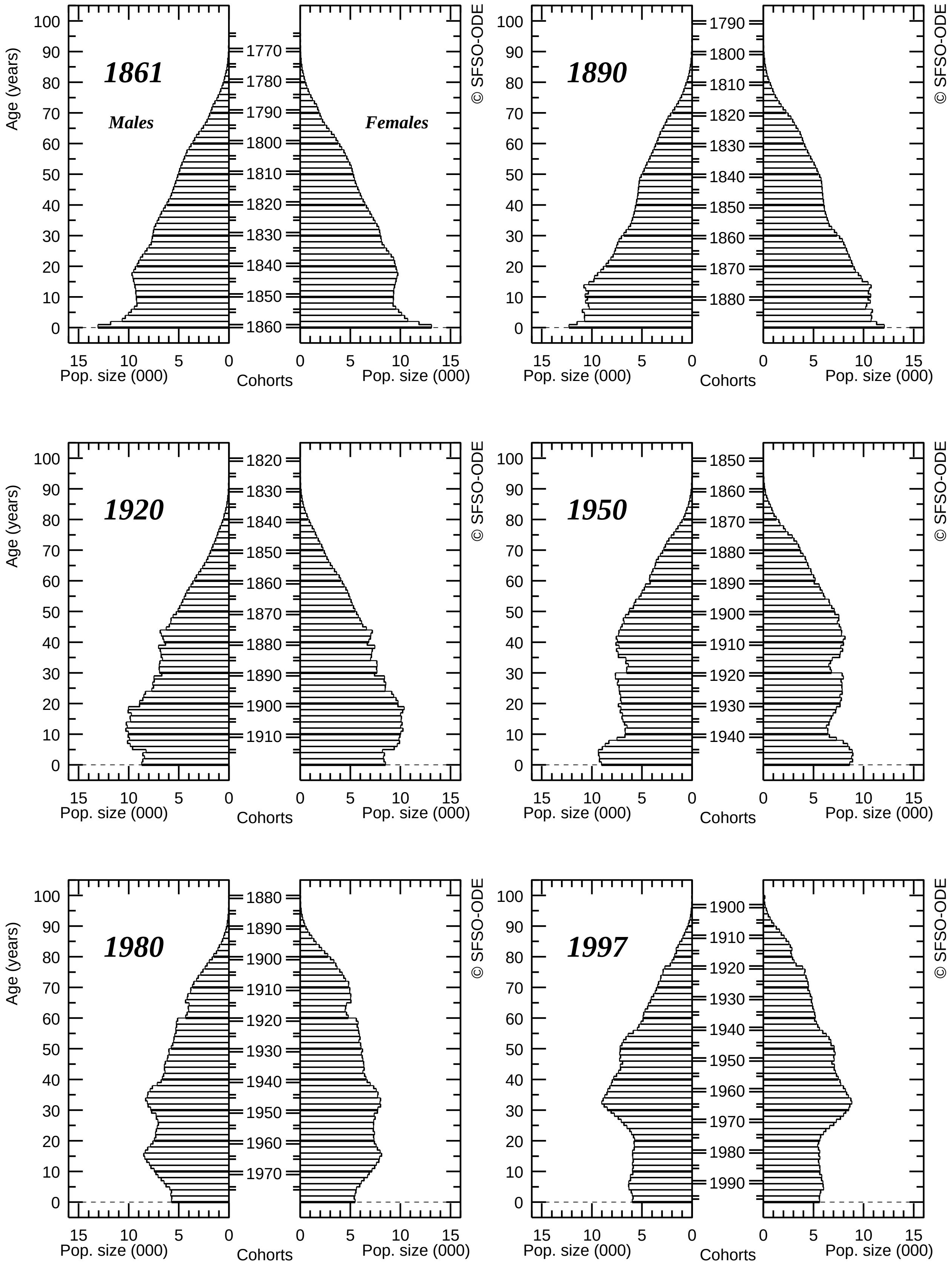


Figure 2.1.A SWITZERLAND. AGE-SEX STRUCTURE at January 1, 1997

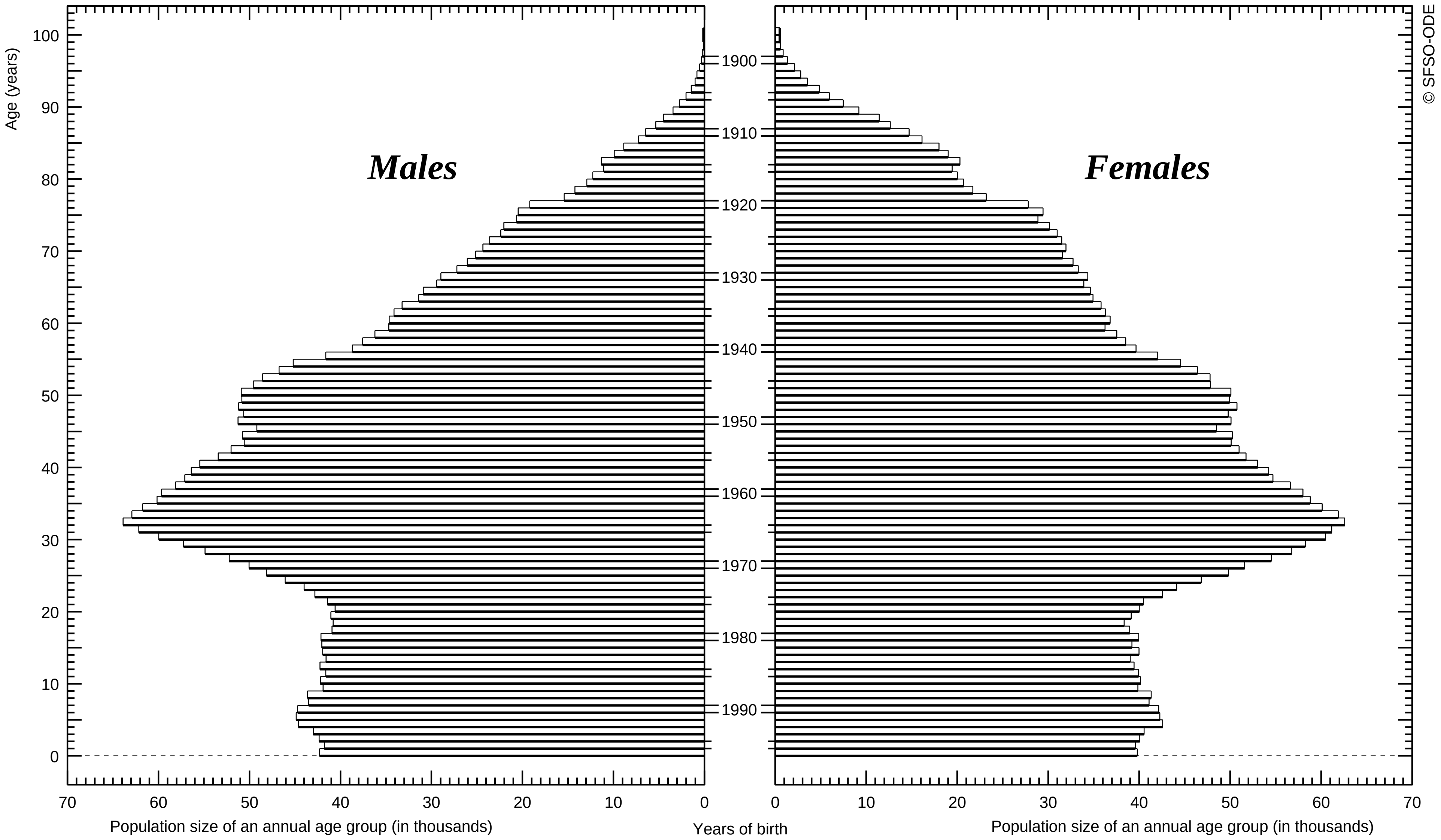


Figure 2.2 SWITZERLAND. AGE-SEX STRUCTURES
at January 1 of each year from 2000 to 2050
(total population size reduced to 1 million persons)
SFSO A, B and C scenarios

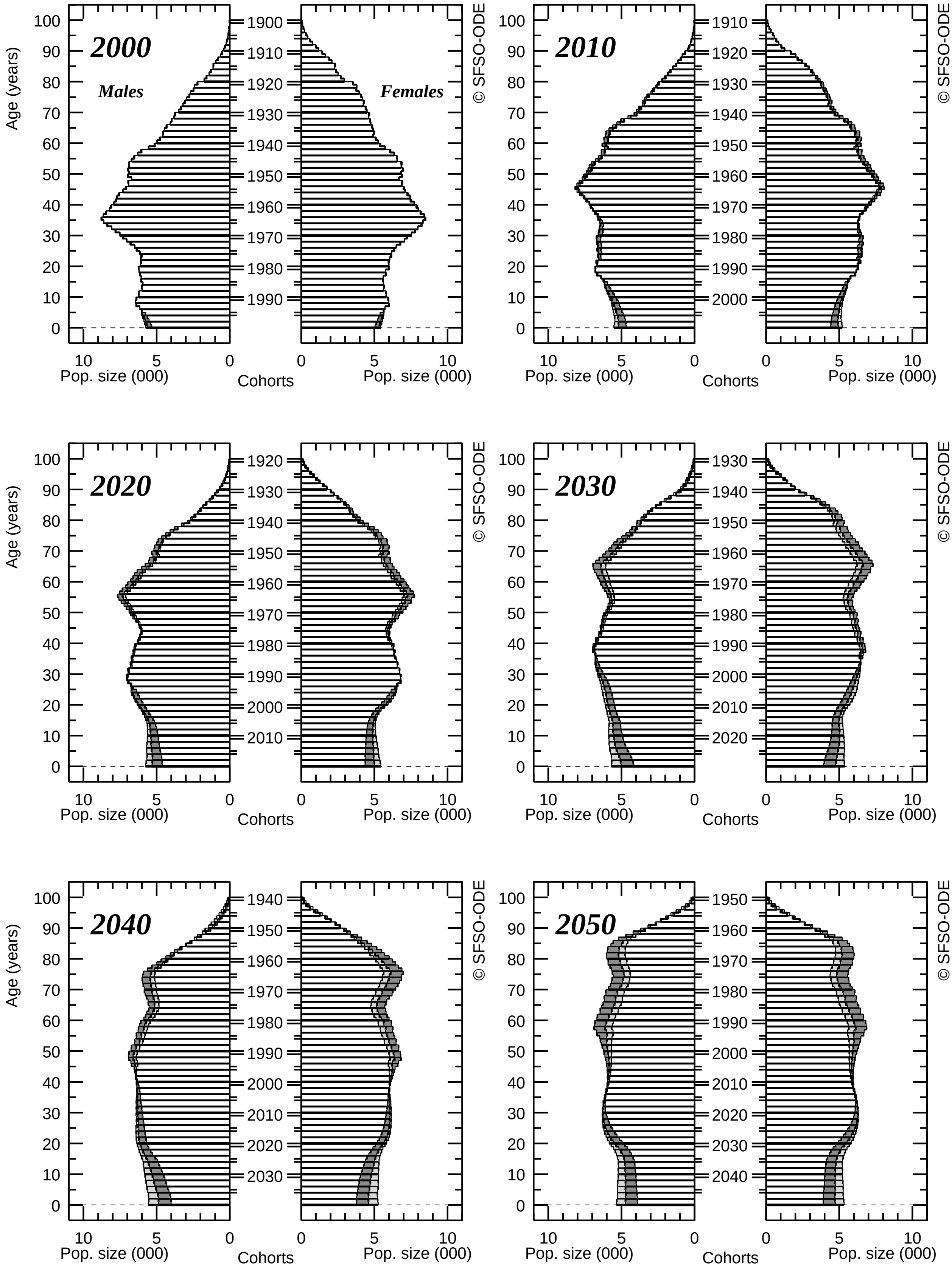
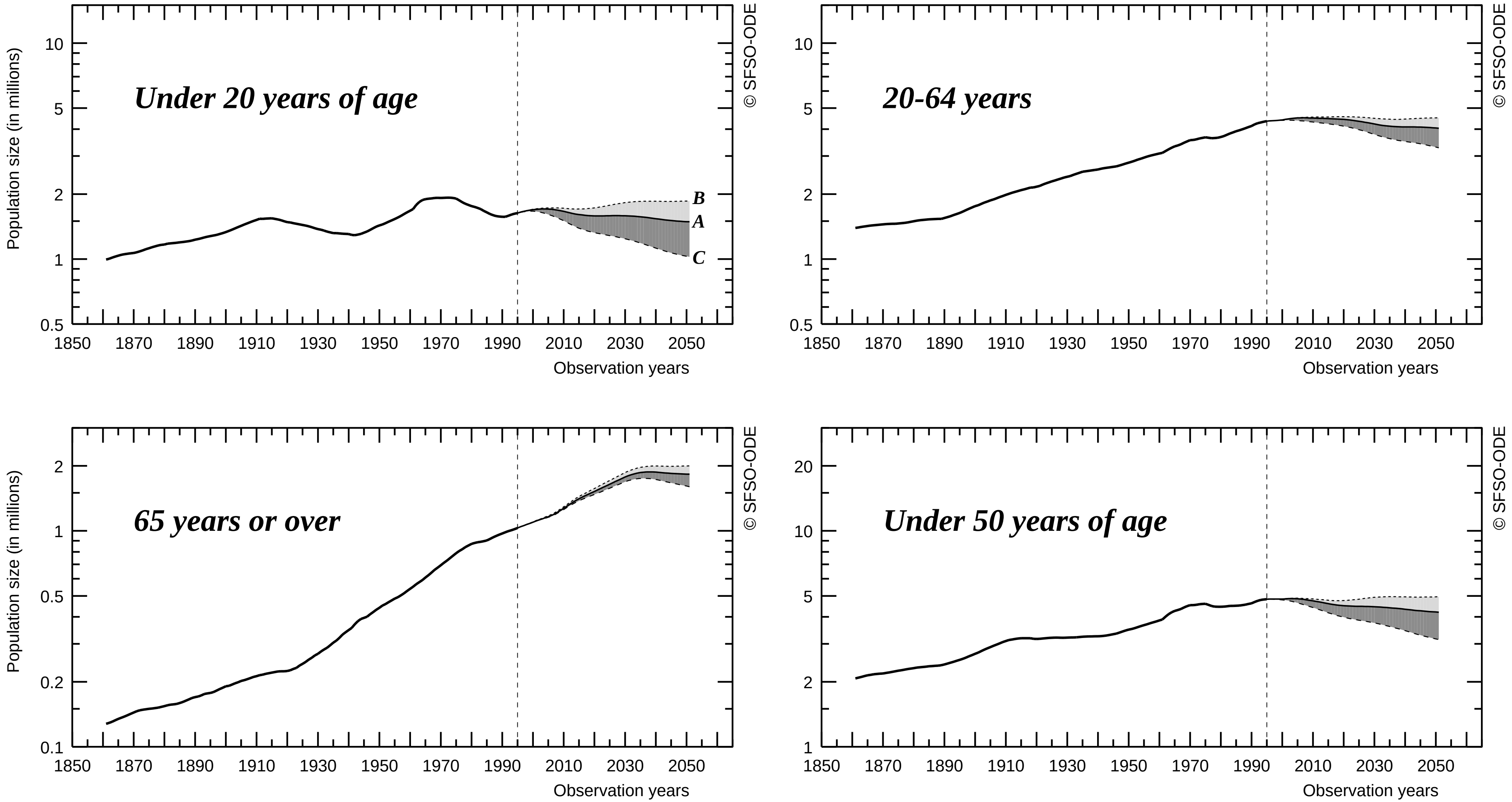


Figure 2.3 SWITZERLAND, 1861-2050
Total POPULATION SIZE by age groups at January 1 of the year
SFSO A, B and C scenarios from 1995
Logarithmic ordinate scales with the same module



The logarithmic ordinate scale shows the relative changes:

the annual rate of increase of the variable represented in ordinates is constant when the curve varies linearly

Figure 2.4 SWITZERLAND, 1861-2050
Development of the composition by age groups of the population at January 1 of the year
SFSO A, B and C scenarios from 1995

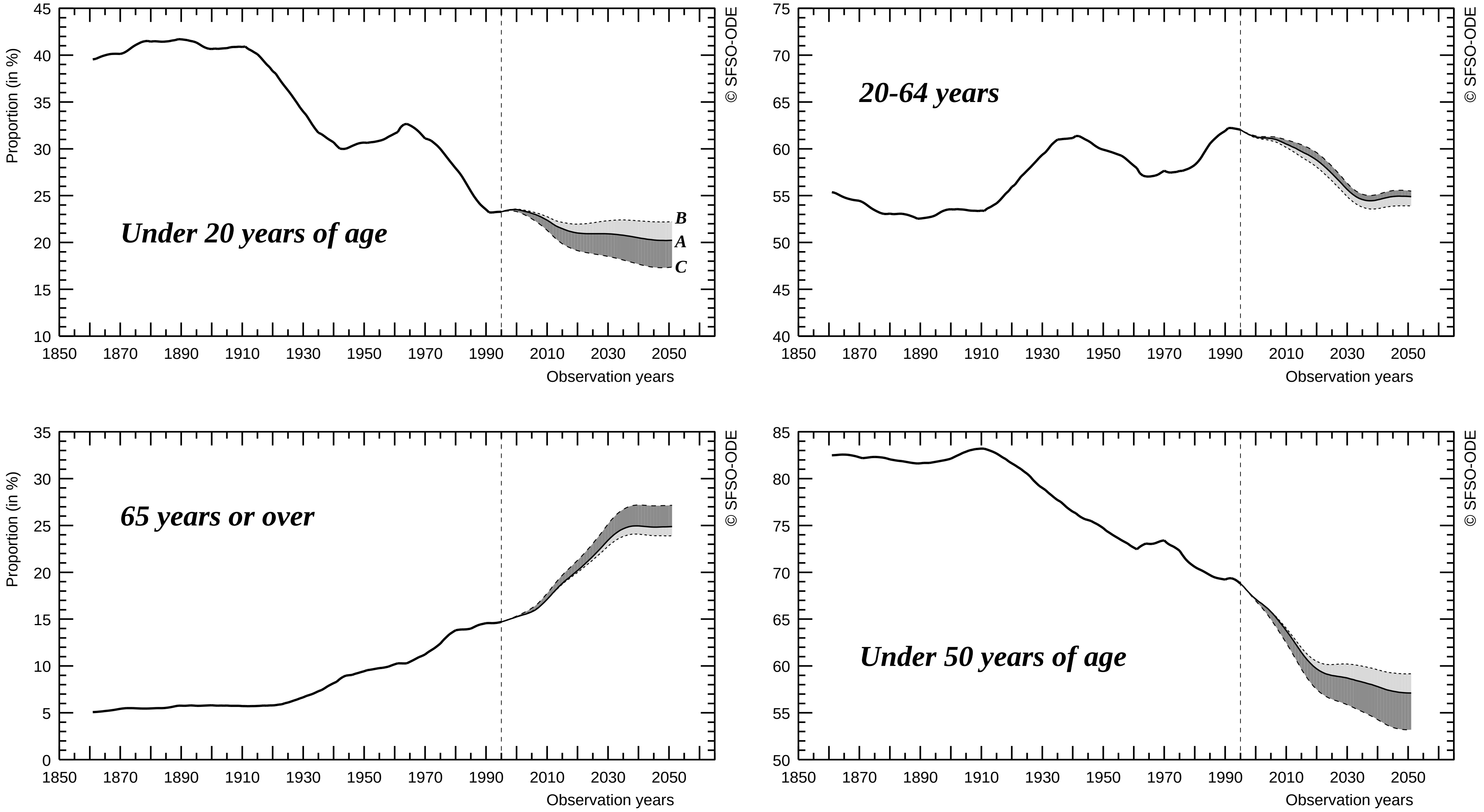
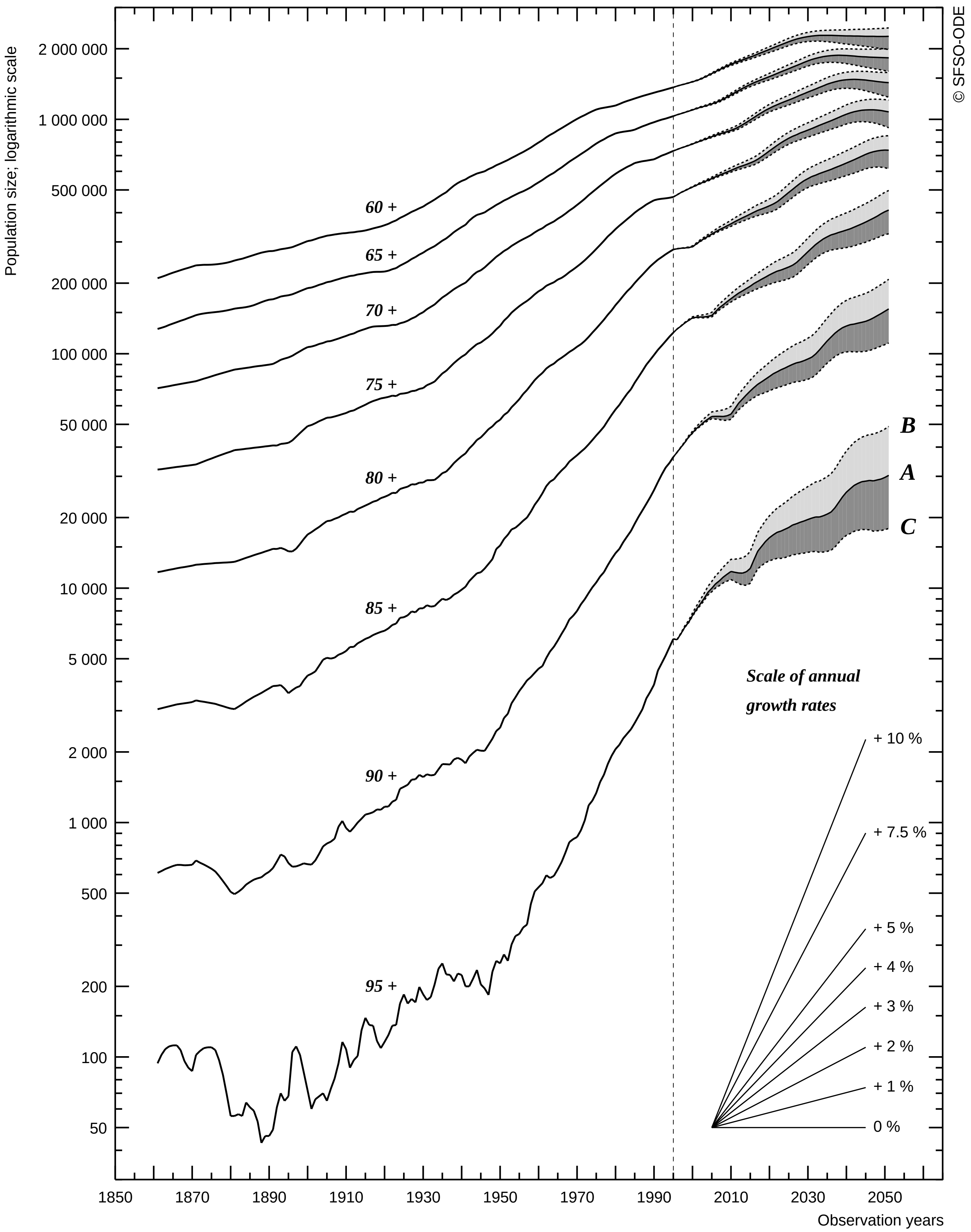
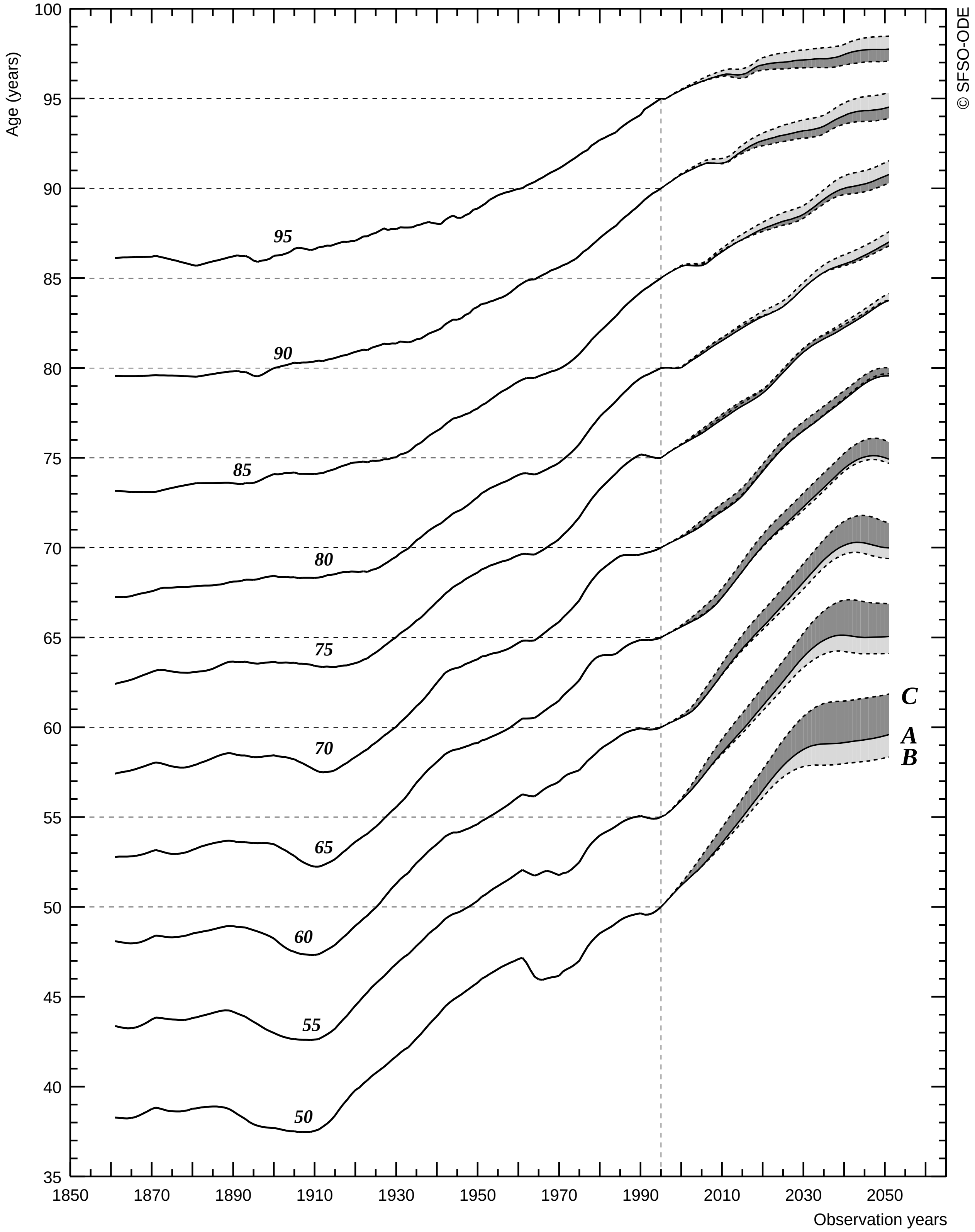


Figure 2.5 SWITZERLAND, 1861-2050. Total POPULATION SIZE of at least that age (60, 65..., 95 years) at January 1 of the year SFSO A, B and C scenarios from 1995



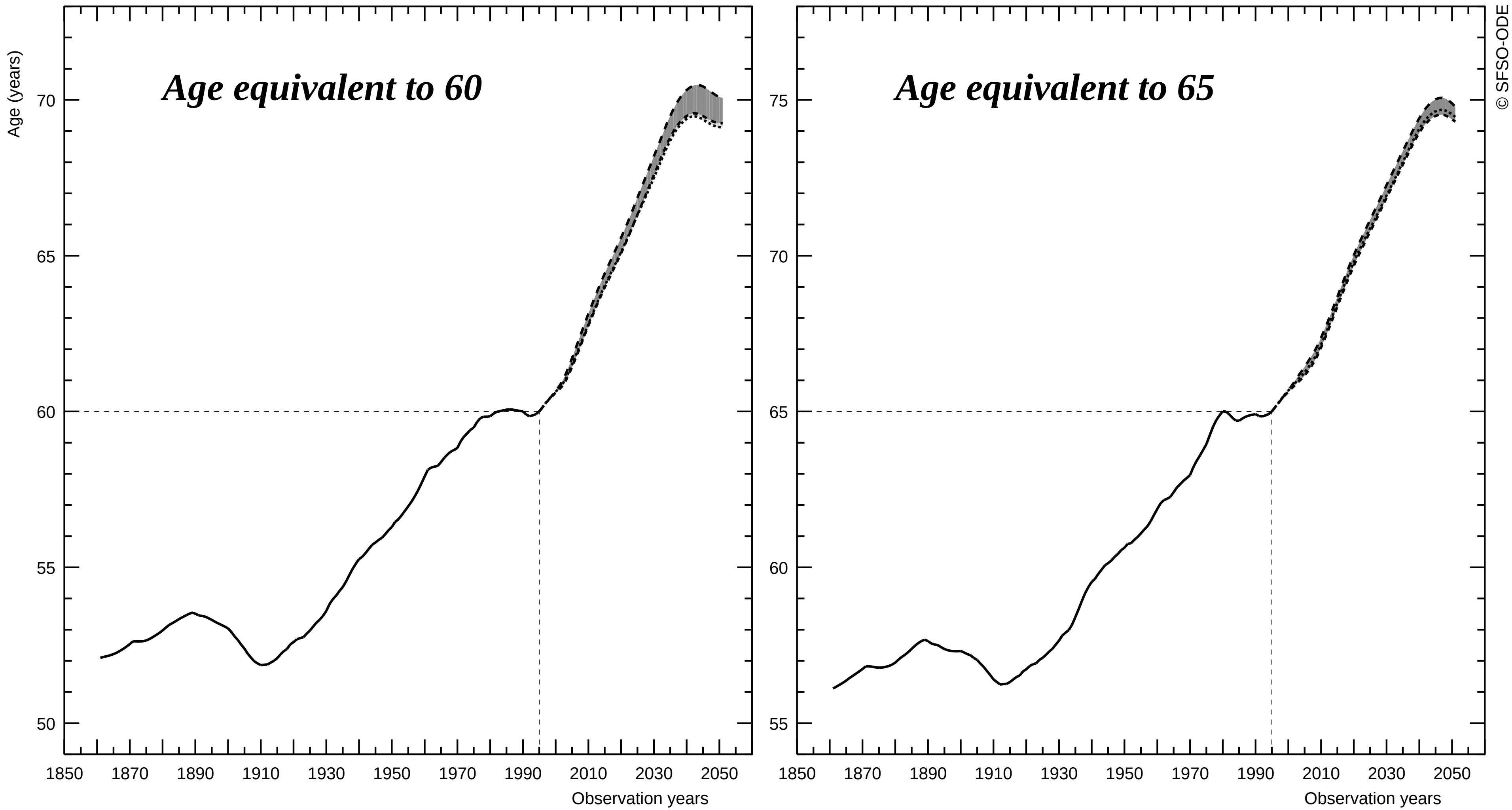
The logarithmic ordinate scale shows the relative changes

Figure 2.6 SWITZERLAND, 1861-2050
Age equivalent to a given age on January 1, 1995
SFSO A, B and C scenarios from 1995



The age of 47.3 on January 1, 1910 is equivalent to 60 years of age on January 1, 1995, because the proportion of persons at least 47.3 years of age on January 1, 1910 is the same (19.5%) as that of persons aged at least 60 on January 1, 1995

Figure 2.7 SWITZERLAND, 1861-2050
Ages within the population aged 20 or over equivalent to 60 and 65 on January 1, 1995
SFSO A, B and C scenarios from 1995



Within the population aged 20 or over, the age of 51.9 on January 1, 1910 is equivalent to 60 on January 1, 1995 because the proportion of persons aged 51.9 or over on January 1, 1910 is the same (25.4%) as that of persons aged 60 or over on January 1, 1995

Figure 2.8 SWITZERLAND. Age distribution of male and female populations at January 1, 1997

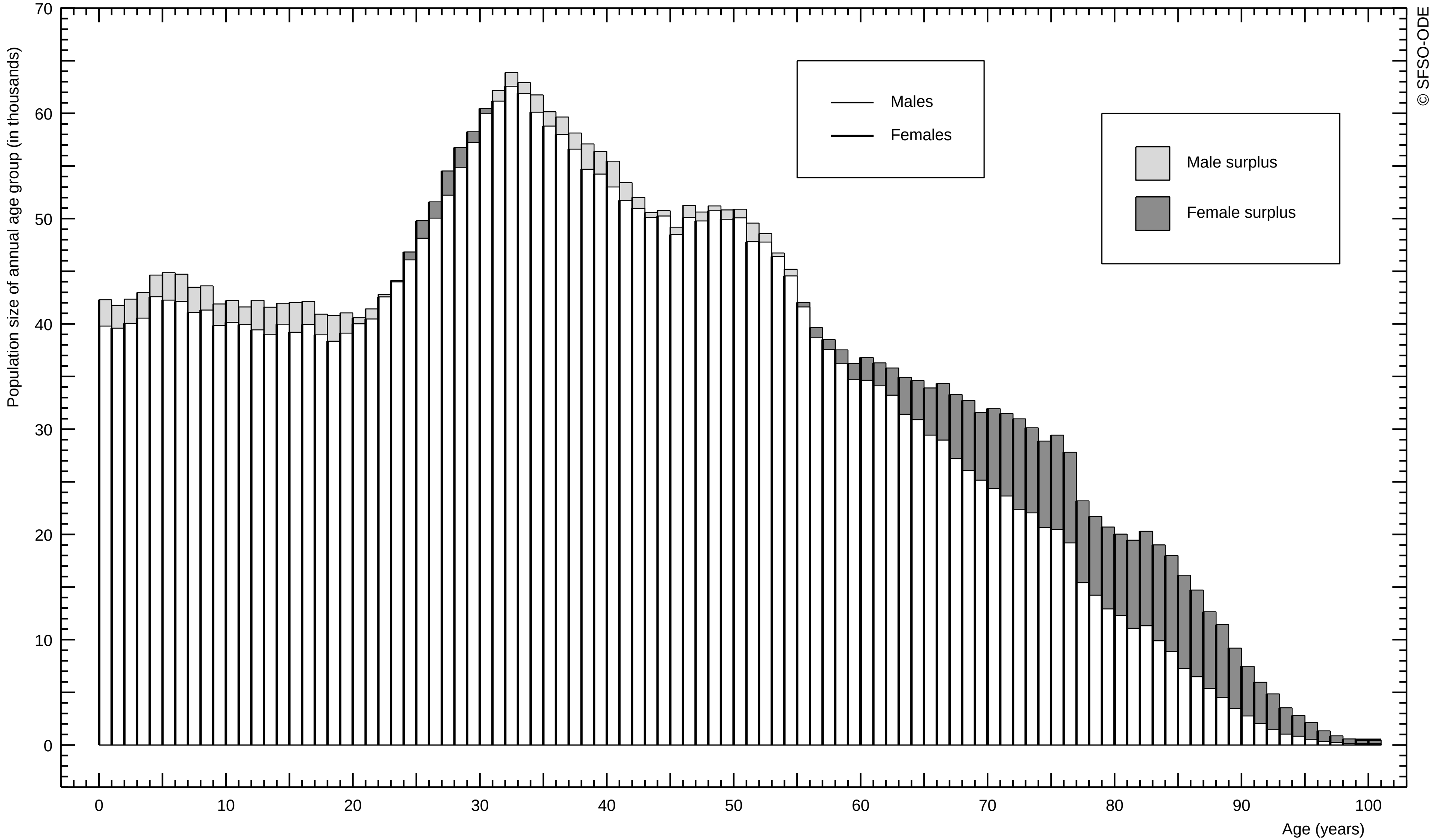
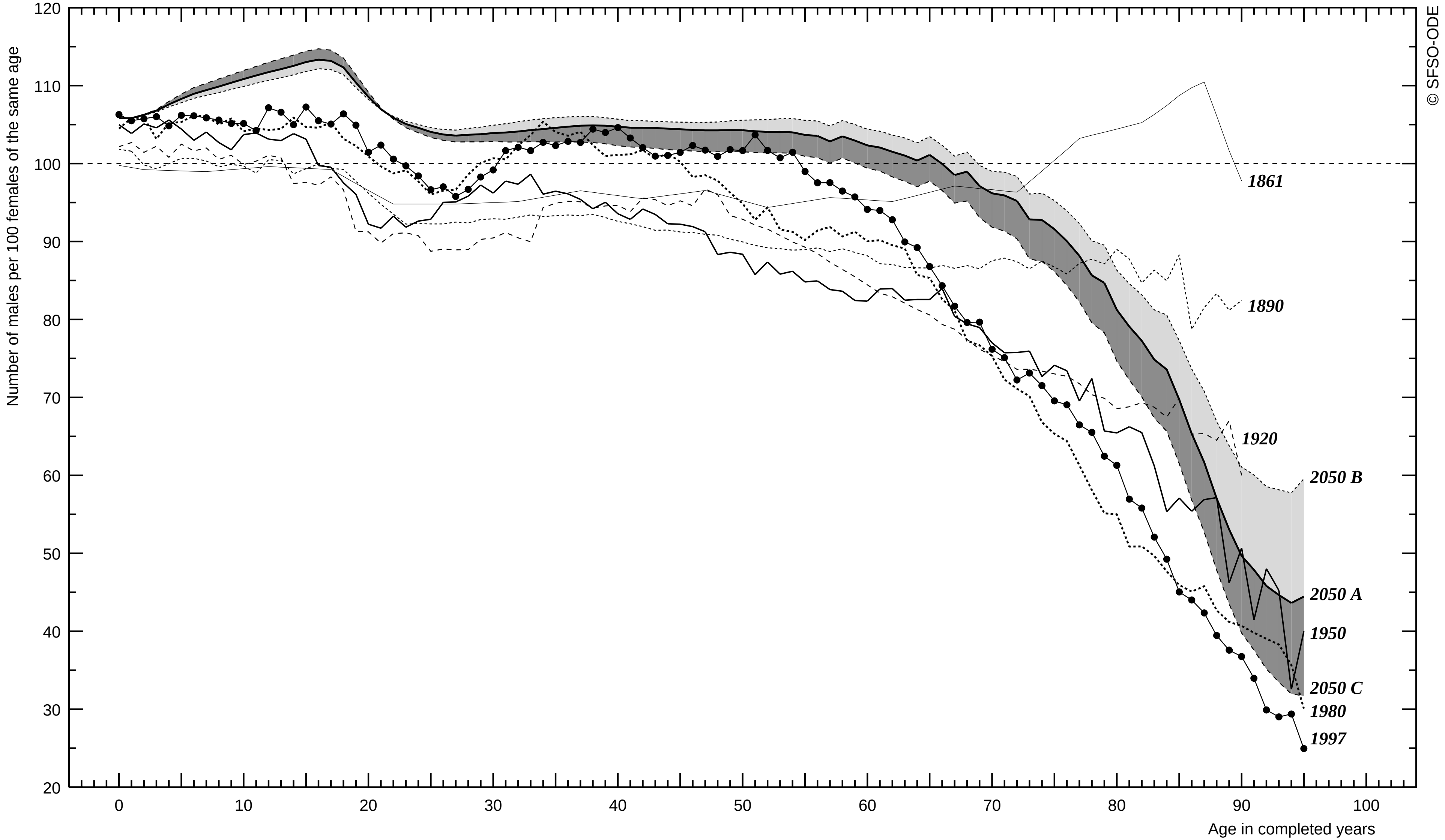


Figure 2.9 SWITZERLAND, 1861, 1890, 1920, 1950, 1980, 1997 and 2050 (SFSO A, B and C scenarios)
Age-specific sex ratio



Chapter 3: First marriage

A stable marriage rate up to the First World War

Figures 3.1 and 3.2 chart the trend in the age-specific first marriage rates since 1876 for males and females, respectively.

Prior to 1913, marriage rates were highly *stable*. The First World War caused a sharp drop in rates at all ages, which was more or less offset by the upturn at the beginning of the 1920s.

Increasingly earlier marriages during the 1940s, 1950s and 1960s

From the end of the 1930s, *ages* at first marriage *began to fall sharply* and continued to do so until the 1970s. The marriage rate rose particularly significantly among the younger age groups: so, 3% of girls married in their twentieth year in 1930; forty years on, 8% did so; the proportion of women already married at 25 years of age rose from 35% in 1930 to nearly 60% in 1970.

Mean age at first marriage, which had remained close to 26 and a half years for women and 28 and a half years for men between 1870 and 1940, fell by two years between 1940 and 1970 (Figures 3.11 and 3.12). This earlier accession of successive generations to adulthood will have far-reaching implications, especially on fertility patterns. In generational terms, the lowering of the age at marriage begins with the 1915-1920 birth cohorts.

Marriage is now later than in the 19th century

The tide turned in the 1970s, and the trend reversed more quickly than it had developed: in just two decades, the trend towards earlier marriages had been wiped out and age at marriage is now *later* than it was it at the end of the 19th century. In 1996, it averaged nearly 27 and a half for women and nearly 30 for men. Little more than a quarter of women are ever-married by their 25th birthday, and fewer than 2% of girls marry in their twentieth year. This reversal of the trend of mean age at first marriage occurred with the 1940-1945 birth cohorts.

Figures 3.3 and 3.4 show the trend in the proportion of *ever-marrieds* at the same age. The fall, then rise, in age at marriage, then the decline in its final intensity in the post-1925 birth cohorts, are clearly shown, although, as will be seen later, these proportions are skewed (causing them to be *understated* in the post-1920 birth cohorts) by the migration effect.

More or less concurrent with the decline in *early* first marriages was an increase in *later* first marriages: both in terms of rates and probabilities of marrying, there was a general increase from 1975 at all ages above 25 for women, 27 for men (Figures 3.5 and 3.6, corresponding to figures 3.1 and 3.2). But this rise in later nuptiality came to a halt at the end of the 1980s, and both rates and probabilities have levelled off or declined since.

Fewer legally-constituted marriages, more consensual unions

The reduction in the age at first marriage was accompanied by a rise in the marriage *rate*, although the two processes neither started nor ceased occurring exactly simultaneously or for the same generations. The proportion of ever-marrieds at 50 years of age (Figures 3.7 and 3.8), which had hovered consistently around 80% for men and women alike in the 1855-1890 birth cohorts increased with successive generations, peaking with the 1920 birth cohorts (88% for the male birth cohorts of 1920 and 1921, 89% for the female birth cohorts of 1923 and 1924). Conversely, for the post-1920 birth cohorts, and especially for those born after 1950, the proportion has significantly declined, attesting to a growing rejection of legally-constituted marriage in favour of non-marital unions. The female birth cohort of 1960 could expect approximately 81% of ever-marrieds at 50 years of age, the corresponding male birth cohort, 74%.

The total first marriage rate deduced from the age-specific first marriage rates[3] had declined to a very low level in 1976 (58 first marriages per 100 men, 60 per 100 women). It rose by approximately 14 points for both sexes until 1988, only to fall again substantially to 1976 levels by 1995. This new decline seems to have levelled off in 1996, however (58.5 per 100 men and 64.0 per 100 women, up 0.4 points over 1995).

A brief word on the significance of a total first marriage rate: in 1996, the number of *male* first marriages before 50 years of age represented 58.5% of the total number of an average male cohort in marriageable ages, and the number of female first marriages before 50 years of age represented 64% of an average female birth cohort in marriageable ages. Since 1870, there has been only one year in which the rates were lower than those of 1976 or 1995: 1915, with 57.2% for men and 55.4% for women, respectively.

As is to be expected, the values for the total first marriage rate based on age-specific probabilities[4] (Figures 3.9 and 3.10) are not as low as those deduced from age-specific rates: in 1996, they are 66.2% for men and 71.9% for women, 8 points higher than those based on the age-specific rates.

The size of generations of marriageable age and tensions on the «marriage market»

The sex-specific annual number of first marriages is the product of the average size of generations of marriageable age by the total period first marriage rate derived from the age-specific rates. These three quantities can be depicted on a semi-logarithmic chart (Figures 3.13 and 3.14): the *relative* variation in the number of first marriages is the *sum* of relative variations in the average size and in the total period rate.

---

[3] For a given observation year, the total first marriage rate based on age-specific rates (see Glossary) is the value attained by the proportion of ever-marrieds by age 50 within a hypothetical cohort whose first marriage rate at each age would be that observed at the same age (but in different cohorts) during the year under review

[4] For a given observation year, the total first marriage rate based on probabilities of marrying (see Glossary) is the value attained by the proportion of ever-marrieds by age 50 within a hypothetical cohort whose probability of first marriage at each age would be that observed at the same age (but in different cohorts) during the year under review. Experience shows that the total rate for year *n* based on probabilities is less variable than that based on rates and deviates less from the proportion of ever-marrieds at 50 years of age within the *real* cohort which reached its own mean age at first marriage in year *n*.

The increase in the average size of the generations of marriageable age paralleled that of the total population but, with the arrival at marriageable age of the smaller post-1964 birth cohorts, the average size has fallen since 1992 (in spite of positive net migration) and will continue to do so for at least the next ten years which, at an equal total period rate, will bring a reduction in the annual number of first marriages.

Even admitting that marriage is not exclusively an affair of never-married men and never-married women, a comparison of the average size of the male and female generations of marriageable age (Figure 3.15) gives an indication of the tensions on the «marriage market» deriving from the fact that the unequal sizes of successive generations relate to the *same* generations for both sexes whereas the average age between never-married men and never-married women at the time of marriage is just over *two years*.

Historically, there has usually been a surplus of single women, but the underlying trend has been for this female surplus to diminish and, since the 1970s, for a male surplus to emerge. On this underlying trend are superimposed four fluctuations reproducing with a time lag the fluctuations in the birth rate: the female surplus peaks in 1889 (13%, due to the relatively high birth rate of 1875), 1921 (18%, due to the relatively high birth rate of the period 1890-1910), in 1951 (7%, due to the relatively high birth rate of 1920-1921), in 1981 (1%, due to the relatively high birth rate of 1964).

Figure 3.15 also shows the trend in the ratio between the total period rate of male first marriage and its female counterpart: the correlation between this trend and that of the ratio between the average size of the female generations of marriageable age and the average size of the male generations is very close, showing the sensitivity of the first marriage rate to the tensions on the «marriage market». In periods of a *surplus* of never-marrieds of a given sex of marriageable age, the corresponding total first marriage rate is relatively *lower* than that of the other sex.

Immigration produces understating of Swiss nuptiality rates[5]

For the generation born in year *g*, the sum of age-specific first marriage rates up to and including age *x* (in the vertical-sided parallelograms of the Lexis diagram, i.e., by age reached in a calendar year) provides the proportion of ever-marrieds at age x in completed years on December 31 of year $g + x$. This sum *should* coincide with the proportion of those whose legal marital status is other than never-married which would be observed in a census carried out at that date among people born in year *g*.

[5] Readers who do not wish to dwell on the methodological aspects can skip to the next chapter.

Three conditions must still be satisfied, however:

- the census declarations have to be true (which will not be the case, for example, where unmarried people living in consensual unions nevertheless declare themselves as married in the census return);
- migrant nuptiality must be identical to that of non-migrants (same proportions of ever-marrieds at the same age on arrival in or departure from Switzerland);
- the number of people who marry in Switzerland but live abroad after marriage must be exactly offset for each sex and at each age by the number of people who marry abroad but live in Switzerland after marriage.

In a country like Switzerland which has experienced significant net migration over the past half century, the latter condition is the least satisfied, especially for men. The reason is that a significant number of immigrants tend to marry in their country of origin after arrival in Switzerland while continuing to reside in Switzerland after their marriage. Consequently, the age-specific proportions of ever-marrieds obtained by cumulating the rates based on the numbers of marriages reported by Swiss vital statistics are *lower* than those observed in the census.

This is clear, and becomes clearer over time, from a comparison of the two statistical sources (Figures 3.16 and 3.17): the proportion of ever-marrieds at each age, estimated from the numbers of marriages reported by Swiss vital statistics, differs little from that of the census up to the 1960 census. The trends then begin to diverge more widely with subsequent censuses. So, the proportion of ever-marrieds at age 50 deduced from vital registration data (87.7%) is 2.5% lower for the 1920 male birth cohort than that (90.2%) reported by the 1970 census; for that born in 1930 reported in the 1980 census, the corresponding difference attains nearly 7% (84.8 and 91.5%, respectively) and, 13% for the 1940 cohort reported by the 1990 census (78.3 and 91.3%). For female same year cohorts, the two sources give less different but, again, increasingly divergent estimates, with differences of 0.4% (87.1 and 87.5%), 4.4% (85.9 and 90.3%) and 7.5% (84.1 and 91.6%), respectively.

So, both the generational and cross-sectional data on the nuptiality in Switzerland deduced from the vital statistics are significantly *skewed* by the migration effect. This skew, which results from the inevitable under-estimation of the number of marriages of residents by Swiss registration data, produces an *underestimated* nuptiality.

Figures 3.18 and 3.19 show data corresponding to that shown in figures 3.3 and 3.4, but expressed in completed age, derived from census and from vital statistics. While the general trend is not significantly different between sources, the proportion of never-marrieds at 50 completed years of age derived from the censuses does not decline from the 1920-1925 birth cohorts, contrary to what the registration data suggest. There is no doubt, however, that this proportion of ever-marrieds at 50 years of age will decrease significantly with the increase in non-marital unions in the cohorts born in 1950 and after.

It might be thought that this observational skew could be avoided by comparing marriages of *Swiss nationals* celebrated in Switzerland to the population of Swiss nationality. Since 1972, figures have been available on both the age-sex structure of the population of Swiss nationality (providing the denominators for the first marriage rates) and on marriages of Swiss never-marrieds regardless of the marital status or nationality of their spouse before marriage, by year of birth (providing the numerators of the rates).

The total period rate of *male* first marriage (left-hand side of figure 3.20) thus obtained for Swiss nationals is as expected: from 1972 to 1995, it is *higher* by approximately 3 first marriages for 100 men than the rate for male population as a whole, Swiss and foreign nationals combined. The total generational rates for Swiss nationals up to the date of the 1990 census gives at each age a proportion of ever-marrieds closer to the census results (for the total population) than the total rates for the total population derived from the vital statistics.

For the *female* population, by contrast, Figure 3.21 produces results *contrary* to expectations: the total female first marriage rate for women of Swiss nationality alone is *below* that for the total population.

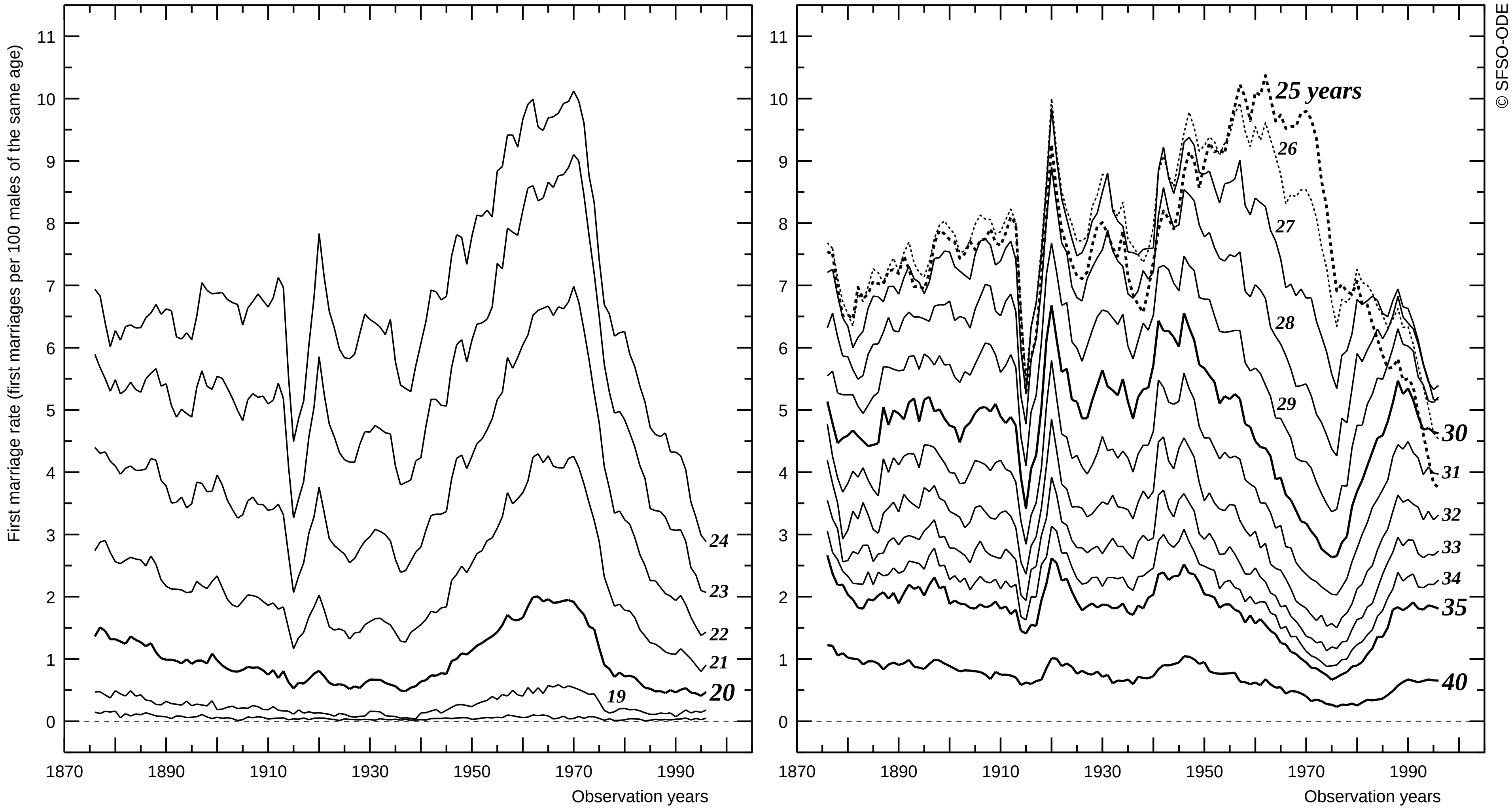
The reason for this apparent anomaly is the sex-differential effect of marriage on nationality: the nationality of a Swiss or foreign male who marries in Switzerland is unchanged by marriage and the rate calculated by referring the number of marriages celebrated in Switzerland of never-married men of Swiss nationality to the size of the male resident population of Swiss nationality of the same age is correct, at least if the number of never-married men of Swiss nationality residing in Switzerland who marry abroad is discounted as insignificant.

The same applies to the marriages of women, *except* where prior to marriage she was of *foreign* nationality and her husband of *Swiss* nationality: in such cases, it was very common until 1991 for the woman to acquire, automatically and instantaneously, Swiss nationality by marriage[6]. Consequently, the rate calculated by referring the number of marriages of never-married Swiss women celebrated in Switzerland to the size of the female resident population of Swiss

[6] Before the legislation changed on January 1, 1992, a foreign woman automatically acquired Swiss nationality by marriage to a Swiss man, whether the marriage took place in Switzerland or abroad.

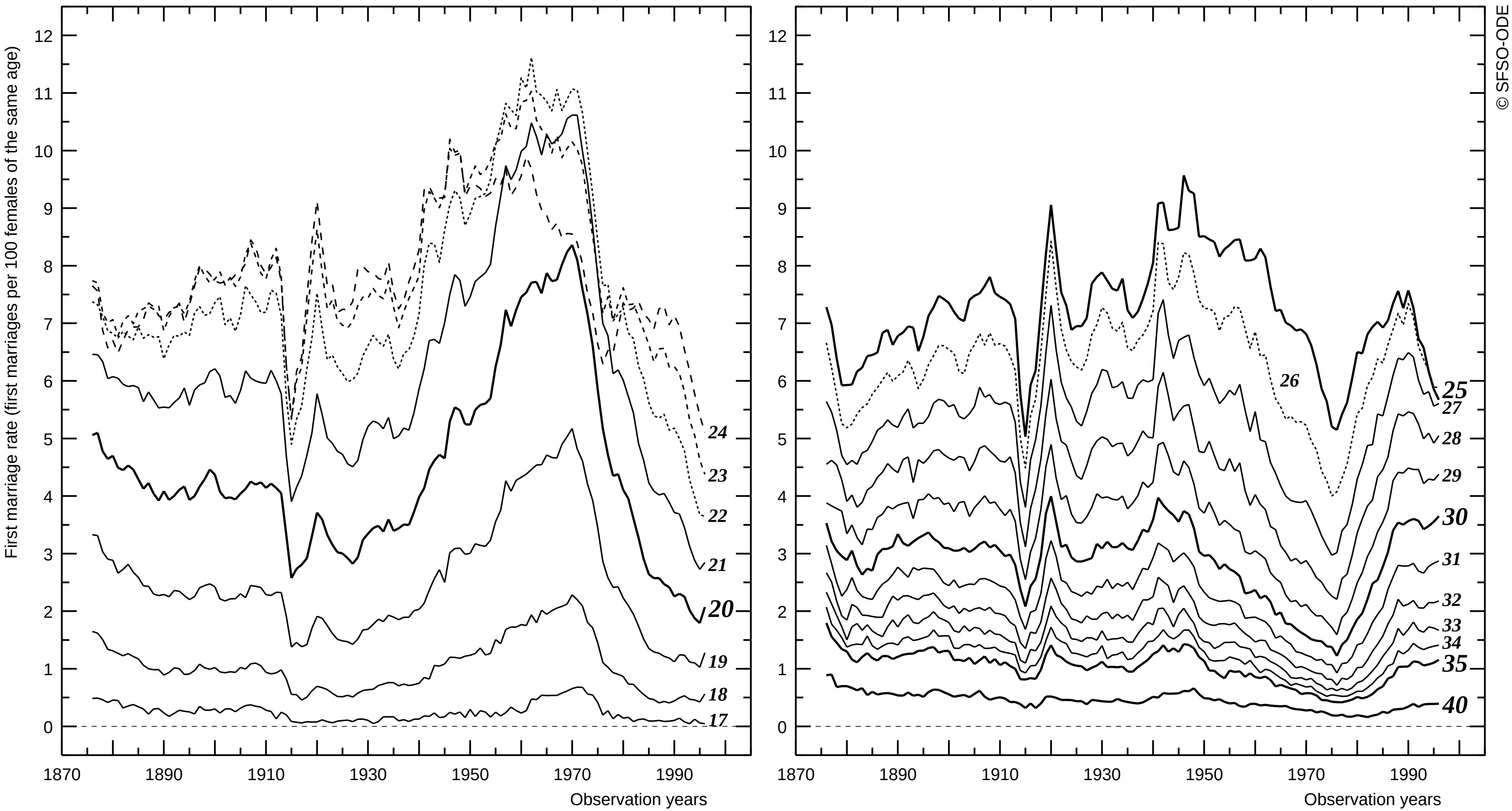
nationality of the same age is *underestimated* because that population size is *too high*: it also includes foreign nationals who have become Swiss nationals by marriage to a Swiss man (in Switzerland or abroad) and are living in Switzerland after their marriage. Consequently, the total period rate itself is underestimated.

Figure 3.1 SWITZERLAND, 1876-1996
MALE FIRST MARRIAGE RATE at the same age (rate by age reached during the calendar year of the marriage)
Left-hand side: ages 18-24, right-hand side: ages 25-40



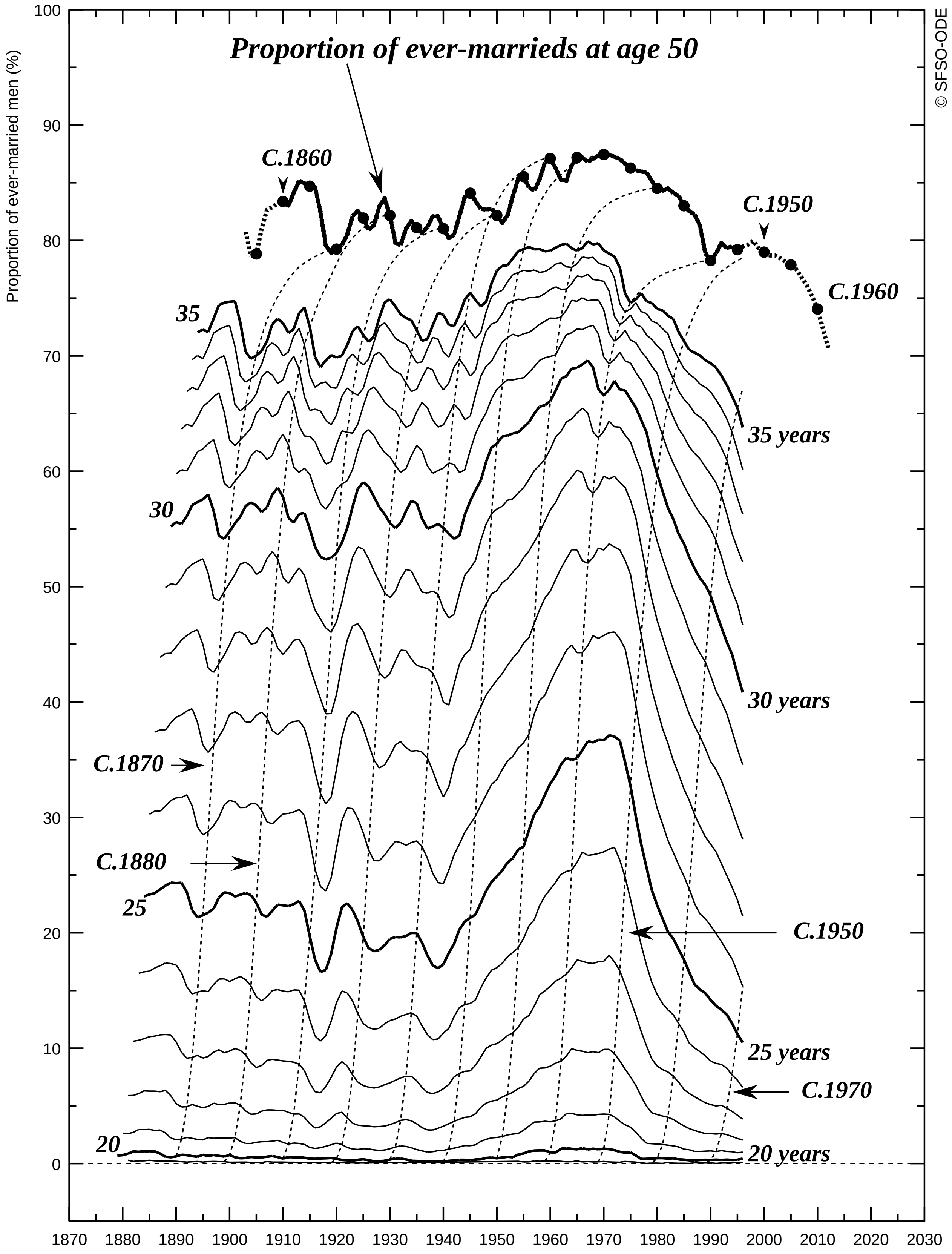
The male first marriage rate at age 20 in 1990 is the ratio of the number of never-married men born in 1970 who married in Switzerland in 1990 to the (average) number of men born in 1970 resident in Switzerland in 1990

Figure 3.2 SWITZERLAND, 1876-1996
FEMALE FIRST MARRIAGE RATE at the same age (rate by age reached during the calendar year of the marriage)
Left-hand side: ages 17-24, right-hand side: ages 25-40



The female first marriage rate at age 20 in 1990 is the ratio of the number of never-married women born in 1970 who married in Switzerland in 1990 to the (average) number of women born in 1970 resident in Switzerland in 1990

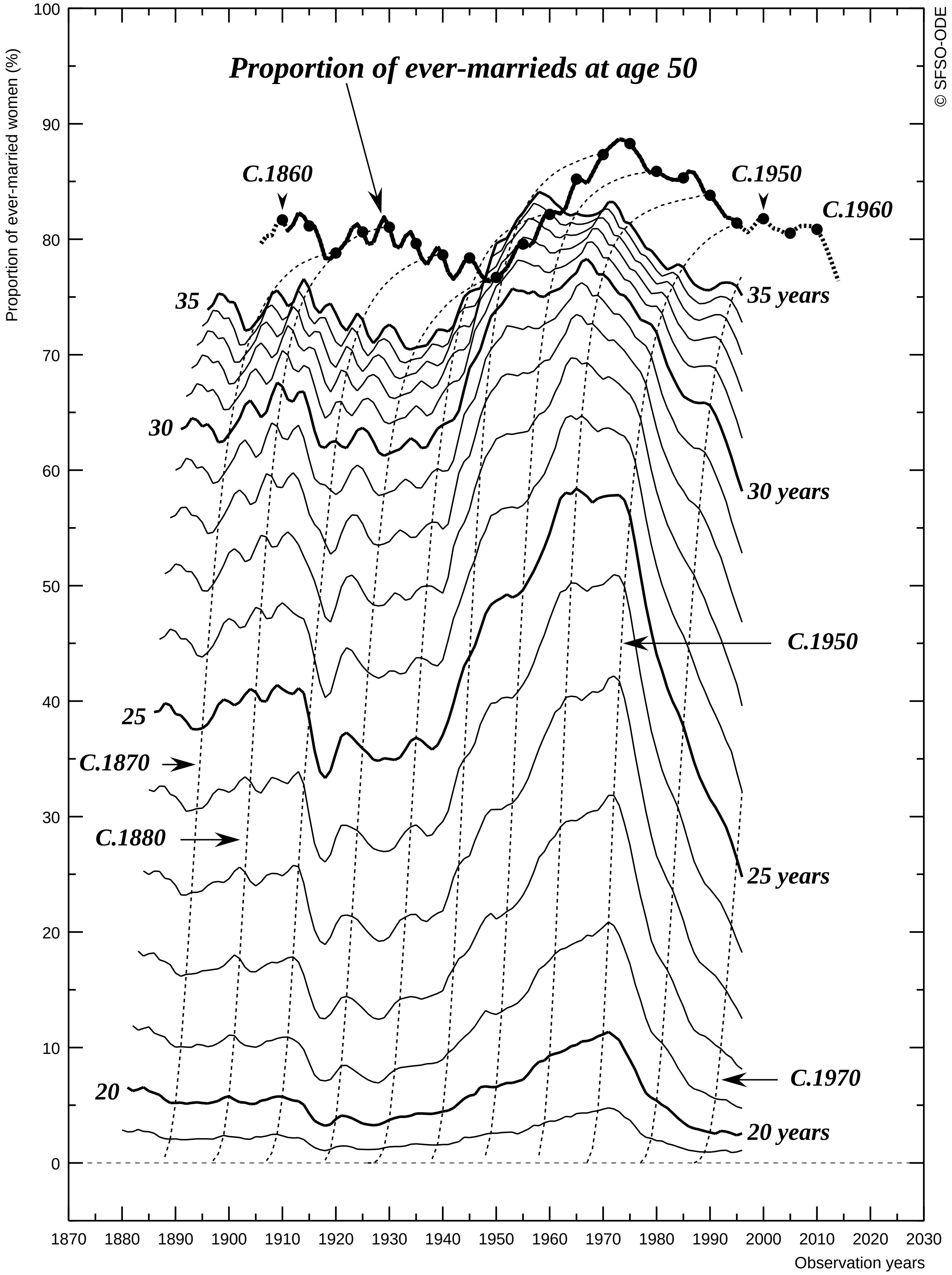
Figure 3.3 SWITZERLAND. Proportions of EVER-MARRIEDS at certain birthdays in the MALE birth cohorts born in and after 1860
Proportion at 50 years of age extrapolated by freezing the male first marriage rate, at the same age, at its actual value in 1995-1996



The solid lines represent the proportions of ever-marrieds at the same age

The dotted lines represent the proportions of ever-marrieds of the same birth cohort

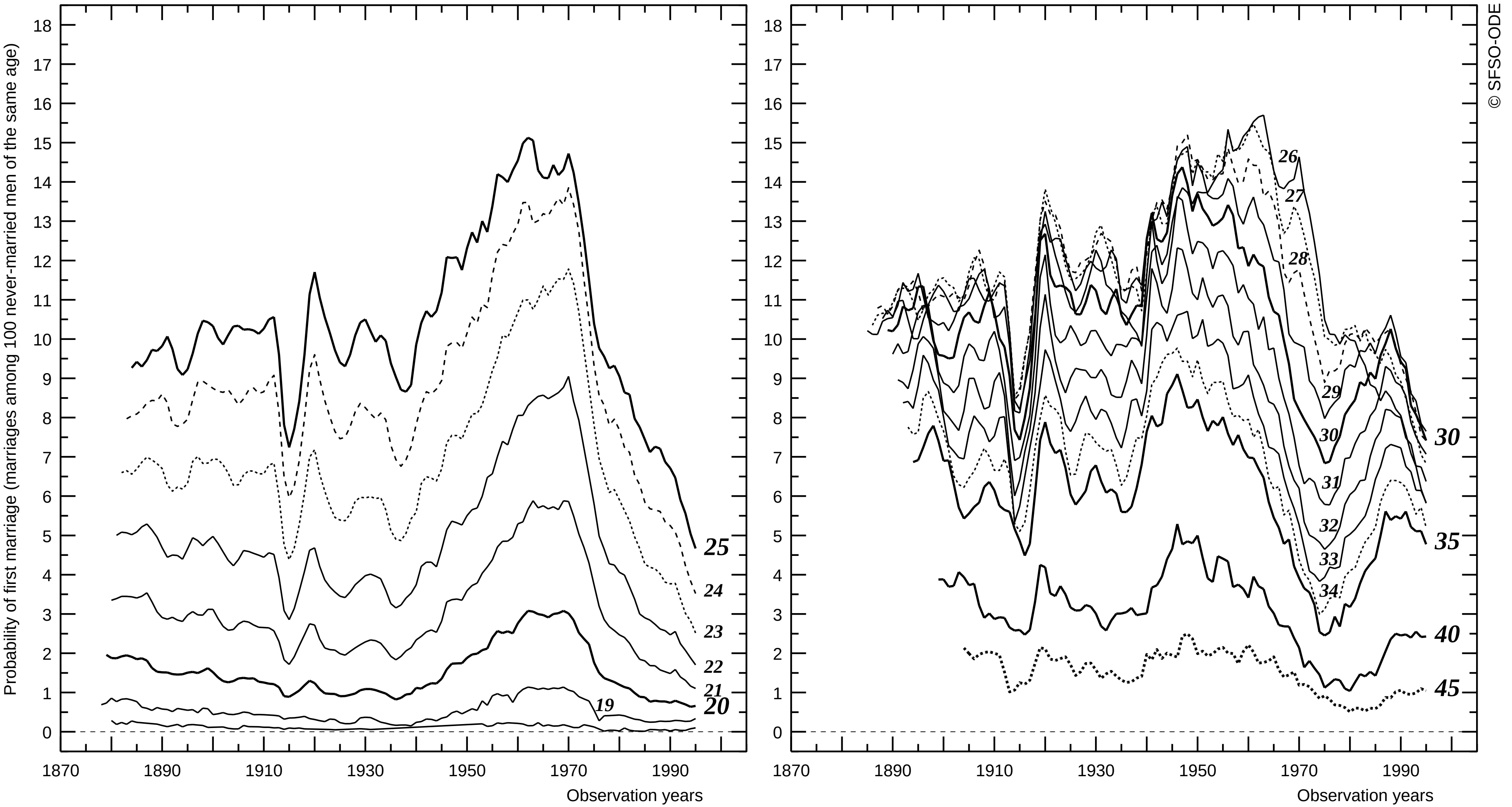
Figure 3.4 SWITZERLAND. Proportions of EVER-MARRIEDS at certain birthdays in the FEMALE birth cohorts born in and after 1860
Proportion at 50 years of age extrapolated by freezing the female first marriage rate, at the same age, at its actual value in 1995-1996



The solid lines represent the proportions of ever-marrieds at the same age

The dotted lines represent the proportions of ever-marrieds of the same birth cohort

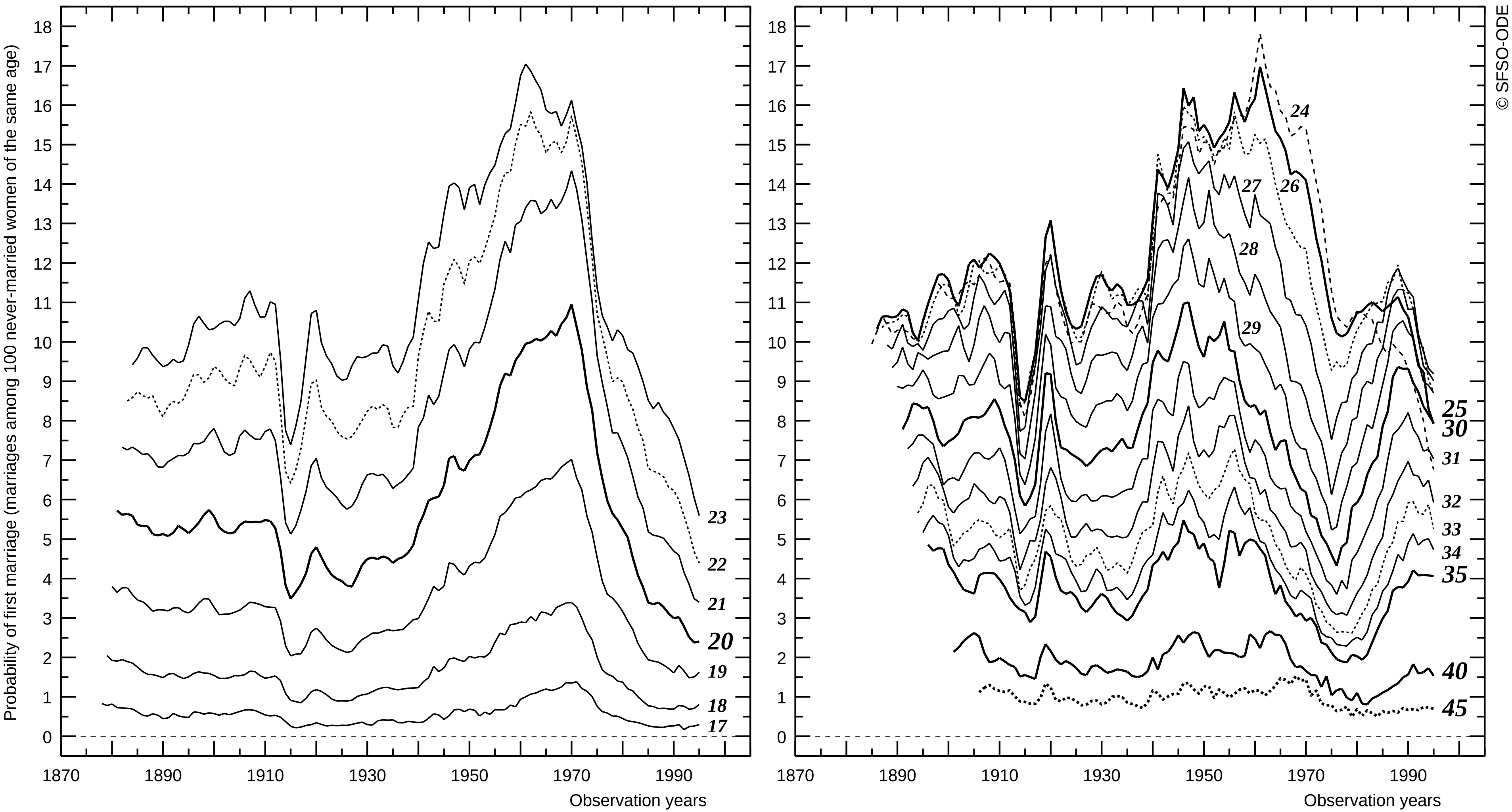
Figure 3.5 SWITZERLAND, 1876-1996
MALE FIRST MARRIAGE PROBABILITIES at the same age (probabilities between two consecutive birthdays)
Left-hand side: ages 18-25, right-hand side: ages 26-45



The probability of male first marriage at 20 years of age in 1990 is the proportion,

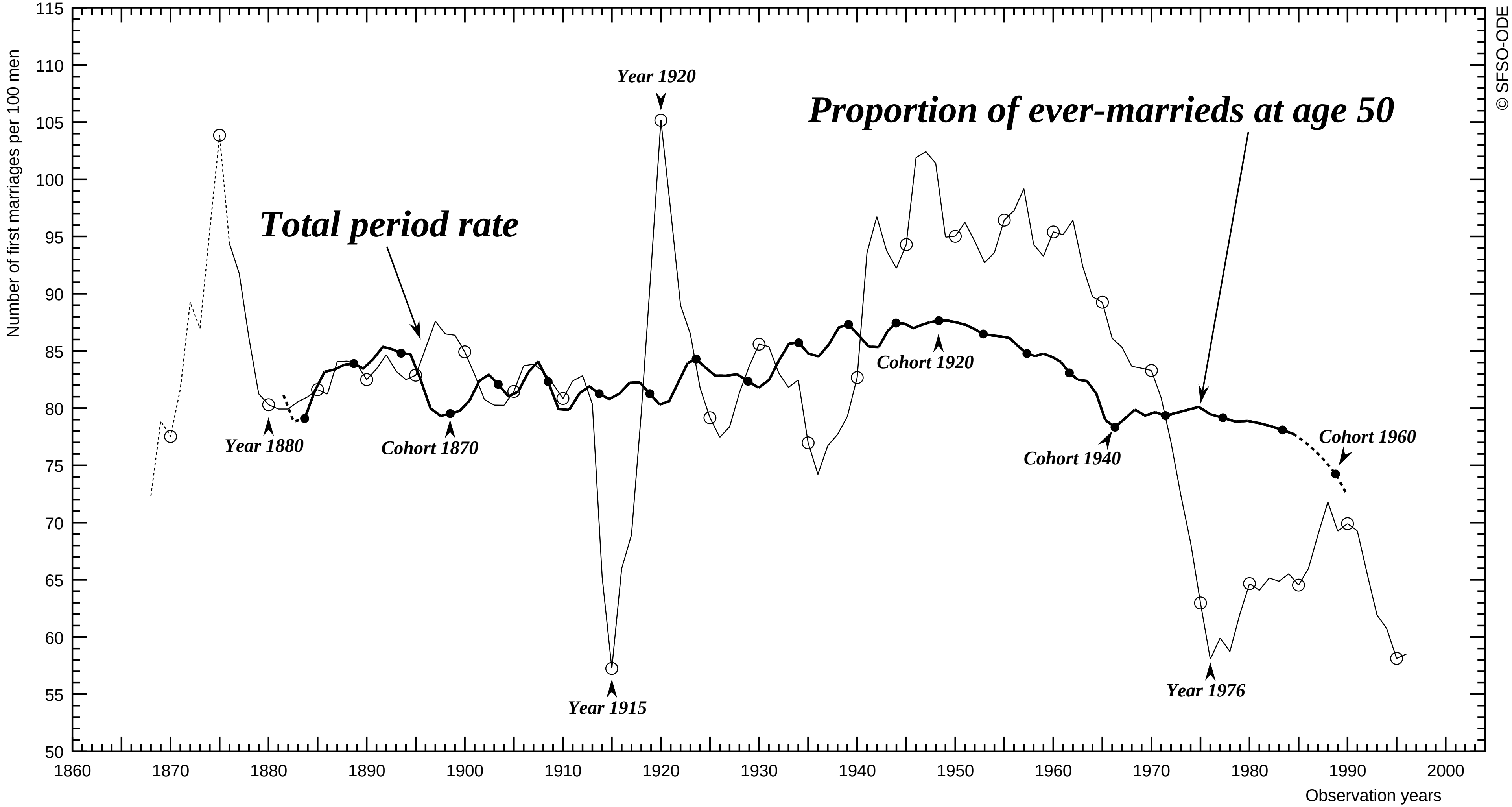
among men born in 1970 who were never-married and resident in Switzerland on their 20th birthday, of those who married in Switzerland before reaching their 21st birthday

Figure 3.6 SWITZERLAND, 1876-1996
FEMALE FIRST MARRIAGE PROBABILITIES at the same age (probabilities between two consecutive birthdays)
Left-hand side: ages 17-23, right-hand side: ages 24-45



The probability of female first marriage at 20 years of age in 1990 is the proportion,
among women born in 1970 who were never-married and resident in Switzerland at their 20th birthday, of those who married in Switzerland before reaching their 21st birthday

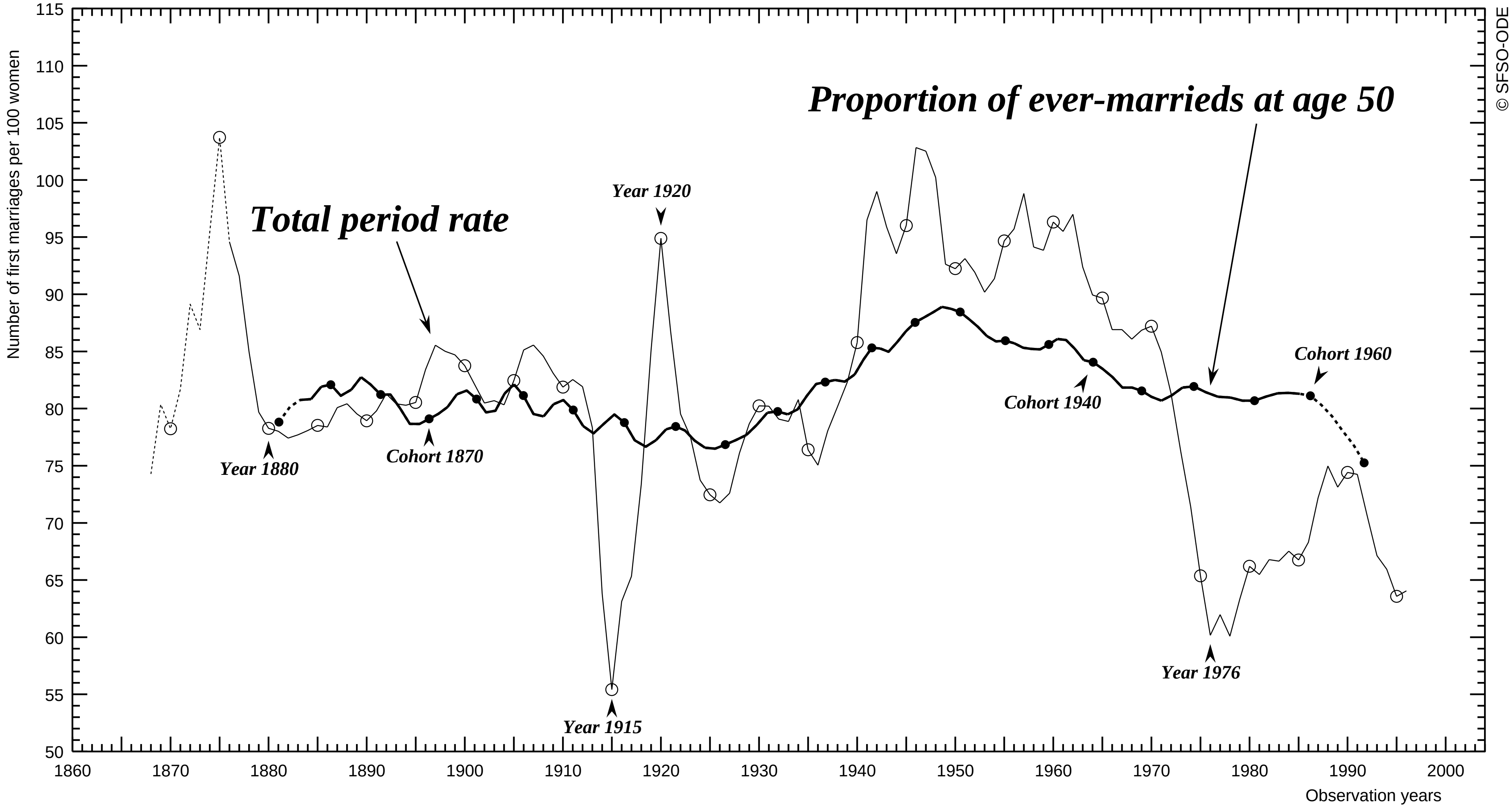
Figure 3.7 SWITZERLAND, 1868-1996
TOTAL MALE FIRST MARRIAGE RATE based on age-specific rates
and PROPORTION OF EVER-MARRIEDS at 50 years of age shifted by the mean age at first marriage
Dotted lines: proportion estimated by freezing the rate, at the same age, at its actual value in 1996
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The proportion of ever-married men aged 50 in completed years in the 1870 birth cohort,

whose mean age at first marriage was 28.5 years, is assigned to observation year 1870 + 28.5 = 1898.5

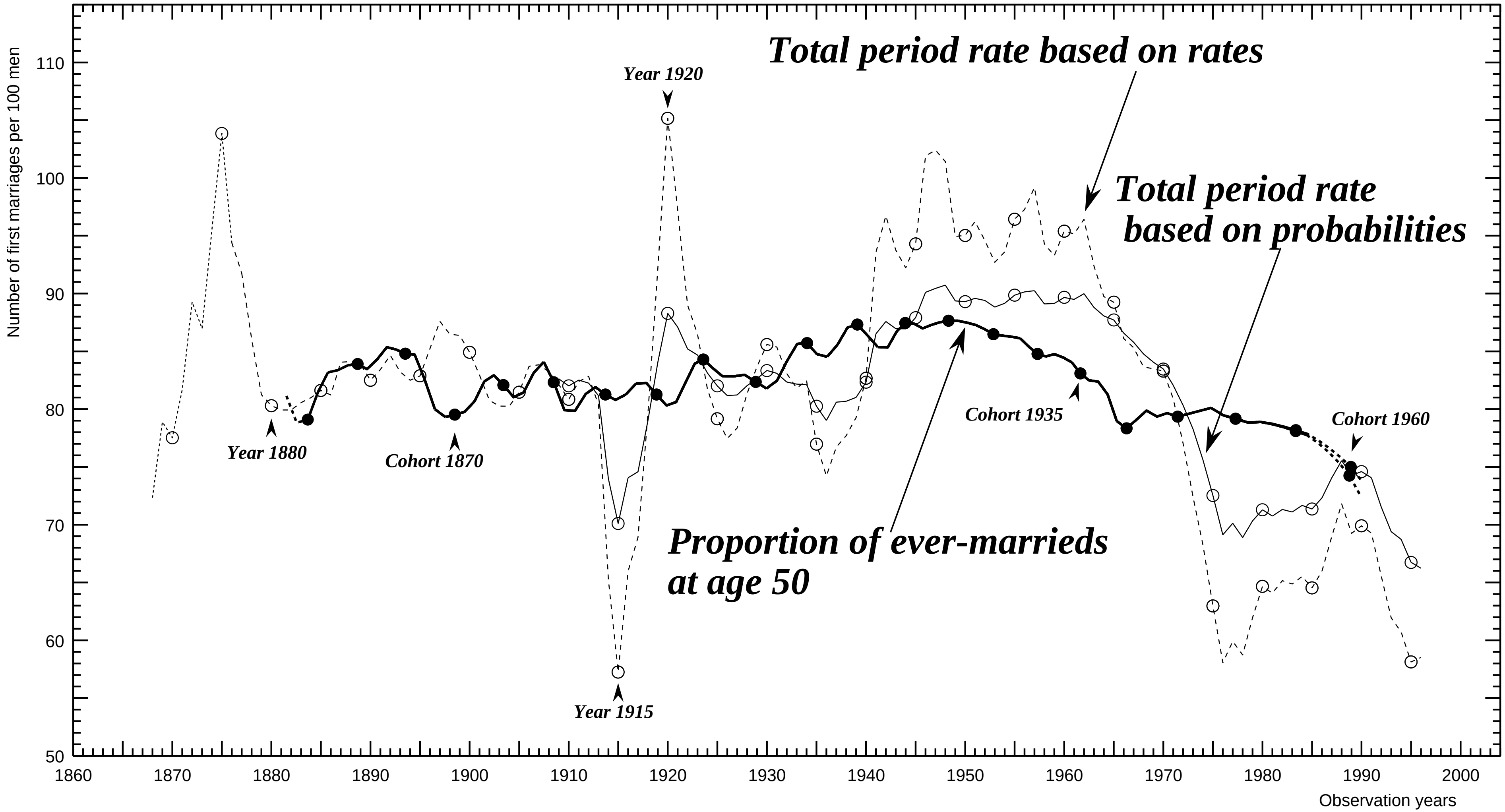
Figure 3.8 SWITZERLAND, 1868-1996
TOTAL FEMALE FIRST MARRIAGE RATE based on age-specific rates
and PROPORTION OF EVER-MARRIEDS at 50 years of age shifted by the mean age at first marriage
Dotted lines: proportion estimated by freezing the rate, at the same age, at its actual value in 1996
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The proportion of ever-married women aged 50 in completed years in the 1870 birth cohort,

whose mean age at first marriage was 26.4 years, is assigned to observation year 1870 + 26.4 = 1896.4

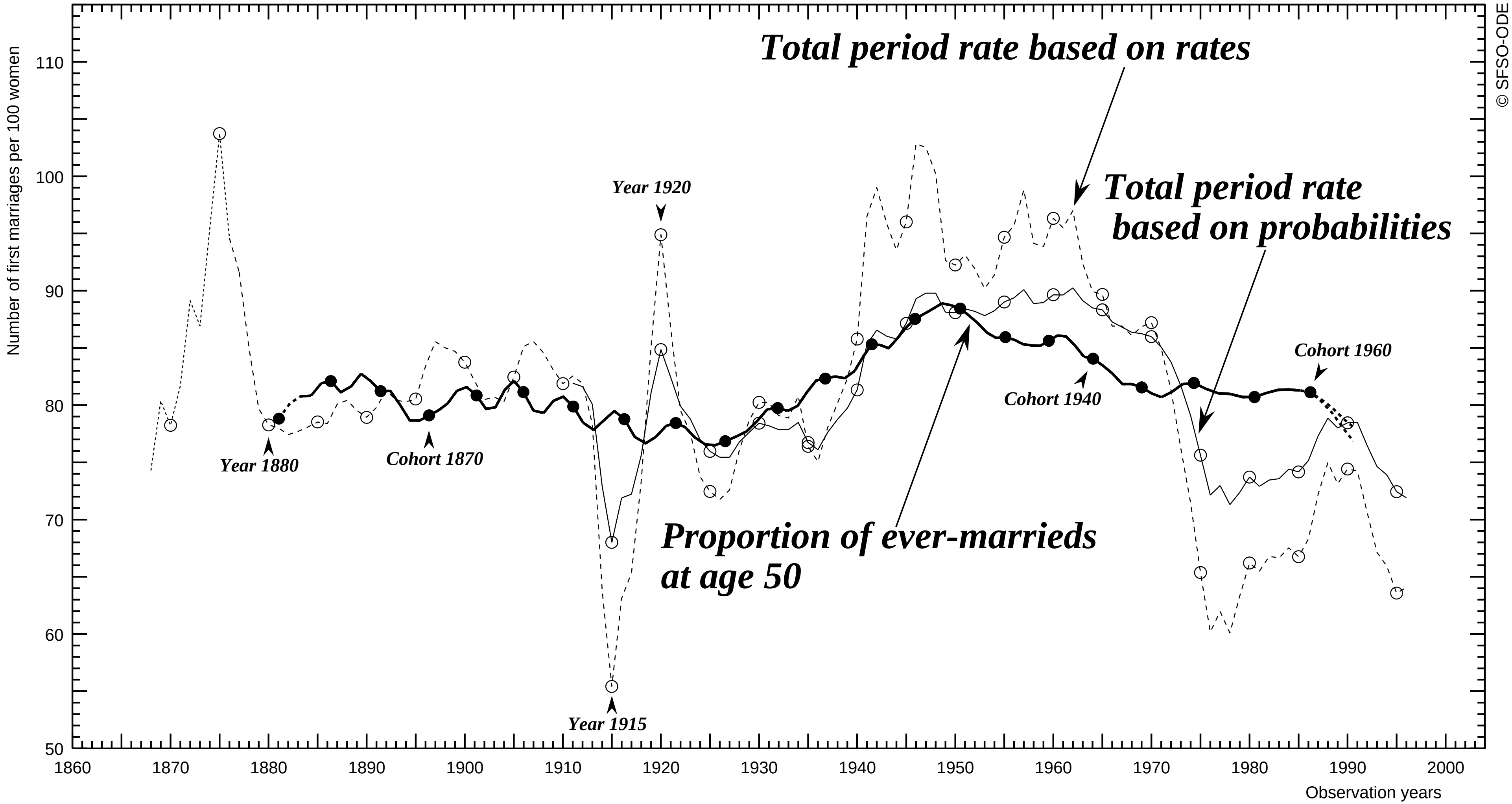
Figure 3.9 SWITZERLAND, 1868-1996
TOTAL MALE FIRST MARRIAGE RATE based on age-specific RATES and age-specific PROBABILITIES and PROPORTION OF EVER-MARRIEDS at 50 years of age shifted by the mean age at first marriage
Dotted lines: proportion estimated by freezing the rate or the probability, at the same age, at its actual value in 1996
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The proportion of ever-married men at 50 years of age in the 1870 male birth cohort,

whose mean age at first marriage was 28.5 years, is assigned to observation year 1870 + 28.5 = 1898.5

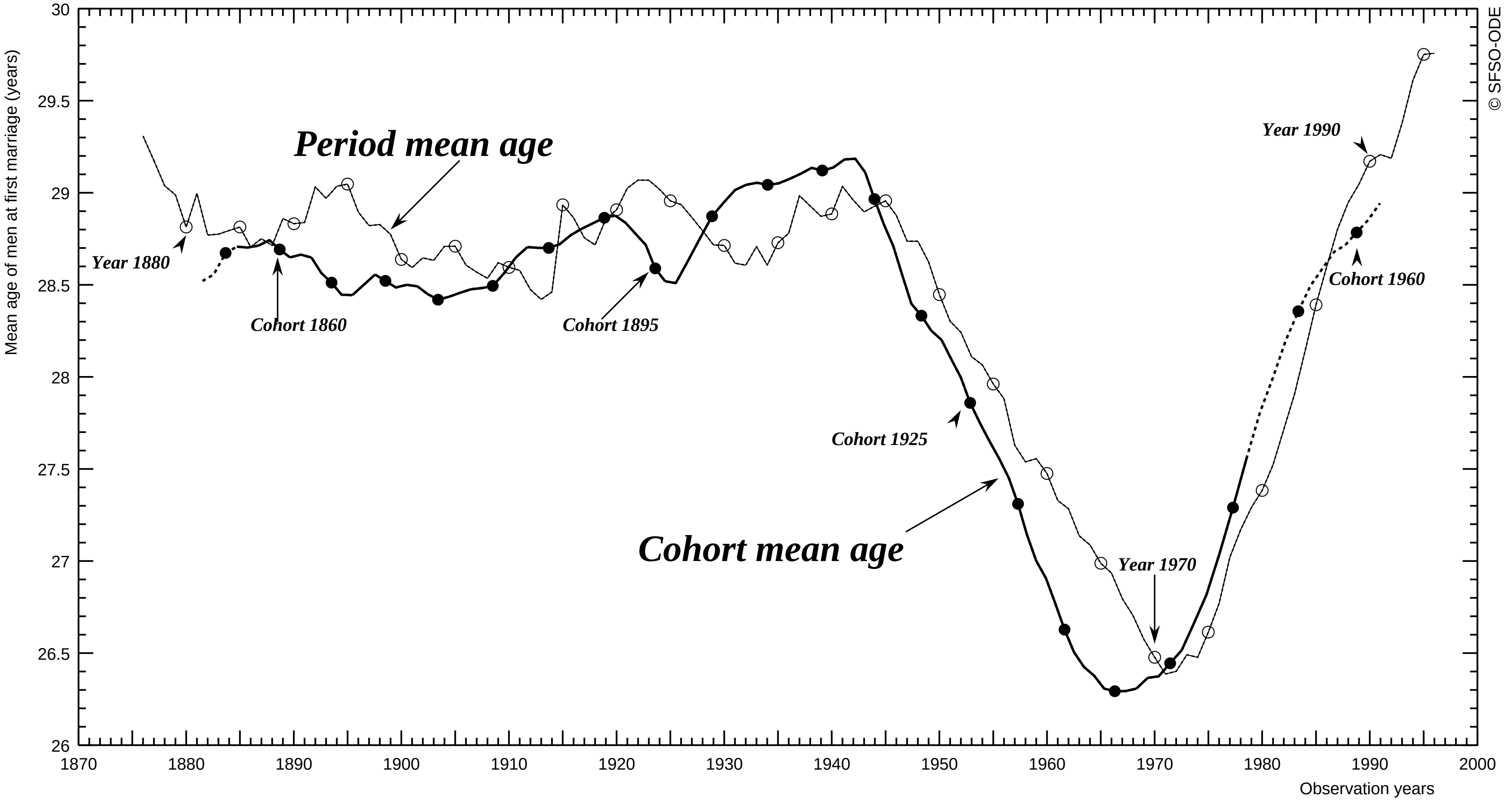
Figure 3.10 SWITZERLAND, 1868-1996
TOTAL FEMALE FIRST MARRIAGE RATE based on age-specific RATES and age-specific PROBABILITIES and PROPORTION OF EVER-MARRIEDS at 50 years of age shifted by the mean age at first marriage
Dotted lines: proportion estimated by freezing the rate or the probability, at the same age, at its actual value in 1996
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The proportion of ever-married women at 50 years of age in the 1870 female birth cohort,

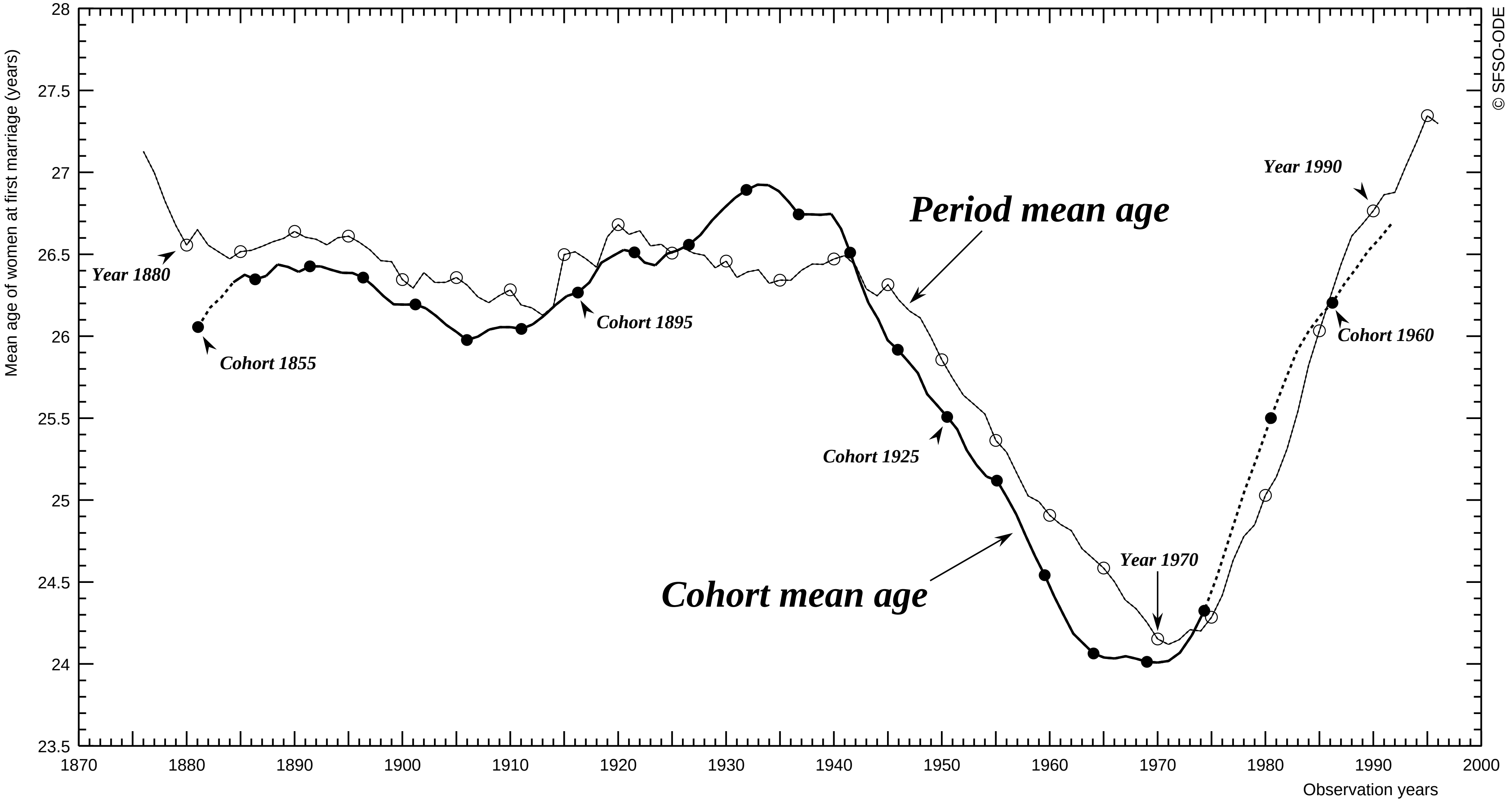
whose mean age at first marriage was 26.4 years, is assigned to observation year 1870 + 26.4 = 1896.4

Figure 3.11 SWITZERLAND, 1876-1996
MALE MEAN AGE AT FIRST MARRIAGE. PERIOD AND COHORT CALCULATION BASED ON RATES
The cohort mean age is shifted by the male mean age at first marriage
Dotted lines: estimated mean age
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



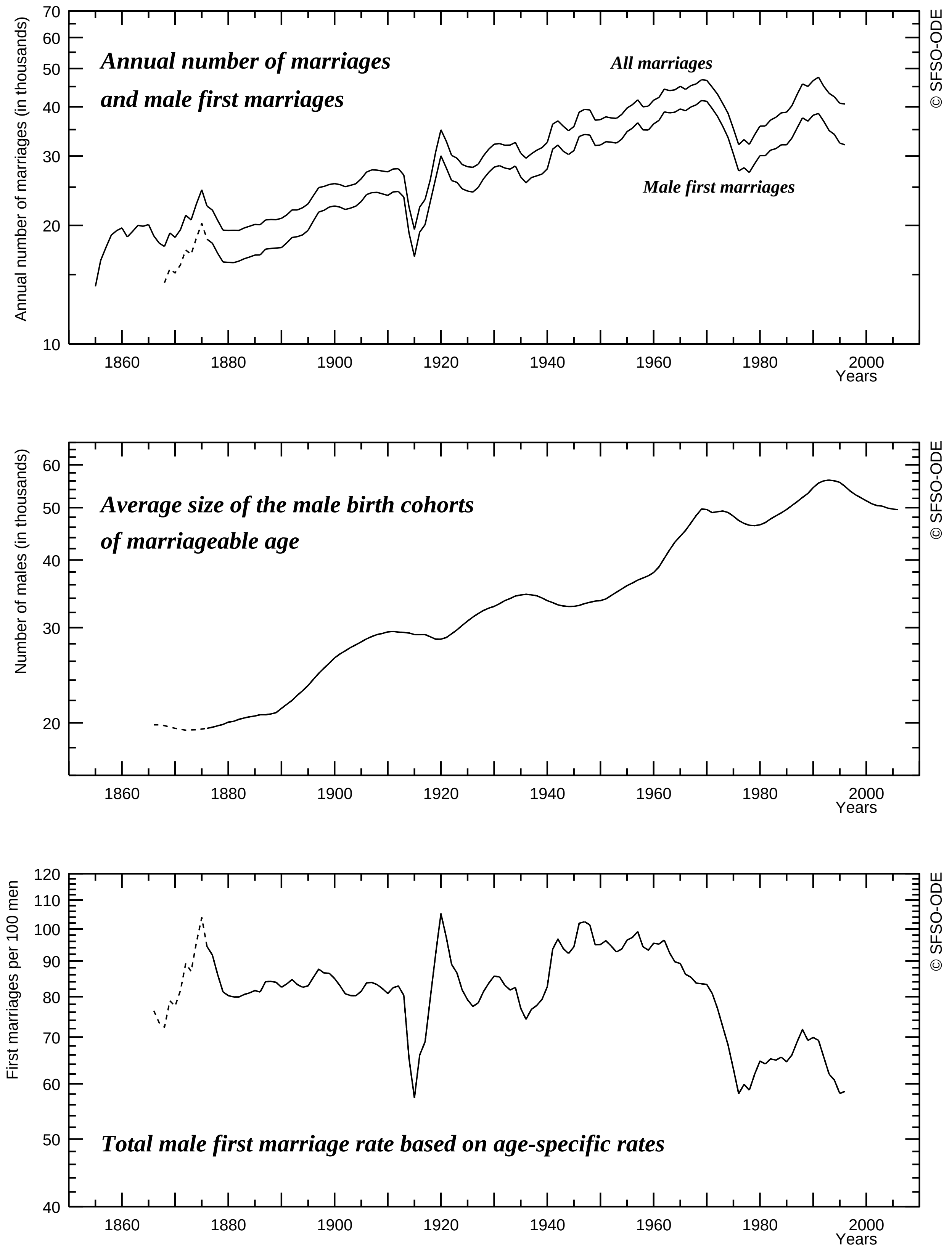
The mean age at first marriage of the male birth cohort born in 1870, equal to 28.5 years, is assigned to observation year 1870 + 28.5 = 1898.5

Figure 3.12 SWITZERLAND, 1876-1996
FEMALE MEAN AGE AT FIRST MARRIAGE. PERIOD AND COHORT CALCULATION BASED ON RATES
The cohort mean age is shiftted by the female mean age at first female marriage
Dotted lines: estimated mean age
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



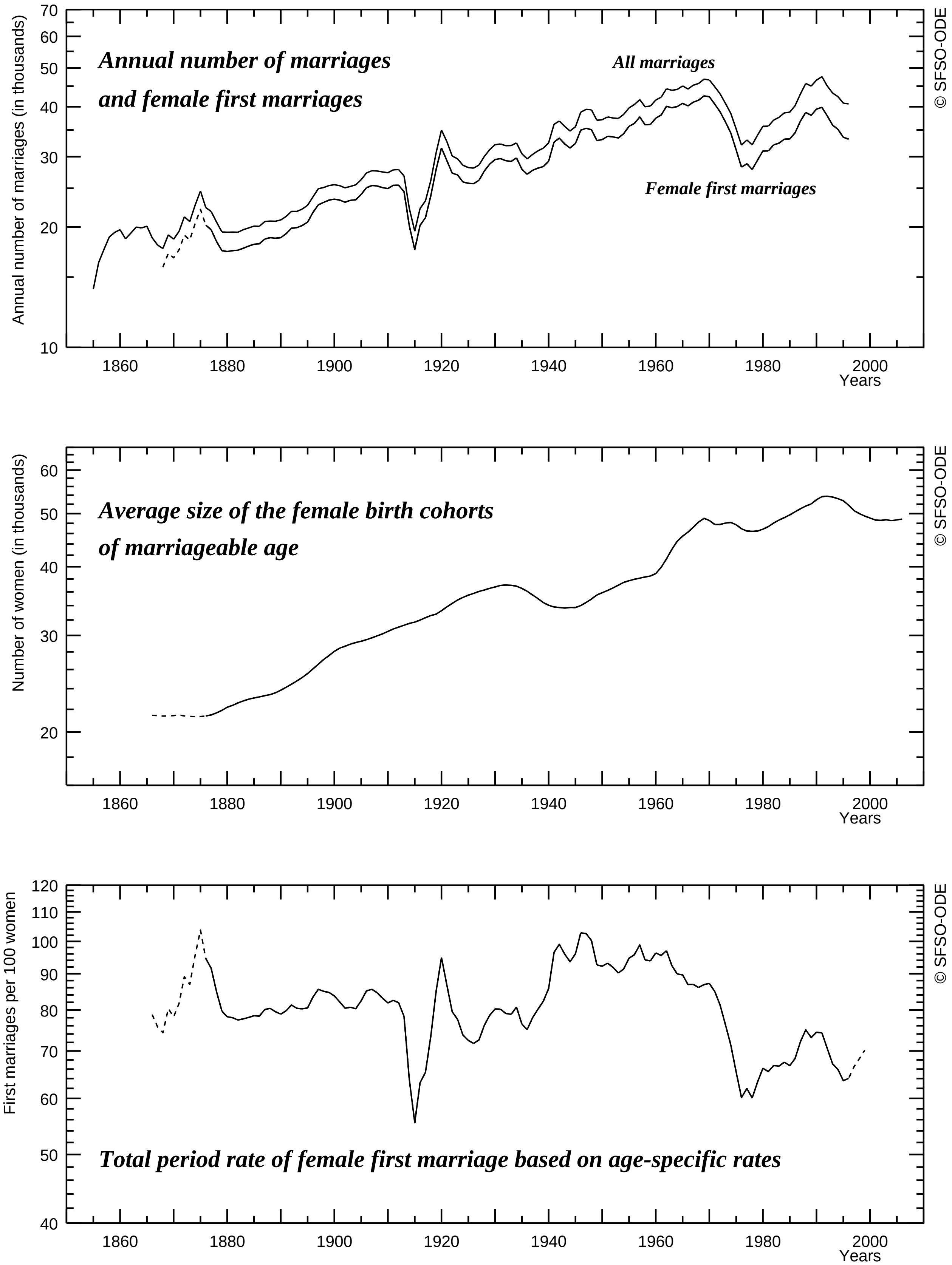
The mean age at first marriage of the female birth cohort born in 1870, equal to 26.4 years, is assigned to observation year 1870 + 26.4 = 1896.4

Figure 3.13 SWITZERLAND, 1868-2003
Annual number of MALE MARRIAGES and FIRST MARRIAGES
Average SIZE of the MALE birth cohorts of marriageable age
TOTAL MALE FIRST MARRIAGE RATE
Logarithmic scales, dotted lines: estimates



The relative change in the annual number of male first marriages during a period is the sum of the relative changes in the average size of the cohorts and in total period rate

Figure 3.14 SWITZERLAND, 1868-2003
Annual number of FEMALE MARRIAGES and FIRST MARRIAGES
Average SIZE of the FEMALE birth cohorts of marriageable age
TOTAL FEMALE FIRST MARRIAGE RATE
Logarithmic scales, dotted lines: estimates



The relative change in the annual number of female first marriages during a period is the sum of the relative changes in the average size of the cohorts and in total period rate

Figure 3.15 SWITZERLAND, 1875-1996
Comparative trends:
(1) of the ratio of the average SIZE of the FEMALE birth cohorts of marriageable age to the average SIZE of the MALE birth cohorts of marriageable age
(2) of the ratio of the TOTAL MALE first marriage RATE to the TOTAL FEMALE first marriage RATE

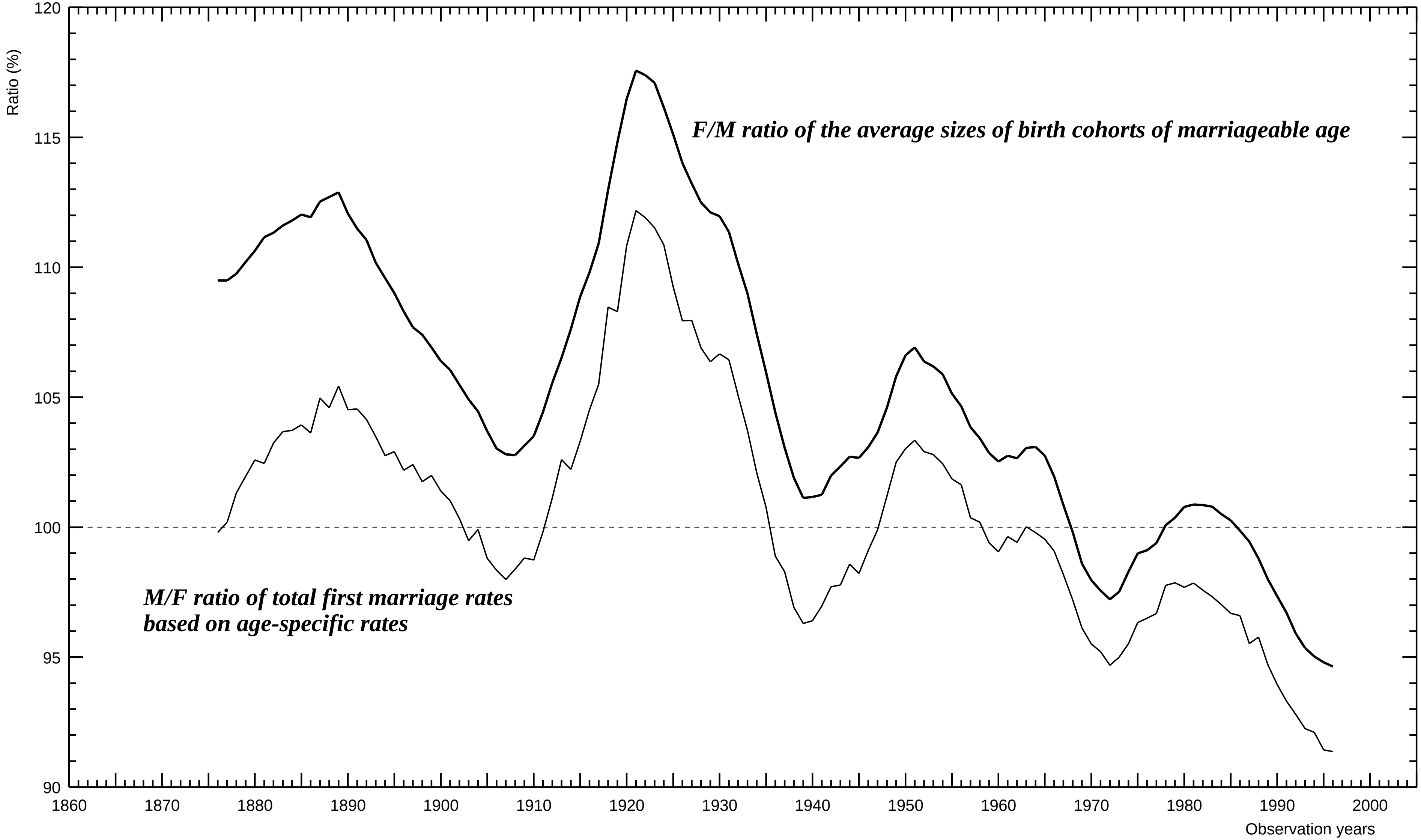


Figure 3.16 SWITZERLAND, censuses from 1900 to 1990. MALES
Proportion of ever-marrieds by age reached in the census year
Comparison between census results and cumulative registration data

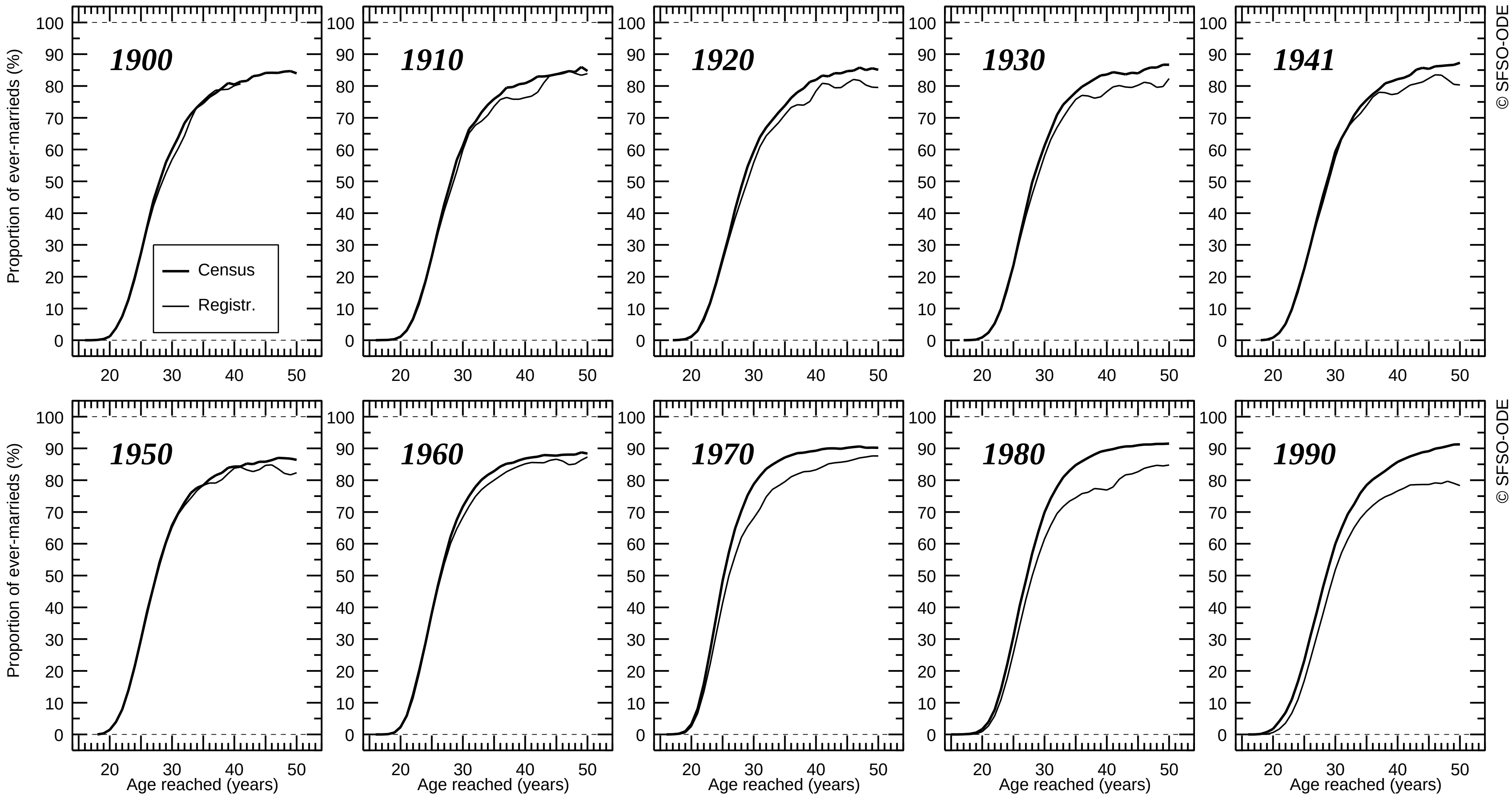


Figure 3.17 SWITZERLAND, censuses from 1900 to 1990. FEMALES
Proportion of ever-marrieds by age reached in the census year
Comparison between census results and cumulative registration data

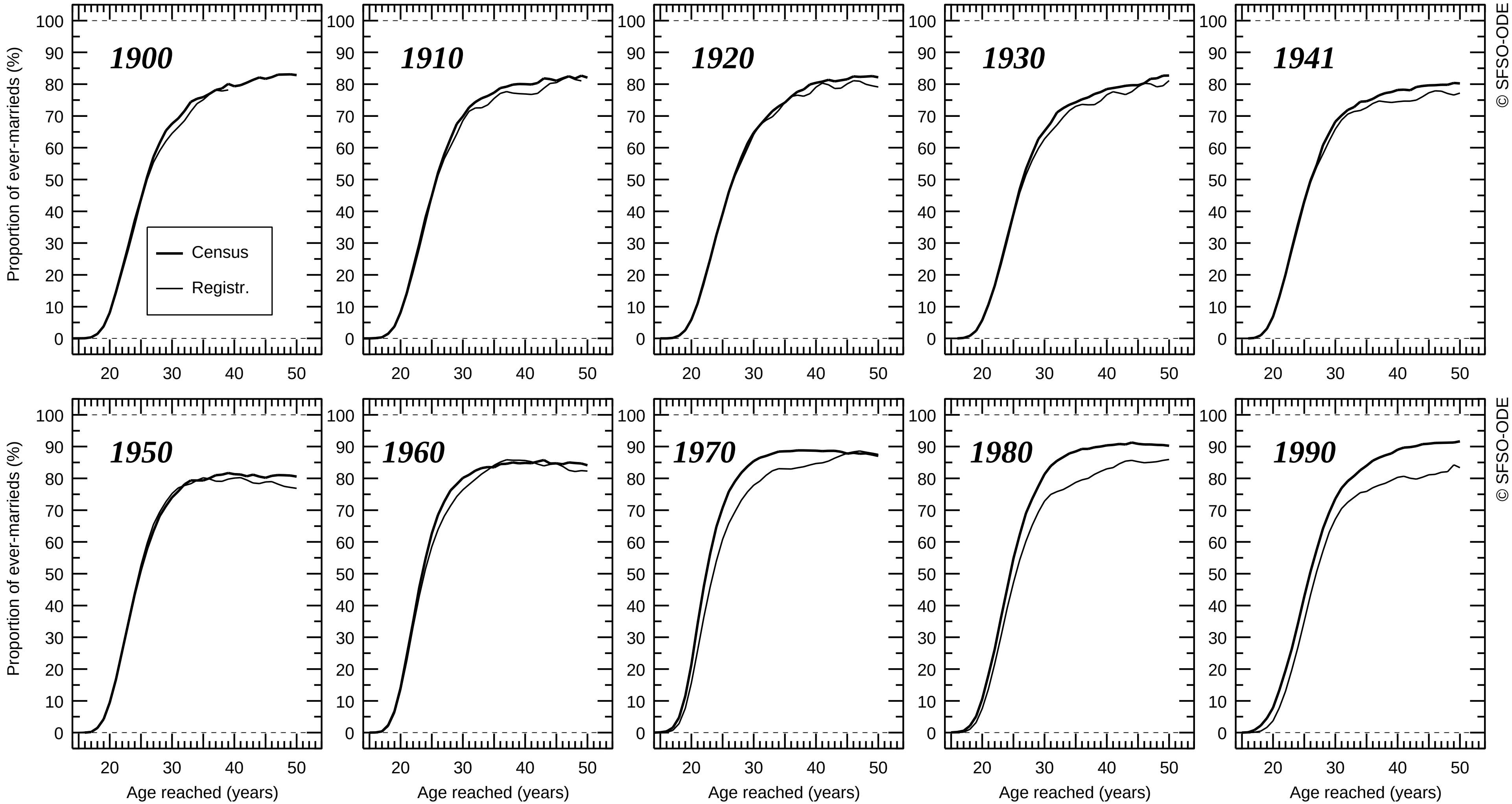


Figure 3.18 SWITZERLAND, MALE birth cohorts born from 1850 to 1975
Proportions of ever-married men of the same age in completed years
reported in the vital statistics and in census statistics
Solid circles: census data
Solid lines and empty circles: registration data
The larger diameter circles refer to age 50 in completed years

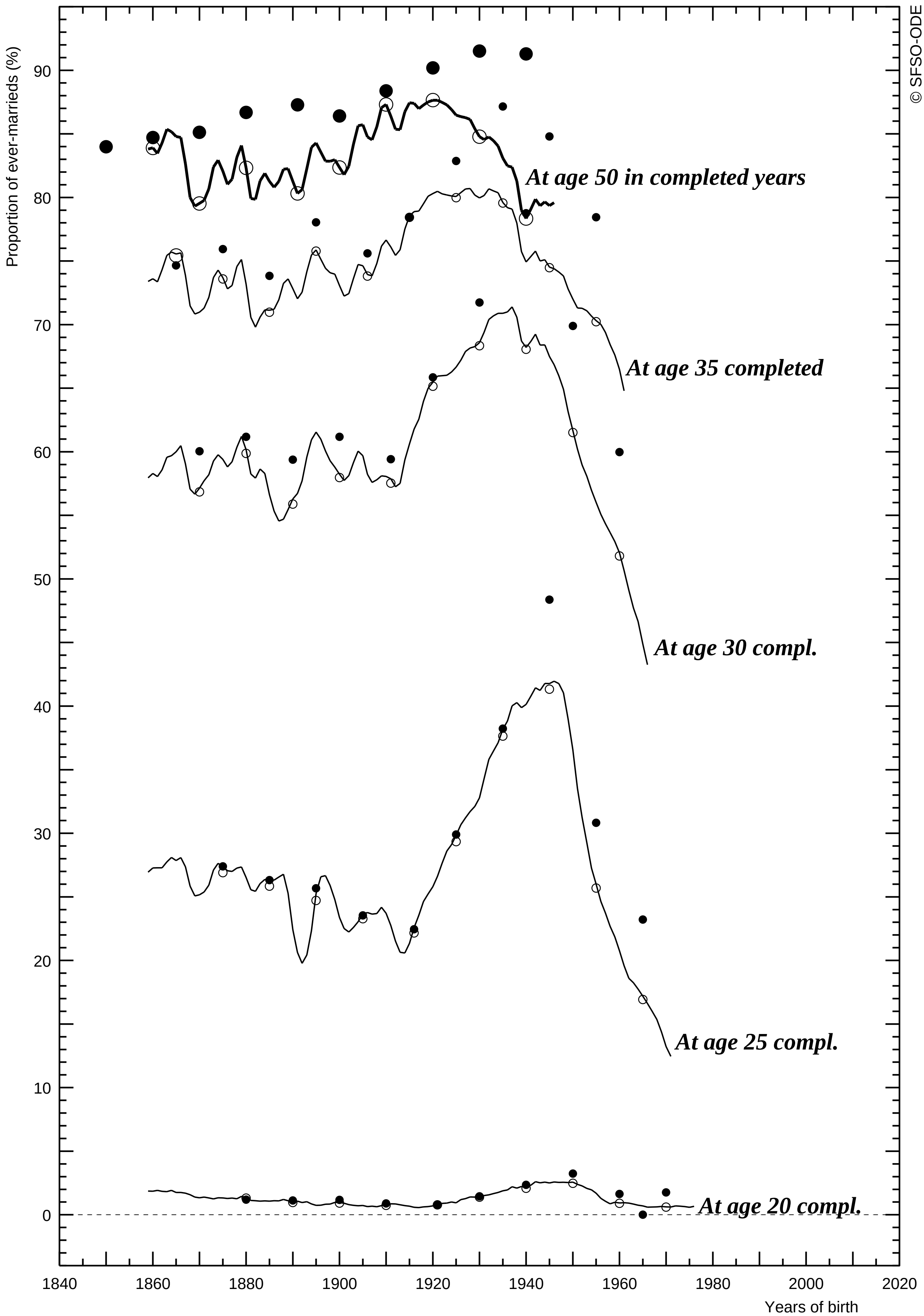


Figure 3.19 SWITZERLAND, female birth cohorts born from 1850 to 1975
Proportions of ever-married women of the same age in completed years reported in the vital statistics and in census statistics
Solid circles: census data
Solid lines and empty circles: registration data
The larger diameter circles refer to age 50 in completed years

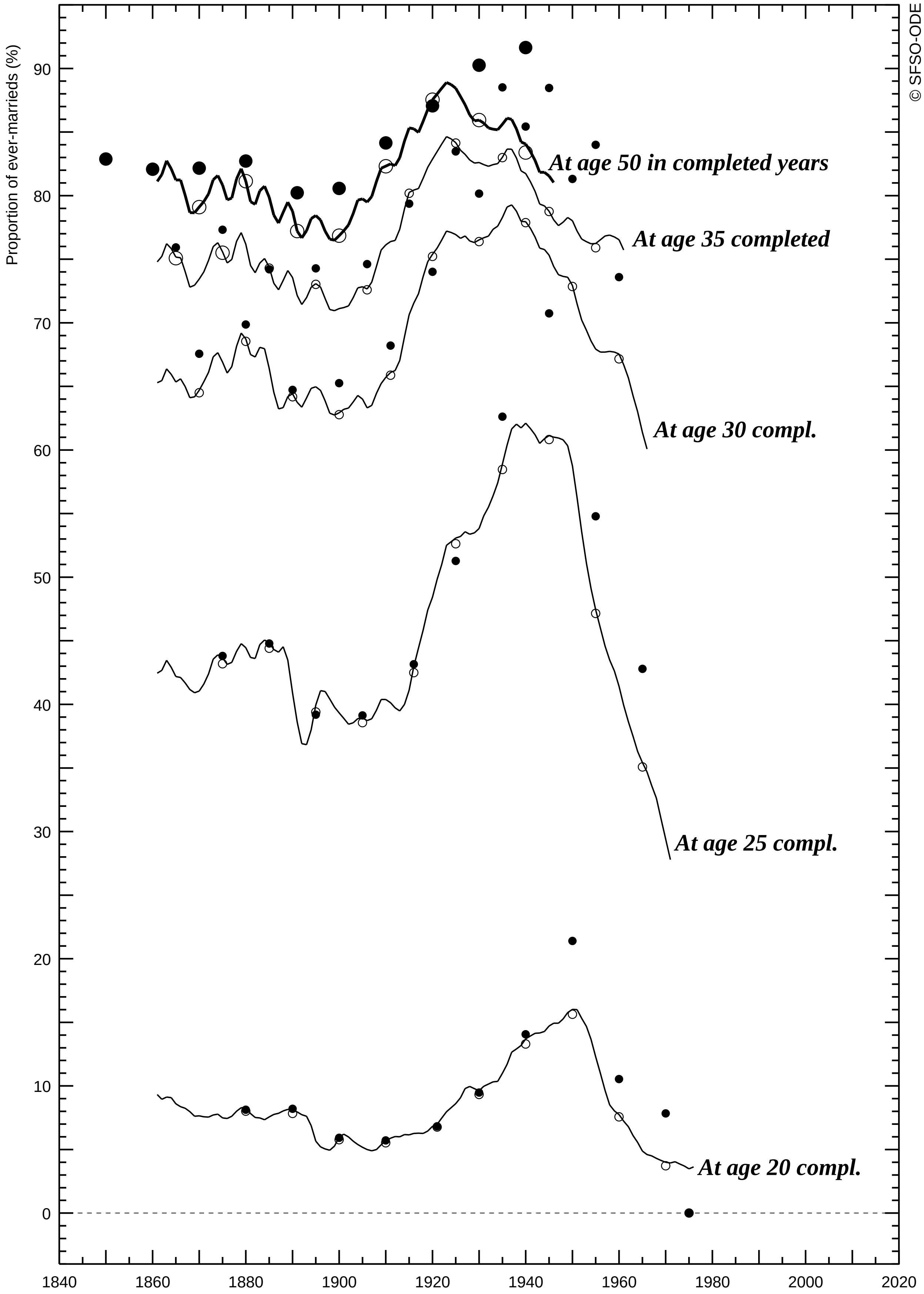
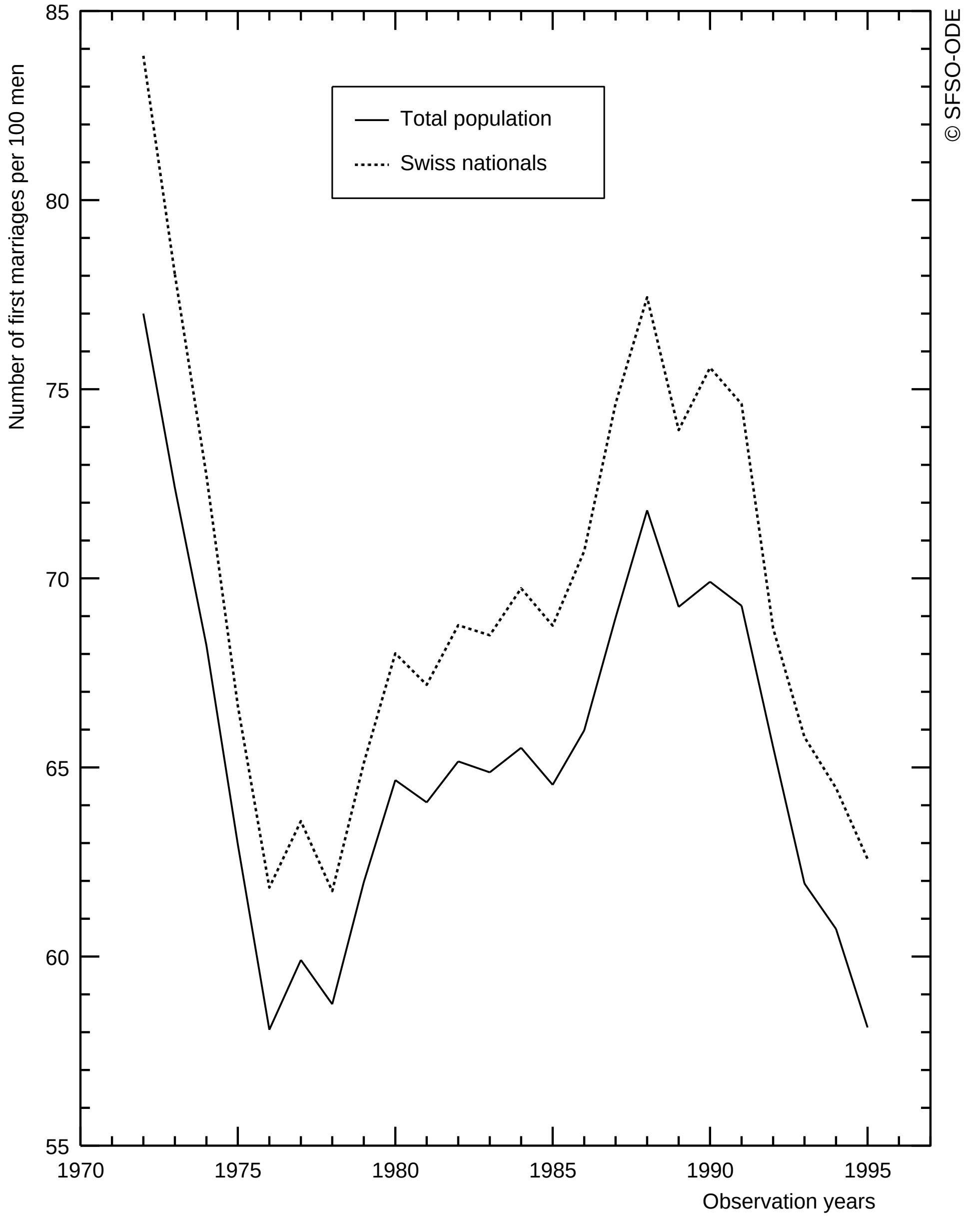


Figure 3.20 SWITZERLAND, males
Left-hand side: total male first marriage rate, 1972-1995
Right-hand side: proportion of ever-married males by age in the census of 4.12.1990



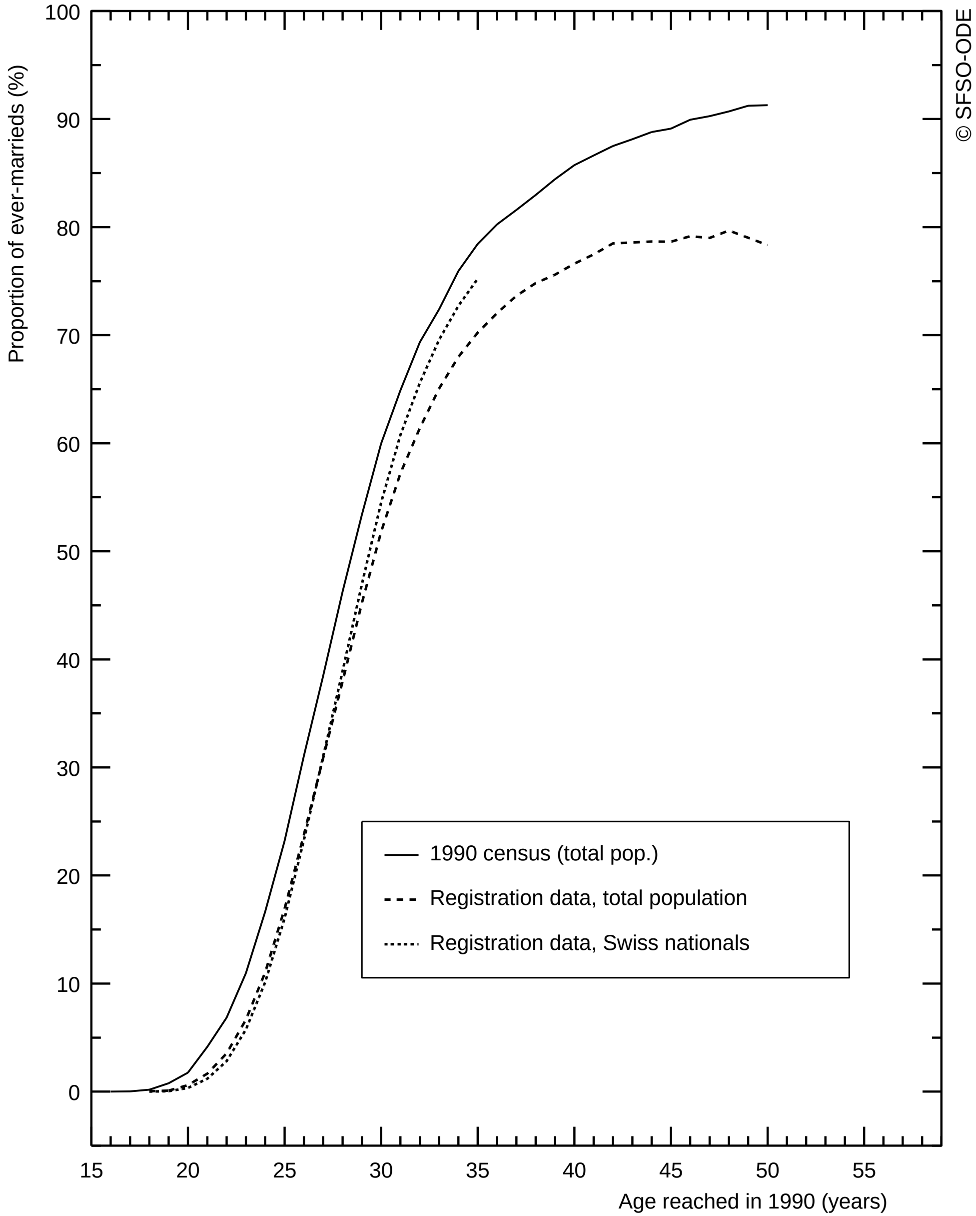
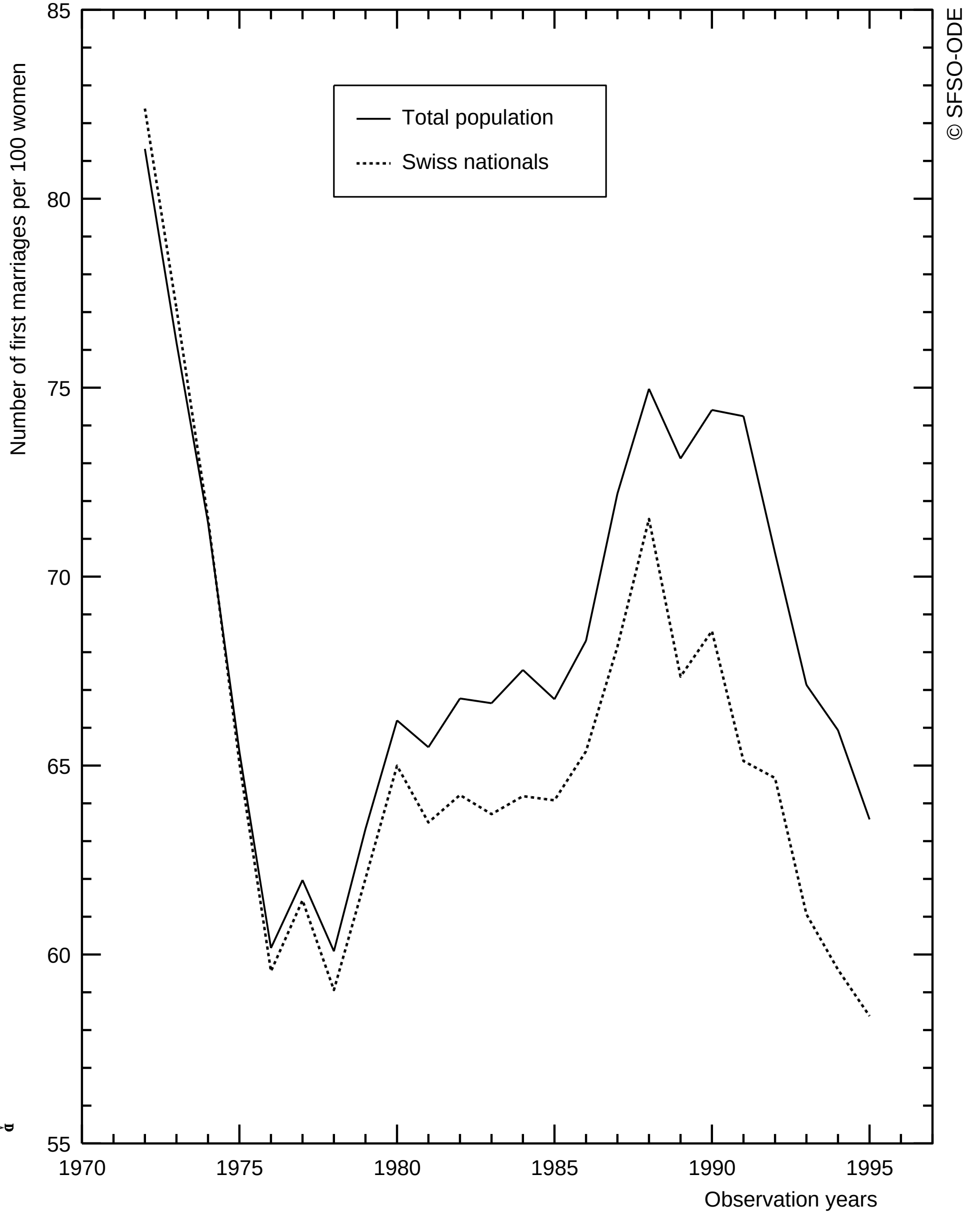
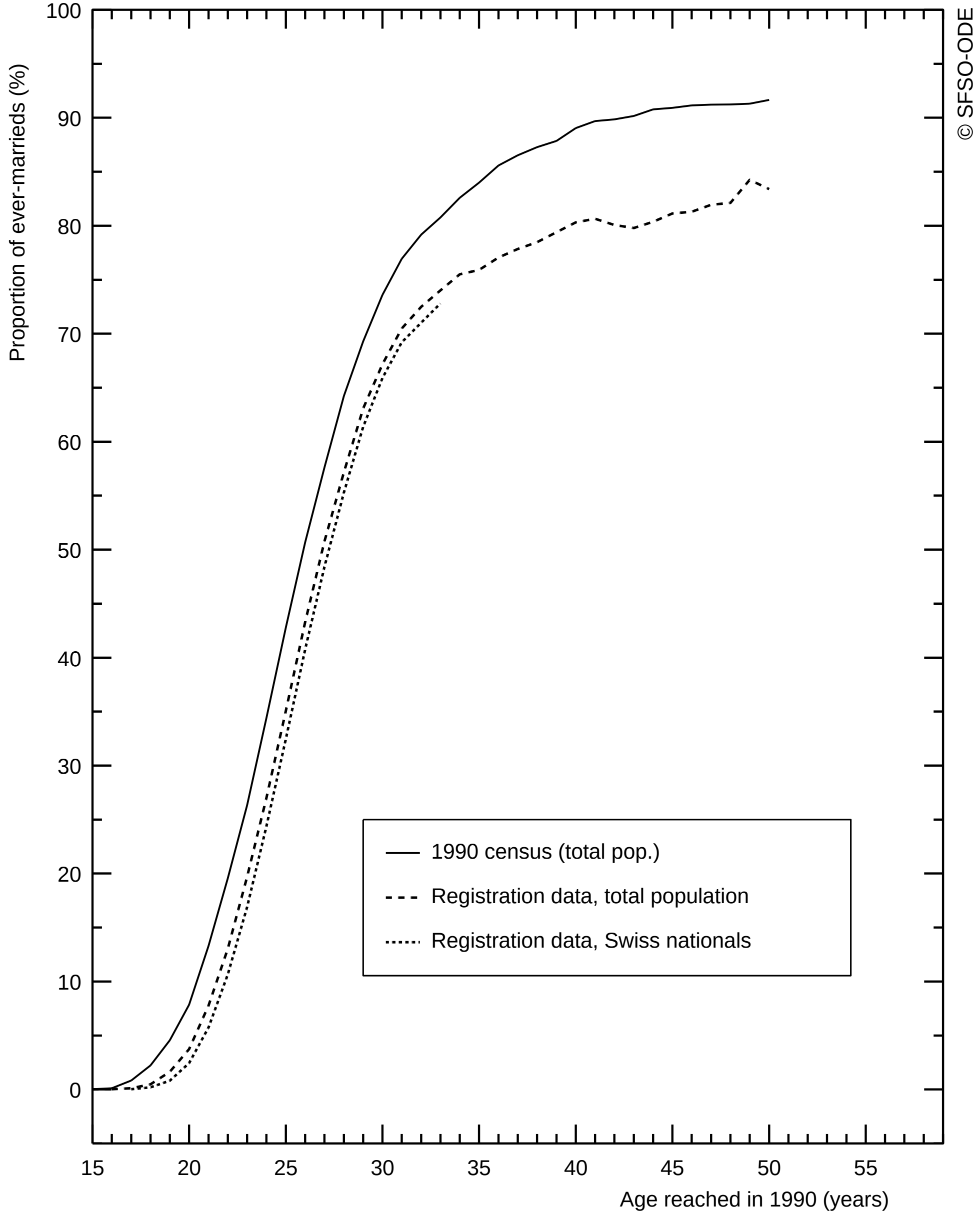


Figure 3.21 SWITZERLAND, females
Left-hand side: total female first marriage rate, 1972-1995
Right-hand side: proportion of ever-married females by age in the census of 4.12.1990





Chapter 4: Divorce

Records of the number of divorces granted each year by the Swiss courts date back to 1876. Annual breakdowns of divorces by year of marriage are available from 1920, enabling the duration-specific divorce rates (duration attained during the calendar year of the divorce) to be calculated from that year. The denominators of these rates are the numbers of *initial* marriages in each cohort[7] and not, as would have been preferable had they been available, the numbers of marriages *subsisting* in each duration. But what is probably more serious and leads to some *over-estimation* of divorce frequency, is that the denominators cover only marriages *recorded by the Swiss statistical system*. But a divorce granted in Switzerland may very well refer to a marriage celebrated abroad.

Stable divorce rates to the mid-1960s, rising rapidly for the past thirty years

Figure 4.1 shows the trend of duration-specific divorce rates since 1920. Until the mid-1960s, the rates are stable or rising slightly. Then, there is an *abrupt* increase at each marriage duration. In the space of thirty years they have more or less *tripled* and their continuing rise shows no signs of levelling off, although at certain durations (1, 2, 4 and 5 years), a slight dip is to be seen which might have at least something to do with the imperfection of the data available.

The total period rate (Figure 4.2) moves from a value which hardly deviated from 12 divorces per 100 marriages between 1945 and 1965 to nearly 40 divorces per 100 marriages in 1996. The most striking feature of this rise in divorces is the *simultaneity* with which the rates at the different marriage durations began to pick up speed. This is not a phenomenon which gradually spread to the successive marriage cohorts, but an abrupt *general* increase around 1965 in the propensity to divorce, both for recent marriages (after 2 to 5 years) and those married for 10, 15, 20 or even 25 years. And yet there was no change in Swiss divorce law at that time.

In terms of proportion of marriages ending in divorce in the successive cohorts, there is a slow and regular increase from the 1920 cohort (10% of marriages ending in divorce) to the 1955 cohort (15%), followed by an acceleration, with the 1970 cohort likely to attain a proportion close to 30%.

In the same way as that used for first marriage rates, the crude divorce rate for the pre-1920 period can be estimated from the information on the annual numbers of both marriages and divorces. We used the duration-specific divorce rates observed in 1925 (preferred to 1920, which was too close to the end of the First World War) to plot the annual series of the average size of the marriage cohorts exposed to the risk of divorce. This same estimation method, applied to

[7] A marriage *cohort* is composed of all the marriages that were celebrated during the same calendar year.

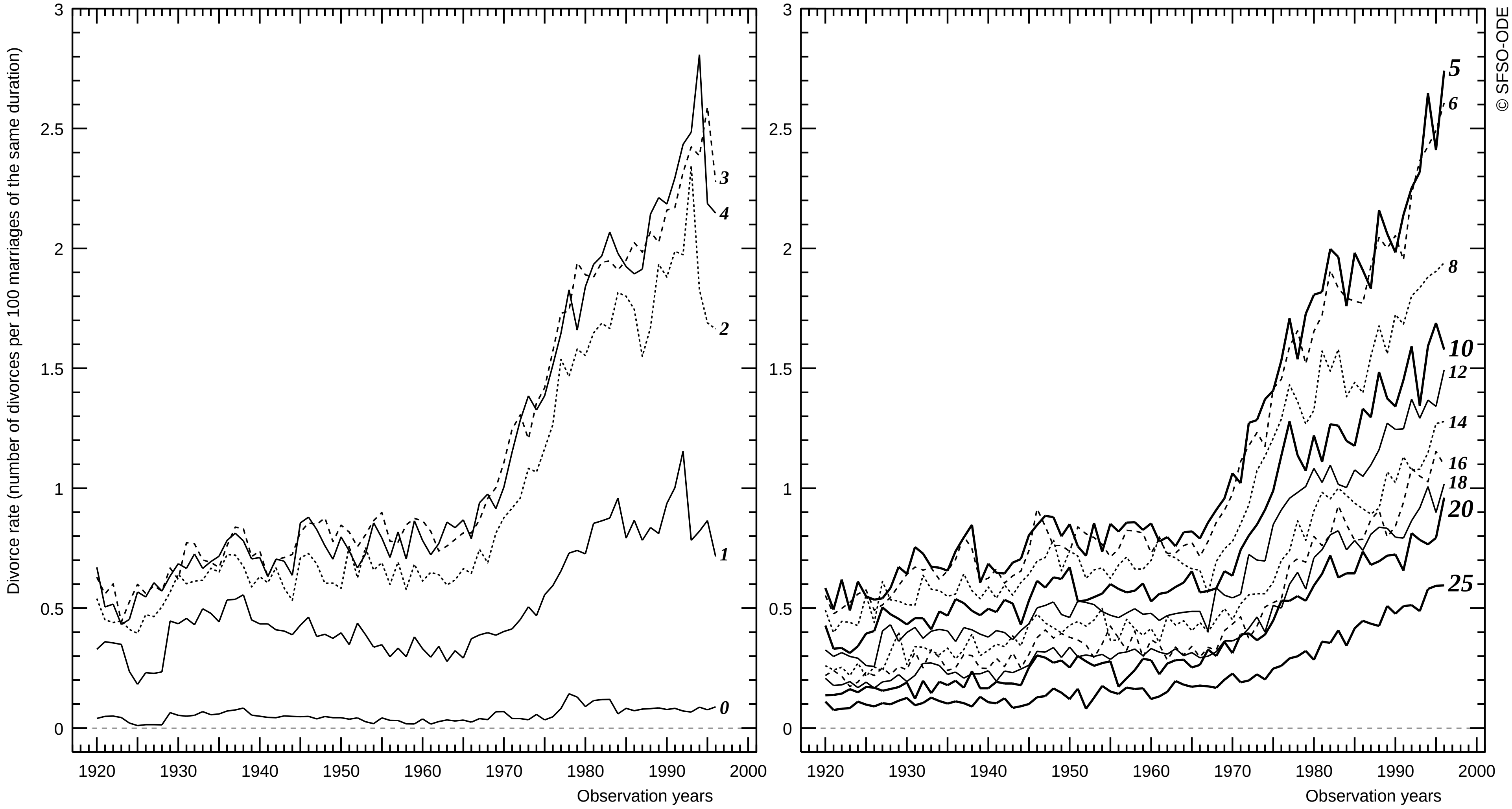
the period 1920-1996 for which the rates are available, never produces a total period rate with a more than 0.5% error (the maximum error is in 1984, when the total period rate is 28.9% and the estimate 29.4%).

We see, therefore, that at the end of the 19th century and up to the First World War, the total period rate was stable at around 4 divorces per 100 marriages. There is an upsurge in divorces in 1920, although a very moderate one compared to contemporary values, the rate rising from 7.9% in 1919 to 8.9% in 1920, falling back to 7.7% in 1921. Likewise, there was a somewhat more sustained rise in divorce in 1945-1946 (total period rate of 10.0% in 1944 and 13.4% in 1946).

Figure 4.3 illustrates how the annual number of divorces translates into the product of the total period rate by the average size of the marriage cohorts exposed to the risk of divorce. It will be seen that the rise in the annual number of divorces has been checked for twenty years by the decrease, then the levelling-off, in the number of marriages.

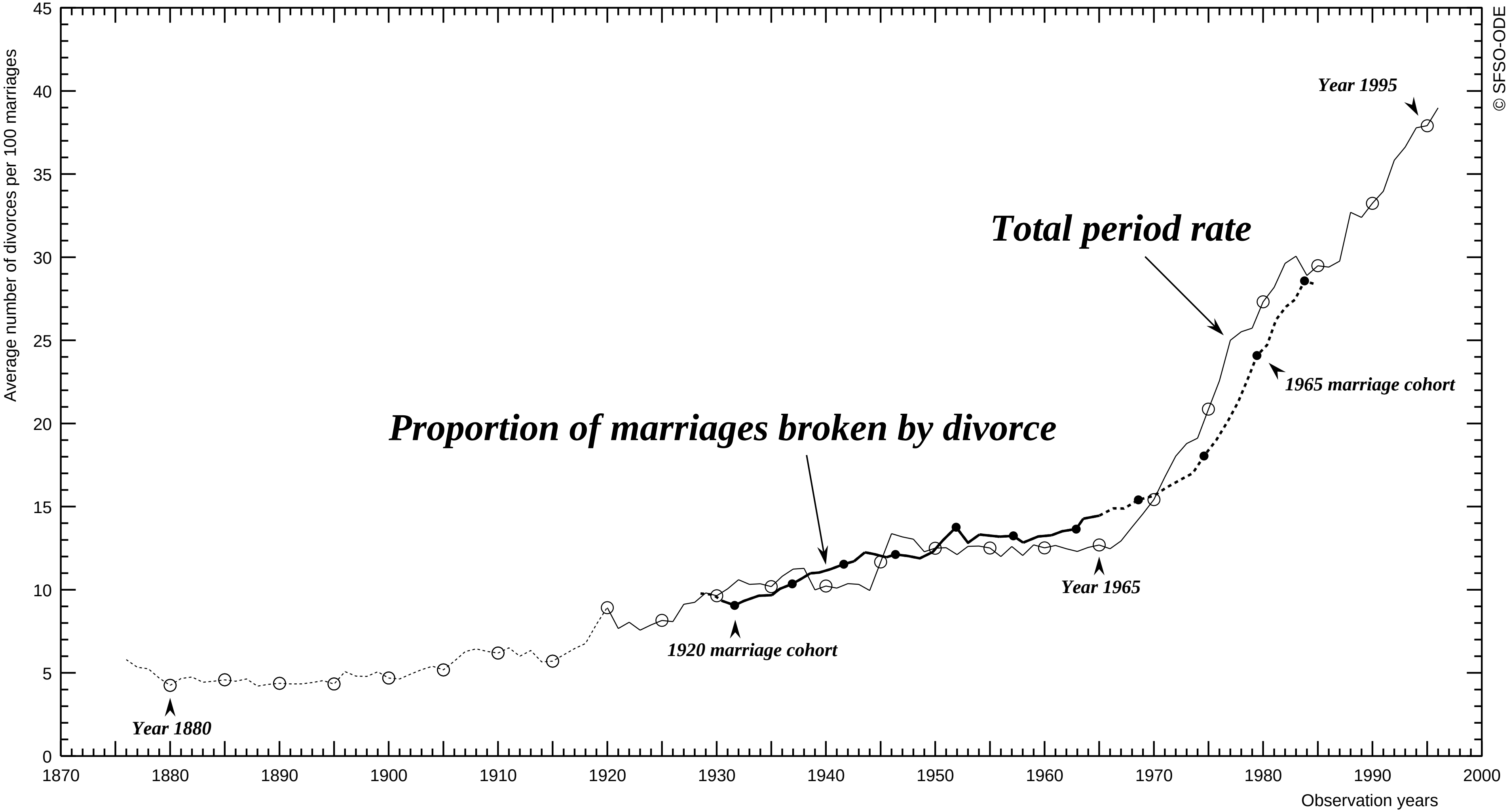
Average marriage durations at the time of divorce (Figure 4.4) have not varied significantly in period terms for 75 years (between 10 and 11 years from 1920 to 1945, between 11 and 12 years since the Second World War). Due particularly to the simultaneous increase in rates from the mid-1960s, the average marriage duration at the time of divorce between marriage cohorts begins to increase from 11.5 years in the 1920-1945 cohorts to nearly 15 years in the cohorts formed around 1960. This should then begin to decrease, with marriages formed in 1970 probably having an average duration of 13.5 years.

Figure 4.1 SWITZERLAND, 1920-1996
DIVORCE RATE at the same marriage duration
Rate by duration reached during the calendar year of the divorce
Left-hand side: durations from 0 to 4 years, right-hand side: durations from 5 to 25 years



The divorce rate at the duration of 2 years in 1990 is the ratio of the number of divorces granted in Switzerland in 1990 corresponding to marriages celebrated in 1988 to the number of marriages recorded by Swiss vital statistics in 1988

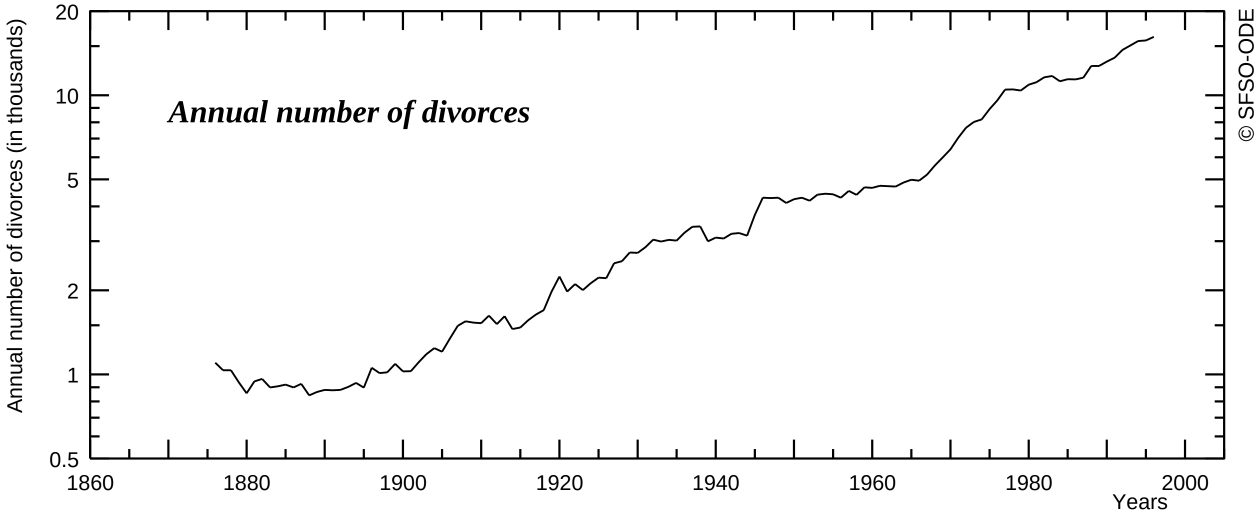
Figure 4.2 SWITZERLAND, 1876-1996
TOTAL DIVORCE RATE and
PROPORTION of marriages broken by divorce in the marriage cohorts
shifted by the average marriage duration at the time of divorce
Dotted lines: estimates
The circles denote the observation years (empty circles) or the marriage cohorts (solid circles) whose years are multiples of 5

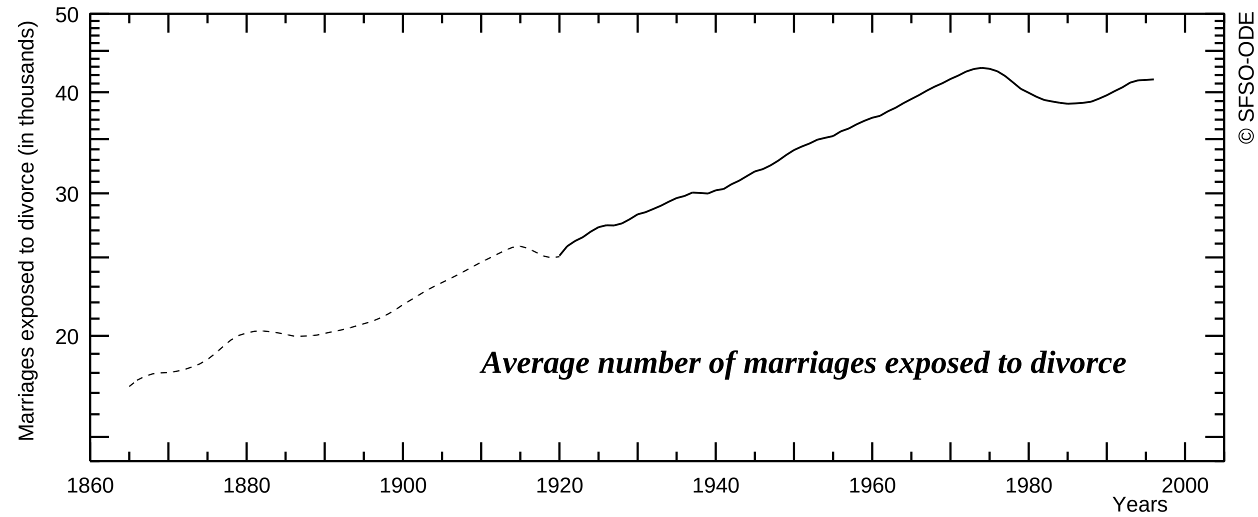


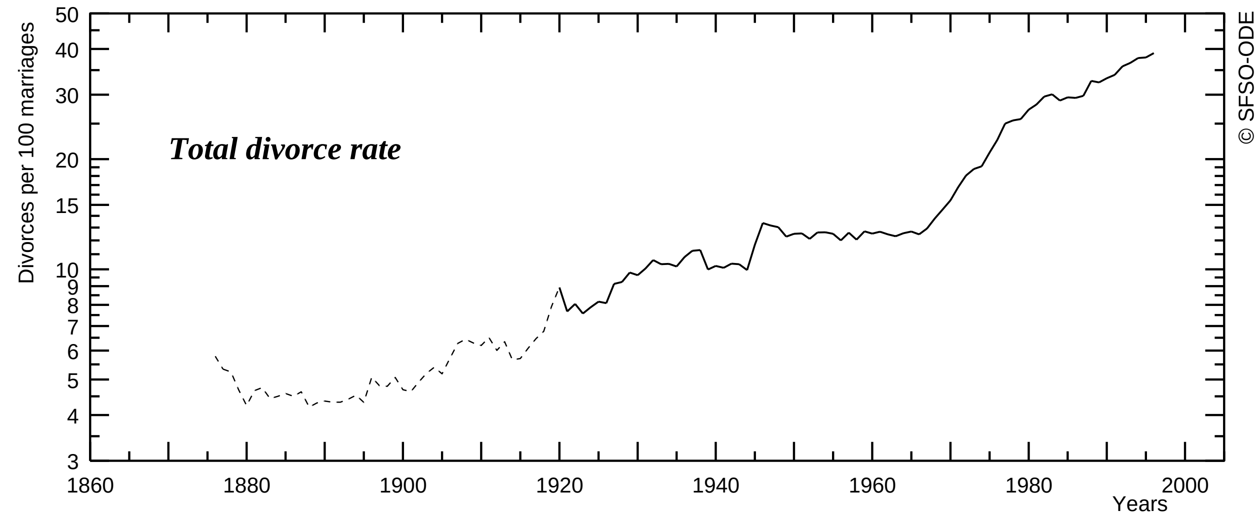
The proportion of marriages broken by divorce in the 1920 marriage cohort,

whose average marriage duration at the time of the divorce was 11.7 years, is assigned to observation year 1920 + 11.7 = 1931.7

Figure 4.3 SWITZERLAND, 1865-2003
Annual number of DIVORCES
Average SIZE of the marriage cohorts exposed to divorce
Total DIVORCE RATE
Logarithmic scales, dotted lines: estimates

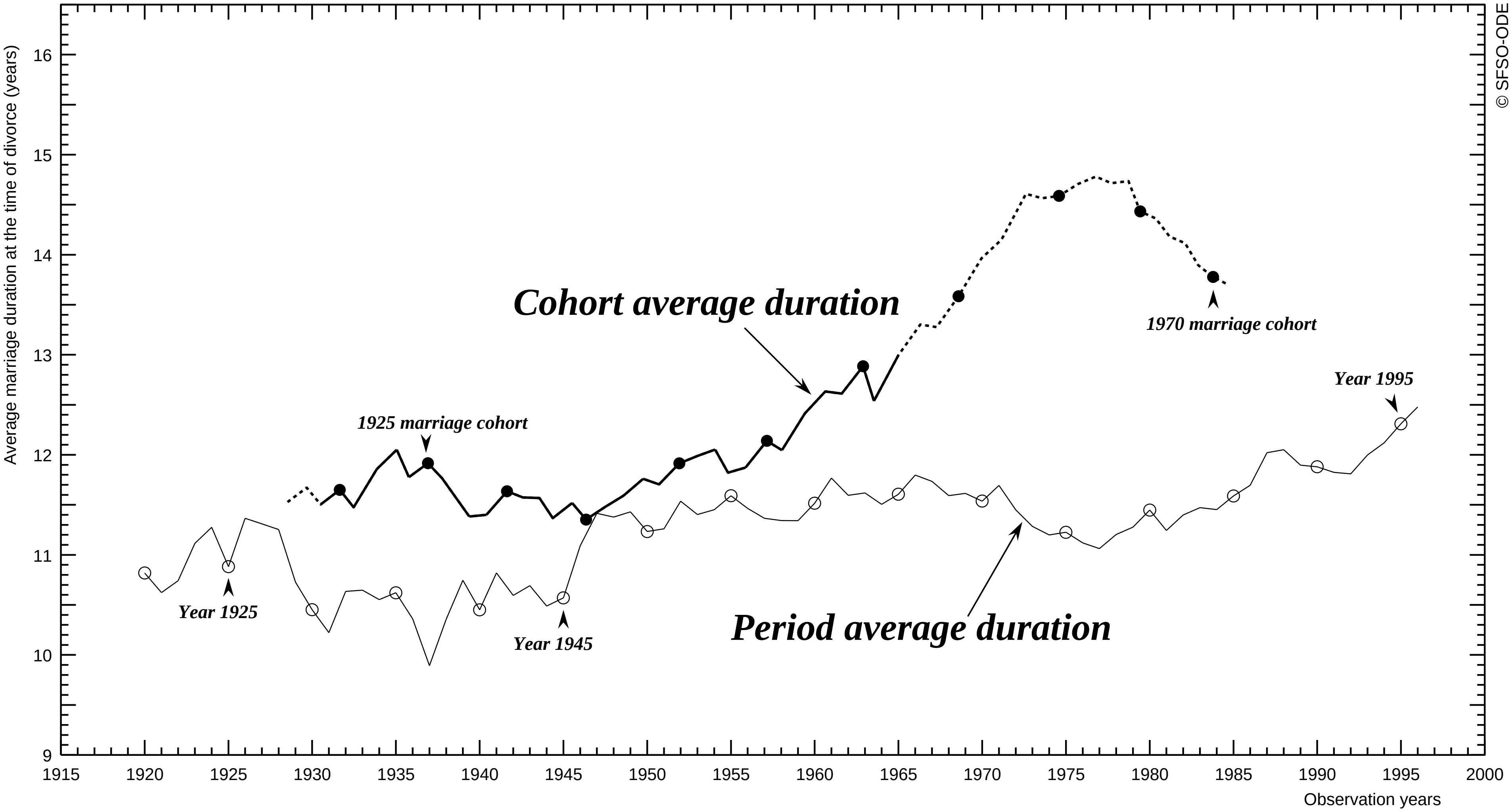






The relative change in the annual number of divorces during a period is the sum of the relative changes in the average number of marriages exposed to divorce and in the total period rate

Figure 4.4 SWITZERLAND, 1920-1996
AVERAGE marriage DURATION at the time of DIVORCE, PERIOD AND COHORT analysis
(the latter shifted by the average marriage duration at the time of divorce)
Dotted lines: estimated mean age
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The average marriage duration at the time of divorce in the 1925 marriage cohort, equal to 11.9 years, is assigned to observation year 1925 + 11.9 = 1936.9

Chapter 5: Fertility

Figure 5.1 shows the age-specific fertility rate trends since 1932. Figures 5.1.A, 5.1.B and 5.1.C, relating to the period 1932-2050, incorporate the rates derived from SFSO scenarios A, B and C. Skews from the migration effect mentioned earlier which affect the first marriage rates, most probably have no significant equivalents as regards fertility.

General rise in fertility from the end of the 1930s, peaking in 1964

The rise in age-specific fertility rates begins in 1938-1940. At all ages below 30, it occurs in two phases: a sharp rise from 1940 to 1945, a lull (in the under-25s) or a slight drop (between 25 and 30) over the next ten years, followed by a fresh upturn from 1955 to 1964. Generally, the rates show significant rises. So, the proportion of women giving birth in the year of their twenty-fifth birthday doubled from 10% in 1938 to 20% in 1964.

At the higher reproductive ages (30 and over), the rise of 1940-1945 is followed by a fairly significant decline, moderating somewhat between 1955 and 1964.

Fertility has declined and remained at a low level for twenty years

From 1964, all rates fell sharply. A rapid decline for ten years at all ages was followed by two diverging trends which still persist today: at the lower end of the age range (up to 26 years), the rates continue to decline, although at a slower pace, while at the higher reproductive ages (30 and over), there is a rising trend at all ages.

Finally, the last reported fertility rates (1996) are below their values at the end of the 1930s at *all* ages. So, as we saw earlier in relation to marriage, the phase of rising fertility rates which, in the under-30s, stretched over twenty-five years from the early 1940s to the mid-1960s, has been completely negated by the decline of the following thirty years.

Such a context obviously makes long-term forecasting a difficult undertaking. In its calculations up to 2050, the SFSO mapped out three scenarios. The central scenario, called scenario A (Figure 5.1.A), assumes a slowdown in the declining rates at the younger ages (up to 26) and a continuing upturn at the higher ages up to 2010. Beyond 2010, the rates are assumed to remain invariant at the same age. Scenarios B and C lie either side of scenario A. The former forecasts a less pronounced fall – even an upturn – among the younger ages and a slightly more vigorous increase at the higher ages (Figure 5.1.B), while the latter suggests a more pronounced decline in the younger ages and a more modest upturn at the higher ages (Figure 5.1.C).

Figure 5.2 shows the age-specific trend in *children ever-born* for successive birth cohorts since 1910. The most fertile generations of contemporary times are the 1920-1935 birth cohorts, with an average of 2.2 children per woman, a little more than the 1910 birth cohort (barely over 2), but markedly more than the most recent generations whose completed fertility can be estimated without too much uncertainty: the generations born from 1955 to 1960 will in all likelihood be below 1.8 children per woman.

The SFSO scenarios (Figures 5.2.A, 5.2.B and 5.2.C) give the 2000 birth cohort, who will be 50 years of age at the end of the time frame, a completed fertility of 1.58 children per woman in scenario A, 1.75 in scenario B and 1.35 in scenario C.

Figure 5.3 shows the recorded fertility rates during *the same observation year*, figure 5.4 those referring to *the same generation*. We have applied a reference curve to these figures corresponding to observation year 1970 (Figure 5.3) or the 1940 birth cohort (Figure 5.4), a year and generation whose age-specific rates lead to a total close to replacement (2.1 children per woman). The time-related progressive distortions in these curves are clear to see: the age at first birth falls then rises, while its overall level rises then falls. Figure 5.4 in particular shows the growing delay with which the most recent generations (those born in 1960, 1965 and 1970) had their first children.

Figures 5.3.A and 5.4.A are equivalent to figures 5.3 and 5.4, the unobserved rates being those of the SFSO scenarios.

Fertility since the mid-19th century: a long-term decline punctuated by the astonishing interlude of the forty boom years (1938-1978)

The total fertility rate which, by addition, summarizes the age-specific rates, can be estimated for the period prior to 1932, the first year for which we have age-specific rates.

The reason is that where both the total number of births in year *n* are known – which is the case since 1803 – and the size of the female population of reproductive age (15-49 years) per year of age at either end of the year - which is the case since 1861 -, the total period rate can be estimated from the annual number of reported births and the estimated weighted average size of the female generations of reproductive age during year *n* (see Glossary): the total period rate is the ratio of the absolute number of annual births to the weighted average size of the female generations of reproductive age. Strictly, this weighted average size should be computed using the (unknown) age-specific fertility rates of year *n itself*, but it is well known that a weighted average is not particularly sensitive to changes in the weighting coefficients (and not at all if the female population size is invariant from one age to another, a situation from which one is never very far off). So, the rates of a *different* year to year *n* can be used as weighting coefficients. We used those of 1932, and applied this estimation method to every year in the period 1861-1996; the accuracy of this method is revealed by the period since 1932: the maximum error made on the period rate in absolute values was in 1968, when it was - 0.08 children per woman; between 1932 and 1996, it exceeds 0.03 children per woman only from 1962 to 1975 – a period when the age at first birth was particular early and hence very different from that of 1932.

The total fertility rate in Switzerland (Figure 5.5) was about 3.6 to 3.8 children per woman at the end of the 19th century, rising to 4.4 children per woman in 1875 as a result of the high nuptiality recorded at that time. It started to decline rapidly from 1900 to 1913 down to 3 children per woman. The First World War initiated a fall which was only partly compensated by the upturn in 1920-1922. In 1923, it returned to the downward trend seen at the turn of the century. It was not until 1938 that a reversal of the trend began to emerge which was to prove surprising in both duration and magnitude.

If the fertility of the last sixty last years is recontextualized in its long-term trend, it is legitimate to wonder whether the present situation is not quite simply a return to the previous very long-term trend manifested in the *effective* fertility trend during the periods 1900-1913 and 1923-1937: the four-decade interlude of high fertility (1938-1978) would represent a sort of *historical anomaly* of very great magnitude, as unexpected as it is unexplained, which could be described as a *forty-year baby boom*. This being so, the demographic transition phase in post-industrialized European countries would give way to a period of low, relatively stable, long-term markedly below-replacement fertility.

Lower, but also later fertility

Figure 5.6 shows the trend of age at first birth by observation year and by year of birth. The lowering in mean age at childbirth between the female 1910 birth cohort (30.6 years) and 1945 birth cohort (26.8 years) is nearly *four* years – a very large difference. The subsequent rise, which is not yet completed and may even be only half attained, should return it to values close to 30 years. This dual movement in age at childbirth is to be associated with that of age at first marriage (Figures 5.7 and 5.8). It is also probable that, among the 1855-1910 birth cohorts or during the period 1870-1930, age at childbirth was fairly invariant to judge by the stability observed in age at first marriage.

Figure 5.9 presents both the total fertility rate trend and that of the transversal average age at childbirth in a correlation diagram, showing periods of rapid change in either measures of fertility (1940-1945 and 1964-1976 in particular).

Figure 5.10 is similar to figure 5.9, but presenting the longitudinal rather than the transversal measures. While the transversal measures have virtually turned *full circle* over the past sixty years, the longitudinal measures have turned only three-quarters of a circle.

Figures 5.9.A and 5.10.A are identical to figures 5.9 and 5.10., apart from the fact that they also include the assumptions in the SFSO scenarios up to 2050. In transversal terms (Figure 5.9.A), all three scenarios – especially scenario B, the other scenarios differing by a lower total period rate – significantly «close the circle», with the situation in 2050 being similar[8] to that at the end of the 1930's, especially as regards average age at childbirth. The longitudinal picture

[8] Close from the viewpoint of the two measures considered (average parity per woman and longitudinal average age at childbirth), but most probably not in terms of *breakdown* by number of children.

(Figure 5.10.A) is somewhat different: the average age of the 2000 birth cohort is fairly close to that of the 1910 birth cohort, but completed fertility is markedly lower, even in scenario B.

The average size of female generations of reproductive age

As was done earlier for marriage, the comparative trend of the annual number of births, the average size of female birth cohorts in reproductive ages and the total fertility rate can be represented on a semi-logarithmic chart: the relative variation of the annual number of births is the sum of the relative variations of average size and rate (Figure 5.11). In the same way, the relative uncertainty about the number of future annual births is the sum of relative uncertainties relating to average size and total period rate, respectively.

The average size of the female generations of reproductive age has in the past increased at a rate close to that of the population as a whole, as has the average size of the generations of marriageable age (Figures 3.13 and 3.14) but, like the latter, is set to decrease over at least the next ten years, which, for the same total fertility rate, will cause a fall in the annual number of births.

Differential birth order fertility trends

The data, available from 1932 to 1996, on *birth order fertility* (breakdown of live births into *extra-marital* births and, for births *in wedlock*, into births distinguished by *birth order* (the statistical units used are defined in the appendix), enable us to show the observed birth order trend.

Figure 5.12 shows that *all* birth orders, including extra-marital births, were involved in the two most salient general trends, the upturn of 1940 to 1945 and the abrupt fall of 1964 to 1975. Birth orders 3 and above reproduce and accentuate the overall trends: the upturn of 1940 to 1945 is somewhat faster for birth orders 3 and above than for birth orders 1 and 2, but the fall of 1964 to 1975 in particular is considerably more pronounced. Between 1964 and 1975, the period rate for birth order 3 and above declines spectacularly by *two thirds*, from 0.82 to 0.28 children per woman, while the rates for birth orders 1 and 2 fall from 1.00 to 0.65 and 0.76 to 0.58 children per woman, respectively. The total period rate of extra-marital births, which is markedly lower in Switzerland than in neighbouring countries, increased very slightly from 1932 to 1965, from 0.07 to 0.10 children per woman, returning to 0.06 in 1975.

Moderate fertility decline in birth orders 1 and 2, a very pronounced decline in birth orders 3 and above

The total rates have been relatively stable (birth order 1) or very slowly decreasing (birth orders 2 and 3 and above) over the past twenty years, while the rate of extra-marital births has risen slightly (0.12 children per woman in 1996), although remaining far below the much higher values currently observed in countries like England or France (about 0.60 children per woman).

By generation (Figure 5.13 to be compared with figure 5.12), the decline in completed fertility at birth order 1 or 2 is significantly below that of the corresponding total rate: this is attributable to the depressive effect exerted by the rising age at motherhood for each birth order on the order-specific total rate (the curves in figures 5.15 and 5.16 *intersect*, as do those of figure 5.5).

Between the 1915 and 1955 birth cohorts, completed fertility at birth order 1 increases initially by 0.10 children per woman up to the 1935 cohort, then decreases by 0.05; that at birth order 2 increases by 0.10, then decreases by 0.07. Lifetime non-marital fertility (Figure 5.14) increases slightly (by 0.02) between the 1915 and 1955 birth cohorts.

But – and herein lies the most salient feature of overall fertility decline – completed fertility at birth order 3 and above decreases *uninterruptedly* from the 1917 cohort to the 1951 cohort (Figure 5.17). Comparing the 1915 and 1955 cohorts, the reduction at birth orders 3 and above amounts to 0.53 children per woman, constituting a decisive factor in the decrease of 0.42 children per woman in completed fertility of all birth orders together between these two generations forty years apart. Note that between the 1948 and 1959 birth cohorts, completed fertility at birth order 3 and above is fairly stable.

The approximate stability of completed fertility – around 2.2 children per woman – in the most fertile generations of the contemporary period (those born between 1915 and 1935) is therefore the product of a combined fertility *increase* at birth orders 1 and 2 and fertility *decline* at birth order 3 and above.

The subsequent decline in completed fertility between the 1935 and 1955 birth cohorts is the result of a relatively *moderate* decline in birth orders 1 and 2 and a *pronounced* decline in birth orders 3 and above. In other words, between the 1935 and 1955 birth cohorts, the proportion of zero-parity women[9] increased (from approximately 19 to 24%), the proportion of single-parity women increased hardly at all (from 13 to 15%); the lower fertility of the 1955 birth cohort is especially attributable to the more pronounced increase in 2-children families (the proportion rising from 32 to 41%), the most marked decreases being observed in the proportion of the largest families (at least three children: down from 36 to 21%, of which precisely three children: down from 21 to 16%, four children or more: down from 15 to 5%).

Figures 5.18 to 5.21 show the age-specific fertility rate trends for *each* birth order. These figures are similar to figure 5.1 for *all* birth orders. The substantial decline in the rates at birth order 3 and above at all ages between 1964 and 1975 is particularly notable.

[9] Assuming no *remarriage* nor *extra-marital* birth, completed fertility at birth order 1 is equal to the proportion of women who, at the end of their childbearing age, have *at least* one child. More generally, completed fertility of birth order r is equal to the proportion of women who, at the end of their childbearing age, have *at least* r children. The difference between completed fertility at birth order r and completed fertility at birth order $r + 1$ is equal to the proportion of women who have precisely r children.

Figure 5.22 shows the sex-specific trends of mean age at first marriage and birth order-specific mean age at childbirth over the observation years, figure 5.23 shows them over the successive generations. The entire age of family formation first falls, then rises. In particular, the dwindling number of births in birth order 3 and more means that the mean age at childbirth for birth order 2, from being lower than mean age at childbirth for all birth orders together has now risen slightly above it.

Non-marital fertility

Although few and therefore having little influence on mean age at childbirth for all birth orders together, *extra-marital* births have changed in significance in the recent period. Up to the 1940-1945 female birth cohorts, the mean age at extra-marital childbirth was lower than and paralleled the trend in women's mean age at first marriage; in successive generations, it rises more quickly, equalling, then slightly exceeding, mean age at childbirth of birth order 1 in the current marriage.

This particular trend reflects the fact that extra-marital births today are increasingly less what they once were – namely unwanted births resulting from unprotected sexual intercourse to girls who did not ultimately marry the child's father; they have increasingly become wanted births to unmarried, generally never-married, women living in consensual unions which they do not particularly wish to convert into legally-constituted marriages. This is borne out by figure 5.18 which reveals the rapid decline since 1964 of non-marital fertility rates in the under-30s and their rapid increase at 30 and 35 years of age since the mid-1970s.

Increasing inadequacy of classification of births by birth order in the current marriage

Birth order, as defined in Swiss vital statistics – namely birth order *in the current marriage* – is increasingly less relevant, due to the rise in *divorces* (the same woman may have *two* children of birth order 1 if she gets divorced, then remarries) and the increase in *extra-marital* births (a birth order 1 child in the current marriage may actually be a *biological* birth order 2 child if the mother had a child by a different father before the current marriage)[10]. It is likely that the very rapid decline in fertility rates at birth orders 3 and above is accentuated to a small but growing extent by this increasingly marked distortion between the birth order in the current marriage and the biological birth order.

This increasing inadequacy of the statistical system does not, however, call into question the main conclusion drawn from the birth order analysis: the decline in completed fertility within successive female generations is primarily attributable to the lower birth-rate of children of birth order 3 and above.

[10] If the mother had a child out of wedlock, married the child's father and had then a second child, the first child was classified as born out of wedlock and the second as born in the current marriage with birth order 2.

Generation replacement

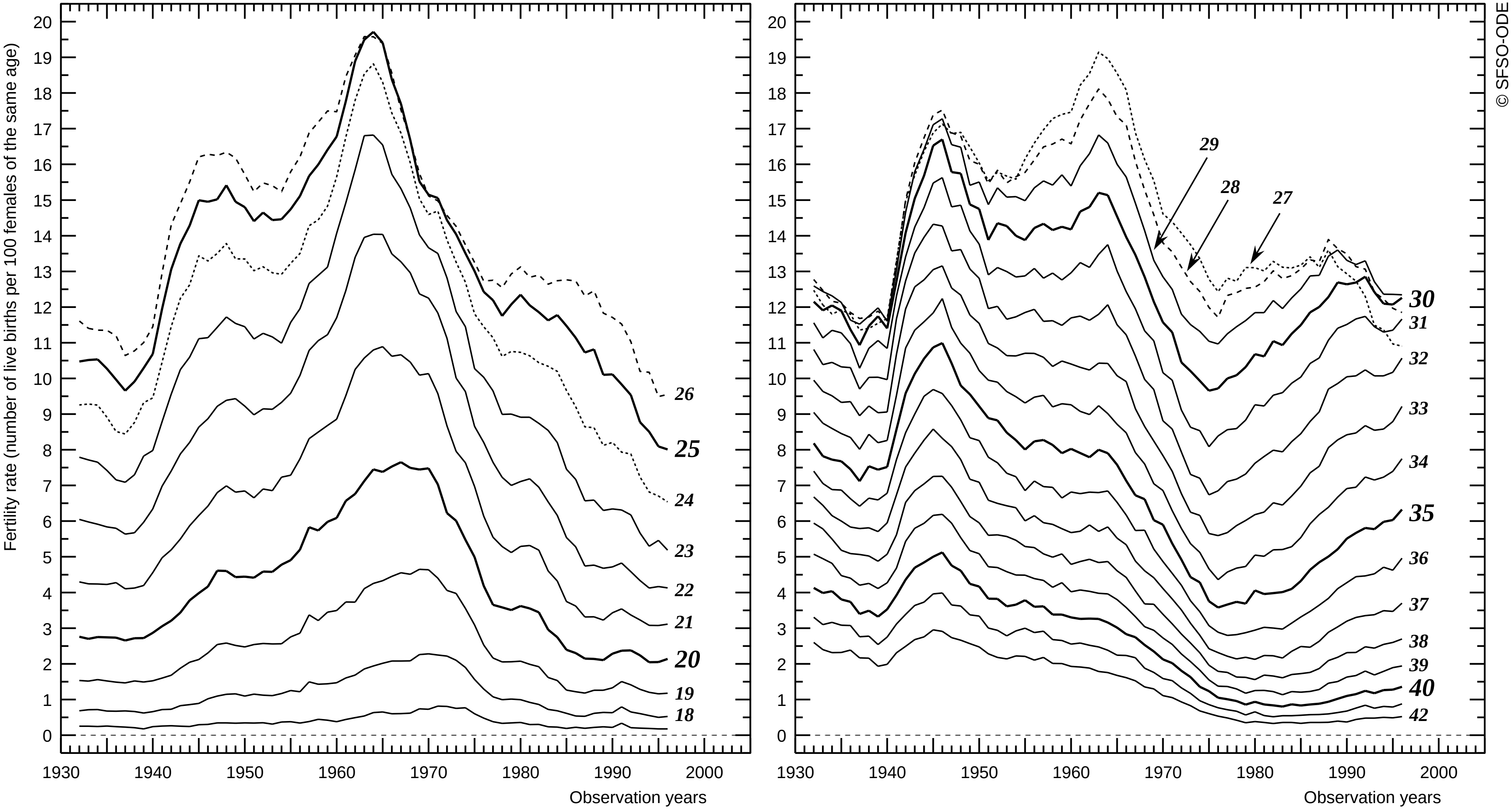
The mortality trend since the 19th century is described in the next chapter. Combining the transversal and longitudinal fertility tables with their mortality counterparts, the level of fertility necessary to ensure the identical replacement of women by their daughters at childbearing age – i.e., approximately adulthood – can be calculated.

Figure 5.24 (left-hand side) shows the trend of the total *effective* fertility rate and the trend of the exact replacement rate; the right-hand side of the figure shows the same generation-specific and completed fertility-specific trends. The decline in female mortality between birth and age at childbirth has lowered the replacement "bar": a hundred and twenty years ago, replacement fertility was 3.3 children per woman because of the high mortality of the time; now, 2.07 suffices.

In the absence of any mortality between birth and childbearing age, the replacement level would be 2.05 children per woman. No further significant reduction in the threshold is to be expected in the future, therefore.

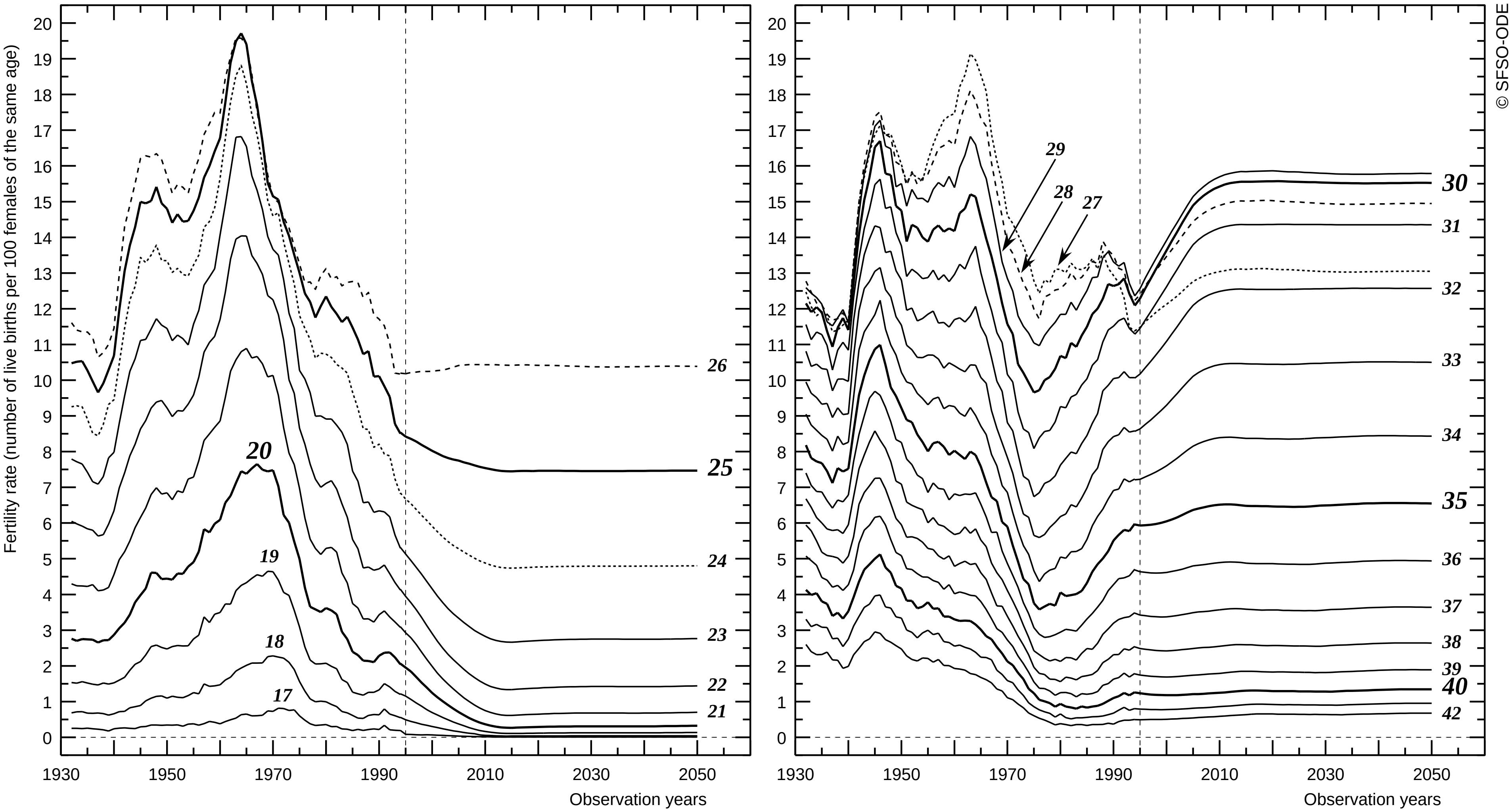
Replacement was not attained from 1922 to 1943, nor at any time since 1970. Of the cohorts born since 1907, only those born from 1915 to 1940 ensured their own replacement (with a completed fertility just 0.1 child per woman above replacement level). The three SFSO scenarios forecast that none of the 1940 to 2000 birth cohorts will ensure its own replacement.

Figure 5.1 SWITZERLAND, 1932-1996. AGE-SPECIFIC FERTILITY RATE at the same age
Rate by age reached during the calendar year of the birth
Left-hand side: ages 17-26, right-hand side: ages 27-42



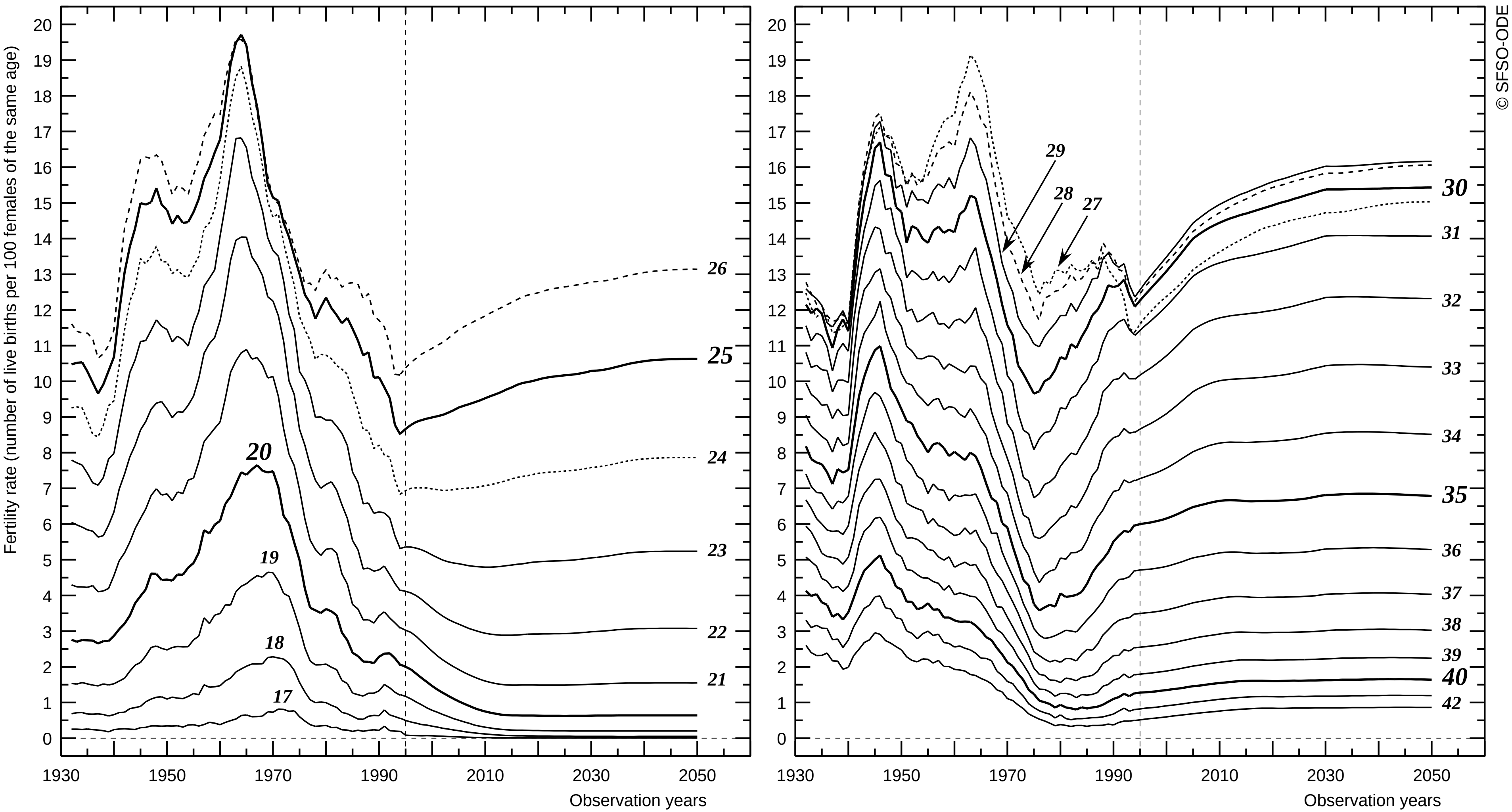
The fertility rate at 20 years of age in 1990 is the ratio of the number of children born in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.1.A SWITZERLAND, 1932-2050. SFSO A scenario, from 1995
AGE-SPECIFIC FERTILITY RATE at the same age (rate by age reached during the calendar year of the birth)
Left-hand side: ages 17-26, right-hand side: ages 27-42



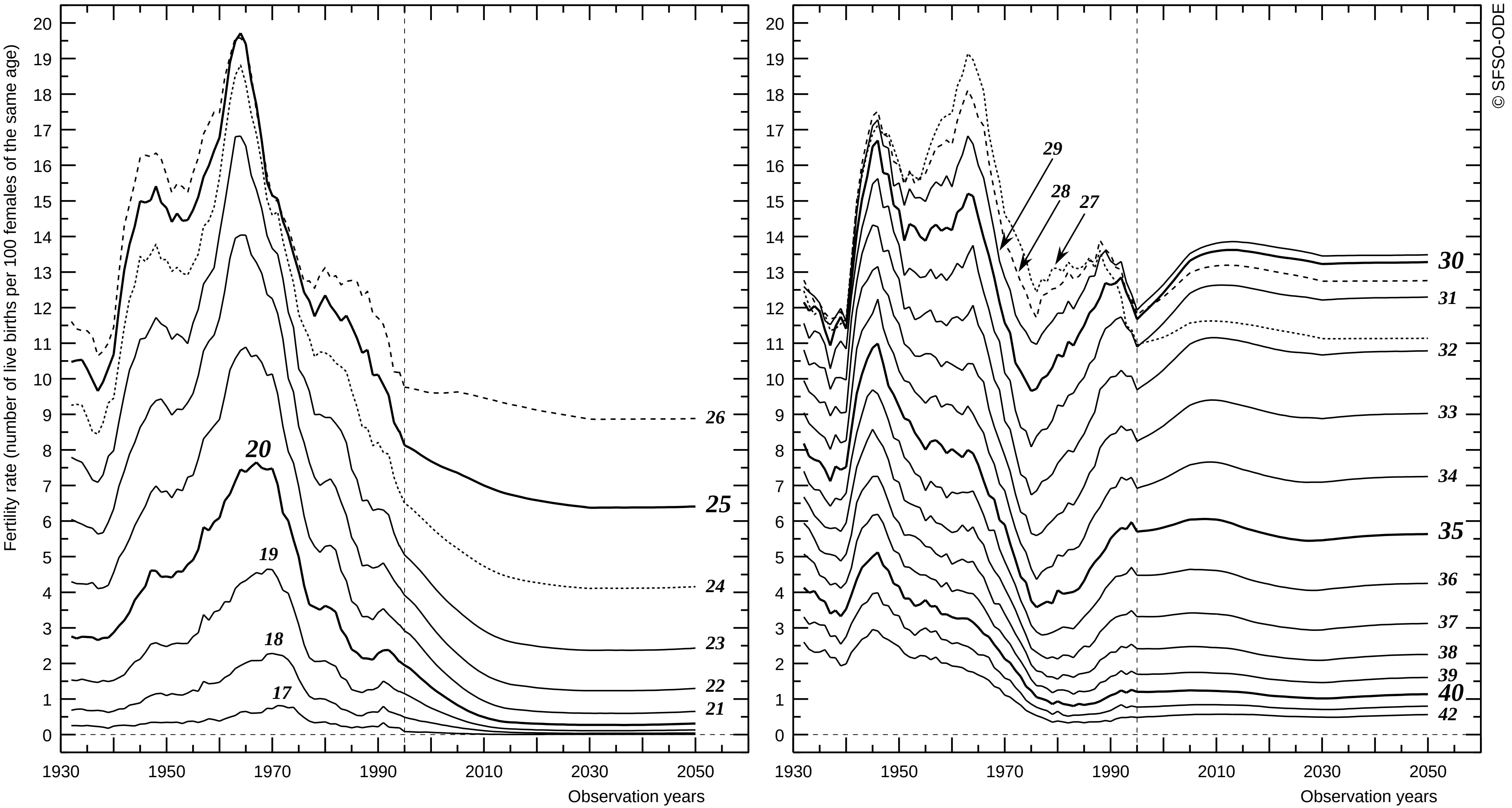
The fertility rate at 20 years of age in 1990 is the ratio of the number of children born in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.1.B SWITZERLAND, 1932-2050. SFSO B scenario, from 1995
AGE-SPECIFIC FERTILITY RATE at the same age (rate by age reached during the calendar year of the birth)
Left-hand side: ages 17-26, right-hand side: ages 27-42



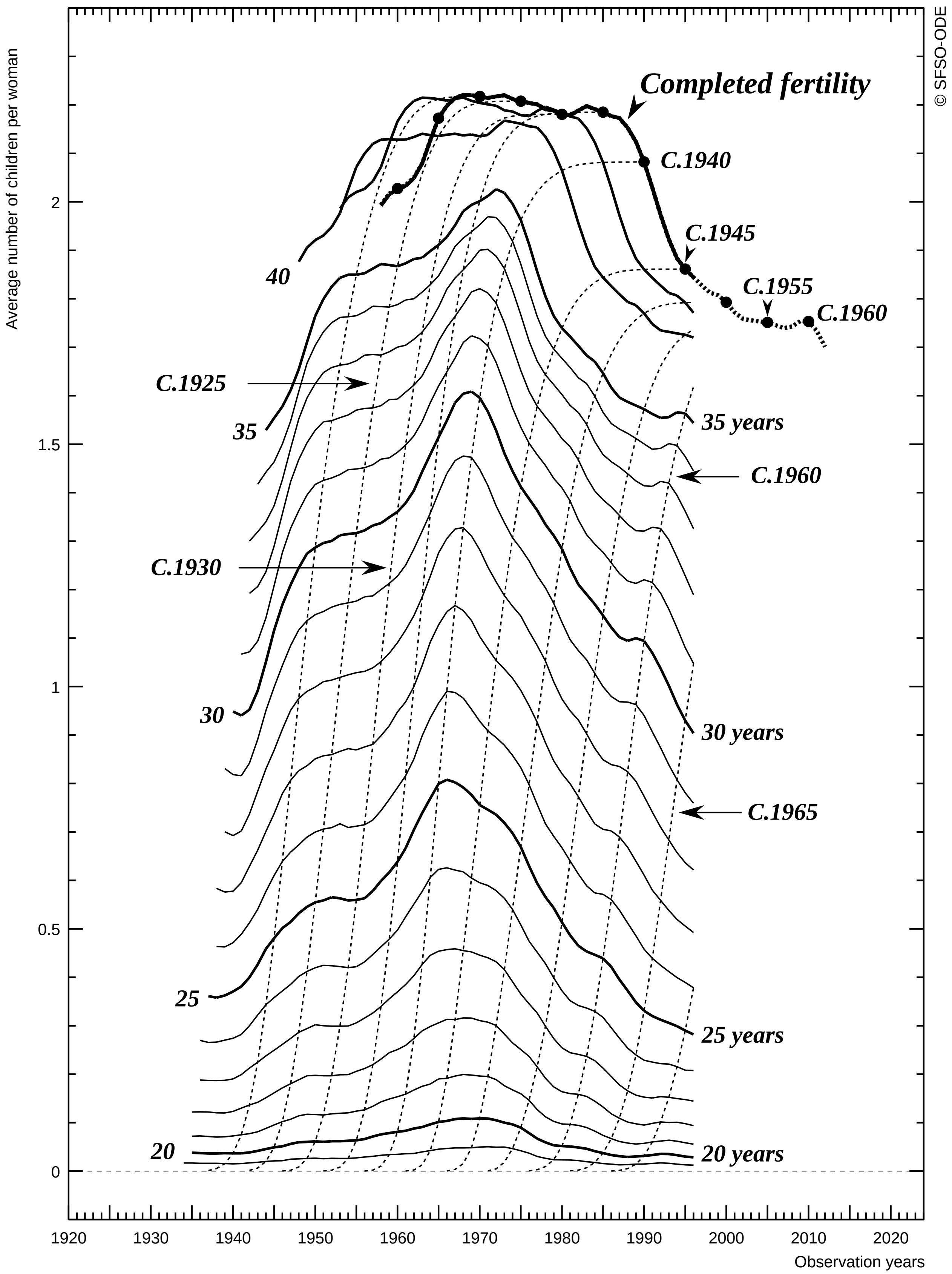
The fertility rate at 20 years of age in 1990 is the ratio of the number of children born in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.1.C SWITZERLAND, 1932-2050. SFSO C scenario, from 1995
AGE-SPECIFIC FERTILITY RATE at the same age (rate by age reached during the calendar year of the birth)
Left-hand side: ages 17-26, right-hand side: ages 27-42



The fertility rate at 20 years of age in 1990 is the ratio of the number of children born in Switzerland in 1990 whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

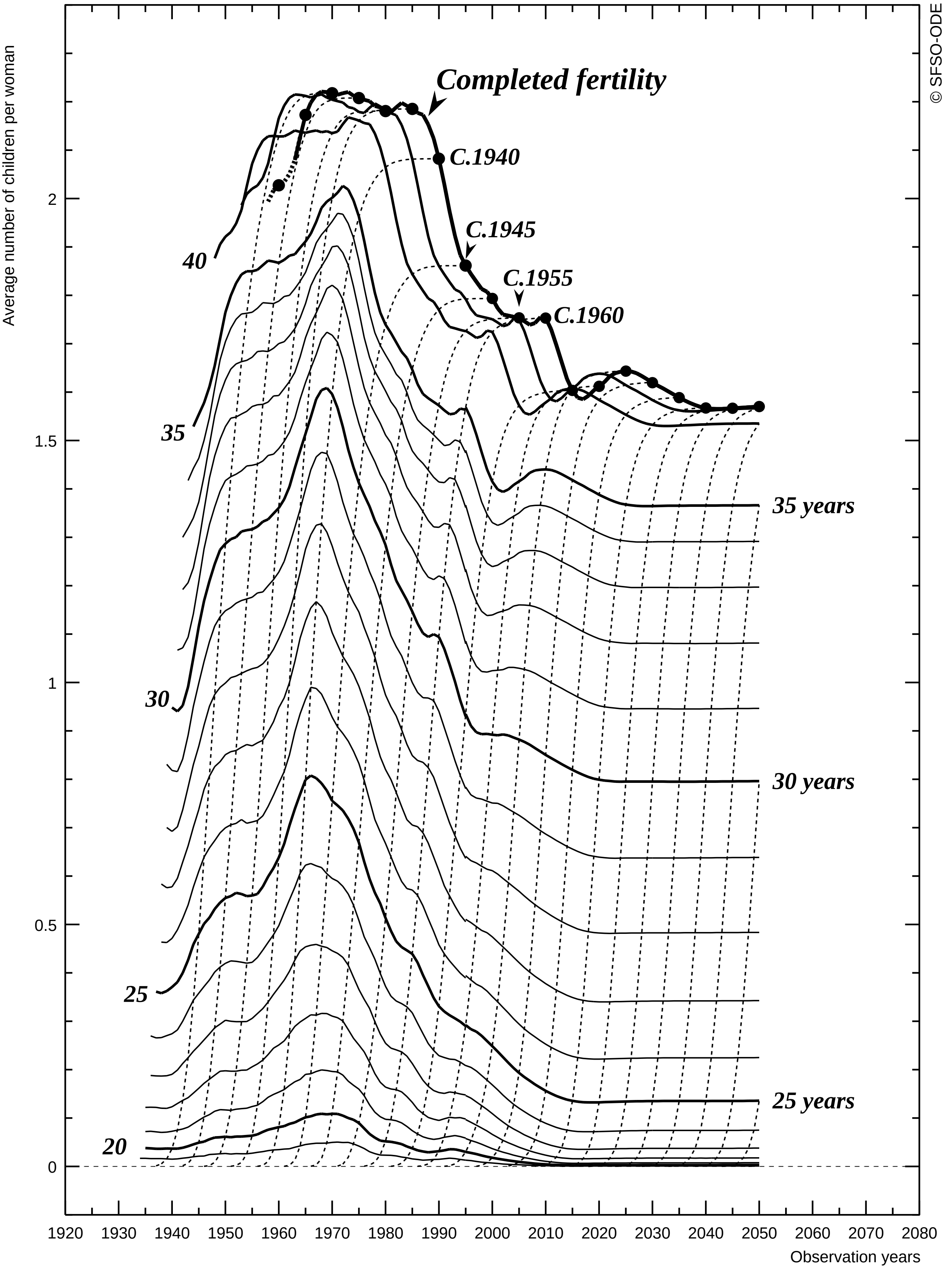
Figure 5.2 SWITZERLAND. INCOMPLETE FERTILITY at certain birthdays and COMPLETED FERTILITY of female birth cohorts born in and after 1920
Incomplete fertility at 19th, 20th..., 34th, 35th, 40th and 45th birthdays
birth cohorts born in 1920, 1925, 1930..., 1970
Completed fertility extrapolated by freezing the fertility rate, at the same age, at its actual value in 1995-1996



The solid lines represent incomplete fertility at the same age

The dotted lines represent incomplete fertility of the same female birth cohort

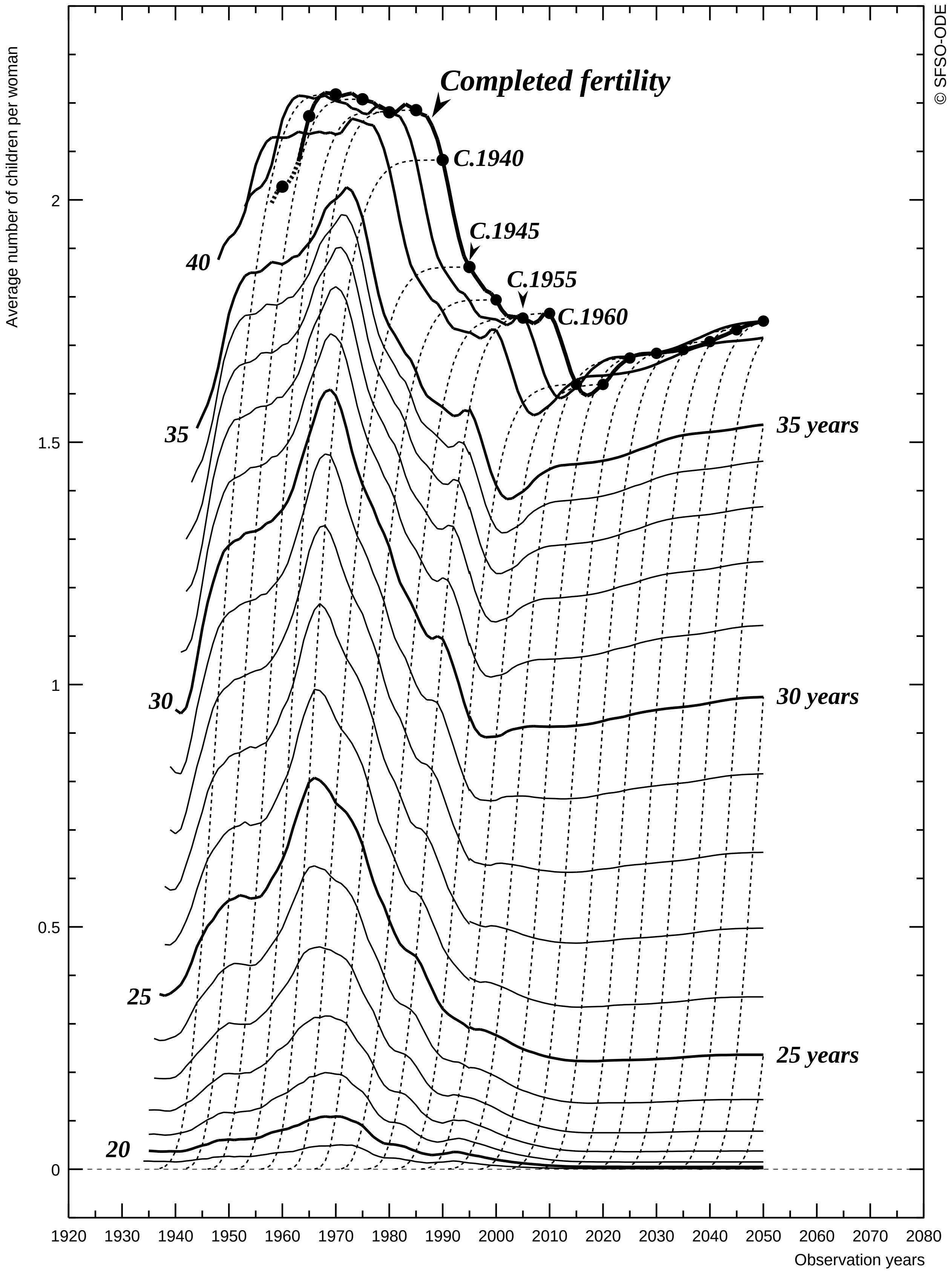
Figure 5.2.A SWITZERLAND. Incomplete fertility at certain birthdays and COMPLETED FERTILITY of female birth cohorts born in and after 1920 Incomplete fertility at 19th, 20th..., 34th, 35th, 40th and 45th birthdays birth cohorts born in 1920, 1925, 1930..., 2025 SFSO A scenario from 1995



The solid lines represent incomplete fertility at the same age

The dotted lines represent incomplete fertility of the same female birth cohort

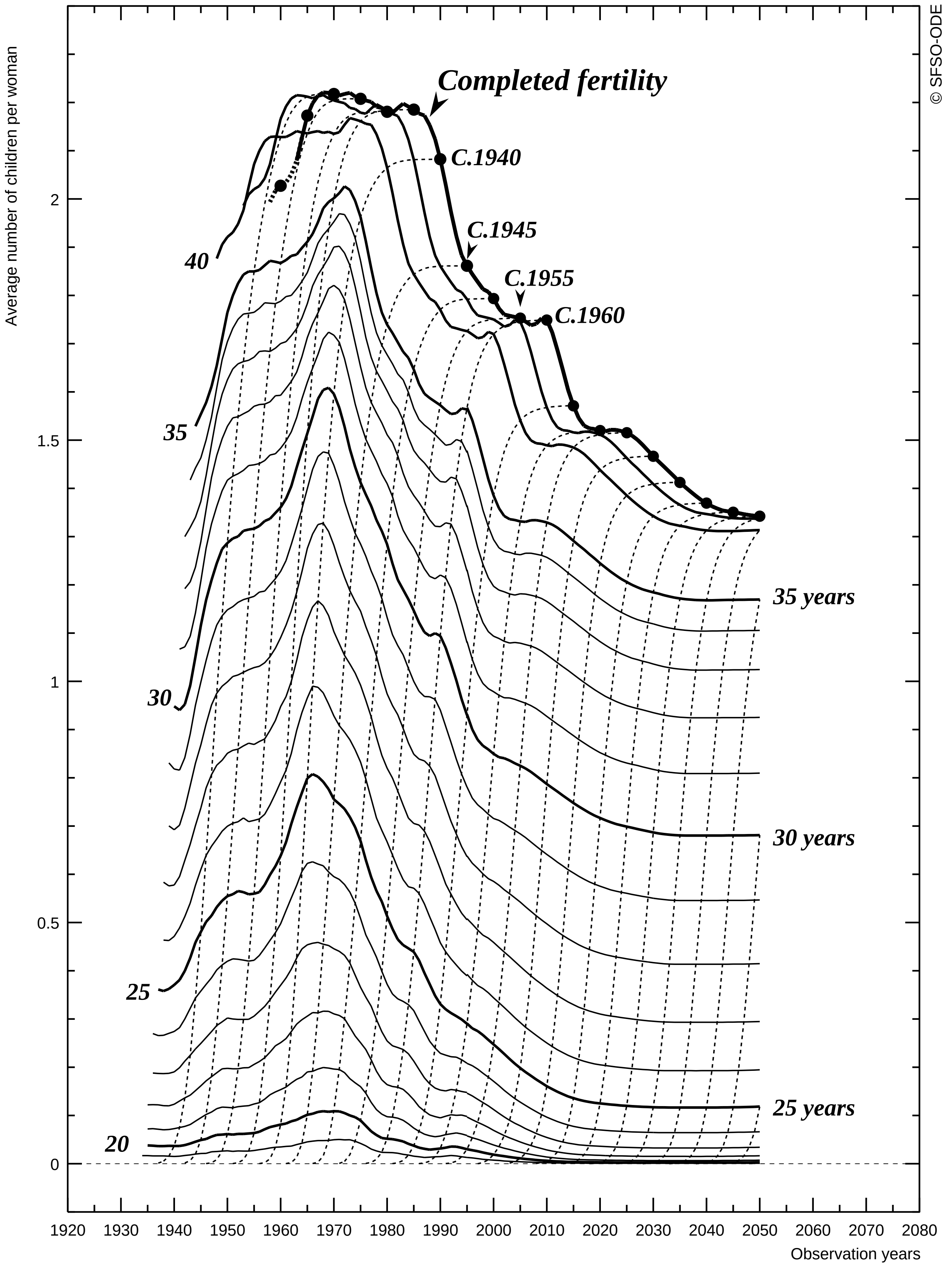
Figure 5.2.B SWITZERLAND. Incomplete fertility at certain birthdays and COMPLETED FERTILITY of female birth cohorts born in and after 1920 Incomplete fertility at 19th, 20th..., 34th, 35th, 40th and 45th birthdays birth cohorts born in 1920, 1925, 1930..., 2025 SFSO B scenario from 1995



The solid lines represent incomplete fertility at the same age

The dotted lines represent incomplete fertility of the same female birth cohort

Figure 5.2.C SWITZERLAND. Incomplete fertility at certain birthdays and COMPLETED FERTILITY of female birth cohorts born in and after 1920 Incomplete fertility at 19th, 20th..., 34th, 35th, 40th and 45th birthdays birth cohorts born in 1920, 1925, 1930..., 2025 SFSO C scenario from 1995



The solid lines represent incomplete fertility at the same age

The dotted lines represent incomplete fertility of the same female birth cohort

Figure 5.3 SWITZERLAND, 1932-1996
AGE-SPECIFIC FERTILITY rates
by age reached during the calendar year of the birth
Dotted line: rates of 1970
Total period fertility rate of 1970: 2.10 children per woman

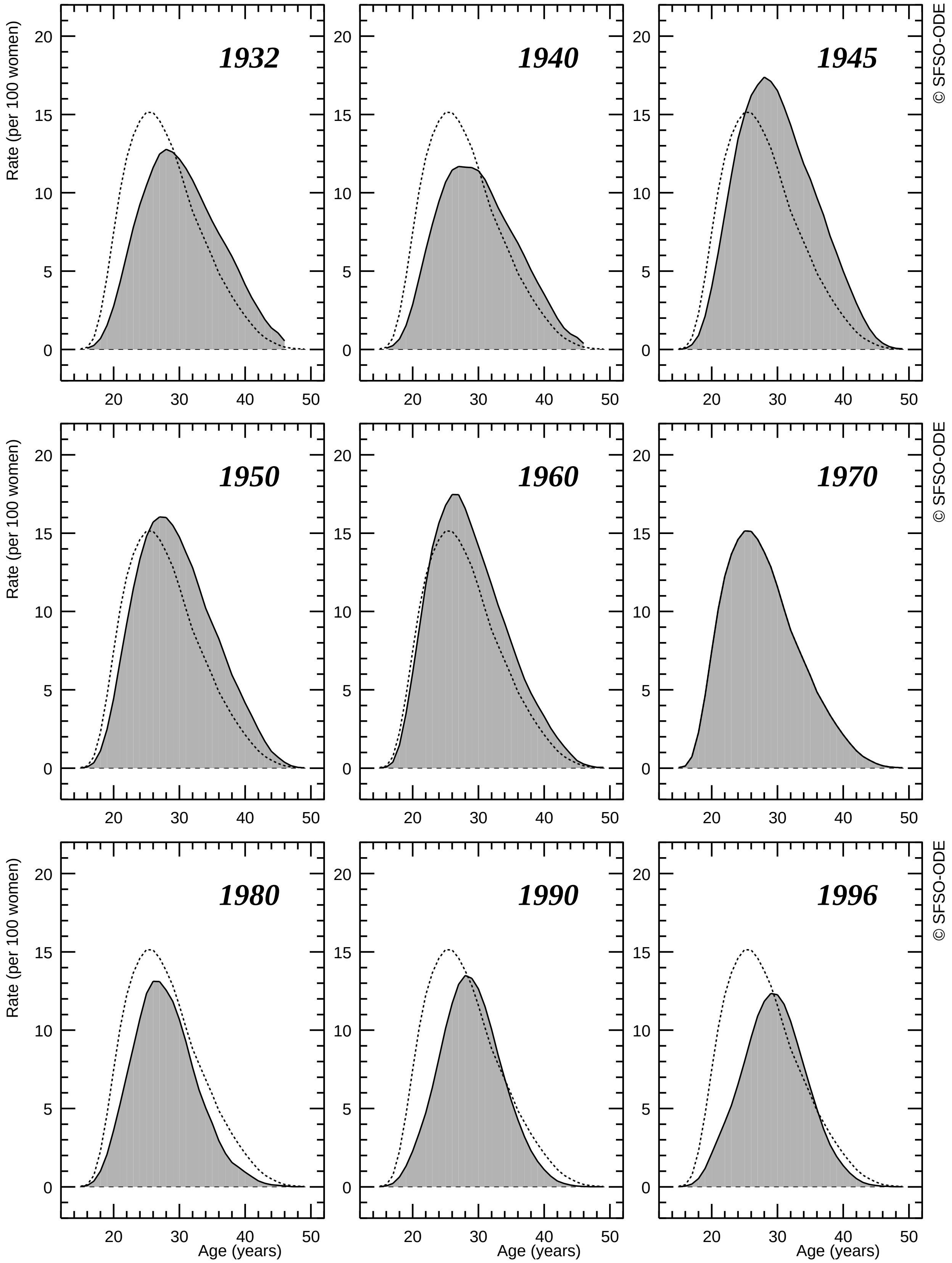


Figure 5.3.A SWITZERLAND, 2000, 2025 and 2050
AGE-SPECIFIC FERTILITY rates
by age reached during the calendar year of the birth
SFSO A, B and C scenarios
Dotted line: rates observed in 1996
Total period fertility rate observed in 1996: 1.50 children per woman

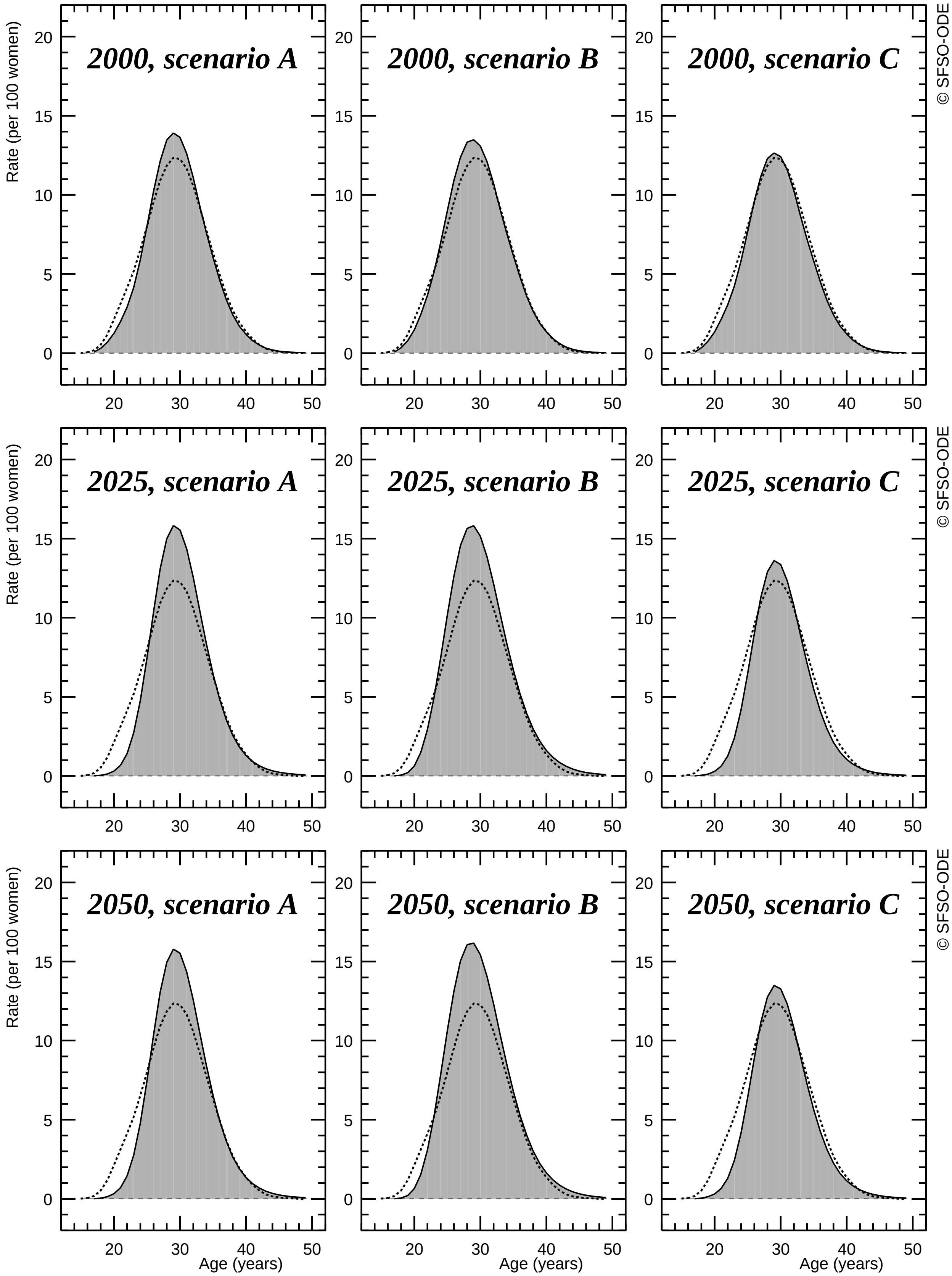


Figure 5.4 SWITZERLAND, birth cohorts 1920-1970
AGE-SPECIFIC FERTILITY rates
by age reached during the calendar year of the birth
Dotted line: rates of the 1940 female birth cohort
Completed fertility of the 1940 female birth cohort: 2.08 children per woman

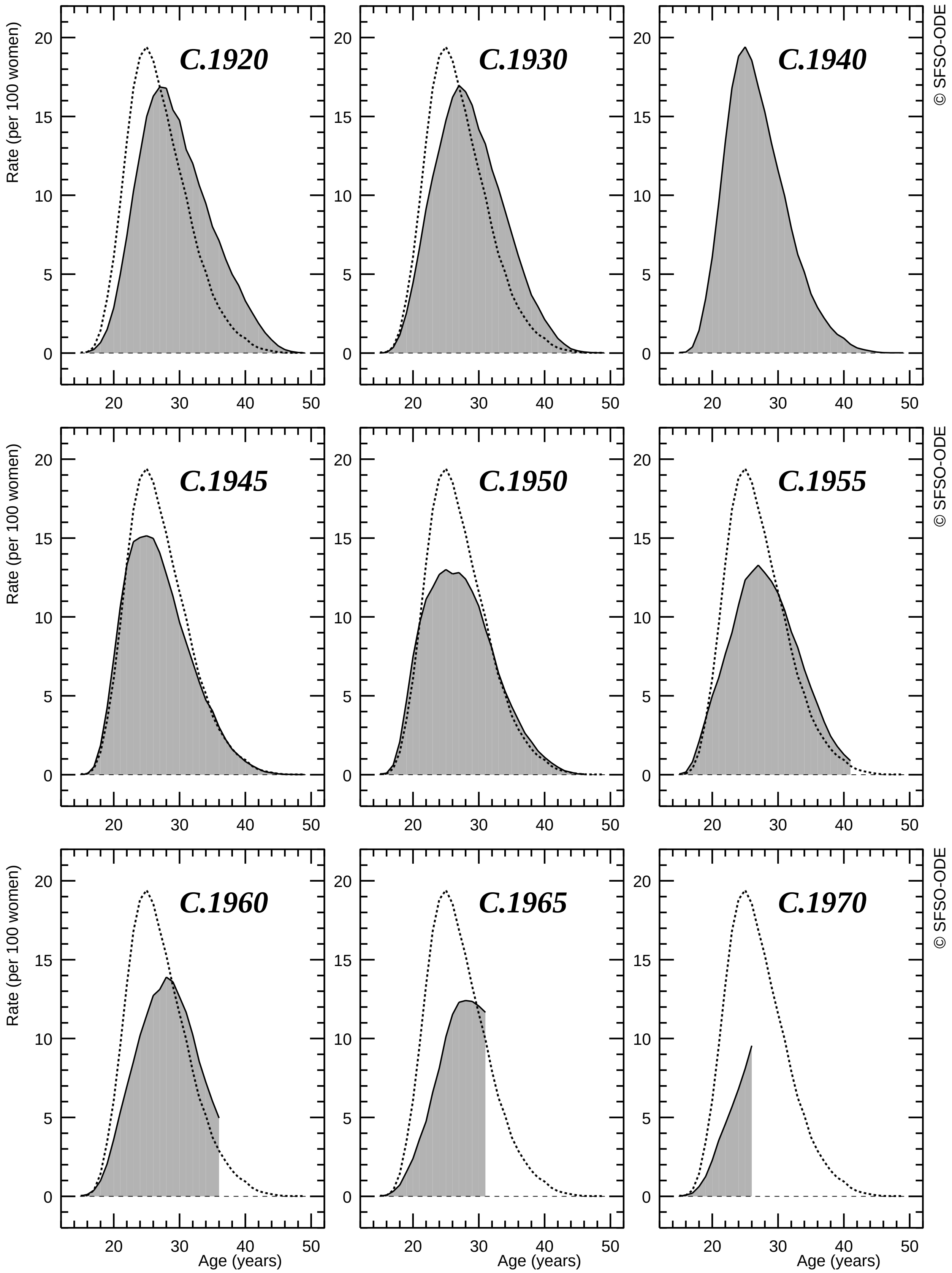


Figure 5.4.A SWITZERLAND, female birth cohorts 1960, 1980 and 2000
SFSO A, B and C scenarios
AGE-SPECIFIC FERTILITY rates
by age reached during the calendar year of the birth
Dotted line: rates of the 1940 female birth cohort
Completed fertility of the 1940 female birth cohort: 2.08 children per woman

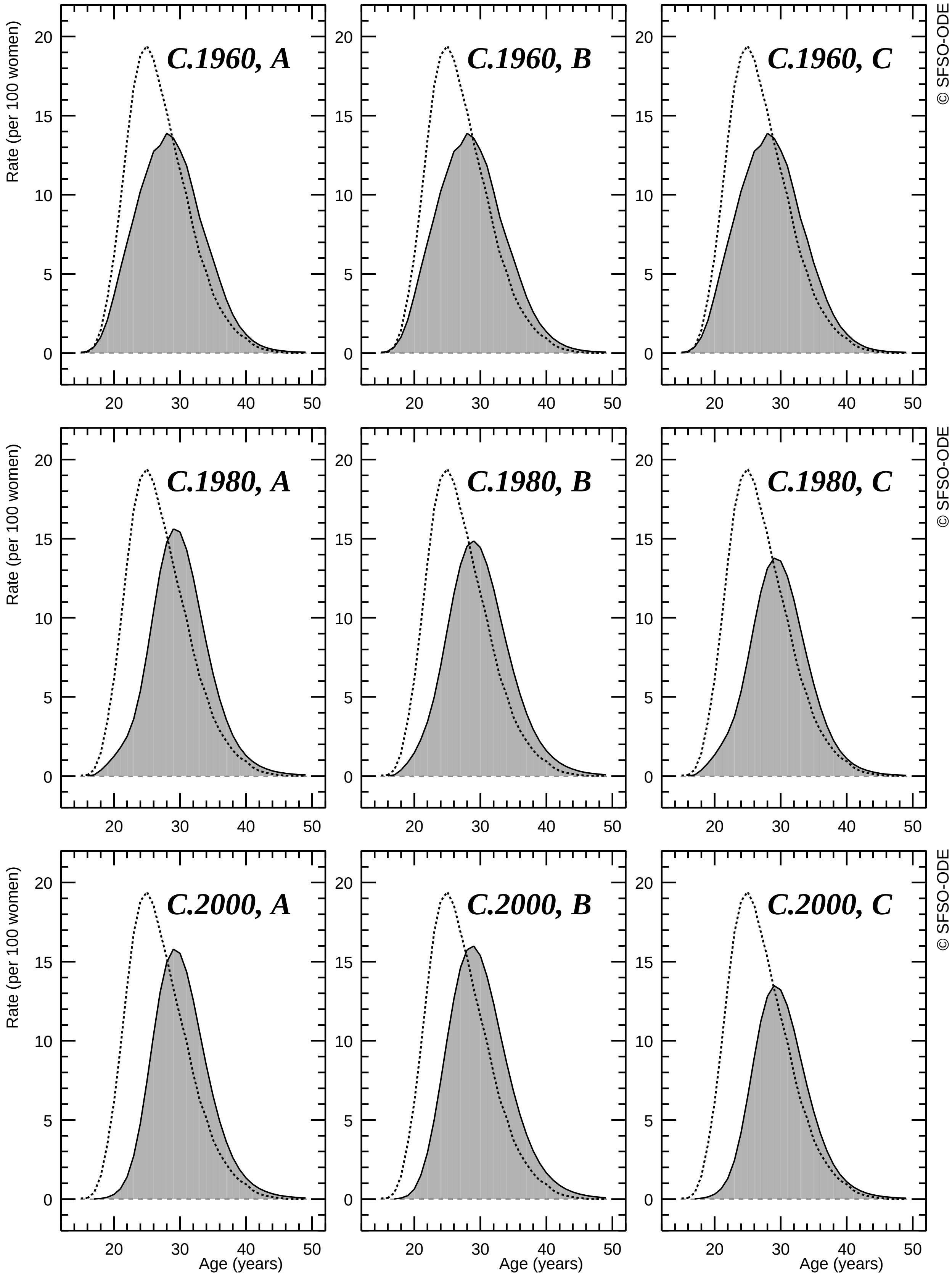
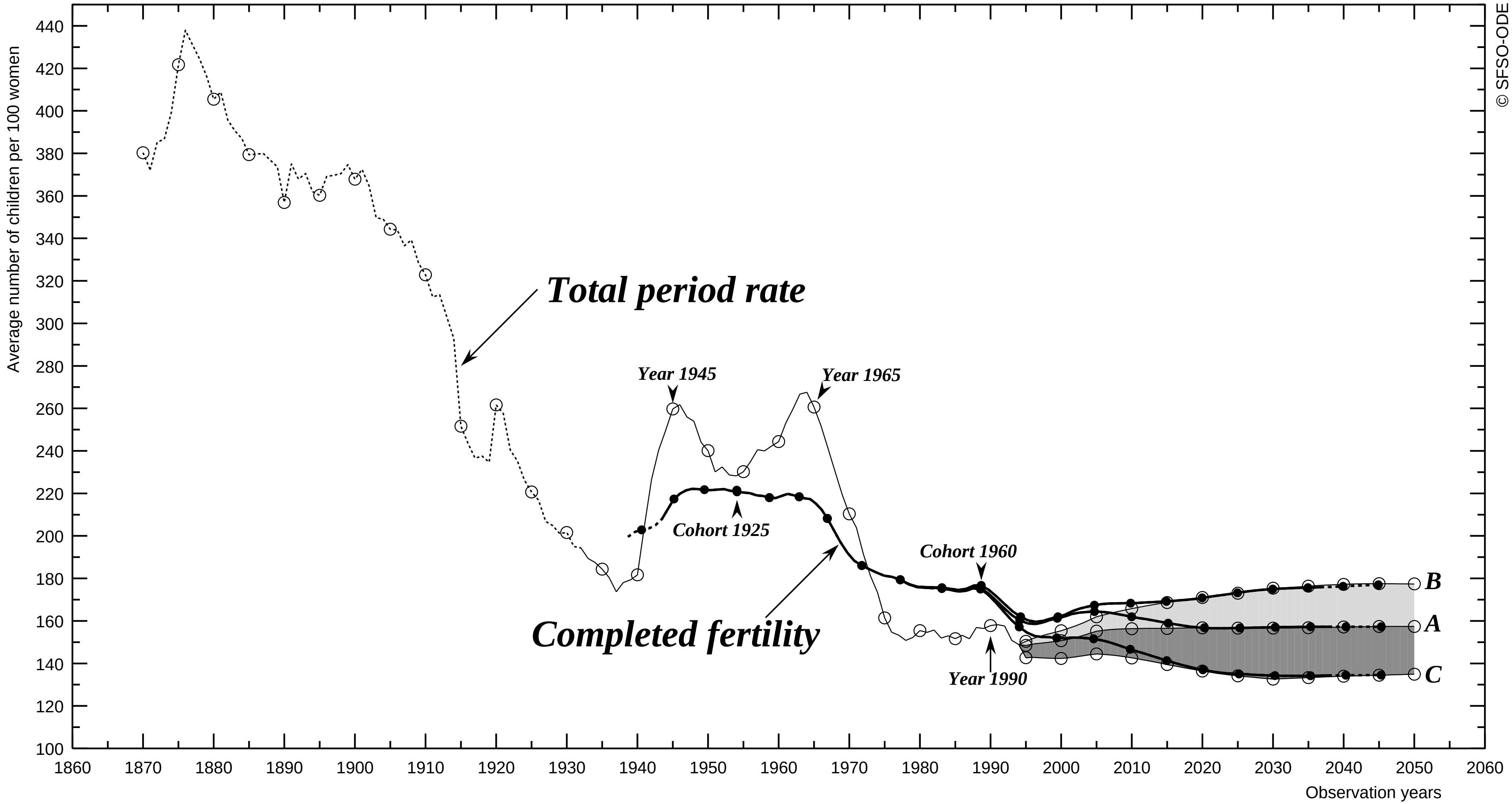
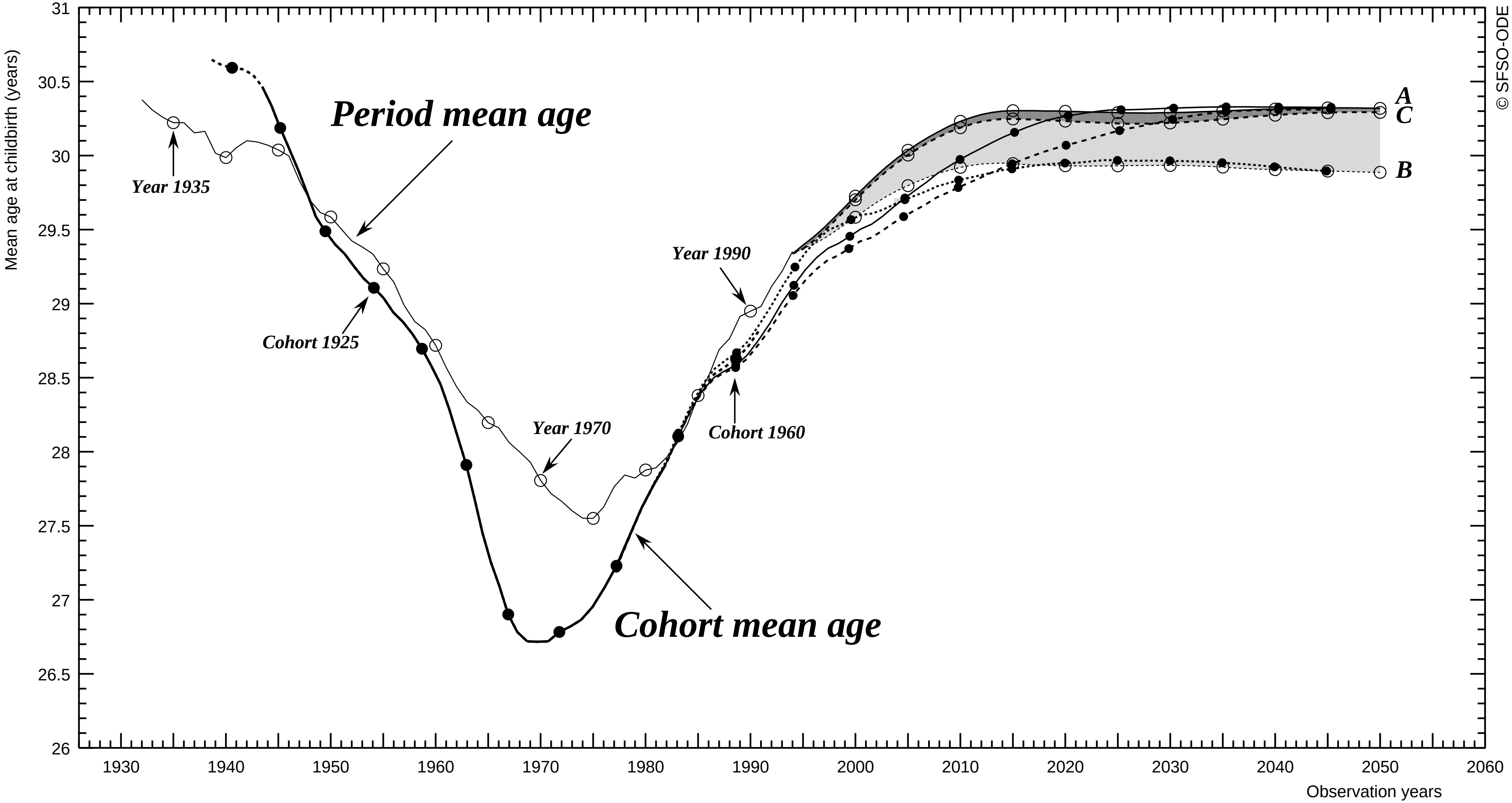


Figure 5.5 SWITZERLAND, 1870-2050
TOTAL FERTILITY rate and COMPLETED FERTILITY shifted by the mean age at childbirth
SFSO A, B and C scenarios from 1995
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The completed fertility of the 1925 female birth cohort, whose mean age at childbirth was 29.1 years, is assigned to observation year 1925 + 29.1 = 1954.1

Figure 5.6 SWITZERLAND, 1932-2050
Mean age at childbirth, Period and cohort (the latter shifted by the mean age at childbirth)
SFSO A, B and C scenarios from 1995
Dotted lines: estimated mean age
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The mean age at childbirth of the 1925 female birth cohort, equal to 29.1 years, is assigned to observation year 1925 + 29.1 = 1954.1

Figure 5.7 SWITZERLAND, 1876-2050
SFSO A, B and C scenarios from 1995
Period mean age at first MARRIAGE by SEX
and women's period mean age at CHILDBIRTH

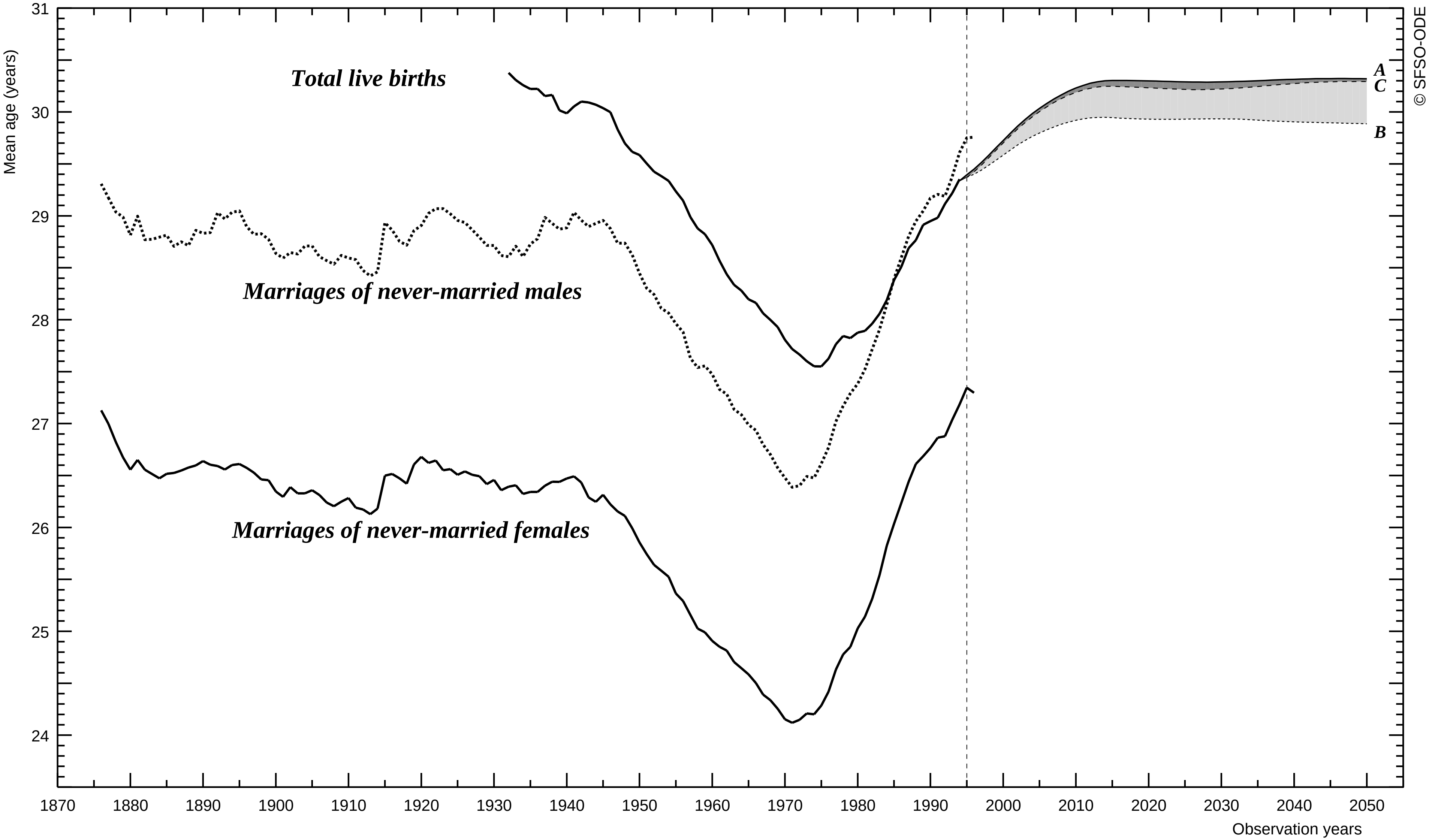


Figure 5.8 SWITZERLAND, 1860-2015 FEMALE BIRTH COHORTS
SFSO A, B and C scenarios from 1995
Cohort mean age at first MARRIAGE by SEX
and women's cohort mean age at CHILDBIRTH

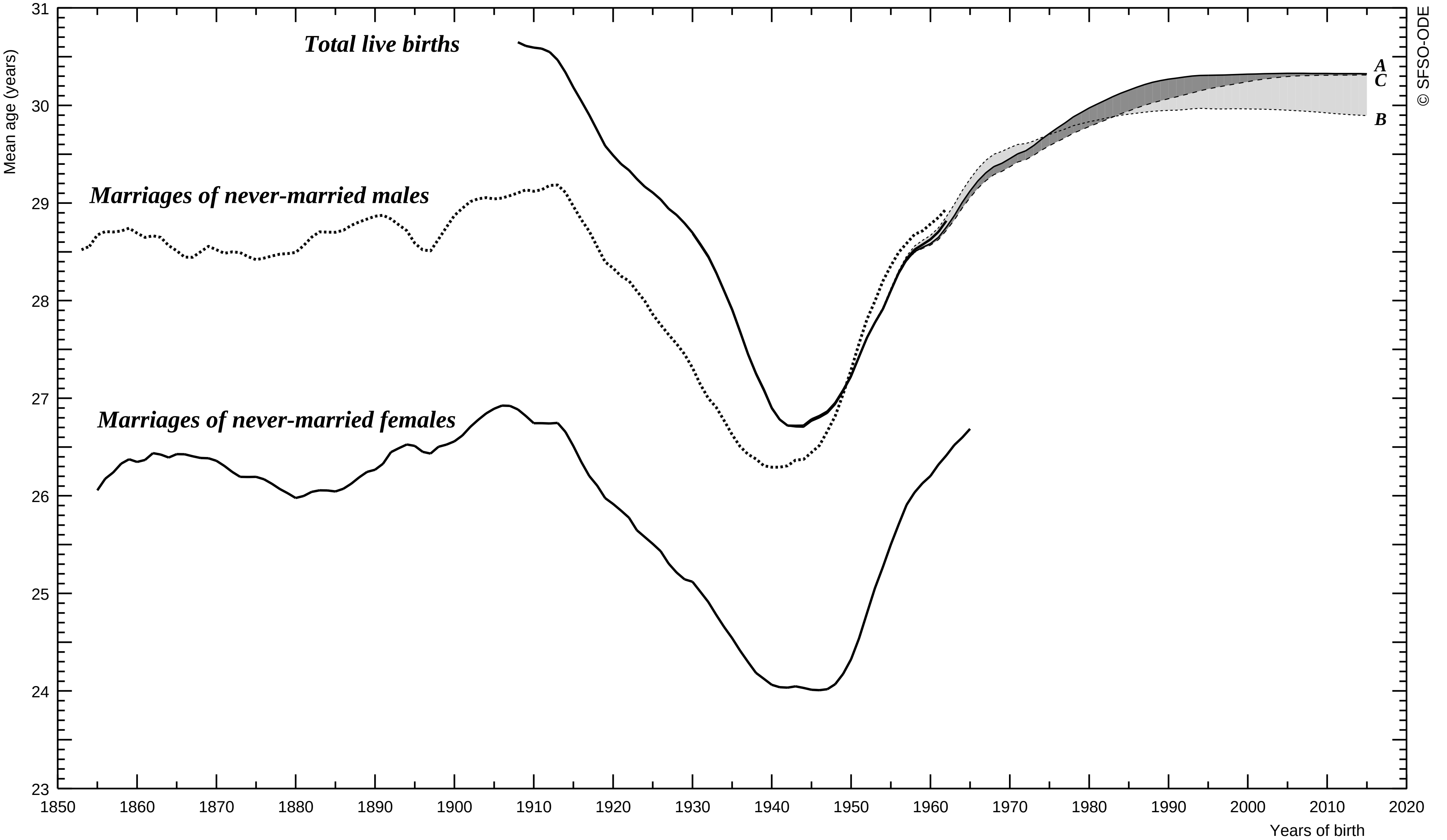


Figure 5.9 SWITZERLAND, observation years 1932-1996. CORRELATION between:
- TOTAL PERIOD FERTILITY RATE
- PERIOD MEAN AGE at CHILDBIRTH

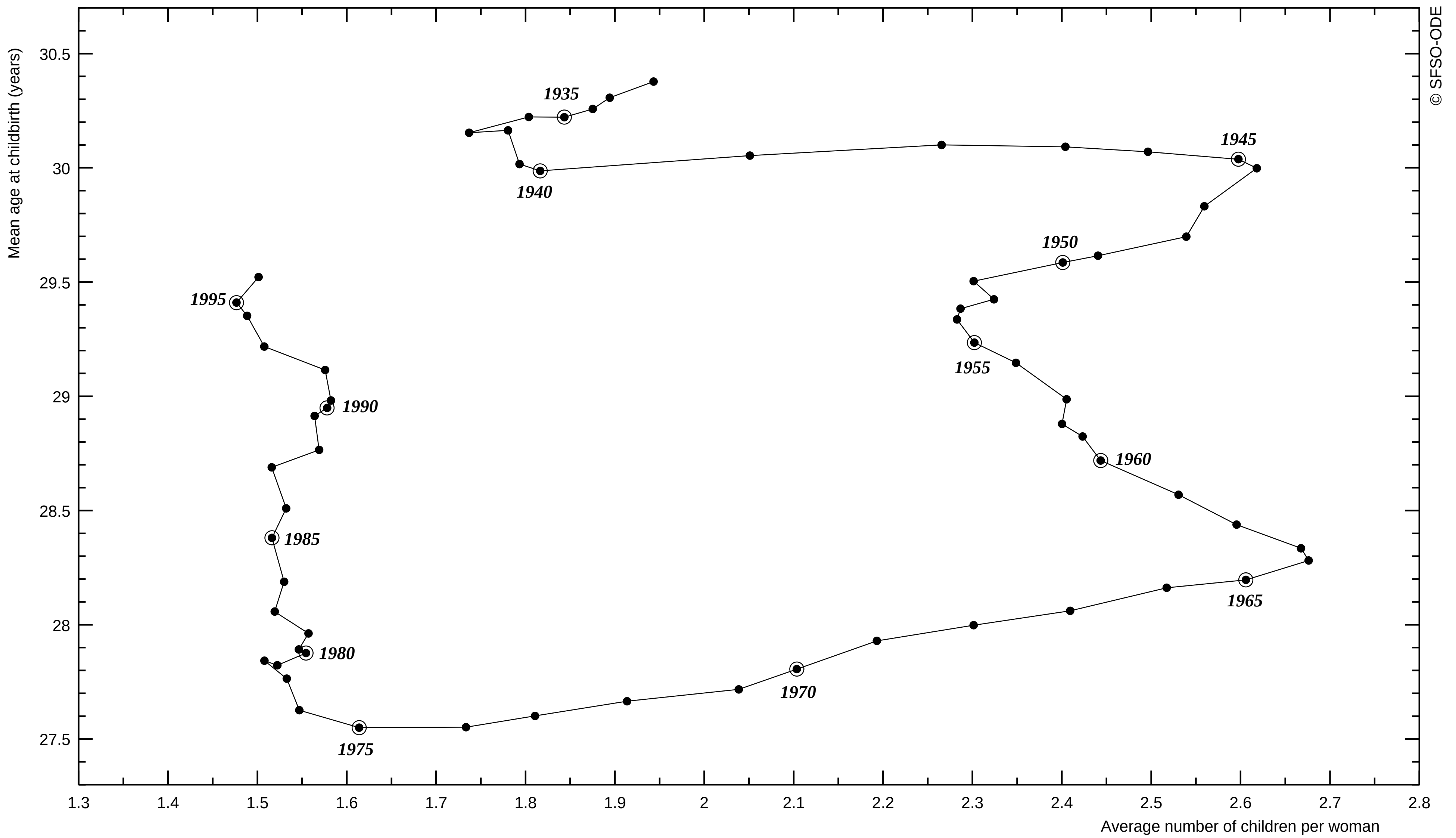


Figure 5.9.A SWITZERLAND, observation years 1932-2050. CORRELATION between:
- TOTAL PERIOD FERTILITY RATE
- PERIOD MEAN AGE at CHILDBIRTH
Observations up to 1995, SFSO A, B and C scenarios thereafter

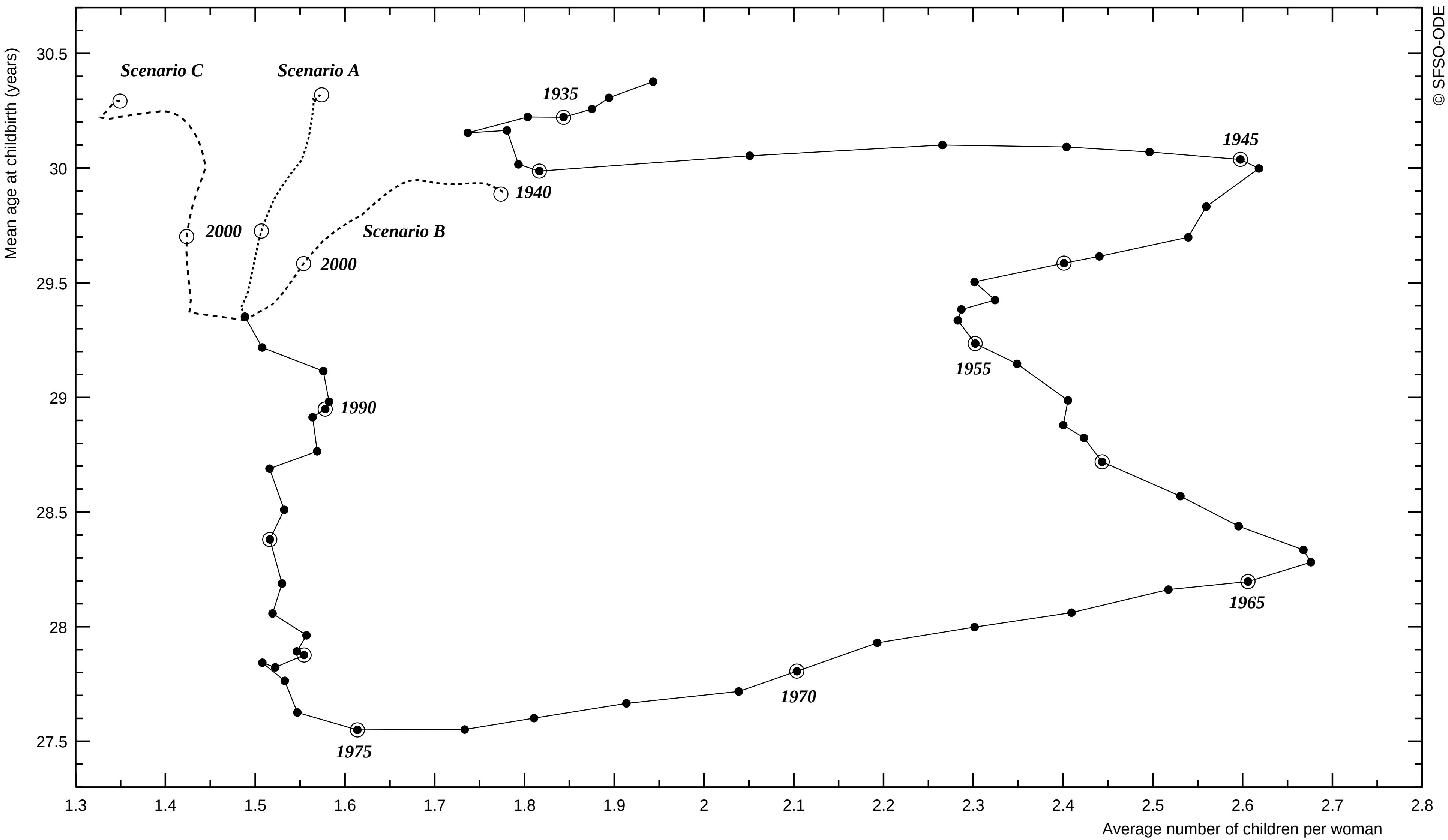


Figure 5.9.B SWITZERLAND, Observation years 1932-1996. CORRELATION between:
- TOTAL PERIOD FERTILITY RATE
- STANDARD DEVIATION OF PERIOD AGE AT CHILDBIRTH

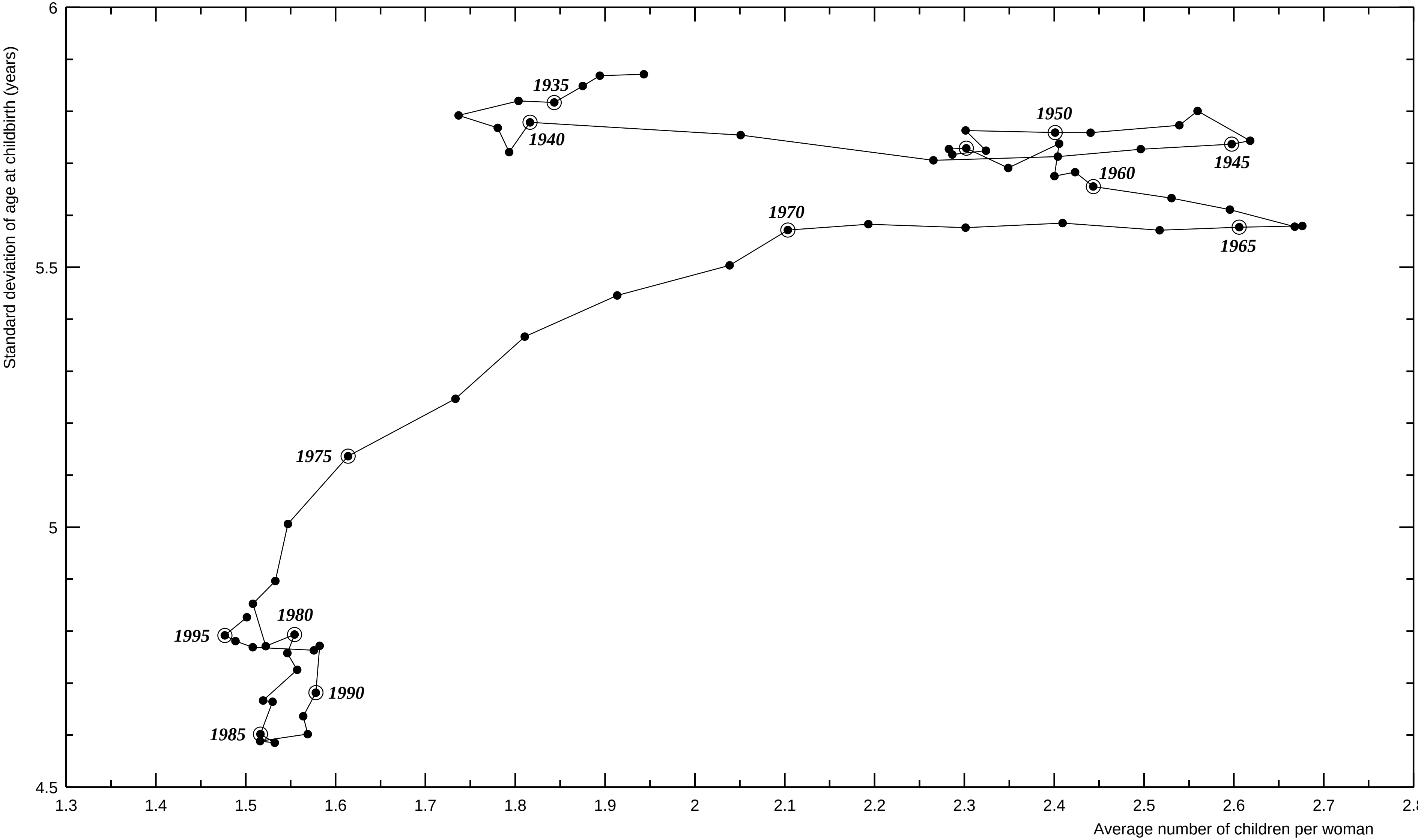


Figure 5.10 SWITZERLAND, female birth cohorts 1908-1962. CORRELATION between:
- COMPLETED FERTILITY
- COHORT MEAN AGE AT CHILDBIRTH

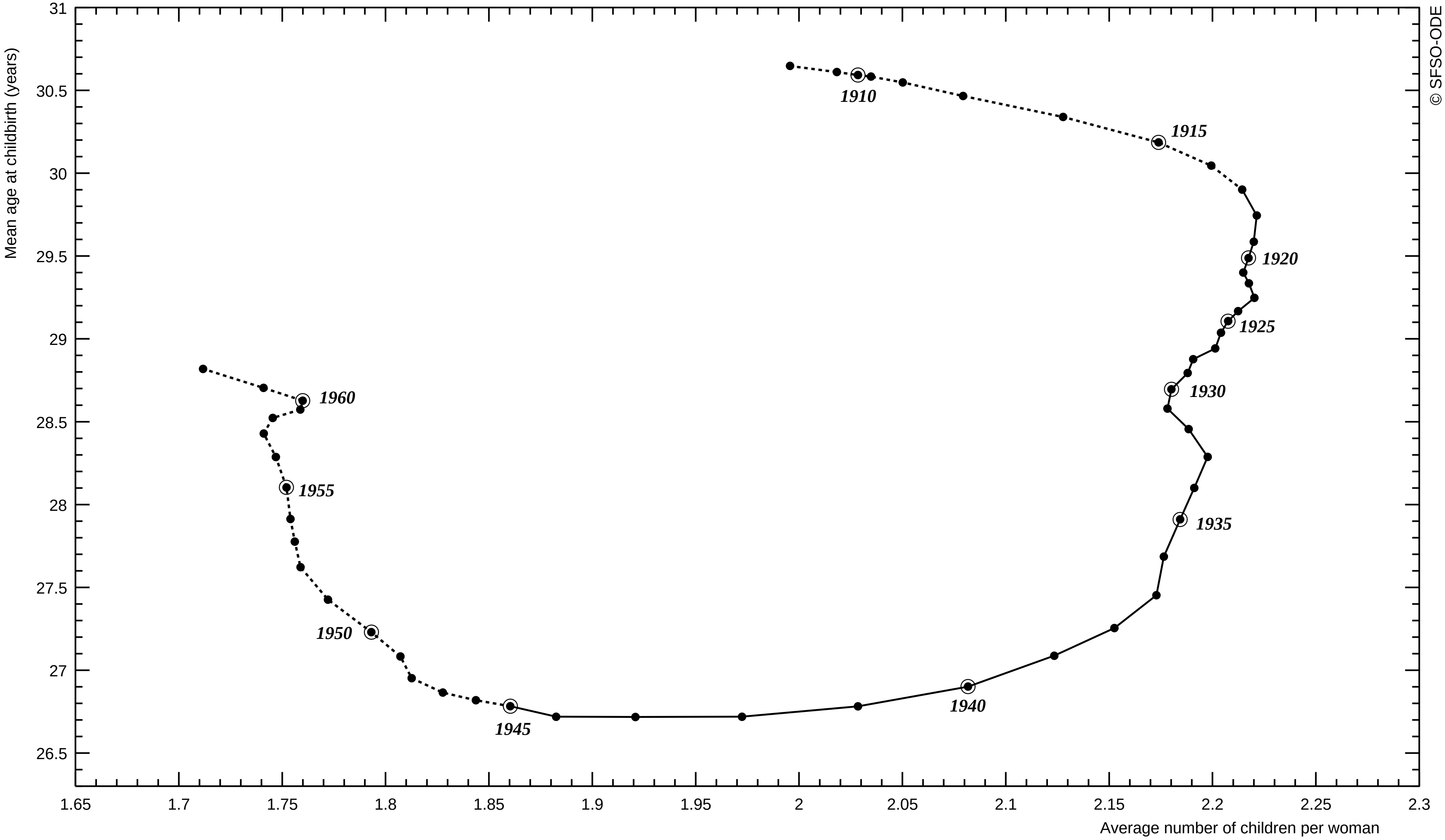


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Figure 5.10.A SWITZERLAND, female birth cohorts 1908-2000. CORRELATION between:
- COMPLETED FERTILITY
- COHORT MEAN AGE AT CHILDBIRTH
Observations up to 1995, SFSO A, B and C scenarios thereafter

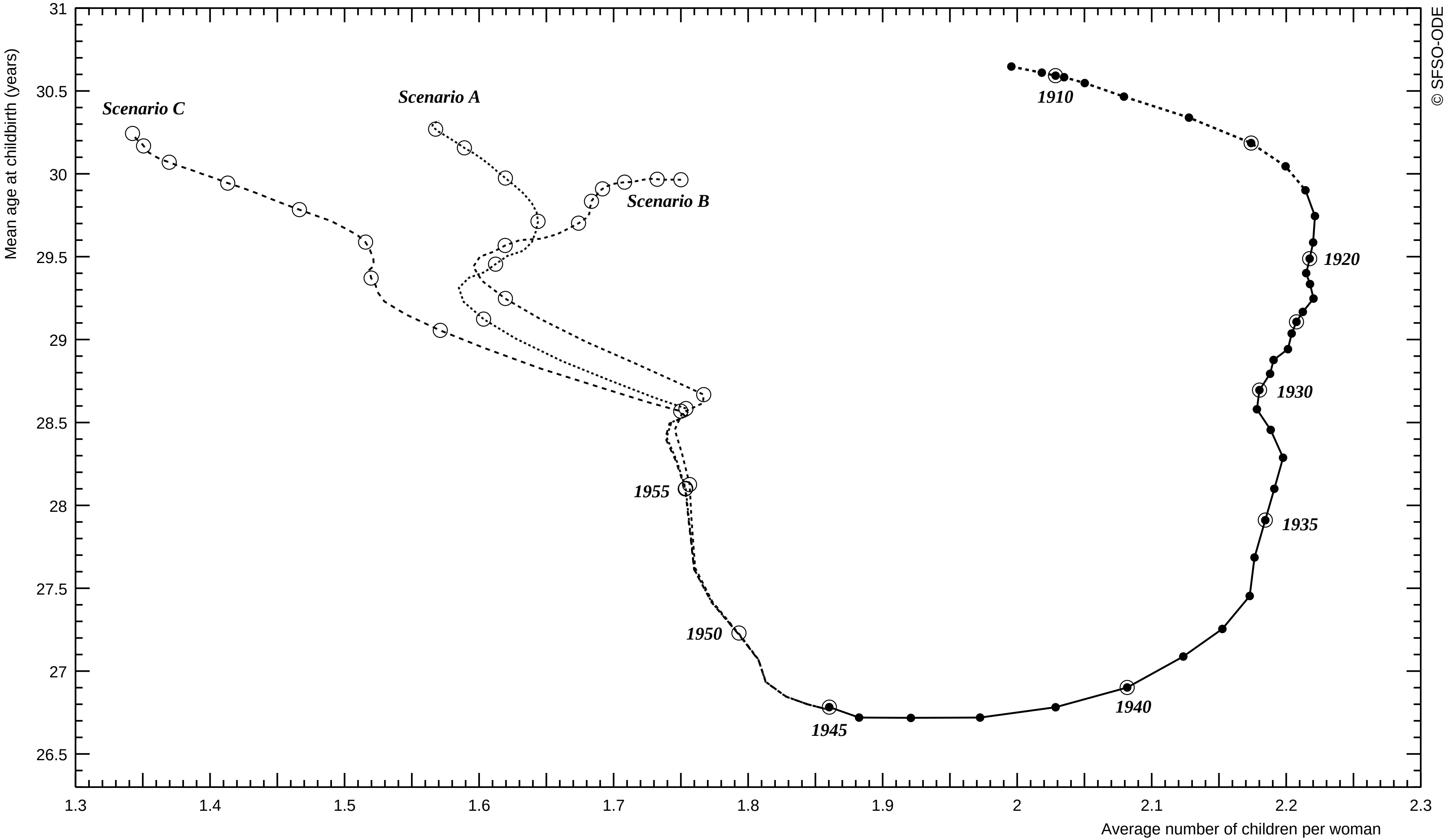

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Figure 5.10.B SWITZERLAND, female birth cohorts 1908-1962. CORRELATION between:
- COMPLETED FERTILITY
- STANDARD DEVIATION OF COHORT AGE AT CHILDBIRTH

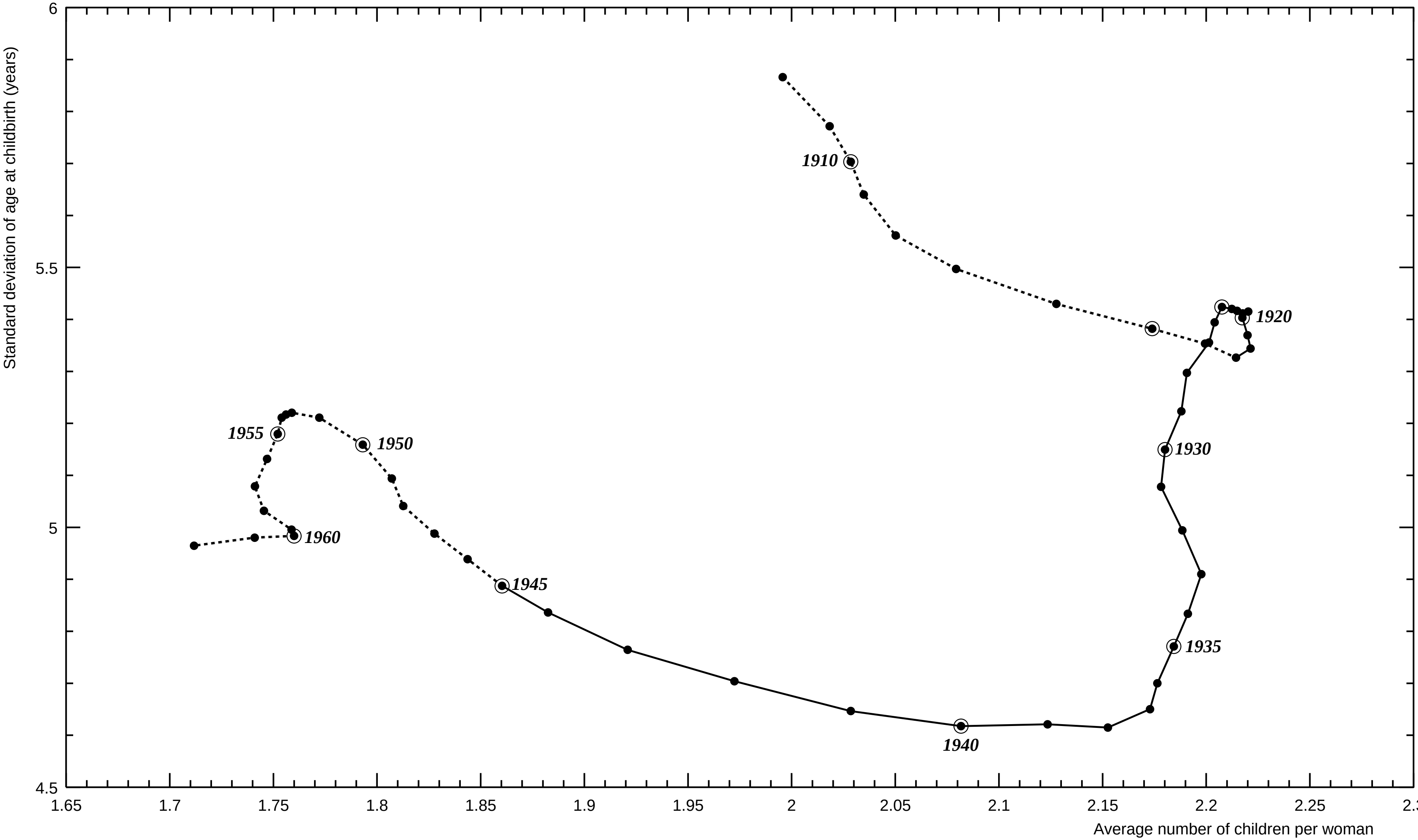
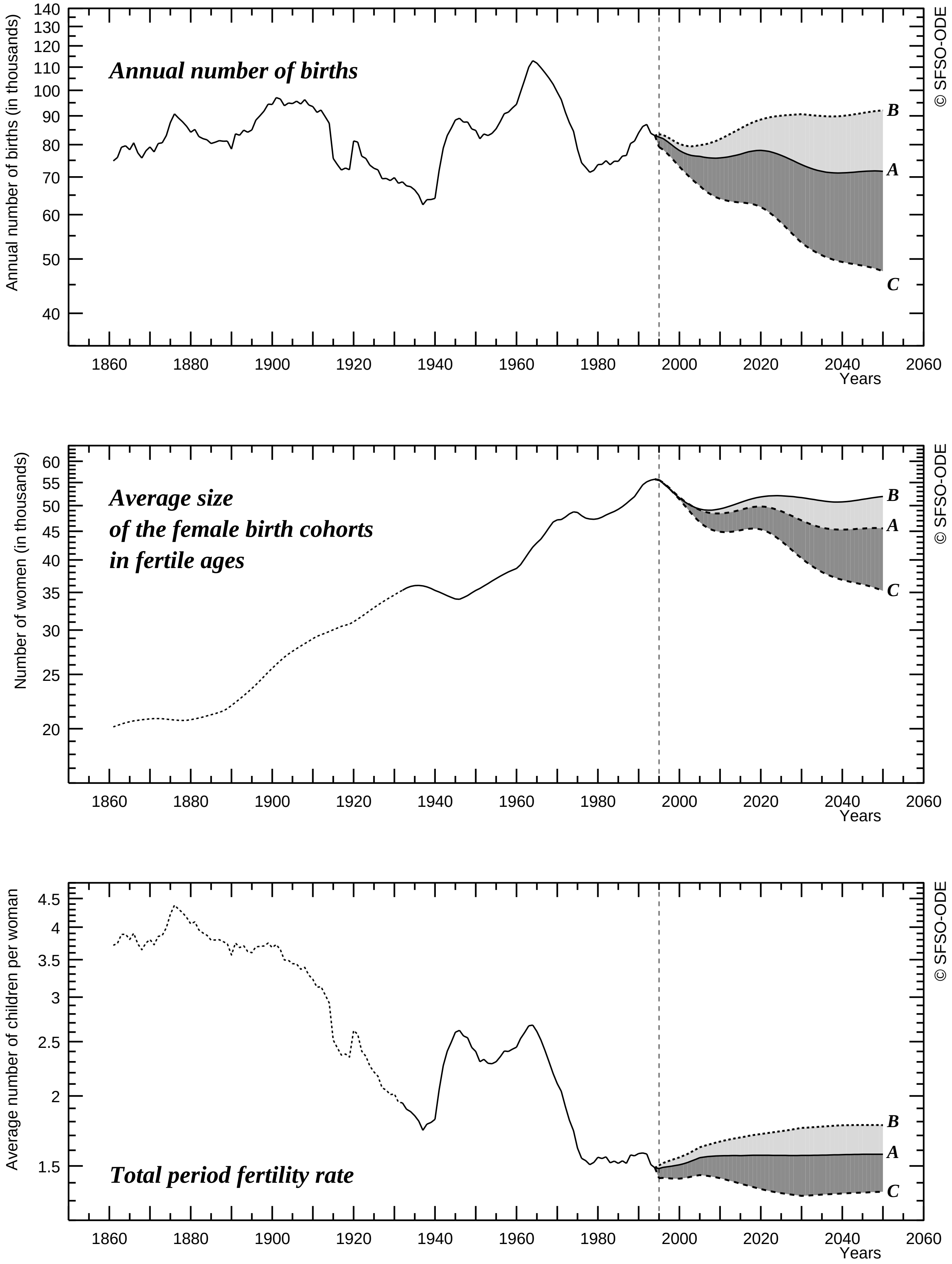


Figure 5.11 SWITZERLAND, 1861-2050
Annual number of BIRTHS
Average SIZE of the female birth cohorts in fertile ages
TOTAL FERTILITY RATE
Logarithmic scales of same moments; dotted lines: estimates



The relative change in the annual number of births during a period is the sum of the relative changes in the average size of the cohorts and in total period rate

Figure 5.12 SWITZERLAND, 1932-1996
Total FERTILITY rate by BIRTH ORDER within the current marriage

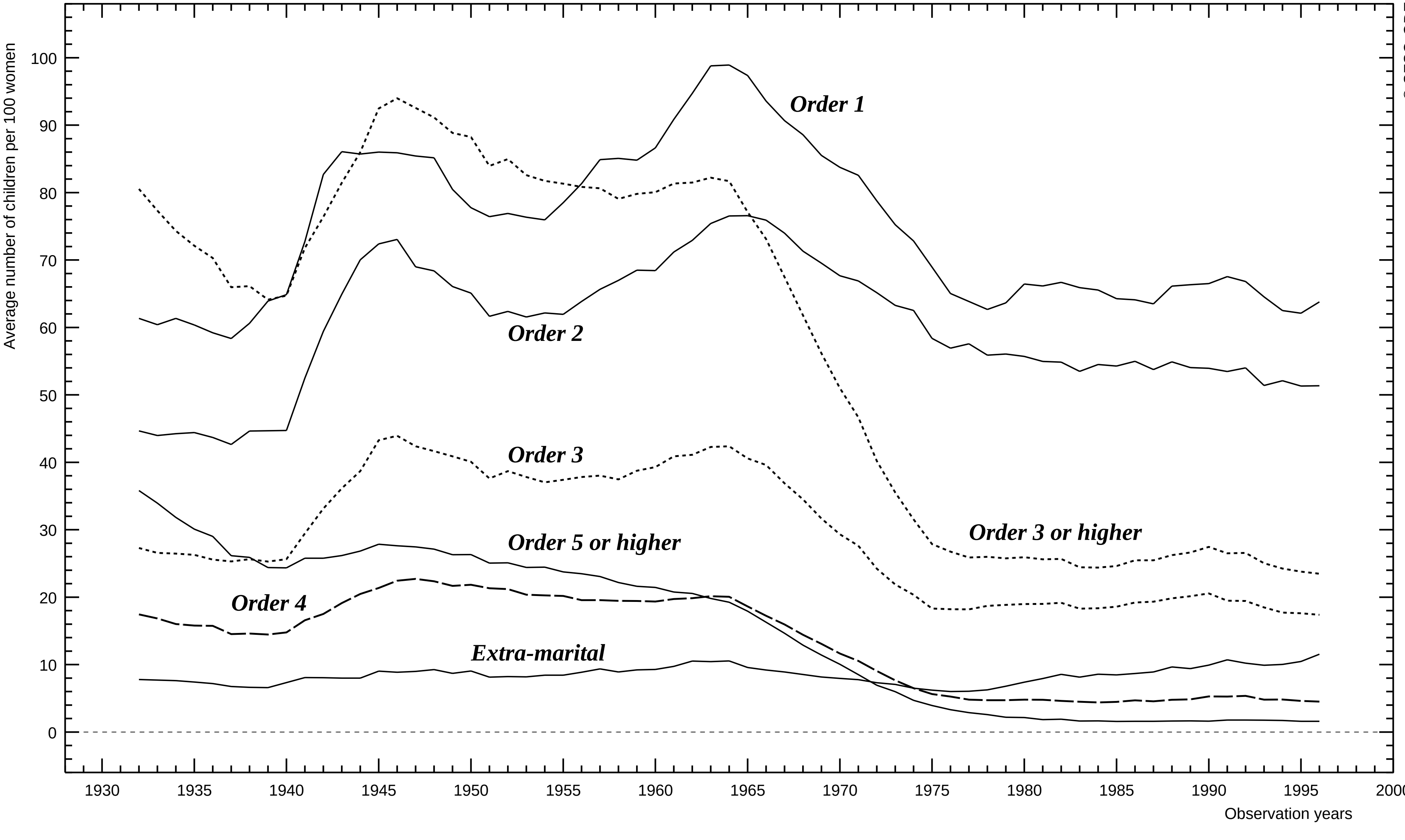


Figure 5.13 SWITZERLAND, observation years 1932-1996
COMPLETED FERTILITY of female birth cohorts by BIRTH ORDER within the current marriage

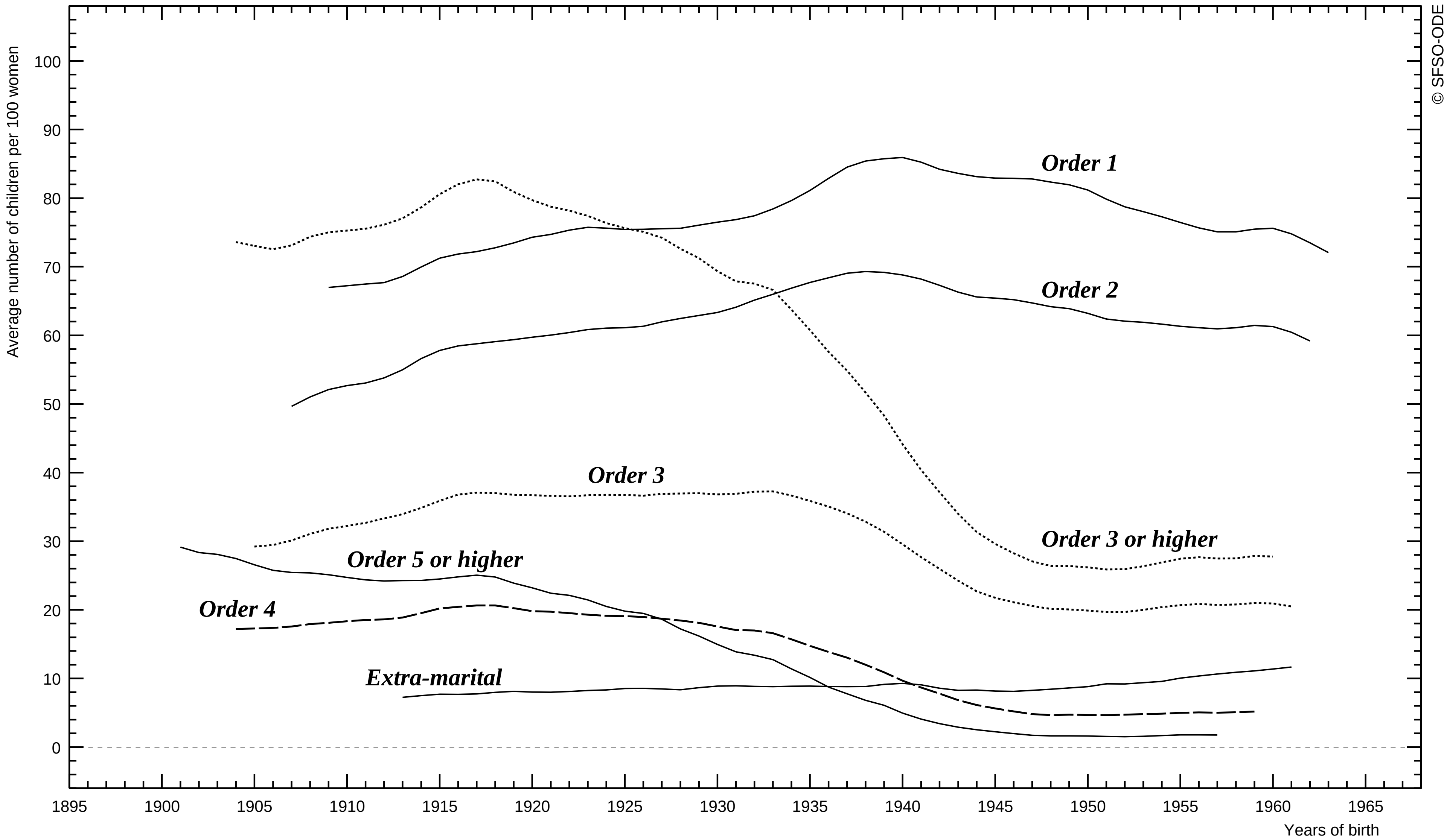
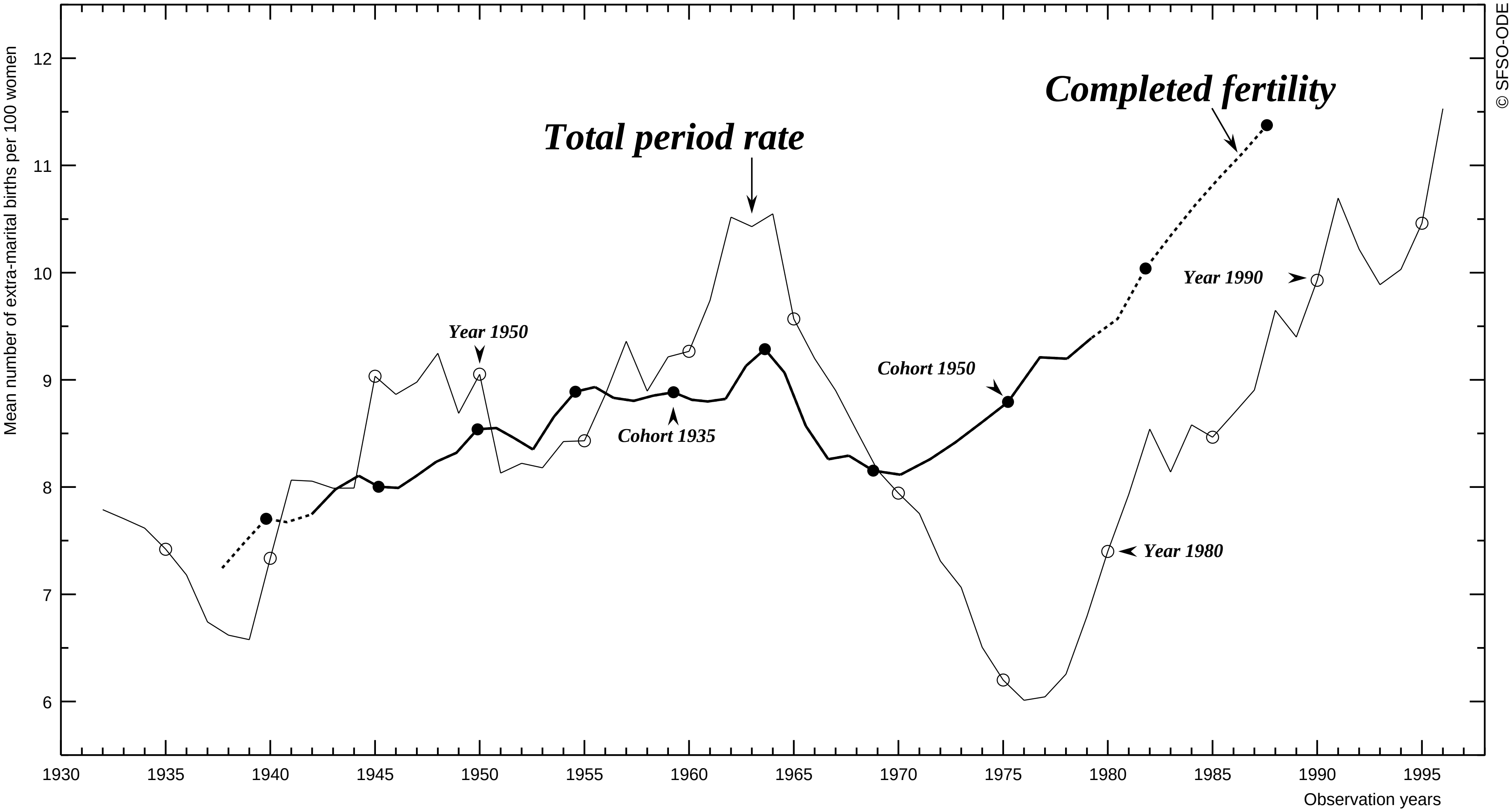


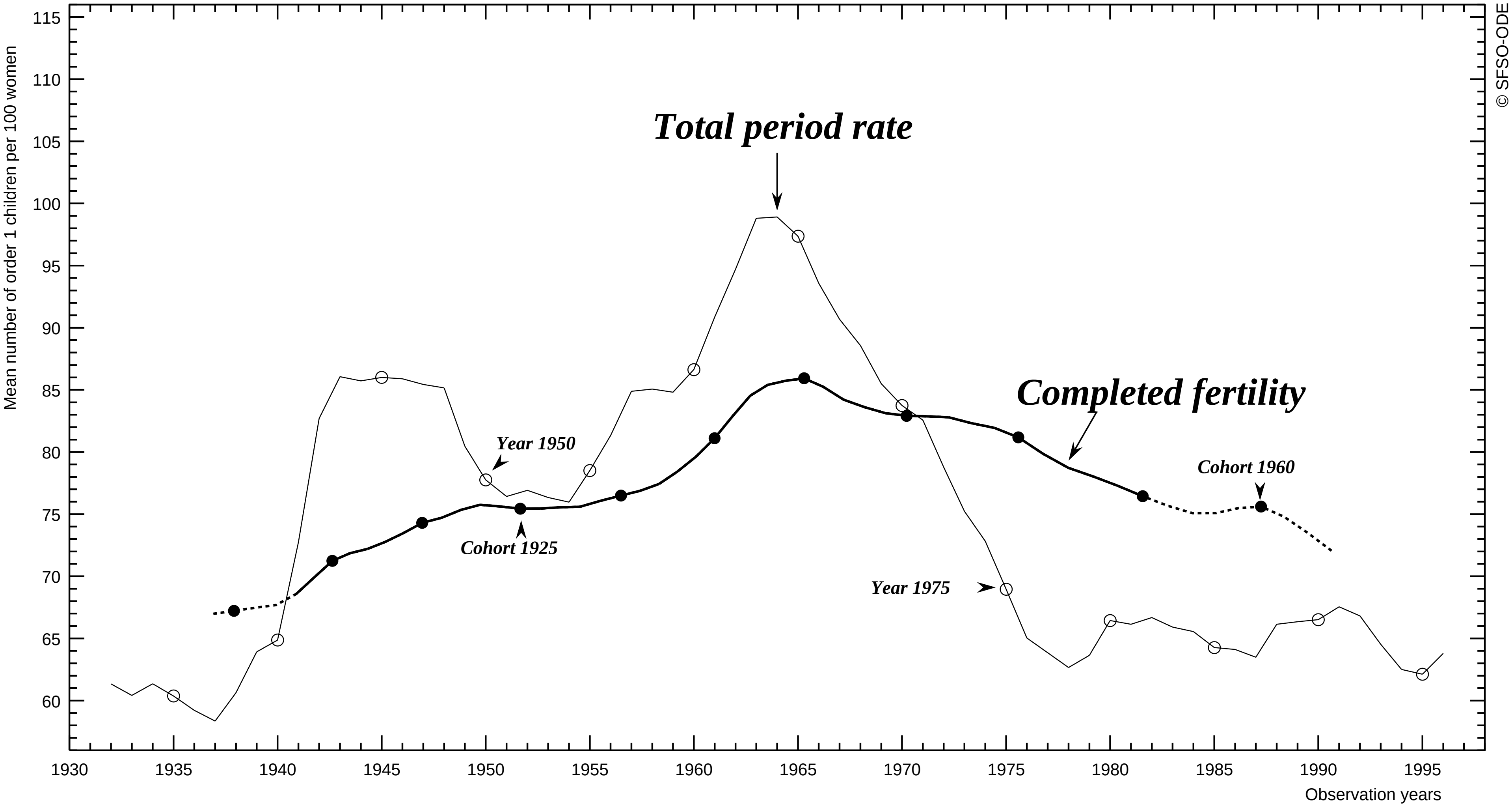
Figure 5.14 SWITZERLAND, 1932-1996
TOTAL NON-MARITAL FERTILITY RATE and
COMPLETED NON-MARITAL FERTILITY shifted by the mean age at childbirth
Dotted lines: estimated completed fertility
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



The completed non-marital fertility of the 1935 female birth cohort,

whose mean age at extra-marital childbirth was 24.3 years, is assigned to observation year 1935 + 24.3 = 1959.3

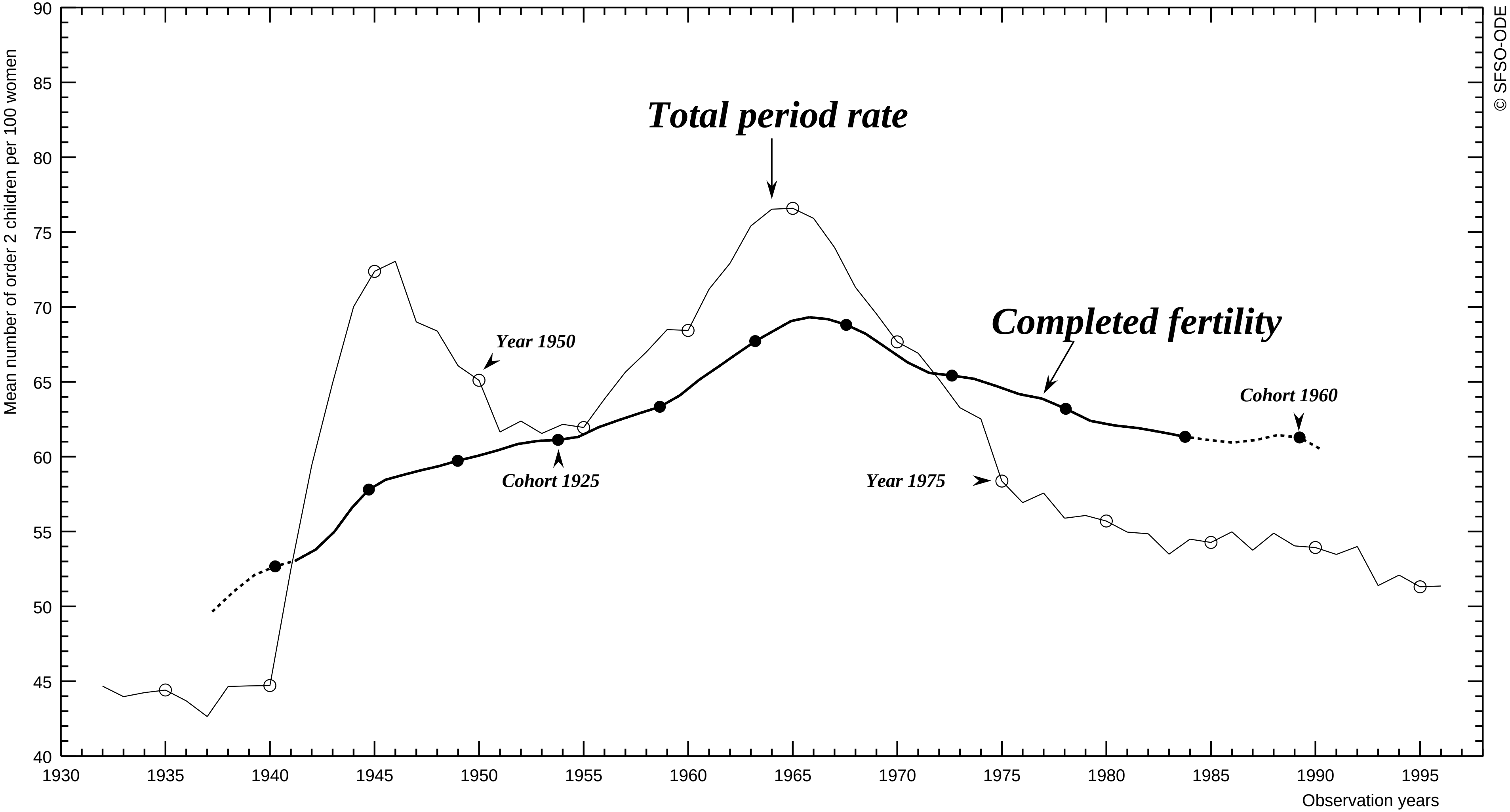
Figure 5.15 SWITZERLAND, 1932-1996. ORDER 1 FERTILITY within the current MARRIAGE
Total FERTILITY rate and COMPLETED FERTILITY shifted by the mean age at childbirth
Dotted lines: estimated completed fertility
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



Completed fertility at order 1 in the 1925 female birth cohort, whose mean age at order 1 childbirth was 26.7 years,

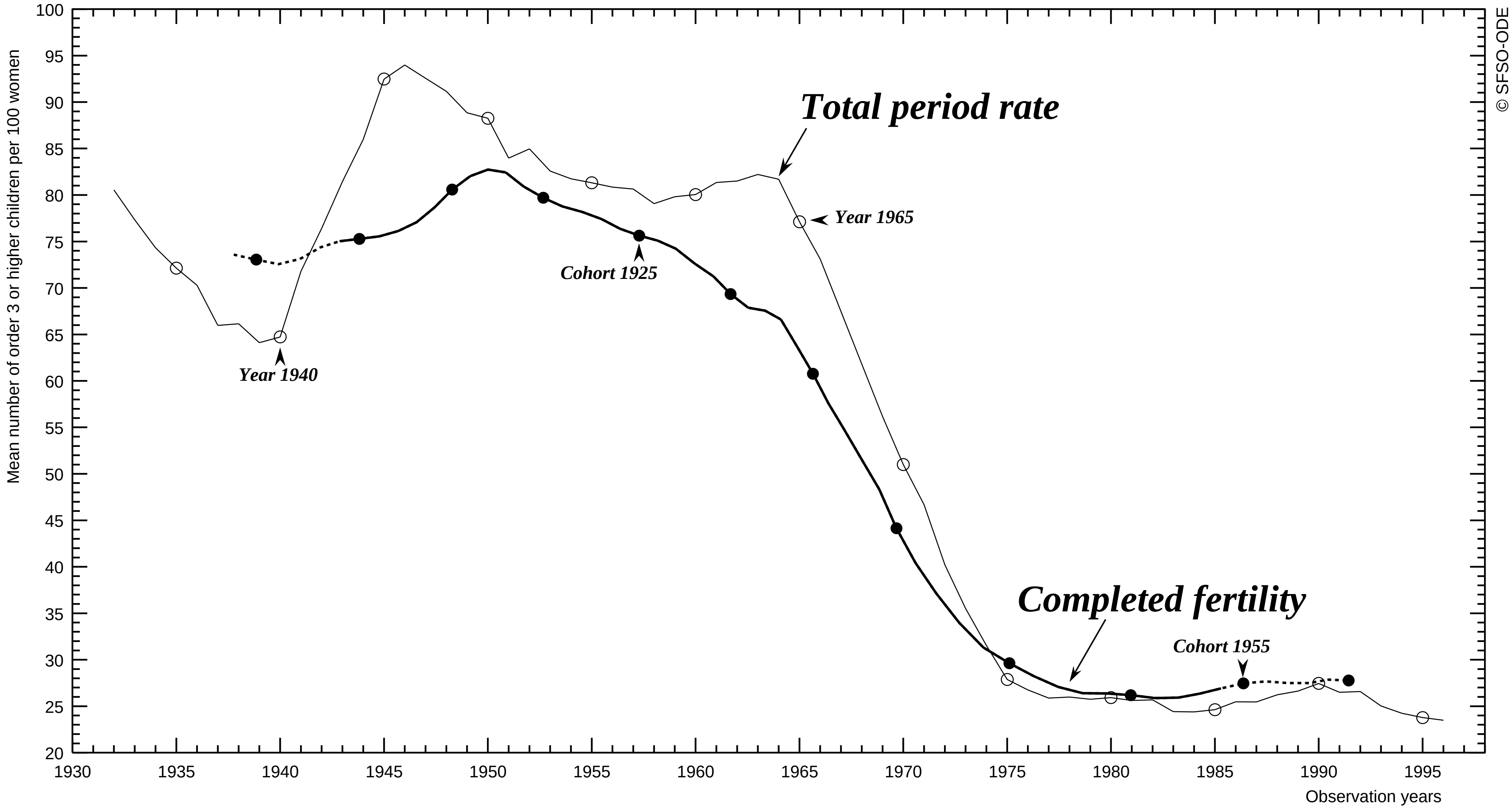
is assigned to observation year 1925 + 26.7 = 1951.7

Figure 5.16 SWITZERLAND, 1932-1996. ORDER 2 FERTILITY within the current MARRIAGE
Total FERTILITY rate and COMPLETED FERTILITY shifted by the mean age at childbirth
Dotted lines: estimated completed fertility
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



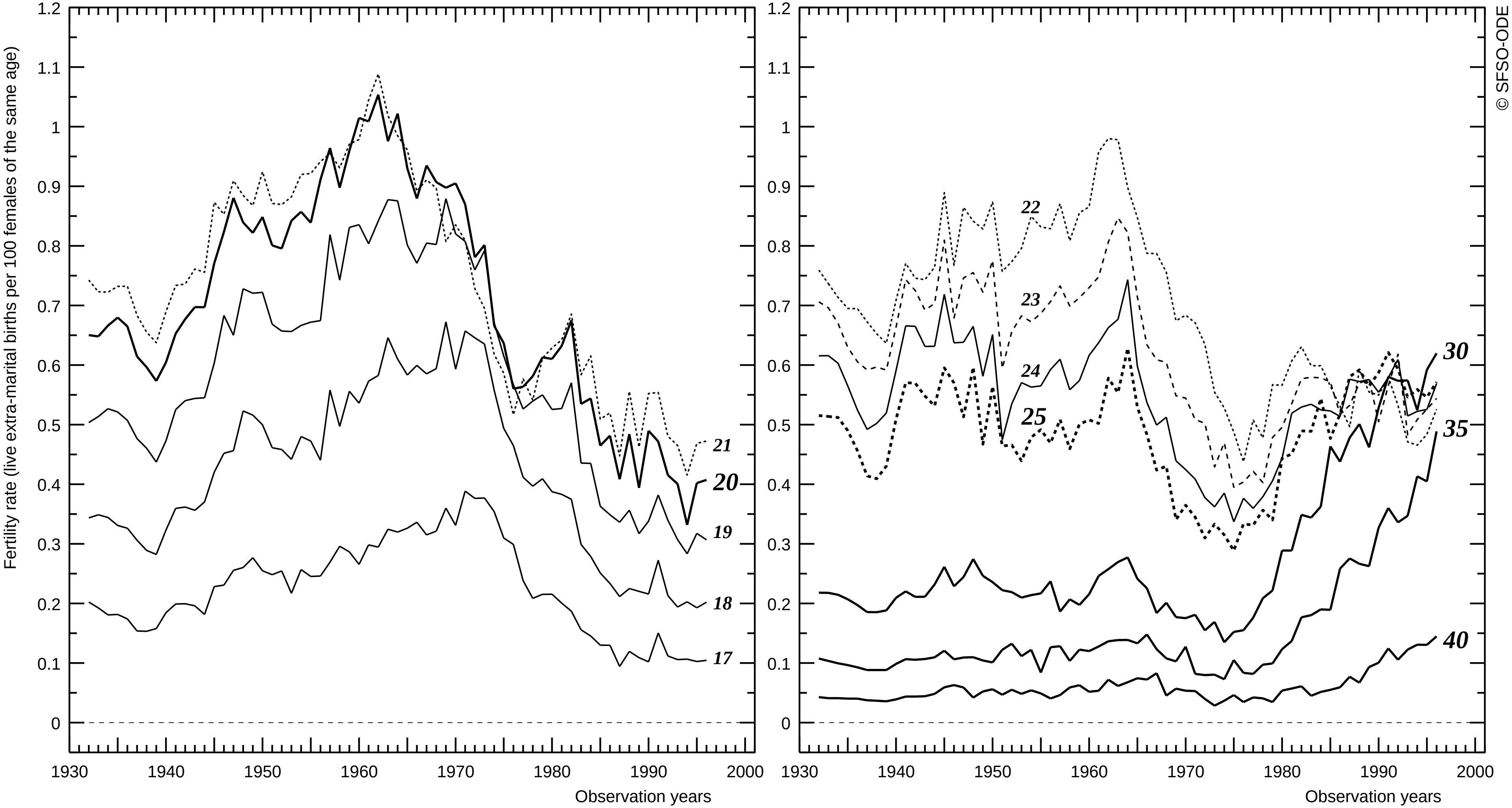
Completed fertility at order 2 in the 1925 female birth cohort, whose mean age at order 2 childbirth was 28.8 years,
is assigned to observation year 1925 + 28.8 = 1953.8

Figure 5.17 SWITZERLAND, 1932-1996. ORDER 3 or higher FERTILITY within the current MARRIAGE
Total FERTILITY rate and COMPLETED FERTILITY shifted by the mean age at childbirth
Dotted lines: estimated completed fertility
The circles denote the observation years (empty circles) or the birth cohorts (solid circles) whose years are multiples of 5



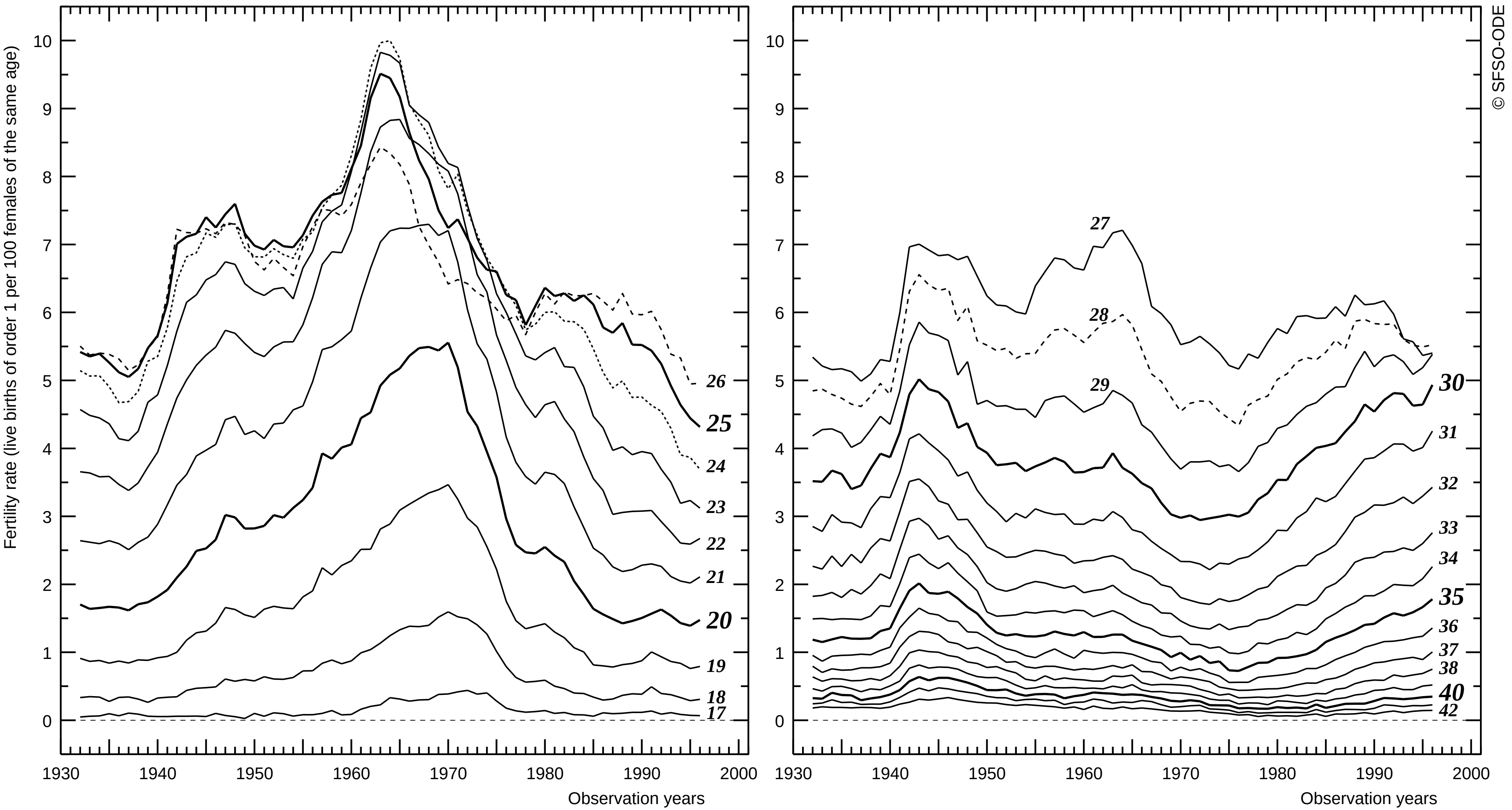
Completed fertility at order 3 or higher in the 1925 female birth cohort, whose mean age at order 3 or higher childbirth was 32.3 years, is assigned to observation year 1925 + 32.3 = 1957.3

Figure 5.18 SWITZERLAND, 1932-1996. EXTRA-MARITAL FERTILITY RATE at the same age
(rate by age reached during the calendar year of the birth)
Left-hand side: ages 17-21, right-hand side: ages 22-40



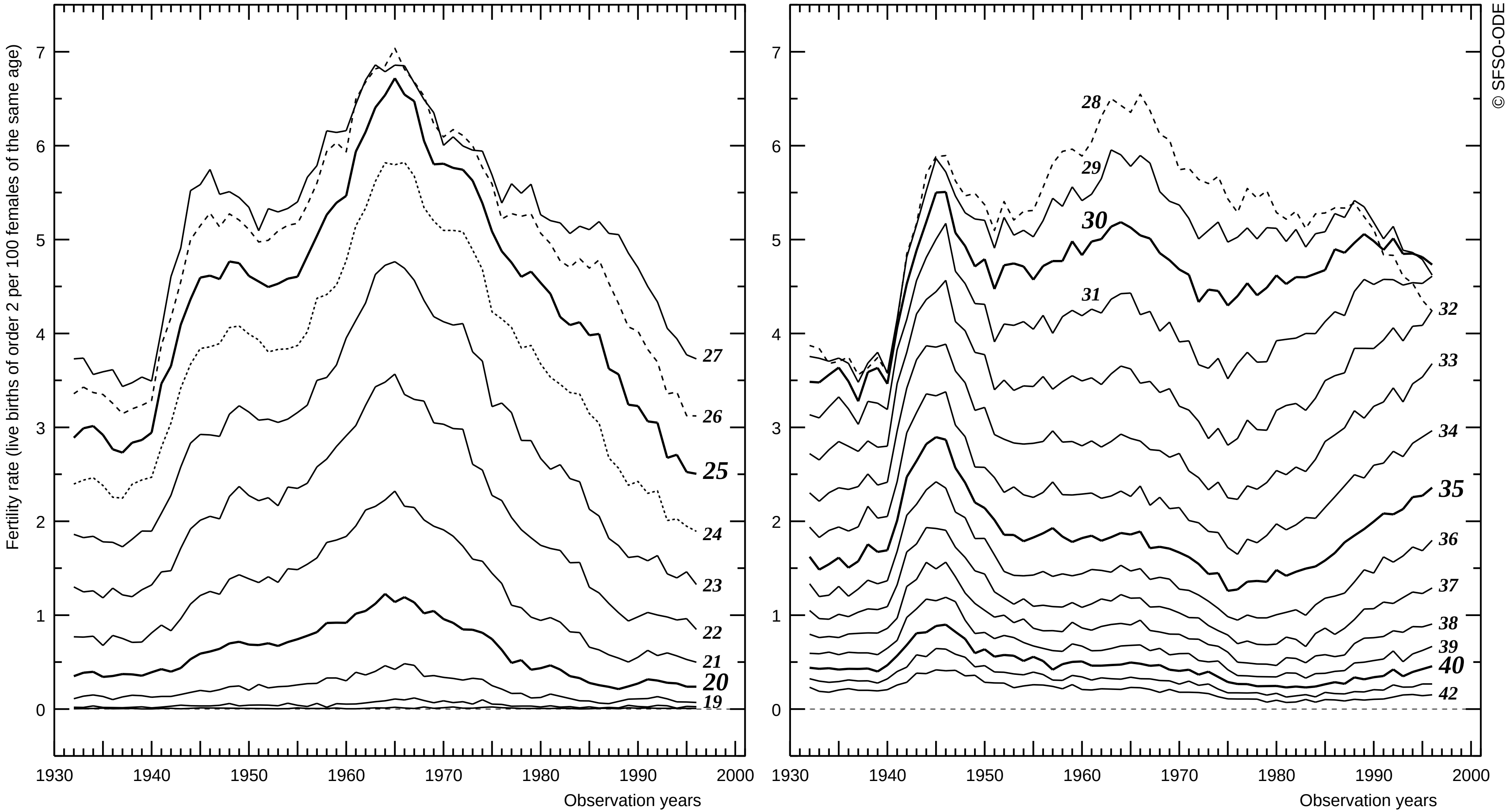
The non-marital fertility rate at 20 years of age in 1990 is the ratio of the number of children born out of wedlock in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.19 SWITZERLAND, 1932-1996. AGE-SPECIFIC FERTILITY RATE, for BIRTH ORDER 1 within the current marriage
Rate by age reached during the calendar year of the birth
Left-hand side: ages 17-26, right-hand side: ages 27-42



The order 1 fertility rate at age 20 in 1990 is the ratio of the number of order 1 children within the current marriage, born in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

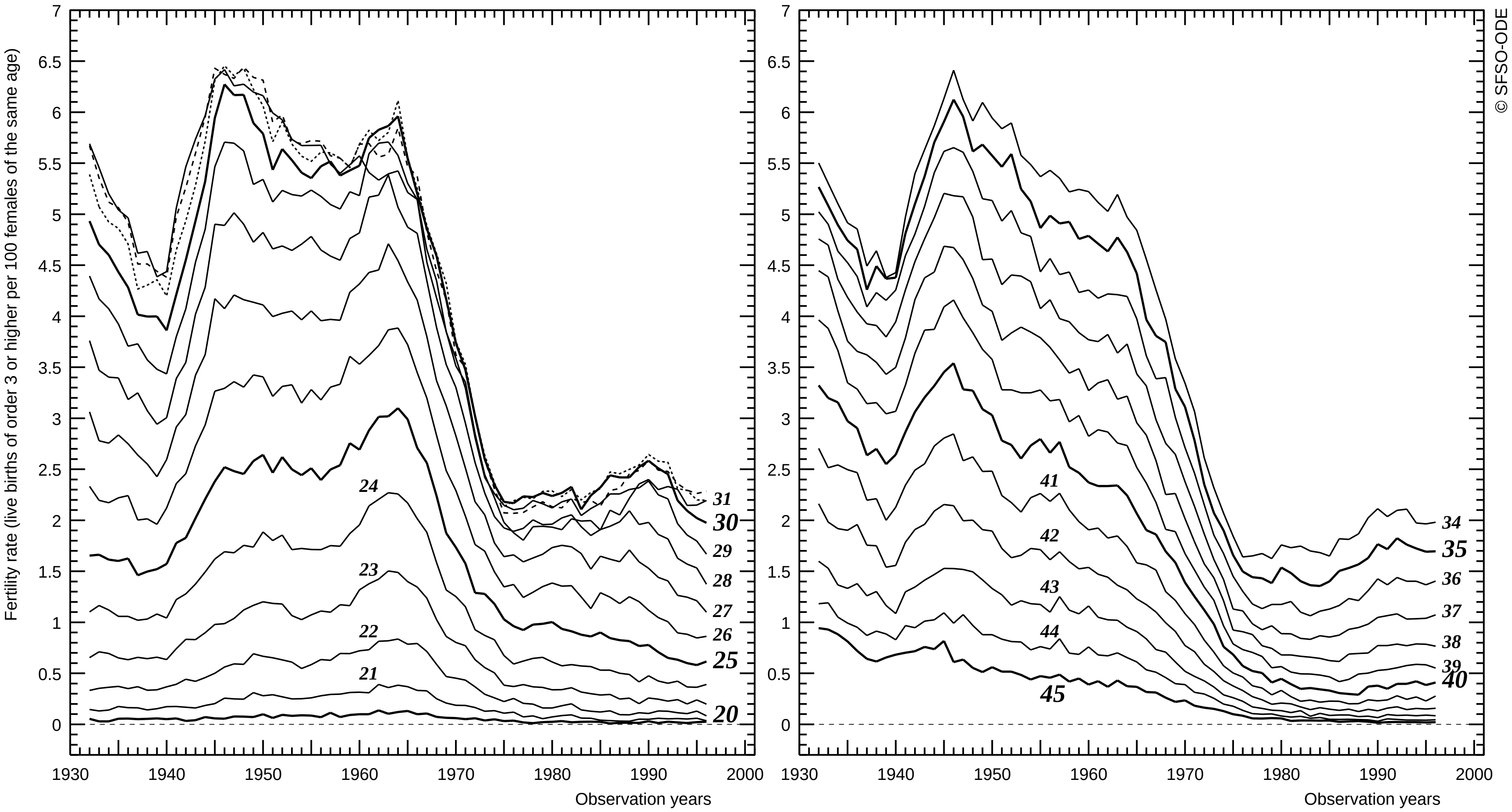
Figure 5.20 SWITZERLAND, 1932-1996. AGE-SPECIFIC FERTILITY RATE, for BIRTH ORDER 2 within the current marriage
Rate by age reached during the calendar year of the birth
Left-hand side: ages 17-27, right-hand side: ages 28-42



The order 2 fertility rate at age 20 in 1990 is the ratio of the number of order 2 children within the current marriage, born in Switzerland in 1990,

whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.21 SWITZERLAND, 1932-1996. AGE-SPECIFIC FERTILITY RATE, for BIRTH ORDER 3 or higher within the current marriage
Rate by age reached during the calendar year of the birth
Left-hand side: ages 20-33, right-hand side: ages 34-45""Left-hand side: ages 20-33, right-hand side: ages 34-45



The order 3 or higher fertility rate at age 20 in 1990 is the ratio of the number of order 3 or higher children within the current marriage, born in Switzerland in 1990, whose mothers were themselves born in 1970, to the (average) number of women born in 1970 resident in Switzerland in 1990

Figure 5.22 SWITZERLAND, 1876-1996
Period mean ages at FIRST MARRIAGE by SEX
and at CHILDBIRTH by BIRTH ORDER

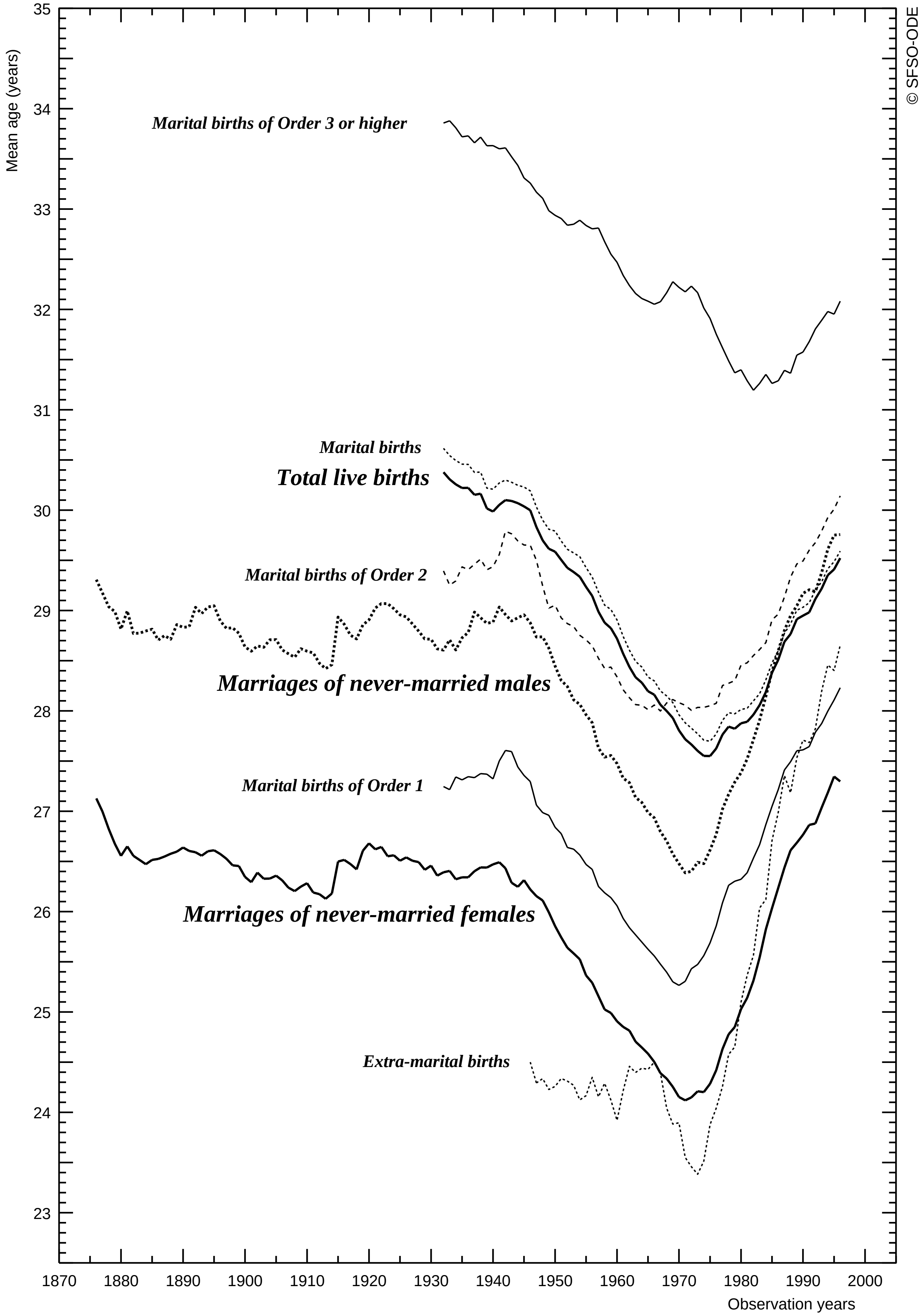


Figure 5.23 SWITZERLAND, 1876-1996
Cohort mean ages at FIRST MARRIAGE by SEX
and at CHILDBIRTH by BIRTH ORDER

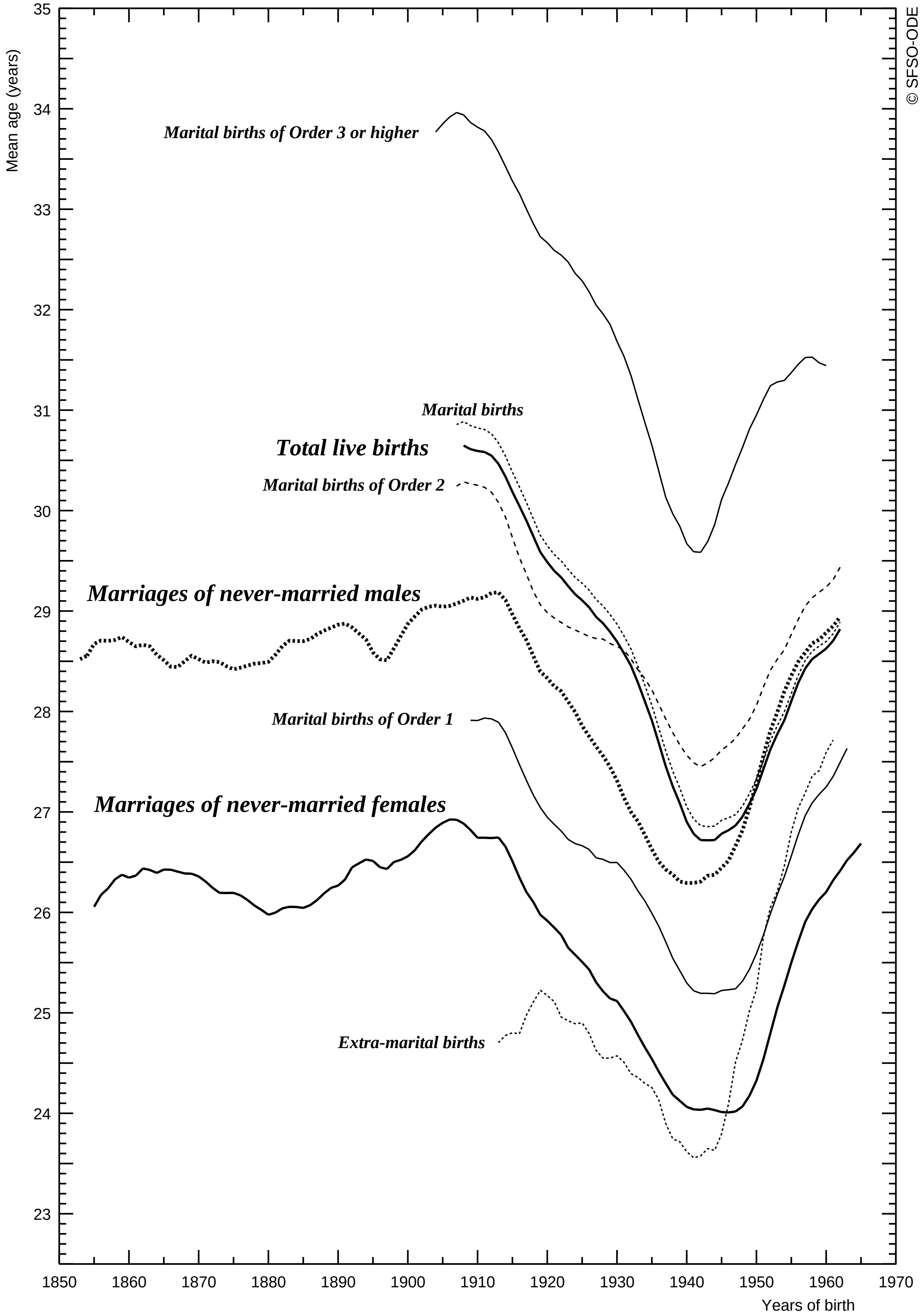
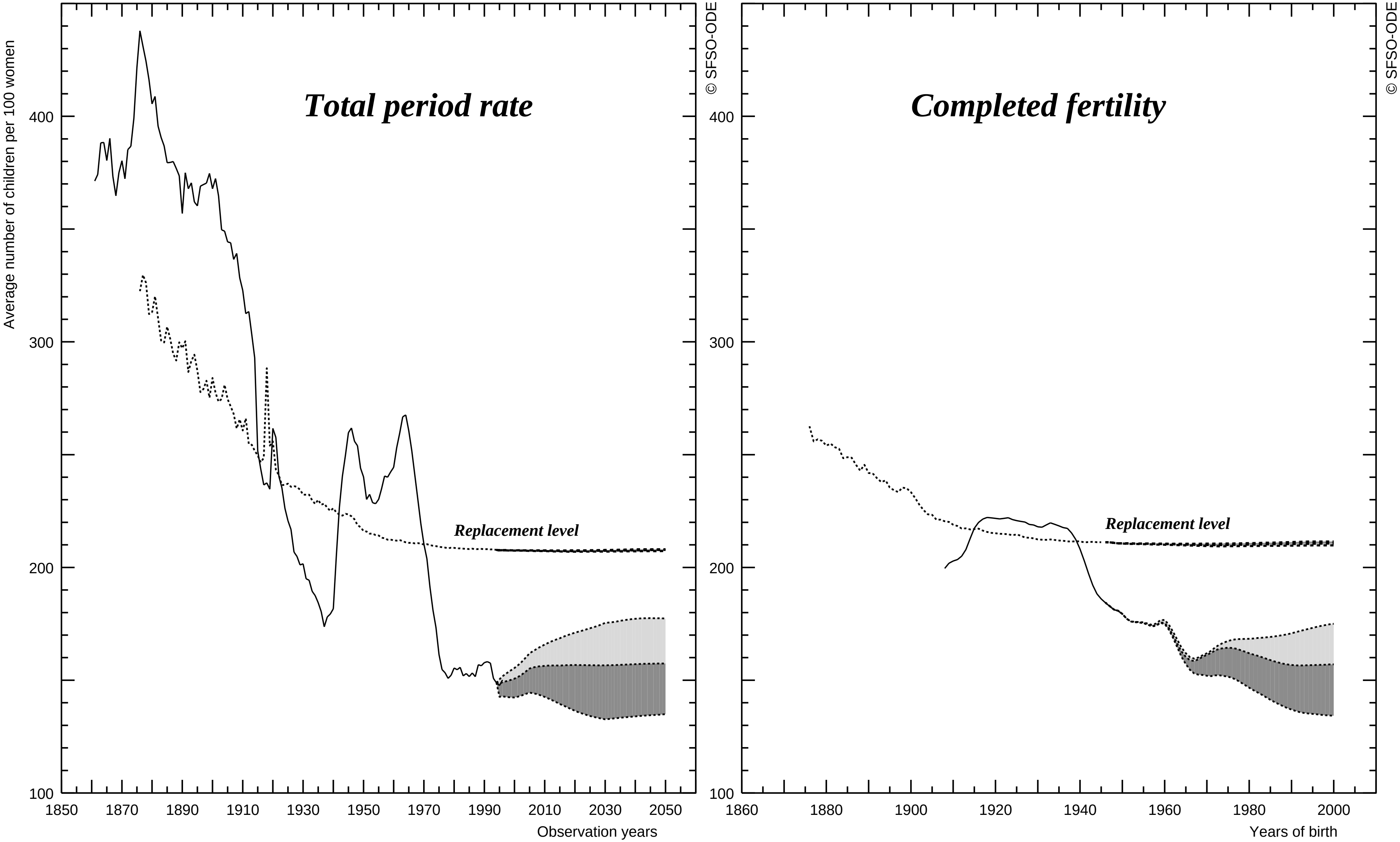


Figure 5.24 SWITZERLAND, 1871-2050
Comparison of observed total PERIOD FERTILITY rate and PERIOD REPLACEMENT level
Comparison between observed COMPLETED FERTILITY and COHORT REPLACEMENT level



Chapter 6: Mortality

Age- and sex-specific annual life tables can be constructed for Switzerland from 1876. But because of the low probabilities of dying at most ages, all are subject to significant random variation making it impossible to give the same detailed age-, observation year- and sex-specific information for mortality as for first marriage or fertility. All that can be done is to present for each observation year, the probabilities by *age band* or life expectancies at *certain ages*. The average age-sex-specific probabilities over a *period of several* consecutive observation *years* can also be presented.

For probabilities of dying according to the observation year, we chose to use *decennial* age brackets with 10-year multiple intervals: probabilities between 0 and 10 years, 10 and 20 years, etc. We also considered the probabilities between 0 and 1 year, between 1 and 20 years, 20 and 60 years and 60 and 80 years. For the sex-specific life expectancies of each observation year, we confined ourselves to intervals which were multiples of 10 years: life expectancy at birth, life expectancy at 10 years, etc. As these were period averages, we used the decennial periods 1880-1889, 1890-1899, ..., 1980-1989, the extreme periods having durations less than ten years: 1876-1879 and 1990-1996.

Extraordinary decline in mortality, especially in the first year of life

Figure 6.1 shows the annual trend since 1876 of sex-specific probabilities of dying for four age groups: between 0 and 1 year (the probability between 0 and 1 year is usually called the *infant mortality rate*), between 1 and 20 years, 20 and 60 years and 60 and 80 years. The progress made over the past 120 years in increasing life expectancy is truly extraordinary, especially at the start of life: the infant mortality rate has been divided by 40, falling from 20% (one in five babies did not survive to their first birthday in 1875) to 0.5% now. The probability of dying between 1 and 20 years of age has been divided by 20 or 30, from 15% for both sexes to 0.8% for males and under 0.4% for females. At adult ages, mortality decline is slower but still significant: a young person aged 20 today has an 89% chance of celebrating his sixtieth birthday if a male, 94% if a female, compared to little more than 50% 120 years ago. A sexagenarian had only a 20% chance of reaching 80 – he now has a 50% chance if male, and nearly 70% if female.

Figure 6.1. shows an exceptionally high probabilities of dying among both sexes for age groups 1-20 and 20-60 in 1918 due to the epidemic of Spanish flu, and a rapid decline in the probabilities of dying between 1 and 20 years of age in the immediate aftermath of the Second World War; this is particularly pronounced for female death probabilities, whose relative difference with male probabilities widened and remain wide today.

Figures 6.2 (males) and 6.3 (females) show the development from 1876 to 2050 of the decennial probabilities of dying; the post-1995 values are those derived from the three SFSO scenarios.

The probability between 0 and 10 years of age shows the sharpest decline. In a remarkable exception to the general continuous decline, the death probability *stops decreasing* in the 1970s for both men and women aged 20-40, and the SFSO scenarios, which forecast continued mortality decline at the other ages predict an *increase* in the death probabilities in the 20-30 and 30-40 decennial age bands for both sexes.

Above 40, the SFSO predicts no slowdown in the decline for males (except in scenario C), but does forecast some slowdown in the rate of decline for females in each of the three scenarios.

Living longer: almost twice as long over 120 years

Life expectancy at the 10-year multiple ages (Figures 6.4 and 6.5) increases at all ages, especially in the first year. Life expectancy at birth in 1875 was *lower* than at 10 years of age and close to that at 20 years of age due to the very high infant and child mortality of the time[11]. Its increase in the space of 120 years has almost *doubled* the mean length of life which has risen from 39.5 in 1876 to 76.0 years in 1996 for men and from 42.5 to 82.0 years for women.

At the other ages, the increase in longevity decreases at the higher ages, but remains no less remarkable for that. So, at 60 years of age, life expectancy increases eight years for men and twelve years for women, rising from 12 years in 1875 to 20 years today for the former, and from 12.5 to 24.5 years for the latter.

An exception to mortality decline in the past ten years: 20-40-year-olds

Figure 6.6 compares the death probability curves between succeeding decennial periods. The rate of mortality decline has not been uniform over the past 120 years. The most rapid progress, especially for females, was made in the immediate aftermath of the Second World War, especially with the development of antibiotics and sulphamides. Even so, some *setbacks* are discernible: mortality in the decennial period 1910-1919 did not decline from the preceding period 1900-1909 among males aged 15-35 due to the flu epidemic. In the past decade in particular, however, mortality has ceased to decline among males aged 20-40 and females aged 20-35 despite the virtual eradication of infectious diseases. This can be attributed to the rise in violent deaths (accidents and suicides) and the emergence of AIDS at ages where – apart from AIDS – disease is now seldom fatal. Nevertheless, the halt in a century of almost consistent mortality decline at the onset of adult ages among both men and women (except for the decade 1950-1959 for females), is rapidly assuming larger proportions in the most recent tables. The male death probability curves for the period 1990-1996 reveal a very pronounced *narrowing* around age 20, which the SFSO predicts will *accentuate* in the future. Figures 6.6.A to 6.6.C show the projected curves for the period 2040-2049 compared with those of the most

[11] It can be shown that life expectancy at birth is *lower* than life expectancy at 1 year of age if the infant mortality rate exceeds the inverse of life expectancy at birth (increased by 0.5). Such was the case in Switzerland until 1974 for males, and until 1969 for females. Life expectancy at birth has exceeded that at 10 years of age since 1912 and 1906 for males and females, respectively.

recent period (1990-1996) and that of fifty years ago (1940-1949). Accordingly, scenario B assumes that the probability of dying at 30 years of age for males and 25 for females in 2040-2049 will return to its 1940-1949 level, while scenarios A and C forecast that it will be even *higher*.

Excess male mortality

Figure 6.7 is the curve chart of male and female probabilities of dying. Excess male mortality, which appeared only between 40 and 70 years at the end of the 19th century, can be seen to progressively spread first to all adult ages then to all ages. Prior to 1920-1929, there was a slight excess female mortality at puberty and childbearing age which has since completely disappeared.

Figure 6.8 shows for each decennial period the age-specific variations in the ratio of the male probability of dying to the female probability at the same age. In 1875, the ratio was between 0.85 (at 15 years of age) and 1.5 (around 50 years of age). Up to the Second World War, its maximum value hardly changed, while its minimum value fell to 0.7, representing an *increase* in excess female mortality between the periods 1876-1879 and 1900-1909, then rose close to 1 as excess female mortality declined then disappeared. The decade 1940-1949, and especially the following decade, saw excess male mortality increasing at all ages, the maximum ratio value reaching 3.5 at about 20 years of age. At age 50 and above, the ratio increases, the second maximum (1.7 around 55 years of age in 1950-59, 2.3 around 70 years of age in 1990-96) increasing and shifting towards increasingly older ages.

The difference in life expectancy at birth between females and males (Figure 6.9), which was no more than two and a half years in 1875 and three years after the First World War, increases from the 1930s to reach six and a half years around 1975, where it has more or less remained since. In its scenarios for 2050, the SFSO forecasts that it will stabilize (scenario C) or decrease to five and a half years in 2050 in scenario A, or just over four years in scenario B.

Figure 6.10 illustrates the age-specific[12] decomposition of the difference in life expectancy at birth between males and females. It will be seen that the current high excess male mortality around age 20 – an age at which mortality is low – has a lesser effect on the difference than that around 70 years of age.

Remaining life expectancy

The decline of mortality has increased the age at which the average *remaining* life expectancy is constantly equal to a given value. Figures 6.11 and 6.12 show the sex-specific trends in the ages at which there remains an average 5, 10, 15, 20 and 25 years of life. The age at which there remains 25 years of life has risen

[12] This decomposition, which is additive over all ages, is expressed as follows: if, at age i the male probability of dying were equal to the female probability, the difference between life expectancies at birth would be reduced by the quantum shown on the y-axis of figure 6.10. In previous periods when infant mortality rates were still high, with significant excess male mortality at age 0, the contribution of this age 0 to the difference between life expectancies at birth was highly significant. This is why figure 6.10 is restricted to ages 1 year and above.

by 15 years for men (from 39 in about 1875 to 54 today) and by 17 years for women (from 42 to 59 years of age). That at which there remains an average 10 years of life has risen by 10 years for men and 14 years for women. The SFSO scenarios predict a future slowing down in the rate of these increases.

Dependency ratio and average duration of retirement

It is interesting to compare the rate of increase in the ageing of the population and that in the age at which the average remaining life expectancy is constant.

Figure 6.13 shows the past and future trend of the equivalent age of 60 (and 65 years) today, where the homology is defined firstly by the *same dependency ratio* of the working age or retired population (20 and above) as in figure 2.7, and secondly, by the *same average remaining life expectancy*. It will be seen that, in the past, the probability of dying – the female probability in particular – declined more rapidly than the increase in the ageing of the population aged 20 and above. This will probably not continue to hold true in the future, however.

In other words, while the imbalance between the working age and retired populations could, in the past, be offset by raising the age of separation from the labour force accordingly, the retired population would nevertheless have enjoyed an *increasing* average length of retirement.

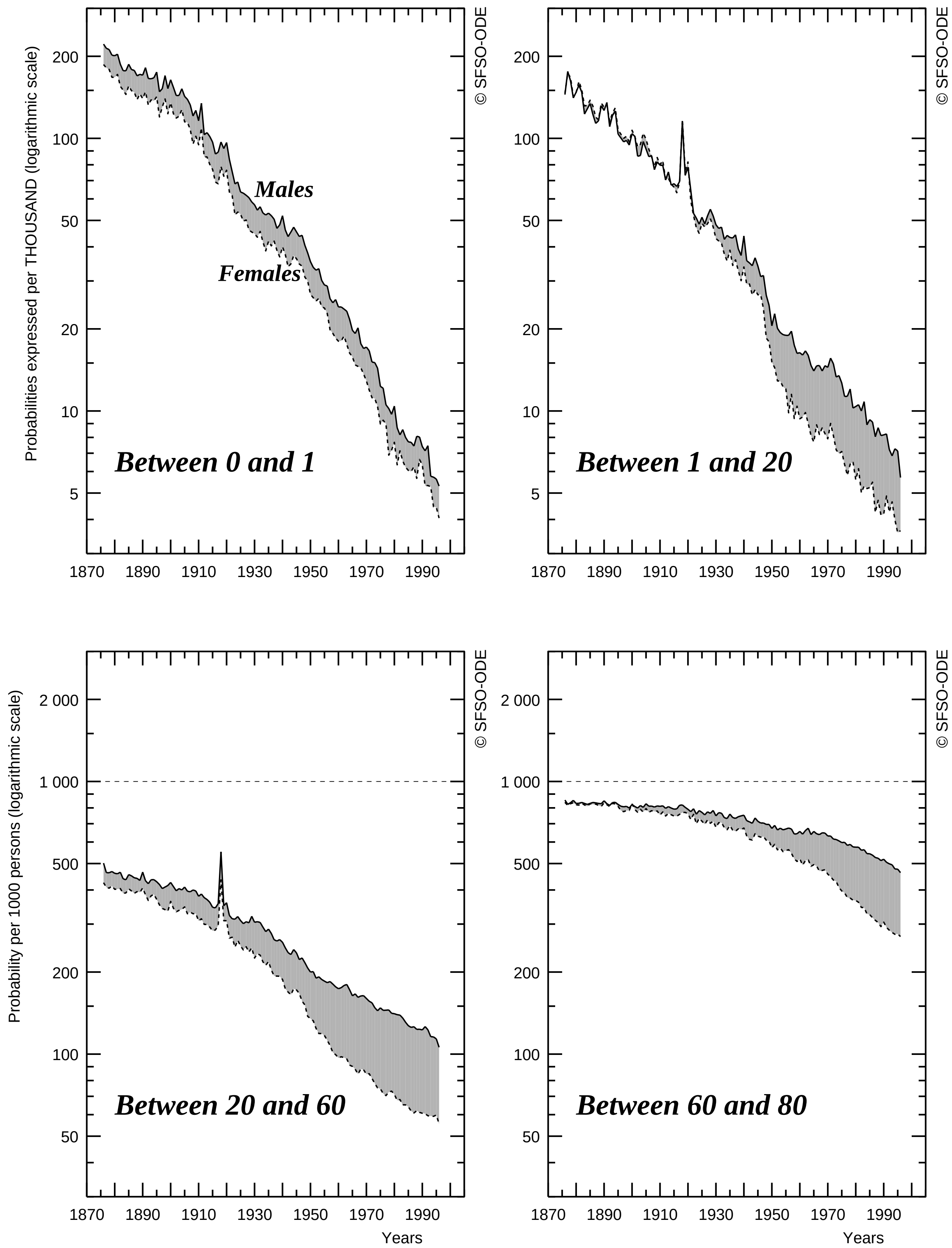
If, in the future, the retirement age is raised to maintain an average length of retirement equal to its present level, the revenue/expenditure imbalance of a pay-as-you-go pension system caused by the ageing of the population will not be fully offset. To restore the balance, a policy mix of the following measures will be needed: increase the employer/employee contribution rates, reduce average pension levels compared to average wages, increase immigration, increase women's labour force participation.

The proportion of the total population with a fixed remaining life expectancy

Another way of measuring the increased ageing of the total population taking account of the general improvement in health, is to determine at January 1 each year the proportion of the population whose age exceeds that which corresponds to a given remaining life expectancy under the observed life table for that year. Figures 6.14 and 6.15 show for men, women and both sexes, the trend from 1876 to 2050 in the proportion of people whose age is at least equal to that corresponding in the life table for the same year to a remaining life expectancy equal to five years (Figure 6.14) or ten years (Figure 6.15).

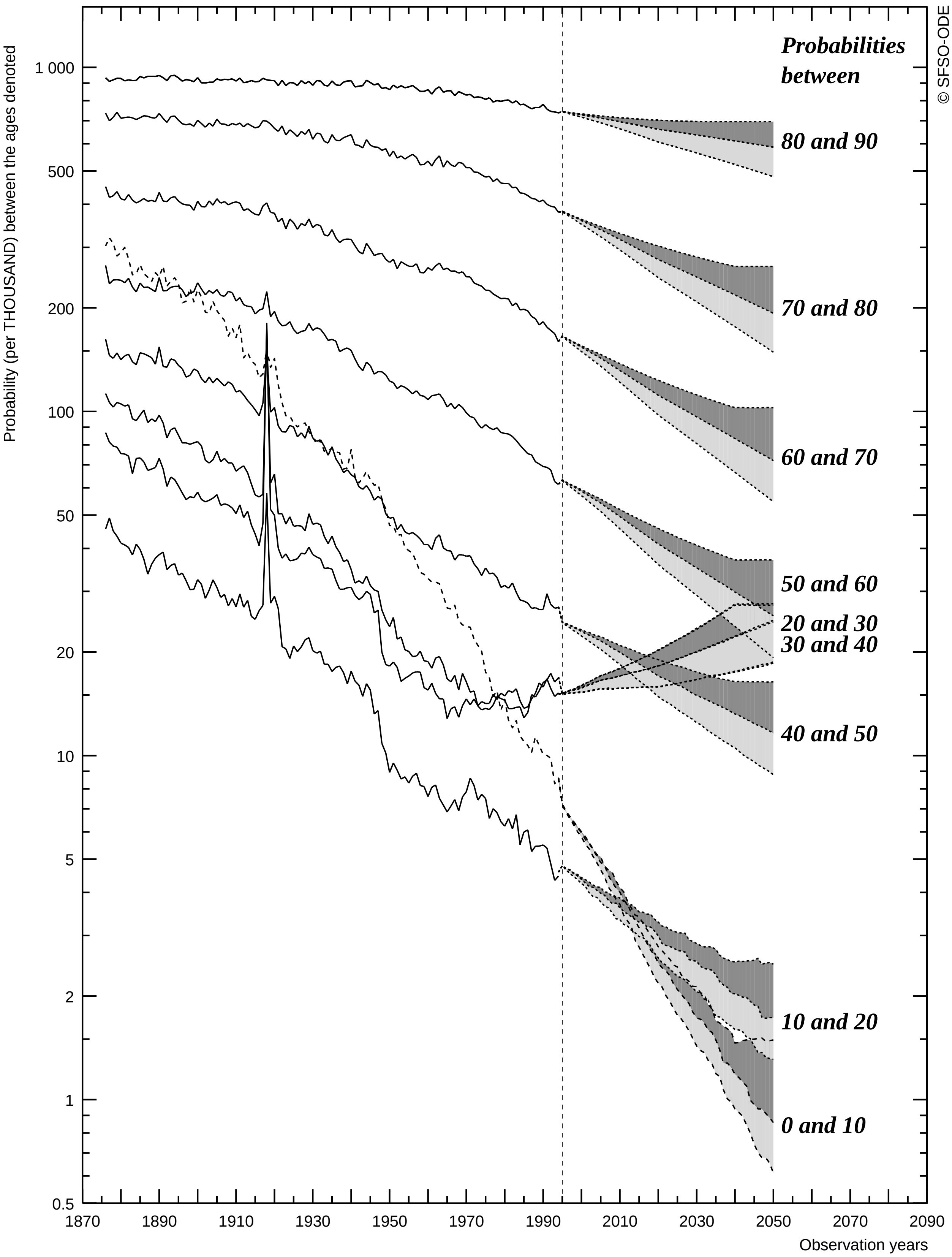
It will be seen that with this definition of old age, which is *variable* in terms of age but reasonably *invariant* in terms of health, the proportion of "old" people has remained relatively stable for a century: between 0.5 and 1.5% people with less than five years of life remaining on average, having regard to their age, and between 4 and 6.5% people with less than ten years of life remaining. These proportions will increase sharply during the next fifty years in each of the three scenarios posited by the SFSO: the former would rise from 1.3% for both sexes now to 2.9% (scenario A) by 2050, and 2.5 and 3.8% in scenarios B and C, respectively; the latter would rise from 5.2% now to 9.8% (scenario A), or 8.7 and 12% in scenarios B and C. The future rate of ageing of the population is thus likely to outstrip any expected rate of decline in mortality.

Figure 6.1 SWITZERLAND, 1876-1996
Probabilities of DYING between various ages by SEX
Logarithmic scales of same moments



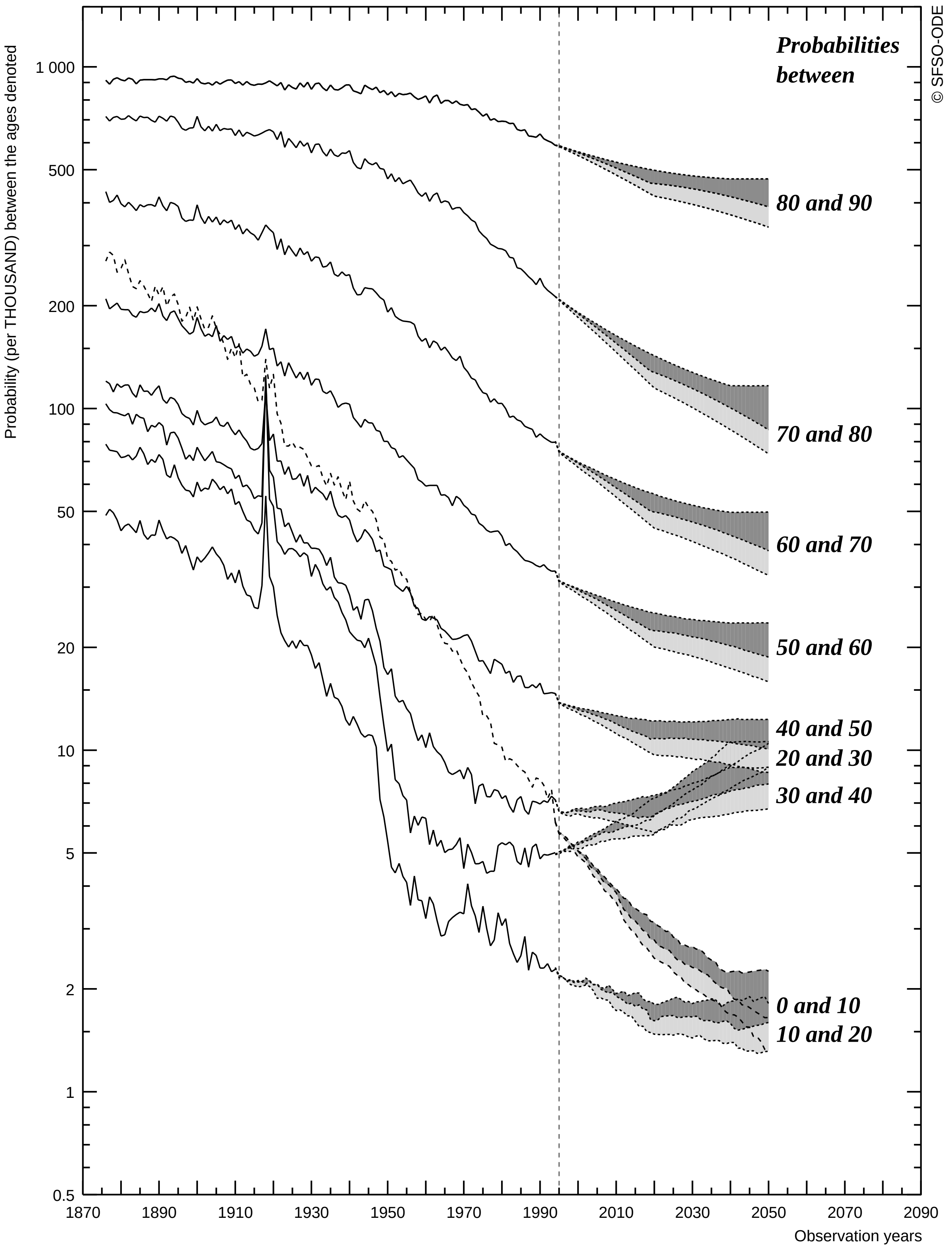
The probability of dying between ages x and y is the probability that a person still living at age x, will die before reaching age y

Figure 6.2 SWITZERLAND, 1876-2050
Decennial MALE probabilities of DYING
SFSO A, B and C scenarios from 1995
Logarithmic ordinate scale



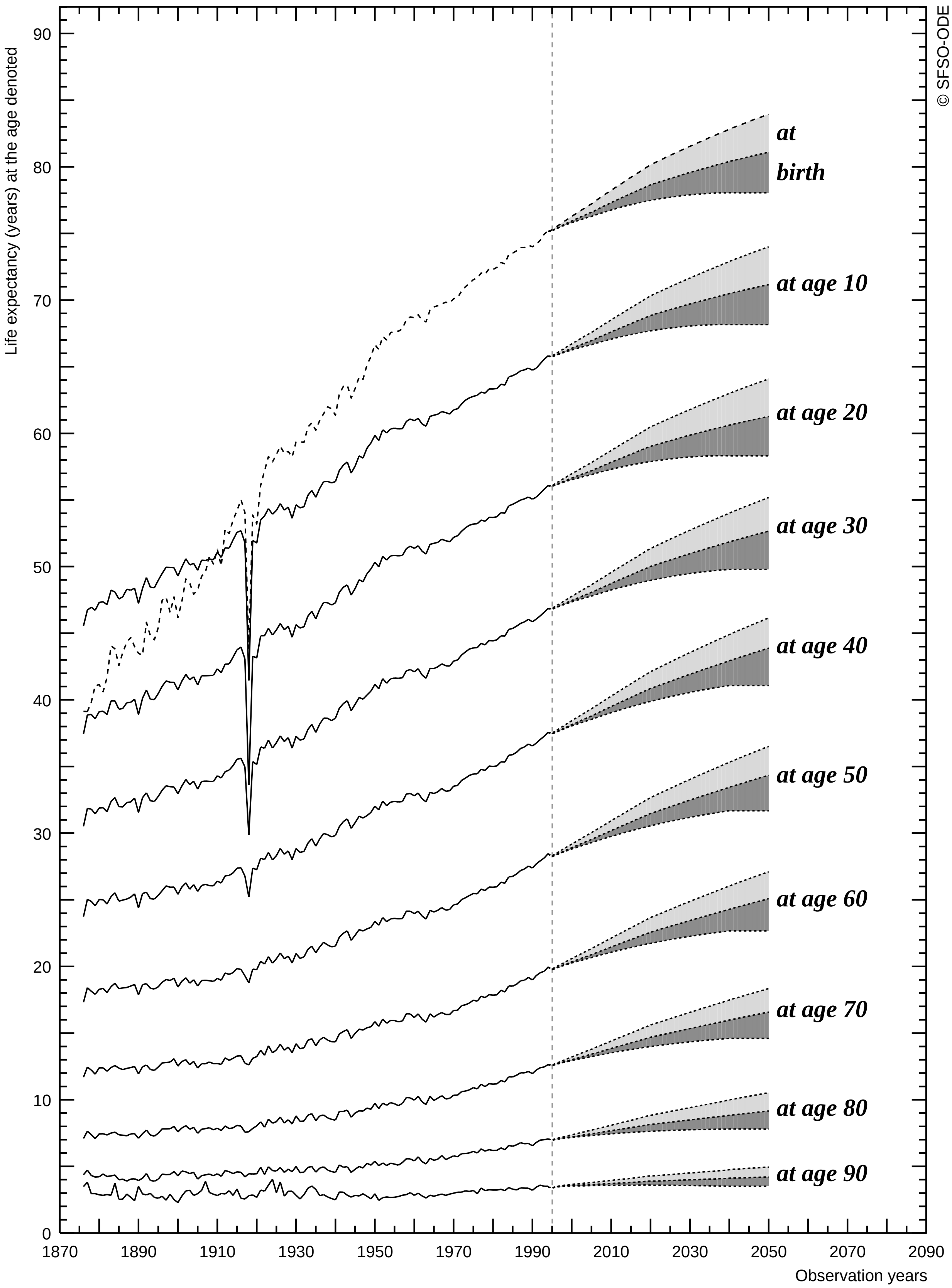
The probability of dying between ages x and x+10 is the probability that a person still living at age x, will die before reaching age x+10

Figure 6.3 SWITZERLAND, 1876-2050
Decennial FEMALE probabilities of DYING
SFSO A, B and C scenarios from 1995
Logarithmic ordinate scale



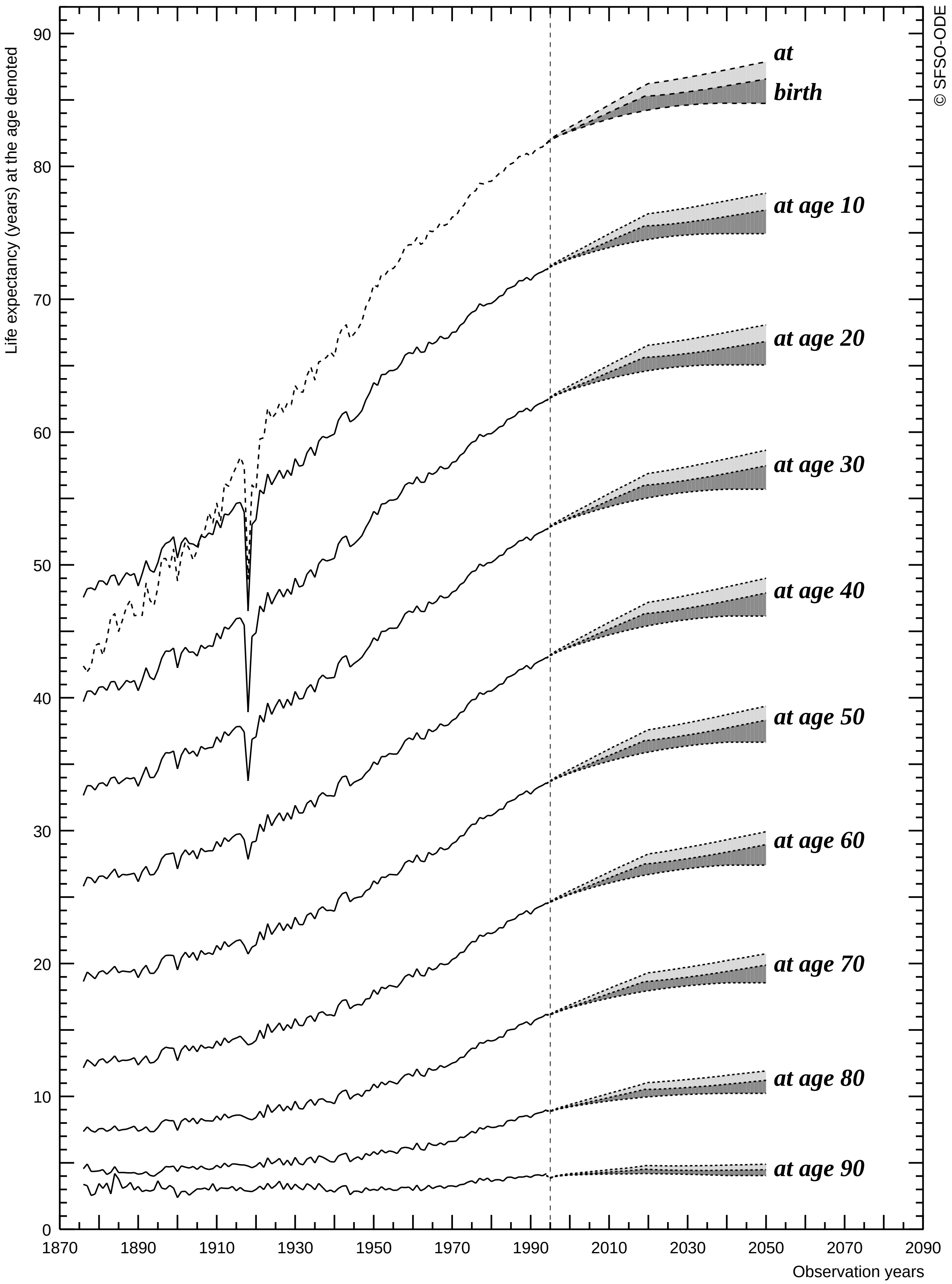
The probability of dying between ages x and x+10 is the probability that a person still living at age x, will die before reaching age x+10

Figure 6.4 SWITZERLAND, 1876-2050
MALE LIFE EXPECTANCY at various ages
SFSO A, B and C scenarios from 1995



The life expectancy at age x is the average number of years of life remaining to a person still living at age x

Figure 6.5 SWITZERLAND, 1876-2050
FEMALE LIFE EXPECTANCY at various ages
SFSO A, B and C scenarios from 1995



The life expectancy at age x is the average number of years of life remaining to a person still living at age x

Figure 6.6 SWITZERLAND
Periods 1876-1879, 1880-1889, 1890-1899..., 1980-1989 and 1990-1996
PROBABILITIES of DYING by AGE and SEX

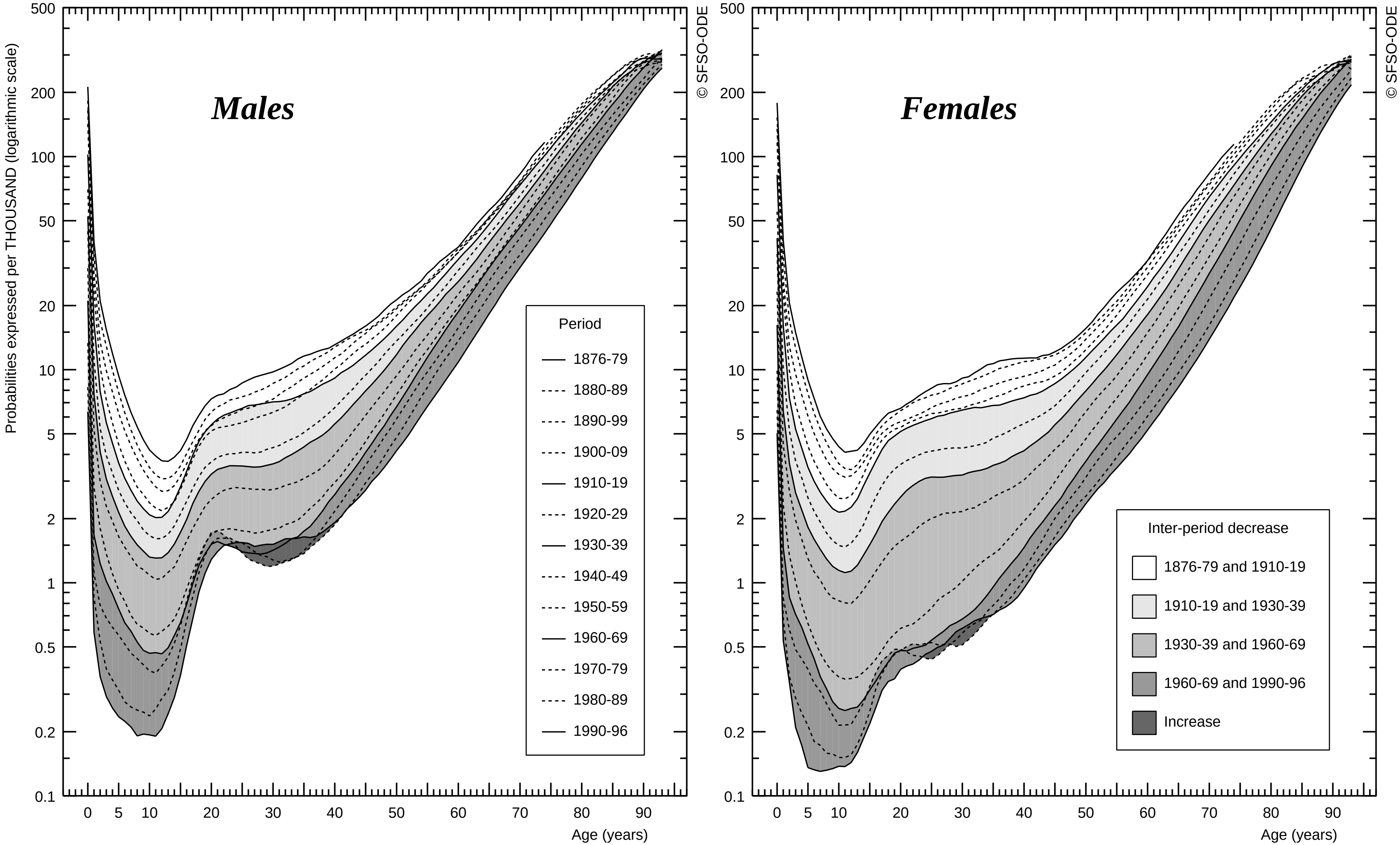


Figure 6.6.A SWITZERLAND
Periods 1940-1949, 1990-1996 and 2040-2049 (SFSO scenario A)
PROBABILITIES of DYING by AGE and SEX

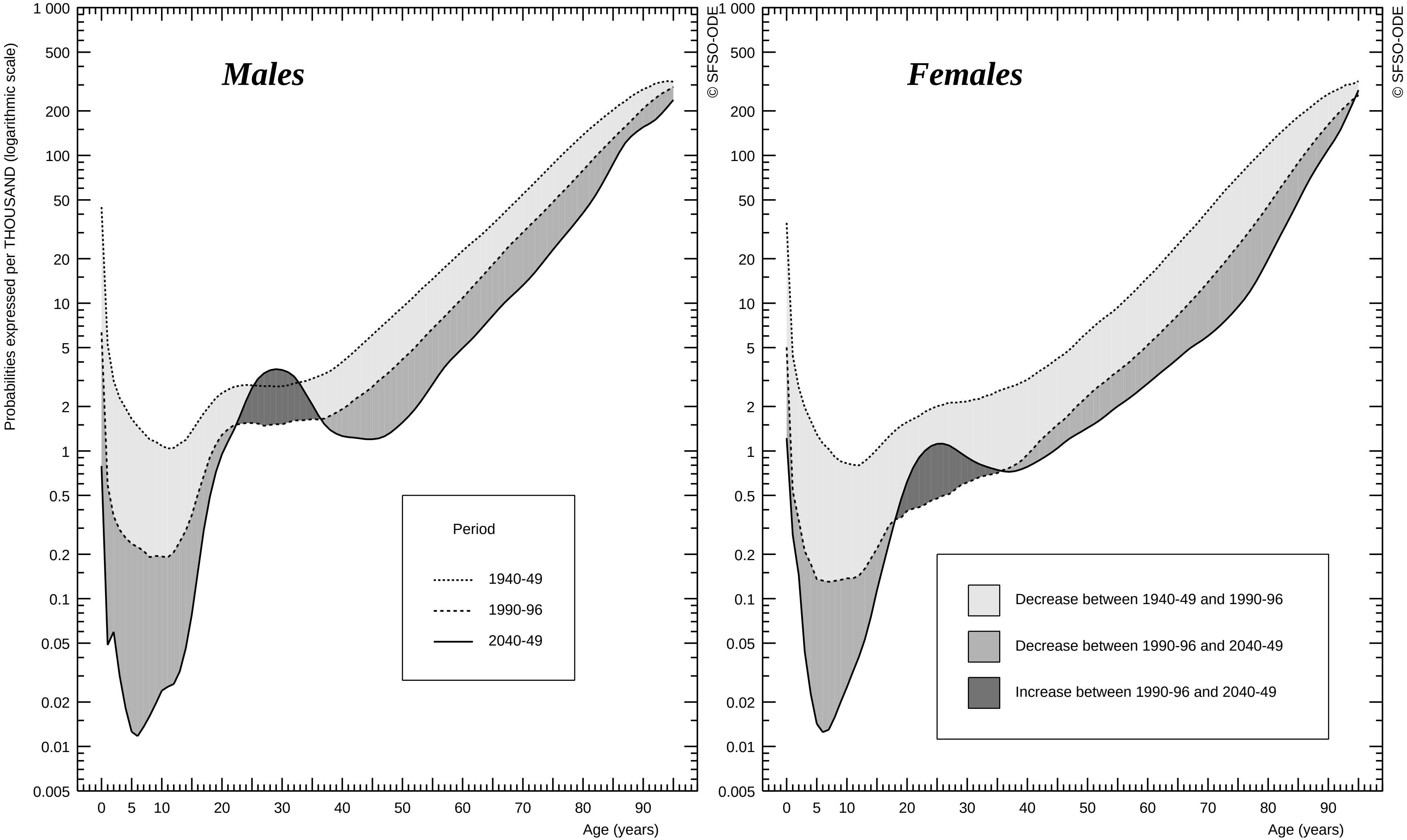


Figure 6.6.B SWITZERLAND
Periods 1940-1949, 1990-1996 and 2040-2049 (SFSO scenario B)
PROBABILITIES of DYING by AGE and SEX

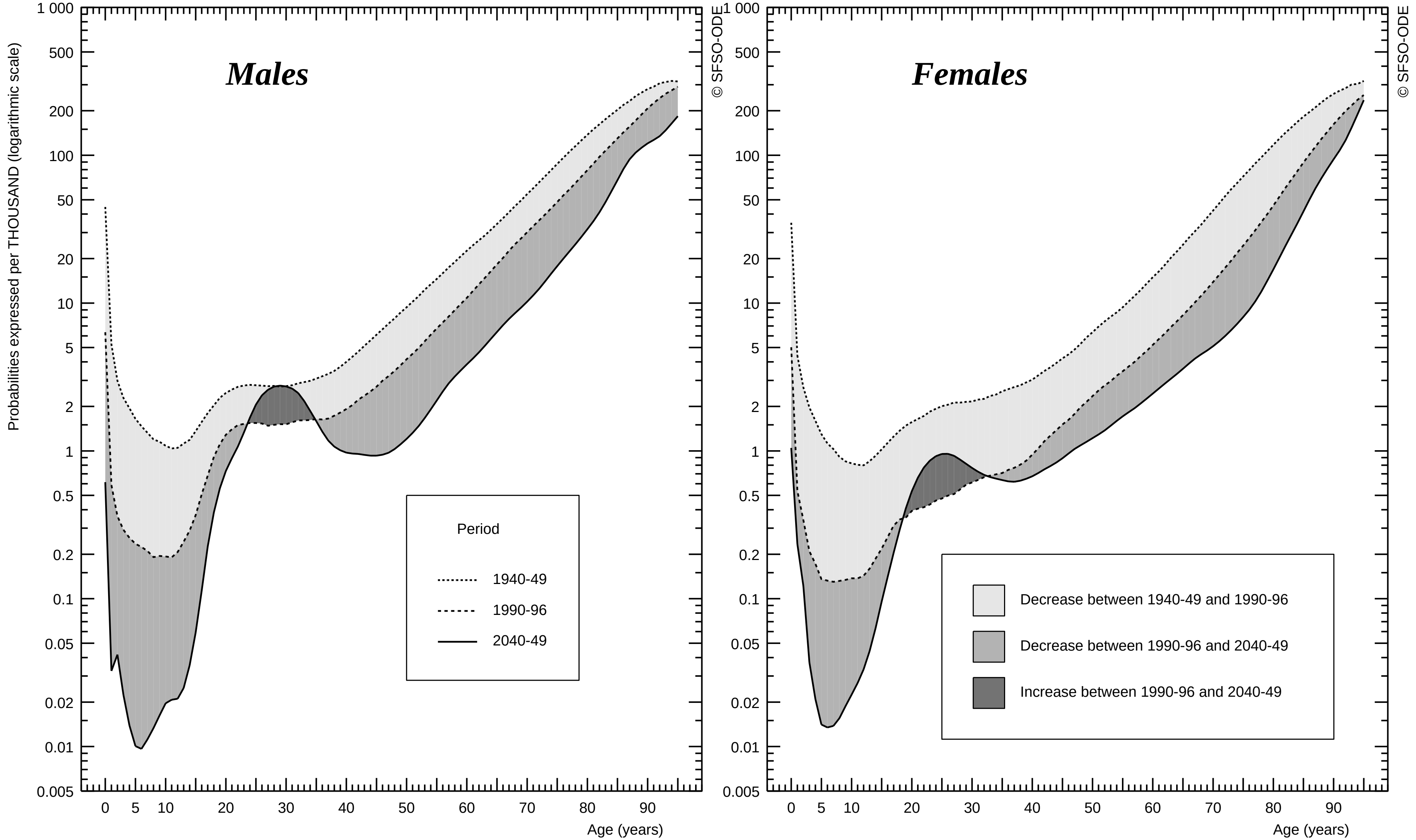


Figure 6.6.C SWITZERLAND
Periods 1940-1949, 1990-1996 and 2040-2049 (SFSO scenario C)
PROBABILITIES of DYING by AGE and SEX

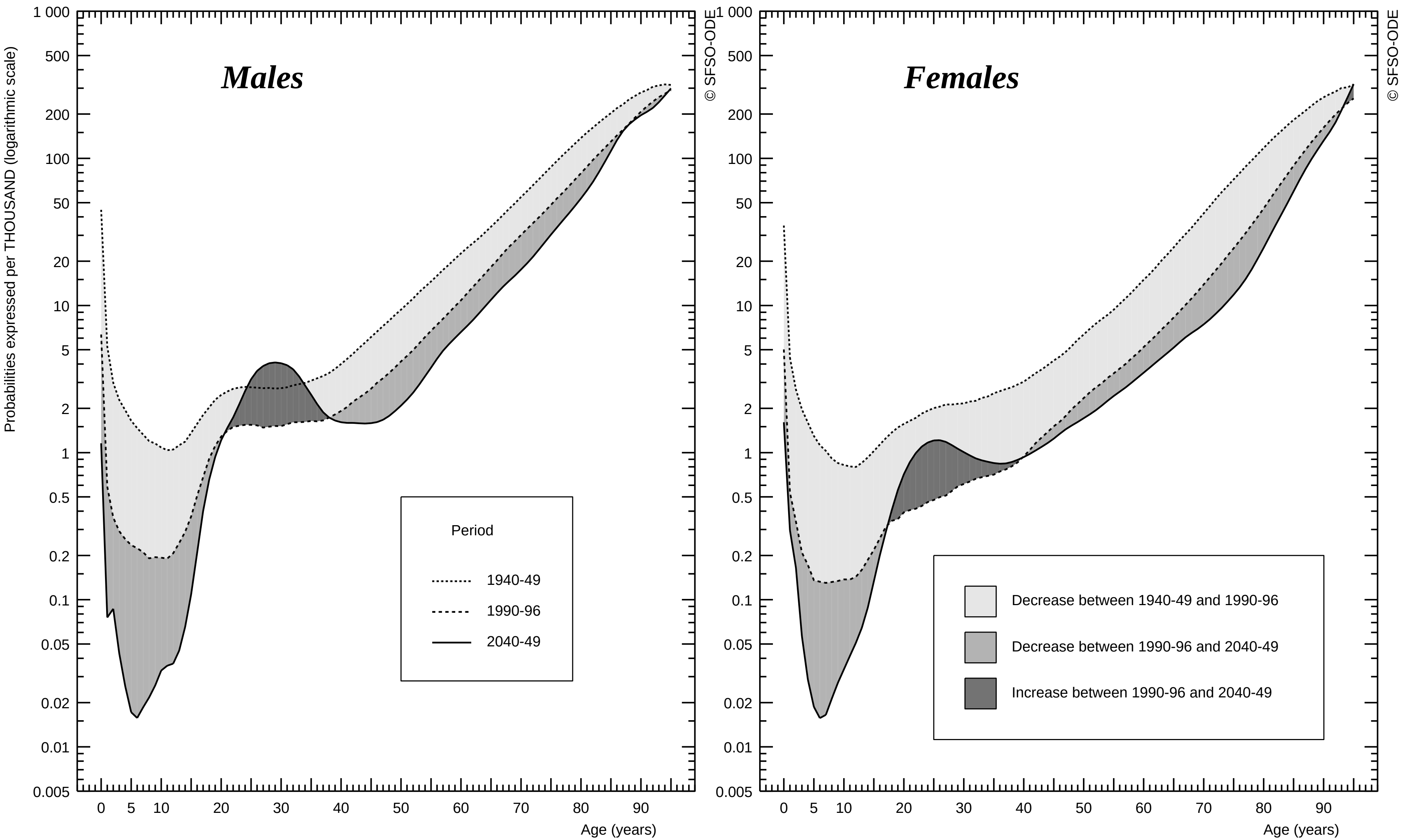


Figure 6.7 SWITZERLAND
Periods 1880-1889, 1890-1899..., 1980-1989 and 1990-1996
PROBABILITIES of DYING by AGE and SEX

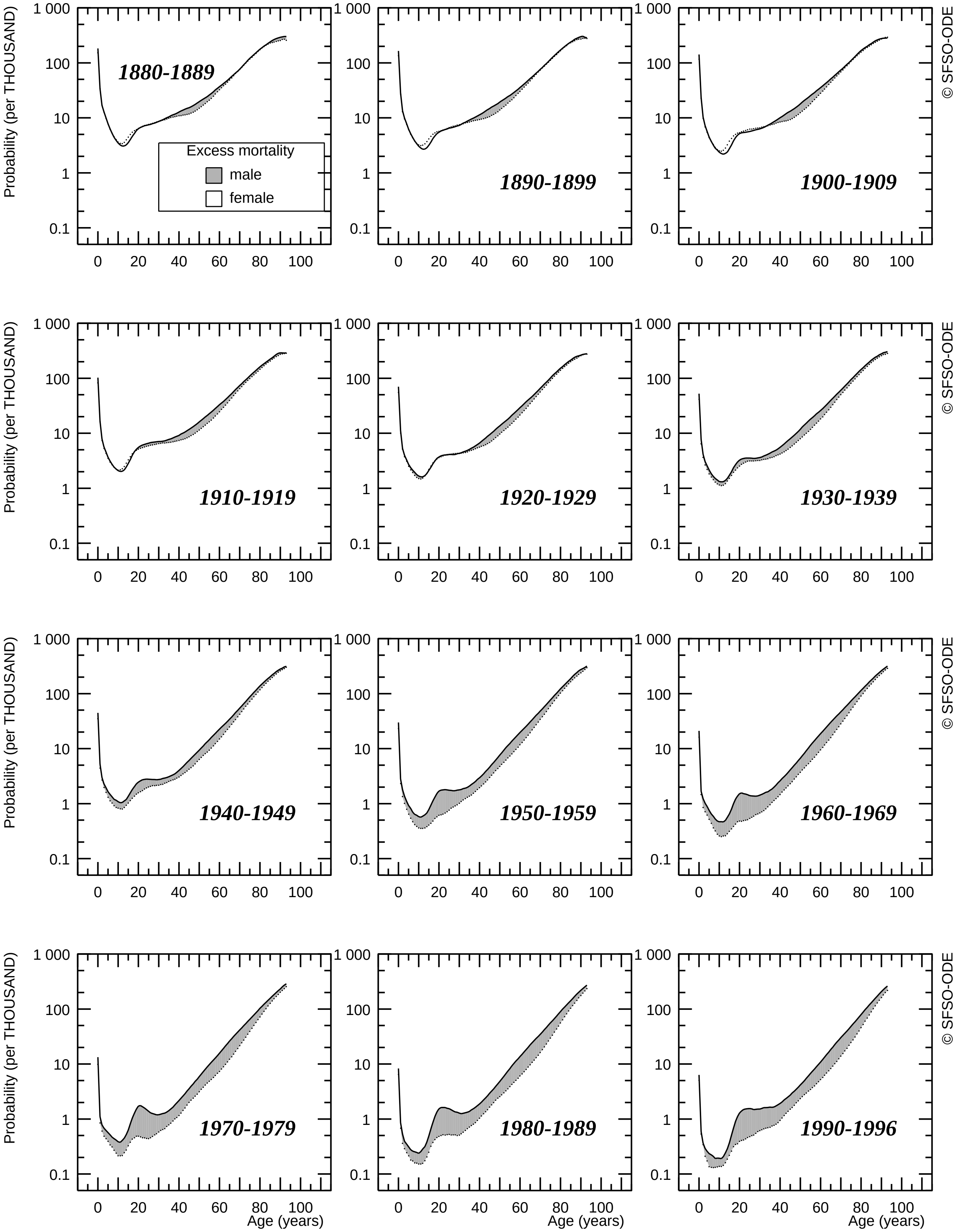


Figure 6.8 SWITZERLAND, 1876-1996
Age-specific RATIO of the MALE probability of dying
to the FEMALE probability of dying at the same age

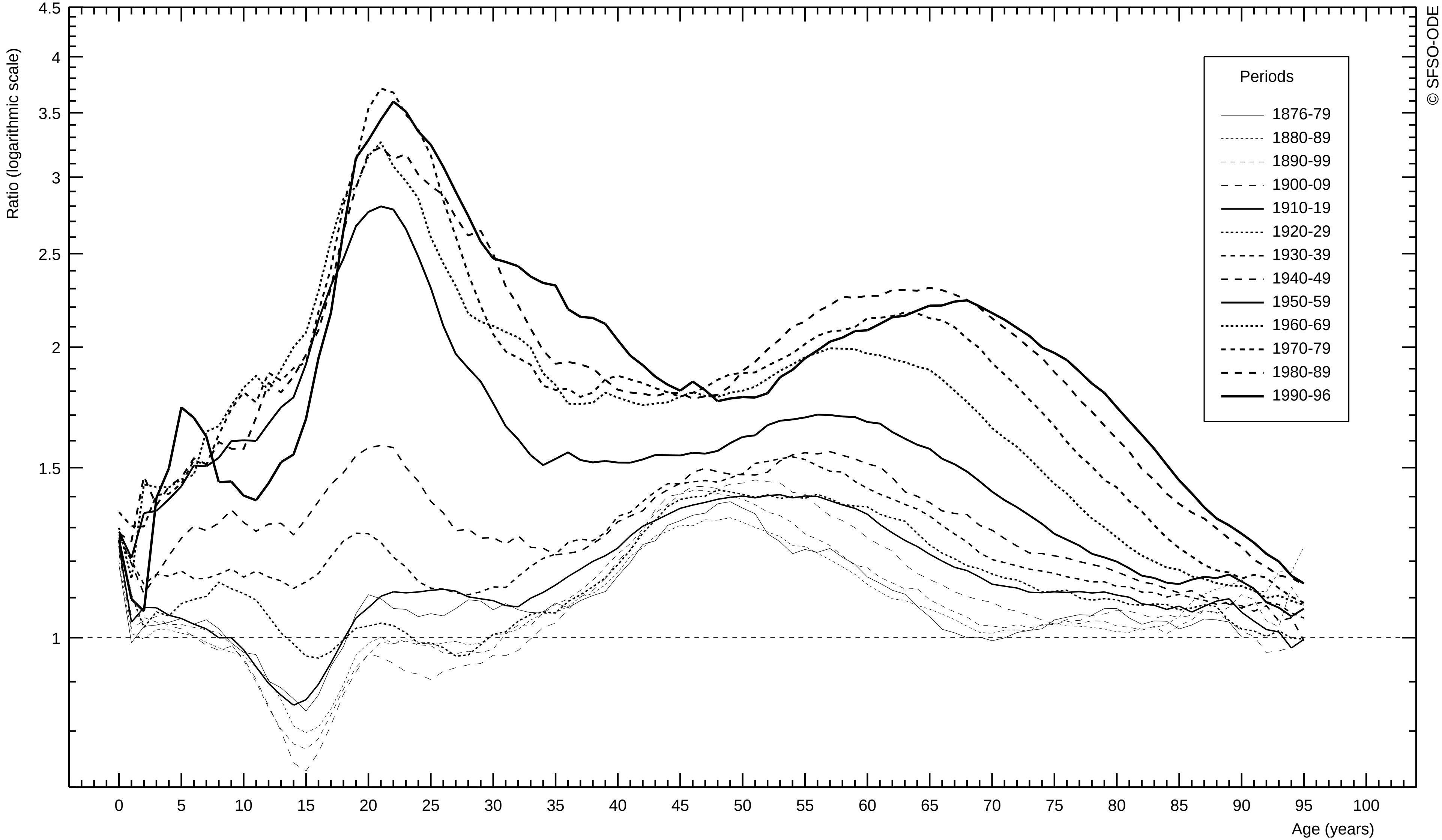


Figure 6.9 SWITZERLAND, 1876-2050
SFSO A, B and C scenarios from 1995
DIFFERENCE between FEMALE and MALE life expectancies at birth

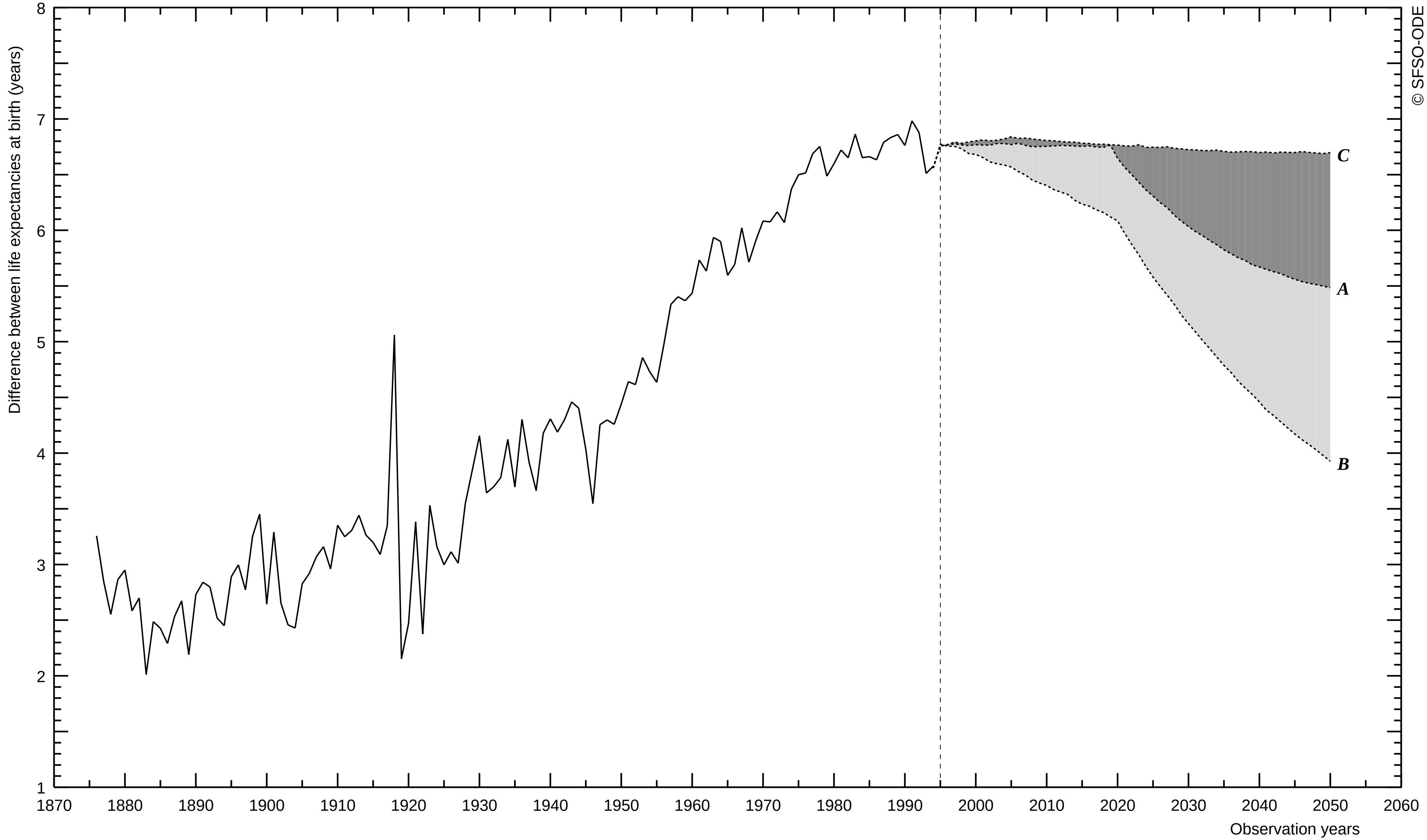


Figure 6.10 SWITZERLAND, 1876-1996
Contribution of ages higher than 0
to the difference between FEMALE and MALE life expectancies at birth

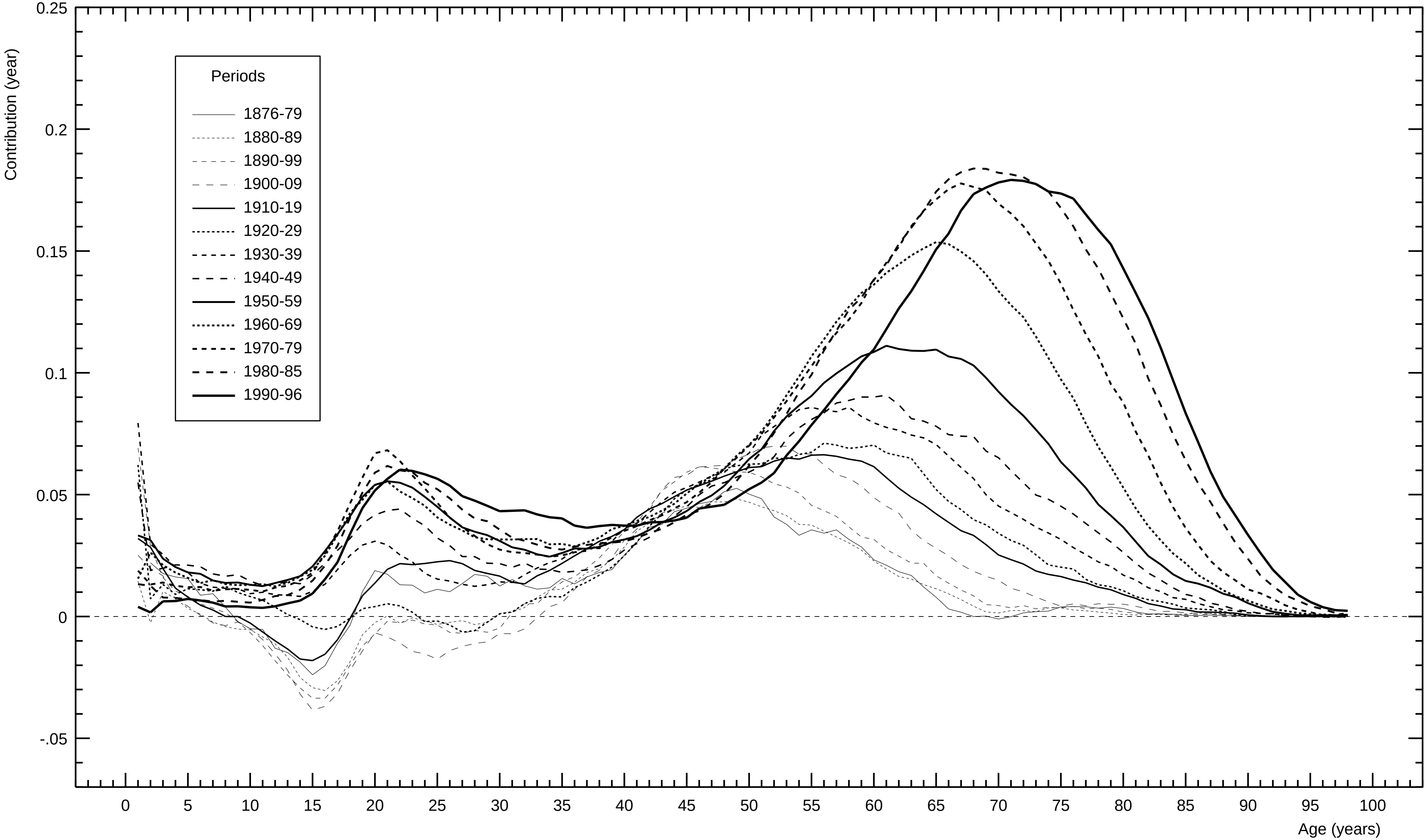
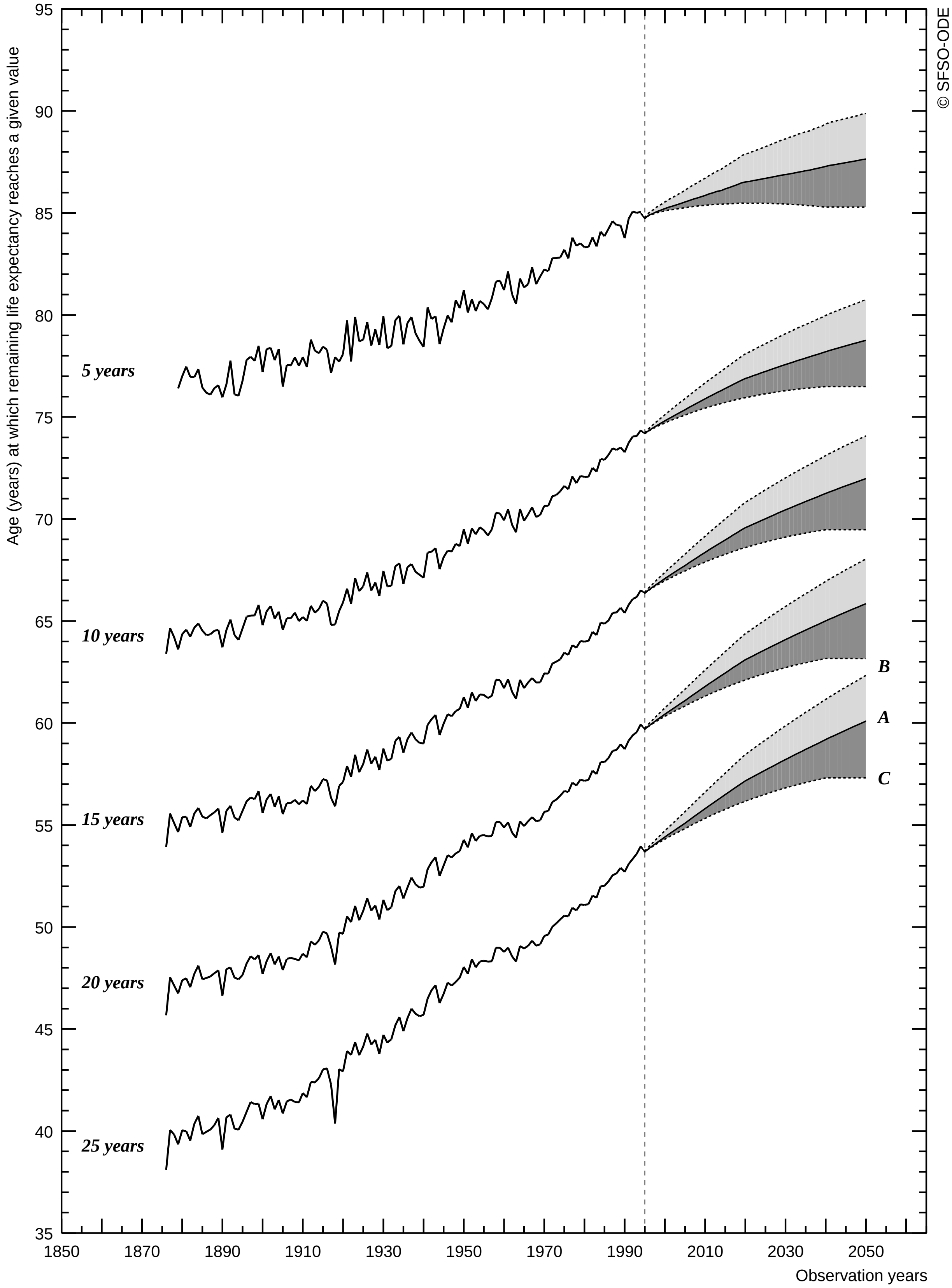


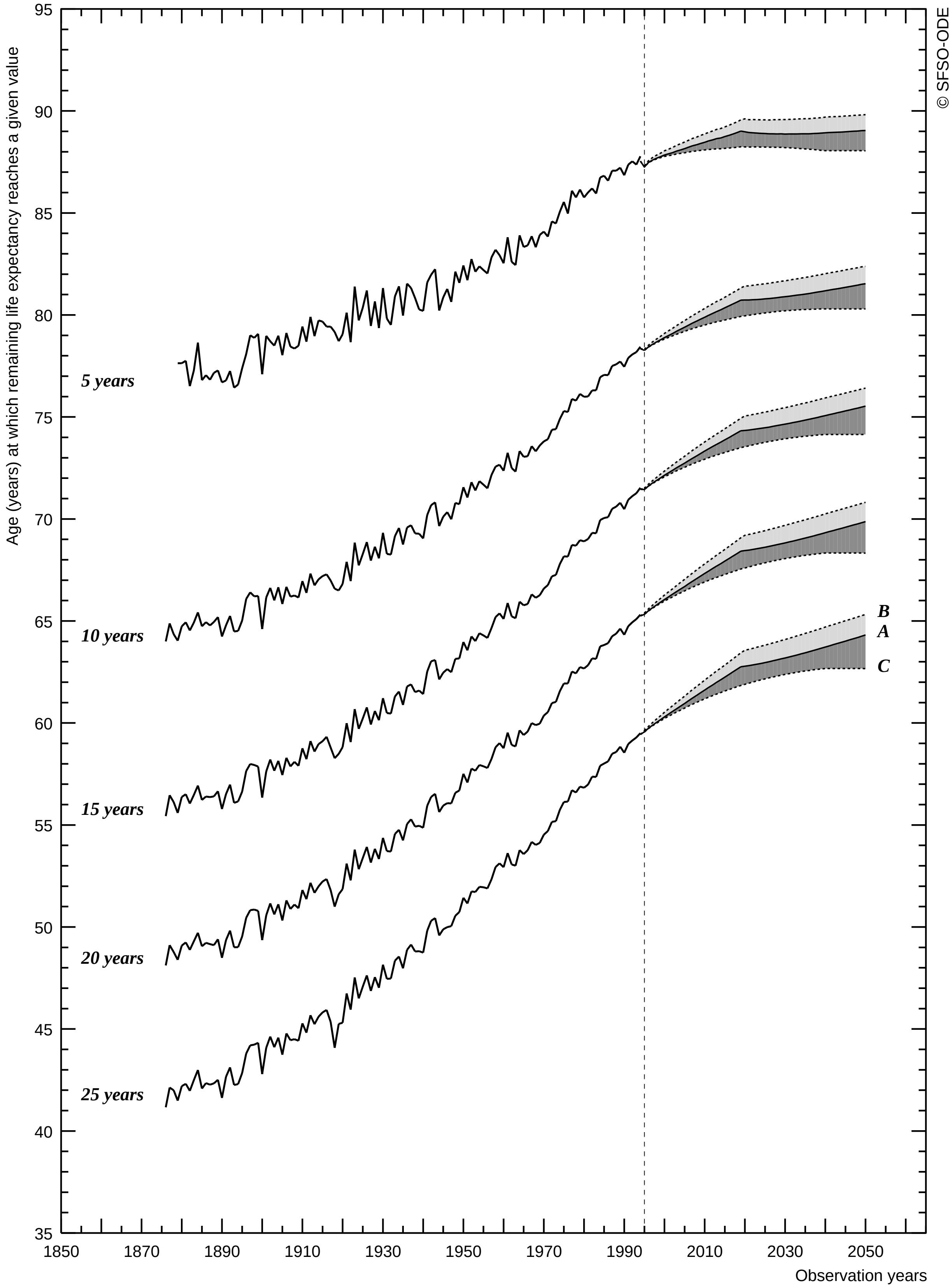
Figure 6.11 SWITZERLAND, 1876-2050, Males
Age at which remaining life expectancy reaches a given value
SFSO A, B and C scenarios from 1995



The remaining life expectancy at age x is the average number of years

of life remaining to a person still living at age x

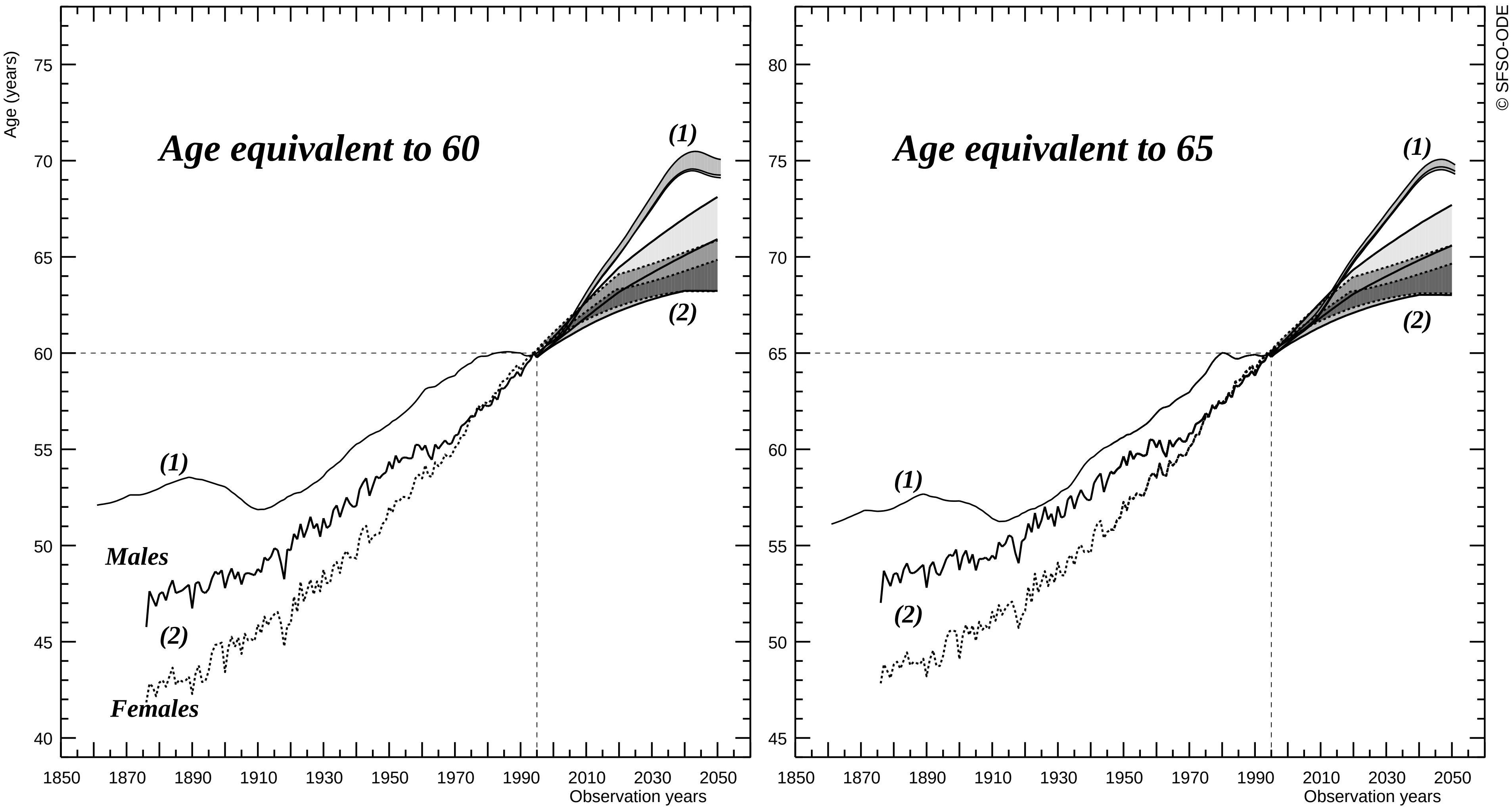
Figure 6.12 SWITZERLAND, 1876-2050, FEMALES
Age at which remaining life expectancy
reaches a given value
SFSO A, B and C scenarios from 1995



The remaining life expectancy at age x is the average number of years

of life remaining to a person still living at age x

Figure 6.13 SWITZERLAND, 1861-2050
Curve (1): Ages within the population aged 20 or over EQUIVALENT to 60 and 65 at January 1, 1995
Curves (2): Ages equivalent to 60 and 65 in 1995 in terms of remaining life expectancy, by sex
SFSO A, B and C scenarios from 1995



The curves (1) are identical to those of figure 2.7

The curves (2) denote for each sex the age at which remaining life expectancy is the same as at 60 or 65 years of age in 1995

Figure 6.14 SWITZERLAND, 1876-2050
Proportion of the population at an age
where the REMAINING life expectancy is 5 years at most
SFSO A, B and C scenarios from 1995

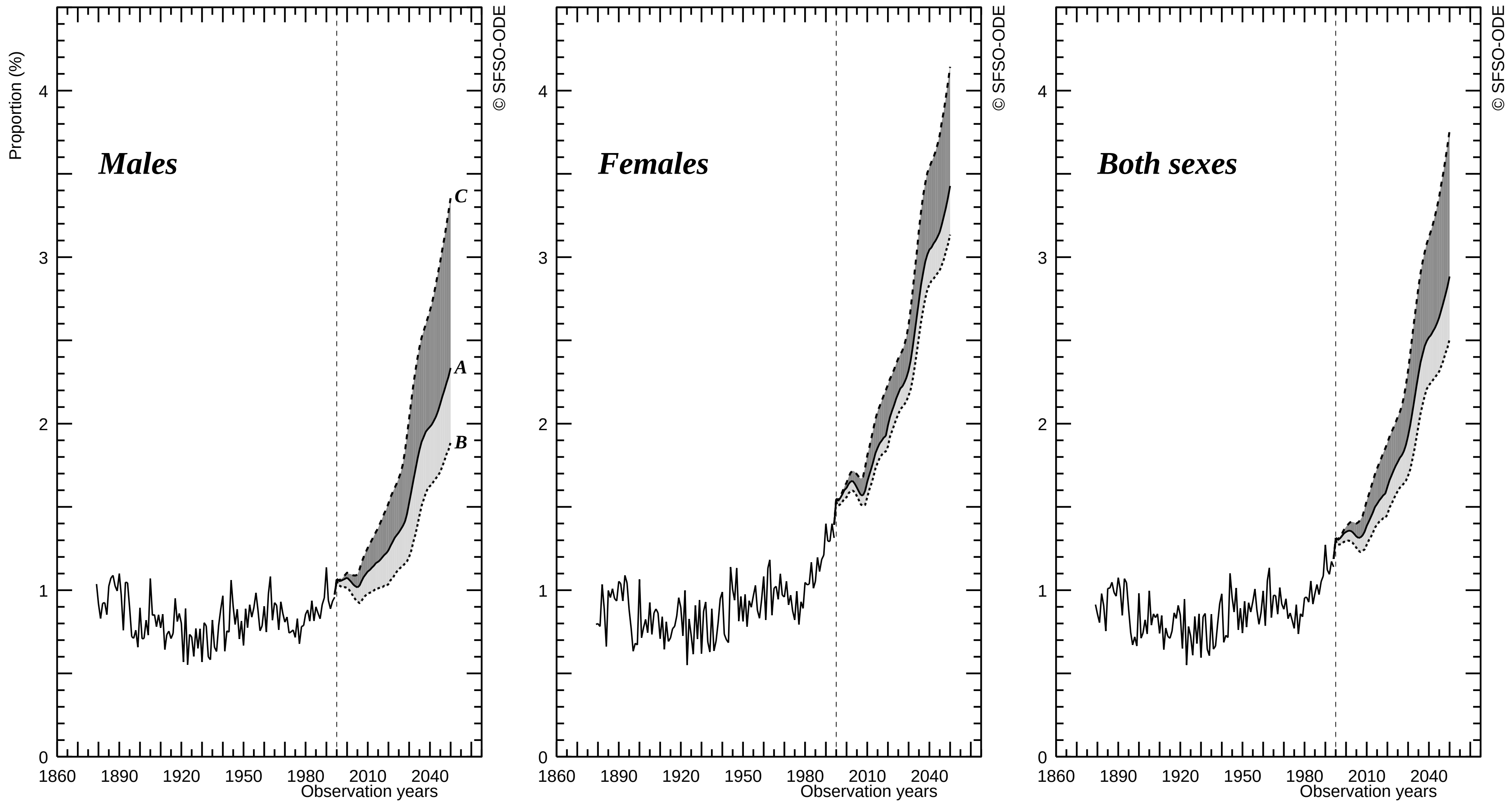
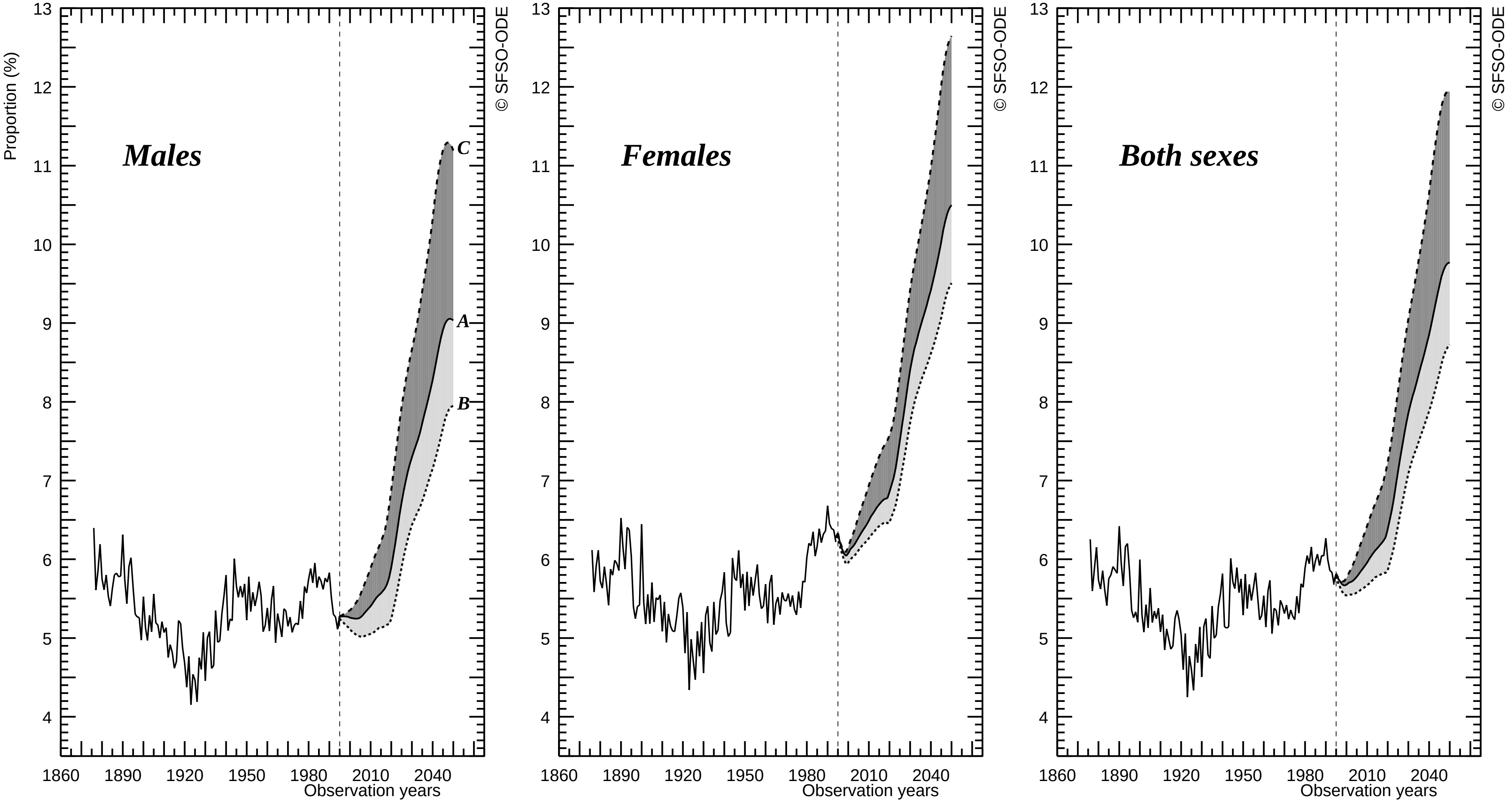


Figure 6.15 SWITZERLAND, 1876-2050
Proportion of the population at an age
where the REMAINING life expectancy is 10 years at most
SFSO A, B and C scenarios from 1995



Chapter 7: Daily and monthly fluctuations in marriages, births and deaths

Switzerland has *monthly* breakdowns of marriages since 1886, live births since 1871 and deaths since 1901. A *daily* breakdown has been available since 1968 for marriages, in 1926 and 1927 and since 1965 for live births[13].

The glossary contains technical information on the method of analysis used for these daily and monthly series.

Friday, wedding day

Figure 7.1 shows the trend in the *daily* marriage coefficients from 1968 to 1996, figure 7.2 that for the daily live birth coefficients in 1926-1927 and 1965 to 1996.

As regards marriages[14], there is a very high concentration on *Fridays:* more than half of all marriages (between four and five in seven) take place on a Friday. The dominance of Friday seems to have been declining somewhat since the early 1980s, however: a daily coefficient of 4.8 in 1980 slipping to 4.5 in 1996. Since 1970, Thursday has replaced Saturday as the next most popular day to Friday, but the number of marriages celebrated on Thursday accounts for only approximately 80% of the total daily average. The other days of the week are even more rarely chosen as wedding days. Civil marriages, in particular, almost never take place on Sunday.

Fewer Sunday and Saturday births

While the concentration of births is naturally far less pronounced than for marriages, that is not to say that births are relatively evenly distributed over the days of the week. While that may well have been the case up to the end of the 1950s, as the available data for 1926 and 1927 show[15], *Sunday* from the early 1960s, followed by *Saturday* from the 1970s, differed from the other days of the week by the declining number of births. This phenomenon, which increased up to 1975-1978 when the deficit of the Sunday births exceeded 20%, can probably be attributed to the increased frequency of induced labour and Caesarean births. This trend was brought to an abrupt halt in 1990 when the Sunday daily coefficient levelled off in the vicinity of 0.85, and the Saturday coefficient around 0.93. The Sunday and Saturday deficits are substantially equalized over Monday to Friday, with no discernible lead (manifested in an excess of Friday births) or lag (on Monday) effect. On the contrary, if the 1990-1996 data are to be believed, the Monday rate could be set for a downturn somewhat similar to those of Saturday and Sunday.

---

[13] The daily death statistics are not considered here.

[14] The day of marriage reported by the vital statistics is naturally that on which the *civil* marriage takes place.

[15] Confirmed by the daily data available for France from 1946 to 1950.

More spring and summer weddings

Figures 7.3 (long-run seasonal coefficient for the same month) and 7.6 (inter-period seasonal profiles) show the variations in *monthly seasonal coefficients* of marriages since 1890. Switzerland was still largely rural at the end of the 19th century, with a seasonal marriage rate dictated by the climate and agricultural cycle: relatively few marriages in June and September, and fewer still in July and August, due to work in the fields; very few from December to March because of the weather. Marriages were bunched together in two two-monthly periods: April-May and October-November. This seasonal profile changed shape over time, with an increasing number of May to September marriages and fewer in April, October and November, so that today marriage is concentrated in the spring and summer months – from May to September. Two months – June and August – are outstanding for the particularly rapid rise in their seasonal coefficient over the past twenty years at the expense of July (is it because it is harder to assemble the entire family in July due to holidays? or because the newly-weds want to honeymoon during July?). Today, just over half (52%) of all marriages take place during the four months of June, May, August and September.

The seasonality of marriages presents a fairly contrasting picture: the month with the largest number of marriages (May from 1910 to 1930, August at present) has 70% more marriages than an average month, while that with fewest (January about 1980) has 60% less, i.e., a relative range of from 1 to over 4.

Births substantially evened out throughout the year

By comparison, the seasonal coefficients of births deviate far less from one (Figures 7.4 and 7.7): from 11% above the average month to 11% below, i.e., a relative range of from 1 to just 1.2. Most children are born from February to May, fewest between October and December. This birth rate seasonality has not substantially changed for 120 years, despite an increase in the seasonal contrast between the last quarter of the 19th century and the 1960s.

Since the 1970s, a quite unexpected phenomenon has developed: the seasonal coefficients *below* one have generally tended to *rise* while those *above* one have *fallen* (except for September). In other words, the distribution of births within the year is *evening out.*

It might have been assumed that improved fertility control would have given couples a better chance of choosing the month of their children's birth. Moreover, in a society where increasing numbers of young women are going out to work, it might have seemed that there would be optimum chances of a birth in spring, say in May.

The reason is that the advantage for the mother is not to be too obviously pregnant during the preceding summer, and to plan the most laborious phase of pregnancy for winter and early spring when it might be less unpleasant than in the summer heat, and especially to be able to have maternity leave and annual leave following on. The advantage for the child is to experience its first winter when it is already seven months old. Persuasive as this argument may be, the seasonal coefficients from February to June have *all* declined over the past twenty years, while those from August to December are *all* rising. In other words, since couples have had more control over the month of birth, all the indicators seem to suggest that they are choosing increasingly *randomly*...

Fewer deaths in the winter period

Most deaths occur in the winter season months from December to April, fewest from June to September (Figures 7.5 and 7.8). This seasonal profile has changed little in the past century, but the contrast between the seasons is less and less sharp. At the turn of the century, there were 20% more deaths in February, March and April than in an average month. Now, February and March are less than 10% above the average month, while April is at the level of the average month. Only December, with a seasonal coefficient of about 1.06 remains at the same level as a century ago.

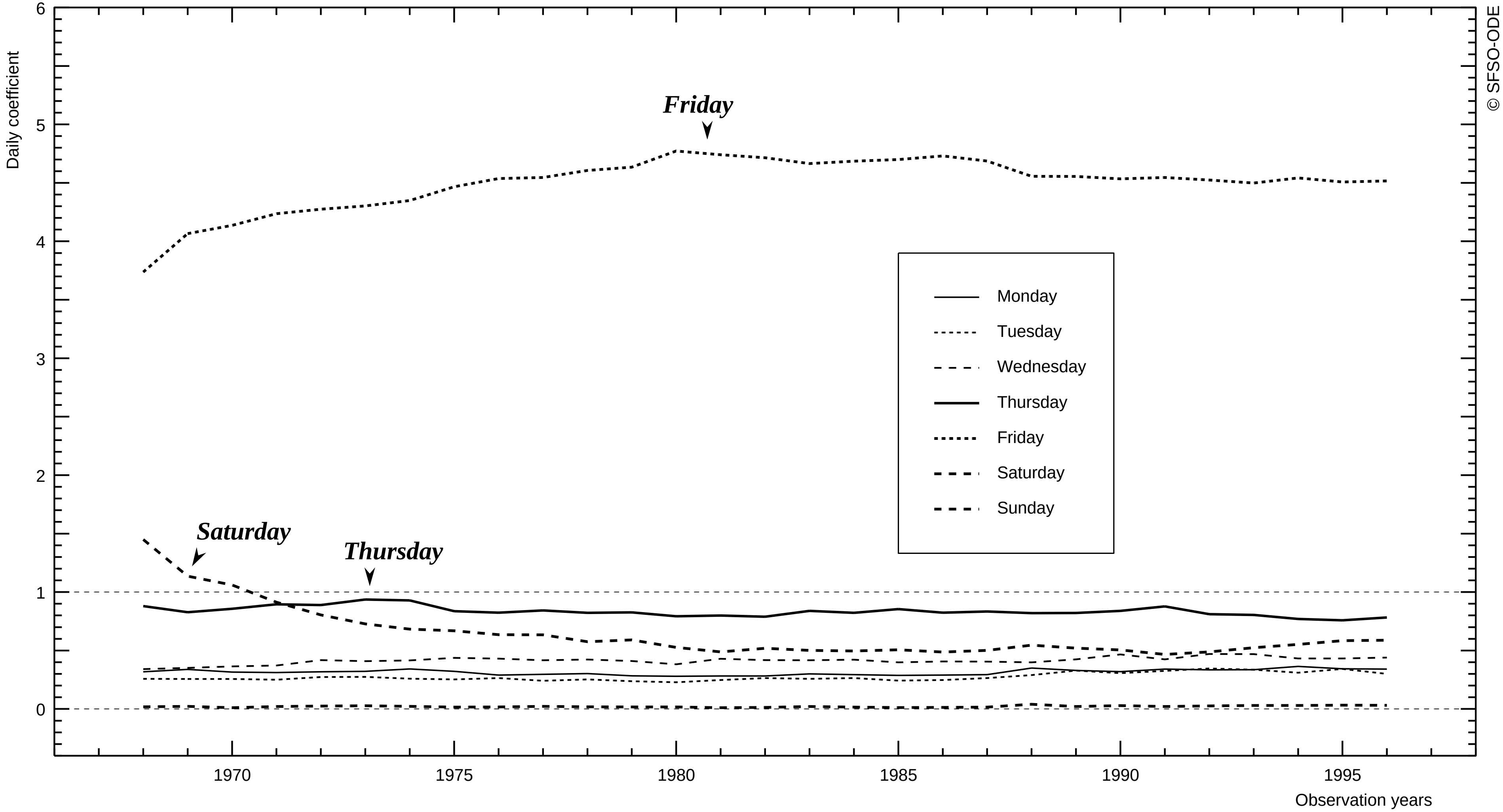
This reduction in the seasonal contrast of mortality testifies to man's growing mastery of the seasons, and even the abolition of seasons in various areas of everyday life. The same fruit and vegetables are now available year-round; homes are kept at a more-or-less constant temperature all year round; we move from place to place with much the same ease regardless of climatic or weather conditions. The seasonal rhythms of life and death have been loosened.

Changing seasonal contrasts

Figure 7.9 shows the standard deviation of the twelve monthly seasonal coefficients for births, marriages and deaths. For births, the standard deviation slowly increased from 0.02 at the end of the 19th century to 0.07 during 1940-1950; it decreased thereafter, levelling off at 0.06 until about 1975 when it fell sharply to barely 0.03 in 1992. For marriages, the standard deviation has always been far higher than for births, consistently exceeding 0.25. Its general trend has been upwards (0.25 at the end of last century, 0.44 in 1992), with wide fluctuations.

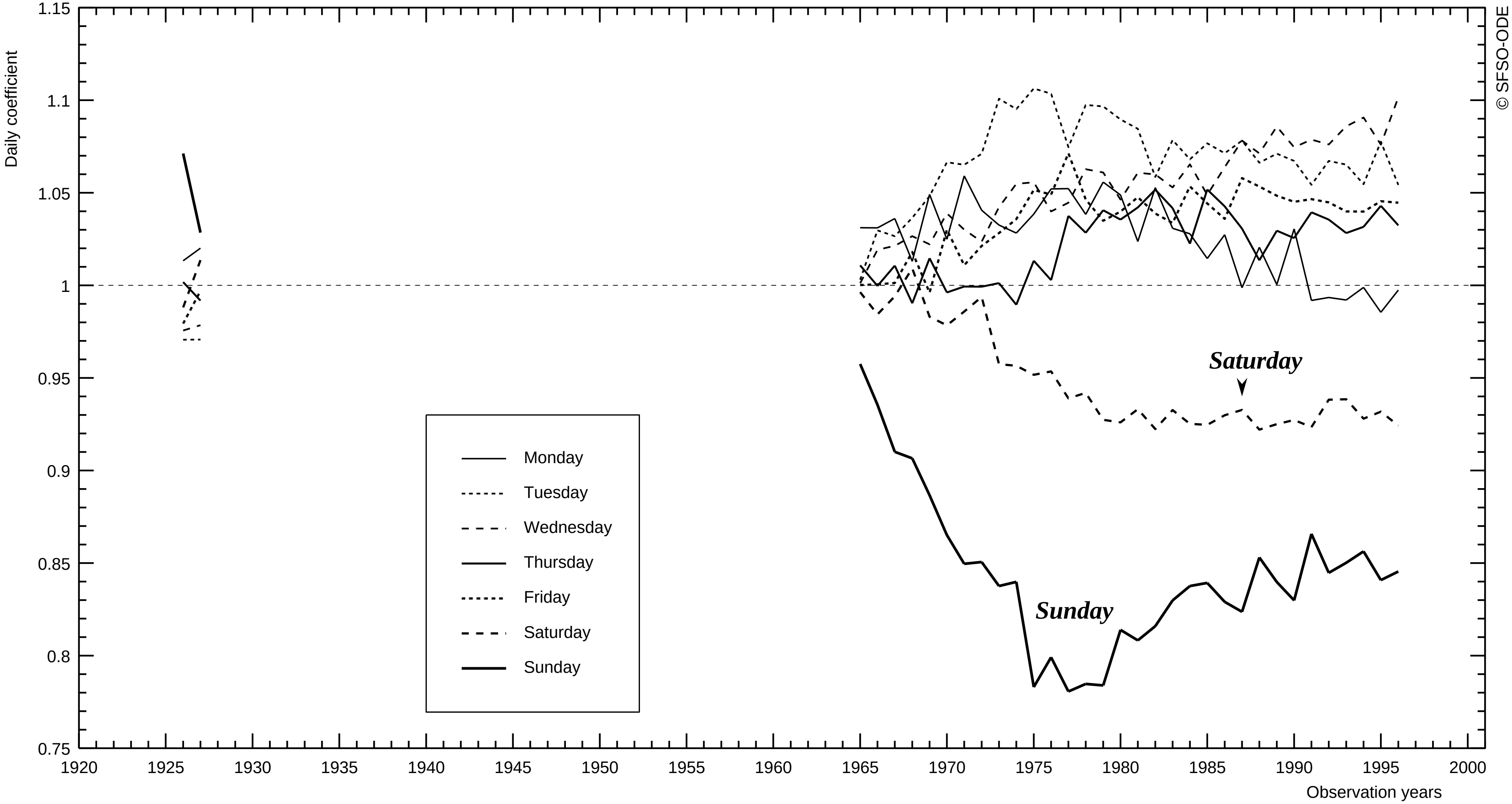
The standard deviation of the twelve seasonal coefficients of deaths fell from 0.14 at the turn of the century to 0.06 about 1975 (when it was close to the standard deviation of the seasonal coefficients for births). It has barely moved from this value for the past twenty years, unlike its birth counterpart, which has halved.

Figure 7.1 SWITZERLAND, 1968-1996
DAILY COEFFICIENTS OF MARRIAGES



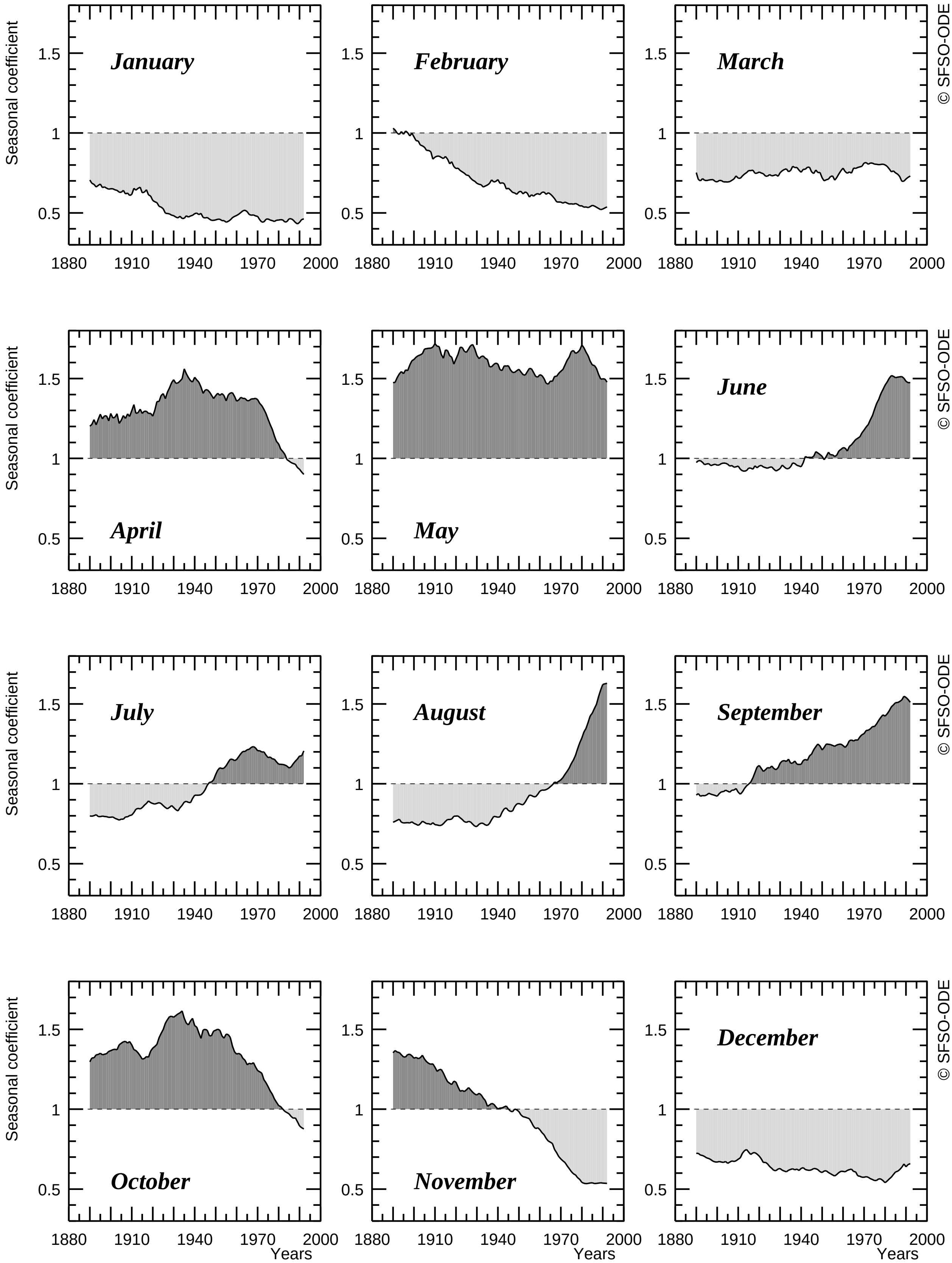
In each year, the average daily coefficients of the seven days of the week is equal to 1

Figure 7.2 SWITZERLAND, 1926-1996
DAILY COEFFICIENTS OF LIVE BIRTHS



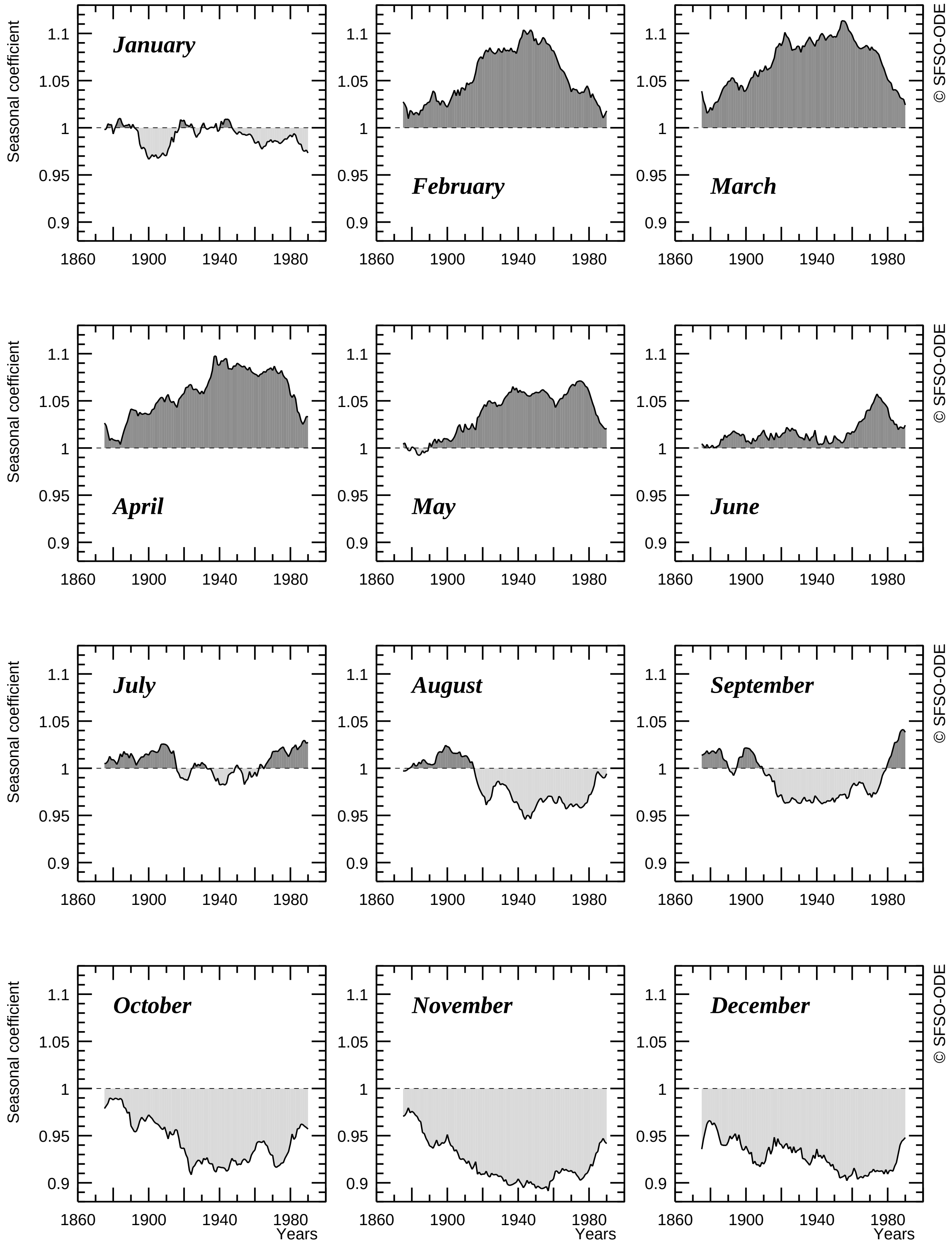
In each year, the average daily coefficients of the seven days of the week is equal to 1

Figure 7.3 SWITZERLAND, 1890-1992
Monthly SEASONAL COEFFICIENTS of MARRIAGES



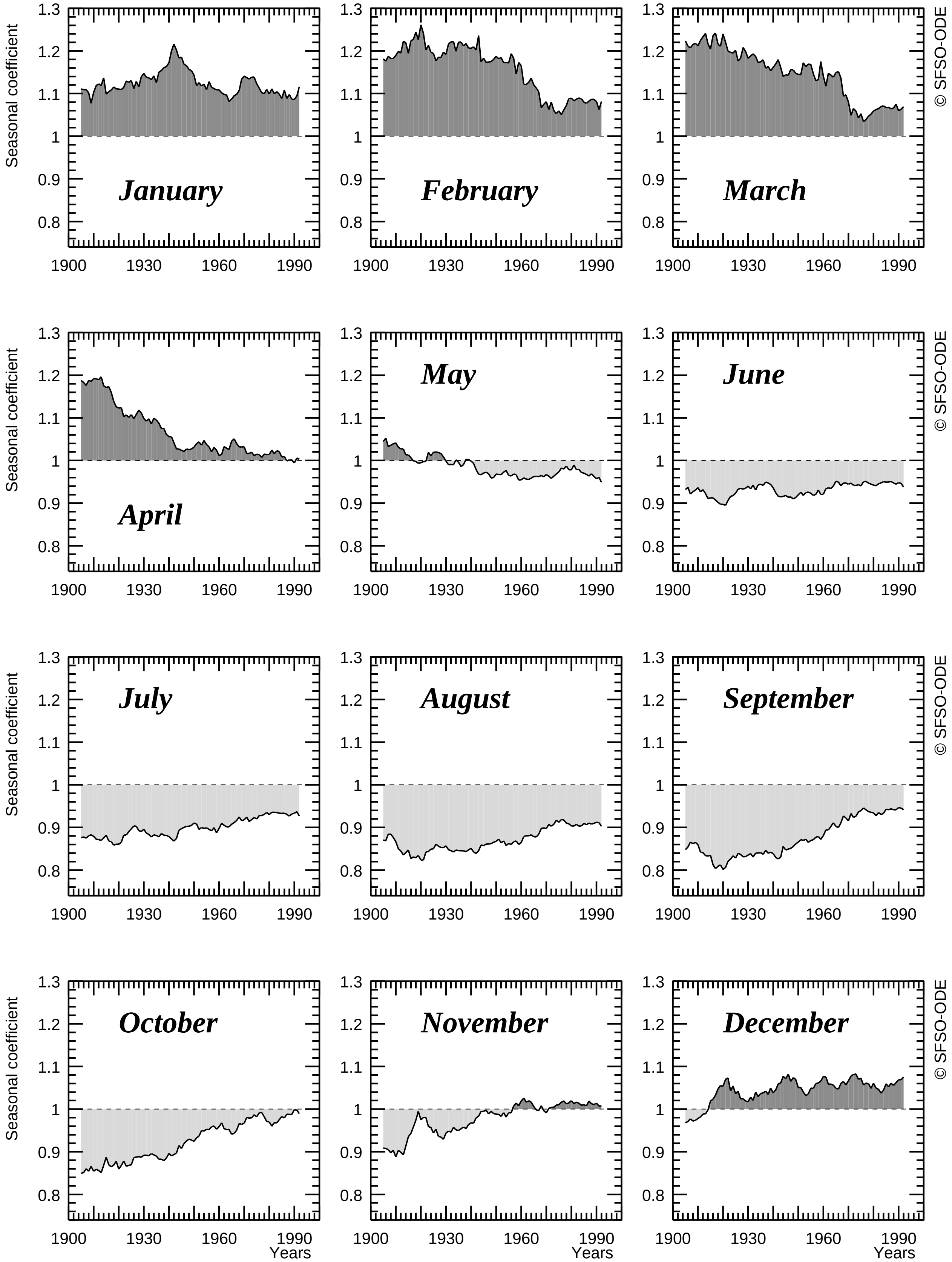
In each year, the average of the twelve monthly seasonal coefficients is equal to 1

Figure 7.4 SWITZERLAND, 1875-1992
Monthly SEASONAL COEFFICIENTS of LIVE BIRTHS



In each year, the average of the twelve monthly seasonal coefficients is equal to 1

Figure 7.5 SWITZERLAND, 1905-1992
Monthly SEASONAL COEFFICIENTS of DEATHS



In each year, the average of the twelve monthly seasonal coefficients is equal to 1

Figure 7.6 SWITZERLAND. 1890-1992
SEASONAL PROFILE of MARRIAGES

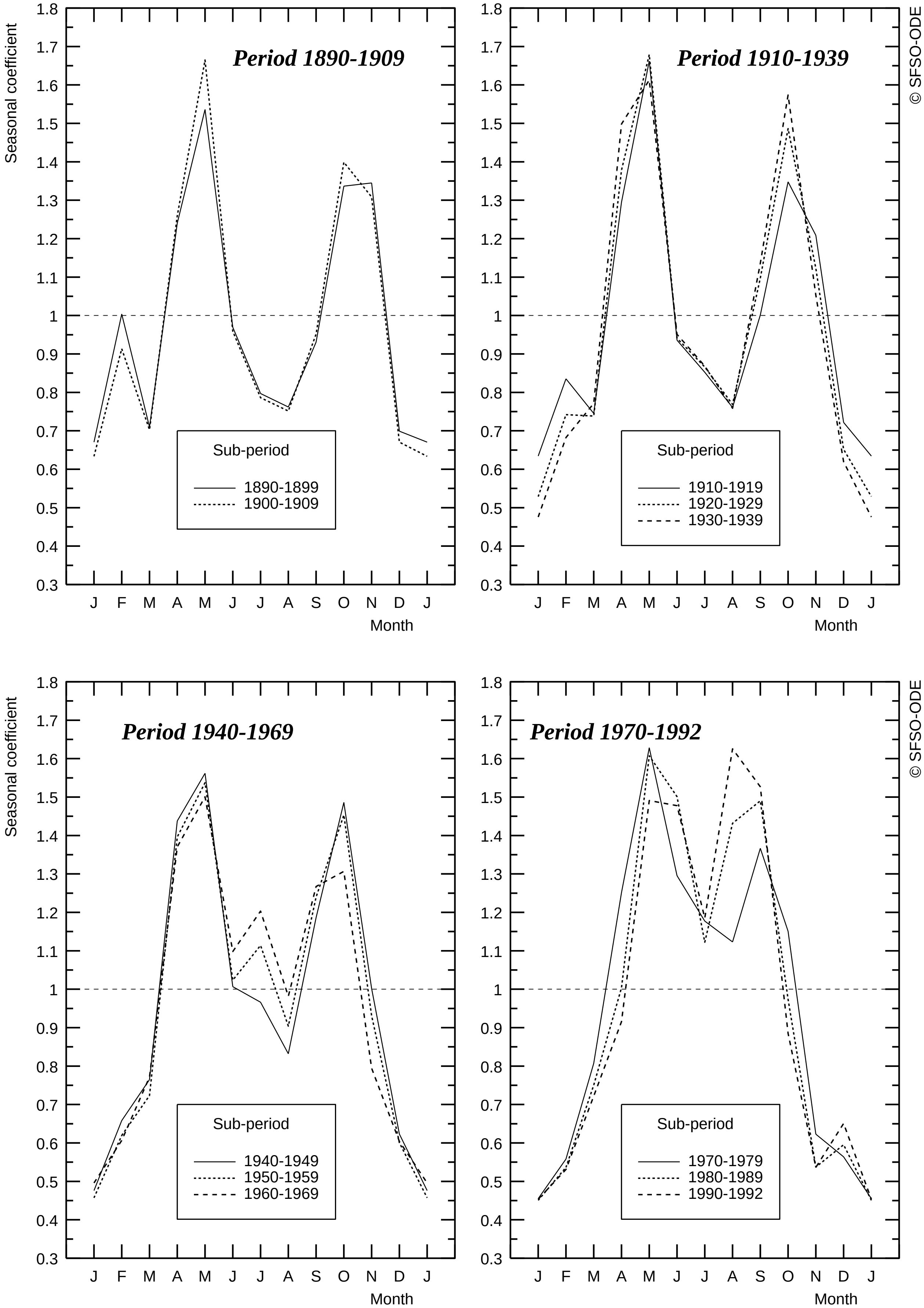


Figure 7.7 SWITZERLAND. 1875-1992
SEASONAL PROFILE of LIVE BIRTHS

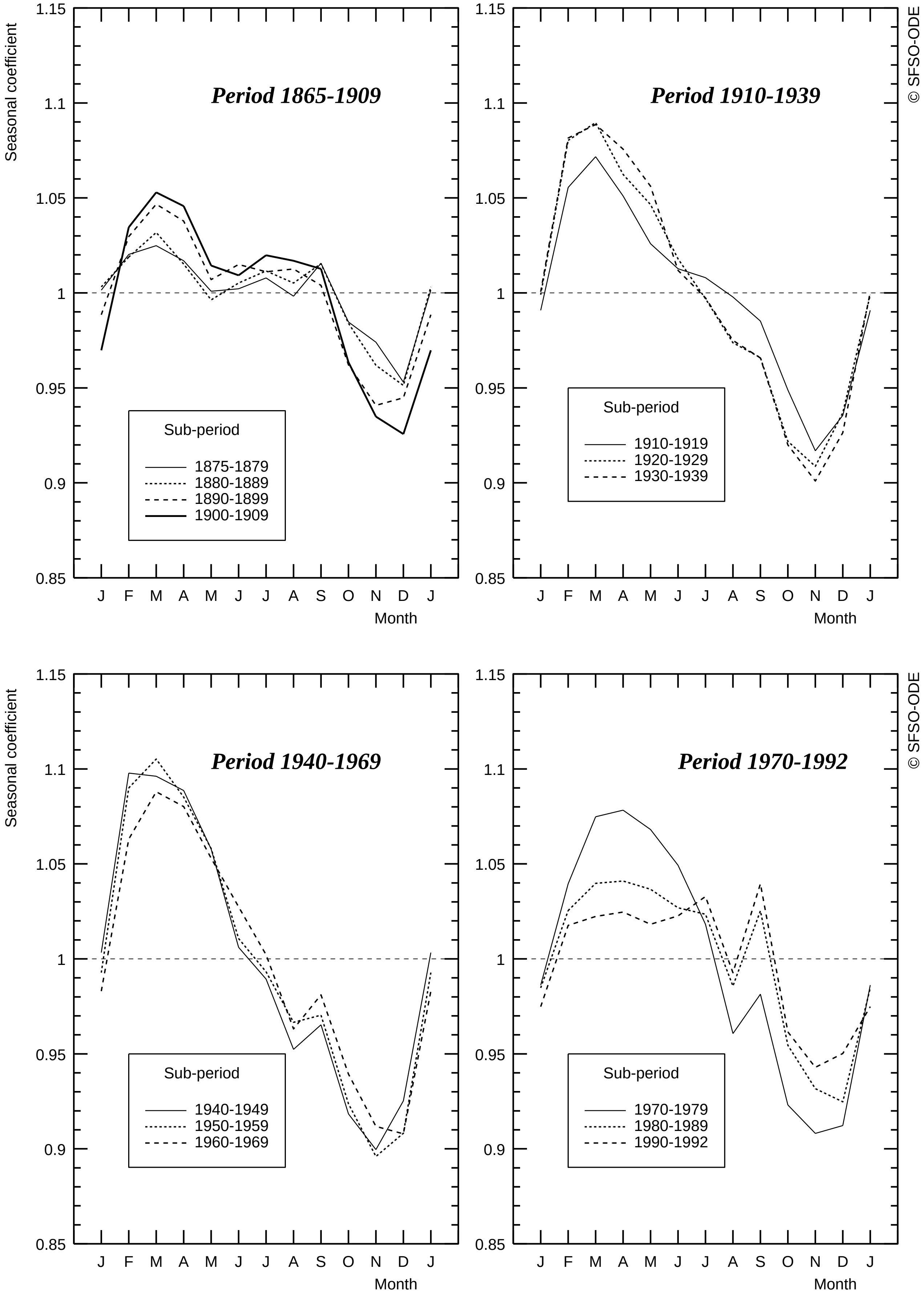


Figure 7.8 SWITZERLAND. 1905-1992
SEASONAL PROFILE of DEATHS

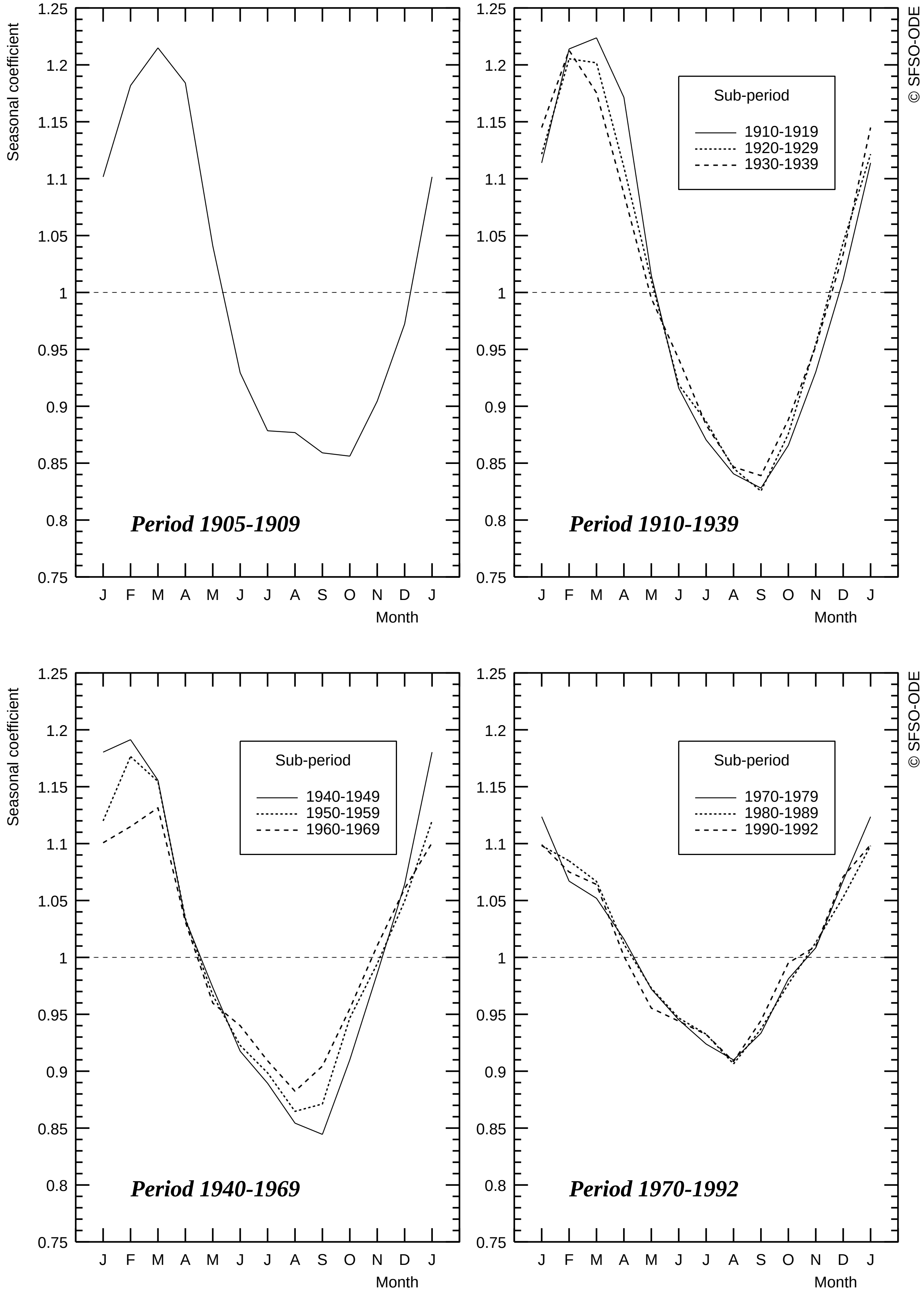
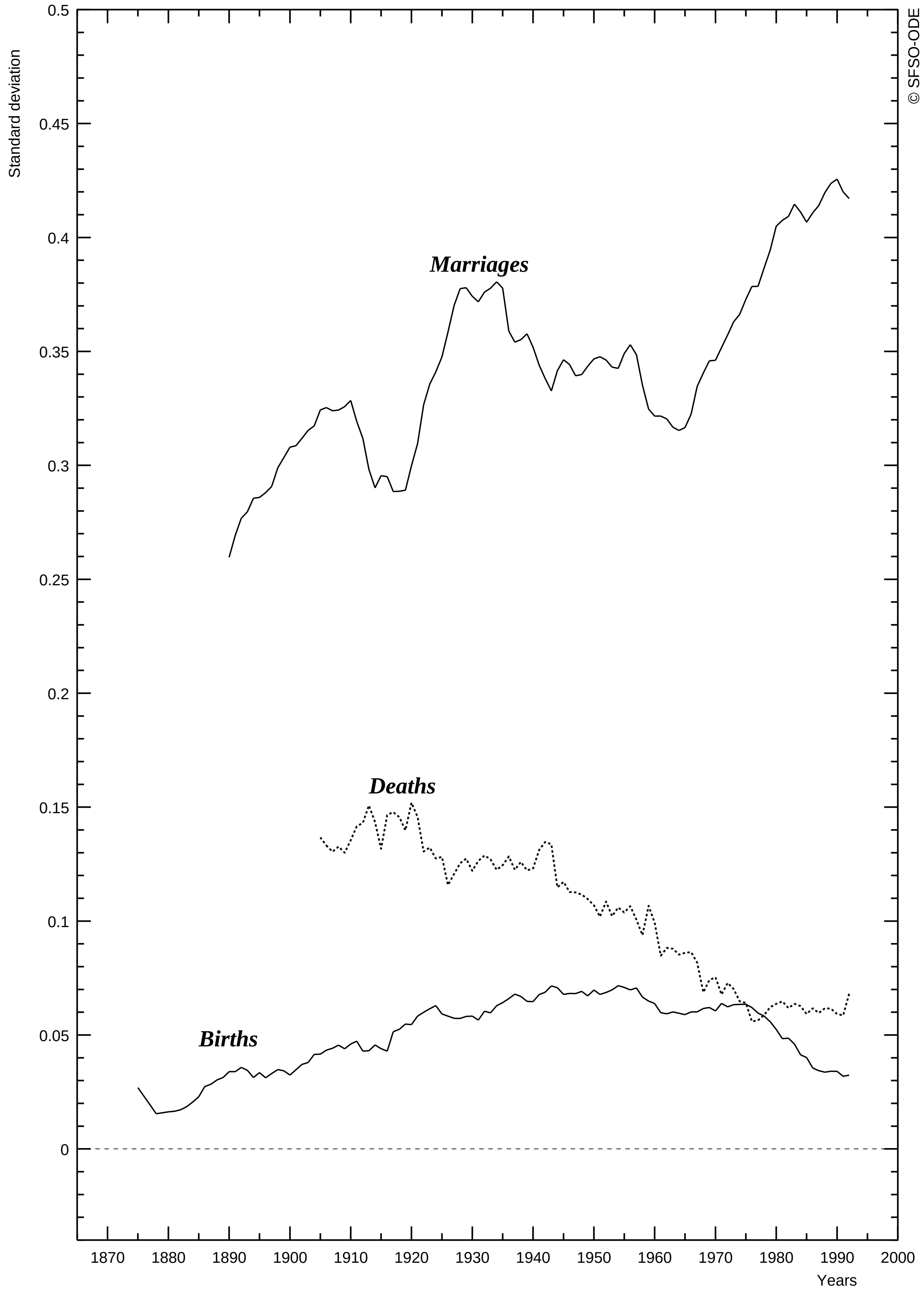


Figure 7.9 SWITZERLAND, 1875-1992. Births, marriages and deaths
Standard deviation of the twelve monthly seasonal coefficients



A daily and monthly fluctuation analysis of the numbers of vital events (births and marriages) led to the establishment of monthly series free from of daily structures and monthly seasonal fluctuations. The ratio of the adjusted monthly number to the relevant *monthly* denominator gives the corresponding total monthly rate. A different procedure is used for deaths, as explained in the glossary.

Total first marriage rate

Figures 8.1 and 8.2 chart the trend of the monthly sex-specific total first marriage rates since 1977. The variations substantially parallel one another, but the male rate is below its female counterpart (53 first marriages per 100 men and 61 first marriages per 100 women, respectively, in December 1996). These variations have been fairly slight over the past 20 years.

A pronounced downward trend set in at the beginning of 1992, however: in January 1992, there were 68 first marriages per 100 men and 73 per 100 women.

The change in legislation on marriages between Swiss men and foreign women leads to an upsurge in marriages in November and December 1991

In November 1991 and especially December 1991, there was also a short-lived but significant rise in first marriages: this exceptional peak (the total rates surging by 0.35 over surrounding months) was caused by the change in the law introduced on January 1, 1992 on the acquisition of Swiss nationality by marriage. From that date, marriage to a Swiss man no longer *automatically* confers Swiss nationality on a foreign woman.

The «magic date» of 8.8.88

A peak in the marriage rate half the magnitude of that of December 1991 (a leap of 0.18 in the total period rate) also occurred in August 1988 due to an exceptionally very high number of marriages on Monday August 8. That day, 1 954 marriages were celebrated against a daily average of 143 and 149 marriages the previous and following weeks, 44 and 43 marriages on the Mondays August 1 and August 15, and 539, 664 and 720 on the Fridays July 29, August 5 and August 12 (Figure 8.7). There can be no doubt that we must see in this, as also in Austria, a particular attraction, specific to the German-speaking areas, for the date 8.8.88. July 7, 1977 had already produced a similar phenomenon, but of less magnitude (496 marriages celebrated on Thursday 7.7.1977 against 112 and 101 on the Thursdays June 30 and July 14, respectively, and 610, 473 and 441 on the Fridays July 1, 8 and 15), which had had only a slight impact on the monthly number of marriages.

Fertility has ceased declining, but remains very low

Like the total monthly first marriage rates, that of fertility (Figure 8.3) has changed little for twenty years. The decline which set in at the beginning of 1992 (159 children per 100 women in January 1992) came to a halt at the beginning of 1995 when the rate touched 148 children per 100 women. Since then, a very modest recovery has set in, raising the rate to 149 children per 100 women in December 1996.

The effect on deaths of the flu epidemic of January 1990

Figures 8.4 and 8.5 show the twenty-year trend of the monthly life expectancy at birth for males and females. The effects of the flu epidemics and harsher than normal weather conditions for the month concerned are clear to see[16]. Specifically, the last major flu epidemic was that of January 1990, which increased the death toll by approximately 1 800, or 35% (7 000 instead of 5 200) for both sexes (Figure 8.6).

The following chapter considers two other examples of flu epidemics.

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[16] If in a given year, a month with a normally high death rate (December, January and February) has, in the absence of flu, appreciably the same number of deaths as another month with a normally low death rate, the rate for the first month will be relatively high.

Swiss Federal Statistical Office

Observatoire démographique européen

Figure 8.1 SWITZERLAND
Total monthly MALE FIRST MARRIAGE rate since 1977
Series adjusted for seasonal variations, then smoothed by Hoem moving average on 25 terms and trend extrapolated

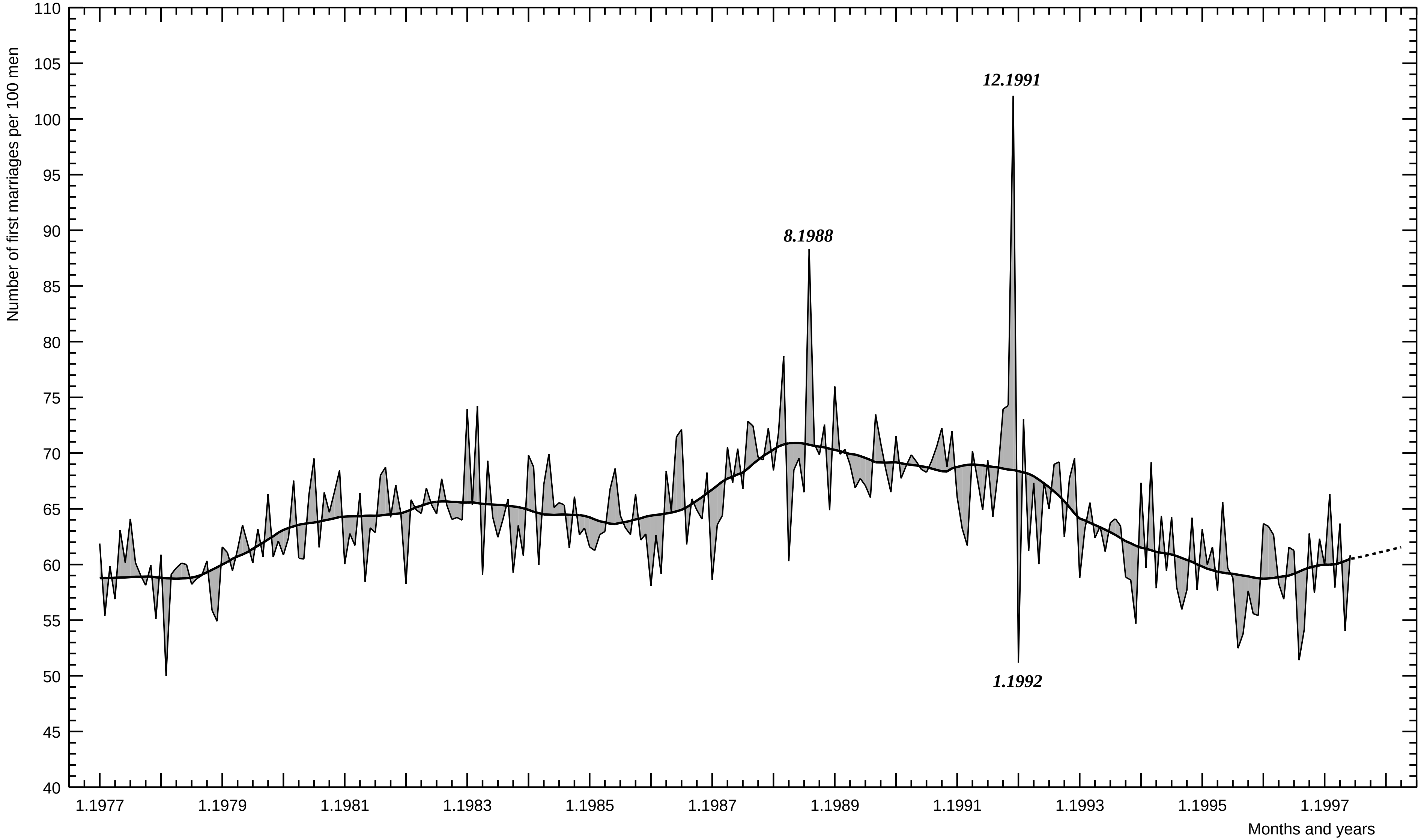


Figure 8.2 SWITZERLAND
Total monthly FEMALE FIRST MARRIAGE rate since 1977
Series adjusted for seasonal variations, then smoothed by Hoem moving average on 25 terms and trend extrapolated

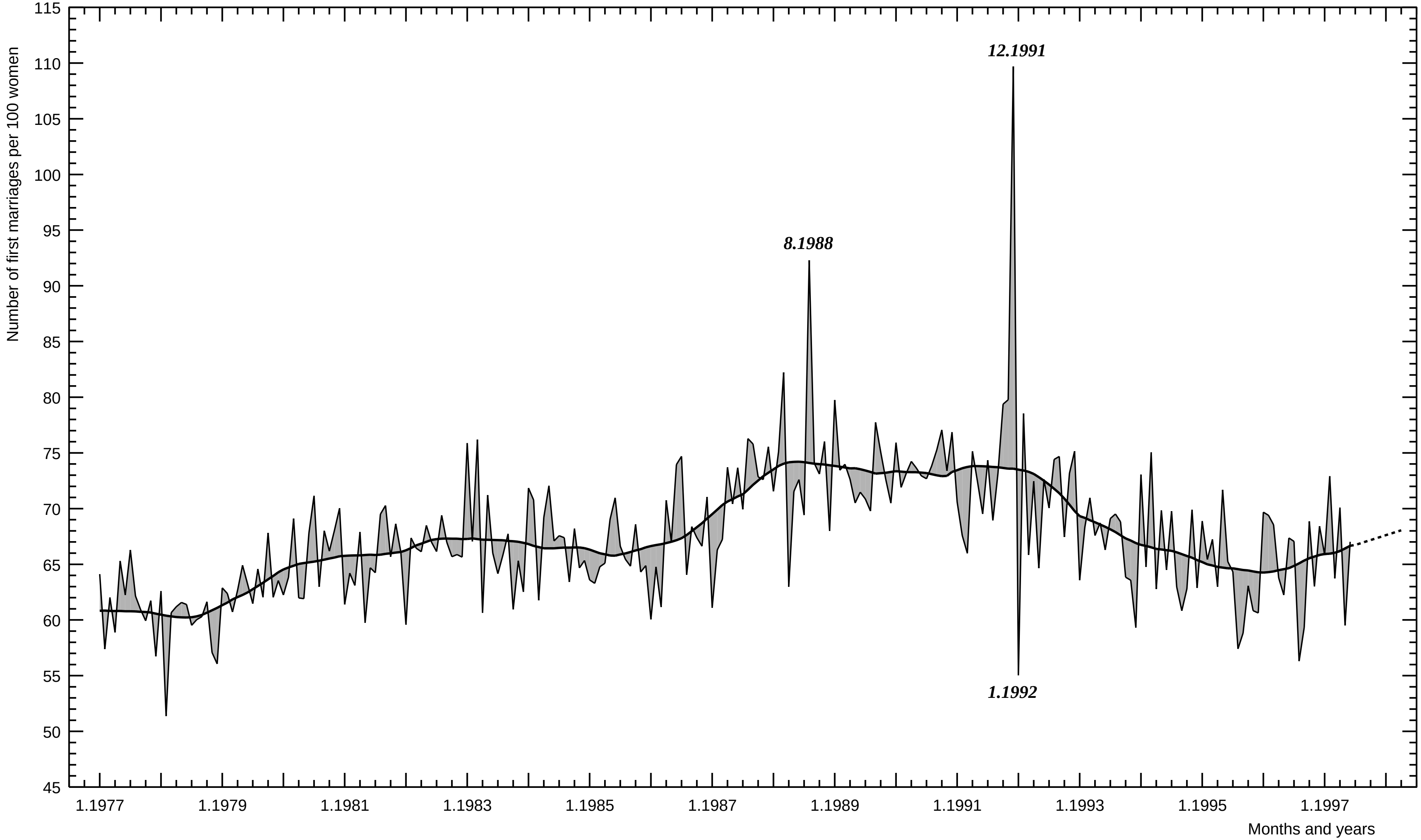


Figure 8.3 SWITZERLAND
Total monthly FERTILITY rate since 1977
Series adjusted for seasonal variations, then smoothed by Hoem moving average on 25 terms and trend extrapolated

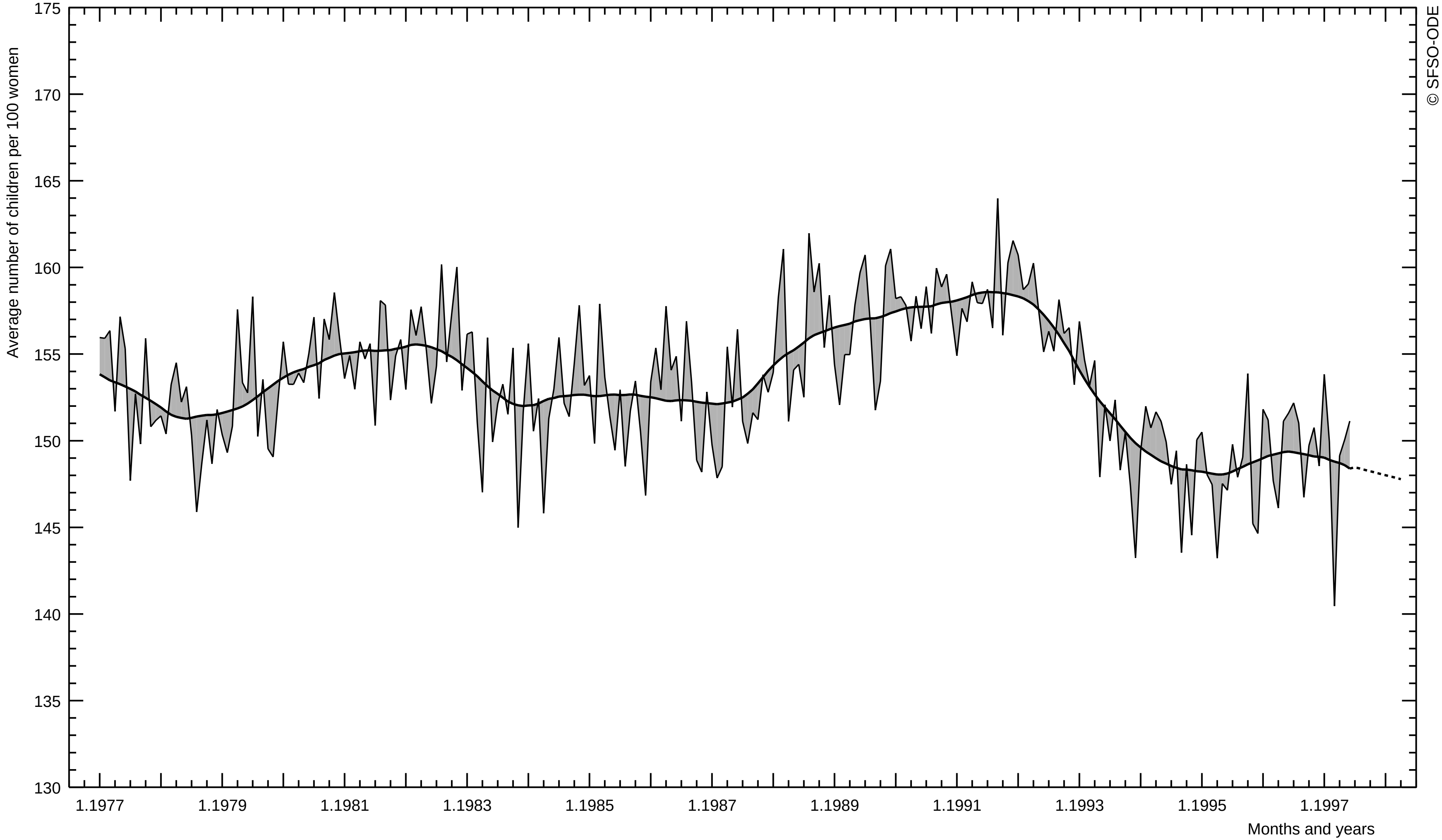


Figure 8.4 SWITZERLAND
Monthly MALE LIFE EXPECTANCY at BIRTH since 1977
Series adjusted for seasonal variations and smoothed by Hoem moving average on 25 terms

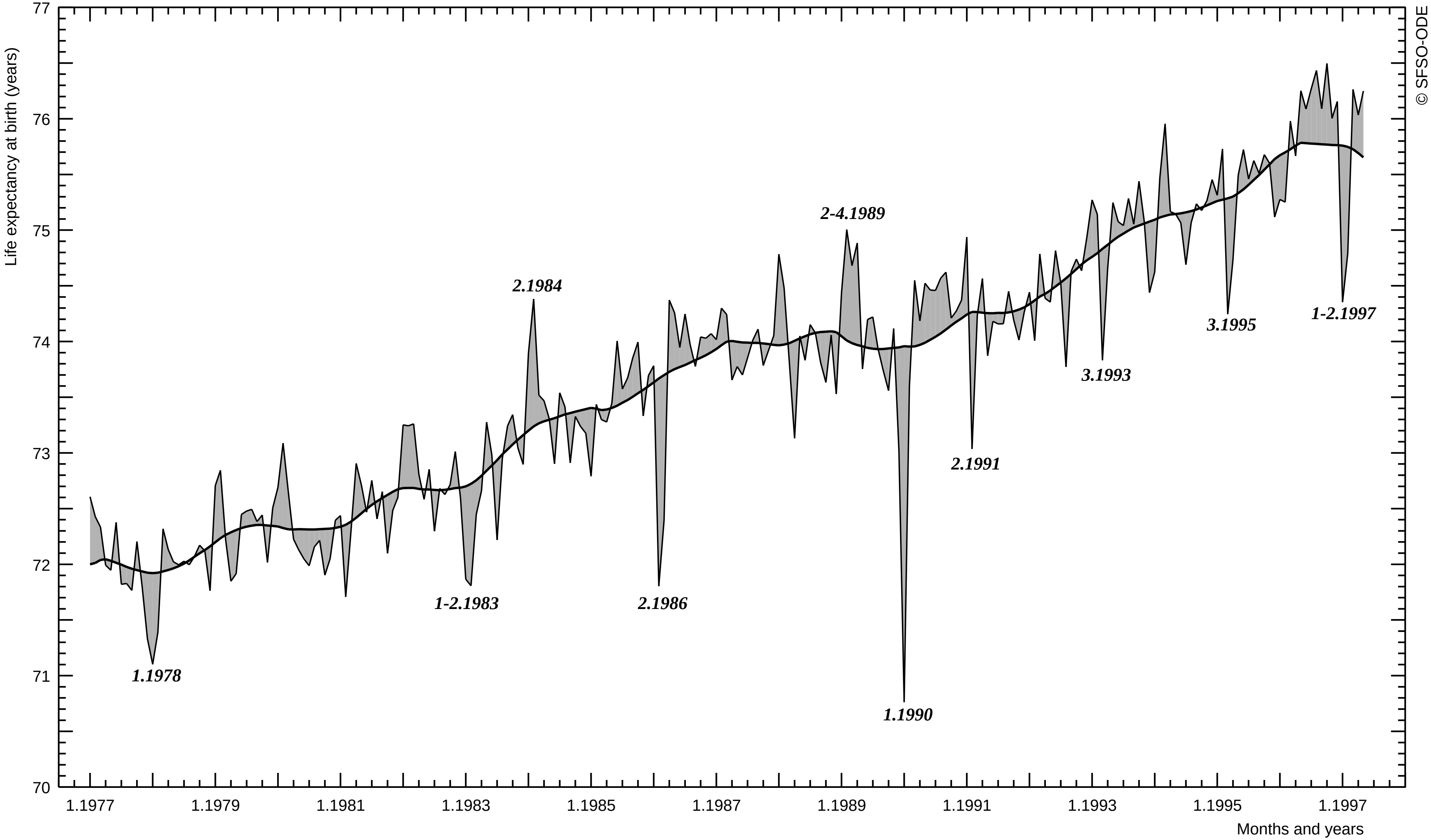


Figure 8.5 SWITZERLAND
Monthly FEMALE LIFE EXPECTANCY at BIRTH since 1977
Series adjusted for seasonal variations and smoothed by Hoem moving average on 25 terms

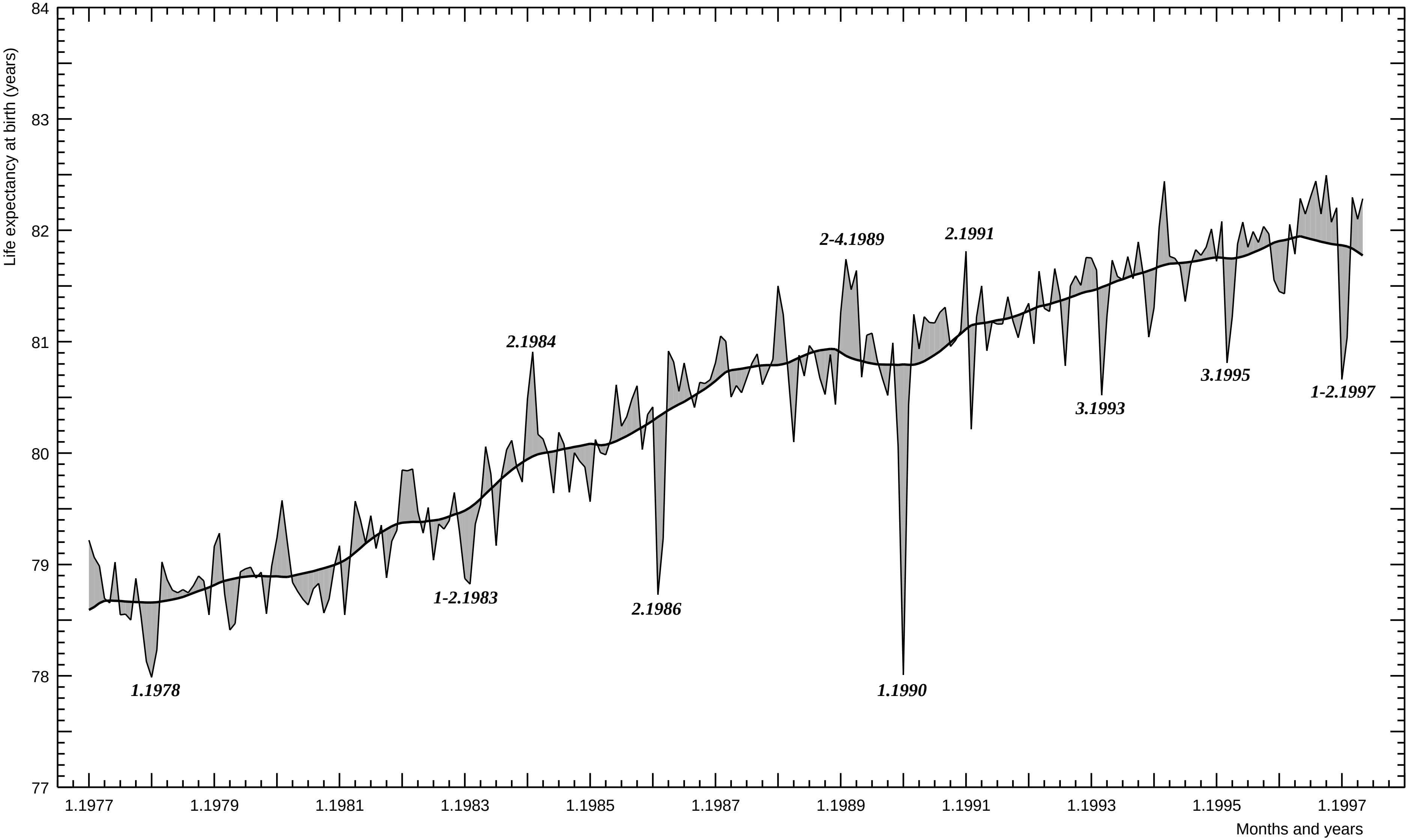


Figure 8.6 SWITZERLAND
Monthly number of deaths since 1977
Series adjusted for seasonal variations, then smoothed by Hoem moving average on 25 terms

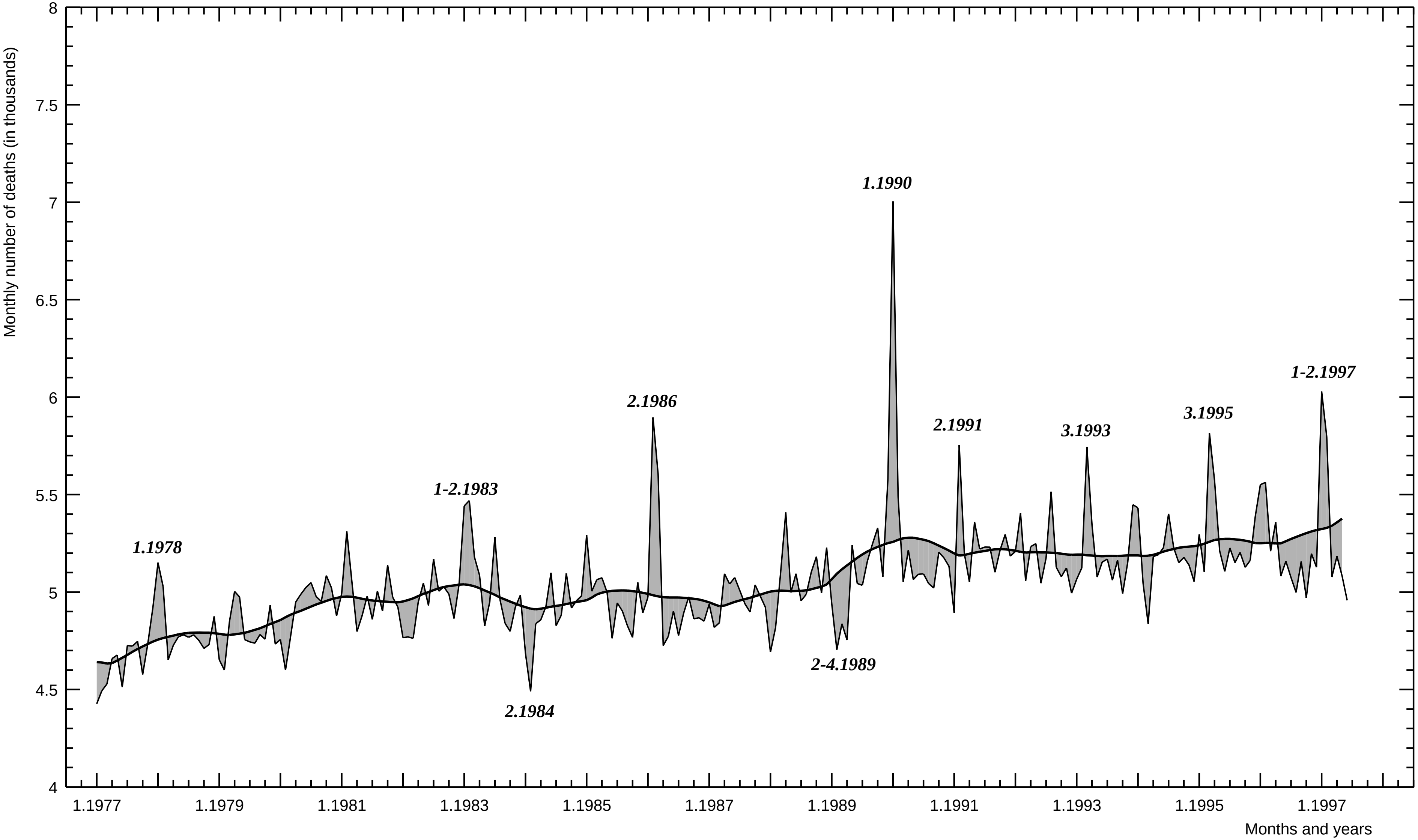
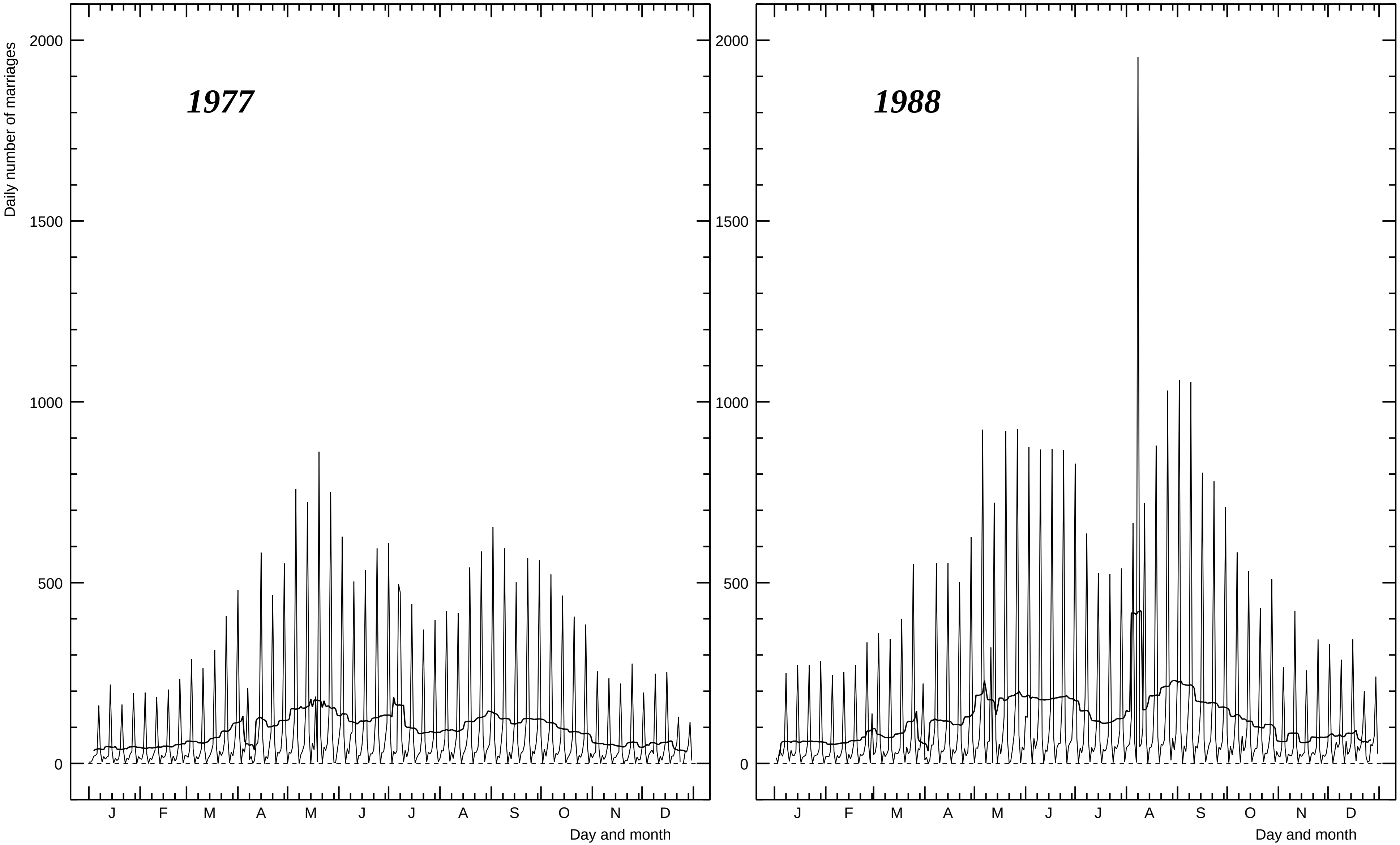


Figure 8.7 SWITZERLAND, 1977 and 1988
Daily number of marriages
Bold line: moving average over one week, centered



Chapter 9: Some specific episodes in Swiss demographic history

An examination of the trends in the total monthly fertility and first marriage rates and in monthly life expectancies at birth brings to light exceptional episodes. For this reason, figures 9.1 to 9.3. show twenty-year monthly variations in the total rates (for first marriage and death, we considered one sex only – female for first marriage, male for mortality – because the variations for males and females closely parallel one another).

Mortality peaks due to flu epidemics: their effects on the birth rate nine months after

Apart from the two World Wars (1914-1918 and 1939-1945), *flu* epidemics have caused abrupt, short-term declines in the monthly life expectancy at birth, often but increasingly seldom in recent times, followed by an equally abrupt and short-term fall in the total fertility rate nine months later. Such is the very characteristic case of the flu outbreak in the winter of 1926-1927, which produced high excess mortality in January 1927 and high sub-fertility in October 1927. The most recent manifestations of this phenomenon were in the winter of 1969-1970 (excess mortality in January 1970, sub-fertility in October 1970) and the winter of 1974-1975 (excess mortality in December 1974, sub-fertility from August to October 1975). By contrast, the epidemic of the winter of 1989-1990, which produced significant excess mortality in January 1990, produced no perceptible sub-fertility in October 1990.

Figures 9.1 to 9.3 show how the three monthly indexes have remained stable since 1980, compared to the prior-period fluctuations.

The demographic trend in the First World War

Figure 9.4 shows in greater detail the trend in the three indexes during the First World War. As regards marriage rate, the outbreak of war (August 1914) produced an immediate but transient fall in the number of marriages (September to November 1914); the marriage rate curve then climbs again uninterruptedly returning in 1919 to its 1914 starting level. The depressive effect of the 1914-1918 war on the marriage rate is more-or-less equalized by the start of the 1920s.

The fall in marriages in September 1914 is reflected nine months later in the number of births, which troughs in May 1915. The later blips in the total fertility rate are caused by the Spanish flu epidemic whose effects are naturally first seen on mortality: the epidemic raged for six months, from July to December 1918 (peaking in October and November 1918), with a small transient resurgence in February 1920. There is a nine-month lag in the effects on fertility, which troughed in August 1919 then, to a less marked extent, in October 1920.

The effects of Spanish flu on the sex-age-specific mortality rate in 1918 and 1919 can be seen by comparing the death probability curves for these two years with that for 1917 (Figures 9.5 and 9.6 for 1918 and 1919, respectively).

Persons in the 25-30 age group experienced the highest relative increase in their probability of dying in 1918 compared to 1917: it quadrupled for men, tripled for women. By contrast, the relative effect of flu on those aged 50 and over, and in the first year of life, was very low. Some after-effects of the flu epidemic can still be seen in 1919 in men aged 20-35, and women aged 20-45.

The demographic trend during the Second World War

The detailed trend of monthly rates during the Second World War years is shown in figure 9.7.

As in the First World War, the total marriage rate falls abruptly in the month (October 1939) after war was declared. It returns to a relatively high level in December 1939 and March 1940 before falling abruptly in May 1940 when the invasion of France took place. In June 1940 it resumes a relatively regular pattern which continues fairly undisturbed until the end of the war.

Again mirroring the Great War, the fall in the marriage rate results nine months later in a pronounced slump in fertility (June 1940 and February 1941). The second quarter of 1941 marked the beginning of the Swiss *baby boom*, which was essentially completed *during* the war years, in the space of five years. Compared to its immediately pre-war level (1.8 children per woman), the total fertility rate rose by 0.8 children per woman – an increase exactly equal to that of the French *baby boom* which was a post-war phenomenon but largely completed within a year.

Three harsh winters in 1938-1939, 1939-1940 and 1943-1944 produced transient excess mortality in February 1939, January 1940 and March 1944, with no effects on subsequent fertility. There was no mortality crisis comparable to the Spanish flu epidemic of 1918 in this period.

The fertility trend in Switzerland from 1940 to 1945 – which is very close (Figure 9.8) to that observed at the same time in the other European country spared by war: Sweden – is an invaluable benchmark for all European countries. It is reasonable to assume that what was to prove a massive rebound in fertility combined with a huge fall in age at marriage and childbirth was a sort of *historical necessity* that no contemporary observer foretold or was even aware of. Be that as it may, the war is almost certainly not the cause of this major development, *pace* the claims of various analysts who saw the baby boom as a kind of making-up for the destructive effects of the war. The question of causality in the *forty boom years* is clearly not settled. The fact remains that the overall parallelism of fertility rates in Switzerland, Sweden and France during the period 1930-1955, discounting the war years themselves (1939-1945), and the close proximity of the Swiss and Swedish rates throughout the period, are particularly striking.

Two specific bouts of flu are illustrated in figure 9.9: that of the winter of 1926-1927, which caused the excess mortality of January 1927 and the subfertility of October 1927, and the *Asian flu (Hong Kong flu)* epidemic of autumn 1957 which caused the excess mortality of October-November 1957 and the sub-fertility of July-August 1958.

More Christmas and New Year conceptions

To conclude this chapter, figure 9.10 offers purely anecdotal evidence of the trend in the daily number of live births observed in 1970, 1980, 1981 and 1991, and its moving seven day average, which is free from in-week fluctuation.

The phenomenon to which we wish to call attention is the *sudden rise* in the seasonal coefficients curve in September compared to the adjacent months of August and October (Figure 7.7). It appears only from the 1940s and has become more pronounced in recent periods.

It represents an annual *birth surge* every second half of September, i.e., an increase in conceptions at the end of the previous year. In figure 9.10, this fertility surge is clearly observable in 1970, 1980, 1981 and 1991.

In figure 9.11, which expands the corresponding graph in figure 9.10, the number of births in 1991 can be seen to increase from the end of August up to about September 20, returning about the middle of October to a trend in line with that observed since spring and early summer.

This surge in the daily birth curve is observable at the same time of the year in all European countries which produce daily statistical data. The reason for the increase in Christmas and New Year conceptions is most probably attributable to its being the time of year when fewest couples are kept apart, especially by work.

Figure 9.1 SWITZERLAND, 1880-1996
Total monthly FERTILITY rate
Series adjusted for seasonal variations,
then smoothed by Hoem moving average on 25 terms
Logarithmic ordinate scales with the same module

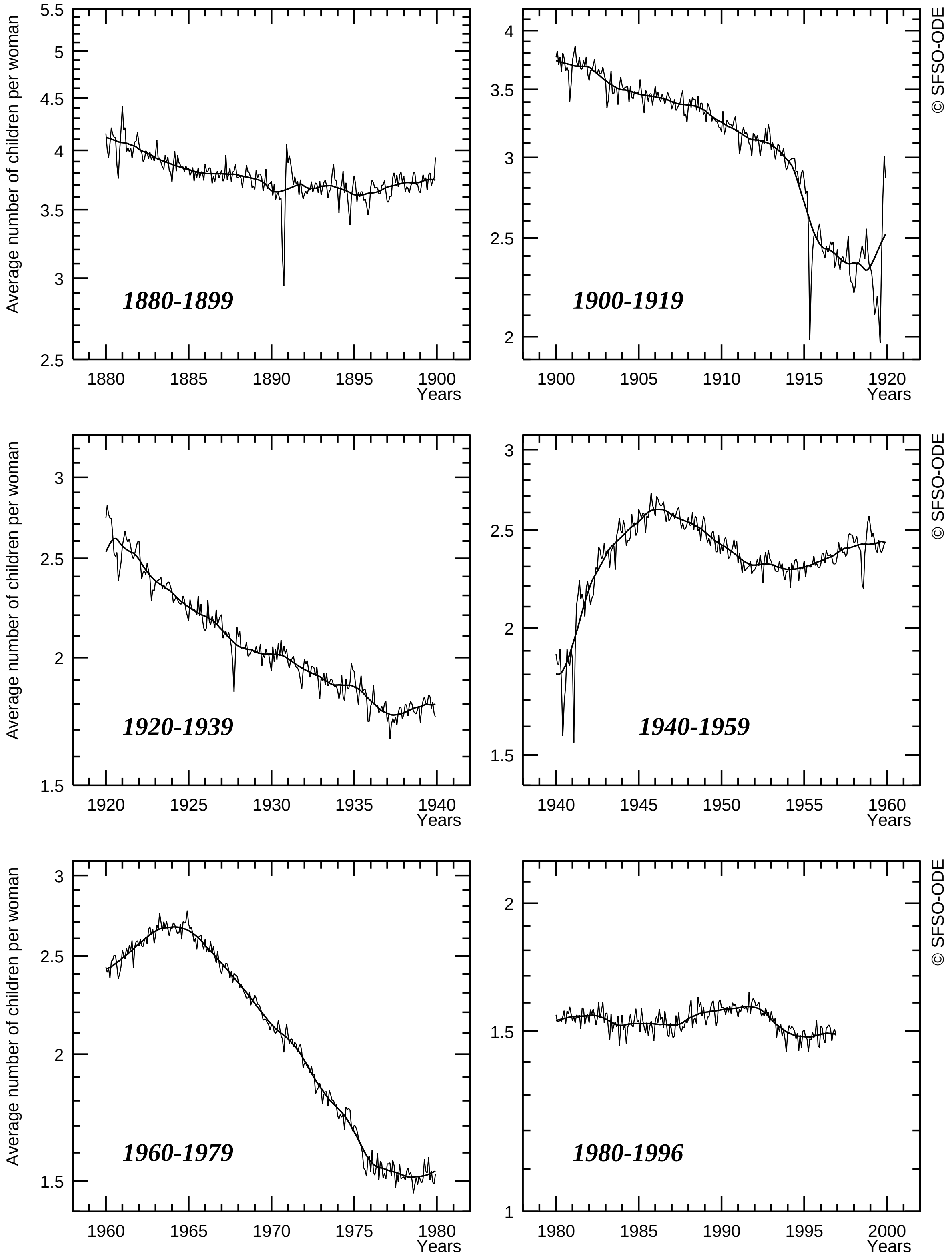


Figure 9.2 SWITZERLAND, 1886-1996
Total monthly FEMALE FIRST MARRIAGE rate
Series adjusted for seasonal variations,
then smoothed by Hoem moving average on 25 terms
Logarithmic ordinate scales

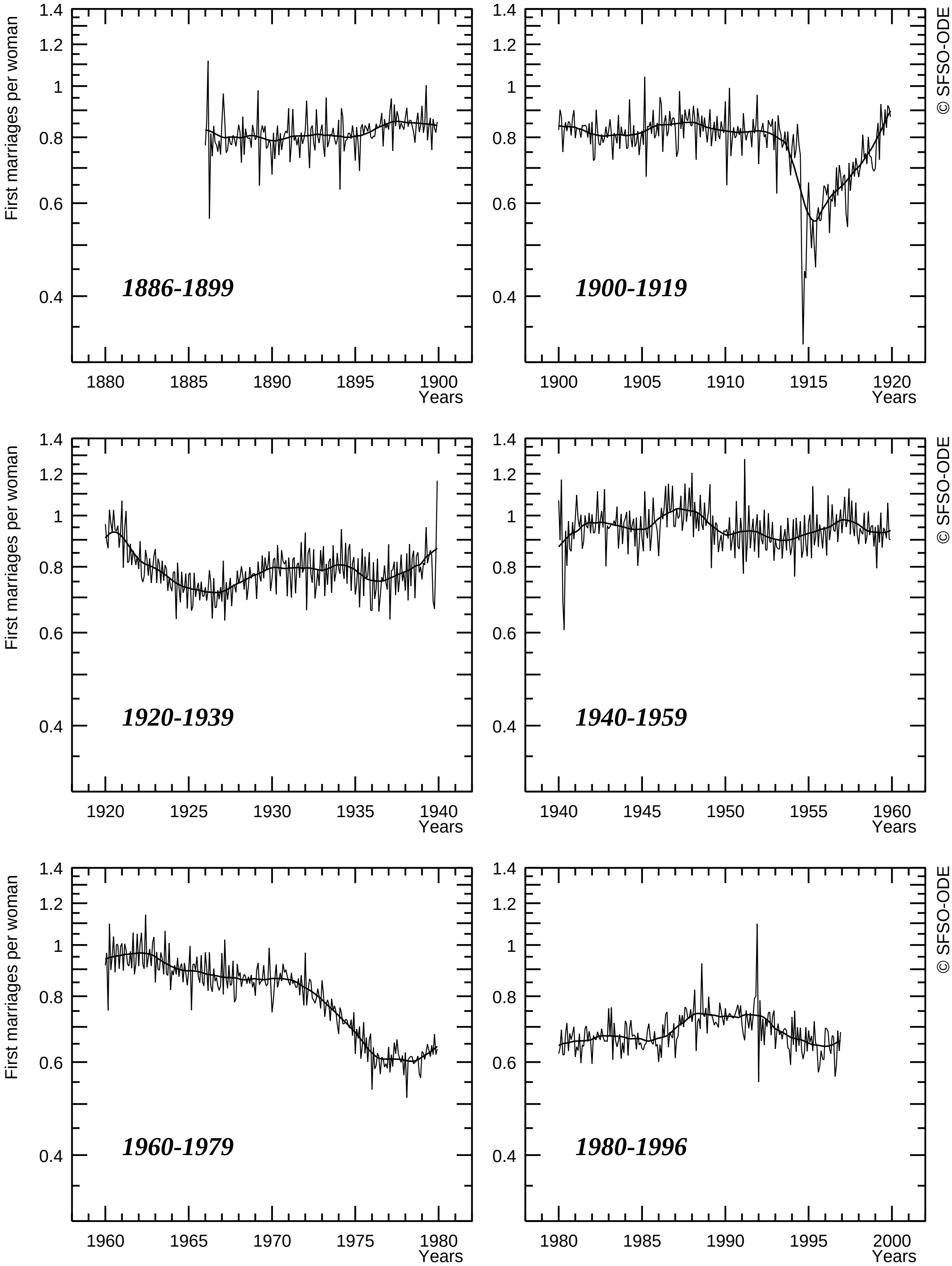


Figure 9.3 SWITZERLAND, 1901-1996
Monthly MALE LIFE EXPECTANCY at BIRTH
Series adjusted for seasonal variations,
then smoothed by Hoem moving average on 25 terms

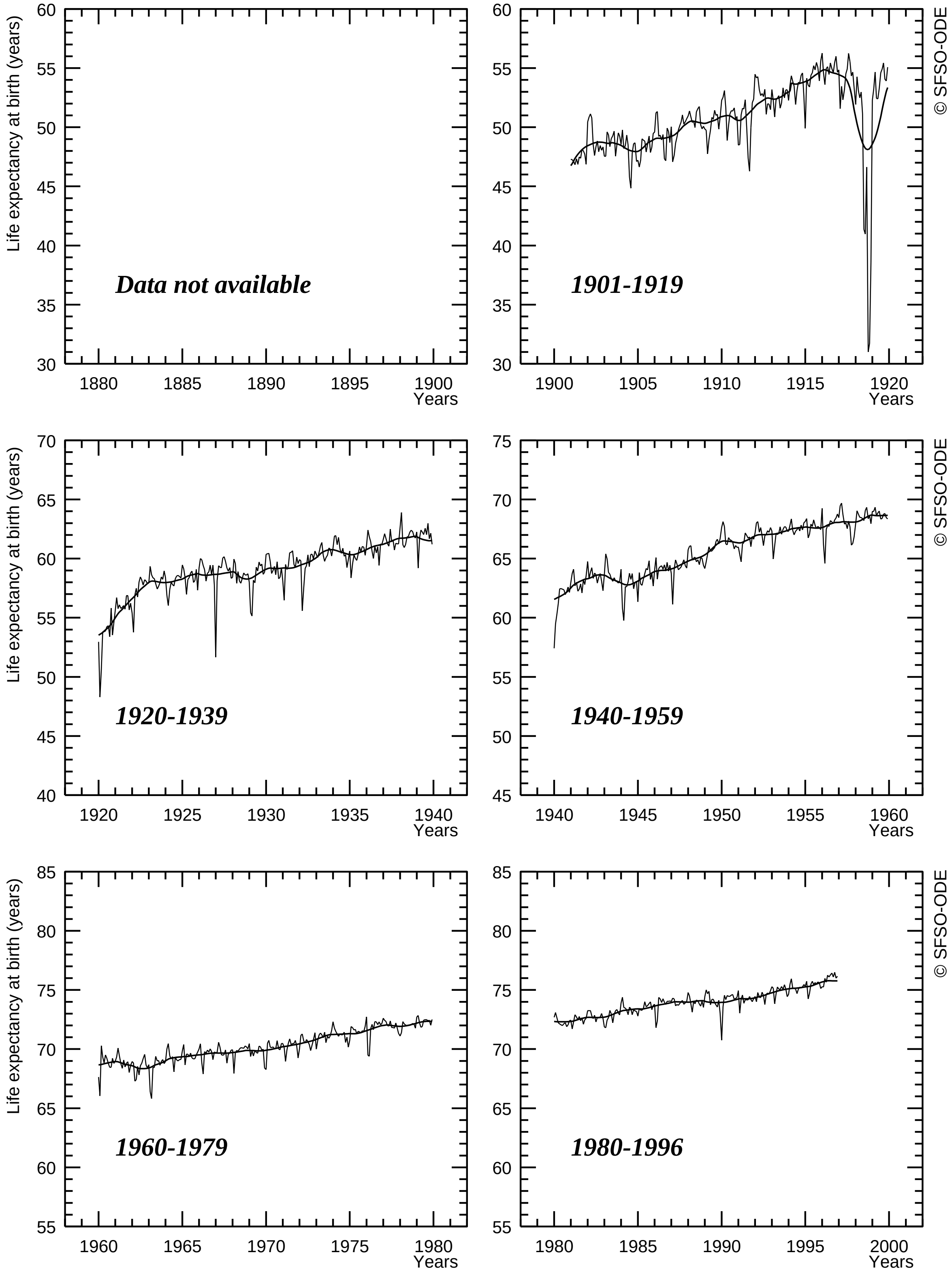
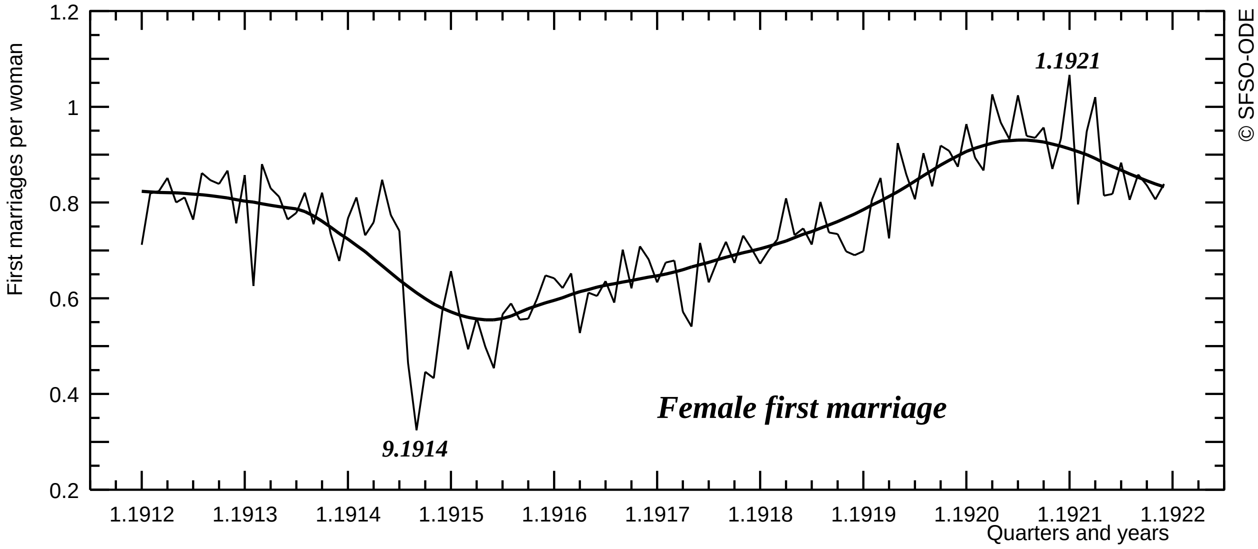
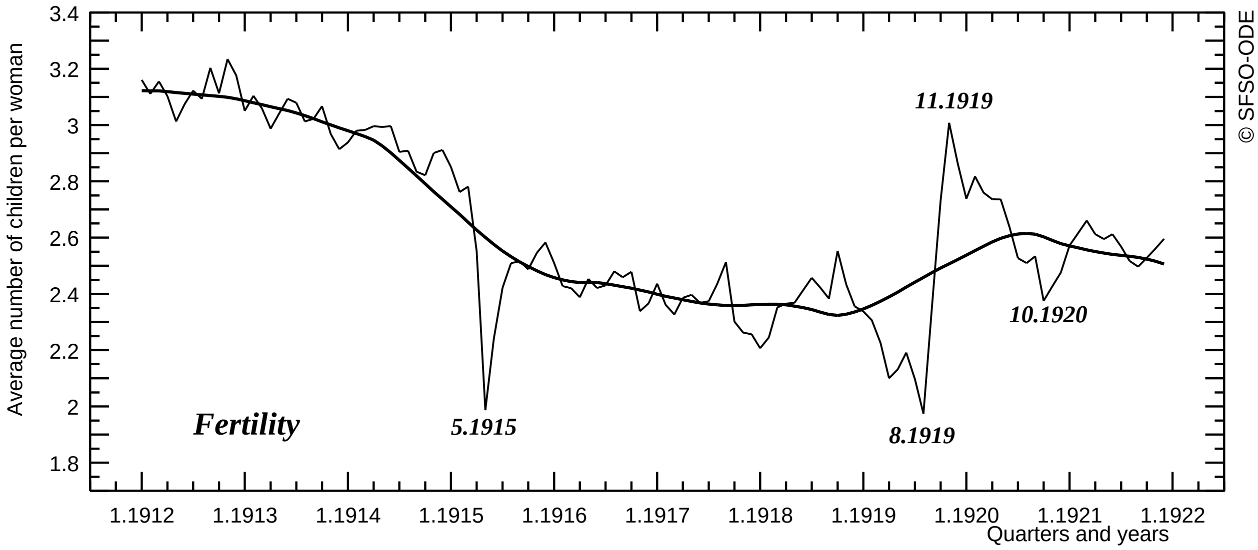


Figure 9.4 SWITZERLAND, 1912-1921
Total monthly FEMALE FIRST MARRIAGE
and FERTILITY rate and monthly MALE LIFE EXPECTANCY at BIRTH
Series adjusted for seasonal variations and smoothed by moving average





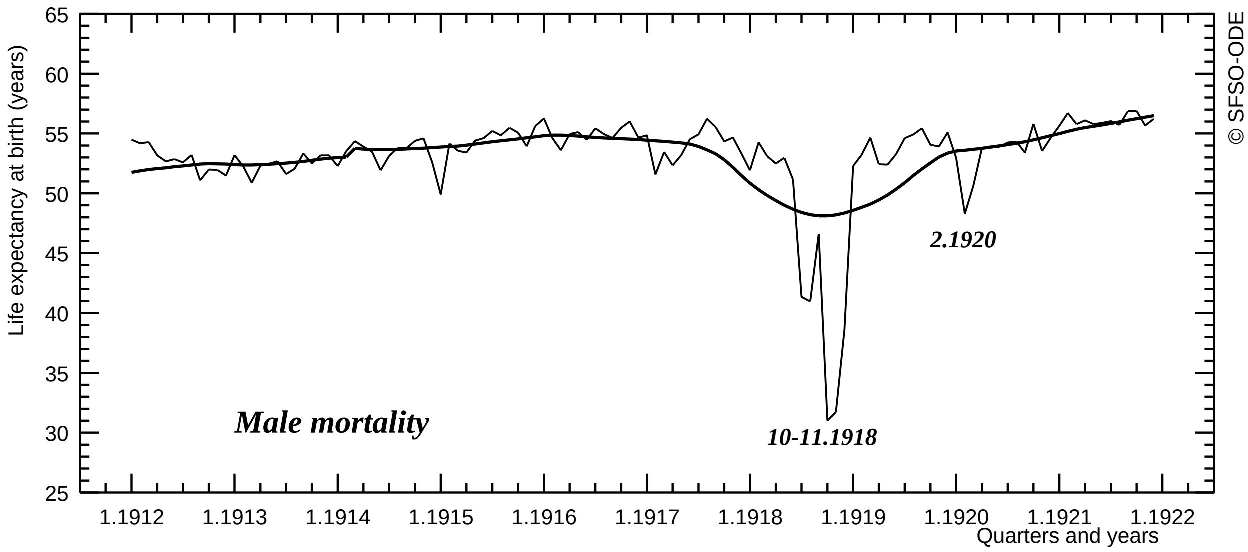


Figure 9.5 SWITZERLAND
1917 and 1918
PROBABILITIES of DYING by AGE and SEX

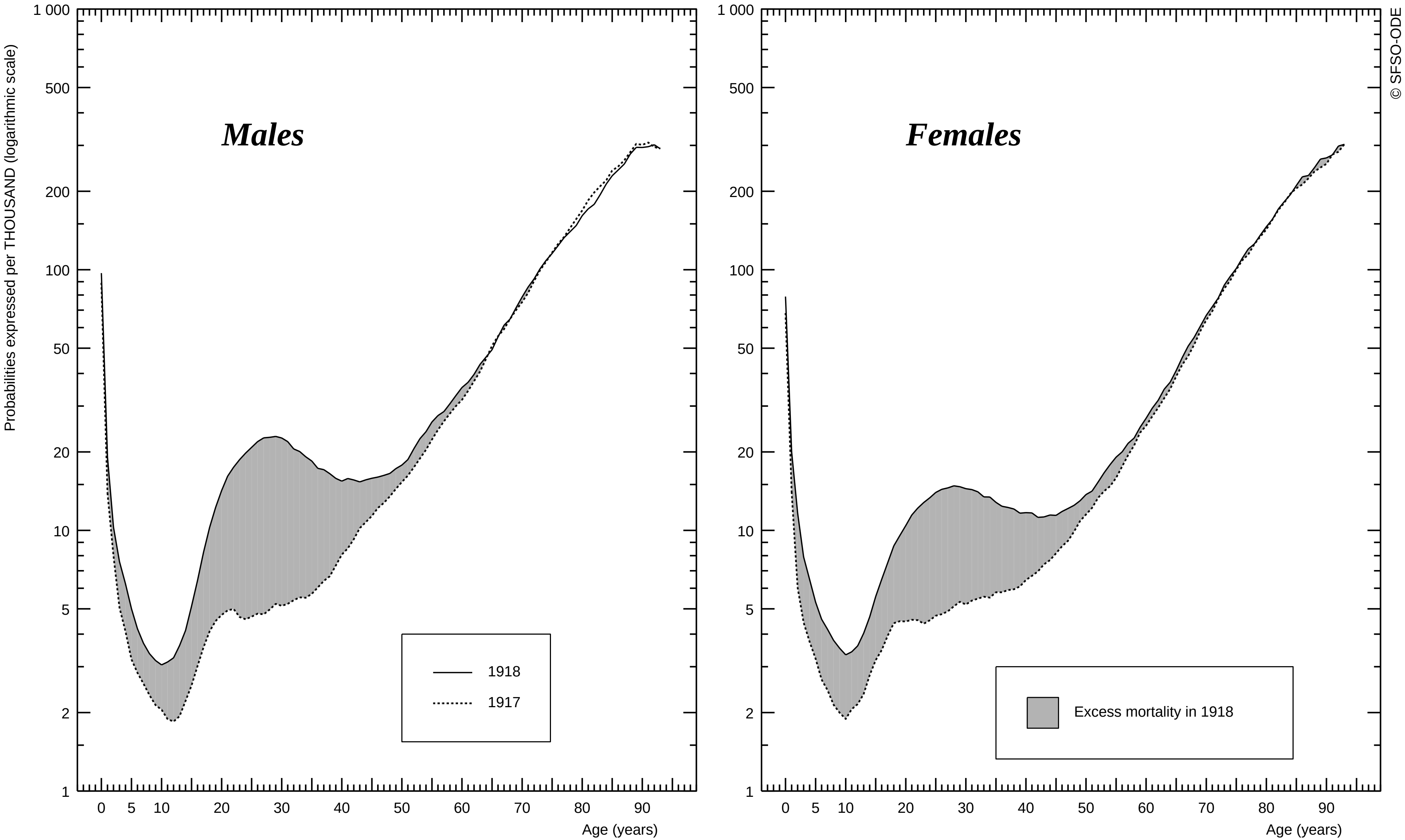


Figure 9.6 SWITZERLAND
1917 and 1919
PROBABILITIES of DYING by AGE and SEX

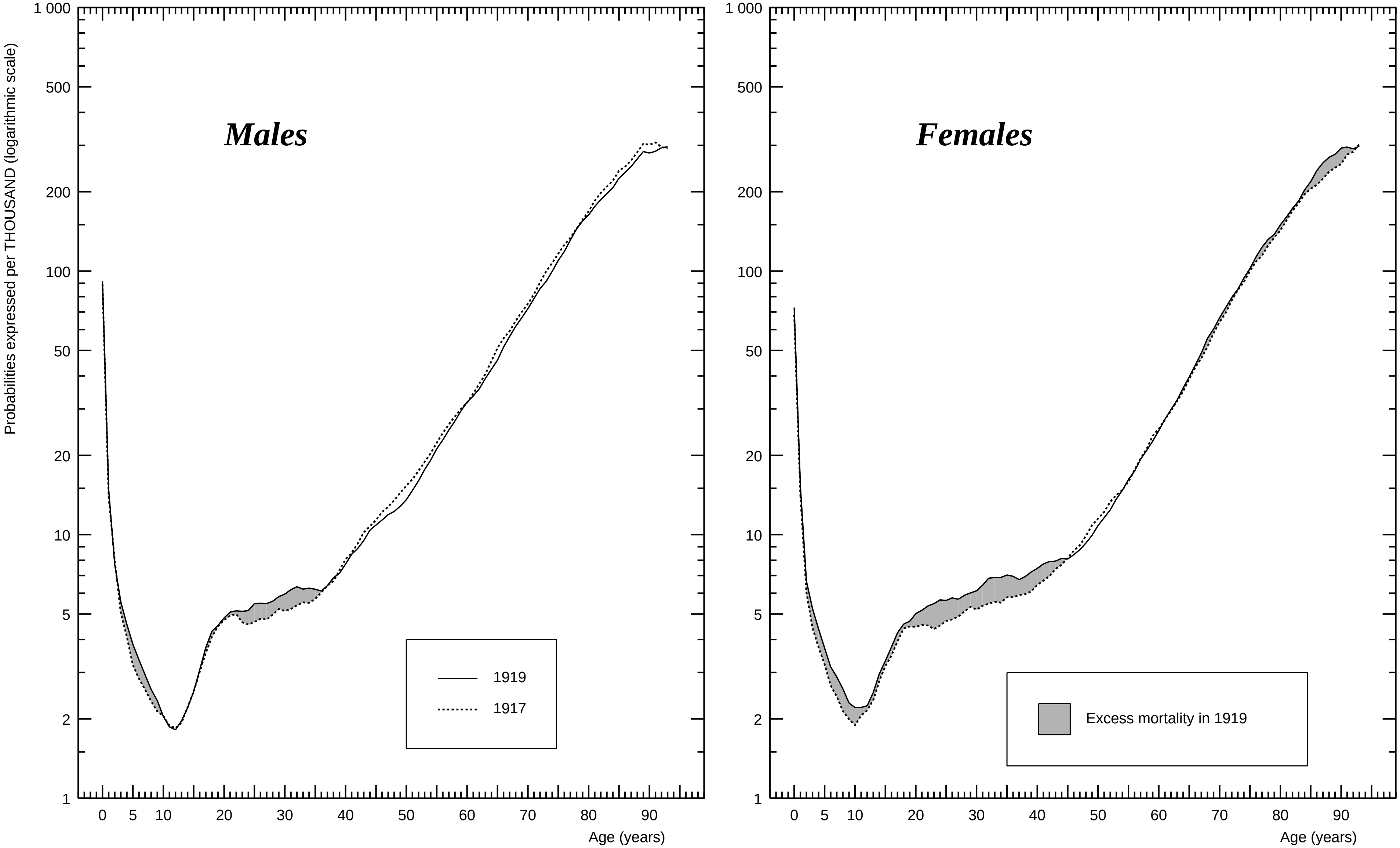


Figure 9.7 SWITZERLAND, 1937-1946
Total monthly FEMALE FIRST MARRIAGE
and FERTILITY rate and monthly MALE LIFE EXPECTANCY at BIRTH
Series adjusted for seasonal variations and smoothed by moving average

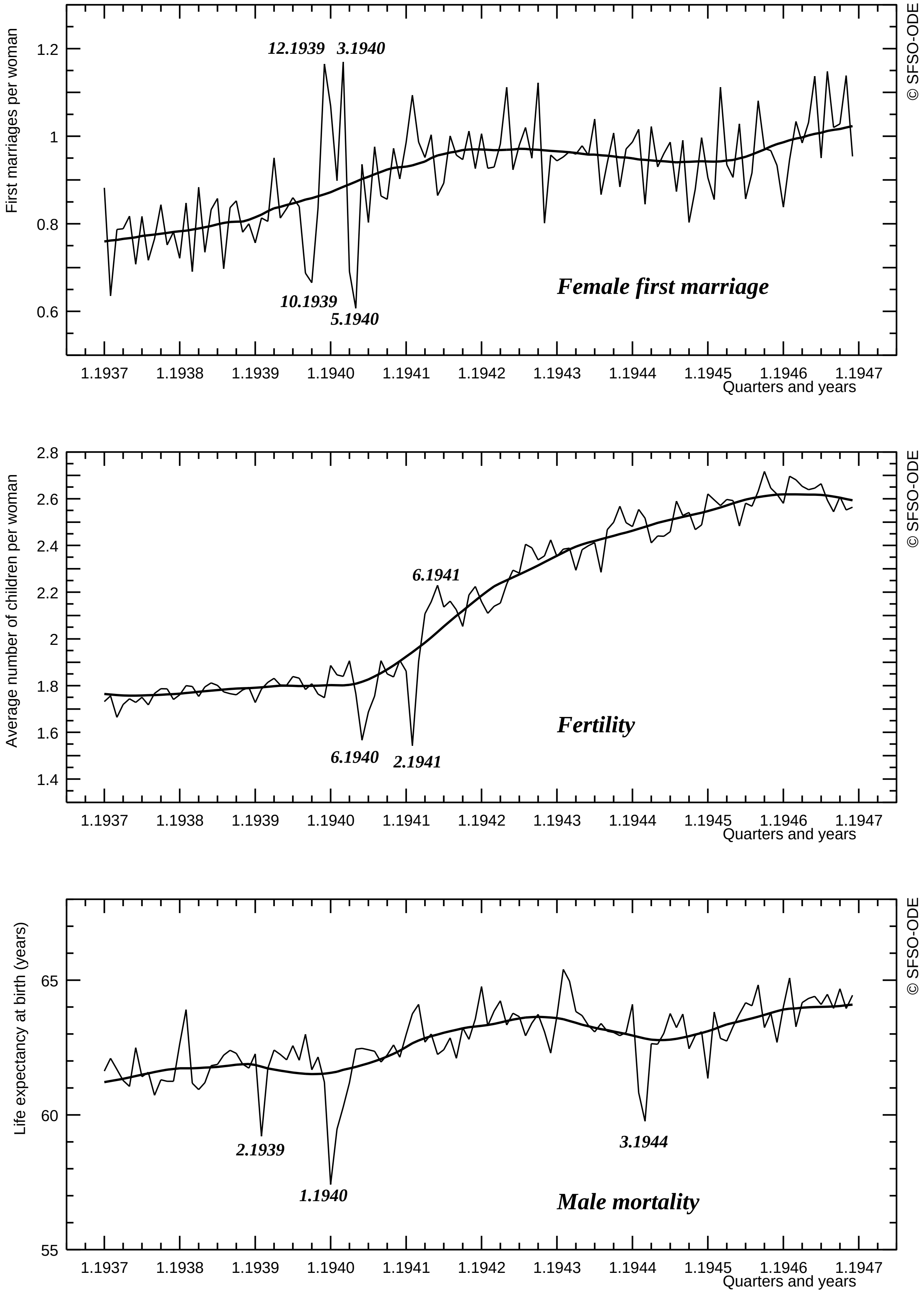


Figure 9.8 SWITZERLAND, SWEDEN and FRANCE, 1930-1955
Total monthly FERTILITY rate
Data adjusted for seasonal variations and smoothed by moving average

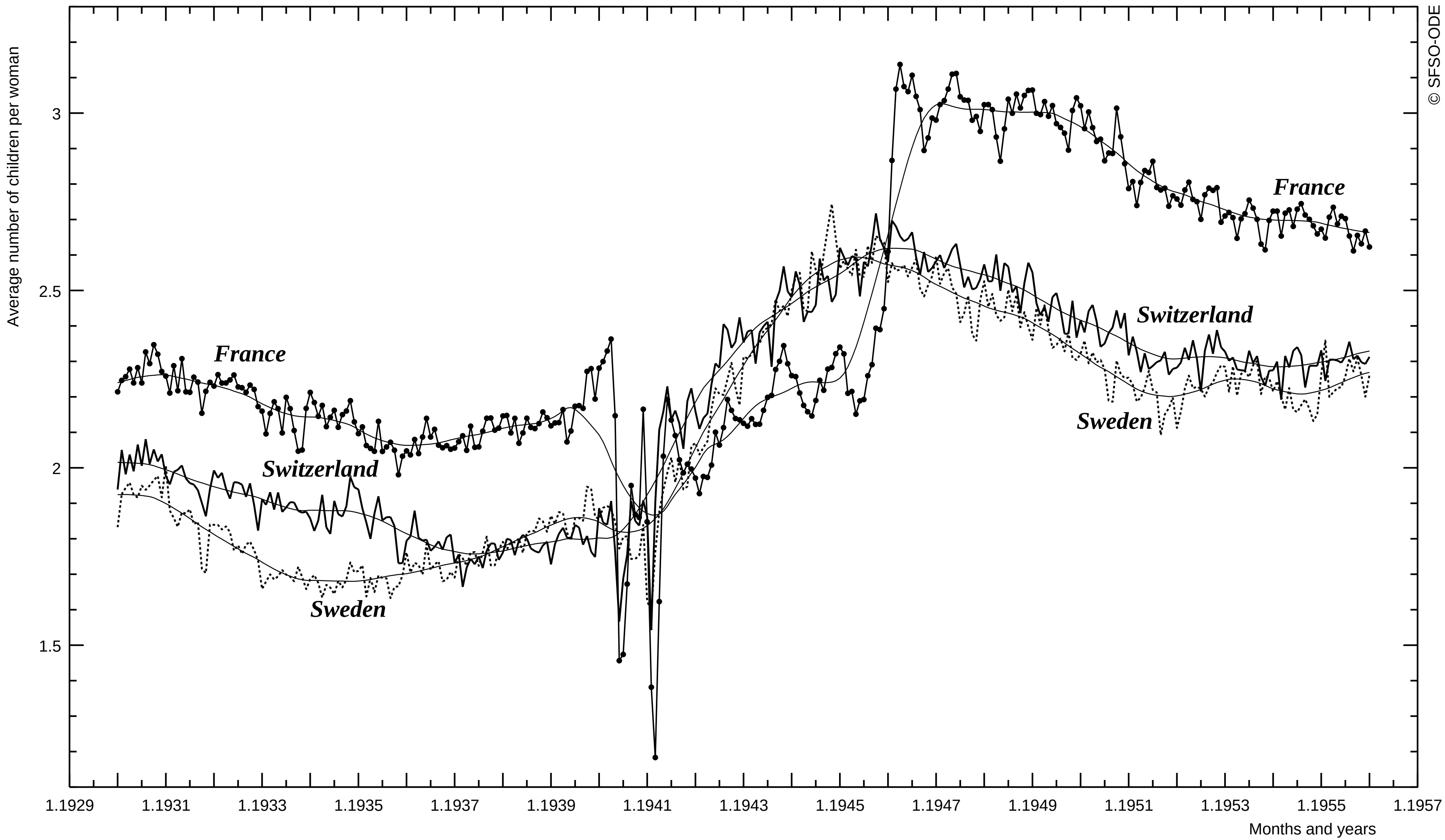


Figure 9.9 SWITZERLAND, 1926-1928 and 1957-1959
Monthly MALE LIFE EXPECTANCY at BIRTH and Total FERTILITY rate
Series adjusted for seasonal variations and smoothed by moving average
Effects of January 1927 and October-November 1957 flu epidemics (Asian flu)

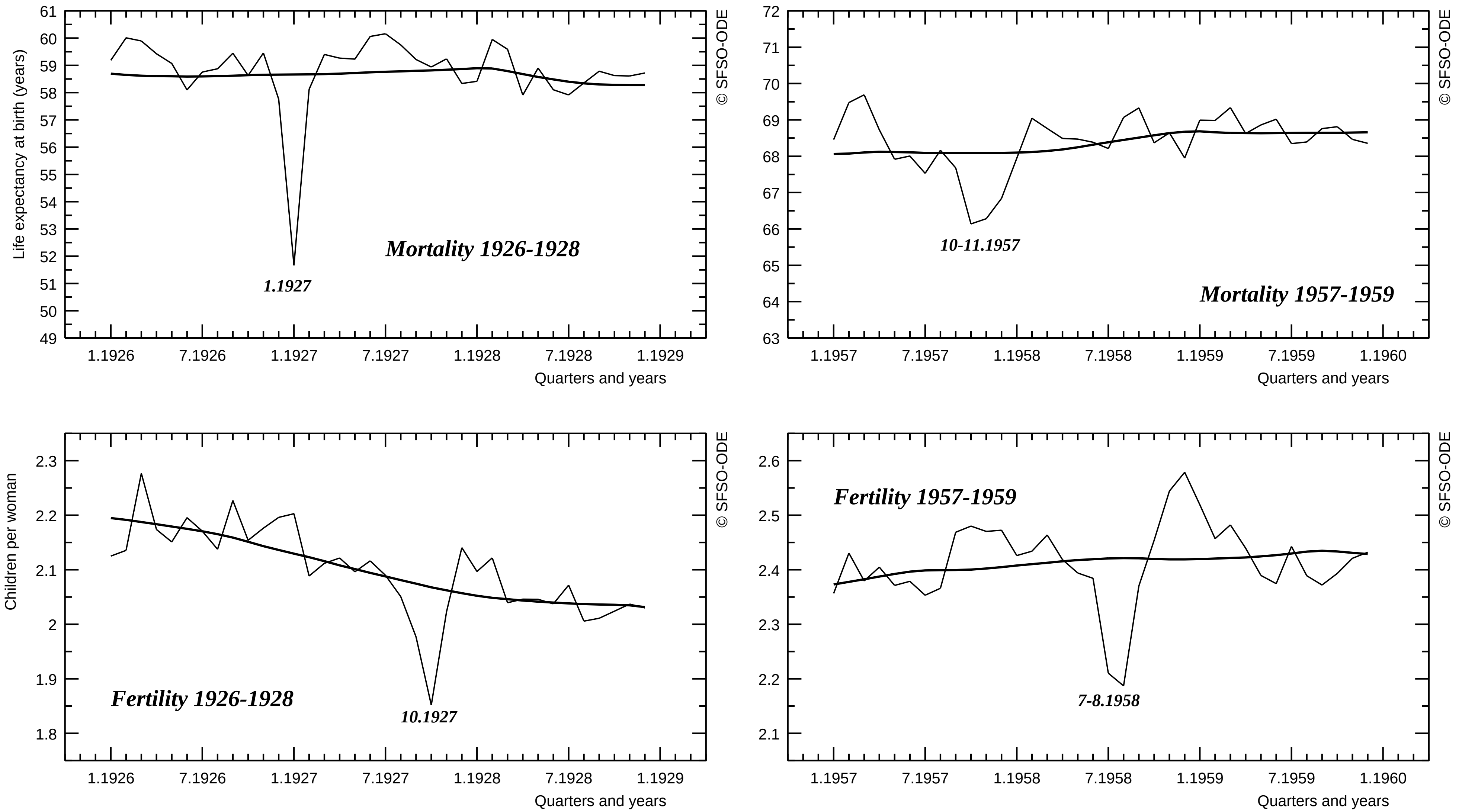


Figure 9.10 SWITZERLAND, 1970, 1980, 1981 and 1991
Daily number of live births
Bold line: moving average over one week, centered

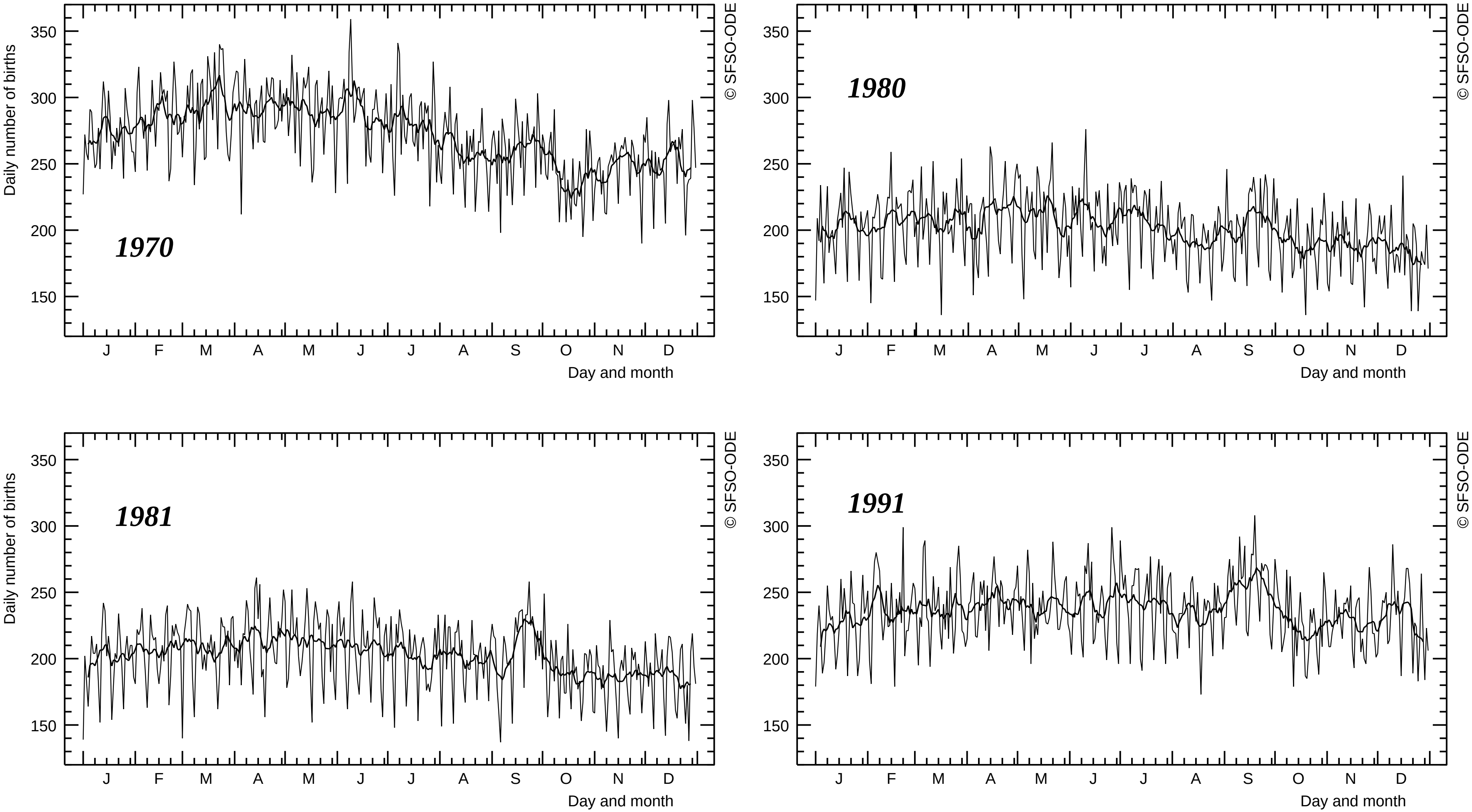


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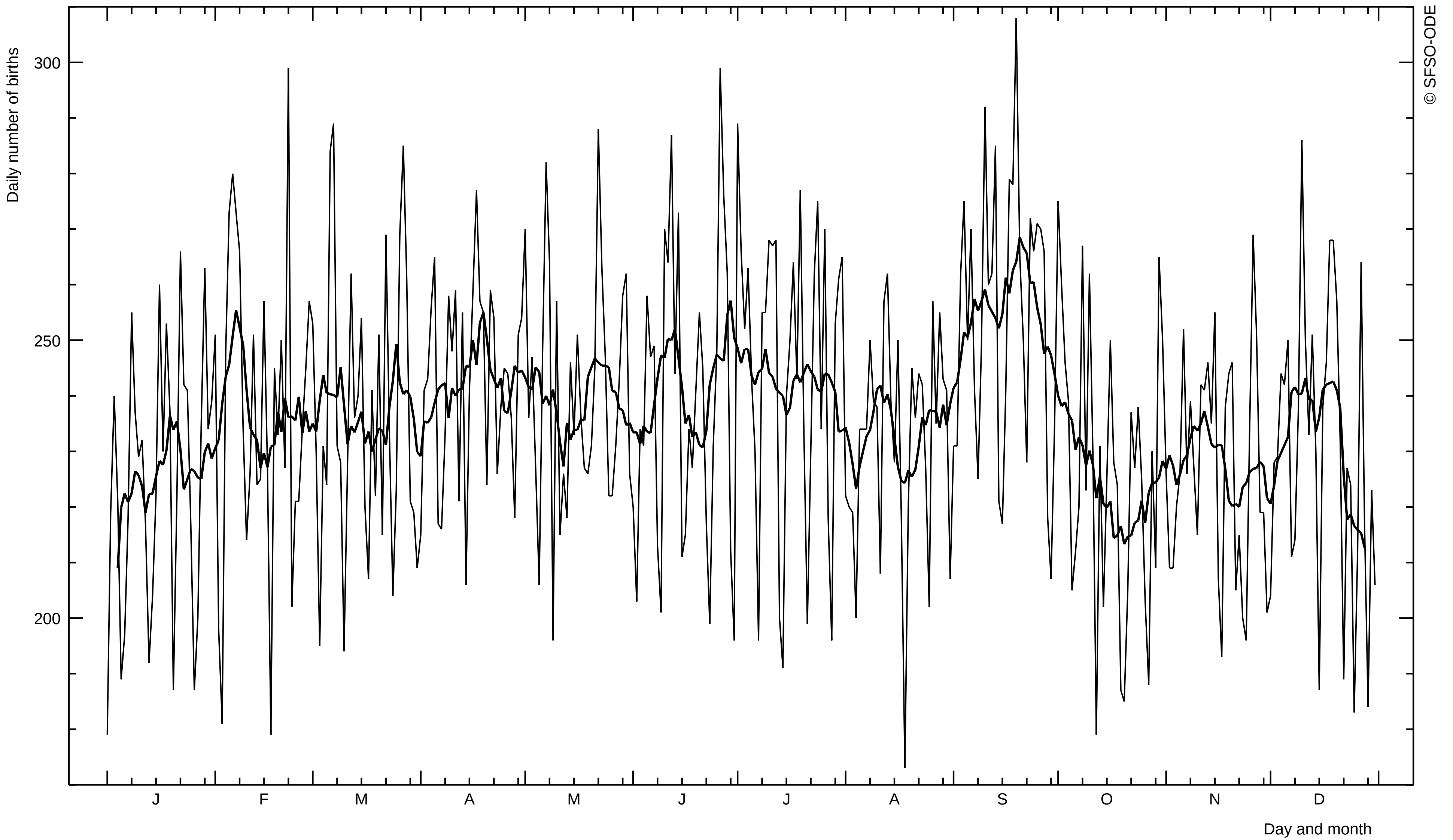
Figure 9.11 SWITZERLAND, 1991
Daily number of live births
Bold line: moving average over one week, centered



Chapter 10: Switzerland and its European neighbours

This chapter briefly compares Swiss demography with those of its immediate neighbours, except Liechtenstein, i.e., Germany, Austria, France and Italy. The data for Germany refer to the post-reunification territory, except as regards mortality.

An age structure little different from those of its neighbours

Figures 10.1.A to 10.1.D compare Switzerland's age structure to that of each of its neighbours. Overall, there are few differences, due mainly to national historical particularities (military losses in Germany and Austria affecting the 1920-1925 male birth cohorts, high birth rates in Germany from 1934 to 1941 and in Austria from 1939 to 1941, low Italian birth rate since 1980). Switzerland's early baby boom during World War Two clearly stands out by comparison with the French age pyramid. Generally, the similarities are greatest with Austria, especially below 40.

Ageing at the same rate as that observed or expected in neighbouring countries

Figures 10.2 and 10.3 compare for Switzerland, each neighbouring country and the European Union as a whole, the trend for the age within the population aged 20 and over which is equivalent to age 60 at January 1, 1995. They show a remarkably similar aspect, especially over the coming half-century. Inter-country differences in the past two decades are chiefly related to the size of the baby bust in the period 1915-1919.

Nuptiality less in decline but later than in neighbouring countries

The male (Figure 10.4) and female (Figure 10.5) total first marriage rates, which had declined so greatly in Switzerland from 1960 to 1975 to become the lowest of the five countries considered, rose again from 1975 to 1988 before turning down again. In recent years, however, it has exceeded those observed in Germany, Austria and France, remaining close to that of Italy. The extreme sensitivity of the Austrian rates are clear: on three occasions (1972, 1983 and 1987) they fluctuated wildly following changes in the law on taxation of married couples.

Over successive generations, the quantum of marriage measured by the proportion of 50-year-old ever-marrieds was long lower in Switzerland than in adjacent countries; it decreased in Switzerland as elsewhere, with a swing-away from legally-constituted marriages and an increase in non-marital unions, but in the 1960 birth cohorts the differences between Switzerland and the other countries narrowed.

As regards age at marriage (Figures 10.7 and 10.8), Switzerland presents a more singular case. The general trend in the 1950s and 1960s towards increasingly early marriage was reversed in Switzerland some years ahead of the other countries, with a pronounced rise in the mean age at first marriage. Of the 1960 birth cohorts, those of Switzerland married latest: on average, a year later than in Italy, two years later than in France.

Fertility not so low as in Germany, Austria and Italy, but lower than in France

The total fertility rate (left-hand side of figure 10.6) which, in Switzerland, barely moved from the interval of 1.5-1.6 children per woman for twenty years, is not so low as the particularly low levels reported in Germany, Austria and especially Italy (less than 1.2 children per woman in 1995). Since the Second World War, however, the Swiss rate has been consistently at least 0.2 child per woman lower than that of France.

In terms of completed fertility (left-hand side of figure 10.6) among the female birth cohorts of around 1960, Switzerland is slightly higher than Germany, Austria and Italy, but approximately 0.3 child per woman below France. Like age at first marriage, age at childbirth is generally later in Switzerland than in adjacent countries: approximately two years between the mean ages at childbirth of Switzerland and Austria.

A rising, but still among the lowest, proportion of extra-marital births

As stated in chapter 5, extra-marital births is where Swiss fertility differs most from its German, Austrian and French counterparts, and bears most resemblance to Italian fertility. During the 1950s and 1960s, Switzerland registered only about 4% of extra-marital births, barely more than Italy, against approximately 7% in France and over 12% in Austria. Germany's situation was heterogeneous, with a proportion of extra-marital births in West Germany close to that observed in France, while East Germany (former GDR) very much resembled Austria (Figure 10.10).

The second half of the 1960s saw the proportion rising in all countries, but much more rapidly in some (East Germany: over 40% since 1991, France: 36% in 1994). With barely 8% in 1996, Switzerland ranks alongside Italy as one of the lowest proportions in Europe.

One of the healthiest populations in Europe

Figures 10.11.A, 10.11.B and 10.11.C compare the trend since the Second World War of the male and female probabilities of dying in four age groups in Switzerland, Germany (data for West Germany only), Austria and France. Switzerland has consistently recorded the lowest mortality for each age group and sex over the past fifty years. Only France manages to attain Swiss levels – and then only in the 1-20 and 60-80 age groups.

This overall assessment must be qualified, however. A comparison of the age-sex-specific average probabilities of dying for the period 1990-1994 (Figure 10.12) shows that both male and female mortality is lower in Switzerland than in Germany and Austria among the over-35s, and in the first year of life; on the other hand, Swiss mortality is higher than German mortality between 10 and

35 years old, and above Austrian mortality between 20 and 35 years old. Compared to France, the difference is indistinct under 25 years of age, very clearly in Switzerland's favour between 25 and 60 years of age, but with a slight advantage to France among women aged over 60 and men aged over 65.

While mortality is admittedly low at the ages where Switzerland obtains less favourable results compared to Germany and Austria, it must be pointed out that, around the age of 25, the mortality rate is approximately one third higher in Switzerland and France than in Germany or Austria.

In terms of life expectancy at birth over the period 1990-1994, Switzerland ranks highest for men (74.6 years) ahead of Germany and France (73.2 years) then Austria (72.8 years), but only second for women (81.3 years) behind France (81.4 years) but ahead of Germany (79.5 years) and Austria (79.3 years). The rankings are almost identical for life expectancy at 60 years of age, where men can expect a further 19.5 years of life in Switzerland, 19.3 in France, 18.2 in Austria and 18.1 years in Germany, while women can hope for 24.6 years in France, 24.2 in Switzerland, 22.5 in Germany and 22.4 years in Austria.

The differences between life expectancy at birth in Switzerland and in each of the other three countries (Figure 10.13) confirm that the Swiss excess mortality around 25 years of age compared to Germany and Austria has much less of an effect (on life expectancy at birth) than that of the lower Swiss mortality after 35 years of age. The significant effect of low Swiss infant mortality on life expectancy at birth. is especially important, compared with Austria.

Figure 10.1.A SWITZERLAND and GERMANY (post-reunification). AGE-SEX STRUCTURES at January 1, 1996
Total population reduced to one million in each country

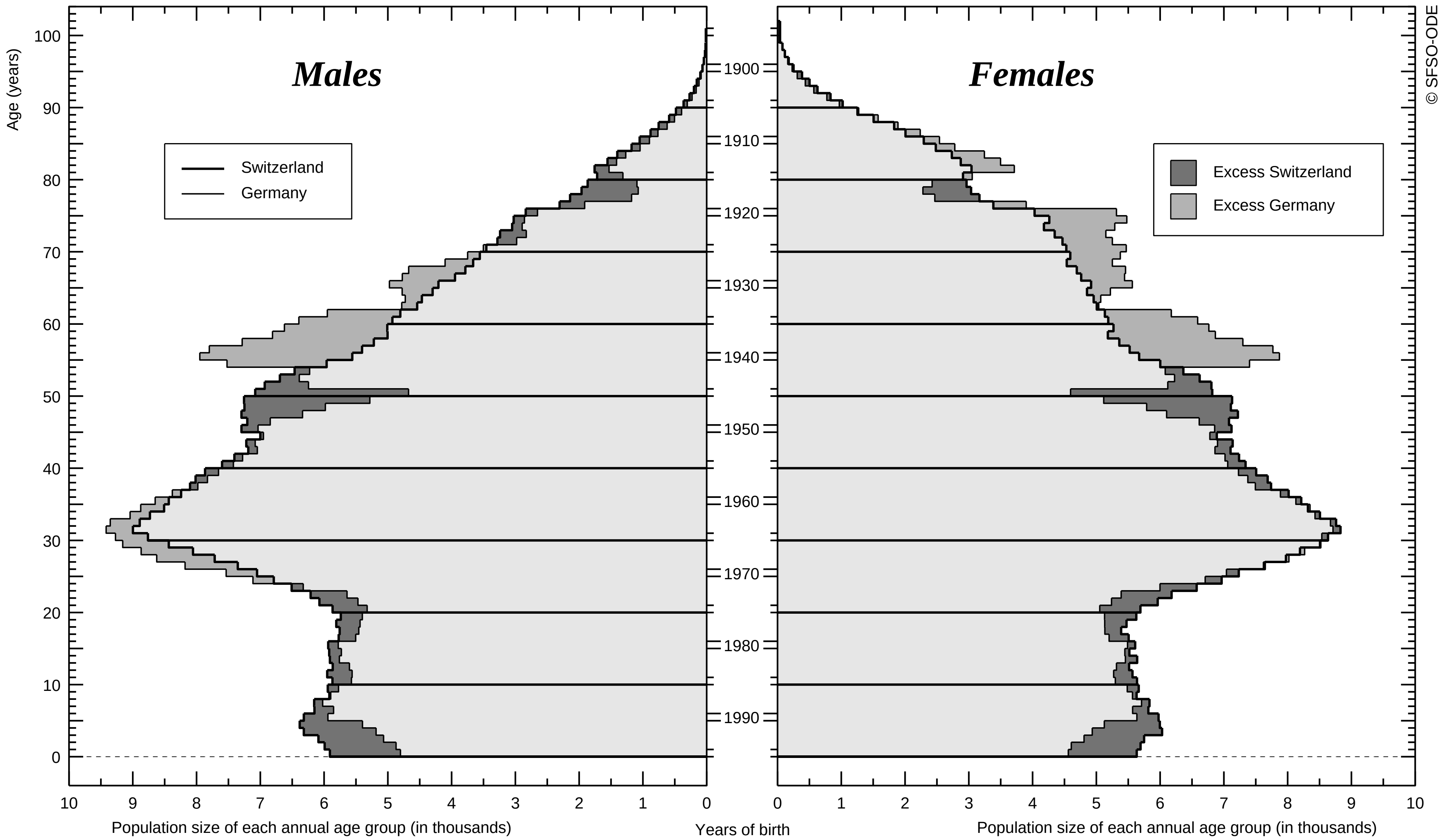


Figure 10.1.B SWITZERLAND and AUSTRIA. AGE-SEX STRUCTURES at January 1, 1996
Total population reduced to one million in each country

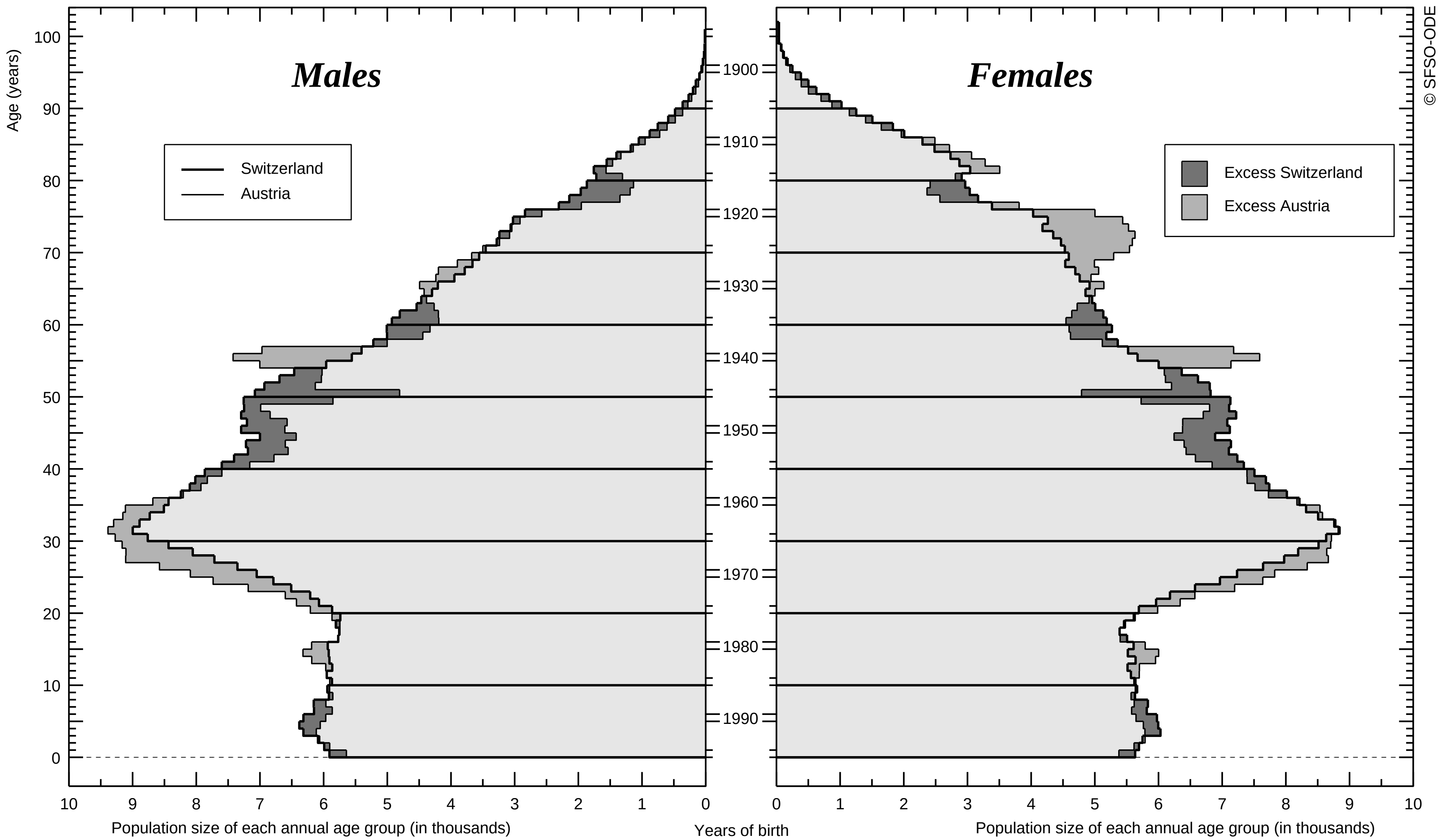


Figure 10.1.C SWITZERLAND and FRANCE. AGE-SEX STRUCTURES at January 1, 1996
Total population reduced to one million in each country

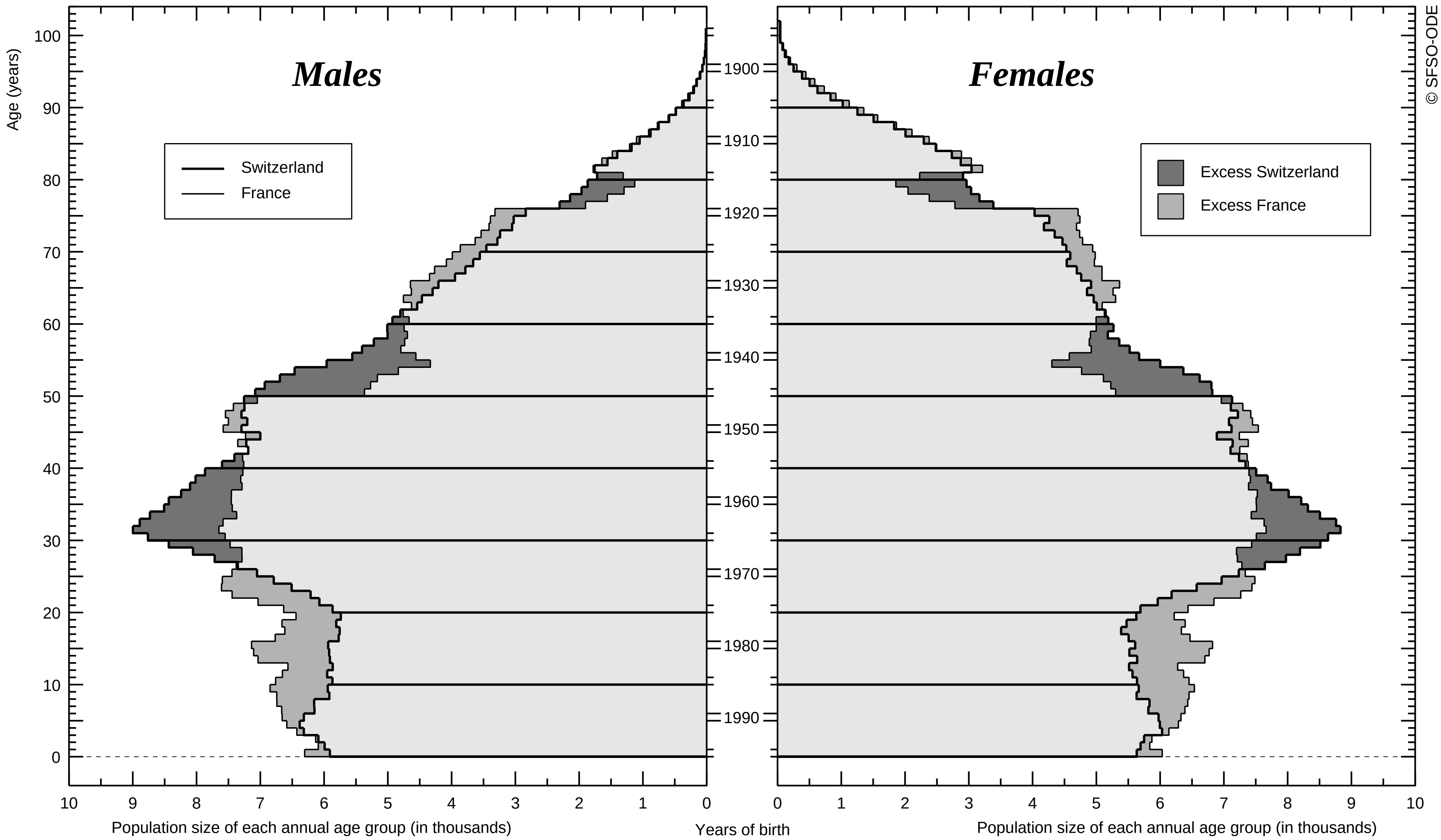


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Figure 10.1.D SWITZERLAND and ITALY. AGE-SEX STRUCTURES at January 1, 1996
Total population reduced to one million in each country

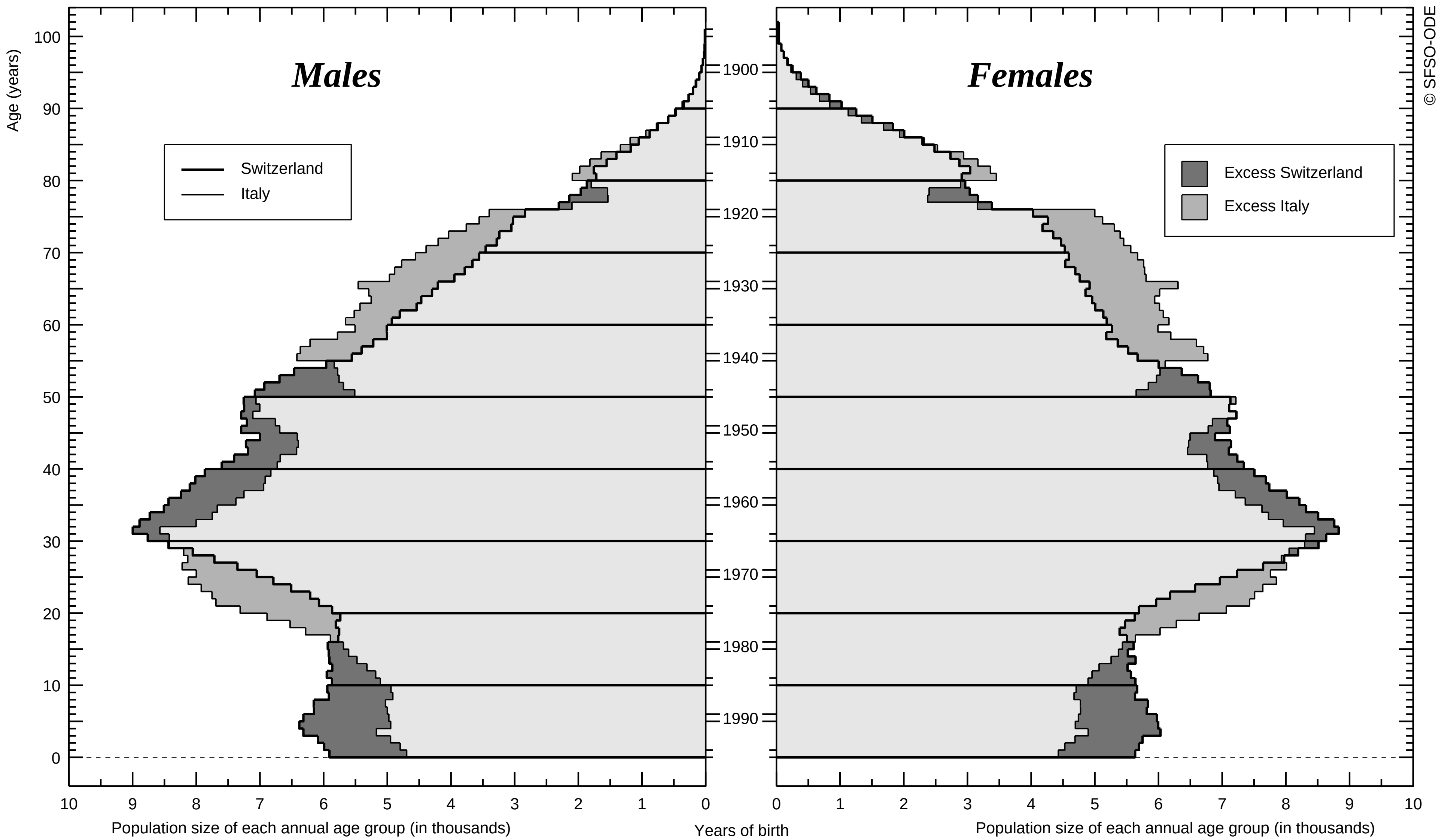

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Figure 10.2 SWITZERLAND, GERMANY, AUSTRIA, FRANCE, ITALY and EUROPEAN UNION (Eur15)
EQUIVALENT AGE, within the population aged 20 or over, to age 60 at 1.1.1995
Observations up to 1995, SFSO A, B and C scenarios for Switzerland
Eurostat high, baseline and low alternative projections for the other countries

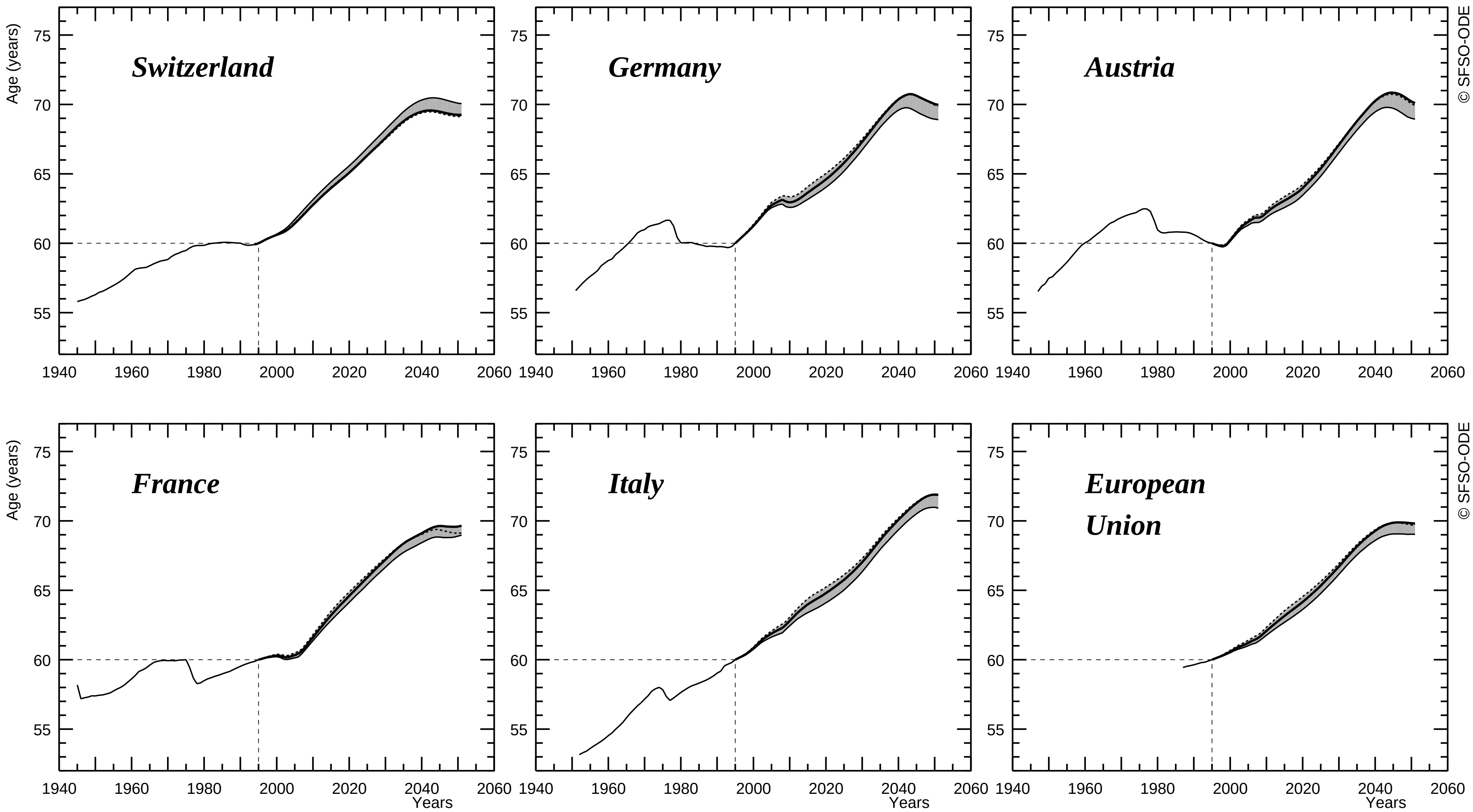


Figure 10.3 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
EQUIVALENT AGE, within the population aged 20 or over, to age 60 at 1.1.1995
Observations up to 1995, SFSO scenario A for Switzerland
Eurostat baseline projections for the other countries

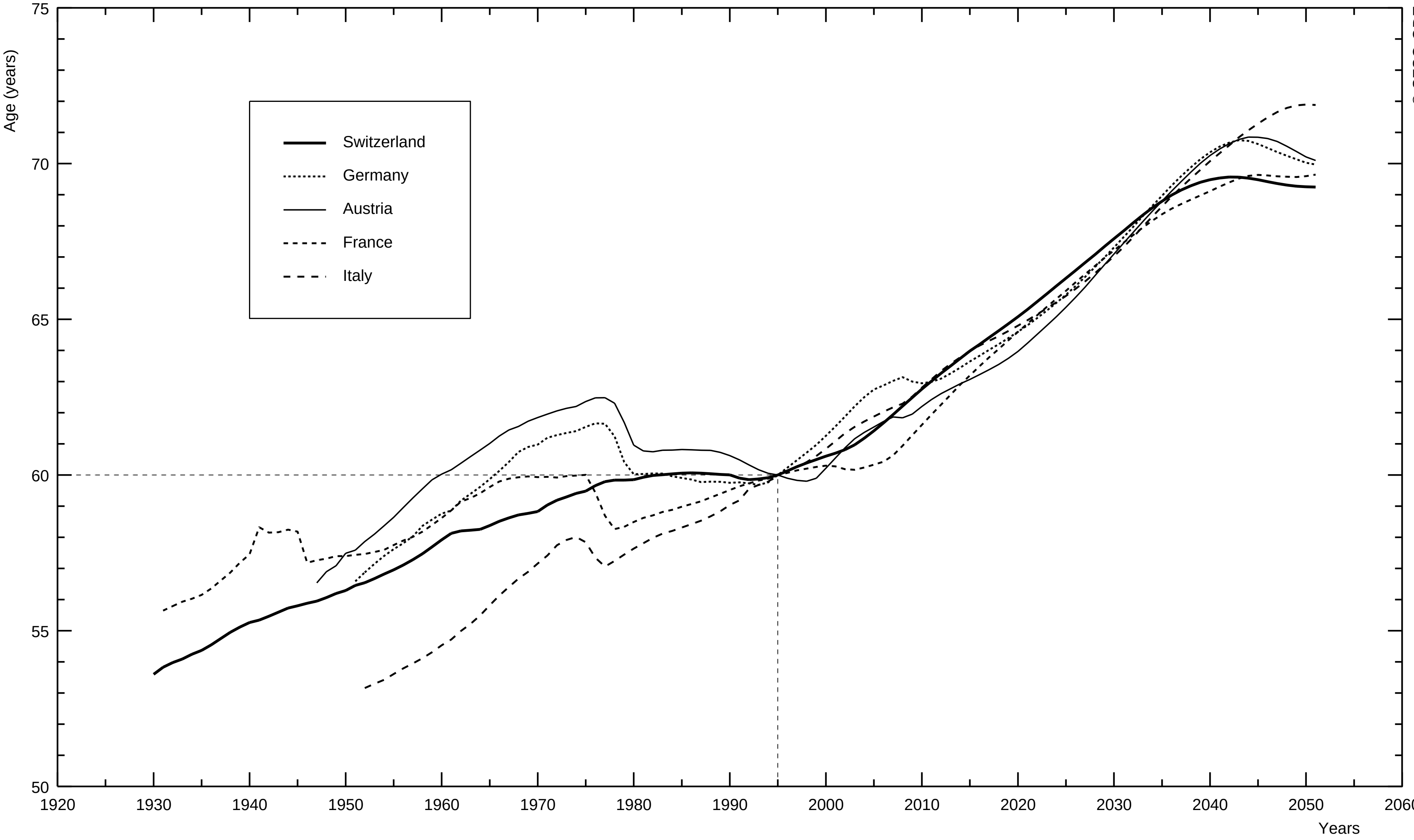


Figure 10.4 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
Annual total MALE FIRST MARRIAGE rate
and proportion of ever-marrieds in the male birth cohorts

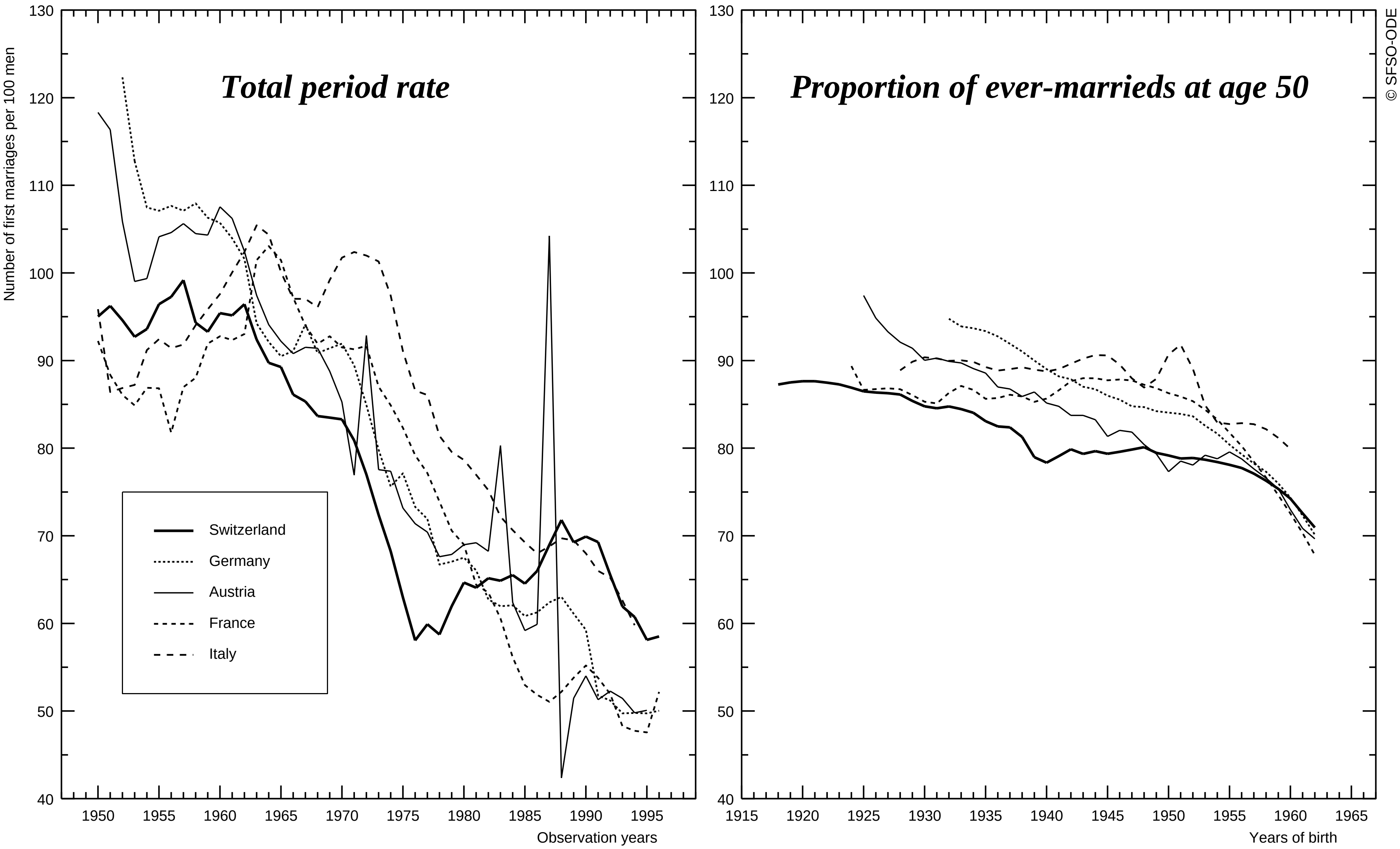


Figure 10.5 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
Annual total FEMALE FIRST MARRIAGE rate
and proportion of ever-marrieds in the female birth cohorts

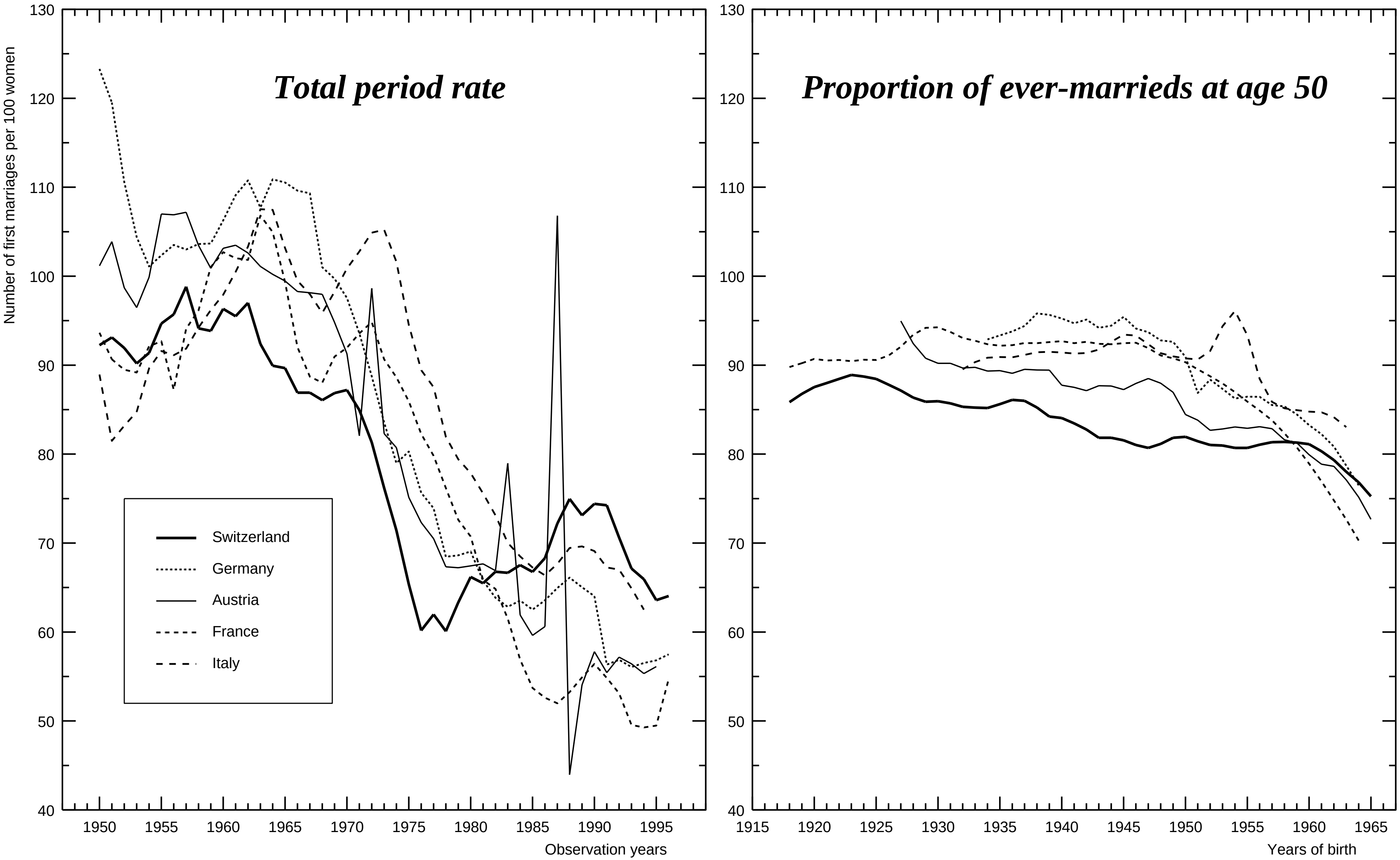


Figure 10.6 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
Annual total FERTILITY rate and completed fertility of female birth cohorts

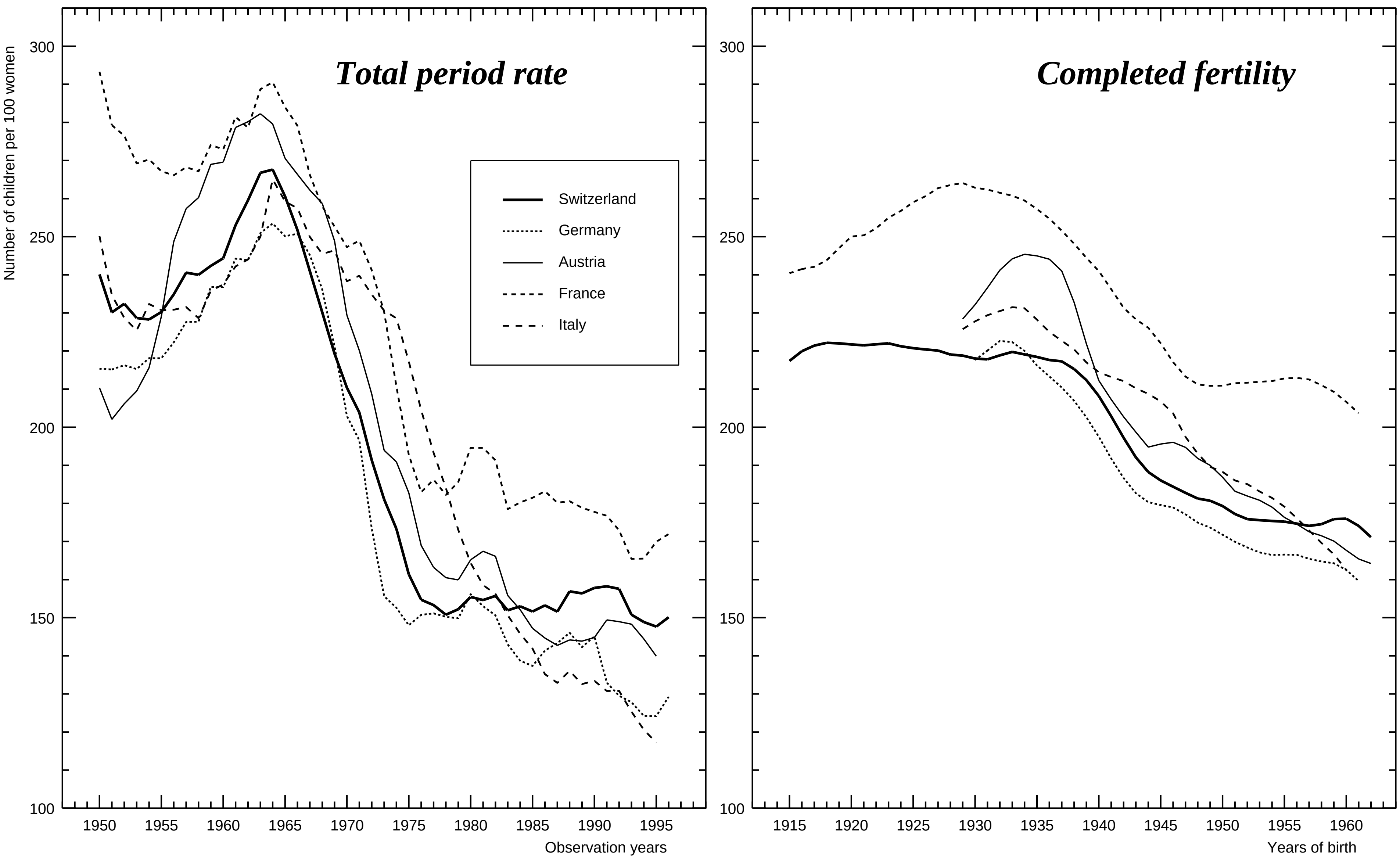


Figure 10.7 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
MEAN AGE at MALE FIRST MARRIAGE
through observation years and by birth cohorts

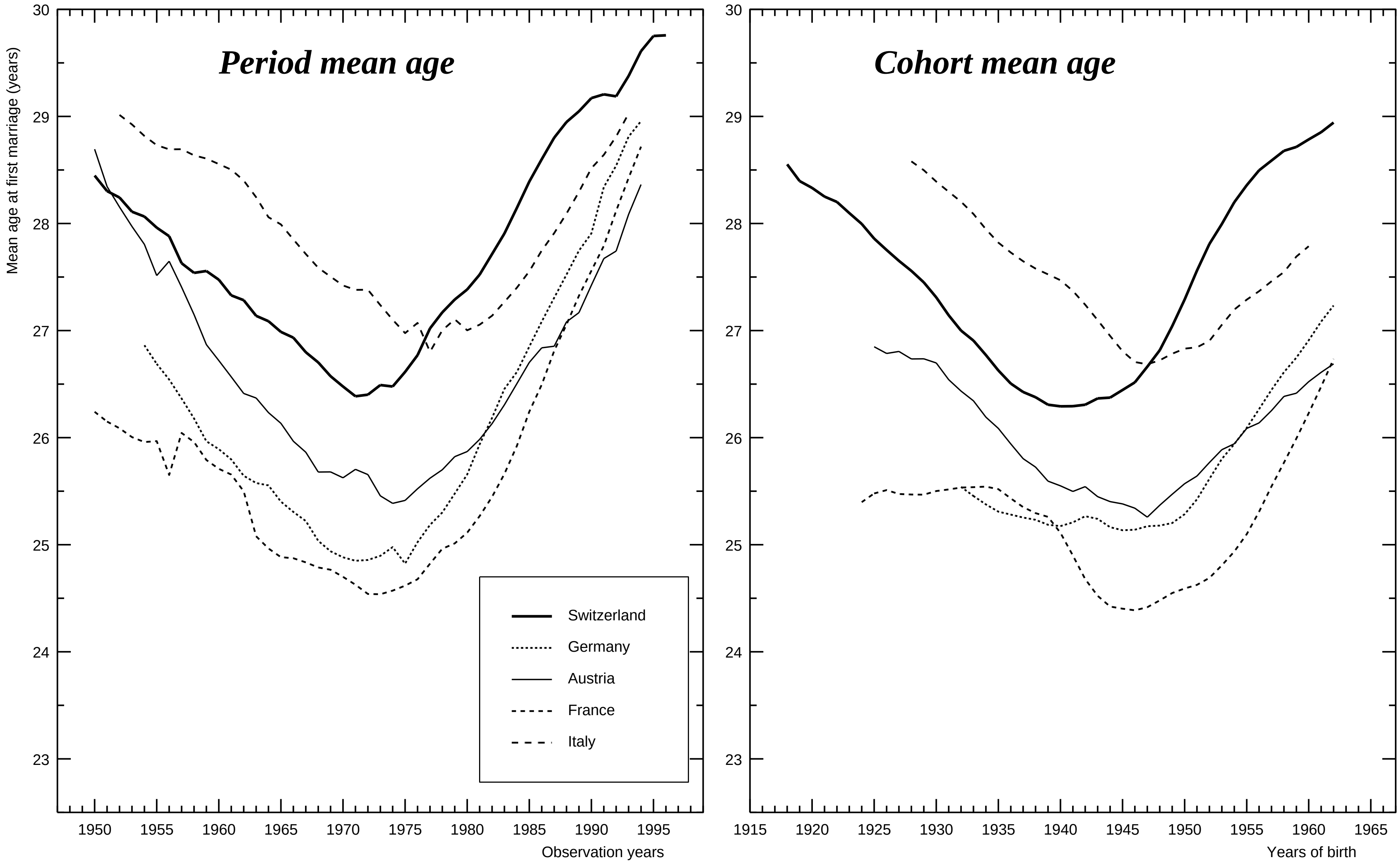


Figure 10.8 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
MEAN AGE at FEMALE FIRST MARRIAGE
through observation years and by birth cohorts

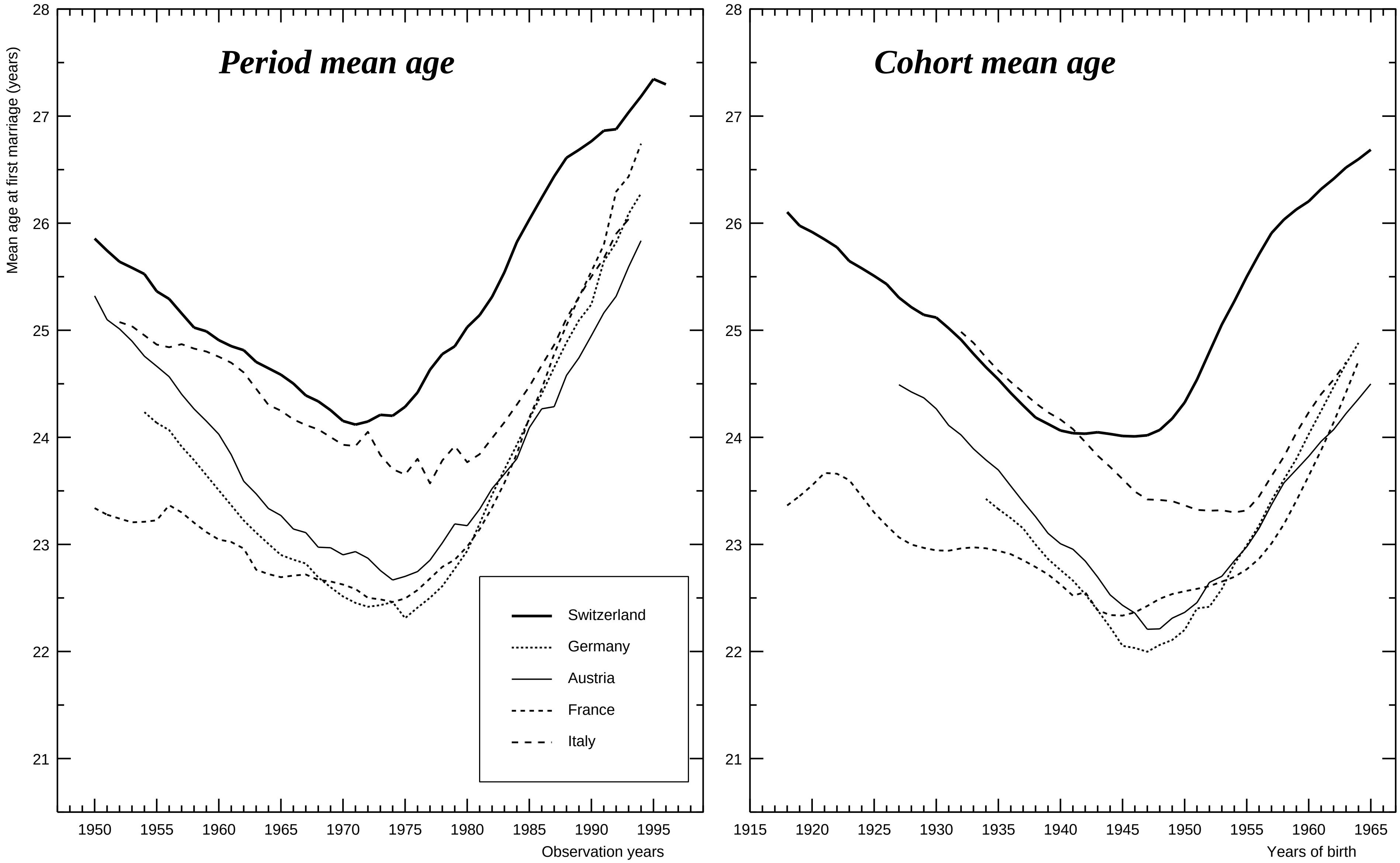


Figure 10.9 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
MEAN AGE at CHILDBIRTH
through observation years and by birth cohorts

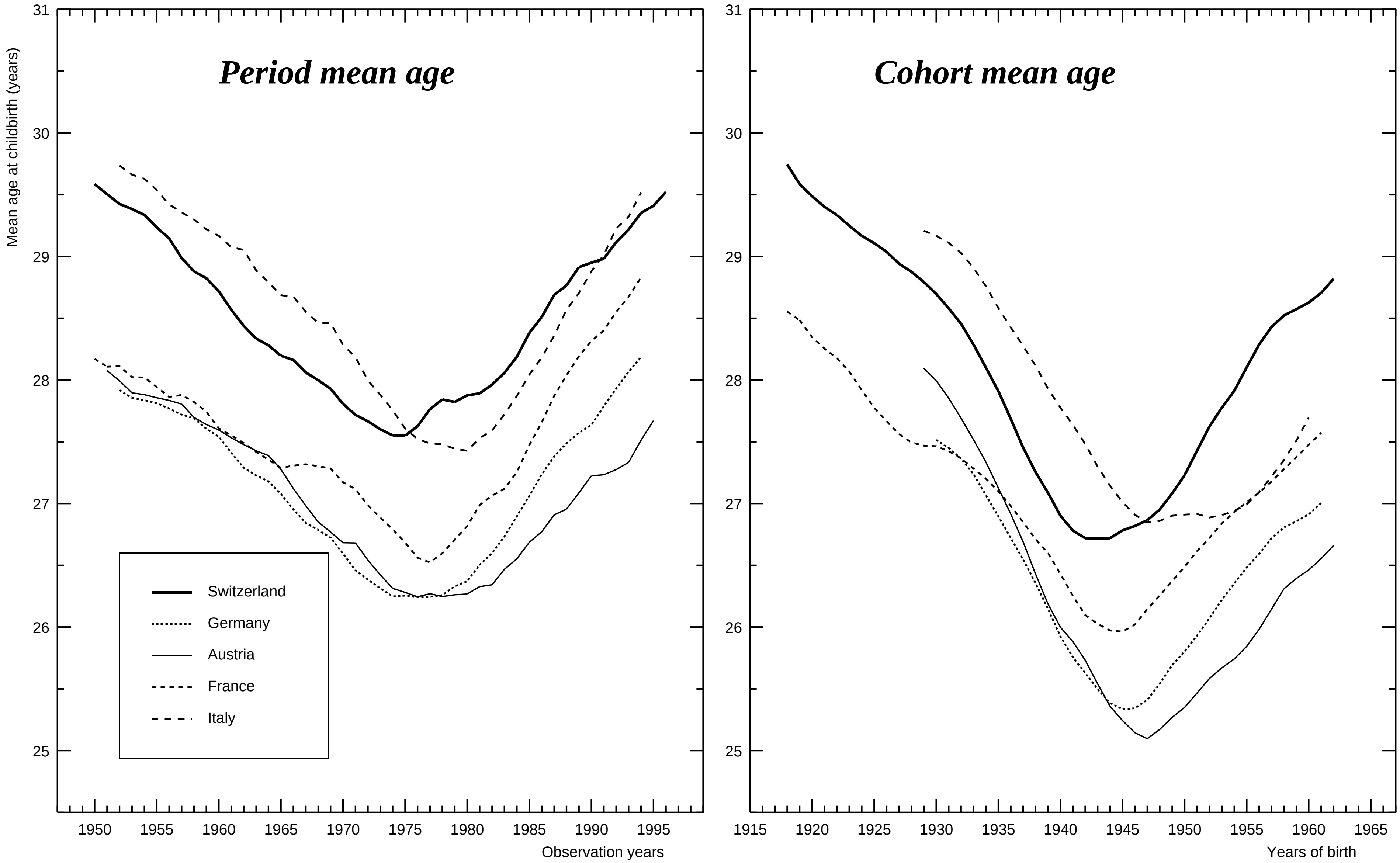


Figure 10.10 SWITZERLAND, GERMANY, AUSTRIA, FRANCE and ITALY
Proportion of EXTRA-MARITAL BIRTHS

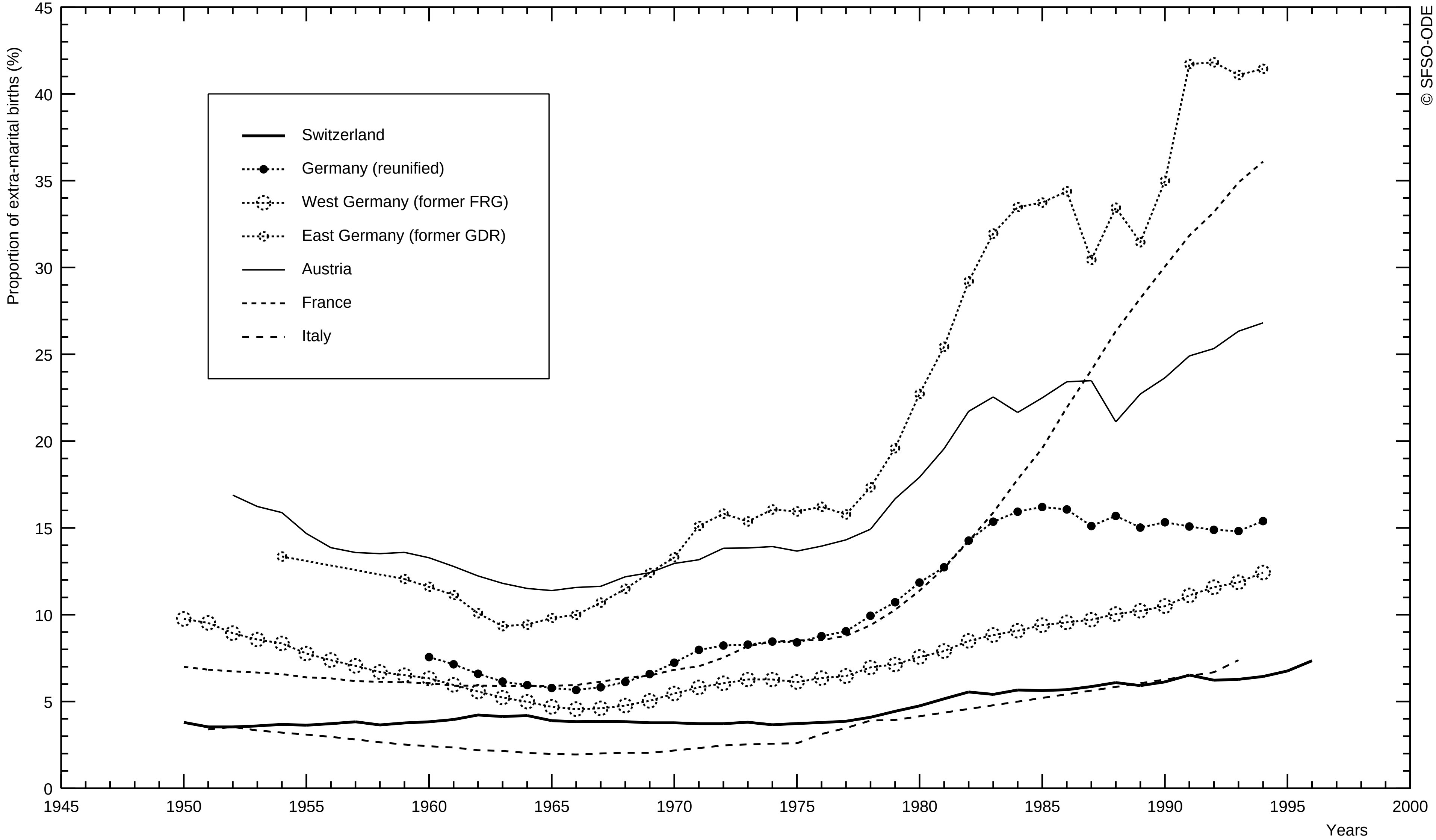


Figure 10.11.A WEST GERMANY (FRG pre-reunification), 1957-1994 and SWITZERLAND, 1946-1996
Probabilities of DYING between various ages, by SEX

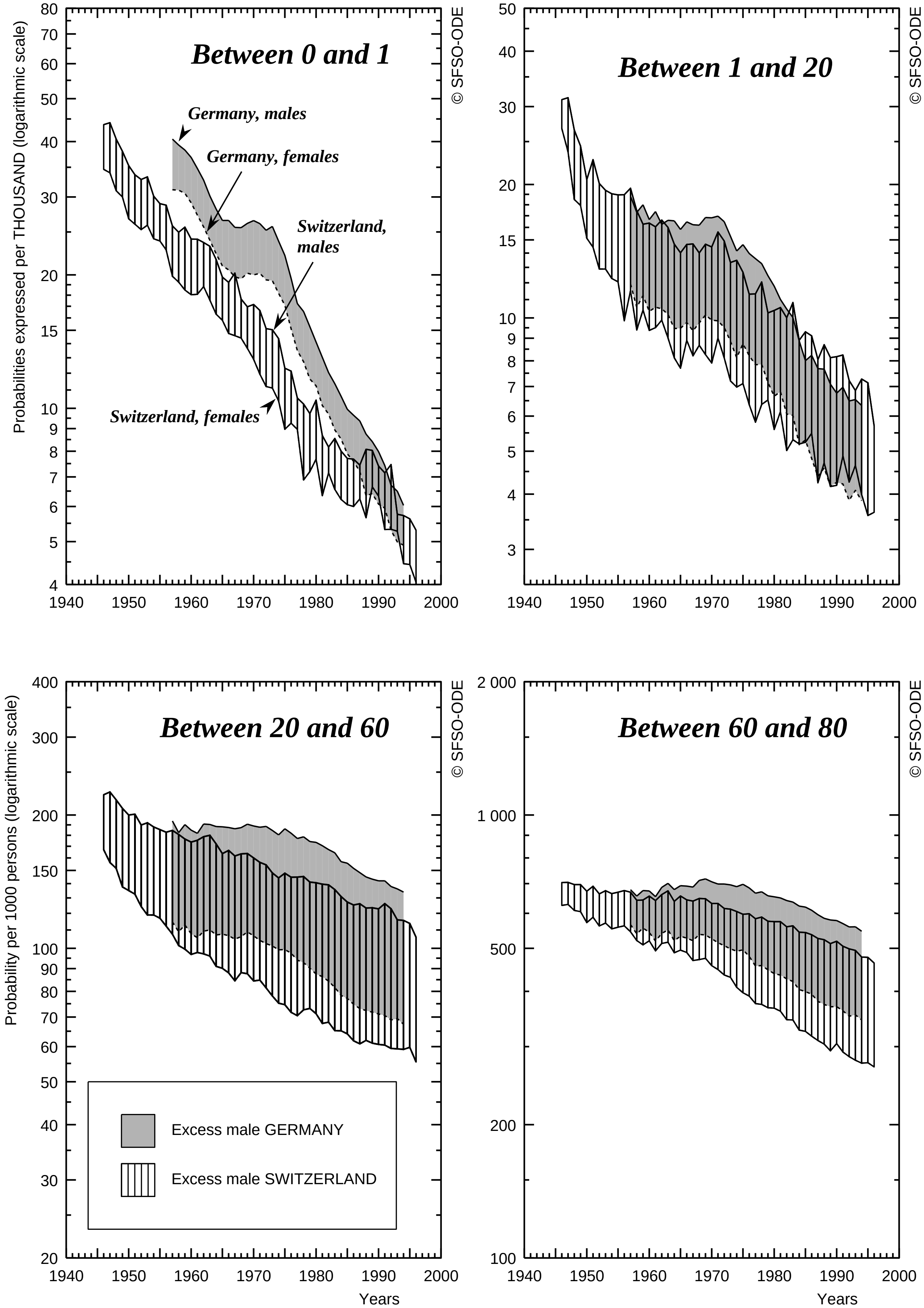


Figure 10.11.B AUSTRIA, 1946-1995 and SWITZERLAND, 1946-1996
Probabilities of DYING between various ages, by SEX

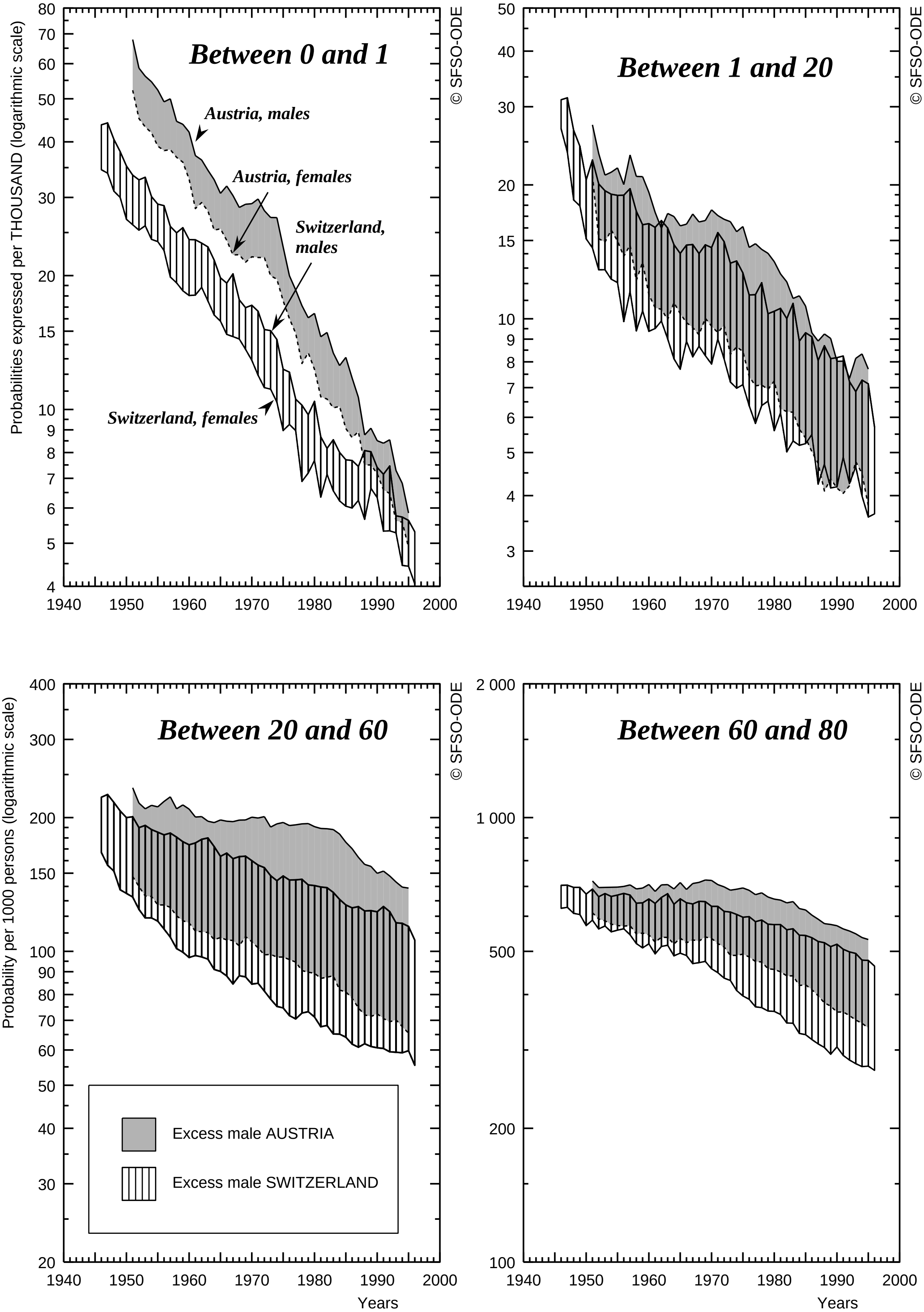


Figure 10.11.C FRANCE, 1946-1994 and SWITZERLAND, 1946-1996
Probabilities of DYING between various ages, by SEX

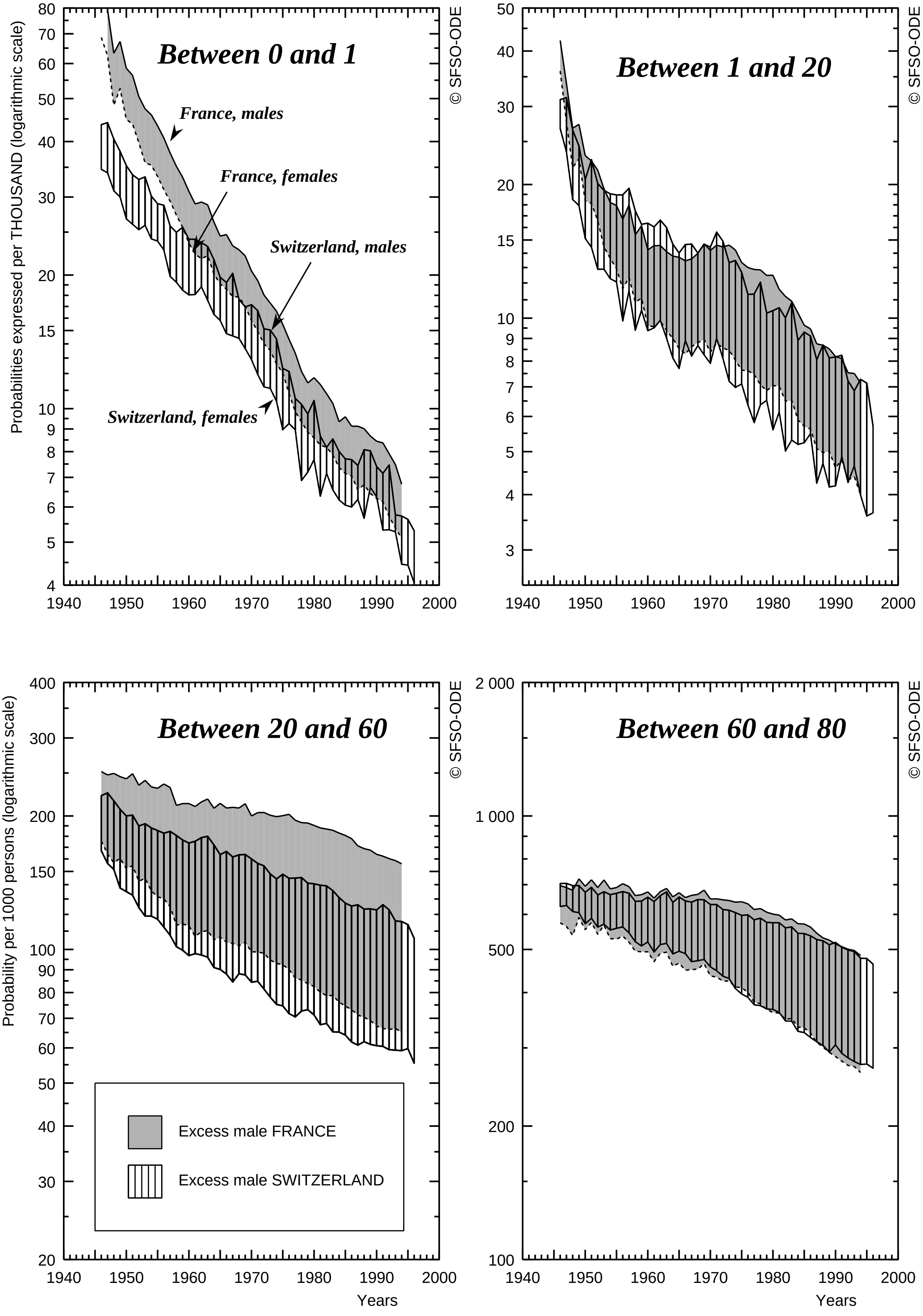
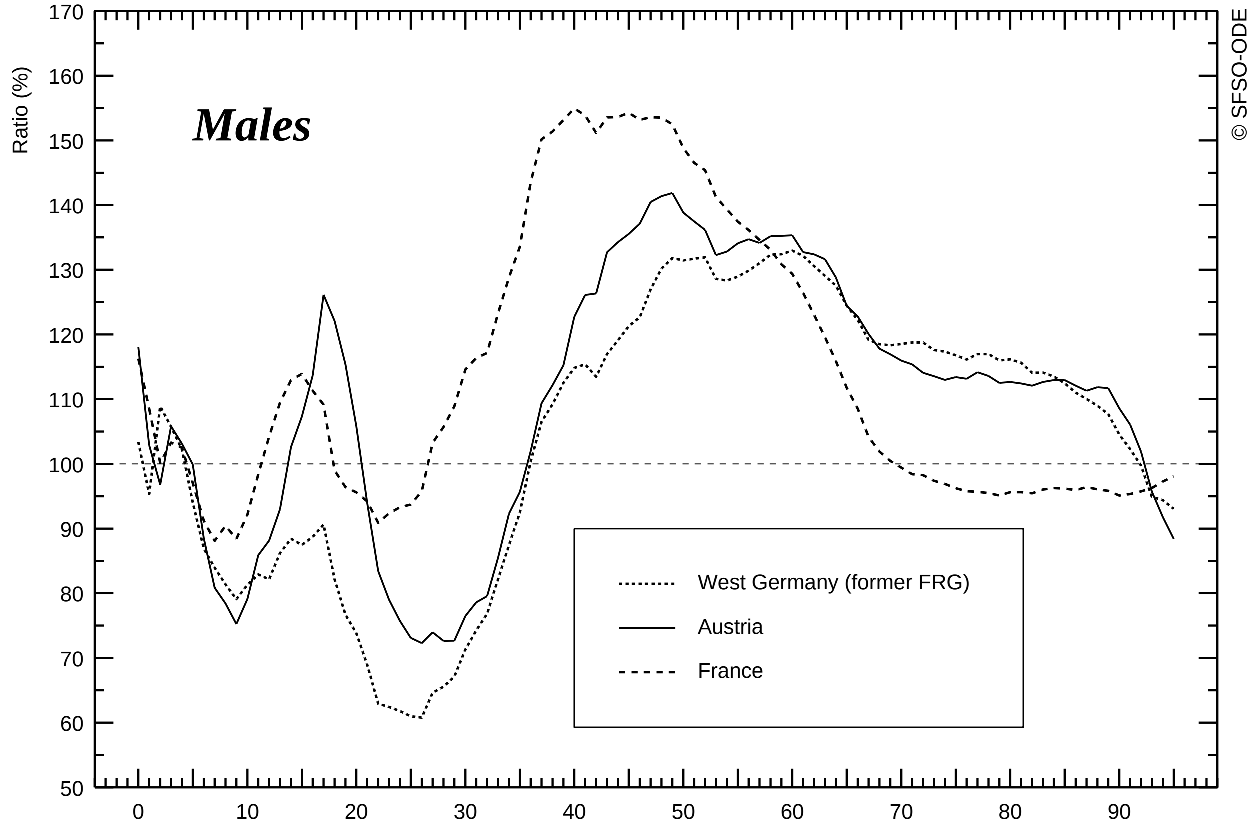


Figure 10.12 Period 1990-1994
Comparison between SWITZERLAND,
WEST GERMANY, AUSTRIA and FRANCE
Ratio of the probability of dying observed in each of the three countries
to that observed at the same age for the same sex in Switzerland



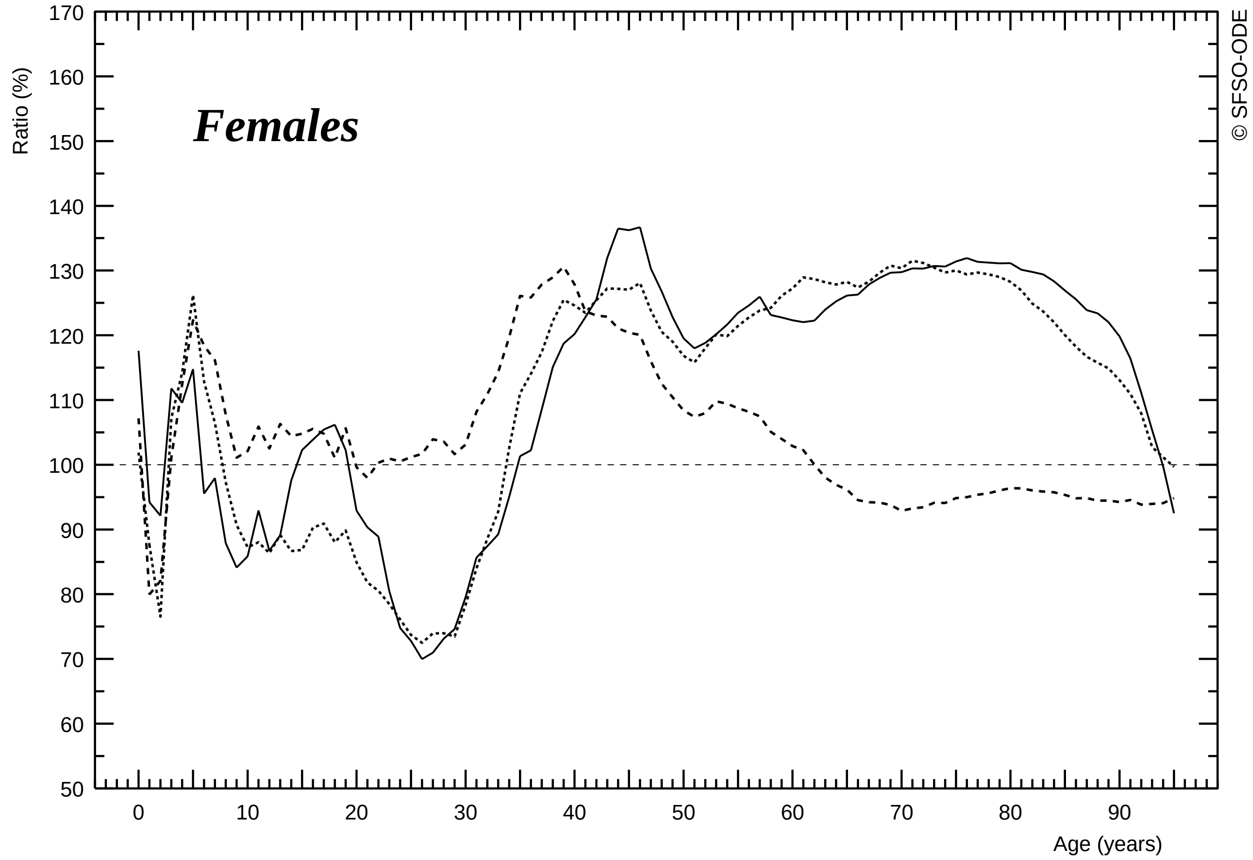
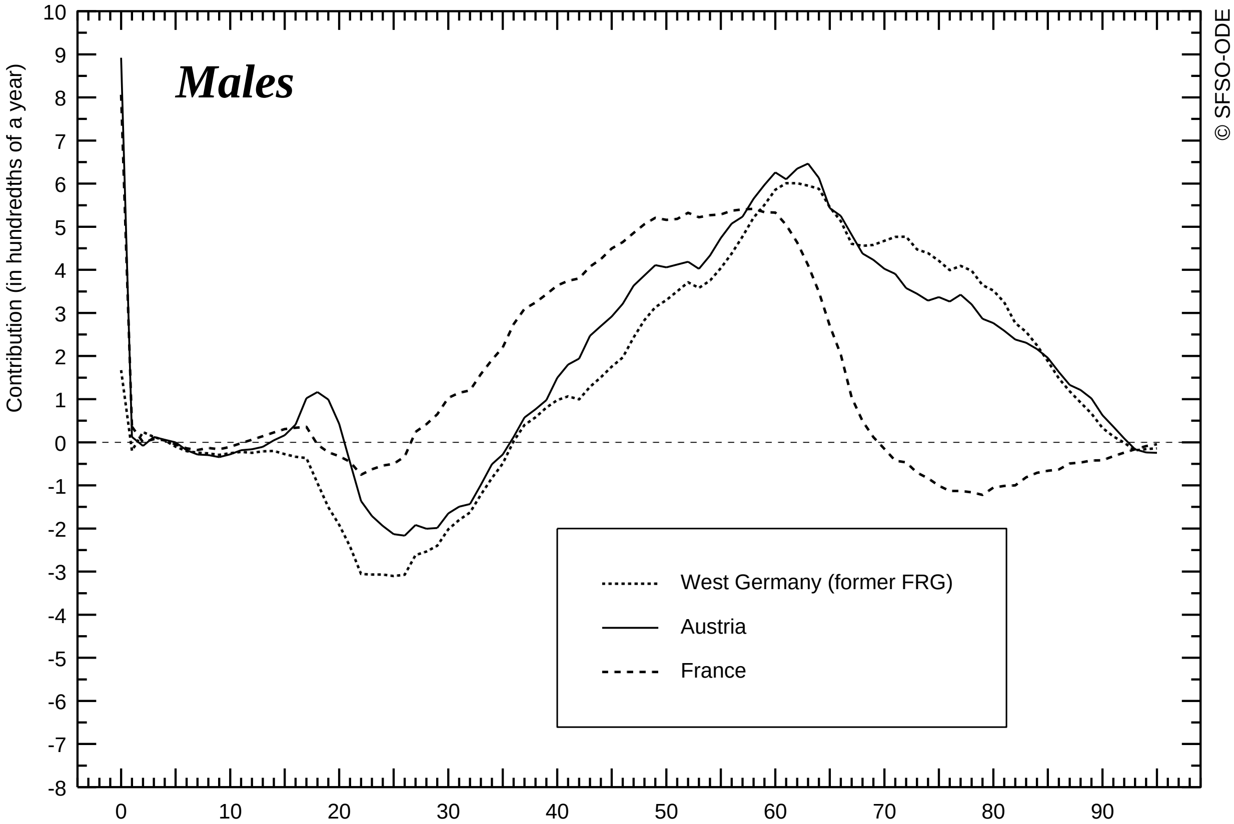
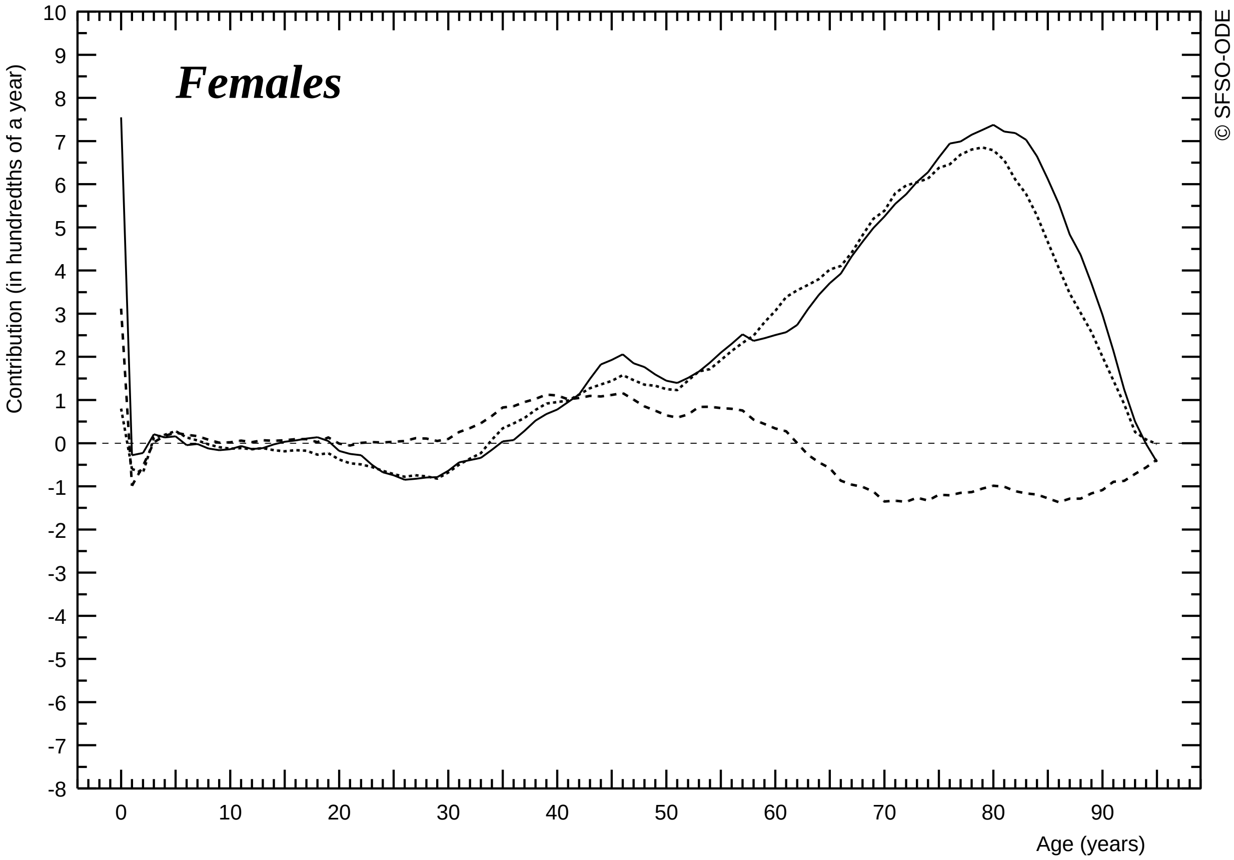


Figure 10.13 Period 1990-1994
Comparison between SWITZERLAND,
WEST GERMANY, AUSTRIA and FRANCE
Age-specific contribution to the difference in life expectancies at birth
in each of the three countries and in Switzerland





Appendices

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Index of glossary headings

***Age** at the occurrence of an event in a given year*

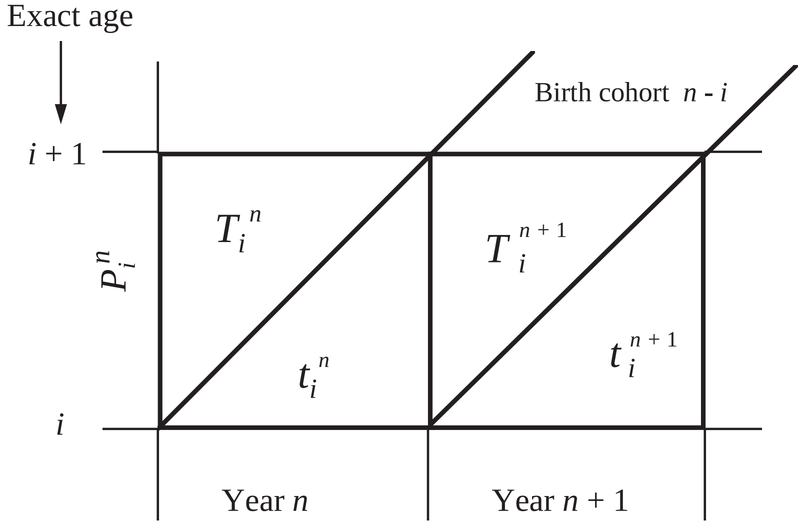
The statistics of observed vital events (births, marriages, deaths) in a given year are compiled by *age* (of the mother, the newly-married person, the deceased), generally according to an annual breakdown. There are two ways of defining age:

- the ordinary sense of age *at last birthday*, also called *age in completed years;* or
- starting from the year of birth and taking as the age the year's difference between the year of observation and the year of birth; this gives the *age reached during the calendar year of the event*, also called age *reached*.

The age in completed years is, on average, a half-year above the age *reached*.

The most accurate information on the age at the occurrence of an event is that derived from the classification of events observed each year *both* by age in completed years at the time of the event and by year of birth (classification by *triangle* in the Lexis diagram).

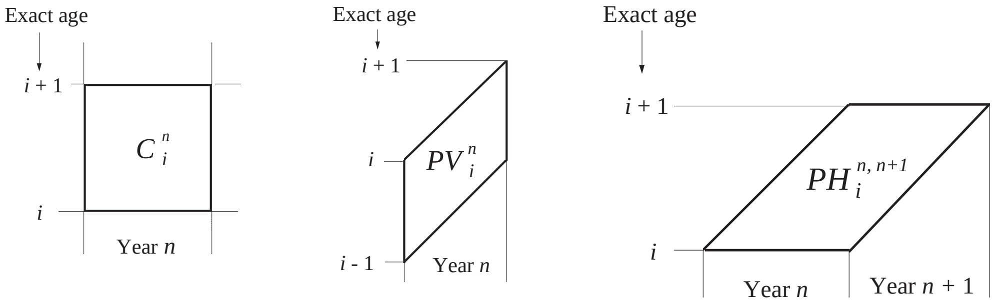
Consider the events which occurred in year n to persons whose *exact* age at the time of the event lay between i and $i + 1$ (events located in the *square* of the Lexis diagram): their number is broken down into t_i^n events located in the *lower* triangle (relating to persons born during year $n - i$) and T_i^n events located in the *upper* triangle (relating to persons born during year $n - i - 1$).



Notation of the numbers of events situated in the triangles of the Lexis diagram

The number of events occurring in year *n* which correspond to the age *i* in *completed* years is $C_i^n = t_i^n + T_i^n$ (events situated in a *square*) while the number of events occurring in year *n* which correspond to the age *reached i* is $PV_i^n = t_i^n + T_{i-1}^n$ (events situated in a *vertical*-sided *parallelogram).*

The number of events at age *i* in *completed* years within the *generation* born in *n - i*, situated in a *horizontal*-sided parallelogram straddling the two consecutive calendar years *n* and *n* + 1 is denoted as $PH_i^{n,\, n+1} = t_i^n + T_i^{n+1}$.



Notation of the numbers of events situated in the square (C), the vertical-sided parallelogram (PV) and the horizontal-sided parallelogram (PH) of the Lexis diagram

Age-specific contribution to the difference in life expectancy *of two life tables*

Consider two life tables, e.g., the male and female tables for the same year or the tables of a given sex for two different years or the tables of a given sex for two different countries. Their life expectancies at a given age, let it be age *x*, are different. Can the difference in life expectancy at age *x* be distributed between the different ages *i (i>=x)*?

Let the tables be designated 1 and 2 respectively; let the probabilities of dying at age *i* be Q_i^1 and Q_i^2; let the numbers of survivors at age *i* be S_i^1 and S_i^2; and let the life expectancies at age *x* be E_x^1 and E_x^2:

$$E_x^2 - E_x^1 = \frac{\sum_{i=x+1}^{\omega} S_i^2}{S_x^2} - \frac{\sum_{i=x+1}^{\omega} S_i^1}{S_x^1}$$

Consider a life table whose probabilities of dying at ages *x* to *y*-1 *(y>x)* are those of table 1 and the probabilities at the ages *y* and above are those of table 2. Let the life expectancy at age *x* of this composite table be $E_x^{12,y}$. An initial measurement of the contribution of ages *y* and above to the difference of $E_x^2 - E_x^1$ consists in the difference $E_x^{12,y} - E_x^1$.

Consider likewise a life table whose probabilities of dying at ages *x* to *y*-1 *(y>x)* are those of table 2 and the probabilities at the ages *y* and above are those of table 1. Let the life expectancy at age *x* of this second composite table be $E_x^{21,y}$. A second measurement, generally close to the first, of the contribution of ages *y* and above to the difference of $E_x^2 - E_x^1$ consists in the difference $E_x^2 - E_x^{21,y}$.

To establish the symmetry of the result, we take half the sum of these measurements:

Contribution of ages y and above $= \frac{E_x^{12,y} - E_x^1 + E_x^2 - E_x^{21,y}}{2}$

The contribution of age i is the difference between the contribution of ages i and above and that of ages i +1 and above.

***Age-specific fertility rate** at a given age for a given year*

Probability, for a woman of the age considered and subject to the fertility conditions of the year under review, of bearing a live born child in the following twelve months.

Two kinds of rates can be established for a given calendar year: the rate tc_i^n at age i in *completed* years for year n and the rate tpv_i^n at age i *reached* for year n.

Approximately, the fertility rate tc_i^n of year n at age i in *completed* years is the ratio of the number of births C_i^n located in the square of the Lexis diagram to half the sum of the total female populations P_i^n and P_i^{n+1}; the fertility rate tpv_i^n of year n at age i *reached* is the ratio of the number of births PV_i^n located in the vertical-sided parallelogram of the Lexis diagram to half the sum of the populations P_{i-1}^n and P_i^{n+1}.

***Age-specific fertility rate** at a given age for a given generation*

Two kinds of fertility rates can be established for generation g: the rate tpv_i^{g+i} at age i *reached* during the calendar year $g + i$ (calculated in a vertical-sided parallelogram) and the rate $tph_i^{g+i,g+i+1}$ at age i in *completed* years straddling calendar years $g + i$ and $g + i + 1$ (calculated in a horizontal-sided parallelogram).

The sum up to age a of the former gives the incomplete fertility of generation g at December 31 of year $g + a$ (when women of generation g will be a completed years old), that of the latter gives the incomplete fertility of generation g at its a + 1st birthday.

***Age-specific first marriage rate** of a given sex at a given age for a given year*

Probability, for a person of the given sex who has reached the given age and is subject to the first marriage conditions of the year under review, of marrying within the following twelve months. Conventionally, the rates tc_i^n and $tph_i^{n,n+1}$ by age in *completed* years are limited to 49 years and the rates tpv_i^n at age *reached* to 50 years (in the rate at age 50 *reached*, only the first marriages located in the *lower* triangle of the Lexis diagram are counted).

Age-specific probability of dying *of a given sex at a given age for a given year*

Probability, for a person of the given sex, who has reached the exact given age and is subject to the mortality conditions of the year, of dying within the following twelve months.

Age-specific probability of dying *of a given sex between two given ages (more than a year apart) for a given year*

Probability, for a person of the given sex who has reached the first exact given age and is subject to the mortality conditions of the year, of dying before reaching the second age.

Age-specific probability of first marriage *of a given sex at a given age straddling two given consecutive calendar years*

Probability, for a *never-married* person of the given sex who has reached the given age and is subject to the first marriage conditions of the year under review, of marrying within the following twelve months. In this study, we obtained the probability of first marriage $q_i^{n,n+1}$ at age *i* in *completed* years for the birth cohort born in $n - i$ (straddling years *n* and *n* + 1) by dividing the first marriage rate $tph_i^{n,\,n+1}$ at age *i* for the birth cohort born in $n - i$ by one minus the sum over ages *j* at most equal to $i - 1$ of the age-specific first marriage rates $tph_j^{n-i+j,\,n-i+j+1}$ for the *same* birth cohort (that born in $n - i$, reaching age *j* in year $n - i + j$):

$$q_i^{n,n+1} = \frac{tph_i^{n,\,n+1}}{1 - \sum_{j}^{i-1} tph_j^{n-i+j,\,n-i+j+1}}$$

Ageing *of the population*

A population is said to be *ageing* when the proportion of *old* persons in it, regardless of the age level chosen to define them, provided it is high enough, *increases* over time. Synonym: *demographic ageing*. The degree of ageing of a population in the vicinity of a given age can be measured by the temporal variations of the *equivalent age* (see this term in the glossary) of that given age.

Average size of *female* **generations of reproductive age** *for a given year*

The average size E_g^n of the female generation *g* in year *n* is the average size of that generation at January 1 and December 31 of the year, i.e., half the sum of the populations P_{n-g-1}^n and P_{n-g}^{n+1}, where P_i^n is the size of the population of age *i* in *completed* years at January 1, year *n*:

$$E_g^n = \frac{P_{n-g-1}^n + P_{n-g}^{n+1}}{2}$$

The average size of the female generations of reproductive age in year *n* is the *weighted* average of the average sizes E_g^n of the various female generations, the weighting coefficient of E_g^n being the age-specific fertility rate tpv_{n-g}^n observed in year *n* for generation *g*:

$$G^n = \frac{\sum_g tpv_{n-g}^n E_g^n}{\sum_g tpv_{n-g}^n} = \frac{N^n}{I^n}$$

where N^n and I^n are the absolute number of births in year *n* and the total fertility rate of year *n,* respectively.

Note that the second and third terms are equivalent only if the first approximation presented in this glossary under the heading *Age at the occurrence of an event in a given year* is adopted. By contrast, equality between the first and third term defines the quantity G^n very precisely.

Average size of generations of a given sex of marriageable age*, for a given year*

The average size E_g^n of generation *g* – as it might be *male* – in year *n* is the average size of that generation at January 1 and December 31 of the year, P_i^n being the size of the male population of age *i* in *completed* years at January 1 *n,* half the sum of the populations P_{n-g-1}^n and P_{n-g}^{n+1},:

$$E_g^n = \frac{P_{n-g-1}^n + P_{n-g}^{n+1}}{2}$$

The average size of the male generations of marriageable age during year *n* is the *weighted* average of the average sizes E_g^n of the various male generations born in *n* - 50 or after, the weighting coefficient of E_g^n being the male first marriage rate tpv_{n-g}^n observed in year *n* for generation *g* (at age *n - g reached*):

$$G^n = \frac{\sum_g tpv_{n-g}^n E_g^n}{\sum_g tpv_{n-g}^n} = \frac{M^n}{I^n}$$

where M^n and I^n are the absolute number of marriages of male never-marrieds in year *n* of less than 50 completed years of age and the total male first marriage rate for year *n*, respectively.

Note that the second and third terms are equivalent only if the first approximation presented in this glossary under the heading *Age at the occurrence of an event in a given year* is adopted. By contrast, equality between the first and third term defines the quantity G^n very precisely.

Completed fertility *of a generation*

Average number of children per woman born in their fertile life to women born in a given year.

Specifically, the *completed fertility* of generation *g* is the sum of the age-specific *fertility rates* by age *reached* tpv_i^{g+i} or age in *completed years* $tph_i^{g+i,\,g+i+1}$ (the two sums always being very close to one another), extended to all reproductive ages in that generation.

It is also very broadly the average number of children observed in a census carried out after year $g + 50$ in which women of generation *g* would be asked how many children they have borne in their reproductive life. For these two definitions to coincide, there must be either *zero* mortality and migration, or mortality and migration must be *independent* of the number of children already born and the children's countries of birth and the mother's country of residence at the time of birth must be *the same*. These conditions are generally not far from being met if one takes the precaution of excluding from the statistics births to mothers not residing in the country and including births abroad to mothers residing in the country.

Crude birth rate *in a given year*

Ratio of the absolute number of births in the year to half the sum of the size of population at January 1 and December 31.

Crude death rate *in a given year*

Ratio of the absolute number of deaths in the year to half the sum of the size of population at January 1 and December 31.

Crude rate of natural increase *in a given year*

Ratio of the difference between the annual number of births and the annual number of deaths to half the sum of the total population size at January 1 and December 31. The crude rate of natural increase is the difference between the *crude birth rate* and the *crude death rate*.

Daily coefficients *of a given phenomenon for a given year*

The *seven* daily coefficients of a given phenomenon (births, marriages, deaths, etc.) for a given year, attached to each day of the week with a mean equal to 1, measure the differential quantum of occurrence of the phenomenon by *type* of day (Monday, Tuesday, ..., Sunday). Approximately, the daily coefficient of, e.g., *Monday* for a given calendar year is the ratio between the average number of events occurring on a *Monday* and the average number of events occurring on *any* day of the year under review.

Specifically, the frame of the multiplicative underlying model, on the basis of which the daily coefficients are estimated, is as follows. The number *N(t)* of events occurring on day No. *t*, *t* = 1, 2, ..., 365 (or 366), of type *j*, (*j* = 1 for Monday, *j* = 2 for Tuesday, ..., *j* = 7 for Sunday), is:

$$N(t) = c_j \; f(t) + \varepsilon(t)$$

where *f(t)* is a *smooth* time function, where the daily coefficients c_j of mean one are only *j-dependent* and where $\varepsilon(t)$ is a null mean accidental variable over a certain number of days, consecutive or otherwise.

The daily coefficients c_j and the values *f(t)*, free from in-week fluctuation, are estimated by an iterative process in which the *initial* estimate of the *f(t)* is the moving average[1] over two consecutive weeks of the *N(t)*, which provides the daily *ratios N(t) / f(t)* by type of day; these ratios are then averaged out over the year after eliminating the extreme ratios (the ten highest and ten lowest of the 52 or 53 ratios corresponding to the same type of day, and taking the arithmetic mean of the remaining ratios), which gives an estimate of the seven coefficients c_j, after adjustment to make the mean exactly equal to 1.

This estimate of the c_j leads to a new estimate of the *f(t)* by dividing the observed values *N(t)* by the estimated corresponding daily coefficient; that new estimate of the *f(t)* being smoothed in turn by the moving average.

The process is repeated using this moving average as the *initial* moving average of the *N(t)*. The iteration process is discontinued when the estimates of *f(t)* and c_j are stabilised. In practice, 5 to 6 iterations will suffice.

The series of *daily values adjusted for in-week fluctuations* is the series of ratios $N(t)/c_j$ established on the basis of the daily coefficients c_j finally selected. The *monthly* absolute number of events in a given month, adjusted for the number of days in the month and their distribution by type of day – the «adjusted daily composition of the month» for short – is equal to the product of the number of days in a standard month multiplied by the weighted average of the adjusted daily values $N(t)/c_j$, the weighting coefficients being the daily coefficients c_j:

$$N^* = \textit{adjusted monthly number} = \frac{365.24}{12} \; \frac{\textit{Gross observed monthly number}}{\textit{cumulative daily coefficients of the days of the month}}$$

A standard year contains 365.24 days (one year in 4 is a *leap* year, except 3 in 400)

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[1] The moving average we used, which we call the *Hoem moving average*, is a smoothing process which offers the advantage of giving an average value for *all* dates in the period, unlike conventional moving averages which provides no value at either end of the period (e.g., 6 at either end in the case of a 12-term moving average). The software to calculate this moving average was kindly made available to us by its creator, Professor Jan Hoem, University of Stockholm, to whom we are most grateful.

Duration-specific divorce rate *at a given duration in a given year*

Ratio of the number of divorces granted during the year corresponding to marriages of the duration considered to the *initial* number of marriages potentially having that duration (marriages still subsisting or already dissolved by widowhood or divorce). The numerator and denominator of this ratio relate to events *registered in the country concerned* (divorces granted by a national court, marriages celebrated in the country).

Equivalent age *at a date t of a given age at a given date within a given population*

Being a population developing over time, an age and a date, e.g., the total resident population of Switzerland, the age of 60 and the date of January 1, 1995. Let p be the *proportion* of people of at least 60 years of age within the population of Switzerland on January 1, 1995. The age which, at any date t, before or after January 1, 1995, is, for the population of Switzerland, *equivalent* to the age of 60 at January 1, 1995 is that above which the *same* proportion p is situated within the population of Switzerland considered at date t. In other words, the *quantile* of order $1 - p$ of the total resident population in Switzerland, which is variable year over year and is equal to the age of 60 on January 1, 1995, is the *equivalent* age to 60 at any date t.

The equivalent age within a *subpopulation* can be defined and its temporal variation studied. Hence, as regards pensions, the age which, at January 1 of each year within the subpopulation aged *20 and over* residing in Switzerland, is equivalent to 60 years of age at January 1, 1995 is the age which divides that subpopulation in the same ratio as the age of 60 does for the subpopulation at January 1, 1995.

Event frequency *at a given age for a given year*

Ratio for the given age of the number of events to the sum of the durations of exposure to the risk.

Take the example of the mother's age-specific fertility rate. Three types of rates can be calculated:

- the rate tc_i^n at age i in *completed* years for year n taking the number of births C_i^n located in the *square* of the Lexis diagram;
- the rate tpv_i^n at age i *reached* for year n taking the number of births PV_i^n located in the *vertical-sided parallelogram* of the Lexis diagram;
- the rate $tph_i^{n,n+1}$ at age i in *completed* years straddling years n and $n + 1$ (this rate refers to a couple of two consecutive years of observation but only one generation: that born in $n - i$) taking the number of births PH_i^n located in the *horizontal-sided parallelogram* of the Lexis diagram.

If P_i^n is the population of resident women of age *i* in *completed* years at January 1 of year *n*, the denominators for each of these three numbers of live births taken as numerators are approximately (1) half the sum of the populations P_i^n and P_i^{n+1}, (2) half the sum of the populations P_{i-1}^n and P_i^{n+1}, and (3) the population P_i^{n+1}, respectively.

The measures of each of these three rates by the three ratios just given are only a *first approximation* because the denominators associated with the numerators are only an approximation of the corresponding number of *person-years exposure to the risk*. Consider, for example, the rates tc_i^n by age in completed years. If, during the two-year period between January 1 $n - i - 1$ to December 31 $n - i$, the birth rate *varies significantly* (seasonal variations being insignificant), i.e., if the density of the *life lines* across the square of the Lexis diagram is highly variable, half the sum of the female populations P_i^n and P_i^{n+1} may prove a poor estimate of the proper denominator: account must be taken of the respective populations of these two consecutive generations (in terms of permanent residents) and the distributions of the dates of i^{th} birthday within them.

Taking an extreme example, suppose that *all* births in years $n - i - 1$ and $n - i$ are concentrated in January $n - i - 1$ and uniformly distributed throughout that month. Here, the proper denominator is $P_i^n / 24$ (P_i^n persons exposed to the risk for half a month each on average, or 1/24th of a year) and not half the sum of P_i^n and P_i^{n+1}, which in this case is equal to $P_i^n / 2$. Furthermore, the rate calculated with the proper denominator would relate, on average, to age $i + 1 - 1/18$ and not to age $i + ½$ as do the rates tc_i^n by age in completed years when the life lines are uniformly distributed within the couple of two consecutive annual generations. Finally, migrations during the period of observation must be taken into account.

Using an appropriate methodology, each of the three types of rates can be correctly estimated *regardless* of the quadrilateral figure in the Lexis diagram (square, vertical-sided parallelogram, triangle) corresponding to the absolute numbers of events available. All the fertility and first marriage rates, and all the probabilities of dying, reproduced in this work were calculated using complex formulae taking account of the specific characteristics of the generations concerned (evaluated at year of birth) and migrations. Accordingly, they may differ slightly from the rates and probabilities calculated using the first approximations given above.

Fertility table *for a given year*

Series of age-specific fertility rates by mother's age during the year.

First marriage table *for a given sex and a given year*

Series of age-specific first marriage rates for that sex in that year.

Generation

Generation *g*, called also Cohort *g*, is composed of all the person born during calendar year *g*.

Growth rate *of a population in a given year*

Ratio of the difference between the total population at December 31 and January 1 to half the sum of both. The growth rate is the sum of the *crude rate of natural increase* and *relative net migration*.

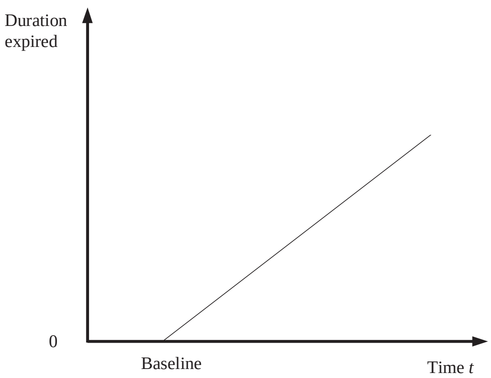
Infant mortality rate

The infant mortality *rate* is actually a *probability*: the probability of dying (cf. this term) between 0 and 1 year, i.e., between birth and the first birthday. In other words, it is the probability that a new-born baby will die before reaching its first birthday.

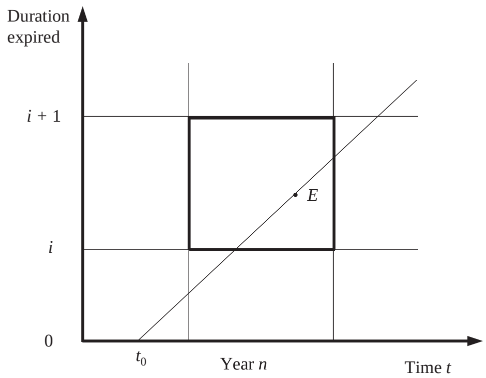
Lexis diagram

A diagrammatic representation by time periods of the duration (time elapsed) since a baseline moment. The duration corresponding to moment *t*, baseline moment t_0 is $t\text{-}t_0$. Consequently, the curve representing the duration by time period is a half right-angled line called the *life line* of the unit concerned. In this way, the development of a *person's age* (duration since birth) or the *duration of a marriage* (duration since celebration) can be represented over a time period.

An event occurring to the unit concerned is located by its date of occurrence *t*. Events occurring in a given calendar year *n* are located in a *vertical* band. Those occurring at the completed duration *i*, i.e., at a duration ranging between *i* and *i* + 1, are located in a *horizontal* band. Life lines for the same *cohort* (same *generation* if age-specific, same *marriage cohort* for marriage durations), i.e., units whose baseline moment is the same calendar year, form a diagonal angled at 45 degrees.



Half-right-angle representing duration



Event *E* occurring in year *n* at completed duration *i*

***Life expectancy** at a given age for a given sex and a given year*

Average number of years of life remaining to a person of the sex considered who has just reached the exact age considered, subject to the conditions of mortality in that year.

If the probability of dying at age *i* observed in year *n* is designated as Q_i^n, the proportion S_i^n of survivors on their i^{th} birthday is:

$$S_i^n = 1 - \prod_{j=0}^{i-1} \left(1 - Q_i^n\right)$$

and life expectancy at age *i* is calculated by the formula (ϖ being the maximum length of human life):

$$E_i^n = \frac{\sum_{j=i+1}^{\varpi} S_j^n}{S_i^n} + \frac{1}{2}$$

***Life table** for a given sex and a given year*

Series of age-specific probabilities of dying for that sex in that year.

Marriage cohort

A marriage cohort is composed of all the marriages celebrated during the same calendar year. The expression *marriage cohort,* applicable to marriages celebrated during the same year, is equivalent to the expression *birth cohort or generation,* applicable to persons born during the same calendar year. Marriage and birth cohorts (generations) are identified by the date of the corresponding year.

Monthly interpolation of an annual series

To obtain the monthly total first marriage and fertility rates, the quantities involved (average size of the generations subject to the phenomenon, ratio of the number of first marriages of a given sex before age 50 in completed years to all marriages) known only each *year* must be interpolated on a *monthly* basis.

Let *G* be the quantity considered, and *G(n)* its value for year *n.* This value is assigned to the middle of year *n*, i.e., on July 1 *n.* Take the six values of *G* assigned on July 1 of the successive years *n*, *n*+1, *n*+2, *n*+3, *n*+4 and *n*+5. A 5-degree polynomial passes through the six points whose abscissas are on July 1 of the successive years and whose ordinates are the annual values of *G*. On this polynomial, whose parameters are determined, for example, by the Fisher orthogonal polynomials method, we compute the ordinates that correspond to abscissas equal to the *middles* of the months of the central year stretching from July *n*+2 to June *n*+3: these ordinates are the monthly interpolated series of the quantity *G*. For the years at either end of the annual series, the ordinates read on the polynomial can be *provisionally* used but subsequently revised one or more times as the required data becomes available.

Monthly life expectancy at birth *of a given sex for a given month*

The *annual male* mortality rate, for example, can be denoted as the *life expectancy at birth* attached to the male life table for the year under review.

Let *D(T)* be the monthly number of male deaths in month *T* and *D*(T)* the corresponding adjusted number for the duration (in number of days) of the month and seasonal variations. The *monthly* male life expectancy at birth for month *T* can be constructed by determining the life expectancy at birth of the *hypothetical* life table constructed from an annual number of male deaths equal, at each age, to the product of the number actually observed at that age in the year multiplied by the ratio between *D*(T)* and one twelfth of the number of male deaths at all ages observed during the year. This monthly index is expressed in terms of life expectancy at birth and adjusted both for the duration (in number of days) of the month and monthly seasonal variations.

Monthly seasonal coefficients *of a given phenomenon for a given multiannual period*

The *twelve* monthly seasonal coefficients of a given phenomenon for a given *multiannual period*, attached to each month of the year with a mean equal to 1, measure the differential quantum of occurrence of the phenomenon by *type* of month (January, February, ..., December). Approximately, the seasonal coefficient of, e.g., *January*, is the ratio between the average daily number of events occurring on the days of January in the multiannual period under review and the average daily number of events occurring on *any* day in this period.

Specifically, the frame of the multiplicative underlying model, on the basis of which the monthly seasonal coefficients are estimated, is as follows. The number *N*(T)* of events, *first* adjusted for the daily composition of the month[2], referring to month No. T, $T = 1, 2, ..., 12\,a$, of type m, ($m = 1$ for January, $m = 2$ for February, ..., $m = 12$ for December), is:

$$N^*(T) = C_m\ \varphi(T) + \varepsilon(T)$$

where a is the number (usually a whole, usually odd, number, say for example 5, 7 or 9) of years in the multiannual period under review, $\varphi(T)$ is a *smooth* time function, the seasonal coefficients C_m of mean one are only *m-dependent* and where $\varepsilon(T)$ is a null mean accidental variable over a certain number of months, consecutive or otherwise.

The seasonal coefficients C_m and values $\varphi(T)$, free from seasonal fluctuation, are estimated by an iterative process in which the *initial* estimate of the $\varphi(T)$ is the moving average[3] over twelve consecutive months of the *N*(T)*, which provides the seasonal *ratios* $N^*(T) / \varphi(T)$ for each type of month; the ratios of the same type of month are then averaged out over the period after eliminating

[2] If no daily data are available with which to estimate the daily coefficients, each will be assigned the value 1. The adjustment of the monthly numbers will then be limited to adjustment of the *number* of days in the month.

[3] Using the *Hoem moving average*, (cf. footnote[1]).

the extreme ratios (the two highest and two lowest of the *a* ratios corresponding to the same type of month and taking the arithmetic mean of the remaining ratios), which gives an estimate of the twelve coefficients C_m, after adjustment to make their mean exactly equal to 1. This estimate of the seasonal coefficients C_m leads to a new estimate of the $\varphi(T)$ by dividing the values *N*(T)* by the estimated corresponding seasonal coefficient, that new estimate of the $\varphi(T)$ being smoothed in turn by the moving average.

The process is repeated using this moving average as the *initial* moving average of the *N*(T)*. The iteration process is discontinued when the estimates of $\varphi(T)$ and C_m are stabilised. In practice, some 15 to 20 iterations are required.

The series of monthly *adjusted* values *for seasonal variation* for the period considered is the series of ratios $N^*(T) / C_m$ calculated from the seasonal coefficients C_m finally estimated.

If analysing, for example, a twenty year period, then in practice successive *rolling* sub-periods of 5, 7 or 9 years will be used: each sub-period providing twelve monthly seasonal coefficients which are assigned to the *central* year of the rolling sub-period. The following rolling sub-period, with a one year lag on the preceding one, provides the twelve coefficients of the following central year, and so on. At either end of the twenty-year period, i.e., for the years which are not central years in any rolling sub-period, the coefficients for the nearest central year may be used, or the seasonal coefficients of the same type of month may be extrapolated by linear fit. For the most recent years, these seasonal coefficients will be revised twice (where 5 year rolling sub-periods have been used), three times (7 year sub-periods) or four times (9 year sub-periods) when the requisite later information becomes available.

Moving average

Let *G* be a monthly quantity, and *G(t)* its value for month *t* counted from a baseline month. Let t_1 and t_2 be the bounds of the range of *t*. The moving average *M(t)* of *G(t)*, centered and calculated on an *odd* number $2p+1$ of terms is defined for *t* ranging between t_1+p and t_2-p:

$$M(t) = \frac{\sum_{u=t-p}^{t+p} G(u)}{2p+1}, \quad t_1 + p <= t <= t_2 - p$$

The moving average *M(t)* of *G(t)*, centered and calculated on an *even* number $2p$ of terms is defined for *t* ranging between t_1+p and t_2-p:

$$M(t) = \frac{G(t-p) + 2\sum_{u=t-p+1}^{t+p-1} G(u) + G(t+p)}{4p}, \quad t_1 + p <= t <= t_2 - p$$

The Hoem moving average coincides with the moving average in the sense shown but is defined for any *t* ranging between t_1 and t_2.

***Net migration** for a given year*

Difference between the number of *immigrants* entering the country during the year under review and the number of *emigrants* leaving it during the year. Synonym: *balance of migration.*

***Proportion of ever-marrieds** at **50 years of age** for a given sex and given generation*

Proportion of persons who have married at least once before their fiftieth birthday among the members of the generation or birth cohort considered.

The *proportion of ever-marrieds at 50 years of age*, or more precisely *on their fiftieth birthday*, within the generation g for the sex considered is the sum of age-specific *first marriage rates* by age *reached* tpv_i^{g-i} or age in completed years $tph_i^{g-i,g-i+1}$ (the two sums being always very close to one another), extended to all ages below 50 (or equal to 50 for rates by age *reached*) for that generation.

It may be also the proportion of ever-marrieds observed in a census carried out around year $g + 50$ recording marital status on the 50th birthday, if mortality and migration are *zero* or *independent* of marital status and if the countries of residence and celebration of the marriage are the *same*. Most of the difference between these two measures of the proportion of ever-marrieds at 50 years of age is because migration and marital status are not independent (the age-sex distribution between never-marrieds and ever-marrieds in the immigrant and emigrant populations are not in the same proportions as non-migrants each year) and especially because the countries of residence and celebration of the marriage are not the same (the number of people residing in Switzerland who marry abroad is not equal at each age and in each year to the number of people residing abroad who marry in Switzerland).

Rate

A term used in many ways in demography, but most generally applied to the *ratio* between two quantities.

***Relative net migration** for a given year*

Ratio of *net migration* for the year under review to the half-sum of the total population at January 1 and December 31.

Replacement of generations

A *female* generation is said to have ensured its own replacement when the number of *daughters* born to women of that generation in their fertile ages is equal to the size of that generation as measured at the time when it was born. The rate of replacement is the ratio of the number of daughters born to the baseline population of the mothers' generation.

In general terms, taking an age-specific fertility table (fertility rate f_i at age i) and age-specific female life table (proportion of survivors $S(x)$ at age x), the rate of replacement for these two tables is denoted by the formula:

$$r = \frac{100}{205} \sum_{i=15}^{49} S\left(i + \frac{1}{2}\right) f_i$$

the sex ratio at birth being 105 males to 100 females. If the number of survivors varies more or less linearly (especially if there is little variation) during the fertile ages, this gives approximately:

$$r \approx \frac{100}{205} S(m) \sum_{i=15}^{49} f_i$$

where m is the mean age at childbirth for the fertility table. In current life tables, the proportion of survivors at the mean age at childbirth is close to 99%. The rate of replacement is thus appreciably:

$$r \approx \frac{1}{2{,}07} \sum_{i=15}^{49} f_i$$

In the life tables of the 1870s, the proportion of survivors was about 65%, giving approximately:

$$r \approx \frac{1}{3{,}2} \sum_{i=15}^{49} f_i$$

In other words, replacement level has changed from 3.2[4] to 2.07 (rounded-off to 2.1) children per woman between the 1870s and now. It cannot drop below 2.05 children per woman, at least if the sex ratio remains invariably equal to 105 males to 100 females.

In transversal terms, i.e., for a given calendar year, replacement is defined by the ratio of the average size of female generations of reproductive age in that year and the population of daughters born during the year when they reach their own mother's age at their birth. Here, the relevant life table is not that of the mothers but that of the daughters and, with this change, the foregoing formulas remain applicable. In particular, the total fertility rate which ensures replacement in the sense indicated is now 2.07 children per woman. The total fertility rate may also be described as the rate of replacement multiplied by 2.07.

Sex ratio

Ratio, within a population or a subpopulation, of the number of *males* to the number of *females*.

[4] The exact value is closer to 3.3 than 3.2 (which is only approximate).

Total annual divorce rate *in a given year*

Ratio of marriages ending in divorce to all marriages subject at each duration to the conditions of divorce in the year under review. The conditions of divorce in the year are evaluated by reference to the duration-specific divorce *rates* between the celebration of the marriage and the decree of divorce. These duration-specific rates are the ratios of the number of divorces observed during the year among marriages of the same marriage-cohort to the initial size of that marriage-cohort.

Total annual fertility rate *in a given year*

Average number of children born to all women subject throughout their reproductive ages to the conditions of fertility observed at the same age in the year under review.

Specifically, it is the sum of age-specific *fertility rates* tc_i^n or tpv_i^n (the two sums always being very close to one another), extended to all reproductive ages in the year under review. The total fertility rate is shown to be equal to the ratio of the absolute annual number of births to the (weighted) average size of the female generations of reproductive age in that year.

Total annual first marriage rate *for a given sex and two given consecutive years, based on age-specific probabilities of marrying*

Proportion, among a population subject at each age to the first marriage conditions of the year under review, of the persons who marry *at least once* before their fiftieth birthday. The first marriage conditions of the year are determined on the basis of age-specific *probabilities* of marrying, the quantum of first marriage at a given age taking account of first marriage among the corresponding generation in the years previous to the one under review (marriages of never-marrieds of each age during the year under review are referred to the number of *never-marrieds* of the corresponding generation).

From the age-specific probabilities of first marriage, $q_i^{n,n+1}$, established at the different ages in completed years i straddling the same pair of consecutive years n and $n+1$, we can deduce the proportion of ever-marrieds at 50 years of age using the formula:

$$1 - \prod_i^{49}\left(1 - q_i^{n,n+1}\right)$$

and it is this quantity which defines the total first marriage rate based on the probabilities of marrying. This rate refers to the two consecutive calendar years $(n, n+1)$.

Note that this total rate can also be expressed as:

$$1 - \prod_i^{49}\left(1 - \frac{tph_i^{n,n+1}}{1 - \sum_{j=0}^{i-1} tph_j^{n-i+j,\,n-i+j+1}}\right)$$

whereas, by expressing the first marriage rate at age reached i in year n as tpv_i^n, the total rate based on age-specific rates is denoted as:

$$I^n = \sum_i^{49} tpv_i^n = 1 - \prod_i^{49} \left(1 - \frac{tpv_i^n}{1 - \sum_{j=0}^{i-1} tpv_j^n} \right)$$

Generally, the total rate based on probabilities of marrying, which *never* exceeds one, is not as variable as the total rate based on age-specific rates, which may exceed one.

Total annual first marriage rate *for a given sex and a given year, based on age-specific rates*

Proportion, among a population subject at each age to the first marriage conditions of the year under review, of those who marry *at least once* before their fiftieth birthday. The first marriage conditions of the year are determined on the basis of age-specific *rates*, the quantum of first marriage at a given age disregarding first marriage among the corresponding generation in previous years to the one under review (marriages of never-marrieds of each age celebrated during the year under review are referred to the *total* population of the corresponding generation and not just to the *never-marrieds* of that generation).

Specifically, the total first marriage rate based on age-specific rates is the sum of the first marriage rates tc_i^n or tpv_i^n (the two sums always being very close to one another) extended to all ages below 50 for the sex considered, observed during the year under review. It is shown that the total *male* first marriage rate, for example, is equal to the ratio of the absolute number of marriages of bachelors (never-married males) under 50 complete years of age celebrated during the year to the average size of the male generations of marriageable age in that year.

Total monthly fertility rate *for a given month*

The total *annual* fertility rate is obtained by dividing the absolute number of births in the year by the average size of female generations of reproductive age in that year. The total fertility rate for a given *month* is similarly obtained as the ratio of the absolute number $N(T)$ of births for the month concerned to a twelfth of the value, interpolated on a monthly basis, of the annual series of the average size of female generations of reproductive age.

However, this ratio is unadjusted for monthly seasonal fluctuations or the daily composition of the month. Accordingly, the monthly absolute number of births is first adjusted and the adjusted monthly rate is obtained by dividing the adjusted number $N^*(T)/C_m$ by one twelfth of the monthly interpolation of the average size of female generations of reproductive age.

Total monthly first marriage rate *of a given sex for a given month*

The total *annual male* first marriage rate, for example, is obtained by dividing the absolute number of *first marriages of males* (before age 50 in completed years) in the year under review by the average size of the male generations of marriageable age that year. The number of male first marriages in the year is therefore the product of the *total* number of marriages (including remarriages) multiplied by the *proportion* of male first marriages in these total marriages. The male first marriage rate for a given *month* is similarly obtained as the ratio of the absolute number $N(T)$ of total marriages for the month multiplied by the value of the preceding proportion, interpolated on a monthly basis, to a twelfth of the value, similarly interpolated on a monthly basis, of the annual series of the average size of the male generations of marriageable age.

However, this ratio is unadjusted for monthly seasonal fluctuations and for the daily composition of the month. Accordingly, the monthly absolute number of total marriages is first adjusted and the adjusted monthly male first marriage rate is obtained by dividing the adjusted number of total marriages $N^*(T) / C_m$ by the monthly interpolated proportion, then dividing the result obtained by one twelfth of the average size, interpolated monthly, of the male generations of marriageable age.

Definition of the statistical units analysed in the study

Swiss resident population

The populations referred to in this work are the *permanently resident populations* in the sense of *civil law domicile*. Any person whose civil law domicile is in Switzerland is considered as forming part of that population. For foreign nationals, the statistics include persons who have their civil law residence in Switzerland, residents with annually-renewable permits (including bona fide refugees), international civil servants, organisations, the staff of diplomatic representations or foreign government enterprises (especially the postal, customs and railway services) and the members of their families established in Switzerland. The permanent resident population does not include seasonal workers, persons on short-term stays, frontier workers, tourists and most asylum-seekers.

Births

Any child which, having been totally extruded (head, trunk, limbs) from its mother's body, draws breath or manifests heartbeats is born alive within the meaning of article 46 of the Swiss Civil Code.

The statistics record live births to mothers domiciled in Switzerland but do not distinguish by residence (permanent or otherwise). Births in Switzerland to women domiciled abroad are not included. Since 1987, births outside Switzerland to women of Swiss nationality domiciled in Switzerland have been included in the statistics. Births outside Switzerland to women of foreign nationality domiciled in the cities of Zurich and Berne and in the canton of Basle-City are also included in the vital statistics. How complete the records of births abroad to persons domiciled in Switzerland are is not known.

For births to *married* mothers, the registration data records the birth *order* to the couple. The birth order of a child born to a married woman is determined by reference to the couple's previous live born children, regardless of the couple's marital status at the time of the previous births. For example, the first birth occurring after marriage has a birth order higher than 1 if one or more children have been born to the couple before their marriage. Births to unmarried mothers are not classified by birth order

Marriages

A marriage is a legal union pronounced by a registrar. Marriages are assigned to the municipality in which the husband was domiciled before the marriage. Marriages performed in Switzerland between persons domiciled abroad are not included. Since 1987, marriages performed abroad between Swiss nationals domiciled in Switzerland have been included in the statistics. Marriages performed abroad between foreign nationals domiciled in the cities of Zurich and Berne and in the canton of Basle-City are also included in the vital statistics. How complete the records of marriages performed abroad between persons domiciled in Switzerland are is not known.

Divorces

*Divorces*A legal divorce is a divorce granted by the proper Swiss legal authority. Prior to 1983, the last locality in which the spouses lived together was regarded as their domicile before the divorce; if that was unknown, the divorce was registered in the place of the husband's domicile at the time when the proceedings were initiated. If that was unknown or was situated abroad, the wife's domicile was taken. Since 1984, the relevant domicile is that of the petitioner at the time the petition is brought. Divorce decrees relating to persons domiciled abroad have not been recorded in the statistics since 1984.

Deaths

The vital statistics record deaths occurring in Switzerland. Deaths are assigned to the municipality in which the deceased was domiciled. Deaths occurring in Switzerland of persons domiciled abroad are not included. Since 1987, deaths of Swiss nationals domiciled in Switzerland occurring abroad have been included in the statistics. Deaths occurring abroad of foreign nationals domiciled in the cities of Zurich and Berne and in the canton of Basle-City are also included in the vital statistics. How complete the records of deaths occurring abroad of persons domiciled in Switzerland are is not known.

Statistical data available for Switzerland

*Resident **population** in Switzerland by sex and age at January 1 of the year*

These figures are available by *year* of age since 1946 and five-year age group since 1920. Using the data by sex and five-year age group provided by the federal population censuses of 1860, 1870, 1880, 1888, 1900, 1910 and 1920 and five-year age group assessments from 1920 to 1945, the SFSO[1] has estimated the population by sex and *single year* of age at January 1 of *every* year from 1861 to 1945. In all, the resident population in Switzerland by sex and *year* of age at January 1 of the year has been available from 1861 to 1997.

*Vital **events** in each calendar year*

The table below shows the time period of the registration data available for Switzerland (squares, parallelograms and triangles refer to the Lexis diagram).

Events	Absolute numbers			Age of the person concerned (or duration of marriage for divorces)		
	Annual	Monthly	Daily	Square	Vertical-sided parallelogram	Triangle
Total births	1803-1996[2]	1871-1996	1926-1927 1965-1996	–	–	1950-1996
Extra-marital births	1944-1996	–	–	1944-1996	–	1946-1996
Marital births by birth order (in the current marriage)	1932-1996	–	–	1932-1945	–	1946-1996
Marriages	1801-1996[3]	1886-1996	1968-1996	–	–	–
Male and female first mariages	1876-1996	–	–	1876-1996	–	1940-1996
Divorces	1876-1996	–	–	–	–	–
Divorces by duration of marriage	1876-1996	–	–	1891-1996	1920-1996	1920-1996
Deaths (total of both sexes)	1803-1996	1901-1996	1969-1996	–	–	–
Male and female deaths	1803-1996	1941-1996	–	–	–	1876-1996

[1] Philippe Wanner, Une nouvelle estimation de la structure par âge de la population de la Suisse de 1860 à 1945 (a re-estimation of the age structure of the population of Switzerland from 1860 to 1945), *Démos* 1997/3. Office Fédéral de la Statistique, Berne.

[2] Estimates pre-1871.

[3] Estimates pre-1876.

List of tables available on the CD-ROM but not associated with graphics

CD-ROM overview

This CD-ROM is in ISO-9660 format and can be used on all IT platforms. The Acrobat Reader software included on the CD-ROM makes for fast location of and access to the desired information. This software is available for the following platforms: Windows (16 bit), Windows (32 bit), Macintosh, Unix (SunOS), Sun Solaris, HP-UX, IBM–AIX, SGI–IRIX, Linux and Digital Unix). For other platforms, software (often shareware) that fulfils the same functions can be found.

The CD-ROM contains:

- the entire publication, including graphics, in PDF format;
- all data tables used to prepare the graphics, in ASCII and Excel format;
- a choice of basic data used to prepare this publication, in ASCII and Excel format.

We recommend using the CD-ROM in conjunction with the publication.

For details of contents, consult the `README.TXT` file in the CD-ROM root directory.

CD-ROM format

This CD-ROM is in ISO-9660 format, the only one that ensures use by the maximum number of IT platforms.

To guarantee portability, coding of accents and other diacritical marks had to be selected solely for ASCII format files and, in some cases, for Excel format files: the character set adopted is ISO 8859/1 (Latin 1). Under certain conditions and on certain platforms, this choice may produce incorrect accents. This limitation does not affect PDF-format files.

Browser

To search for information on the CD-ROM, we recommend using the browser resources that have been added. These, however, require installation on the computer's hard disk of the Adobe "Acrobat Reader" program which, along with its documentation and on-line help, is available on the CD-ROM. The program is free, so Adobe does not need to be approached, and can be redistributed providing Adobe's copyright is complied with.

Acrobat Reader displays on the screen the PDF files that structure browsing and searches on the CD-ROM. The graphics, like the text, are also available in PDF format for on-screen display or print-out.

Installation

Installation of Acrobat Reader varies depending on the platforms. For more details, see the information files provided by Adobe (in the `_INSTALL` directory). The main installation steps on each of the platforms for which Acrobat Reader is available are given below.

Installation on Windows

For a minimum installation that is, however, sufficient for this CD–ROM, execute the `AR16E301.EXE` program in the `16BIT` directory (for Window systems 3.x) or `AR32E301.EXE` program in the `32BIT` directory (for Window 95 and NT) which, in their turn, can be found in the `D:\_INSTALL\WIN\READER` (if necessary, replace `D:` by the CD-ROM reader letter).

For full installation, execute the `RS16E301.EXE` program in the `16BIT` directory (for Window systems 3.x) or `RS32E301.EXE` program in the `32BIT` directory (for Window 95 and NT) which, in their turn, can be found in the `D:\_INSTALL\WIN\RDR_SRCH` (if necessary, replace `D:` by the CD-ROM reader letter).

Once installation is complete, we recommend you link the files with the PDF extension to the `ACRORD16.EXE` or the `ACRORD32.EXE` program.

To start up browsing, double-click on the `START.PDF` file in the CD-ROM root directory.

Installation on Macintosh

The CD-ROM does not contain a Macintosh-format file system (HFS); the *Foreign File Access* and *ISO 9660 File Access* extensions have to be installed for access. The limitations of the ISO 9660 format are particularly obvious on a Macintosh. Inter alia, a file cannot be opened by double-clicking on the icon, as usual – you have to use the application to open the file. However, there is no restriction on browsing with Acrobat Reader.

To install Acrobat Reader, first expand

the `DEMOG_CH:_INSTALL:MAC:READER:ARDR301E.HQX` file
(for minimum installation that is, however, sufficient for this CD–ROM) or

the `DEMOG_CH:_INSTALL:MAC:RDR_SRCH:ARWS301E.HQX` file
(for full installation)

by means of *Stuffit Expander* or another expander program, first installing it, from the CD-ROM to the Macintosh hard disk. Then double-click the installation program *Reader 3.01 Installer* (and, as necessary, on *Search Installer*) to start up installation.

Once installation is complete, drag the `START.PDF` icon on the *Acrobat Reader 3.0* program icon to start up browsing.

Installation on Unix

A CD-ROM is installed on Unix with the command */etc/mount* (often replaced by a daemon). The parameters to be provided for this command vary from system to system. In the event of problems, contact your system administrator. As the CD-ROM is in ISO 9660 format, the name of each file indicates the version, separated by a semi-colon (eg `_INDEX_.TXT;1`). Often an */etc/mount* parameter makes it possible to eliminate displaying the version. However, if the version number has to feature on your system, do not forget to escape the semi-colon with a *backslash* ("\") to prevent its interpretation by the shell.

To install Acrobat Reader, first expand the file (with `gunzip`) and then retrieve it (with `tar`).

`<MOUNT_POINT>/_INSTALL/UNIX/<plateform>/ACROREAD.TGZ`

or

`<MOUNT_POINT>/_INSTALL/UNIX/<plateform>/ACRDSRCH.TGZ.`

Then follow the instructions in the `INSTGUID.TXT` file

in the `ACROREAD` or `ACRDSRCH` directory created during retrieval.

Once installation is complete, and depending on the system, drag the `START.PDF` file icon on the *Acrobat Reader* program icon or double-click the `START.PDF` file icon to start up browsing.

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Additional information

The Population Trends Section Information Service will be delighted to answer any questions you may have about the publication and the CD-ROM

– telephone: 032 713 67 11

– fax: 032 713 83 85

– e-mail: info.bev@bfs.admin.ch

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This study on population trends in Switzerland covers the period from 1860 to 2050 and is based on past observations generated by successive Population Censuses and by annual statistics on population movement, as well as on demographic scenarios with a horizon of 2050 – base year 1995. Commented graphics sketch out the broad outlines of this development.

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