Why the Standard TFR gives a Misleading Impression of the Fertility of Foreign Women: Insights from Switzerland

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Abstract: Since 1971 the Swiss Federal Statistical Office has published annual fertility data split by nationality (Swiss/foreign). These indicate that the TFR for women of foreign nationality has been 0.5 children higher than for Swiss women for most of the period since 1991. However, statistics from household registration (STATPOP) and the Families and Generations Surveys (FGS) in 2013 and 2018 indicate that foreign women, approaching the end of their reproductive lives, have slightly smaller families than women of Swiss nationality. The purpose of this paper is to reconcile these contradictory fertility measures. To do this, we design a novel methodology for tallying the fertility of cohorts of Swiss and foreign nationals through their reproductive life. In addition to birth registrations and population totals by age (the input data for calculating the TFR) we also include estimates of how many children women have at the time of their immigration, emigration and naturalisation. Using these input data, we compile the fertility profiles of Swiss and foreign women aged 15-49 (cohorts 1966-2003). These correspond well with the FGS and household register data.

Several processes impact the final fertility of the two sub-populations. Women frequently immigrate into Switzerland in their 20s. Often arriving childless, they commonly start childbearing soon after immigration. However, there is still a flow of low-fertility women into the country in their 30s and 40s, lowering the average fertility of the foreign population. By contrast, Swiss women start childbearing later and a significant proportion remain childless; however, after starting childbearing they have a higher propensity than foreign women to have a second and third child. Naturalisation and fertility are interlinked; women with children are more likely to naturalise than those without, which then boosts the average fertility of the Swiss population.

We confirm that the standard TFR gives an inflated impression of the ultimate (cohort) fertility of foreign nationals and under-estimates that of Swiss women, and we describe how this happens. Fundamentally, the TFR is a measure of childbearing intensity, not an accurate estimate of completed cohort fertility, especially for a mobile population.

Keywords: Immigrant fertility · Fertility of foreigners · TFR · Cohort fertility · Immigration · Timing of childbearing · Naturalisation · Postponement

1 Introduction

The purpose of this paper is to address a conundrum. Whilst the period TFR of foreigners in Switzerland has consistently been higher than for Swiss nationals (0.5 children or more for most of the past three decades), the pattern is reversed from a cohort perspective: Swiss women have more children than foreign women by the time they reach their late 30s. We have confidence that both these measures are statistically robust, so how can the disparity between the period and cohort measures be reconciled?

The methodology presented in this paper quantifies the processes – births, in- and out-migration and naturalisation – that determine the fertility of cohorts of women as they pass through their reproductive lives. The results of our analysis come very close to the cohort fertility observed in household register data and two recent fertility surveys. Switzerland is a valuable case study because it has a large foreign population as well as excellent data sources.

The structure of the paper is as follows. The literature review focuses on studies that have addressed the weaknesses in the TFR when used for non-native groups. The unique characteristics of Switzerland and its evolving immigrant groups are then summarised, followed by a summary of the data sets used. We then describe the methodology used to tally the fertility of cohorts as they pass through their reproductive life. The elements of the calculation are discussed in more detail: births, immigration, emigration and naturalisation. We then compare the results of our cohort tracking with the fertility measures found in the household register and Family and Generations Surveys. Next, we summarise the processes which influence cohort fertility and address the fundamental weaknesses of the TFR and why it frequently does not indicate the ultimate number of children of foreign nationals. We conclude by discussing our results in the context of previous studies and make suggestions for which measures might better portray the fertility of native and non-native women.

Before launching into the body of the paper, we first need to clarify the definition and characteristics of our population subgroups.

- Swiss national (or simply "Swiss"): someone who holds Swiss citizenship, either from having had at least one Swiss parent or having naturalised. This may be in addition to other nationalities, as becoming Swiss does not automatically (nowadays) preclude holding other nationalities.

- Foreign national: someone with citizenship(s) not including Swiss nationality.

- Immigrant: anyone, of any age, arriving from abroad to live in Switzerland. They may have lived in Switzerland previously or even been born there, and may or may not have Swiss nationality.

The focus of this paper is the dichotomy between Swiss and foreign nationals, as this is the main classification used by the Swiss Federal Statistical Office (SFSO). However, there are several subsets within these two large groups:

1. Swiss born in Switzerland ("Swiss born CH" for short). The majority of these women were Swiss from birth; however, a small proportion were born to

parents with foreign nationality, so did not have the right to Swiss nationality at birth but gained it later in life. In the 2000 census about 5 percent of women aged 15-45 in the "Swiss born CH" category were in this category; in the 2018 Family and Generations Survey (FGS) it was 9 percent.

2. Swiss born abroad. This group also has two components: Swiss from birth, having been born to at least one Swiss parent (whilst living abroad); and immigrants who came to the country as foreigners (as children or adults) and subsequently naturalised. At age 15 half of this group were Swiss from birth and half were naturalised; amongst women in their 40s, 90 percent were naturalised.

3. Foreign national born in Switzerland ("Foreign born CH"). Having been born to foreign parents, but then (often) having spent their childhood in Switzerland, women in this group tend to take up Swiss nationality in their "transition to adulthood" and "settling down" phase of life (and hence join group 1). As such, many in this group could be considered as "pre-naturalised". The rest may choose not to naturalise, either because they do not want to lose their existing nationality, or because they find the naturalisation process too daunting or expensive.

4. Foreign national born abroad. Some come to Switzerland as children with their parents, but the majority come as adults in their 20s and 30s.

Figure 1a shows these four sub-groups by age (15-49) in 2000 and 2018. In the period between these two years, the number of "Swiss born CH" slightly declined in absolute terms (from 1.2m to 1.1m), and the "Foreign born abroad" group rose significantly (from 20 percent to 28 percent of this age group). More than one-third of women in their 30s were "Foreign born abroad" in 2018. Figure 1b shows the proportion of women, Swiss and foreign, by whether they were born in Switzerland or born abroad, by age.

2 Literature review

In demographic literature there have been numerous studies comparing "native" and "non-native" fertility. These non-specific terms may refer to migration status (born in or outside the country of study), nationality (the focus of this paper) or ethnicity (which can include second- or higher-generation migrants).

This literature review focuses on specific aspects pertinent to our analysis: first, why the period TFR can be misleading when interpreted as lifetime (cohort) fertility; second, the timing of migration in relation to first birth and how this impacts the TFR measure; third, the duration of stay in the receiving country and its impact on the TFR; and fourth, the parity progression of migrants. Finally, we give an overview of alternative ways to describe the fertility of immigrants that may be better than the standard TFR. We return to discuss these in the final section of the paper.

The standard measure of fertility, the Total Fertility Rate (TFR), is a measure of the *intensity* of childbearing in a specific year (of the group of women in question); it only approximates ultimate fertility if the population (group) is stable, with no immigration, emigration, mortality or change in timing of childbearing. *Sobotka* and

**Fig. 1a:**   Population of women aged 15-49 in 2000 (left) and 2018 (right)

Population of women in 2000

Population of women in 2018

Swiss born abroad

Foreign born abroad

Swiss born CH

Foreign born CH

- - - - -   the dashed line on right graph shows the cohort that was
15 years old in 2000
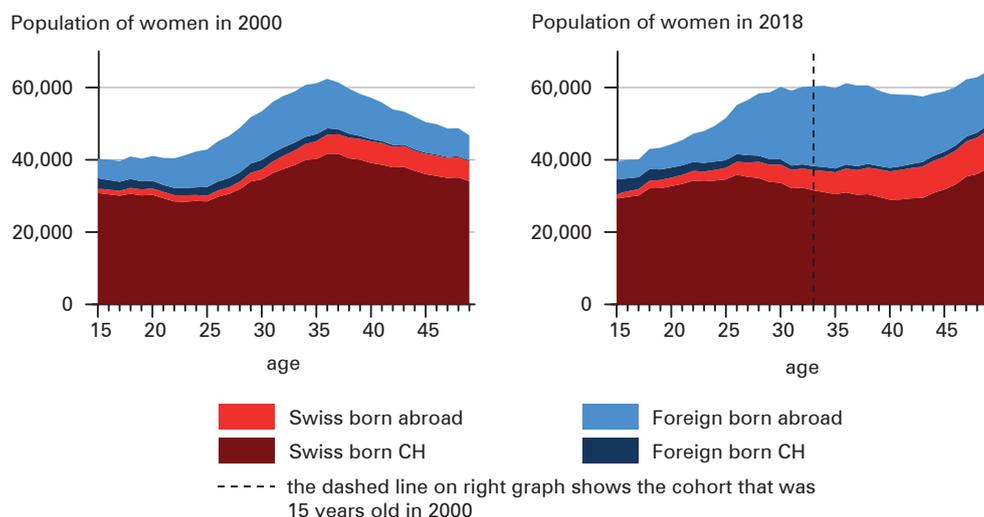
Fig. 1b: Proportion of women aged 15-49 born in Switzerland or abroad in 2018,
Swiss nationals (left) and foreign nationals (right)

In percent

In percent

Born abroad

Born abroad

Born in Switzerland

Born in Switzerland
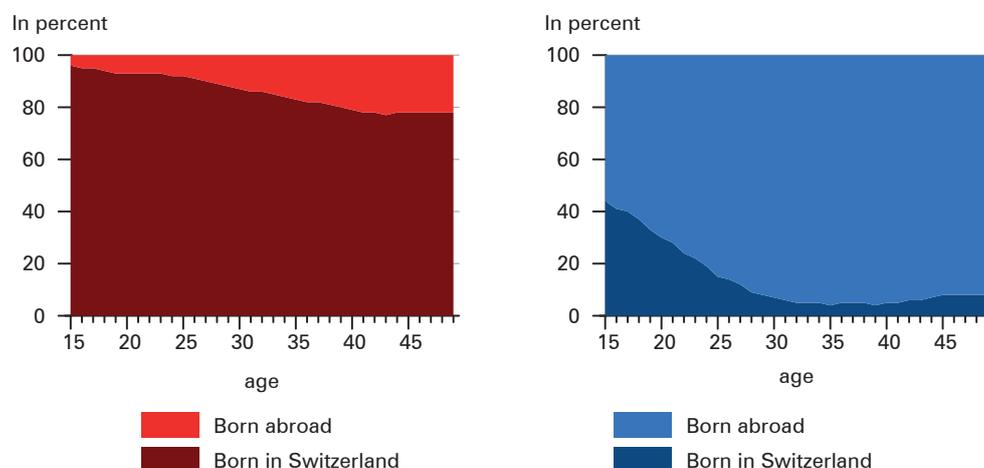
Source: Census 2000, STATPOP 2018, Swiss Federal Statistical Office

Lutz (2010) heavily criticised its use because, although it is a simple measure, it
often misrepresents cohort fertility and is easily misinterpreted by policy-makers.
The distortions to the TFR caused by changes in timing of childbearing have been
addressed extensively (the seminal paper on the deflationary effect of postponement
is *Bongaarts/Feeney* 1998); however, the distortions inherent in calculating the TFR
of non-natives have received less attention.

The reason the TFR fails to characterise immigrant fertility is because there is, commonly, a high intensity of childbearing (often first births) in the years immediately after arrival in the new country following low fertility in the years preceding migration (*Ng/Nault* 1997; *Toulemon/Mazuy* 2004; *Andersson* 2004; *Dubuc* 2012; *Robards/Berrington* 2016; *Tønnessen* 2020). This has been termed a "migration-specific tempo effect" (*Dubuc* 2016). As outlined by *Sobotka* and *Lutz* (2010), the TFR for foreigners (as opposed to immigrants) is even more susceptible to distortion because women who stay longer in a country more often naturalise and are then no longer foreign nationals. Therefore, the TFR of foreigners tends to relate only to women who have been in the country for a relatively short duration – after they arrive but before they naturalise, which is also a period of peak likelihood for starting a family.

In technical terms, a high intensity of first births inflates the TFR1 (first birth TFR) to values that can be higher than unity (one). In a stable population the complement of TFR1 (i.e. 1-TFR1) would be the proportion of women who remain childless; and so a value higher than one would make no sense in cohort terms. *Parrado* (2011), for instance, found values of TFR1 for immigrants to the United States from Mexico to be over 1.5 in the period 1990-2005. As the total fertility rate is the sum of fertility rates of all birth orders, then a "distorted" value for TFR1 will automatically lead to an unrealistically high overall TFR which does not reflect the "true" (cohort) fertility of immigrants.

Because migration and childbearing are often closely interlinked, the average duration of stay of immigrants in the new country has a significant impact on their TFR. The impact of change in average duration of stay, as well as other factors, has been analysed in detail to determine its relative importance on trends in the TFR of immigrants (*Tønnessen* 2020).

The likelihood and intensity of transition to second and third birth of non-natives have been the subject of several studies, with mixed results. In Germany, *Milewski* (2010) found immigrants transitioned to a second birth more frequently than native Germans, even if they had already had a child pre-migration. However, for third births, this only held true for immigrants from Turkey. In Switzerland the opposite was found: the transition to second birth for migrants was less frequent and came after a longer interval than for Swiss natives (*Rojas et al.* 2018). *Berrington* and *Stone* (2017) found that parity progression to third and fourth children is quite high in the United Kingdom for women from Pakistan and Bangladesh, although native British women also have higher proportions of three- and four-child families compared to many other European countries. In Italy migrants from Albania and Morocco are more likely to have a second or third child compared to Italian natives, but Ukrainian immigrants are less likely to do so (*Impicciatore et al.* 2020).

What alternatives to the standard TFR to better describe migrant fertility have previously been proposed? Using data for France *Toulemon* and *Mazuy* (2004) applied three methods to the large data set of the 1999 survey Étude de l'Histoire Familiale: (1) an adjusted TFR, using estimated age-specific fertility rates which took into account the period of high childbearing soon after an immigrant arrives; (2) the "own children method" (*Cho et al.* 1986, Chapter VIII) which reconstructs, for years

prior to the survey, the age-specific period fertility rates (ASFRs) and hence TFRs which include pre-migration fertility; and (3) a novel methodology combining data on the fertility of immigrants at the time they arrived in France (by age of arrival) plus their fertility in subsequent years. They concluded that "true" immigrant fertility was somewhat higher than native fertility but significantly less than the 0.7 excess implied by the standard TFR differential.

Using UK Labour Force Survey data, *Dubuc* (2009) compared two methodologies to describe fertility by ethnicity. She applied the child-woman ratio (CWR) and compared the results of this method with her refined reverse-survival own-child method, both methods including pre- and post-migration fertility for immigrant women. She found that the latter procedure, in particular, offers a reliable means of estimating fertility trends by ethnic and immigrant groups (*Dubuc* 2009, 2016).

Several other studies have also used the "own children method" to compare native and immigrant fertility (*Krapf/Kreyenfeld* 2015; *Abbasi-Shavazi/McDonald* 2002; *Wanner* 2002; *Wanner/Fei* 2005). The general conclusion is that (high-fertility) immigrant populations approach the (low-fertility) norms of the host country after a period of time.

To summarise, the standard TFR, by definition, only includes births to women already present in the country. Some studies (e.g. the ones cited in the previous three paragraphs) include pre-migration fertility histories in their estimates of ultimate (cohort) fertility. This adjusts the numerator (births) in the TFR calculation. Modifying the denominator (population of women aged 15-49) to include (commonly childless) migrants who have yet to arrive in the country has also been proposed as an alternative approach (*Burkimsher/Rossier* 2017).

All approaches to assess non-native fertility are constrained by the availability of reliable data; birth registration (by nationality or country of birth) data are generally available (in many developed countries) and it is *a priori* assumed that these can give estimates of the relative fertility of native and non-native groups. However, neither the fertility of arriving migrants nor the distortions inherent in the migration-specific tempo effect are commonly taken into account – and the impact on the TFR of the fertility of emigrants has never, to our knowledge, been integrated into fertility models (although *Toulemon/Mazuy* 2004 acknowledged this deficiency).

3   The Swiss context

Switzerland has one of the highest shares of foreigners in its population amongst European countries. It also has a history of compiling high-quality demographic statistics (*Calot* 1998). Over one quarter of the 2019 permanent resident population of 8.5 million are non-Swiss; only Luxembourg and Liechtenstein have a higher percentage (*Eurostat* 2020). From being a poor country with predominantly negative net migration through the 19th century and until 1930, Switzerland transformed itself into a wealthy country with its population growing primarily from strong immigration (*Calot* 1998).

Fig. 2:   Foreign female population aged 20-39 by nationality, 1995-2018

Population
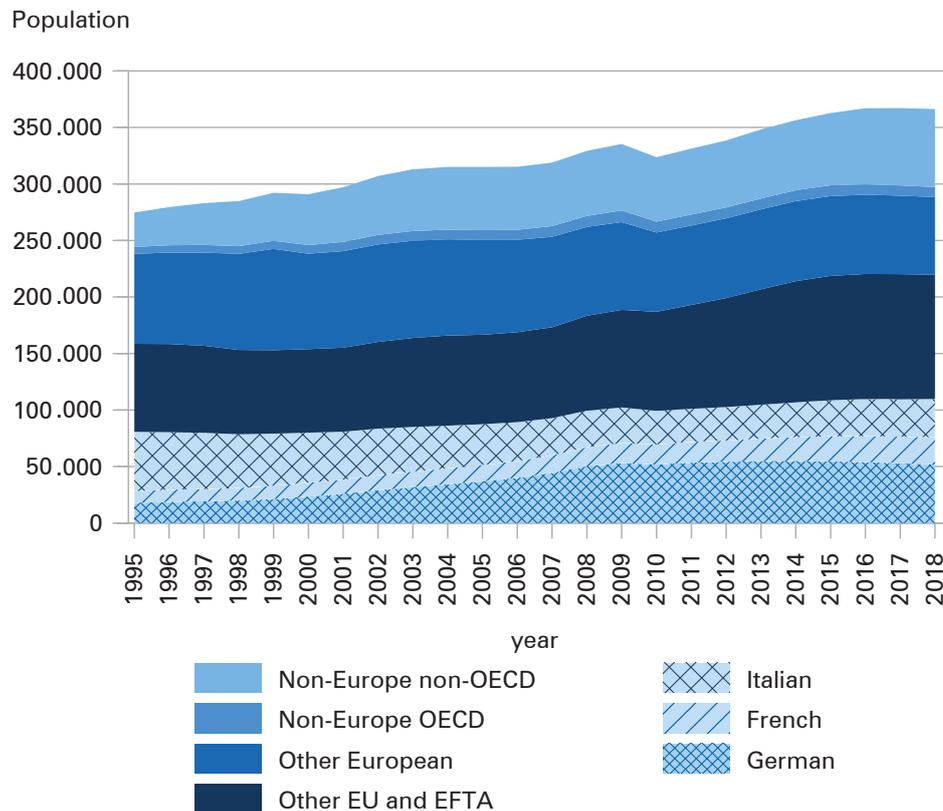
Other EU and EFTA: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Spain, UK (and smaller countries)

Other European: Albania, Belarus, Bosnia, Kosovo, Moldova, Montenegro, North Macedonia, Russia, Serbia, Turkey, Ukraine

Non-European OECD: Australia, Canada, Chile, Japan, Mexico, New Zealand, South Korea, USA

Note: the kink from 2009-2010 reflects the change from the PETRA database to the household register system of collecting population data (STATPOP).

Source: PETRA and STATPOP

Prior to 1990 the main origin countries of immigrants were Italy, Spain and Portugal. The country has a long-standing culture of welcoming refugees, e.g. from Vietnam in the 1970s and Eritrea in recent years; in the 1990s it experienced an influx of migrants from former Yugoslavia. In December 2008 Switzerland joined the Schengen zone and, following that, more immigrants came from the new EU member states of Eastern European. In recent years the diversity of source countries has increased, with highly educated non-Europeans being a particular source of growth (*D'Amato et al.* 2019), a pattern seen elsewhere in Europe (e.g. the

UK; *Dubuc* 2016). Currently, more Germans are arriving than have in the past, but fewer Italians. Figure 2 shows the evolution in the composition of the female foreign population of prime reproductive age (20-39) since 1995.

A number of studies on the fertility of sub-populations in Switzerland provide valuable background information for this study. Already cited are *Calot* (1998); *Wanner* (2002); *Wanner/Fei* (2005); *Rojas et al.* (2018) and *D'Amato et al.* (2019). A comparison of childlessness, using the 2000 census data, indicated that women from many Asian and Anglo-Saxon countries and Germany had higher rates than those born in Switzerland (of whom around 20 percent aged 40-70 were childless), whereas women from southern Europe and the Balkans were less likely to be childless (*Burkimsher/Zeman* 2017). Immigrants from France and Germany comprise a significant and growing share of new arrivals and have characteristic fertility patterns. These are reflected in the linguistic areas of Switzerland: Francophones enter motherhood earlier, whereas Germanophones more often remain childless – but, if they have one child, they move on to a second more readily (*Ruckdeschel et al.* 2018). The demography of foreigners in Switzerland is the topic of two edited volumes of papers: *Wanner et al.* (2012) includes chapters on fertility, naturalisation and emigration; *Steiner* and *Wanner* (2019) covers studies of "Migrants and Expats in Switzerland". The interconnected timing and propensity of life events of migrants (partnership, marriage, migration, birth of first and second child) compared to natives is investigated by *Gerber* and *Burkimsher* (forthcoming).

Extra-marital childbearing is relatively low but growing in Switzerland. In 2019 26 percent of births were outside marriage. Mixed marriages are very common. Since 2000, only a half or fewer of all marriages have been between two partners of Swiss nationality. In 2019 20 percent were between a Swiss man and a foreign woman and 16 percent between a foreign man and a Swiss woman. Of the 16 percent of marriages that were between two partners of foreign nationality, 45 percent were between partners of different nationalities. The analyses in this paper compare women primarily by nationality; however, we should remember that many of their partners have a different origin.

4   Data sources

We summarise here the data sources cited in this paper and discuss their applicability for our study. A critique of their weaknesses is covered in section 6.

1. Census of December 2000. This was the last comprehensive decennial census; since 2010 population registers have been used to supply information on population numbers in a more timely and cost-effective manner. However, the 2000 census provides a wealth of additional information not available in population registers which has been exploited in this paper: the number of biological children and their years of birth (up to the 5th or last); country of birth; nationality and (if applicable) year of naturalisation. However, it does not include the year an immigrant arrived in Switzerland.

2. Household register data (STATPOP) from 2010 onwards. This collates data on all households in Switzerland with information on the age, sex, nationality

and country of birth of all co-residents (*SFSO* 2016a). When people move to Switzerland they are added to the register; when people leave they are recorded as emigrants. Annual data on immigrants, emigrants and naturalisations by age and gender are published. STATPOP superseded the PETRA database, which collated information about foreign residents up to 2009 (*SFSO* 2016b).

3. Birth registration by age and, from 1971, whether the mother had Swiss or foreign nationality (the BEVNAT database). Since 2011 births can be linked to the STATPOP database and so the country of birth of the mother can be retrieved. From 1971 onwards, the SFSO has published the TFR of Swiss and foreign women and, from 2011, by both nationality and country of birth.

4. Families and Generations Surveys (FGS) from 2013 and 2018 (*SFSO* 2013). These are two similar cross-sectional surveys sampled to be representative of the population of Switzerland; there are plans to repeat these every five years. Both surveys sampled almost 5000 women of reproductive age, over 20 percent of whom were foreign nationals. The FGS is similar in scope to the Generations and Gender Survey, which has been carried out in twenty other (mostly) European countries. Both FGS surveys include the year of immigration, but only the FGS 2013 includes the year of naturalisation.

5. Migration-Mobility Survey (*NCCR on the move* 2018). This survey sampled 7700 immigrants who had lived in Switzerland for less than ten years. This data set includes the country of residence of the children of migrants, Switzerland or abroad.

5   Methodology

The aim of our methodology is to estimate the average number of children of women by nationality (Swiss and foreign) as they pass through their reproductive life. As we have comprehensive data from 1981-2018 on the numbers of women immigrating, emigrating and naturalising, as well as their births, then we can track the full reproductive lives (ages 15-49) for cohorts born 1966-1969. For younger cohorts, we have estimates of their fertility over a shorter time span. In the example calculation described below, we have chosen to follow the cohort born in 1979, who reached age 39 in 2018. After this age, around 0.1 children may be expected to be added to their average fertility from additional births at current fertility rates.

Although we use the word "track", we do not have individual-level data for the number of children through the life course of women; rather, we make assumptions on average fertility (by age) at the transition points of immigration, emigration and naturalisation.

Tables 1a and 1b show the elements and steps in the calculation for the 1979 cohort, who turned 15 in 1994. The mid-year population values are derived from the end-of-year population numbers as published by the SFSO (e.g. the mid-year population of 15-year-olds in 1994 is the average of the population of 14-year-olds at the end of 1993 and 15-year-olds at the end of 1994). The inputs of births and children associated with migration and naturalisation are described in sub-sections 5.1, 5.2 and 5.3.

Tab. 1a: Calculation table to track the number of children of the 1979 cohort of women, Swiss nationals

	Age	Mid-year population Swiss nationals	Births <A>	Immigrants Swiss nationals	Children of immigrants <B>	Emigrants Swiss nationals	Children of emigrants <C>	Naturalisations	Children of naturalising women <D>	Incoming children <A>+<B>-<C>+<D>	Cumulative children	Children/woman
1994	15	30284	1	68	0	68	0	135	0	1	1	0.00
1995	16	30527	8	91	0	90	0	201	0	8	9	0.00
1996	17	30752	26	105	0	120	0	234	0	26	35	0.00
1997	18	30957	60	142	0	202	0	414	3	63	98	0.00
1998	19	31267	172	215	2	309	0	407	2	176	275	0.01
1999	20	31544	290	272	5	400	7	322	5	293	568	0.02
2000	21	31765	471	380	11	516	13	332	9	478	1046	0.03
2001	22	32138	586	371	14	458	16	216	35	619	1665	0.05
2002	23	32457	757	381	16	435	18	283	103	859	2523	0.08
2003	24	32570	1006	353	21	440	26	230	131	1132	3655	0.11
2004	25	32675	1394	336	23	473	37	236	182	1562	5217	0.16
2005	26	32797	1775	339	35	472	51	280	273	2032	7249	0.22
2006	27	32979	2203	369	49	508	74	354	418	2596	9845	0.30
2007	28	33192	2659	344	55	466	85	355	432	3061	12906	0.39
2008	29	33434	3186	316	63	392	91	388	486	3644	16549	0.49
2009	30	33773	3631	287	82	331	114	426	549	4148	20697	0.61
2010	31	34144	3998	278	106	291	112	387	512	4504	25202	0.74
2011	32	34275	4129	236	105	314	163	438	596	4667	29869	0.87
2012	33	34367	4194	218	119	265	158	342	486	4640	34509	1.00
2013	34	34716	3811	235	156	239	158	420	622	4431	38940	1.12
2014	35	35125	3688	193	143	254	193	437	673	4311	43251	1.23
2015	36	35555	3279	175	145	220	190	511	818	4052	47303	1.33
2016	37	36037	2672	168	157	189	170	539	895	3554	50857	1.41
2017	38	36567	2048	175	178	195	191	602	991	3027	53884	1.47
2018	39	37100	1626	146	146	171	156	538	878	2495	56379	1.52

Source data for elements in Table 1a and 1b: As published by SFSO: Population; Births <A>; Immigrants by age and nationality; Emigrants by age and nationality; Naturalisations

Children of immigrants/emigrants, <B> and <C>: Number of immigrants/emigrants multiplied by mean fertility at these transitions, by age, as described in Section 5.2 and tabulated in Table 3.

Children of naturalising women: Number of naturalising women multiplied by fertility rates by age at naturalisation, as described in Section 5.3 and tabulated in Table 3.

Tab. 1b: Calculation table to track the number of children of the 1979 cohort of women, foreign nationals

	Age	Mid-year population foreign nationals	Births <A>	Immigrants foreign nationals	Children of immigrants <B>	Emigrants foreign nationals	Children of emigrants <C>	Naturali-sations	Children of naturalising women <D>	Incoming children <A>+<B>- <C>-<D>	Cumulative children	Children/ woman
1994	15	7857	2	657	0	303	0	135	0	2	2	0.00
1995	16	8082	7	728	0	362	0	201	0	7	9	0.00
1996	17	8205	45	585	0	377	0	234	0	45	54	0.01
1997	18	8179	122	810	8	507	5	414	3	122	176	0.02
1998	19	8190	302	1006	20	570	11	407	2	309	484	0.06
1999	20	8421	564	1269	38	650	19	322	5	577	1062	0.13
2000	21	8802	809	1323	39	666	19	332	9	819	1881	0.21
2001	22	9382	976	1689	77	758	34	216	35	984	2865	0.31
2002	23	10256	1120	2084	105	808	41	283	103	1081	3946	0.38
2003	24	11213	1296	2055	138	781	52	230	131	1251	5197	0.46
2004	25	12180	1421	2076	165	765	61	236	182	1343	6540	0.54
2005	26	13158	1502	2023	195	729	70	280	273	1353	7893	0.60
2006	27	14054	1566	2059	262	784	100	354	418	1311	9203	0.65
2007	28	15197	1647	2722	446	792	130	355	432	1532	10735	0.71
2008	29	16674	1770	2867	592	880	182	388	486	1694	12429	0.75
2009	30	17936	1880	2356	618	810	213	426	549	1737	14167	0.79
2010	31	18870	2074	2237	734	959	315	387	512	1981	16148	0.86
2011	32	19701	2130	2067	834	882	356	438	596	2012	18160	0.92
2012	33	20385	2181	1871	896	876	419	342	486	2172	20332	1.00
2013	34	20913	2105	1865	995	888	474	420	622	2005	22337	1.07
2014	35	21381	2038	1780	1129	910	577	437	673	1917	24253	1.13
2015	36	21688	1988	1573	1126	837	599	511	818	1697	25951	1.20
2016	37	21875	1709	1511	1168	770	595	539	895	1387	27338	1.25
2017	38	21902	1426	1281	1034	798	644	602	991	825	28163	1.29
2018	39	21813	1178	1217	1001	759	625	538	878	677	28840	1.32

Source data for elements in Table 1a and 1b: As published by SFSO: Population; Births <A>; Immigrants by age and nationality; Emigrants by age and nationality; Naturalisations
Children of immigrants/emigrants, <B> and <C>: Number of immigrants/emigrants multiplied by mean fertility at these transitions, by age, as described in Section 5.2 and tabulated in Table 3.
Children of naturalising women: Number of naturalising women multiplied by fertility rates by age at naturalisation, as described in Section 5.3 and tabulated in Table 3.

Fig. 3: The contribution of the 4 component elements to the fertility of Swiss and foreign women aged 39 in 2018, relative to the respective sub-populations
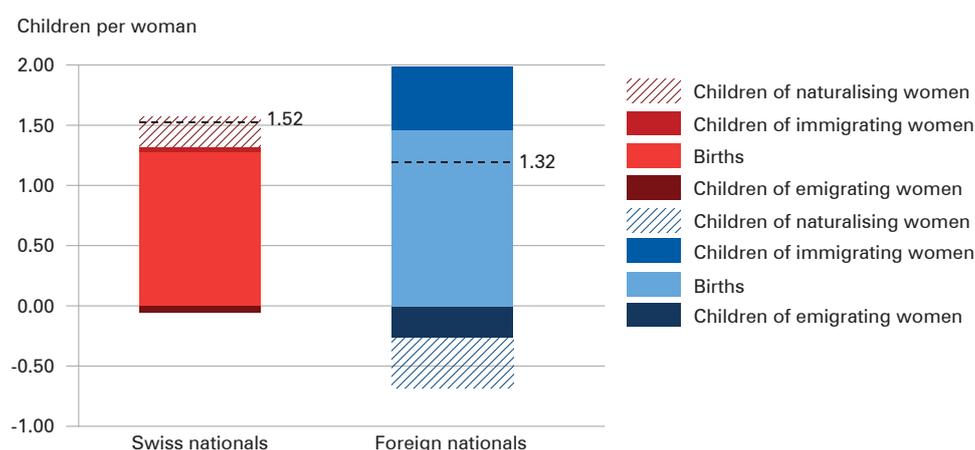
Source: see notes to Tables 1a and 1b

The cohort fertility calculation is straightforward. As shown in the final three columns of Tables 1a and 1b, we calculate the net number of children added from each source each year, and cumulate these. In the final column we divide the cumulated children by the female population in that year. This column is the fertility curve of the 1979 cohort, and the final number (bottom right of the table) is the estimated number of children for that cohort when they reached age 39 in 2018, i.e. their almost completed cohort fertility. Figure 3 demonstrates how the calculated fertility for that cohort at age 39 is compiled from the relative inputs and outputs of births, immigration, emigration and naturalisation.

How do these values for fertility through the reproductive period, calculated using our cohort tracking method, compare to the STATPOP values of co-residing children? STATPOP data are only available from 2011 onwards (so from age 32 upwards for our example cohort). A comparison of the results from the two data sets is shown in Figure 4. Three points should be highlighted. First, there is excellent agreement for the Swiss population up to age 35. At higher ages, we would expect the STATPOP values to under-estimate actual fertility as children will then start to leave home. The observed divergence is as expected. Second, STATPOP shows the fertility of foreign nationals to be about 0.07 children higher than the cohort tracking method at all ages. However, apart from this constant offset, the agreement is good (possible causes are discussed later in section 6). The third point to note is the crossover point between the fertility of Swiss women and foreign women. For STATPOP this is at age 34.5; with cohort tracking it is at 33. Analysing this phenomenon is one of the central aims of this paper and will be discussed at greater length in section 6; it is fundamental to understanding why the TFR inaccurately portrays the fertility of foreigners.

Fig. 4:   Average fertility of women born in 1979 from age 32 to 39 (2011-2018), Swiss and foreign nationals

Children per woman
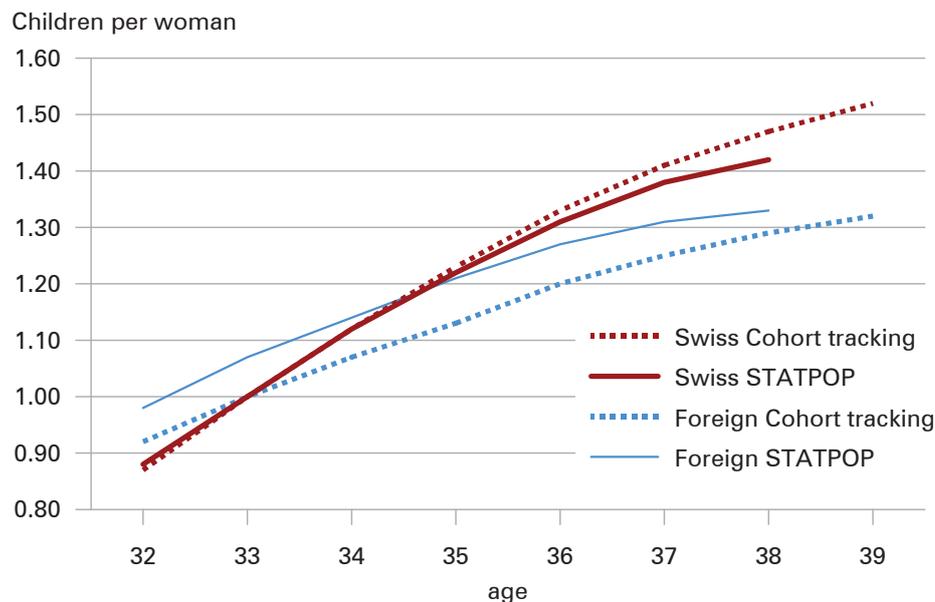
Source: STATPOP and Cohort Tracking methodology (see Appendix)

5.1   Births by nationality and country of birth of mother

The four sub-populations of Swiss and foreign women outlined in the Introduction contribute differing proportions to the total births in Switzerland. Births to women in the "Swiss born CH" category comprised 57 percent of total births in 2010, declining to 51 percent in 2018. Meanwhile the proportion to "Swiss born abroad" stayed quite steady at 8-9 percent. The proportion of births to women "Foreign born abroad" rose from 35 percent to 39 percent between 2010 and 2017 before falling slightly to 38 percent in 2018, whilst births to "Foreign born CH" remained steady at 3 percent.

The four groups have different fertility behaviours, particularly in relation to timing, both age at first birth and subsequent spacing between births. Women who are "Foreign born abroad" become mothers youngest (see Fig. 5). By contrast, the age at first birth of the "Swiss born CH" group is almost two years later and is now approaching 31. The steady rise in mean age at first birth ("postponement") seen since 1970 finally seems to be slowing. The rather young age for "Swiss born abroad" (mostly naturalised immigrants), 28.5 rising to 29.5, suggests that many of these women have either immigrated to Switzerland as children or married a Swiss man and thus had a fast-track route to citizenship (see section 5.3 on naturalisation).

Fig. 5: Mean age at first birth by nationality and country of birth of mother

Age at 1st birth
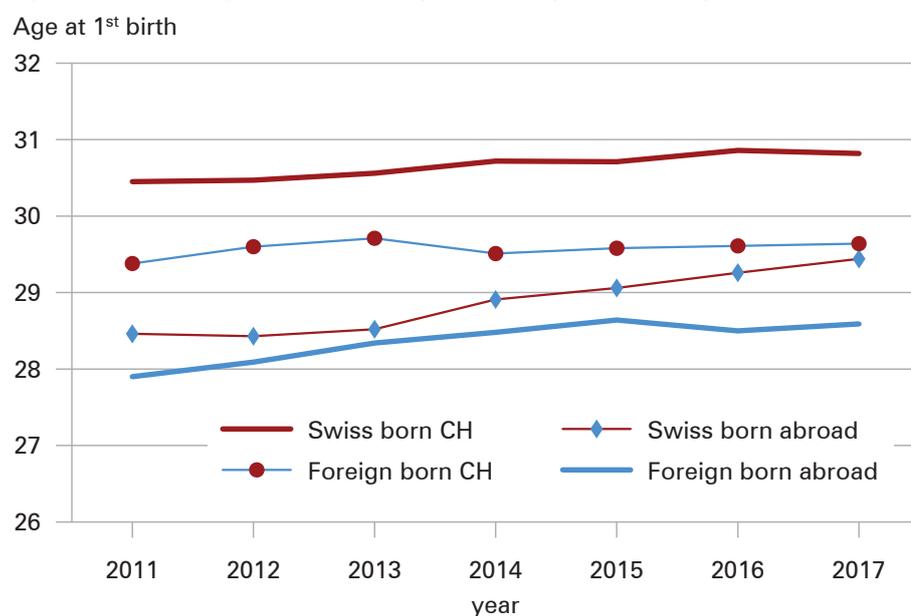
Source: own calculations using BEVNAT and STATPOP data

5.2 Immigration, emigration and fertility rates at those transitions

The main influx of foreign women into Switzerland starts at age 18, often for tertiary education or low-skilled service jobs. This is followed by even stronger in-migration, often for work (for the woman, her partner or both), or joining a partner; this peaks at age 26. Strong immigration is partially balanced by emigration, which follows a similar age trajectory (see Fig. 6). For Swiss nationals their net balance is negative throughout the age range 15-49, with peak outflow at age 25.

The household register, STATPOP, is our main data source on the number of children that women have when they immigrate or emigrate. For our cohort tracking calculations we used the average fertility rates by age from STATPOP for the years 2011-2017 (see Table 3). There were no noticeable trends over this period.

One weakness of the STATPOP data for estimating immigrant fertility is that the mother may arrive in the country before her children, or they may remain in the country of origin, especially if they are older, and this can lead to an under-estimate of the fertility of immigrating mothers. We know from the Migration-Mobility Survey (*NCCR on the move* 2018) that for women under 35, more than 90 percent of mothers arrive with their children; however, this drops to 85 percent for women aged 35-39, 70 percent for women 40-44, and just over half for women aged 45-49. We have used these values to apply a multiplicative coefficient to the STATPOP values to better estimate true fertility at immigration for foreign nationals (i.e. by multiplying the fertility rate calculated from STATPOP by the inverse of the proportions listed above).

Fig. 6:   Number of women immigrating and emigrating by age, mean 2011-2017

Number of women
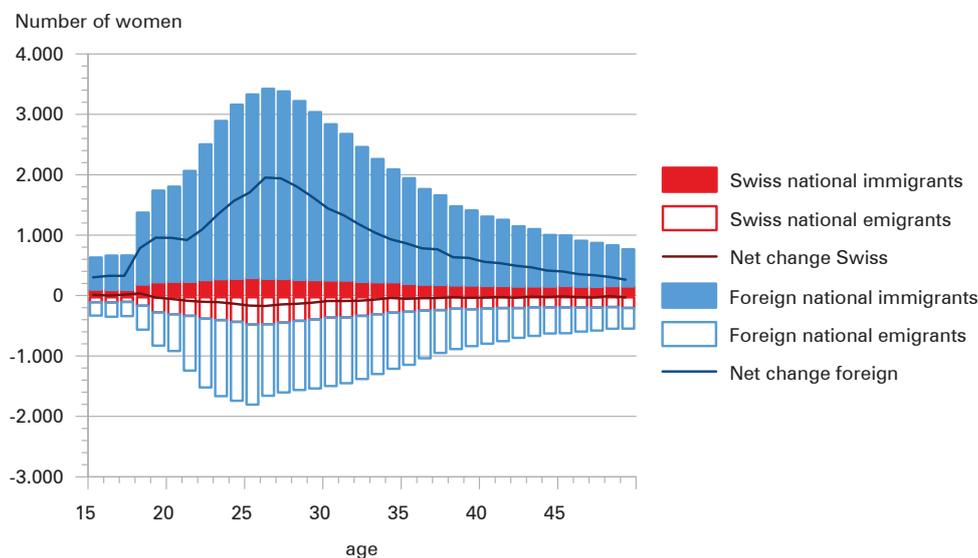
Source: STATPOP

Both the STATPOP data and the FGS of 2013 and 2018 show that the majority of migrants are, in fact, childless, whether they are arriving in or leaving the country (see Table 2).

As discussed in the literature review, entry into motherhood is commonly postponed before migration and then commences in the years shortly afterwards. We found this same behaviour with immigrants to Switzerland (see Fig. 7). We discuss the impact of this high post-arrival childbearing intensity on the TFR, and in particular on the TFR1, in section 8.

STATPOP enumerates not only the number of children of immigrants and emigrants but split by whether or not they (already) hold Swiss nationality. Of note is that the fertility of foreign nationals is slightly higher on emigration than it is on immigration, comparing women of the same age. The opposite is the case for Swiss nationals: their fertility is lower on emigration than on (re-)immigration.

5.3   Naturalisation and fertility at naturalisation

The methodology section showed that naturalisation potentially impacts the cohort fertility of Swiss and foreign nationals, as there is, effectively, a transfer of associated children from the "foreign" tally to the "Swiss" tally. In this section, we discuss the recent history of naturalisation legislation and how this links to family formation of women. We then describe how we estimate the fertility of women when they naturalise.

The SFSO publishes data for the number of men and women naturalising each year (see Fig. 8). Several important changes in the naturalisation rules have been

Tab. 2: Proportion childless in year of immigration and emigration by age group

| | | At immigration | | At emigration |
| | FGS 2013 | FGS 2018 | STATPOP | STATPOP |
		in %		
20-24	93	93	96	97
25-29	87	81	90	89
30-34	82	41	75	70
35-39	51	13	60	53

Note: the FGS 2018 under-sampled childless women and even applying appropriate weights does not fully compensate for this bias.

Source: FGS: women who immigrated in the previous ten years; STATPOP, mean 2011-2017

Fig. 7: Timing of first birth with respect to year of immigration: percent by year who had a child within 10 years of immigrating
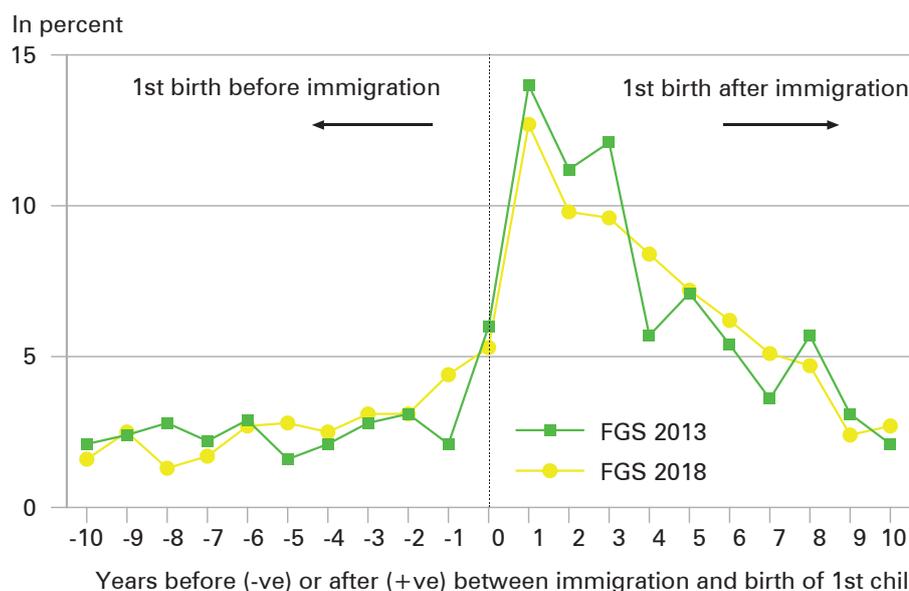
Source: FGS 2013 and FGS 2018, women who immigrated to Switzerland over the age of 15 and aged <=49

made over the past decades. In the 1970s, women who had lost their Swiss citizenship (because of marrying a non-Swiss man, for instance) could regain it on request. Up until the end of 1991, a foreign woman who married a Swiss man automatically gained Swiss nationality (and may thereby have lost her existing nationality); this statute was dropped with the introduction of a new law on citizenship. A foreign woman marrying a Swiss man (and vice versa) can now apply for fast-track citizenship, although this still takes several years (*SwissInfo* 2018). Years spent in

Fig. 8:   Descriptive diagrams of naturalisation trends

8a: Number of women naturalising by age group, 1981-2018
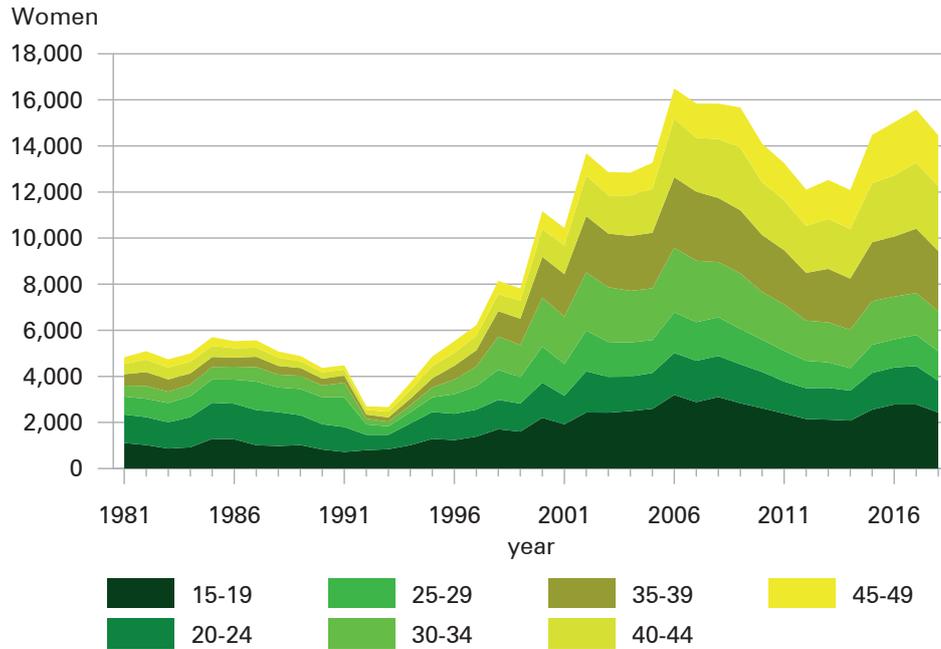
8b: Annual naturalisation rates of women by age (number of naturalisations/foreign population), selected years
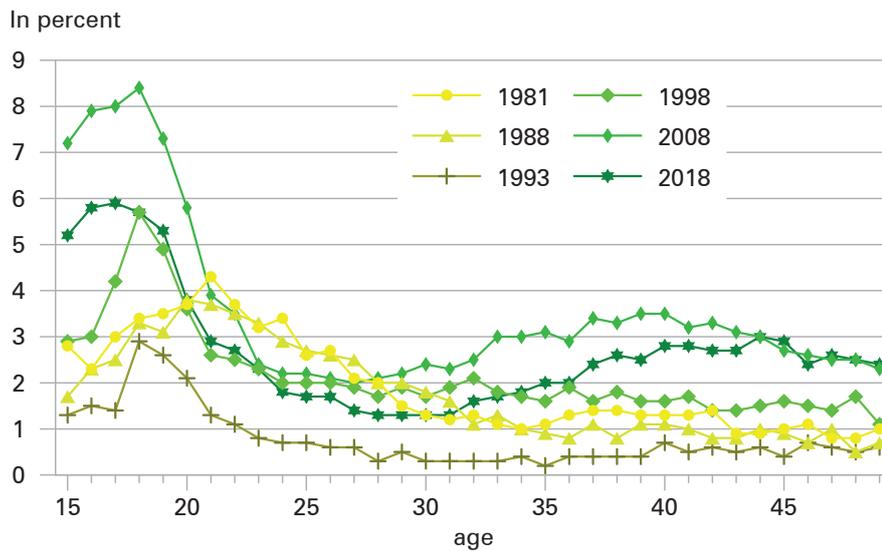
Source: SFSO

Switzerland in childhood count double towards gaining citizenship. The duration of time living in the country before being able to obtain citizenship by the standard route was reduced from twelve years to ten in January 2018 (*SEM* 2018). One of the countries which, until recently, allowed only single citizenship was Germany; however, since 2007, German women can hold dual citizenship of Switzerland and Germany, and many older German women living in Switzerland have chosen to do so (*SwissInfo* 2007).

Naturalisation has traditionally been part of the transition to adulthood and this remains the case for many children who were born or have spent most of their childhood in Switzerland: the peak around age 18 is very marked (Fig. 8b) and at this age almost all are childless. Naturalisation and fertility are interlinked, as described in *Pecoraro* (2012). To summarise, women with children commonly choose to naturalise when their duration of stay is long enough, whilst childless women have a slightly lower propensity to naturalise than mothers.

We used two data sources to estimate the number of children that women have (on average, by age) at the time of their naturalisation. The 2000 census data includes the year of naturalisation, as well as the years of birth of all children. From this we can calculate the number of children a woman had in the year she naturalised. For the pre-census years 1981-2000, we averaged the fertility at naturalisation for four periods, with 1992 being a special year for the reason described above (see Table 3). For the years after 2000 we used the FGS 2013 to calculate fertility at naturalisation; 347 women in the survey had become Swiss since 2000 in their reproductive period (15-49). Fertility at naturalisation is higher at all ages than fertility at immigration or emigration for the reasons described above. Fertility at naturalisation has been rising over time, the main reason being that since 1991 women do not gain Swiss citizenship on marrying a Swiss man; they must wait at least six years, even when fast-tracked.

6 Comparison of cohort fertility measures from different data sets

The purpose of the methodology described in section 5 is to calculate the average fertility of co-existing cohorts – of Swiss and foreign nationals – which can be compared with values obtained from other sources (census 2000, STATPOP, FGS 2013 and FGS 2018). The significance of our methodology is that we understand the source of the inputs (births, immigration, emigration and naturalisation) whereas with other data sources we can only observe the differentials. This section presents the data and discusses the weaknesses of each data source. In the subsequent section, we summarise the processes that determine cohort fertility patterns of Swiss and foreign nationals and then address the question of why the pattern we see in cohort fertility differentials is fundamentally different from that seen in the TFR.

Figure 9 shows the fertility of co-existing cohorts in the years when the census or survey was carried out. For the cohort tracking method the graph plotted is for the latest year for which we can calculate, 2018 (see the data tables in the Appendix).

Tab. 3: Fertility at immigration, emigration and naturalisation by age

	Immigration Swiss nationals	Emigration Swiss nationals	Immigration foreign nationals	Emigration foreign nationals	Naturalisation 1981-1986	Naturalisation 1987-1991	Naturalisation 1992	Naturalisation 1993-2000	Naturalisation >2000
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00
18	0.00	0.00	0.02	0.00	0.03	0.03	0.00	0.01	0.00
19	0.01	0.02	0.03	0.03	0.08	0.11	0.01	0.01	0.00
20	0.02	0.02	0.03	0.03	0.13	0.10	0.03	0.02	0.00
21	0.03	0.03	0.03	0.03	0.16	0.16	0.03	0.03	0.08
22	0.04	0.03	0.05	0.05	0.19	0.16	0.05	0.04	0.16
23	0.04	0.04	0.05	0.06	0.21	0.19	0.22	0.10	0.36
24	0.06	0.06	0.07	0.08	0.22	0.20	0.32	0.17	0.57
25	0.07	0.08	0.08	0.09	0.24	0.25	0.30	0.26	0.77
26	0.10	0.11	0.10	0.12	0.27	0.30	0.39	0.43	0.98
27	0.13	0.15	0.13	0.16	0.31	0.32	0.49	0.56	1.18
28	0.16	0.18	0.16	0.18	0.38	0.36	0.47	0.76	1.22
29	0.20	0.23	0.21	0.23	0.45	0.43	0.50	0.82	1.25
30	0.29	0.34	0.26	0.32	0.49	0.49	0.83	1.06	1.29
31	0.38	0.39	0.33	0.37	0.58	0.57	1.00	1.18	1.32
32	0.45	0.52	0.40	0.47	0.62	0.58	1.13	1.27	1.36
33	0.54	0.60	0.48	0.56	0.79	0.67	1.18	1.32	1.42
34	0.66	0.66	0.53	0.68	0.86	0.76	1.30	1.50	1.48
35	0.74	0.76	0.63	0.73	1.00	0.84	1.28	1.66	1.54
36	0.83	0.86	0.72	0.83	1.07	0.92	1.59	1.60	1.60
37	0.94	0.90	0.77	0.85	1.19	1.01	1.61	1.63	1.66
38	1.02	0.98	0.81	0.89	1.25	1.04	1.65	1.77	1.65
39	1.00	0.91	0.82	0.89	1.23	1.15	1.63	1.84	1.63
40	0.99	0.89	0.87	0.91	1.32	1.21	1.46	1.75	1.62
41	1.03	0.84	0.87	0.85	1.44	1.28	1.49	1.68	1.60
42	0.96	0.81	0.78	0.83	1.50	1.30	1.47	1.82	1.59
43	0.93	0.70	0.78	0.81	1.57	1.38	1.72	1.66	1.56
44	0.87	0.63	0.71	0.67	1.58	1.30	1.50	1.71	1.54
45	0.69	0.49	0.67	0.51	1.44	1.40	1.53	1.65	1.51
46	0.58	0.38	0.56	0.47	1.66	1.39	1.47	1.70	1.49
47	0.47	0.33	0.46	0.35	1.57	1.47	1.36	1.68	1.46
48	0.41	0.25	0.41	0.29	1.71	1.36	1.52	1.68	1.43
49	0.33	0.19	0.34	0.19	1.48	1.61	1.36	1.67	1.40

Source: STATPOP for fertility at immigration/emigration; census 2000 for fertility at naturalisation in 2000 and before; FGS 2013 for fertility at natu-ralisation after 2000

Fig. 9: Cohort fertility of female Swiss (red, bold line) and foreign nationals (turquoise, lighter) aged 20-49 in year(s) of observation
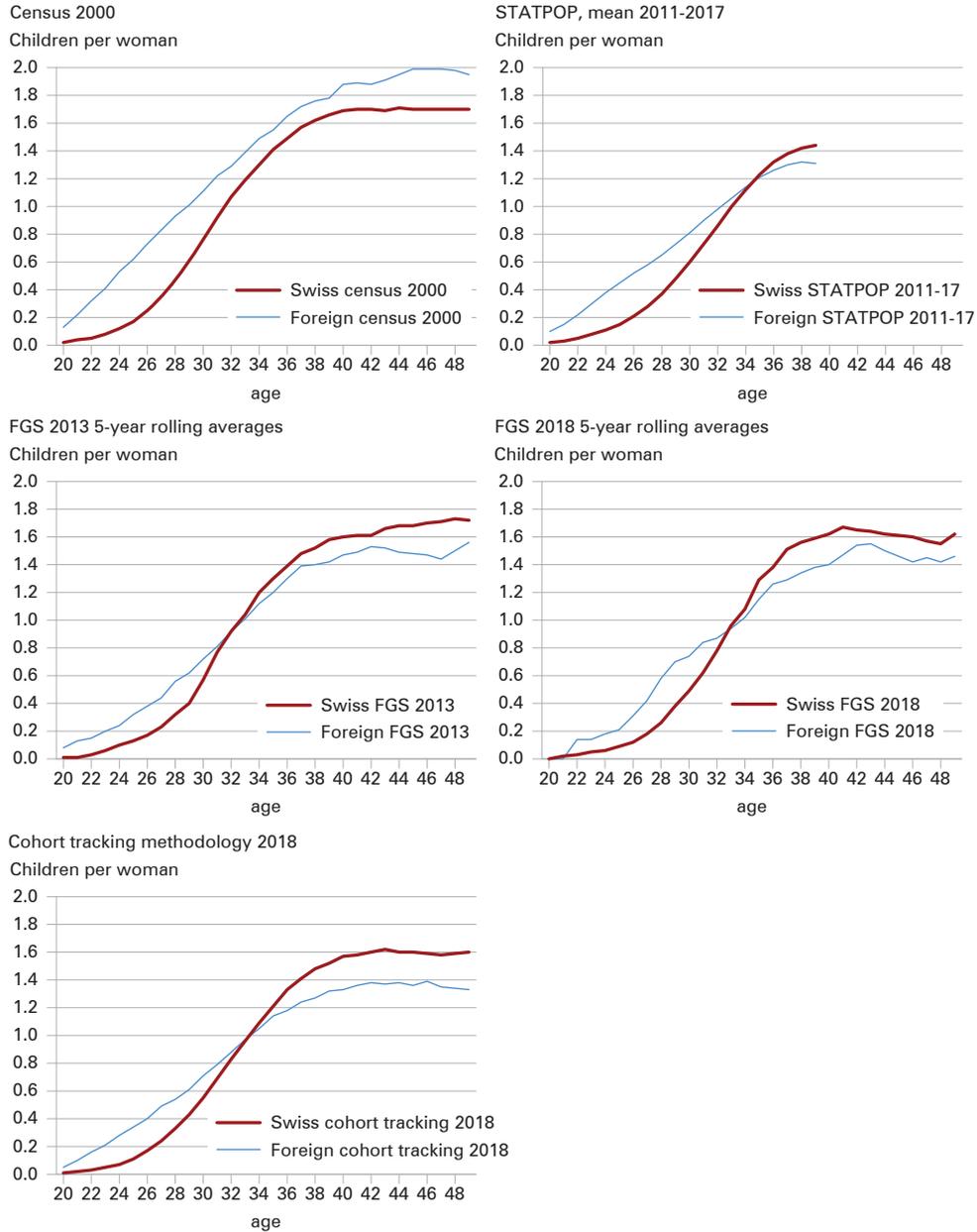
Source: own calculations based on sources as listed

The first point to note is that there appears to have been a change in the Swiss-foreign differential between the census in 2000 and 2011. In 2000, foreign women had higher fertility across all the reproductive ages compared to Swiss nationals. However, since 2011, the four different data sources all point to the same conclusion: women of Swiss nationality past their mid-30s have higher fertility than women of foreign nationality. The values for completed cohort fertility differ between the data sets, yet they all show this same crossover. For STATPOP the crossover occurs at age 35; with the FGS 2013 and FGS 2018 it is at age 33; and with our cohort tracking for 2018 it is at age 34.

The second point to note is that the comparability between our cohort tracking results and STATPOP is particularly close, which gives us confidence in our calculation process. It should be noted that the mean fertility by age was calculated for years 2011-2017 for the STATPOP values. No trends were discernible over that period for the fertility of Swiss nationals nor of foreign women.

We now discuss each data set in turn. The census data are almost comprehensive, although 4.5 percent of Swiss women and 8.9 percent of foreign women aged 20-39 did not respond to the question on their number of children. However, these data are now twenty years old; no comparable data set has been compiled since. It is interesting to note the convergence in the Swiss-foreign fertility differentials between the ages of 35 and 39 in 2000. It would appear that although completed cohort fertility (CCF) of Swiss nationals has fallen only slightly since then, from 1.7 to 1.6, the CCF of foreign nationals has fallen much more steeply. It should be noted that in the 1990s there was an influx of migrants driven by the wars in the Balkans, first Serbians and Croatians in the early 1990s, followed by Kosovars in 1998/99. Since then there has been an increase in the proportion of migrants who are highly skilled, as well as (and including) Germans, both groups who tend to have lower fertility (see section 3 and Fig. 2).

The main weakness of the STATPOP values is that they take into account only children who are co-habiting with their mother. Analysis is by household: if a household includes a female aged 20-39, then any child(ren) 15 or more years younger than her are considered to be hers. In Germany a similar analytical method to ours was used with their Mikrozensus: it was found that up to their late 30s the fertility of women assessed by co-residential children was very close to that reported by women on their biological children (*Krapf/Kreyenfeld* 2015). For this reason, we only include women up to age 39. Foreign women are more likely to have their children leave soon after age 40 as, on average, they start childbearing at a younger age than Swiss women do (Fig. 5). There is a sharp increase in emigration from age 18 (of both Swiss and foreign nationals), many of them leaving the parental home for higher education. The FGS 2013 data shows that 46 percent of women in their 40s and who immigrated at age 15 or above had an eldest child aged 18+; this compares to only 39 percent of Swiss women of the same age born in Switzerland. Similar proportions were found in the FGS 2018 data: 42 percent of foreign women versus 38 percent of Swiss women in their 40s had an adult child.

Another difficulty when using the STATPOP database is analysing households in which there are two adult women living with children: as there is no registered

link between parents and their children, which woman might be the biological mother? We discount such cases. The SFSO population numbers are higher for women in their early 20s than the STATPOP numbers used in our fertility analysis; 20 percent higher for Swiss nationals and 30 percent for foreigners because of these complications. *A priori* we assume that the women in households that are analysed are representative of all women of that age, but this may not be the case. Because childless women are more mobile, they can miss being registered and so the fertility of younger migrants may be over-estimated. De-registration upon emigration may not take place and so the household register may remain out-of-date for some time. The downward kink from 2009-2010 in Figure 2, when a change of population data sets took place, is evidence of this possibility.

For the Family and Generation Surveys of 2013 and 2018 the question is how representative they are. The FGS 2018 intentionally over-sampled women with children under the age of 13, yet applying weights to "boost" the sample of childless women can lead to distortions. Unintentional over-sampling of women with children is a common problem of surveys, as they tend to be at home more often than childless women are (*Kreyenfeld et al.* 2011).

In our cohort tracking calculations, we estimate the average fertility by age at immigration, emigration and naturalisation. These estimates are prone to bias and may cause over- or under-estimation which are likely to be compounded at older ages. The estimate of fertility at naturalisation is particularly tentative post-2000 and this could have a substantial impact on the final estimates of cohort fertility by nationality.

Taking all these limitations into consideration, it is reassuring that the different data sets point to the same conclusion. Although the fertility of foreign women in their 20s is higher than that of Swiss nationals, by the late 30s the fertility of Swiss nationals has overtaken that of foreign women. The next section details the processes that cause this crossover to happen.

7   The processes that affect cohort fertility

This section summarises the differences in behaviour of the sub-groups of population that lead to the fertility patterns seen in the previous section.

1. Foreign women born abroad tend to start childbearing at younger ages than Swiss women born in Switzerland (Fig. 5); hence the fertility of foreign women is higher than that of Swiss women up to the mid-30s (Fig. 9).

2. Swiss women born in Switzerland, after starting childbearing later, have a higher propensity to have a second child after their first and after a shorter duration (*Rojas et al.* 2018). Hence, Swiss mothers have larger families than mothers of foreign nationality (section 8 and Table 4).

3. The ongoing influx of low fertility (often childless) foreign women in their 30s "dilutes" the average fertility of foreign women at these ages (Tables 2 and 3).

4. Foreign women who naturalise have higher fertility than foreign women who do not (section 5.3, section 8, Table 4 and *Pecoraro* 2012). Naturalisation has

the biggest impact on the net balance of "incoming" children at higher ages, effectively boosting the fertility of Swiss women and reducing that of foreign women (Table 1).

5. Foreign emigrants have (slightly) higher fertility than foreign immigrants, whereas Swiss nationals have slightly higher fertility at (re-)immigration than Swiss women at emigration (section 5.2 and Table 3).

Having described the difference in fertility of Swiss and foreign women across the reproductive life course, and the processes leading to these differentials, we now tackle the question of why the TFR fails to accurately describe the fertility of foreign and immigrant women.

8   The standard TFR and a comparison with cohort fertility measures

The SFSO publishes the TFR of foreigners together with that of the Swiss population (Fig. 10), describing the TFR in their statistical digest as the "average number of children per woman" (*SFSO* 2019). Since 2011, the SFSO has also provided the TFR by country of birth and nationality (Table 4). From those published statistics the layman would assume that foreigners – and foreigners born abroad especially – have more children than Swiss women do, and considerably more than the "Swiss born in Switzerland". Yet this is misleading. Section 6 of this paper demonstrated that cohorts of women with Swiss nationality older than their mid-30s actually have higher fertility than those of foreign nationality: Section 7 described how this happens.

The TFR of foreign women has been quite stable since 2001, at around 1.87 (Fig. 10), despite changes in their composition (Fig. 2). For Swiss nationals, it rose from a minimum value of 1.22 in 2001-2003 to 1.40 in 2009 and has remained quite stable since. Because women aged 39 (the focus in our analyses) have passed through most of their reproductive life with quite stable age-specific fertility rates then, from a naïve perspective, we could expect the TFR would predict ultimate cohort fertility. However, postponement of childbearing has been steady and ongoing from 1970 until very recently and the associated distortion causes the TFR to under-estimate cohort fertility (*Bongaarts/Feeney* 1998), deflating the overall TFR of Switzerland by about 0.2 every year.

In addition to the published TFRs, we have also been supplied with data on births by biological birth order. Therefore we can calculate the TFR1 and deduce the fertility of mothers (women who have had at least one child, TFR/TFR1), and the synthetic childlessness rate (1-TFR1) (Table 4). The TFR1, first birth rate, is especially interesting as it points to the main weakness of the standard TFR. For foreign women the TFR1 is higher than one; the subgroup with the highest rate being for the "foreign born abroad", a similar statistical quirk as found by *Parrado* (2011) for Mexican immigrants to the United States. However, the TFR1 is simply a measure of the intensity of having a first birth, which, as we saw in Figure 7, is particularly high in the years immediately after immigration to Switzerland.

Fig. 10: The standard TFR for Swiss and foreign women, 1971-2018

Children per woman
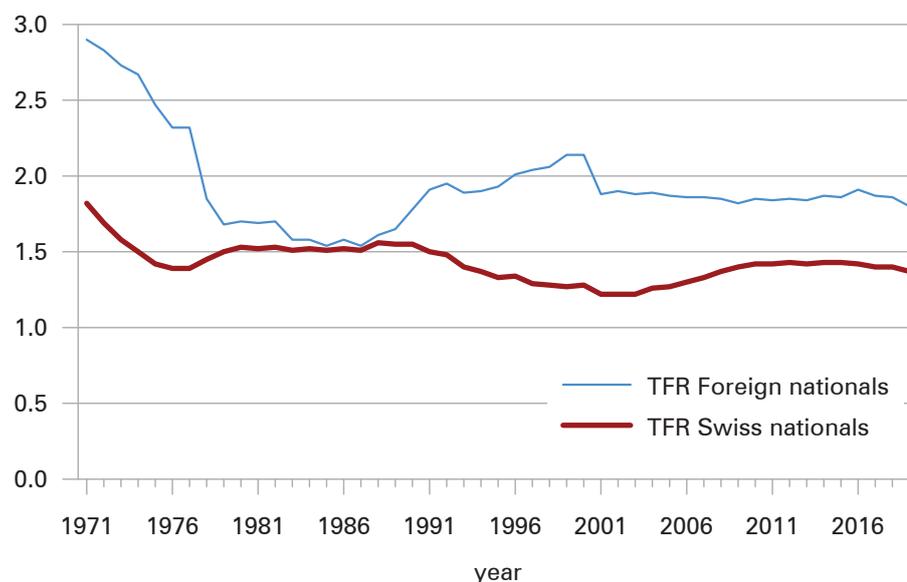
Note: the sharp downward kink in the TFR of foreign women between 2000 and 2001 is because after 2000 births to asylum seekers and other temporary residents were no longer included in the statistics.

Source: SFSO

Table 4 shows the important differences – and also an interesting similarity – between the TFR and cohort fertility measures.

First, the differences. The TFR and TFR1 show significantly higher values for foreign women than for Swiss nationals. The TFR for subgroup "Foreign born abroad" is over 0.5 children higher than for "Swiss born CH" women. By contrast, looking at cohort fertility, Swiss women aged about 39 have higher fertility than foreign women by an average of 0.2 children across the four data sets. The subgroup with the highest cohort fertility is "Swiss born abroad", who are mostly naturalised immigrants (as discussed in section 5.3). The fertility of "Foreign born abroad" women is significantly lower: they can be considered mostly to be "pre-naturalised" immigrants.

The childlessness section of Table 4 shows a wide range of values between the two FGS rounds and STATPOP: the difficulties of sampling and registering (and de-registering) childless women were discussed in section 6. The synthetic childless rate (1-TFR1) gives "impossible" negative values for the "Foreign born abroad" subgroup. For Swiss women, we see the opposite problem: it is excessively high. Both are caused by tempo distortions: postponement deflates the TFR1 whilst the migration tempo effect inflates it.

Tab. 4:   Period and cohort measures of fertility

	Swiss	Foreign	Swiss born CH	Swiss born abroad	Foreign born CH	Foreign born abroad	All born in CH	All born abroad
Mean 2011-2018								
TFR (SFSO published)	1.42	1.86	1.41	1.54	1.45	1.94	1.42	1.84
TFR1 (see note@)	0.67	1.02	0.67	0.67	0.75	1.06	0.68	0.96
Cohort fertility age ~39								
FGS 2013 mean ages 37-41	1.50	1.35	1.45	1.81	1.53	1.34	1.46	1.46
FGS 2018 mean ages 37-41	1.59	1.38	1.58	1.63	1.56	1.36	1.58	1.44
STATPOP mean 2011-2017	1.44	1.32	1.42	1.60	1.28	1.32	1.41	1.39
Cohort tracking 2018	1.52	1.32						
Childlessness age ~39								
1-TFR1 (hypothetical childlessness*)	33%	-2%	33%	33%	25%	-6%	32%	4%
FGS 2013 mean ages 37-41	27%	26%	29%	12%	23%	26%	29%	23%
FGS 2018 mean ages 37-41	22%	26%	24%	14%	29%	25%	24%	22%
STATPOP mean 2011-2017	29%	29%	31%	20%	31%	29%	31%	26%
Fertility of mothers at ~39								
TFR/TFR1 (fertility of mothers@)	2.13	1.83	2.10	2.31	1.94	1.83	2.09	1.90
FGS 2013 mean ages 37-41	2.03	1.83	2.03	2.05	1.97	1.81	2.03	1.88
FGS 2018 mean ages 37-41	2.04	1.86	2.08	1.90	2.21	1.83	2.08	1.85
STATPOP mean 2011-2017	2.03	1.86	2.05	2.02	1.86	1.86	2.03	1.90

Highest values on each line are in green

Lowest values on each line are in yellow

@ TFR1: calculated from data supplied by SFSO on births by birth order, age of mother, nationality and country of birth for 2011-2017.

* The TFR1 and, therefore, the calculation of childlessness is subject to the distortion of the migration-specific tempo effect.

Weights have been applied to the FGS 2013 and 2018 data

Source: SFSO and own calculations

The group with the lowest observed childlessness is the "Swiss born abroad" ("post-naturalised") subgroup, yet their TFR1 is low. The likely explanation is that they commonly have had at least one child by the time they naturalise.

We see remarkable agreement for four different estimates of the "Fertility of mothers"; the synthetic measure (TFR/TFR1) and the three sets of observed values. In each of these cases the number of children of Swiss mothers is higher than of foreign mothers. The subgroup of mothers with the lowest fertility is the "Foreign born abroad" (the "pre-naturalised").

One final observation: the differentials in cohort fertility by country of birth (final two columns) are smaller than between nationality (first two columns). In particular, average cohort fertility at age 39 is very similar for women born either in Switzerland or abroad. However, the fertility of Swiss-born *mothers* averages 0.16 children higher than for immigrant *mothers*, the reason being that the latter more often stop after having had one child.

One of the primary weaknesses in calculating the standard TFR is the denominator used in the ASFR calculation, the exposed population. In their country of origin, future migrants are in the denominator during the period when they are often childless; hence the TFR of that country is "deflated". This is the case for any country with strong emigration of young adults, such as the Eastern European countries. It is also the case for Swiss nationals in Switzerland as they have net out-migration throughout their reproductive life course (Fig. 6). By contrast, in the arrival country they are only in the denominator for the most fertile period of their reproductive life (late 20s and early to mid-30s), and so their TFR in the receiving country is "inflated" and the TFR in that country is boosted.

9   Discussion and conclusions

The purpose of this paper was to elucidate the processes that lead to the completed cohort fertility of women with Swiss nationality being higher than that of foreign nationals, whilst the TFR of foreign women is substantially higher than that of Swiss women. Using a novel methodology that tracks the arrivals and departures of Swiss and foreign women and their children to the "system", we enumerate the relative impact of births, immigration, emigration and naturalisation. This cohort tracking method also bypasses any distortion from postponement, a well-known problem of the standard TFR.

Our findings support studies from other countries showing a high intensity of first births in the years after migration, following low pre-migration fertility (*Ng/ Nault* 1997; *Toulemon/Mazuy* 2004; *Andersson* 2004; *Dubuc* 2012; *Robards/ Berrington* 2016; *Tønnessen* 2020). Our methodology does not take into account the duration of stay in Switzerland, unlike *Toulemon* and *Mazuy* (2004). However, like *Toulemon* and *Mazuy* and *Dubuc* (2009, 2012) pre-migration fertility is taken into account. The fertility of emigrants is also included in our calculations. We also enumerate the impact of naturalisation on the fertility of foreigners and Swiss nationals, as hypothesized by *Sobotka* and *Lutz* (2010). As nationality (Swiss/foreign)

is the dichotomy employed by the Swiss Statistical Office, it is important to take the significant impact of naturalisation into account.

The impact of foreigner fertility continues to be larger for Switzerland than other European countries (*Sobotka* 2008). From 2011-2018, it has boosted the overall TFR of the country by an average of 0.11 children per woman annually. The fertility curve by age of foreigners is bi-modal, as described in *Burkimsher* (2017) and it is the early bulge of women in their 20s that boosts the country's TFR, the cause being the high intensity of births commonly observed in the years following immigration. In several Swiss cantons the number of babies born to foreigners exceeds the number born to Swiss women. However, we wish to underline that this is not because foreigners have larger families than native Swiss. In fact, the opposite is true, as demonstrated in this paper. *Berrington* and *Stone* (2017) deplored the problem of the media inciting prejudice by interpreting the higher TFR of immigrants (as published by national statistical offices) as indicating that they have large families. We propose that a better descriptor to publish would be the "fertility of mothers" – TFR/TFR1 – which we have shown corresponds much more closely to the observed cohort fertility of mothers. This measure has the advantage of mitigating the impact of any misestimates of the population and would be easier to implement than trying to correct the TFR for the migration-specific tempo effect (although it would depend on a country recording all births by biological birth order). It is particularly challenging to keep track of the highly mobile childless population, even in a country like Switzerland with a comprehensive household registration system.

The statistics published by the SFSO generally dichotomise between Swiss and foreign nationals. However, the country of birth of the mother would be a more precise basis for comparison, as it does not change through a person's life (Austria and Sweden, for example, do this). We have found that the ultimate (cohort) fertility of women, whether born within or outside Switzerland, is currently quite similar. Childlessness is higher amongst Swiss women, but Swiss mothers have, on average, more children than foreign mothers. The standard TFR fails to describe this reality and can feed into a media narrative of prejudice against foreigners.

2017 has since become available, as have the results from the FGS 2018, and these have been incorporated into this paper.

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Appendix

Tab. A1: Cohort fertility table, Swiss nationals

age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17			0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
18				0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.00
19					0.02	0.02	0.03	0.03	0.03	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.00
20						0.04	0.03	0.05	0.05	0.06	0.08	0.08	0.08	0.09	0.09	0.09	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.03	0.01
21							0.07	0.06	0.08	0.09	0.09	0.11	0.12	0.12	0.13	0.14	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.05	0.03	0.02
22								0.11	0.10	0.14	0.14	0.14	0.16	0.17	0.18	0.20	0.20	0.18	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.14	0.14	0.13	0.13	0.08	0.05	0.03
23									0.17	0.15	0.22	0.21	0.20	0.27	0.23	0.22	0.24	0.25	0.25	0.25	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.21	0.21	0.21	0.20	0.19	0.19	0.18	0.18	0.17	0.05
24										0.24	0.22	0.31	0.29	0.27	0.36	0.32	0.30	0.27	0.34	0.33	0.33	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.29	0.28	0.27	0.26	0.26	0.26	0.26	0.25	0.24
25											0.33	0.31	0.29	0.40	0.38	0.36	0.41	0.39	0.36	0.34	0.43	0.41	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.37	0.36	0.35	0.34	0.34	0.34	0.33
26												0.43	0.40	0.38	0.51	0.48	0.46	0.52	0.50	0.46	0.44	0.55	0.53	0.52	0.50	0.50	0.49	0.50	0.50	0.49	0.49	0.48	0.47	0.46	0.46	0.45	0.44	0.43
27													0.54	0.51	0.48	0.63	0.60	0.58	0.63	0.61	0.57	0.55	0.66	0.65	0.64	0.62	0.62	0.62	0.61	0.62	0.61	0.60	0.59	0.58	0.58	0.57	0.56	0.55
28														0.66	0.63	0.60	0.75	0.72	0.69	0.75	0.72	0.69	0.66	0.79	0.77	0.76	0.75	0.74	0.74	0.74	0.74	0.73	0.73	0.71	0.71	0.70	0.70	0.69
29															0.79	0.75	0.72	0.88	0.85	0.81	0.87	0.84	0.81	0.79	0.90	0.89	0.89	0.87	0.87	0.87	0.86	0.87	0.86	0.85	0.85	0.84	0.83	0.83
30																0.91	0.88	0.85	1.00	0.96	0.93	0.98	0.95	0.92	0.90	1.02	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.97	0.97	0.96
31																	1.03	1.00	0.96	1.10	1.08	1.03	1.08	1.05	1.03	1.02	1.01	1.13	1.12	1.11	1.12	1.14	1.12	1.12	1.12	1.12	1.10	1.09
32																		1.13	1.10	1.08	1.20	1.17	1.13	1.18	1.15	1.13	1.12	1.12	1.22	1.23	1.23	1.24	1.24	1.23	1.23	1.23	1.23	1.21
33																			1.23	1.20	1.17	1.26	1.33	1.30	1.27	1.24	1.23	1.23	1.31	1.31	1.33	1.33	1.33	1.34	1.33	1.33	1.33	1.33
34																				1.31	1.28	1.26	1.41	1.40	1.37	1.35	1.32	1.31	1.38	1.39	1.39	1.33	1.41	1.41	1.42	1.41	1.41	1.41
35																					1.38	1.35	1.33	1.46	1.45	1.43	1.43	1.39	1.44	1.44	1.45	1.46	1.49	1.47	1.47	1.48	1.47	1.48
36																						1.44	1.41	1.48	1.51	1.50	1.48	1.46	1.50	1.48	1.49	1.51	1.51	1.53	1.52	1.52	1.53	1.52
37																							1.48	1.52	1.54	1.54	1.52	1.52	1.55	1.53	1.52	1.54	1.55	1.54	1.56	1.55	1.55	1.57
38																								1.52	1.55	1.58	1.57	1.56	1.58	1.56	1.53	1.55	1.56	1.57	1.58	1.56	1.58	1.58
39																									1.55	1.54	1.57	1.58	1.55	1.58	1.58	1.54	1.55	1.57	1.57	1.59	1.58	1.57
40																										1.58	1.57	1.56	1.58	1.59	1.58	1.59	1.56	1.57	1.58	1.58	1.58	1.62
41																											1.60	1.58	1.61	1.60	1.59	1.60	1.59	1.57	1.58	1.59	1.59	1.60
42																												1.61	1.60	1.62	1.60	1.60	1.61	1.60	1.58	1.59	1.59	1.60
43																													1.61	1.60	1.60	1.60	1.60	1.61	1.61	1.59	1.59	1.62
44																														1.62	1.62	1.60	1.59	1.60	1.60	1.60	1.59	1.60
45																															1.62	1.61	1.61	1.60	1.60	1.58	1.59	1.60
46																																1.62	1.61	1.61	1.61	1.59	1.58	1.60
47																																	1.62	1.61	1.61	1.60	1.59	1.60
48																																		1.62	1.62	1.61	1.60	1.59
49																																			1.62	1.61	1.61	1.60

Note: Cells marked in pink indicate the 1979 cohort: darker cells are the data plotted in Figure 4.
Cells marked in orange are the set of cohort fertility values for 2018: darker cells are the data plotted in Figure 9.

Source: Own calculations, as described in section 5 Methodology

Tab. A2: Cohort fertility table, foreign nationals

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
15	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16		0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17			0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.01	0.06	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
18				0.03	0.03	0.03	0.05	0.06	0.06	0.07	0.08	0.09	0.08	0.07	0.06	0.06	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
19					0.06	0.05	0.06	0.10	0.11	0.13	0.14	0.15	0.15	0.14	0.13	0.12	0.12	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.05	0.05	0.04	0.04	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.05
20						0.11	0.10	0.15	0.17	0.19	0.21	0.23	0.24	0.23	0.22	0.22	0.21	0.13	0.13	0.12	0.12	0.11	0.12	0.11	0.11	0.10	0.09	0.09	0.14	0.13	0.13	0.07	0.10	0.11	0.10	0.10	0.10	0.10
21							0.17	0.21	0.23	0.26	0.28	0.31	0.32	0.33	0.32	0.32	0.32	0.20	0.22	0.21	0.20	0.19	0.18	0.19	0.18	0.17	0.16	0.15	0.21	0.20	0.19	0.19	0.19	0.16	0.16	0.16	0.15	0.16
22								0.25	0.28	0.32	0.31	0.38	0.40	0.41	0.42	0.43	0.43	0.32	0.32	0.32	0.31	0.28	0.28	0.26	0.27	0.25	0.24	0.23	0.30	0.28	0.27	0.25	0.25	0.25	0.22	0.22	0.22	0.21
23									0.34	0.35	0.38	0.45	0.47	0.49	0.50	0.53	0.54	0.44	0.44	0.42	0.41	0.38	0.37	0.36	0.35	0.35	0.32	0.31	0.36	0.36	0.34	0.33	0.31	0.31	0.30	0.28	0.28	0.28
24										0.44	0.43	0.50	0.54	0.56	0.58	0.61	0.64	0.55	0.55	0.55	0.50	0.48	0.46	0.45	0.43	0.42	0.42	0.38	0.43	0.42	0.43	0.40	0.40	0.37	0.37	0.37	0.34	0.34
25											0.53	0.53	0.60	0.63	0.65	0.68	0.71	0.64	0.66	0.65	0.62	0.57	0.55	0.54	0.52	0.50	0.49	0.47	0.51	0.49	0.48	0.48	0.45	0.45	0.42	0.42	0.43	0.40
26												0.63	0.63	0.69	0.71	0.74	0.78	0.75	0.75	0.75	0.75	0.68	0.63	0.63	0.60	0.58	0.56	0.53	0.56	0.56	0.54	0.53	0.53	0.51	0.56	0.48	0.47	0.49
27													0.71	0.71	0.78	0.80	0.85	0.81	0.85	0.83	0.81	0.75	0.73	0.69	0.67	0.65	0.63	0.59	0.63	0.61	0.62	0.59	0.59	0.59	0.65	0.57	0.54	0.54
28														0.79	0.79	0.85	0.91	0.88	0.90	0.94	0.88	0.85	0.80	0.78	0.75	0.73	0.71	0.66	0.70	0.68	0.67	0.68	0.66	0.66	0.72	0.63	0.64	0.61
29															0.87	0.88	0.97	0.95	0.98	0.99	0.99	0.92	0.90	0.85	0.84	0.80	0.78	0.75	0.79	0.76	0.75	0.74	0.74	0.73	0.80	0.72	0.70	0.71
30																0.97	0.97	1.00	1.04	1.06	1.04	1.03	0.97	0.95	0.91	0.89	0.86	0.83	0.88	0.86	0.83	0.82	0.82	0.82	0.90	0.80	0.80	0.79
31																	1.07	1.06	1.09	1.12	1.12	1.09	1.08	1.02	1.01	0.98	0.95	0.90	0.95	0.95	0.92	0.90	0.89	0.89	0.96	0.88	0.88	0.88
32																		1.15	1.16	1.16	1.19	1.16	1.14	1.14	1.08	1.07	1.04	1.00	1.05	1.02	1.01	1.00	0.97	0.97	1.04	0.98	0.96	0.97
33																			1.23	1.23	1.22	1.23	1.21	1.19	1.20	1.14	1.13	1.09	1.14	1.20	1.09	1.15	1.14	1.04	1.11	1.03	1.06	1.05
34																				1.29	1.28	1.26	1.27	1.24	1.24	1.29	1.20	1.18	1.23	1.20	1.17	1.22	1.14	1.13	1.20	1.11	1.11	1.14
35																					1.33	1.31	1.30	1.32	1.31	1.35	1.30	1.25	1.28	1.32	1.25	1.29	1.27	1.19	1.24	1.17	1.18	1.18
36																						1.36	1.35	1.34	1.36	1.39	1.34	1.35	1.37	1.35	1.32	1.35	1.32	1.25	1.29	1.25	1.23	1.24
37																							1.39	1.38	1.37	1.39	1.39	1.36	1.38	1.41	1.35	1.38	1.39	1.31	1.37	1.28	1.31	1.27
38																								1.41	1.41	1.42	1.42	1.42	1.42	1.43	1.42	1.44	1.40	1.35	1.40	1.32	1.31	1.32
39																									1.43	1.43	1.41	1.43	1.43	1.43	1.43	1.42	1.42	1.40	1.39	1.36	1.34	1.33
40																										1.43	1.43	1.41	1.40	1.40	1.43	1.43	1.42	1.45	1.43	1.40	1.37	1.36
41																											1.44	1.43	1.42	1.40	1.40	1.42	1.41	1.41	1.41	1.38	1.39	1.36
42																												1.42	1.40	1.39	1.40	1.40	1.40	1.40	1.40	1.40	1.37	1.38
43																													1.41	1.39	1.39	1.39	1.39	1.39	1.39	1.38	1.40	1.37
44																														1.40	1.37	1.37	1.38	1.33	1.38	1.38	1.37	1.38
45																															1.39	1.38	1.35	1.34	1.31	1.36	1.38	1.36
46																																1.35	1.33	1.33	1.32	1.36	1.38	1.36
47																																	1.33	1.31	1.29	1.30	1.36	1.35
48																																		1.31	1.32	1.28	1.34	1.34
49																																			1.29	1.30	1.28	1.33

Note: Cells marked in turquoise indicate the 1979 cohort: darker cells are the data plotted in Figure 4.

Cells marked in blue are the set of cohort fertility values for 2018: darker cells are the data plotted in Figure 9.

Source: Own calculations, as described in section 5 Methodology