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*Christophe BERGOUIGNAN, Université Montesquieu-Bordeaux IV*

## **Changing sex ratios at birth during the civil war in Tajikistan: 1992-1995**

Sophie Hohmann (1)

Michel Garenne (2)

(1) EHESS and INED, Paris

(2) IRD and Institut Pasteur, Paris

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Address for correspondence: [so\\_hohmann@hotmail.com](mailto:so_hohmann@hotmail.com) / [mgarenne@hotmail.com](mailto:mgarenne@hotmail.com)

## **Abstract**

Sex ratios at birth are known to change during wars or shortly after. We investigated the changes in sex ratios during the civil war that occurred in Tajikistan shortly after the dismantling of the Soviet-Union. This war was particularly bloody, long lasting, and had many demographic consequences. According to vital registration data, some 27 000 persons died in excess of previous trends during the civil war period (1992-1995), and total mortality was sometimes estimated three times higher by independent observers. Birth rates dropped markedly during the war, and sex ratios at birth increased significantly from 104.6 before the war to 106.9 during the war, to return to baseline values afterwards. The change in sex ratio is investigated according to demographic evidence (migration, delayed marriage, spouse separation), and nutrition, and compared with patterns found in Europe during WW-II, as well as with recent wars in the Middle-East.

**Key words:** Demographic impact; Sex ratio at birth; Secondary sex ratio; Civil war; Conflict; Tajikistan; Central Asia

### **Résumé en français**

Le rapport de masculinité à la naissance peut changer au cours des guerres, ou juste après la fin d'une guerre. Cette étude analyse les changements du rapport de masculinité à la naissance au cours de la guerre civile qui eut lieu au Tadjikistan peu après le démantèlement de l'Union Soviétique. Cette guerre civile fut très meurtrière, dura près de trois ans et eut de nombreuses conséquences démographiques. Les sources de l'Etat Civil indiquent quelques 27.000 décès supplémentaires au cours des années 1992-1995, et certains observateurs estiment trois fois supérieur l'impact sur la mortalité. Les taux de natalité se sont effondrés pendant la guerre, et le rapport de masculinité augmenta de 104.6 à 106.9, pour retrouver son niveau par la suite. Les variations du rapport de masculinité sont étudiées en fonction des paramètres démographiques connus (migration, mariage), de la nutrition, et sont comparées avec celles observées dans d'autres guerres, en Europe et au Moyen-Orient.

## Introduction

Variations in the sex ratios at birth have been the focus a numerous debates in the demographic and biologic literature [Süssmilch, 1761; Ciocco, 1938; Gini, 1951; Visaria, 1967; Teitelbaum, 1970; James, 1987; Chahnazarian, 1988]. A feature of the sex ratios is that they often change during or shortly after wars. This has been documented for a long time in Europe, and reviewed recently in details [Graffelman & Hoekstra, 2000; James, 2009].

For instance, in France, two major accidents occurred during world war periods [Aubenque, 1989]. We reanalyzed variations in the sex ratio using vital registration statistics, available in the Human Mortality database web site (Table 1). In France, during the 1914-1918 war, birth rates dropped for six years, and were above average in 1919-1920. The sex ratio at birth was 104.6 in 1914-1917, equal to the average of previous years (1905 to 1917), but increased markedly in 1918-1920, to reach 106.4 (95% CI= 106.1-106.7), to recover in a few years, reaching again 104.6 in 1926-1930. A similar change occurred during- and after- the Second World War, when fertility dropped again during the war and peaked just after. Sex ratios were low in the pre-war period: 104.2 in 1931-1938, and remained low in the first three years of the war: 104.0 in 1939-1941. They increased markedly thereafter, to reach 105.9 in 1942-1945 (95% CI= 105.7-106.2), and declined thereafter to reach 104.8 in 1955-1959. All those changes were highly statistically significant, with  $P < 10^{-10}$ .

Similar increases in sex ratios were found in other European countries during WW-I and WW-II (United Kingdom, Germany, Austria, Belgium, Italy, Hungary, Romania, Bulgaria, USA, Canada, England & Wales) [reviewed by James, 2009]. Some of the data for European countries are displayed in Table 1, also based on data provided by the Human Mortality Database. On the average, the sex ratio typically increases by 0.6 during the war and by 1.1 after the war, with a range from 0 to 2.0, the impact being largest where the conflicts had the largest impact. In the recent civil war following the dismantling of Yugoslavia (1991-1995), the sex ratio increased in Bosnia-Herzegovnia to a high 1.096 from baseline values of 106.6 (pre-war) and 106.2 (post-war). However, no effect was found in areas less affected by the war, such as Slovenia or Croatia [Polasek et al. 2005; Polasek, 2006]. An increase in sex ratios (from 1.014 to 1.066) was found in Sardasht, a town a North-west Iran which underwent a chemical bombing in 1987 [Saadat, 2006].

On the contrary, some studies found a negative effect of conflicts or of exposure to stressful events on the sex ratio at birth. For instance, in Iran the sex ratio was found to be

lower during the Iran/Iraq war (0.988 in 1980-1988) than it was in pre-war (1.066) or post-war (1.041) periods [Ansari-Lari & Saadat, 2002]. In Slovenia, sex ratios decreased in 1992 compared with 1991 at the time of the high stress caused by the rather small scale conflict [Zorn et al. 2002]. In Japan, sex ratios were found lower (1.004) in the period 9-10 months after the Kobe earthquake than in surrounding years where it averaged 1.066, and natality also dropped at the same time [Fukuda et al., 1998]. In the USA, sex ratios dropped after the 9/11 events, and this was associated with an increase in spontaneous abortions [Catalano et al, 2005 and 2006].

Several theories were developed to explain the rise in sex ratios during wars. W.H. James has been a constant advocate of the impact of changing sexual behaviour. When coital frequency increases, more conceptions occur at both ends of the fertile period and more boys are born [James, 2009]. During wars, couples are separated, and when they meet during short leaves they are likely to have higher coital frequency; in this case higher sex ratio is expected to be associated with lower fertility and lower marriage rate. After wars, former couples reunite, new couples are formed, and they are likely to have higher coital frequency; in that case, higher sex ratio is expected to be associated with higher fertility and higher marriage rate. This theory has been criticized [Gray et al. 1998], but may hide another phenomenon: assuming strong heterogeneity between couples [see for instance Edwards, 1958; Garenne, 2009] men or women with different hormonal profiles might at the same time be more fertile and have higher sex ratios. Of course, the demographic impact on national sex ratios is likely to be visible only if large numbers of couples are involved. This is probably why such effects show up clearly in both world wars, and were clearly associated with expected effects on birth rates and marriage rates. James [2009] noted that during WW-I the effect on sex ratios was highly visible for countries extensively involved in the war, which had typically 15 to 22% of the young male population mobilized, but not for the USA which had only 4% of the population mobilized, and for a much shorter duration. Indeed, changes in birth rates and marriage rates are good checks to evaluate the possible demographic impact of a conflict. If the conflict is too small or too short, changes are unlikely to be visible in national statistics, and unlikely to have affected sex ratios nationwide.

The effect of stress on sex ratios is of different nature, and has a different effect. Stress seems to be associated with increased intrauterine mortality, which is likely to lead to lower sex ratios, since a large majority of foetuses are males. This is why the effect of stress is more transient, is seen typically 3-9 months after the stressful event, and is associated with increased spontaneous abortion. Note that stress can affect people not directly exposed to the

stressful event, as seen in the effect of 9/11 events in New York City on sex ratios in California [Catalano et al., 2005].

Other mechanisms have also been invoked to explain changes in sex ratios during wars. Nutrition is a possible mechanism: food restriction, and possibly changing body composition during hard times (much lower fat mass), might have an effect of hormonal metabolism and on sex ratios. Years of famines or of severe food shortages were sometimes associated with higher sex ratios, such as in Saxony 1834-1854 or in the Netherlands in 1941-1942 [quoted by James, 2009], or in Ukraine 1933-1936 [Adamets, 2002]. Exposure to chemicals has also been invoked. In particular, mustard gas seems to have an effect on testosterone levels and on sex ratios, including in animal models [Safarinejad, 2001]. In this case, exposure to chemicals is expected to induce higher sex ratios. However, exposure to other chemicals seems to induce lower sex ratios, as exemplified by the case of Aamjiwnaang Indians in Canada [Mackenzie et al. 2005].

The aim of this study is to investigate variations in sex ratios during the civil war in Tajikistan, which occurred in 1992-1997. The main reason for choosing this country was that the civil war had several major demographic impacts, with large effects on birth, death, marriage and migration rates. Note that in such a situation, the war might have several impacts, both positive and negative, on the sex ratios.

## **Background on the civil war in Tajikistan**

Tajikistan is located in southern Central-Asia, and borders Afghanistan, Uzbekistan, Kyrgyzstan, and China. Its geography is complex, with several major divisions: the North (Sughd/Sogd), part of the Ferghana Valley; the South Low lands (Khatlon/Hissan); the Central valleys (Garm and Karategin); and the very montaneous areas of Gorno-Badakhshan / Pamir, part of the Himalaya complex, where the altitude exceeds 4000 meters (13,000 feet). The main ethnic group is the Tajik, a group from Indo-European origin and Persian culture, with sizable minorities of Uzbek people (about 25%), located in the north, Pamiri people (in the South East), who have different culture and different religious affiliation, and numerous other smaller groups, including Russians who played a major political and military role during the war.

Tajikistan was colonized by Russians in the later part of the 19<sup>th</sup> century, was integrated in the USSR in 1922 after the October Revolution, and became an official Socialist Soviet Republic in 1929. Due to its difficult geography, its difficult climate, and a lack of natural resources, Tajikistan was one of the poorest of the USSR republics, and is still one of the poorest countries, and one with the lowest Human Development Index in the region. The country is overwhelmingly rural, with declining proportion urban since the mid 1970's (27% urban at the 2000 census). It suffers from its proximity with Afghanistan, a country deeply traumatized by a series of adverse political and military events: the Soviet invasion (1979), the establishment of the Taliban regime (1995), the American invasion (2001), and by their numerous consequences, in particular extensive drug and weapon trafficking.

Tajikistan became independent in September 1991, and the fight for power quickly degenerated in a bloody civil war, which lasted about five years (May 1992 to June 1997), and ended with a peace agreement signed in 1997. Most of the heavy fighting occurred in 1992 and 1993. The origin of the civil war is complex, and has been investigated elsewhere [Dudoignon, 1994; Dudoignon and Jahangiri, 1994; Roy, 2004]. Briefly, it involved a series of regional and clanic conflicts (Leninabadi / Kulyabi versus Garmi / Pamiri), on top of which emerged ideological conflicts (communists/secular versus an alliance of democrats and Islamists) and to a smaller extent religious conflicts (chiites versus sunnites). Many of these conflicts originated in the complex policies during the soviet period, including forced collectivization, arbitrary zoning and border design, and various interplay between political establishment and regional elites. The war itself was a mixture of formal war and several guerrillas. It involved formal fights between regular troops, supported by the Russian army stationed in Tajikistan and the armed opposition forces, as well as numerous informal fights involving warlords and criminal gangs. The official armed forces were considerable given the size of the country: some 16,500 Russian soldiers were involved, and some 12,500 Tajik national soldiers, well equipped with battle tanks and modern artillery. In addition armed bands of all sorts terrorized communities by looting, stealing and hostage taking. The Leninabady-Kulyabi Front militias became involved in severe repression, sometimes qualified as "ethnic cleaning", against Garmis and Pamiris, which included mass killing and systematic burning of villages, especially in the South. [Dudoignon, 1994; Roy, 2004; International Crisis Group, 2001; UNHCR, 1996; OSI, 1998]

The final toll of the conflict was severe. For a population of 5.4 million in 1991, some 600.000 persons were internally displaced (UNHCR), and some 80.000 persons fled the country, mostly to Afghanistan. Registered migration indicates that some 280,000 persons left

the country in 1992-1996, four times more than in the next five years (1997-2001). Estimates of mortality range from 60.000 to 100.000 excess deaths, although we will see later that these numbers are probably exaggerated. In addition, the economy was severely damaged, not counting the fact that the war years were followed by a severe drought lasting four years, all events that may have an impact on marriage and birth rates. Family structures were severely affected by the war, and have not yet fully recovered. The impact of the war on families was later amplified by massive out-migration of workers, primarily to Russia, and in the recent years Tajikistan was one of the countries in the world sending the largest numbers of migrant workers abroad given the size of its population. [Goskomstat, 2005 & 2006].

## **Data and methods**

We used published and unpublished data from the vital registration system and population register of Tajikistan: births by sex, deaths, marriages, divorces, in- and out-migration. Some data were found in United Nations Demographic Yearbooks, some were found on the Goskomstat web site, some on the World Health Organization Statistics web site, some on the Demoscope Web site, others in local statistical publications found in Dushanbe.

The series that were reconstructed are not fully complete. For births, the series ranged from 1950 to 2007, but the breakdown by sex was available only in 1981-1983 and 1985-2004, and the last three years were considered unreliable, probably because the distribution by sex was calculated a posteriori using an arbitrary standard sex ratio. For deaths, the series was complete from 1950 to 2007, but considered unreliable before 1975, as was the case in many republics of the former Soviet Union [Blum & Monnier, 1988; Hohmann, 2005 & 2009]. For marriages, the series was complete from 1950 to 2006, and considered reliable. For divorces, the series was also complete for the same years, and considered reliable only after 1965. For in- and out- migration (registered arrival and departures in the population register), the series ranged from 1951 to 2005, with 1954 and 1955 missing.

Several censuses are available for Tajikistan over the period: 1959, 1970, 1979, 1989 and 2000. They provide an independent check on the reliability of vital registration. From 1970 to 1989, the average intercensal growth rate was 29.6 per 1000, which is consistent with the average rates computed from Vital Registration: birth rate of 38.3 per 1000, death rate of

7.4 per 1000, and net-migration rate of +0.02 per 1000, leaving either a small difference of 1.3 per 1000. From 1989 to 2000, the average intercensal growth rate was 16.8 per 1000, which compares with the average birth rate of 32.7 per 1000, the average death rate of 6.1 per 1000, and the net-migration rate of -6.9 per 1000, leaving a somewhat larger gap of 2.9 per 1000, which could be due to under-registration of out-migration. In conclusion, there is no reason to doubt about the validity of Vital Registration data in Tajikistan, with some possible under-registration of out-migration (about 6% pre-war, and about 16% during the war period).

We plotted annual data, and computed linear trends over periods where trends were visible on graphs. They do vary by event, and will be presented in the next section. Changes during the war period were computed by difference between observed values and values expected from trends.

## **Results**

### Demographic impacts

The civil war period had major demographic consequences in Tajikistan. The average rate of population growth in 1992-1995 (13.1 per 1000) was about half of that of the previous four years (25.2 per 1000) as a result of lower birth rates, higher death rates and increased out-migration.

Birth rates were rising steadily from 1950 (30.0 per 1000) to 1991 (39.2 per 1000), and underwent a major drop during the war, to stabilize at a lower and steady level after 1995, with an average of 28.6 per 1000 [Figure 1].

Death rates were declining since 1975, they rose rapidly during the war, with a peak in 1993 (8.8 per 1000), compared with 6.1 per 1000 in 1991. By 1996, they had recovered the pre-war trend line, and continued to decline with some ups and downs until 2006 [Figure 2]. Compared with the pre-war trend line, the excess mortality during the war can be estimated at 27,000 persons. This is a lower figure than other values sometimes quoted of 50,000 to 100,000 excess deaths, although these values are rarely justified by proper demographic calculations.

Net-migration was positive until 1975, and somewhat negative and steady in the pre-war period, with an average of -1.2 per 1000 between 1976 and 1988. The migration flows



were first disrupted at time of independence (1989-1991), then net-migration became strongly negative during the war, with a low  $-15.2$  per 1000 in 1992 and 1993. By 1998, the situation had stabilized, and net migration was similar to that of the pre-war period [Figure 3].

The impact of the civil war on marriages and divorces was also notable. The marriage rate was stable over time from 1950 to 1991, with only some minor accidents, with an average value of 10 per 1000. The marriage rate declined markedly during the war and even after to reach a low value of 3.7 per 1000 in 1998-1999. Since then it recovered quickly, and by 2006 it was getting close to pre-war levels (8.6 per 1000) [Figure 4].

The divorce rate was on the rise from 1966 to 1979, and roughly steady since, with an average value of 1.5 per 1000 up to 1991. It dropped markedly during the war, and continued to decline until 1999, after which it stabilized at about 0.4 per 1000, and even rose slightly in the recent years (2004-2006) [Figure 5].

In conclusion, there is no doubt that the civil war had major demographic effects. Beyond the increased mortality and out-migration rates, which reflect a major stress, it also induced major changes in marital partnerships, with a major and long lasting drop in marriages for about eight years, and a large drop in births during the four years of the war. Two ingredients of the sex ratios were therefore present: marital disruption, and psychological stress.

### Impact on sex ratios

The impact of the war on the sex ratio at birth was indeed remarkable [Figure 6]. During the pre-war period, sex ratios averaged 104.6 (95% CI= 104.3-104.9), and were similar in the post-war period: 104.9 (95% CI= 104.5-105.4). Note that these sex ratios are somewhat low compared with the world average of 105.5, but are almost identical to those of Iran, the country the closest to Tajikistan ethnically speaking: 104.3 over the 1996-2006 period (95% CI: 104.2-104.4).

The war had a major impact on the sex ratios: by 1991 they rose to 107.0, and stayed high during the whole war period, and were still high in 2006 (106.0), with an average of 106.7 from 1991 to 1996. Each of the annual sex ratio from 1991 to 1996 was significantly higher than the 104.6 baseline:  $P < 10^{-5}$  in 1991, 1992, 1994, 1995;  $P = 0.0002$  in 1993 and  $P = 0.0055$  in 1996. Note that the effect on sex ratios started a year earlier and ended a year later than the excess mortality. It seems to be somewhat more correlated with trends in births,

marriages and migrations, although it started a year earlier than the changes in birth rates and marriage rates.

## **Discussion**

The magnitude of the increase in the sex ratio at birth observed during the civil war in Tajikistan (+2.1) is consistent with the highest values observed during the world wars in Europe (as in France or Belgium in WW-II). Changes in birth rates and marriage rates were also remarkable, and consistent with similar effects in countries deeply affected by WW-I or WW-II.

Large drops in births and marriages during the war were not followed by a marriage boom or a baby boom at the end of the war. This is probably due to the fact that Tajikistan is a very poor country, which received little international help at the end of the war, and needed much more time to recover than European countries in 1919 or 1946. The war period was also followed by a drought, which hampered a quick recovery. This is probably why the increase in sex ratios was limited to the war period, and not existent in the post-war period.

The impact of the war on sex ratios was positive, which means that if stress was also involved (which is likely in such conflicts) the possible negative effects were largely compensated by the positive effects. There are unfortunately no data to document the coital frequency hypothesis. However, since virtually all fighting soldiers were young men staying in the countryside, one could assume that, if married, they were separated from spouses most of the time, a situation similar to that of the French men in 1914-1918. In addition, spousal separation could have occurred for refugees and displaced persons who tried to escape the combat areas. Times were very harsh for the whole population, and Tajikistan is a country prone to famines and severe food shortages. So, it is likely that poor nutrition also played a role on the changes in sex-ratios.

The war period was associated with massive out-migration, of men and also of women, primarily towards Afghanistan and towards Russia. This probably led to increased spouse separation, which might have contributed to the lower fertility. However, this does not seem to have a long term impact on the sex ratios. If the food situation improved after the war, it is by no means secured, and there were again food shortages in year 2008. It would be

interesting to continue monitoring trends in sex ratios over time, to better understand what happened in 1992-1996 in Tajikistan.

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Table 1: Examples of the impact of war on sex ratio at birth (WW-I and WW-II in Europe)

Country	Baseline Period	Sex ratio	Reference Period	Sex ratio	Change	P-value	Signif
<i>During war</i>							
France	1904-1913	104.6	1914-1917	104.6	0.0	0.9798	
France	1932-1941	104.1	1942-1945	105.9	1.8	0.0000	*
Austria	1904-1913	105.3	1914-1918	105.3	0.0	0.9704	
Austria	1933-1939	106.1	1940-1944	106.2	0.0	0.9771	
Belgium	1904-1913	104.5	1914-1918	104.9	0.5	0.1398	
Belgium	1933-1939	104.9	1940-1944	106.5	1.6	0.0000	*
England&Wales	1904-1913	103.9	1914-1918	104.3	0.4	0.0012	*
England&Wales	1933-1939	105.4	1940-1944	106.0	0.7	0.0000	*
Italy	1904-1913	105.4	1914-1918	105.3	-0.1	0.3769	
Italy	1933-1939	105.4	1940-1944	105.7	0.3	0.0062	*
Netherlands	1904-1913	105.1	1914-1918	105.7	0.6	0.0261	*
Netherlands	1933-1939	106.0	1940-1944	106.8	0.8	0.0076	*
Norway	1933-1939	105.9	1940-1944	106.9	1.0	0.0905	
Average					0.58		*
<i>After war</i>							
France	1904-1913	104.6	1918-1920	106.4	1.8	0.0000	*
France	1932-1941	104.1	1946-1948	105.8	1.7	0.0000	*
Austria	1904-1913	105.3	1919-1922	106.6	1.3	0.0000	*
Austria	1933-1939	106.1	1946-1949	106.9	0.8	0.0360	*
Belgium	1904-1913	104.5	1919-1922	106.0	1.5	0.0000	*
Belgium	1933-1939	104.9	1946-1949	106.2	1.2	0.0002	*
England&Wales	1904-1913	103.9	1919-1922	105.3	1.4	0.0000	*
England&Wales	1933-1939	105.4	1946-1949	106.1	0.7	0.0000	*
Italy	1904-1913	105.4	1919-1922	105.6	0.1	0.2450	
Italy	1933-1939	105.4	1946-1949	105.9	0.5	0.0000	*
Netherlands	1904-1913	105.1	1919-1922	106.3	1.2	0.0000	*
Netherlands	1933-1939	106.0	1946-1949	106.8	0.7	0.0061	*
Norway	1933-1939	105.9	1946-1949	106.9	1.0	0.0685	
Average					1.09		*

Table 2: Changes in demographic parameters during the civil war in Tajikistan

	Period			Comment
	Pre-war	War	Post-war	
<i>Crude rate (per 1000)</i>				
Birth rate	39.7	30.8	28.6	Declined by 22%
Death rate	6.9	7.1	4.9	Increased by 45%
In-migration rate	18.5	11.0	2.6	Declined by 40%
Out-migration rate	19.7	26.3	4.6	Increased by 33%
Net-migration rate	-1.2	-15.2	-1.9	Increased 12 fold
Marriage rate	10.0	7.6	5.2	Declined by 63%
Divorce rate	1.50	0.91	0.44	Declined by 74%
<i>Sex ratio (per 100)</i>				
Sex ratio at birth	104.6	106.9	104.9	Increased by 2.2%

Note. Changes in marriage and divorce rates are computed from lowest value after war.



Figure 1: Trends in crude birth rate, Tajikistan, 1970-2006

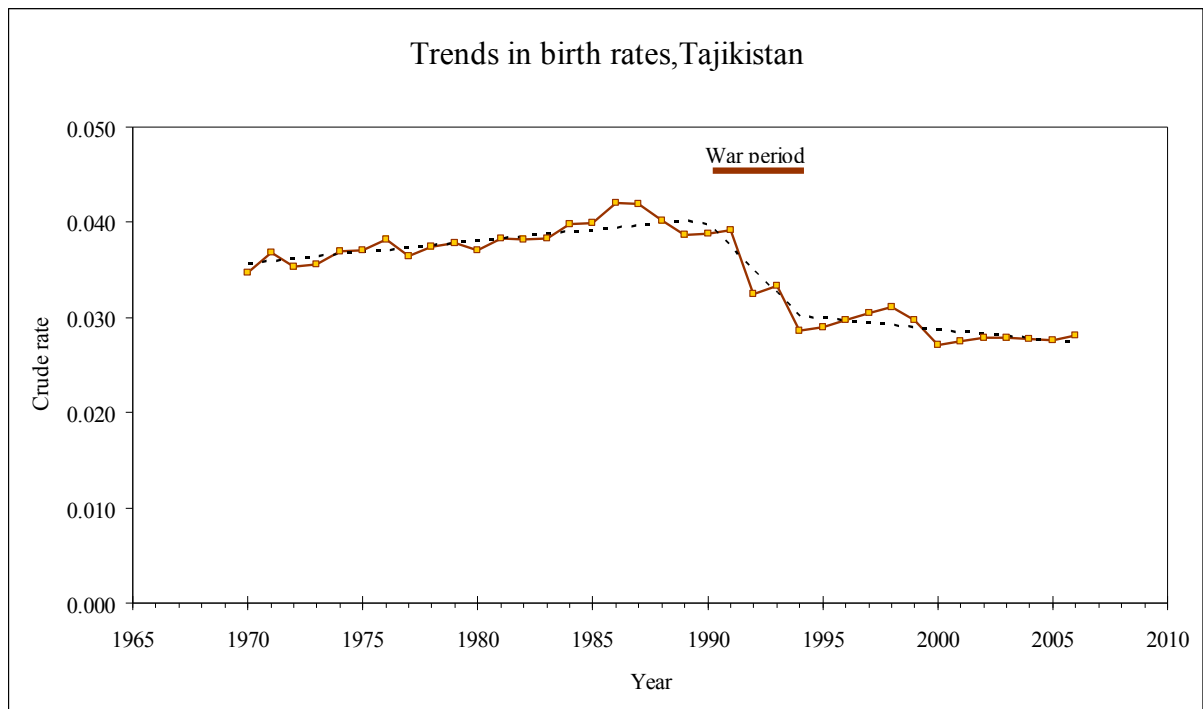


Figure 2: Trends in crude death rate, Tajikistan, 1970-2006

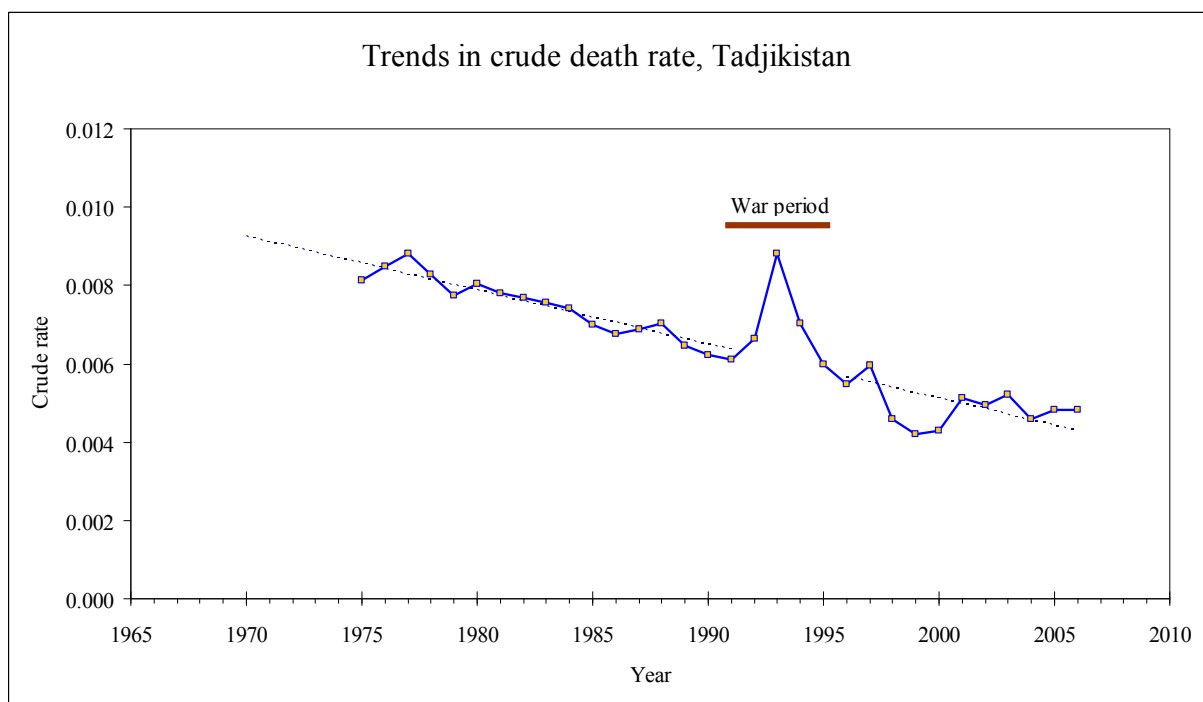


Figure 3: Trends in crude net-migration rate, Tajikistan, 1970-2006

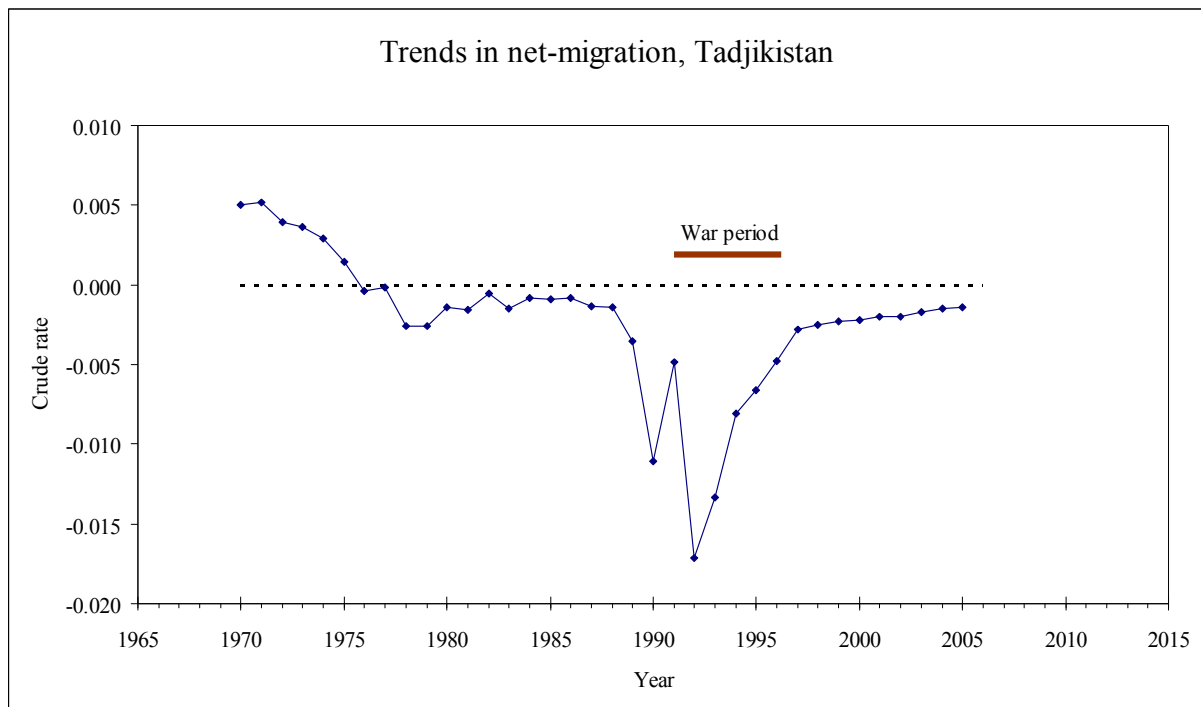


Figure 4: Trends in crude marriage rate, Tajikistan, 1970-2006

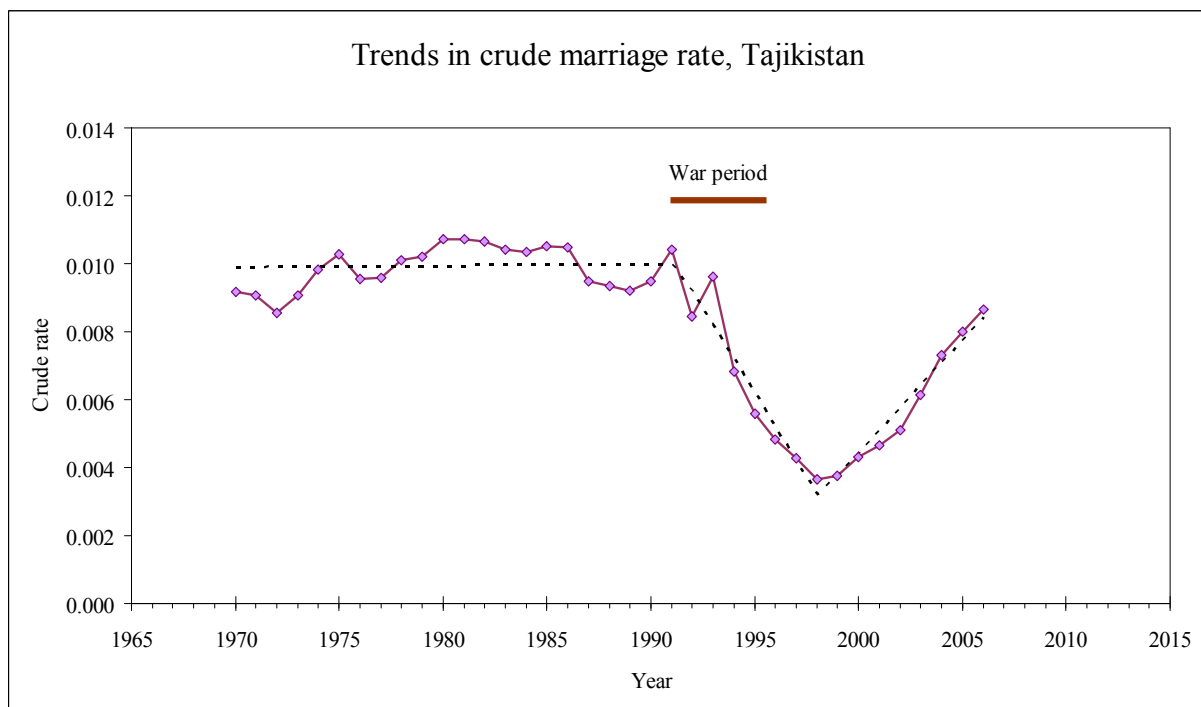


Figure 5: Trends in crude divorce rate, Tajikistan, 1970-2006

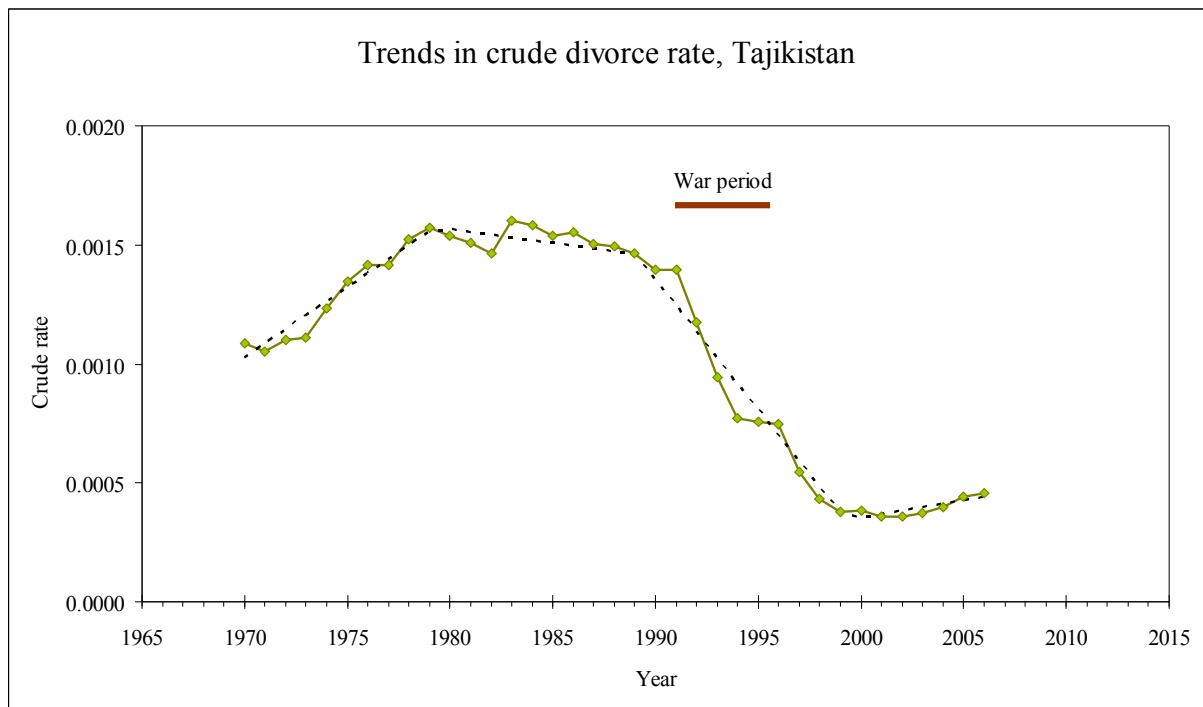


Figure 6: Trends in the sex ratio at birth, Tajikistan

