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Modelling biological birth order and comparison with census parity data in Switzerland

A report to complement the Swiss data in the Human Fertility Collection (HFC)

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1. Introduction

This Technical Report has two main purposes. For users of the database, it describes in detail the derivation of biological birth order and critically compares deduced cohort fertility with the parity proportions from the 2000 census. At a more general level, this report may be of use for other researchers comparing cohort data (from censuses or sample surveys) with period data, as the potential discrepancies between the two are discussed at length. Switzerland is a good example, where the available data is of high quality, and yet still there are slight anomalies between the two.

In Switzerland, only in very recent years have births been registered according to biological birth order; in previous years (and as in many other countries), only marital birth order was recorded. However, with the growth in extra-marital childbearing (see Figure 1) and complex marital histories, then the Swiss Federal Statistical Office (SFSO) decided to record both marital and biological birth order.

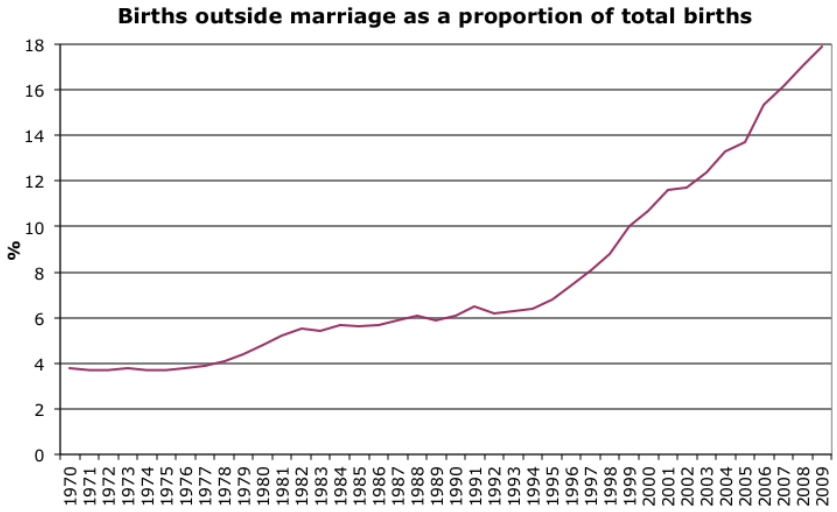

Figure 1: Growth in the proportion of extra-marital births since 1970

This study describes how this recent comprehensive cross-matched data (for a sample see Appendix 1) was then used to extrapolate back in time to deduce biological birth order from 1969, the first year of the database. These processed fertility rates by age (age reached during year, ARDY), cohort and birth order are now available in the Human Fertility Collection (HFC), held at the Max Planck Institute of Demographic Research (MPIDR). For further information, see the website http://www.humanfertility.org. A summary of the (slight) differences in the data for Switzerland between that in the Human Fertility Database (HFD) and the HFC is provided (for full details on the HFD for Switzerland, see the official documentation: Cotter and Zeman, 2011). This HFC-HFD comparison is followed by an assessment of the accuracy of the modelling procedure of the HFC data using census data from 2000, with a critical discussion of all possible reasons for the (small) discrepancies. An overview of data from sample surveys is also included to see whether these can shed any light on the differences.

To make an accurate assessment of fertility trends, it is important that births are decomposed by biological birth order (Ni Bhrolchain, 1992; Sobotka, 2004). The time period for which biological birth order has been recorded is often short, and so trends by birth order are difficult to see as yet. Therefore, it is desirable, if possible, to extend the time frame for these trends by using earlier data to deduce biological birth order. Many countries have faced this same challenge of trying to extrapolate true biological birth order from data on marital birth order by using other data sources. For example, in Britain, two different studies, using sample data from the General Household Survey and the British Household Panel Survey respectively, converted birth registration data into true birth order (Handcock et al, 2000; Smallwood, 2002). In Germany, a similar exercise was first attempted by Birg et al (1990), and more recently followed up by Kreyenfeld (2002) using survey data from the German Socio-Economic Panel, SOEP. In France, the large Family History Survey of 1999, carried out in conjunction with the French census, was used to deduce fertility trends by birth order (Toulemon and Mazuy, 2001).

2. Data sources and deducing biological parity

The primary data source for this study is birth registration data, an annual national data set of number of births to women of each age ('natürlichen Bevölkerungsbewegung', BEVNAT). The mid-year population of women by age is also published by the Swiss Federal Statistical Office. Up to 2009, this was the ESPOP database; however, the system of population registration and rolling censuses changed in 2010 and in future the population database will be known as STATPOP. Both the BEVNAT and population data sets are available as computerised databases dating from 1969.

Since 2005, the true biological birth order of the mother has been recorded for all births in Switzerland, as well as birth order within current marriage, by age of mother. Appendix 1 gives a sample of this data for 2008. Between 1998 and 2004 biological birth order started being recorded, but a significant minority of births were recorded as unknown biological birth order in that time period (see Table 1). Prior to 1998, birth order was registered only as birth order within current marriage ('*rang au sein du lit actuel*'), with births outside marriage being classified as *rang* 0.

Table 1: Proportion of births where biological birth order was unknown, for the period 1998-2004

	Marital	Non-marital	TOTAL
1998	17%	14%	17%
1999	18%	22%	18%
2000	10%	14%	11%
2001	7%	10%	7%
2002	5%	8%	5%
2003	5%	10%	6%
2004	3%	7%	3%

To model the biological parity for pre-1998 data, using all the known equivalencies from 1998-2008, it was assumed that the proportion of births outside marriage is age-dependent, ie. 100 percent of births to girls aged less than 16 are first births, and this proportion declines with increasing age of mother. Similarly, where birth order in marriage is not equal to biological birth order then this will also be age-dependent, as women have had more possibility for multiple marriages and births outside marriage as they get older. The assumption for processing the1998-2004 data was that if biological birth order was recorded then it was considered correct; and the distribution of birth orders which were recorded as unknown follows the same distribution pattern as applied to the pre-1998 data model.

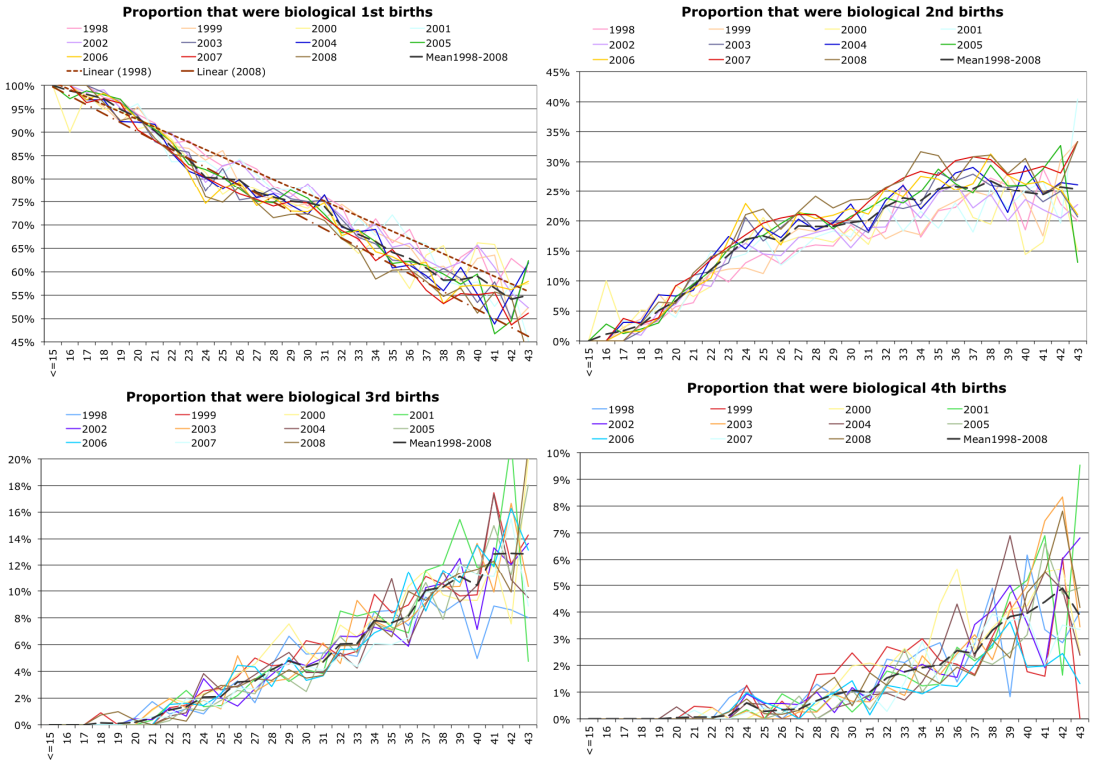

Figure 2: Proportion of births outside marriage by biological birth order, age of mother and year
Note: different vertical scales used on these four graphs

Figure 2 shows the known birth order distributions for births outside marriage for the years 1998-2008, together with the mean value. The first (top left graph) shows how the proportion of births outside marriage declines from 100% of girls aged 15 and under to around 55% of women in their early 40s. The decline in proportion of first births is almost (but not quite) linear. It is interesting to note the difference in slope between the trend lines for 1998 and 2008; it would appear that a declining proportion of extra-marital births are first births. As has been happening across western Europe, marriage is no longer seen as the only acceptable institution for raising a family; long-term non-marital relationships are also increasingly common. In the past, extra-marital childbearing was generally the preserve of young single women, and the vast majority of non-marital births were first children. That pattern is now breaking down, with long-term non-marital relationships growing in acceptability for raising multiple children.

Birth orders within marriage were also analysed; biological birth orders were compared with the birth order within current marriage, and the proportion needing to be re-assigned was ascertained in a similar manner to non-marital births. Then, using all the valid 1998-2008 data, the mean percentage of each 'marital' birth order that should be re-attributed to each 'biological' birth order by age of woman was calculated (see Figure 3). *Note an important point: biological birth order will only ever be the same or higher than marital birth order.*

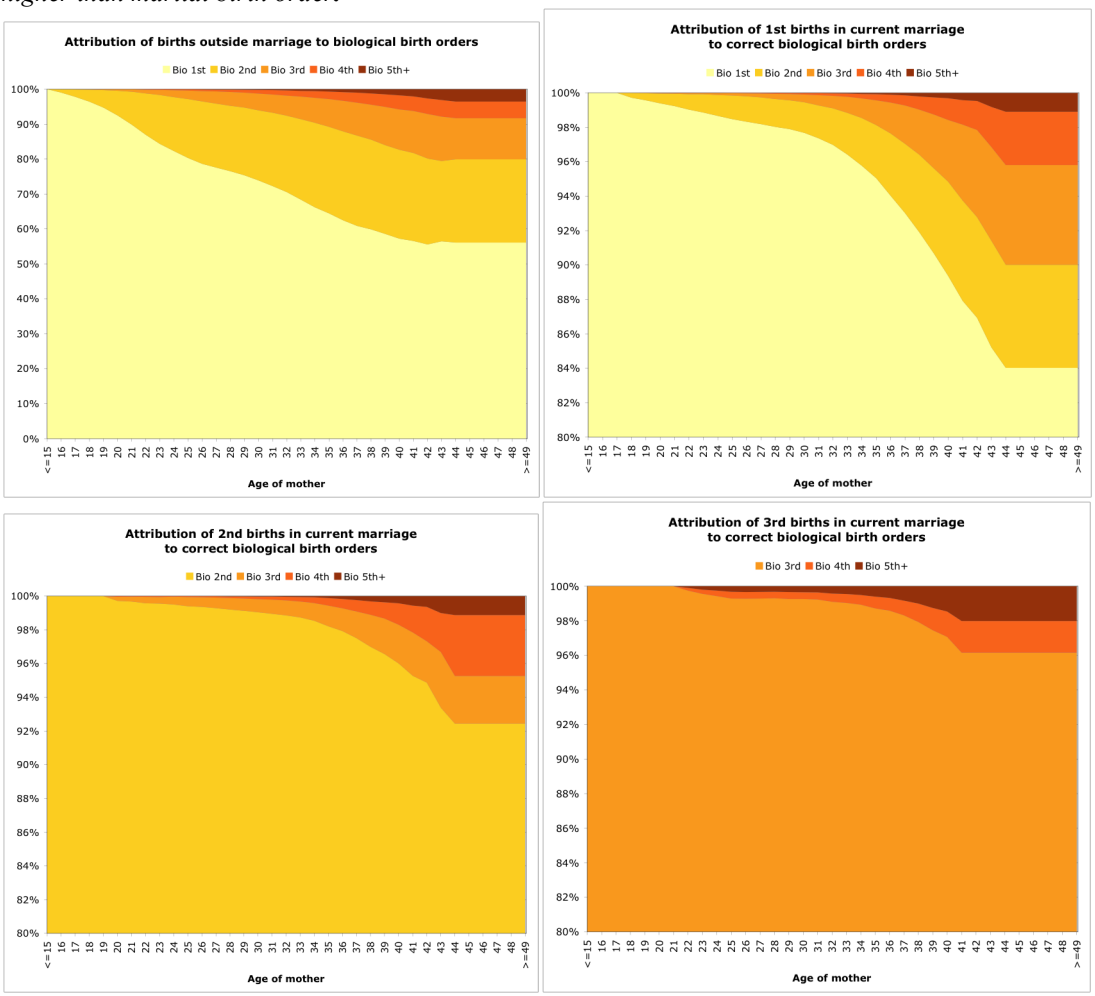

Figure 3: Reassignment from marital birth order to biological birth order
Note: Attribution of birth order 4 was also calculated but is not plotted here.

These percentages were then applied to the pre-1998 data to obtain hypothetical biological birth order distributions for each age. As an example, for births outside marriage, the proportion which are biological first births declines with age of mother, from 100% of the under-16s to 57% of 40 year-olds, whilst the proportion of second births rises to 25%, third births to 12%, fourth births to 4% and higher order births to 2%. Similarly, by age 40, only 89% of births classified as first births within the current marriage are true first biological births, while 6% are biological second births, 4% are third births and 1% are fourth births. As the absolute number of births to women over 43 is small then calculating the

proportions to be re-assigned becomes unstable: this explains why the proportions to be re-attributed to women older than 43 is kept at fixed level (see Figure 3). A mathematical formalisation of this method is given in Appendix 2.

As stated above, all the valid data from 1998-2008 was used to calculate the percentages attributable to each biological birth order, and it was the average of the data from these eleven years that was then applied to data for the years 1969-1997. However, there could well have been a trend over time; in fact the first graph in Figure 2 shows how the proportion of births outside marriage which were first births for 40 year-old women declined from around 59% to 52% between 1998 and 2008. However, lacking further data from prior to 1998, it would be difficult to try to model this trend. What this could mean is that too many births, both extra-marital and marital, have been assigned to higher orders than they should be; this is discussed more in section 4.3.

Data from the eleven years, 1998-2008 inclusive, was used to model the distribution of biological birth orders from marital birth orders. There is a question of whether further data from 2009 (which is already available at the time of writing) and after should be included, as it becomes available. At this stage, it has been decided that the time span is sufficiently long to provide a smooth and coherent data set. Increasing the time span would probably not improve the model any more, because of the point described in the previous paragraph – the trends over time could make the model less valid over time.

3. Differences between the HFD and HDC data for Switzerland

There are two reasons for the (small) differences in equivalent data in the HFD and HFC.

The first of these is that the population figures used are slightly different. The HFD (for all countries) uses the same values for population numbers as in its sister database (and predecessor), the Human Mortality Database (HMD). These are slightly different from the 'official' figures supplied by the SFSO. This can cause slight variations in the calculation of the TFR (and, of course, birth order specific fertility rates). Figure 4 shows these differences in the TFR; the years 1990 and 2001-2003 show marked discrepancies (which have been confirmed to be caused by differences in population values between the HMD and the SFSO-HFC), but otherwise the values are very close. It is possible that later revisions of the HMD population values will resolve these discrepancies.

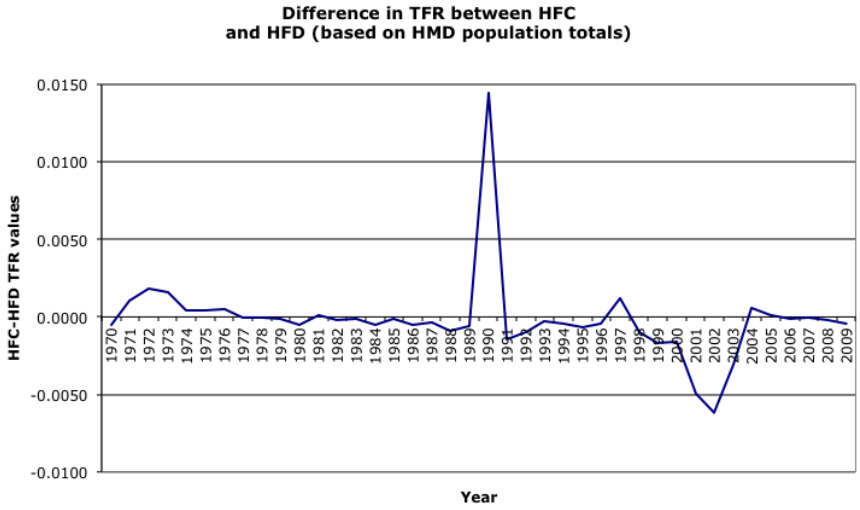

Figure 4: Differences between the TFR in the HFD and that derived from HFC data

The second difference concerns only the data 1998-2004. Most, but not all, of the biological birth orders are known for this period, as shown in Table 1. The derivation of the unknown biological birth orders from the known marital birth orders involved a slightly different process in the HFD as the HFC. The modelling method for the HFC has been described in detail in section 2 and Appendix 2 of this report. However, for the HFD then the births with unknown biological birth order are re-distributed with exactly the same proportions, for the same ages and years, as the known births (Cotter and Zeman 2011). This means that there is less smoothing in the modelling. Because non-marital births had a

greater likelihood of being lower order births in 1998 than later over the succeeding decade (as described in the last paragraph of section 2), then the HFD has slightly more first births in 1998 than the HFC, and fewer higher order births. See Table 2 for the example of 1998; subsequent years had smaller differences. In none of the years 1998-2004 was the difference greater than 5 births in any one cell.

Table 2: Differences in number of births of unknown birth order re-attributed to different birth orders between the HFD and HFC, by age of mother, 1998 data

HFD - HFC	1	2	3	4	5+	TOT
-15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	1	-1	0	0	0	0
21	1	-2	1	0	0	0
22	0	0	0	0	1	0
23	2	-3	0	0	0	0
24	1	-1	-1	1	0	0
25	3	-3	0	0	0	0
26	4	-3	0	0	0	0
27	5	-4	-2	0	0	0
28	3	-3	0	0	0	0
29	4	-3	0	-1	0	0
30	2	-2	0	0	0	0
31	4	-2	-1	-1	0	0
32	4	-4	0	0	0	0
33	0	3	-1	-1	-1	0
34	3	-4	1	0	0	0
35	3	-2	-1	-1	0	0
36	3	0	-2	0	-1	0
37	1	1	-2	1	0	0
38	0	3	-1	0	-1	0
39	0	1	0	0	0	0
40	2	-2	0	-1	0	0
41	1	0	-2	0	0	0
42	0	-1	0	0	0	0
43	0	0	0	0	0	0
44	1	0	0	0	0	0
45	0	0	0	0	0	0
46	0	0	0	0	0	0
47	0	0	0	0	0	0
48	0	0	0	0	0	0
49+	0	0	0	0	0	0
TOT	49	-31	-12	-3	-3	0

4. Assessment of biological birth order model

To assess the success of the modelling of biological parities, the Swiss census data from 2000 was used. This census included the question “Are you the father or mother of one or several children? If so, how many and what years were they born in?”. Cohort fertility was deduced from the BEVNAT data, processed by the method described in the previous section, and by summing the age-specific fertility rates for each birth order for each cohort. The parity proportions can then be deduced from the birth-order specific rates. The youngest cohort for which accurate fertility rates that can be derived is 1954, as the women born in that year reached the age of 15, the start of their potential reproductive lives, in 1969, the year from which birth data is available in the database. By the year 2000, none of the post-1954 cohorts had quite reached the end of their potential reproductive life (defined as age 50), but for this comparative exercise it is only important to be able to compare the fertility patterns up to 2000, not completed cohort fertility.

Figure 5 shows the mean fertility and the parity distributions by cohort up to the year 2000 using the BEVNAT data base and the census data. For the curve of mean cohort fertility, the equivalence is, perhaps, remarkable! However, some differences in the parity distributions are evident; these are greatest for the proportion with no children or with one child; 16 percent compared to 20 percent for each for the cohorts born in the 1950s.

There are several possible explanations for these mismatches: changes in the composition of the population in the years up to the census; weaknesses in the census data; errors in modelling of the pre-1998 biological parity distributions; and differences in the definition of the resident population for birth registration and census collection. These will be discussed in some depth in the following sub-sections.

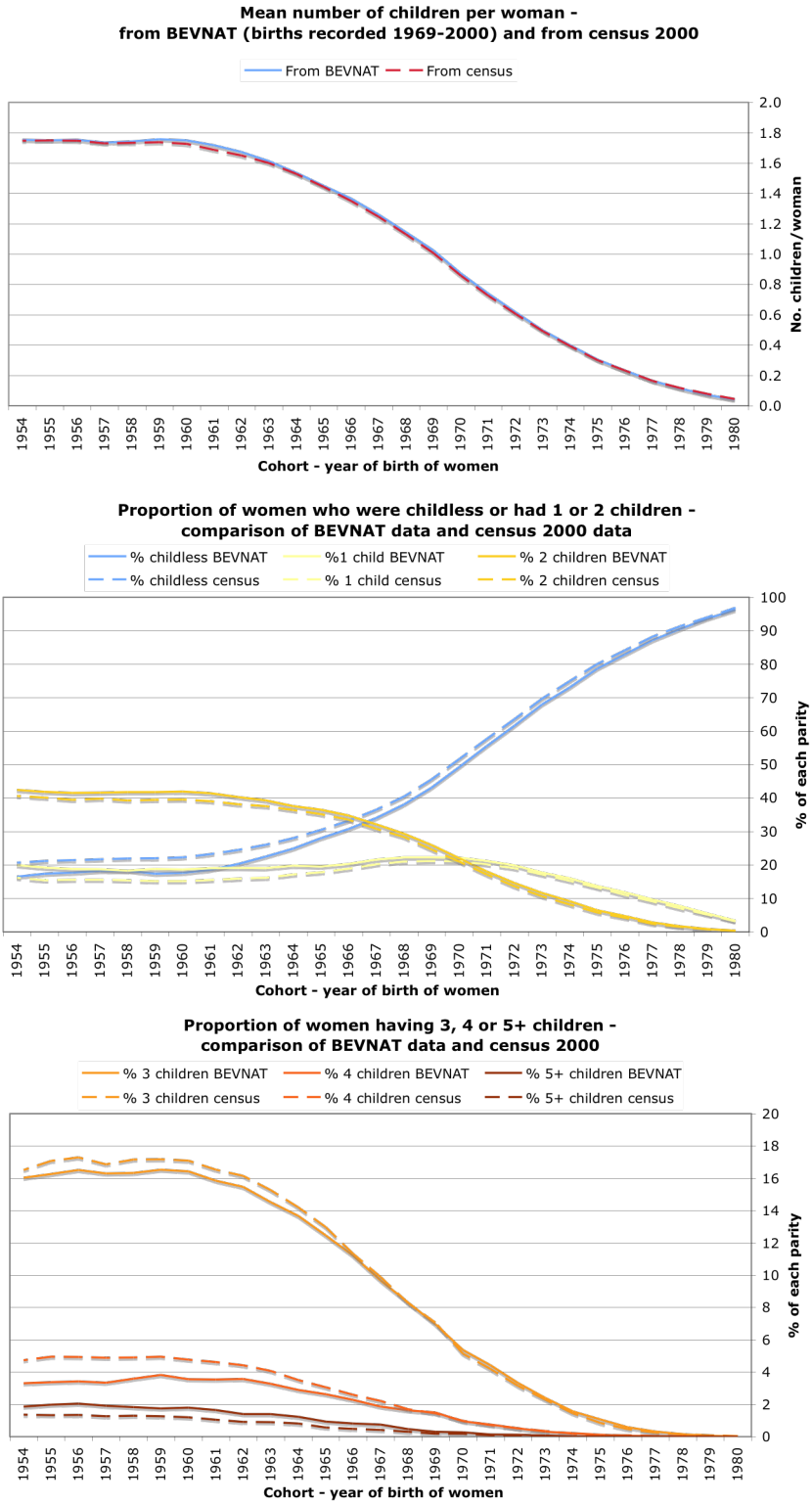

Figure 5: Comparison of fertility indicators derived from census and birth registration data
Note: BEVNAT values are those from re-assigned birth registration data

4.1 Effect of migration

If we look at how the size of each cohort has changed over time (Figure 6), then immigration has clearly swollen the size of some cohorts quite considerably (and is continuing to do so), and this could have a significant impact on fertility measures if the fertility behaviour of immigrant women is different from that of long-term residents. For instance, the size of the 1960 and 1965 cohorts of

women increased by 24% between the start of their reproductive life and the census year 2000, while the 1970 cohort grew by 23%. The expansion of younger cohorts is continuing strongly up to the present. This high level of immigration has the potential to complicate fertility measures, especially when comparing period fertility with cohort fertility.

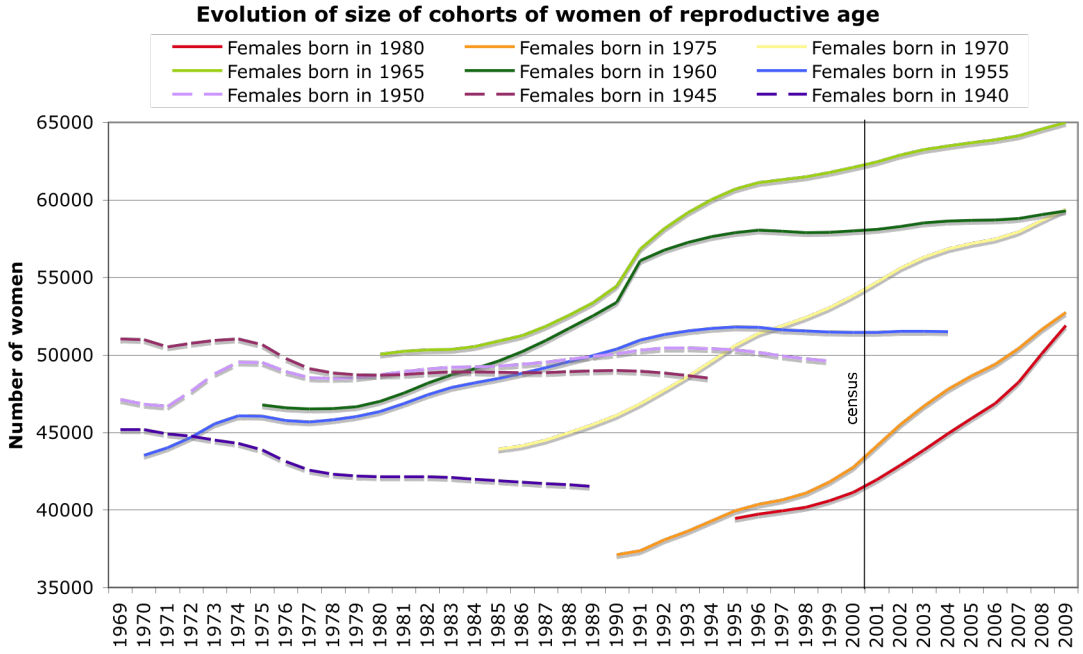

Figure 6: Change in population size of cohorts of women.
Dashed lines are for women born in 1950 and before. Solid lines are for post-1950 cohorts, all of which show a marked increase over time. The lines plot the cohort size from age 15-49

As well as this high level of (net) immigration into Switzerland, there are also several other special features about the Swiss population, which can be summarised as follows:

- The rate of naturalisation (gaining Swiss citizenship) is quite low
- Birth in Switzerland does not give any right to Swiss citizenship; therefore, a significant proportion of the 'foreign' population is Switzerland were, in fact, born in the country
- The highest immigration rates occur in people aged in their 20s and 30s, ie. those in their prime reproductive ages
- The mix of nationalities immigrating into Switzerland is becoming more diverse, with the associated broadening of 'normal' fertility behaviour. For example, low fertility Italians and Germans are being superseded by high fertility non-Europeans
- Only around half of marriages in Switzerland are currently between two Swiss people; in around a third one partner is Swiss, and the other foreign; and for the remaining sixth both partners have foreign nationality
- Of the section of the population with Swiss nationality, there is negative net migration, ie. more Swiss leave Switzerland than return
- Childbearing encourages naturalisation; therefore, a foreign woman having her 3rd birth registered in one year can become a Swiss woman registering her 4th birth a couple of years later by the process of naturalisation!

To help clarify a typology of the population, taking into account place of birth, naturalisation and current nationality, see Table 3.

Table 3: Typology of people living in Switzerland (CH) by nationality at birth, naturalisation status and place of birth

Born Swiss?	Has become Swiss?	Born in Switzerland	Type	Description
No	No	No	a	Non-naturalised immigrant
No	No	Yes	b	Born in CH but foreign
No	Yes	No	c	Naturalised immigrant
No	Yes	Yes	d	Born in CH and naturalised
Yes	x	No	e	Returning Swiss
Yes	x	Yes	f	Swiss-Swiss

Notes: For those who are born Swiss, the question of naturalisation is irrelevant, hence marked x
There are few people in the Type e group (returning Swiss)

Looking back at Figure 6, and knowing that most immigrants arrive in their 20s and 30s, we understand that it is the immigrant Types a and c (and possibly e) that have swollen the cohort population. Let us now look at the mean number of children, by nationality and place of birth (Figure 7). These are the two categories readily available from the Swiss Federal Statistical Office (unfortunately not all six categories as listed in Table 3, though these might be available on special request).

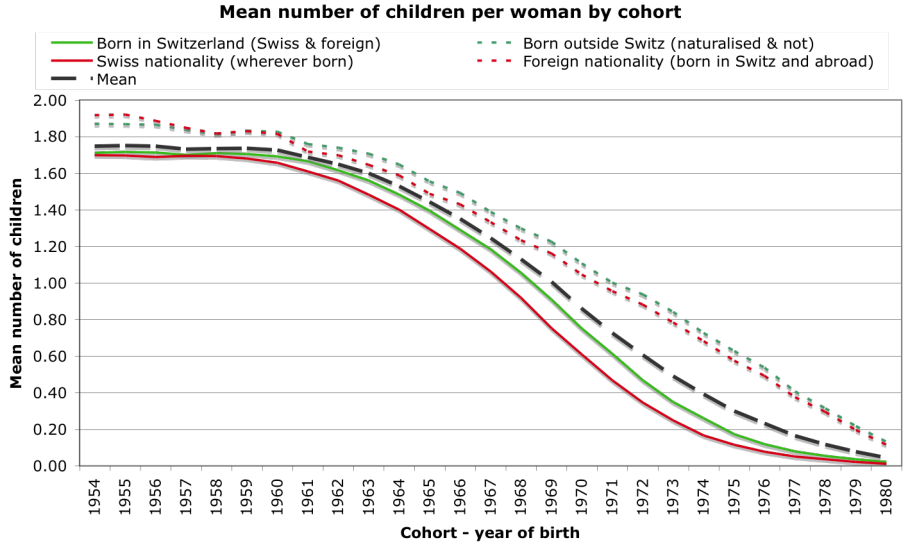

Figure 7: Comparison of fertility of Swiss and foreign women and those born in Switzerland and those born abroad

Red solid line = Types c+d+f (+e)
Green solid line = Types b+d+f
Red dotted line = Types a+b
Green dotted line = Types a+c (+e)

What can we deduce from this graph?

- Women with foreign nationality (red dotted) have a higher fertility than women with Swiss nationality (red solid) (and have their children at younger ages, as shown by the shape of the curve).
- Women who were born outside Switzerland (green dotted) have a higher fertility than those born in Switzerland (green solid) (and similarly have their children at younger ages). These are the Types a and c whose influx has been plotted on Figure 5.
- The green solid line (b+d+f) is (slightly) higher than the red solid line (c+d+f (+e)), for all cohorts. If we discount the Type e women, then by deduction, this means that Type b women have a higher fertility than Type c women.

- The red dotted line (a+b) is higher than the green dotted line (a+c (+e)) for cohorts born before 1959 (and therefore were in their 40s at the time of the census). By deduction, this means that older Type b women have a higher fertility than Type c women (agreeing with the previous conclusion).
- The green dotted (a+c (+e)) line is higher than the red dotted line (a+b) for cohorts born after 1960, and were therefore younger than 40 at the time of the census. By deduction (and ignoring Type e women), this means that younger Type c women have a higher fertility than Type b women (contradicting the previous two conclusions).
- These last three statements show that there appears to be an inconsistency in the data, and we cannot know whether Type b women do have higher fertility than Type c women. We also do not have enough data to know whether Type a women have a higher fertility or not than Types b or c. More comprehensive data from the census, by the typology given in Table 2 would help to clarify this.

Now looking back at the first graph of Figure 5, we may be even more surprised by the exact equivalence in fertility levels derived from birth registration data and that derived from census data. However, the second graph of Figure 5 shows that the proportion of childless women was found to be greater in the census than would have been expected from birth registration data. If a resident cohort of women had followed the birth order specific fertility rates through their reproductive life, then there should have been fewer women left childless in 2000 than there were actually found to be at the census in 2000 (about 16 percent compared to about 20 percent for the 1950s cohorts). One hypothesis would be that these additional childless women immigrated into the country during that time span. One might, therefore, expect that the rate of childlessness amongst the immigrant population to be higher than that of the native Swiss population. However, as we have seen already, Figure 7 shows that immigrants have higher fertility than long-term residents. This does not preclude the possibility that immigrants have larger families, which compensates for the possibility of more being childless. In fact the third graph on Figure 5 would tend to support that: there are more women with 3- and 4-child families at the time of the census than would be expected from the birth registration data: this could be explained if they moved into Switzerland with children already born elsewhere.

Data is available from the census for parity proportions of women by nationality, Swiss compared to foreign (see Figure 8). This contradicts the conclusion of the previous paragraph as it shows that foreign women are less likely to be childless than Swiss women (15 percent versus 22 percent) and more likely to have larger families of four and more children. Once again we have come across an inconsistency which cannot easily be explained.

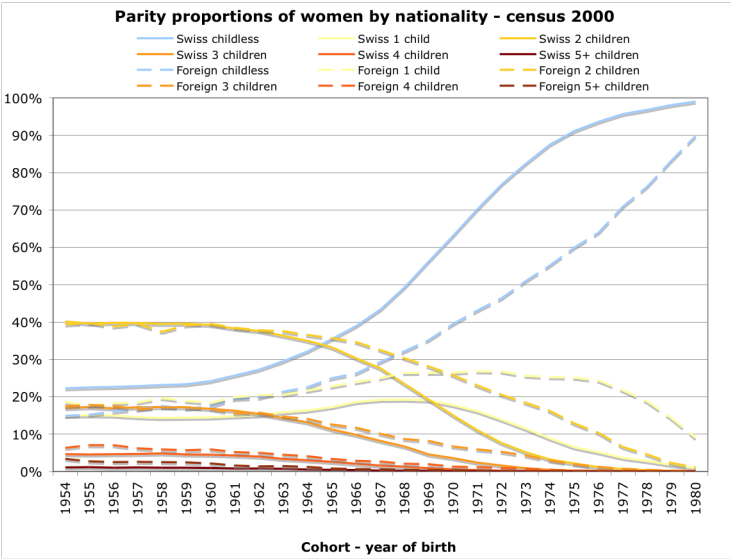

Figure 8: Distribution of family sizes of Swiss and foreign women

The data presented in Figure 8 appears to contradict that of Sauvin-Dugerdil (2005), based on her examination of FFS data: she asserted that new arrivals are somewhat more likely to be either childless or to have larger families (which would fit the data shown in Figure 5). Her analysis showed that the

parity proportions of women with two and three children are very similar for Swiss and foreign women.

There is one possible scenario that could encompass both the observation that foreigners have larger families than Swiss natives, and also the expectation that new immigrants coming into the country are more likely to be childless. This would be that foreigners who are long-term residents in Switzerland (eg. Type b) have larger families and a much lower rate of childlessness than the Swiss natives (Type f), but relatively new arrivals (eg. Type a) are more likely to be childless. With the data sets that we currently have available, we cannot say whether this is, in fact, the case.

Looking back at Figure 6, we see that immigration has been more important for younger cohorts born after the 1950s, and is becoming increasingly significant. Therefore we wonder whether the mismatch in the proportion of childless is really likely to be caused by immigration for the 1950s cohorts; however, the confounding factor of migration is likely to become an increasing 'problem' with more recent cohorts.

It should be noted that another factor that potentially changes the mix of individuals in a cohort is mortality. At younger ages, then those with a higher than average mortality will be those who have had long-term health problems, and so have lower than average fertility. Maternal death during childbirth is very rare. The confounding factor of mortality in changing the population structure is therefore ignored, though it might be reasonable to investigate at some stage.

To summarise this section: trying to examine the effect of migration to explain the mismatch in the parity proportions derived from vital statistics compared to the census results has led us to an indeterminate conclusion. More work is required. Therefore, let us now look at other possible explanations for the discrepancies.

4.2 Weaknesses in the census data

We generally think that a census covers everyone in the country comprehensively. However, there can still be important gaps in the information registered as not everyone completes every part of the census. Figure 9 shows this problem clearly.

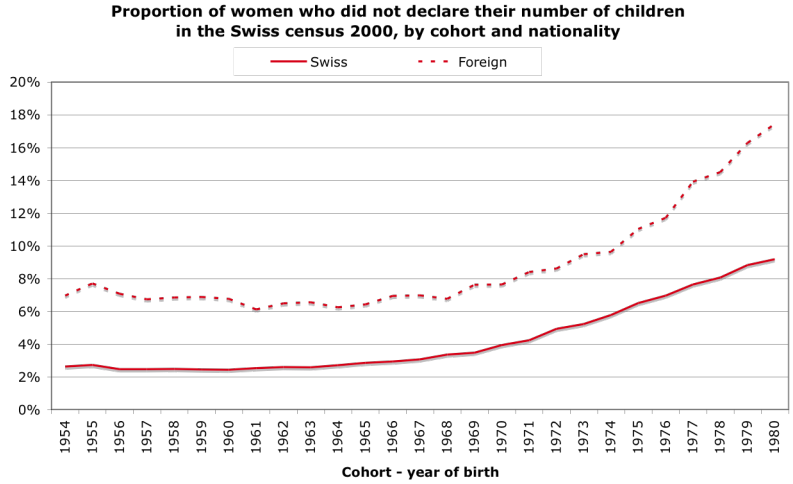

Figure 9: Proportion of women who did not declare their number of children

It has been hypothesised elsewhere that women under the age of 30 who did not declare their fertility were most likely childless (Kreyenfeld et al 2011). However, the analysis described in this paper did not take this approach, but simply discounted the undeclared respondents from the analysis. This is equivalent to considering that the non-respondents have the same parity distribution as those who did respond.

We might wonder if the mismatch discussed above would be lessened if the non-respondents were considered to be all childless. This was tested, but it is clear that the result would be negative. The census childless level is already 'too high' with respect to the vital statistics value, and increasing it makes the mismatch even worse.

Another possibility of weaknesses in the census data is the veracity of everyone who did declare the number of children they had. There are several possible scenarios of misreporting of number of children. We consider here only women respondents; men are considered in any case to potentially have less knowledge of the number of children they have fathered. These are some possible reasons why too few children were reported on the census form, and there could be more:

- Children who have died (especially as young babies)
- Children who are estranged from their mothers (having been taken into care, or when the father had custody after a divorce, or when another relative or friend is bringing up the child)
- Children (particularly of foreigners) who are living in other countries
- Natural children who were given up for adoption
- Other people (eg. husbands, fathers, care home managers) complete the census form and do not know about the individual's children.

In all these cases listed above, the true biological parity will be higher than the parity declared on the census form. We can think of only one example when too many children may have been declared on the census form:

- Adopted children are included as natural-born children

To summarise this discussion, we suggest that *there is a likelihood that the census shows too few declared children for a small, but unknown, proportion of individuals*. Looking back at the second two graphs of Figure 5, then what would happen if we decreased the proportion of childless in the census and increased the proportion of higher order births? This would improve the match for the childless proportion – where the greatest discrepancy lies – but make it worse for the 3- and 4-children.

To conclude, the two unknown factors in the census – undeclared number of children, which may often be because an individual is childless, and erroneously declared number of children, which may under-estimate number of children – have the potential to cancel out, but we have no way of knowing this!

4.3 Possible weaknesses in the modelling procedure and vital statistics

Having considered the real and potential weaknesses of the census results, let us now turn to the possible weaknesses in the modelling procedure used to derive the birth orders.

The fact that the lines of mean number children match extremely closely (Figure 5, top graph) suggests that the number of children and overall fertility rate for the whole population of each cohort is correct – it is just in their distribution between birth orders that the problem occurs (Figure 5, lower graphs). This would also negate the possibility that the fault could be in the estimation of the population totals by cohort. We have also confirmed that there is close agreement in the population totals by cohort between the census figures and those used to calculate fertility rates (taking into account that the annual fertility rates use the mid-year population totals whereas the census was taken at the end of 2000).

As stated earlier, the main mismatch is in the proportion childless and those with one child. However, the calculation of the childlessness rate is simply as the complement of (ie. one minus) the first birth rate. To make a better match with the census childlessness rate, the derived rate needs to be increased, which would mean the rate for birth order 1 needs to be decreased. The logic follows that too many births must have been categorised as first births. More should have had a higher order. But the main job of the modelling procedure is to re-assign registered (extra-marital and marital) birth orders up to higher orders (they are never re-assigned to lower birth orders).

Back in section 2 (next to last paragraph) it was stated that there could have been a trend in more complex partnership histories, and therefore: "too many births, both extra-marital and marital, have been assigned to higher orders than they should be". This current discussion on the mismatch would suggest the opposite: that even more births should have been re-assigned to higher parities than they were in the modelling procedure. Can this be justified in any way, other than to make the values fit with the census results?

If more births registered a first births were moved up to a higher order, then another problem emerges. The parity two rates match rather well, so we do not want those excess first births to be re-assigned as second births. They need to move up to be third or fourth births to make all the parity proportions match best (see Figure 5). These are less likely to come from extra-marital births. So why have not enough births been registered as third and fourth order to married women? Is it possible that the

problem lies in the birth registration procedure? Is there some reason why birth order should tend to be recorded as a lower one than it actually is?

One possibility that was considered was whether the registering of twins or multiple births could give rise to mis-registering birth order. The SFSO has confirmed that twins should be registered with successive birth orders and not the same one. This should avoid any differences between the birth registration and census data. However, whether the guidelines for registration are always followed at a local level we cannot know for sure.

4.4 Differences in definition of resident population

The definition of a resident population is not straightforward, especially for a country which experiences large migration flows and a significant number of temporary residents, ranging from seasonal workers to asylum-seekers. As an example, the Swiss Federal Statistical Office changed the definition of residence applicable to birth registration in 2001 to no longer include births to asylum seekers. This was probably the partial cause of a sudden dip in the official TFR from 1.50 in 2000 to 1.38 in 2001 (see Cotter and Zeman, 2011 for more information on this). The SFSO are changing the definition again for births registered in 2010 (and thereafter), to include asylum seekers who have been in the country for over a year; this appears to be causing a small increase in the TFR from 2009 to 2010.

There are quite well defined differences in populations included in vital statistics (including birth registration) and the census of 2000. See Appendix 3 for a transcript from the relevant document produced by the SFSO (in French), with the most pertinent points highlighted. This document is also available in German (see link in Appendix 3). To summarise, in the census individuals and their families with residence permits A (seasonal workers), L (temporary work permits of < 1 year), F (provisional entry) and N (asylum seekers) are included in the census, but (except for a proportion of asylum seekers as discussed above) they are not considered as permanent residents, and therefore are not included in the ESPOP database of population totals, from which the TFR is calculated. The number of these temporary residents is non-negligible and could plausibly be the major cause of the mismatch in parity proportions derived from census data and birth registration data. It would be helpful if the census data excluding these classes of temporary residents were readily available. It could be expected that temporary residents would be more likely to be childless than longer term ‘permanent’ residents, and including them in the census could feasibly increase the childless proportion and so improve the agreement with the birth registration data.

Another factor that could cause problems is that Switzerland is a country with land borders surrounding it – and so residents living close to the border in neighbouring countries have varying degrees of attachment to it. Some Swiss residents (with Switzerland as their official domicile) give birth in neighbouring countries, and one wonders whether all of these births are ultimately included in the Swiss birth registrations, as they should. It is also not unusual for residents of France, Germany or Italy (and possibly Austria) to give birth in Swiss hospitals (as did the author of this paper). These births should, of course, be registered as to non-residents of Switzerland (and so not included in the birth totals), but one wonders whether some could be mis-registered.

5. Comparison with other data

5.1 Parity proportions from sample surveys

A number of sample surveys have been made in Switzerland and these may be able to shed light on whether the census results or the modelled vital statistics might be more ‘correct’.

Figure 10 shows a comparison of cohort parity distributions from the BEVNAT-modelled data and the Fertility and Family Survey (FFS) of 1994, the biggest survey where data on number of children has been collected. The FFS surveyed 3881 females respondents (plus 2083 males) aged 20-49 (Kreyenfeld et al 2011). The mismatch is again greatest for the 1950s cohorts with the survey showing greater levels of childlessness and mothers with 3 and 4 children than calculated from the vital statistics data. Therefore the proportions compare more closely with the pattern recorded in the census.

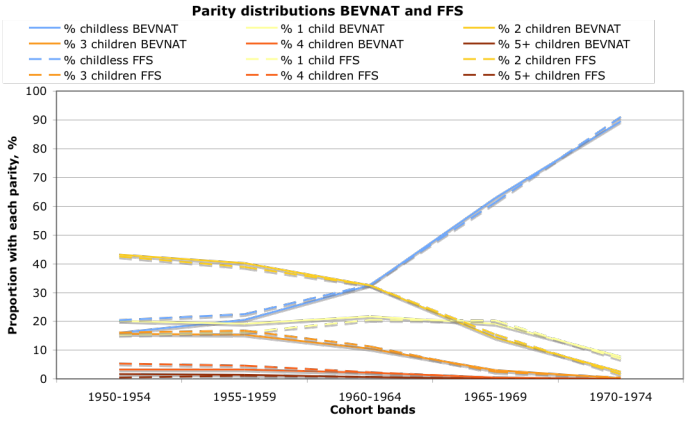

Figure 10: Parity proportions from FFS survey compared to vital statistics

A comparison with fertility data from the Swiss Household Panel (SHP) has been carried out by Kreyenfeld et al (2011). The European Social Survey wave 3 of 2006 (Jowell et al 2007) and European Values Study of 2008 also provide fertility data. Comparative results of mean number of children and parity proportions by cohort are given in Table 4. As the various surveys were carried out in different years, then the comparisons relate to those different times, ie. 1994 for the FFS; 2000 for the main BEVNAT/census comparison and also the SHP; 2006 for the ESS and 2008 for the EVS. The BEVNAT values are those derived from birth registration and population data from 1969 through to the relevant survey year, with birth order modelled as described earlier. The 'adjusted' census data for 2006 and 2008 took the census data from 2000 as a base and then added the births which were recorded after 2000 from the birth registration data base.

Various observations can be made from this table. The first is that there is, on the whole, a very good match between all the data sets. The EVS seems to give less reliable estimates than the ESS, but with smaller sample sizes (45-90 per 5-year cohort band versus 83-119 for the ESS and 419-536 for the SHP) that could be expected. Almost all the survey results give a (slightly) higher mean number of children than calculated from the BEVNAT or census data. This has been considered a common weakness of surveys, as they tend to have a 'family bias', as it is more difficult to access those without children than those who are at home with their children (Kreyenfeld et al 2011). The ESS seems to consistently (slightly) under-estimate the proportion of childless women, but this does not hold true for the EVS, SHP or FFS.

So do the surveys support either the BEVNAT model or the census data as being more correct in their proportions of childless and one-child mothers? The results are not consistent, and in any case all fall within the confidence limits of the sample sizes (roughly +/-4 percent for FFS; +/- 8 percent for ESS; +/- 10 percent for EVS when considering a value of 20 percent). Looking at the SHP, ESS and EVS childless proportions for the different cohort bands (Table 3), four of the twelve measurements have the surveys showing the highest rate of childlessness; five of the surveys show the lowest rate. Looking at all four sample surveys, their proportion of childlessness agrees to within two percent of the census results in three cases (two being from the FFS), and to the BEVNAT results in six cases. So would this support the BEVNAT model over and above the census data? It all depends on whether we believe that the childless are generally under-sampled in surveys and that this is also holds true in these surveys in Switzerland.

Looking at the parity proportions for larger families, then the survey results suggest that the modelling method would be improved if it assigned more births to be third and fourth order births. Comparing the BEVNAT values with those from the SHP and ESS surveys (and some of the EVS data) it would seem that larger families of 3 and more children are more common than would be expected from the BEVNAT database and modelling. However, the possible recent immigration of women with larger families would be an alternative explanation.

Table 4: Mean number of children and parity proportions derived from different data sets: birth registrations (BEVNAT); census 2000; FFS, SHP, ESS and EVS

	BEVNAT 1994	Census 2000	FFS	BEVNAT 2000	Census 2000	SHP	BEVNAT 2006	Census adj. 2006	ESS wave 3	BEVNAT 2008	Census adj. 2008	EVS 2008
1950-1954 cohorts												
Mean no. children	1.8	1.7	1.7	1.8	1.7	1.8	1.8	1.7	1.9	1.8	1.7	1.7
Childless	16%	20%	20%	16%	20%	25%	16%	20%	16%	16%	20%	20%
1 child	20%	16%	15%	20%	16%	13%	20%	16%	12%	20%	16%	18%
2 children	43%	41%	43%	43%	41%	40%	43%	41%	40%	43%	41%	42%
3 children	16%	16%	16%	16%	16%	12%	16%	16%	28%	16%	16%	15%
4 children	3%	5%	5%	3%	5%	9%	3%	5%	3%	3%	5%	3%
5+ children	2%	1%	1%	2%	1%	2%	2%	1%	0%	2%	1%	2%
1955-1959 cohorts												
Mean no. children	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.7	1.9	1.8	1.7	1.5
Childless	20%	22%	23%	18%	22%	25%	18%	21%	17%	18%	21%	27%
1 child	19%	15%	16%	19%	15%	10%	19%	15%	14%	19%	15%	13%
2 children	40%	40%	39%	42%	40%	40%	42%	40%	40%	42%	40%	44%
3 children	15%	17%	17%	16%	17%	17%	16%	17%	25%	16%	17%	13%
4 children	3%	5%	5%	4%	5%	6%	4%	5%	5%	4%	5%	2%
5+ children	1%	1%	1%	2%	1%	2%	2%	1%	0%	2%	1%	0%
1960-1964 cohorts												
Mean no. children	1.3		1.3	1.7	1.6	1.9	1.7	1.7	2.0	1.7	1.7	1.9
Childless	33%		33%	21%	25%	21%	18%	22%	16%	18%	22%	17%
1 child	22%		21%	19%	16%	12%	19%	16%	12%	19%	16%	22%
2 children	32%		33%	40%	38%	37%	41%	40%	43%	42%	40%	32%
3 children	11%		11%	15%	16%	23%	16%	17%	18%	16%	17%	20%
4 children	2%		2%	3%	4%	4%	4%	4%	11%	4%	4%	7%
5+ children	1%		1%	1%	1%	4%	2%	1%	1%	2%	1%	3%
1965-1969 cohorts												
Mean no. children	0.6		0.6	1.2	1.2	1.3	1.6	1.5	1.9	1.6	1.6	1.6
Childless	63%		61%	35%	37%	33%	23%	25%	20%	21%	24%	28%
1 child	19%		20%	21%	20%	21%	20%	18%	10%	19%	18%	13%
2 children	14%		15%	32%	30%	32%	40%	38%	42%	40%	39%	37%
3 children	3%		3%	10%	10%	11%	14%	14%	18%	14%	14%	20%
4 children	0%		0%	2%	2%	2%	3%	3%	10%	3%	3%	2%
5+ children	0%		0%	1%	0%	1%	1%	1%	0%	1%	1%	0%

5.2 Instability in order-specific analysis of fertility postponement and recuperation

The HFC data set of fertility rates by biological birth order has been used to investigate postponement and recuperation of births by birth order in Switzerland (Sobotka et al, 2011). Their study suggests that there might be weaknesses in the modelling of cohort fertility or potential problems with order-specific redistribution of the cohort data used. To quote: “Huge fluctuations across cohorts, as found especially for third and higher-order births in Switzerland, might be attributable to the small absolute size of fertility decline at younger ages (the postponement component) that can make trends in recuperation at older reproductive ages unstable. Alternatively, these fluctuations might signal unreliable estimations of birth order distribution of cohort fertility”. Following this up, Sobotka (personal communication) says “it seems that after the redistribution first birth rates might have been underestimated in the post-1950 cohorts, while 3rd+ birth rates might have been inflated”. This conclusion is in direct contrast to the discussion in section 4, in which it was suggested that more births should have been assigned to higher birth orders. It would also support the idea that there has been a trend over time for an increasing proportion of births needing to be re-assigned to higher birth orders because of biological birth order being higher than marital birth order. And so we return to the proposal suggested back in section 2 that “too many births, both extra-marital and marital, have been assigned to higher orders than they should be” – because of the trends. At the same time, we have a little more evidence that migration could be the cause of the mismatch of parity proportions derived from the census (and sample surveys) and birth registration.

6. Summary and conclusions

The demographic and fertility trends in Switzerland have been studied in depth in several previous studies (Calot, 1998; Fux, 2005; OFS, 2009a; Wanner and Fei, 2005; Rossier and Le Goff, 2005; Sauvain-Dugerdil, 2005; Gabadinho and Wanner, 1999). A recent newsletter of the Swiss Federal Statistical Office was devoted to the subject of fertility trends in Switzerland (OFS, 2009b).

The modelling of biological parity using recently collected marital and biological data to extrapolate back in time has been shown to give reasonably comparable results with the fertility data collected in the 2000 census. The small mismatches in parity proportions (particularly the childless proportion) between the two data sets have been discussed at some length, but no definitive conclusion as to which might be more accurate, or indeed if they could even be expected to be identical, was reached. The potential weaknesses in both data sets have been addressed, as was the confounding factor of migration. This report makes users of the Human Fertility Collection (HFC) for Switzerland aware of possible inconsistencies in the data and suggests where further investigations may help.

The next collection of fertility data of the population in Switzerland is planned to be carried out in a partial census in 2013. With the results of census data from both 2000 and 2013, then the influence of migration and the other possible factors on cohort fertility rates might be able to be clarified.

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Appendix 1: Small sample data of biological and marital birth orders from 2008

		Hors mariage	Rang dans le mariage en cours "du lit actuel"				
Âge de la mère	Rang biolo-gique	0	1	2	3	4	5+
27	0	0	0	0	0	0	0
27	1	456	1821	0	0	0	0
27	2	131	34	1113	0	0	0
27	3	21	3	9	232	0	0
27	4	2	1	1	1	36	0
27	5+	0	0	0	0	1	4
28	0	0	0	0	0	0	0
28	1	536	1984	0	0	0	0
28	2	181	46	1399	0	0	0
28	3	25	9	14	341	0	0
28	4	8	2	1	0	45	0
28	5+	0	0	2	0	2	4
29	0	0	0	0	0	0	0
29	1	558	2118	0	0	0	0
29	2	171	46	1503	0	0	0
29	3	32	8	24	390	0	0
29	4	12	1	1	3	78	0
29	5+	0	0	0	0	0	11
30	0	0	0	0	0	0	0
30	1	579	2216	0	0	0	0
30	2	188	40	1722	0	0	0
30	3	28	12	19	480	0	0
30	4	4	2	2	1	86	0
30	5+	1	0	0	1	3	13
31	0	0	0	0	0	0	0
31	1	574	2156	0	0	0	0
31	2	191	36	1800	0	0	0
31	3	30	12	17	585	0	0
31	4	14	2	7	5	103	0
31	5+	0	1	0	1	1	21
32	0	0	0	0	0	0	0
32	1	534	2072	0	0	0	0
32	2	205	52	1964	0	0	0
32	3	47	8	28	607	0	0
32	4	10	1	7	5	127	0
32	5+	1	0	1	0	0	27
33	0	0	0	0	0	0	0
33	1	501	1854	0	0	0	0
33	2	208	45	2043	0	0	0
33	3	46	21	19	634	0	0
33	4	16	2	10	10	143	0
33	5+	2	0	2	0	1	25
34	0	0	0	0	0	0	0
34	1	450	1695	0	0	0	0
34	2	244	55	1902	0	0	0
34	3	59	11	22	662	0	0
34	4	13	2	4	4	148	0
34	5+	5	0	1	0	0	38

Appendix 2
Redistribution of births with unknown birth order pre-1998 and 1998-2004

This appendix formalises the method used to estimate the numbers of births by biological birth orders where only marital birth order was known.

The variables are as follows:

1. Calendar year *t*.
2. Age reached during the year *y*.
3. Marital status of the mother (married *M* or non-married *NM*).
4. Birth order within the current marriage *j* (1-5+; it is always known, but for married women only).
5. Biological birth order *i* (1-5+ or unknown).

For the years 2005-2008 a complete table of equivalence is available on the relation between marital status of mother, birth order inside marriage, and biological birth order. For the years 1998-2004, the majority of births have been registered by both marital and biological birth order, but there are some unknown cases. We use all the available information to redistribute the unknown cases in the best possible way. The approach we use to redistribute births with unknown biological birth order is expressed in following formulae.

First we identify the proportion of births in each birth order using the information from 1998-2008:

For non-marital births:

$$b_i^{NM}(y) = \frac{B_i^{NM}(y,1998-2008)}{B_{TOT}^{NM}(y,1998-2008) - B_{UNK}^{NM}(y,1998-2008)} \quad [1]$$

For marital births, where biological birth order *i* is not the same as marital birth order *j* then we distribute biological birth order within each category of birth order as follows:

$$b_i^{Mj}(y) = \frac{B_i^{Mj}(y,1998-2008)}{B_{TOT}^{Mj}(y,1998-2008) - B_{UNK}^{Mj}(y,1998-2008)} \quad [2]$$

Proportions $b_i^{NM}(y)$ and $b_i^{Mj}(y)$ are smoothed using the 5-year moving average across age *y* (except no smoothing for <=15 year women and 3-year moving average for 16 year olds). For ages 44+ the calculated proportions were fixed to be the same as for age 43:

for y=16:
$$\hat{b}_i^{NM}(y) = \sum_{a=y-1}^{y+1} \frac{b_i^{NM}(a)}{3} \quad [3]$$

$$\hat{b}_i^{Mj}(y) = \sum_{a=y-1}^{y+1} \frac{b_i^{Mj}(a)}{3} \quad [4]$$

for y=17 to 43:
$$\hat{b}_i^{NM}(y) = \sum_{a=y-2}^{y+2} \frac{b_i^{NM}(a)}{5} \quad [5]$$

$$\hat{b}_i^{Mj}(y) = \sum_{a=y-2}^{y+2} \frac{b_i^{Mj}(a)}{5} \quad [6]$$

for y=44+:
$$\hat{b}_i^{NM}(y) = \hat{b}_i^{NM}(43) \quad [7]$$

$$\hat{b}_i^{Mj}(y) = \hat{b}_i^{Mj}(43) \quad [8]$$

For the years prior to 1998, we then estimate the number of non-marital births by biological birth order using proportions calculated in [3], [5] and [7]:

$$B_i^{*NM}(y,t) = B^{NM}(y,t) \cdot \hat{b}_i^{NM}(y) \quad [9]$$

Similarly, we redistribute the marital birth orders using the proportions calculated in [4], [6] and [8]:

$$B_i^{*Mj}(y,t) = B^{Mj}(y,t) \cdot \hat{b}_i^{Mj}(y) \quad [10]$$

For births in the period 1998-2004, where some biological birth orders are known, but others are not, then the combined data are as follows:

$$B_i^{*NM}(y,t) = B_i^{NM}(y,t) + B_{UNK}^{NM}(y,t) \cdot \hat{b}_i^{NM}(y) \quad [11]$$

$$B_i^{*Mj}(y,t) = B_i^{Mj}(y,t) + B_{UNK}^{Mj}(y,t) \cdot \hat{b}_i^{Mj}(y) \quad [12]$$

Finally, the total number of births by age of the mother and biological birth order is estimated by adding non-marital births and the sum of marital births for each corresponding category of age and biological birth order:

$$B_i^{*}(y,t) = B_i^{*NM}(y,t) + \sum_{i=1}^{5+} B_i^{*Mj}(y,t) \quad [13]$$

Appendix 3
SFSO definition of resident population for census and for birth registration

The most important points relating to registration of births and census are highlighted.

Link to French version :
http://www.bfs.admin.ch/bfs/portal/fr/index/themen/03/22/publ.html?publicationID=2093
Link to German version :
http://www.bfs.admin.ch/bfs/portal/de/index/themen/03/22/publ.html?publicationID=2092

La statistique démographique de la Suisse utilise différents concepts démographiques. Les deux concepts fondamentaux sont: la population résidante et la population résidante permanente (voir tableau).
Toutes les personnes, suisses et étrangères, ayant leur domicile dans une commune au 5 décembre 2000, jour du recensement, font partie de la population résidante de cette commune, au sens du recensement.
La population résidante étrangère comprend: les titulaires d'un permis d'établissement ou d'un permis de séjour (y compris les réfugiés reconnus), les saisonniers, les titulaires d'un permis de séjour de courte durée, les requérants d'asile, les personnes admises à titre provisoire, les fonctionnaires des organisations internationales, les employés des représentations diplomatiques ou des entreprises d'Etat étrangères (poste, chemins de fer, douanes) ainsi que les membres de leur famille vivant en Suisse. En revanche, les frontaliers travaillant quotidiennement en Suisse, les touristes et les personnes en visite ou en voyage d'affaires en sont exclus.
Une même personne pouvant disposer de plusieurs domiciles, le recensement de 2000 établit comme en 1990 une distinction entre le domicile économique et le domicile civil:
– Le domicile économique d'une personne se situe dans la commune où elle réside la majeure partie de la semaine, dont elle utilise l'infrastructure et d'où elle part pour se rendre à son lieu de travail ou de formation.
– Le domicile civil des personnes de nationalité suisse se situe dans la commune où est déposé leur acte d'origine et où elles paient leurs impôts. Pour les ressortissants étrangers, il s'agit de la commune qui leur a délivré leur permis.
Dans la plupart des cas, le domicile civil et le domicile économique coïncident. Les personnes qui ont deux domiciles distincts sont, par exemple, les pensionnaires d'institutions, les élèves vivant en internat et les personnes qui résident durant la semaine près de leur lieu de travail ou de formation (domicile économique) et qui rentrent chez elles (domicile civil) en fin de semaine.
En vertu de l'ordonnance du 13 janvier 1999 sur le recensement fédéral de la population de l'an 2000, la population prise en compte se réfère au domicile économique. Tous les tableaux qui ne portent pas de mention particulière présentent des résultats fondés sur la population résidante au domicile économique.
Contrairement au recensement de la population, la statistique de l'état annuel de la population (ESPOP) opère sur la base du concept de domicile civil et parle de population résidante permanente. La population résidante permanente est généralement calculée en fin d'année (31 décembre). Outre les personnes de nationalité suisse, la population résidante permanente comprend aussi tous les ressortissants étrangers titulaires d'une autorisation officielle de séjour qui leur permet de séjourner au moins 12 mois sur le territoire suisse. Il importe peu que ces personnes séjournent effectivement en Suisse pendant au moins une année. La plupart des indicateurs démographiques (taux de fécondité, de mortalité, de nuptialité, de migration) sont calculés à partir de la population résidante permanente.
Le tableau permet de comparer les notions de «population résidante» et de «population résidante permanente» :

Groupes de personnes	Population résidante	Population résidante permanente
Personnes de nationalité suisse		
• Domicile civil en Suisse	inclus	inclus
• Domicile (permanent) à l'étranger		
– *Domicile économique en Suisse*	inclus	non inclus
– *Personnel des représentations diplomatiques de la Suisse à l'étranger*	partiellement inclus[1]	partiellement inclus[1]
– *Membres de la marine marchande suisse*	partiellement inclus[1]	partiellement inclus[1]
Personnes de nationalité étrangère		
• Titulaires d'une autorisation de séjour annuel (permis B), d'une autorisation d'établissement (permis C), d'une autorisation de séjour de courte durée de 12 à 18 mois (permis L)	inclus	inclus
• Titulaires d'une autorisation saisonnière (permis A)	inclus	non inclus
• Titulaires d'une autorisation de séjour de courte durée de moins de 12 mois (permis L)	inclus	non inclus
• Etrangers admis provisoirement (permis F), requérants d'asile (permis N)	inclus	partiellement inclus[2]
• Personnel des représentations diplomatiques étrangères et des organisations internationales en Suisse et les membres de leur famille (autorisation du DFAE)	inclus	inclus
• Frontaliers (permis G)	non inclus	non inclus
• Personnel des représentations diplomatiques de la Suisse à l'étranger	non inclus	non inclus