

# **Trends in the Frequency of Twin Births over the last Century: European Comparisons**

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**DRAFT** (based on the published articles: Pison & Couvert, 2004; Pison & D'Addato, 2006)

**Abstract:** The evolution of twinning rate in the European countries over the last century follows broadly the same pattern, even though the total levels varied among them. Patterns and differentials in such rates across populations are described, and trends over time are given. Several complementary factors may have played a role in the downward and upward trends of twinning rates observed in most developed countries in the twentieth century, such as changes in age at childbearing, wars, voluntary birth control or, more recently, the advent of techniques to overcome infertility. In the similar pattern followed by the twinning birth rates in the European countries, one exception is the period around World War I, which represents for this reason an interesting scenario to be investigated more in detail. There has been a peak of twinning during the War or just after, but not in all countries. The twinning boom has been of different intensity and has had different timing according to the country. For instance, in France the spectacular twinning peak registered in the World War I period was also due to a “selection effect”: couples who conceived during these years were among the more fecund. Hyper-fecund couples or women thus contributed more to births than they did in peace time. If these couples or women are effectively more at risk of having twins, selection through fecundity increased the twinning rate at that time.

## **1. Introduction: the biology of twinning**

Nearly 1 in every 100 deliveries is a twin birth. Triplet, quadruplet and higher order deliveries occur much more seldom – only once in 10,000 deliveries.

It is a long known fact that twins come in two kinds: identical twins and fraternal twins. Biologists call the former monozygotic twins and the latter dizygotic twins, in reference to their different origins.

Identical (MZ) twins originate from a single egg or zygote, produced by the fertilization of an ovum by a spermatozoon. Fraternal (DZ) twins result from the ovulation and fertilization of two different ova during the same cycle.

Fraternal and identical twins correspond to two different biological processes, and their incidence depends on different factors.

The prevalence of MZ twins is relatively constant worldwide, that is, between 0.3 and 0.4%, regardless of other factors. The same proportion has actually been observed among all mammals, except for some armadillos whose females systematically give birth to monozygotic quadruplets or octuplets. In addition, all women seem to run an equal risk of having identical twins, whether or not they have previously given birth to twins.

Conversely, the prevalence rates of DZ twins (and higher order multiples) vary considerably - ranging between 0.6 to 4.5% in different populations - because they are influenced by several

determinants, including maternal age, parity, individual and family characteristics and region of the world.

Beginning with a near zero level at puberty, the proportion steadily increases up to the age of 37, where it reaches its maximum level, then rapidly decreases back to zero by the time of menopause. Moreover, the age factor being equal, the dizygotic twinning rate increases at higher order of birth. Women may also have several sets of fraternal twins: this predisposition to twin pregnancies is partly genetic and can be observed among the sisters and daughters of women who have had twins. The same variations according to mother's age and order of birth are observed everywhere in the world, but the frequency of twinning differs by region. For instance, controlling for age and birth order, the fraternal twinning rate in sub-Saharan Africa is two times higher than in Europe and four to five times higher than in China or Japan (Pison, 2000). These variations among racial and ethnic groups are partly linked to hormonal differences and genetic origin.

In this paper we focus on European countries, where the proportion of twin births has varied during the last century, rising at times and falling at others. Are these variations similar in different countries, or do some countries show particularities? How can we explain the similarities and differences among them? An overview of secular changes in twinning rates in selected European countries for which detailed statistics on multiple births are available is provided. We will first examine two long-term trends that are common to nearly all the countries: the decline in the twinning rate during the first three quarters of the 20th century, and the recent reversal upward trend since the 1970s or 1980s.

We will focus then on the period around World War I during which there was a peak in twinning rate in many countries, although not in all.

In general, one of the main factors affecting the twinning rate is the age at childbearing: older women tend to have twins more often than younger women. However, changes in age at childbearing are not sufficient to explain the twinning peak around World War I in many countries, such as France, Germany and Italy. For instance, we suggest that in France, beside the traditional factor of changes in age at childbearing, this spectacular twinning peak of First World War was also due to a "selection effect" of the most fecund couples. If these couples or women had a greater propensity than others to have twins, selection through fecundity would have increased the proportion of twin births in that period.

## **2. Data and methods**

To compare the secular trends in twinning rates in European countries, data were drawn from the civil birth registration systems of the National Statistical Offices and from earlier studies where data from official registers had been collected and compiled.

The twinning rate is the proportion of twin deliveries (of live-born or stillborn children) out of the total number of deliveries (of live-born or stillborn children), expressed per 1,000 deliveries. It was computed for each given year using the total number of confinements as the denominator and the annual number of twin confinements as the numerator.

The twinning rates presented are based on the total number of twin births, including both dizygotic (or fraternal) and monozygotic (or identical) twins.

In the second part of the paper, we illustrate the link between fecundity and propensity to have twins using data from 18th century and from 20th century.

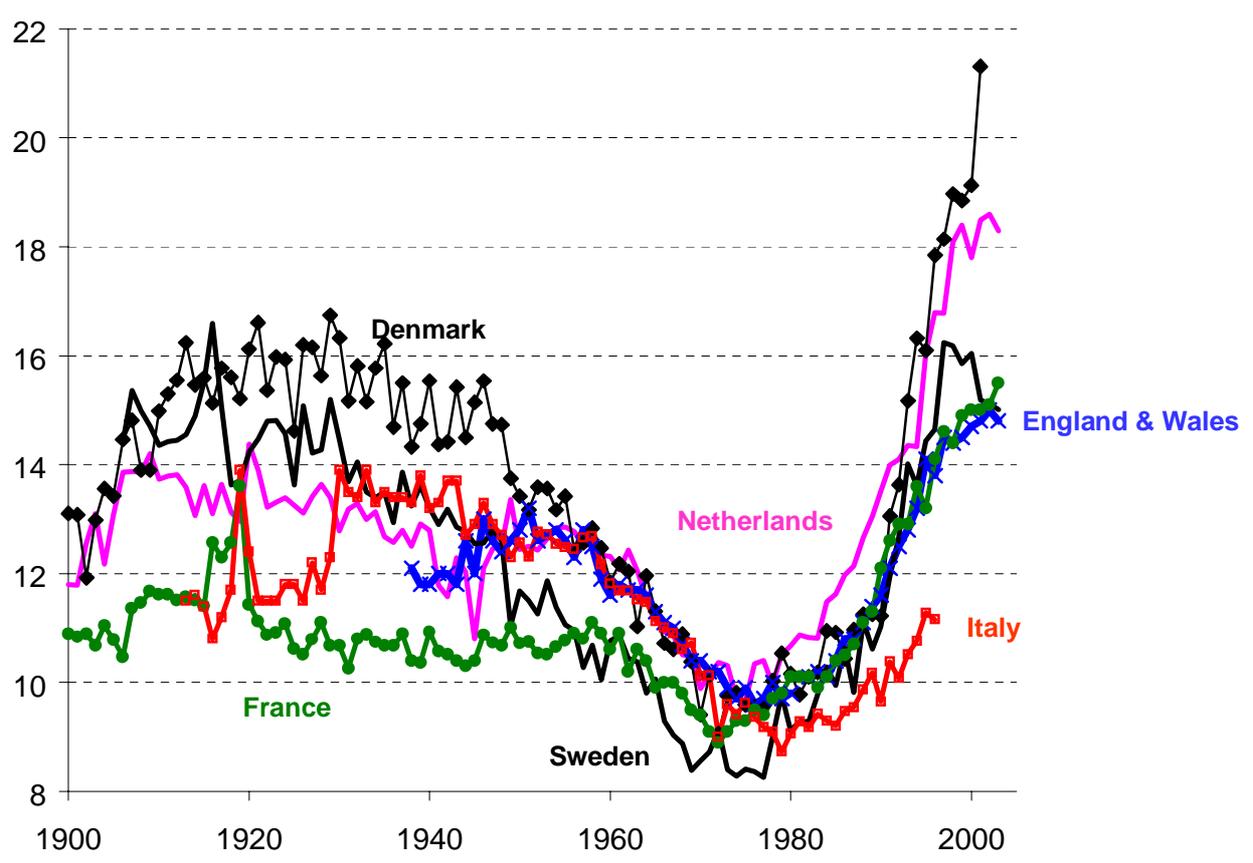
Data for the 18<sup>th</sup> century were provided by Louis Henry's historical survey of France and gathered 23,000 first births occurring during first marriage. Data for this survey are drawn from family

records derived from traditional marriage registers in a sample of 100 French parishes during the period 1670-1830. Records include information on all births to married couples. Data for the 20<sup>th</sup> century were drawn from the last four Family Surveys conducted in France in 1975, 1982, 1990 and 1999. The total sample of these four surveys includes more than one million women representative of the French adult female population. The data collected included a history of unions and births for each woman. We excluded women born before 1920 to reduce risk of recall bias. Our sample covered around 500,000 first births occurring during first marriage.

### 3. Historical trends in twinning rates

Worldwide changes have occurred in the pattern of twinning rates in recent decades. To gain a proper perspective, these variations in twin maternities should be seen in their historical context. Figure 1 shows the historical trends for selected European countries since the beginning of the 20th century. Similar downward and upward trends were observed in most developed countries, even if the overall levels of twinning rates vary among them.

**Figure 1** – Trends of twinning rate over the 20<sup>th</sup> century in selected European countries.



Source: Pison & D’Addato, 2006.

To summarize the trends over time observed, it can be noted that in the first half of the 20th century, the incidence of twin deliveries did not significantly vary, with a visible plateau generally kept until 1960. In the 1960s, the proportion of twin deliveries declined to a minimum in the 1970s or 1980s. The rate then began to increase again and, by the second half of 1980s, it had risen back

to the level of the first half of the century, designing a U-shaped curve in most European countries (Pison & D'Addato, 2006).

The general evolution reported in most European countries clearly emerges calculating the medium twinning birth rates in three different quinquennial periods. The first selected 5 years correspond to the period of the plateau, the second period corresponds to the general decline and the third measure synthesizes the period of the important rise in the proportion of twins (Table 1).

In Europe there is a progressive decrease in the incidence of twinning rates from North to South. By European standards the twinning rate is low among the Latins, medium among the Slavs and relatively high among the Germanic people, particularly among the Nordic people, including the Finns. However, few data are available on the southern European countries (D'Addato, 2006).

**Table 1** - Medium twinning rate per 1,000 births in the periods 1925-29, 1972-76 and 1995-99.

Countries	Medium twinning rate		
	1925-1929	1972-1976	1995-1999
Austria	12.16	9.04	12.08
Czech Republic	12.46	9.34	13.32
Denmark	15.87	9.55	17.98
England & Wales	-	9.86	14.26
Finland	14.49	11.01	15.69
France	10.74	9.22	14.24
Germany	11.93	9.48	14.90
Ireland	12.14	12.07	13.24
Israel	-	10.03	17.40
Italy	11.90	9.40	11.22
Netherlands	13.36	10.08	17.22
Norway	14.50	9.29	15.81
Sweden	14.48	8.52	15.47
Switzerland	12.68	8.90	12.94

*Source: Pison & D'Addato, 2006.*

### 3.1 Decline in twinning rates from around 1950s until the late 1970s

Besides showing inter-population variability, it seems that, in most European countries, a decline in twinning rates – in most cases a substantial decline – began at about the same time in the early 1950s, displaying a reversal of tendency in the late 1970s (Figure 1).

Several complementary factors have played a role in the general phenomenon of declining twinning rates observed from around 1950 until the late 1970s.

Firstly, maternal age is an important determinant in the variations of twinning rates, with a temporal trend toward earlier marriage and childbearing. In fact, as several studies have shown, there is a positive association between twinning incidence, in particular DZ, and maternal age and parity (Blondel & Kaminski, 2002 ; Eriksson & Fellman, 1973). Therefore, the decrease in mean maternal age at delivery and the reduction in the number of children have been considered to be at least partly responsible for the downward trend. Childbearing only partly accounts for the changes in

twinning rates. Women who give birth to twins are less likely to undertake another pregnancy than women who give birth to a single child.

Secondly, under the assumptions that (a) mothers of twins are more fecund than other women, and (b) such women constitute a subpopulation that is inherently twin-prone, the observed decline in twinning rates may be a reflection of the smaller family size chosen by these highly fecund, twin-prone women. In other words, the decline may be related to the voluntary limitation of deliveries (Pison & Couvert, 2004).

In addition to these two main factors, a wide range of suggestions and hypotheses has been offered to further explain the general decrease of the twinning rates. A history of oral contraceptive use has been suggested to contribute to the decline in twinning by acting directly to reduce the probability of double-ovulation (Braken, 1979).

Socio-environmental factors, including increasing urbanization, may be acting to produce the observed changes. This has prompted the suggestion that an urban, sedentary lifestyle may increase the probability of spontaneous abortion in women expecting twins (Parisi & Caperna, 1981). On the other hand, it is hypothesized that mothers in rural regions may have a stronger genetic disposition for twinning and that mothers in the countryside with a good physical condition have a better chance of completing a gestation with multiple embryos than women in urban and industrialized areas (Eriksson et al., 1995).

The decline in twinning rates may also be influenced by a decrease in the probability of conception. Speculations on the cause of decreased sperm concentration include exposure to pesticides and stilbestrol, a growth hormone widely used for livestock (James, 1972). In support of this notion, it has been observed that workmen involved in the manufacture of pesticides have a lower than normal sperm count (Astolfi et al., 2003).

### **3.2 Upward trend since mid-1970s**

Since the mid-1970s, rising twinning rates have been reported in most European countries and, especially during the last two decades, a sudden increase in multiple births has been observed (Figure 2).

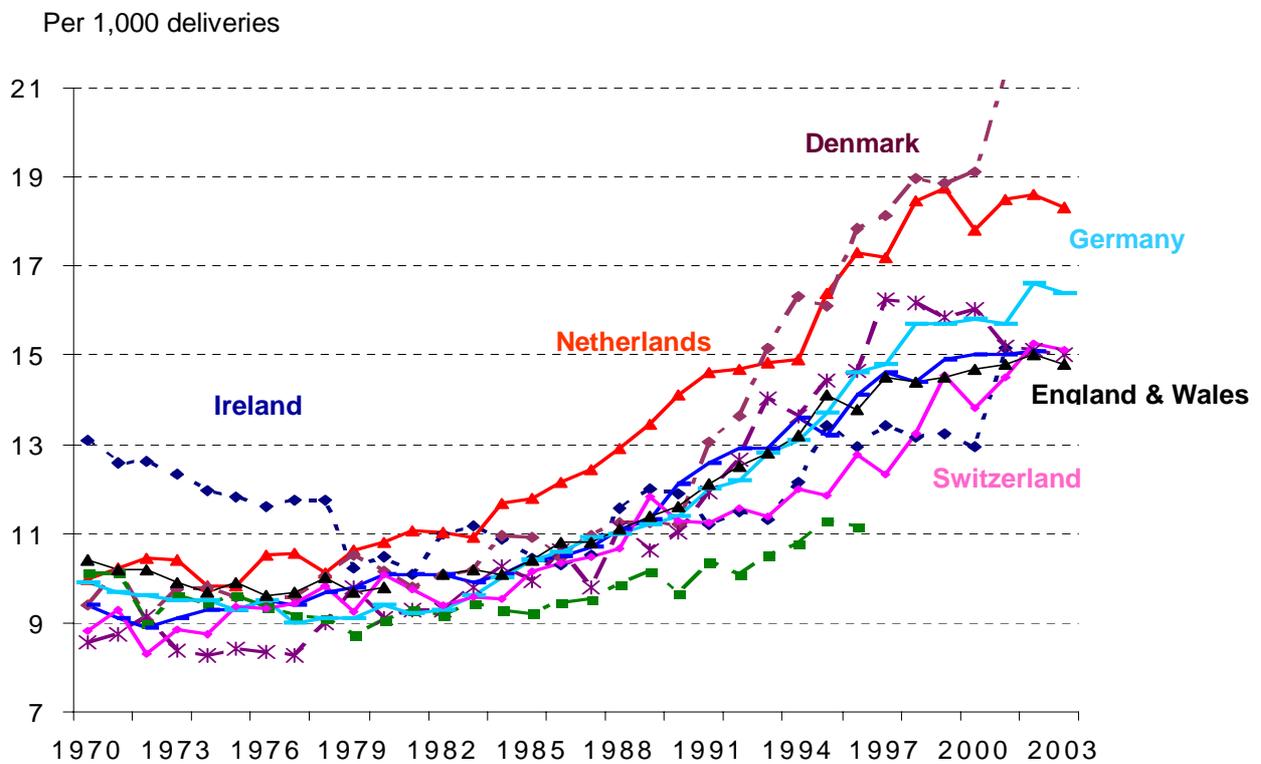
Among the Western countries, the twinning rate was the highest in Ireland until 1984 (the country with the highest total fertility rate in Europe). Afterwards, the highest twinning rates were observed in the Netherlands and in Denmark. In the Netherlands, the twinning rate remained nearly constant between 1970 and 1980 (9.9 - 10.8). In the last two decades, however, the twinning rate increased significantly, more strongly than could have been expected, according to quantitative estimations. It rose 64% in 25 years: from 9.9 per 1,000 in 1970 to 16.3 per 1,000 in 1995.

The rising multiple birth rates have been attributed to the higher proportion of mothers treated with ovulation-inducing hormones, and partially attributed to in vitro fertilization (IVF) practice. These treatments make it possible for hypo-fertile women to conceive, but also increase the likelihood of multiple pregnancies. In Vitro Fertilization (IVF) is suggested to women when ovarian stimulations are unsuccessful. In order to improve the likelihood of success, physicians practicing IVF often implant several ova or several embryos at once—2.3 on average in 2001. However, this procedure involves a high risk of multiple births. Almost one out of four IVF pregnancies leads to the birth of twins, as opposed to one in 100 for natural pregnancies.

After the introduction of assisted reproductive techniques such as IVF, natural twinning rates have been changing depending on how popular these techniques have been in each country. Namely, the variations of these rates among countries were not only due to biological factors, but also to assisted reproductive techniques.

The growing frequency of sterility treatments accounts for two thirds of the increase in the twinning rate – from 0.9% to 1.5% of births – observed over the last thirty years, the remaining third mainly being due to the fact that women tend to have their children later in life.

**Figure 2** – Twinning rate in selected European countries from 1970 to 2003.



Source: Pison & D’Addato, 2006.

#### 4. Multiple births and age of mother: the cases of France and England and Wales

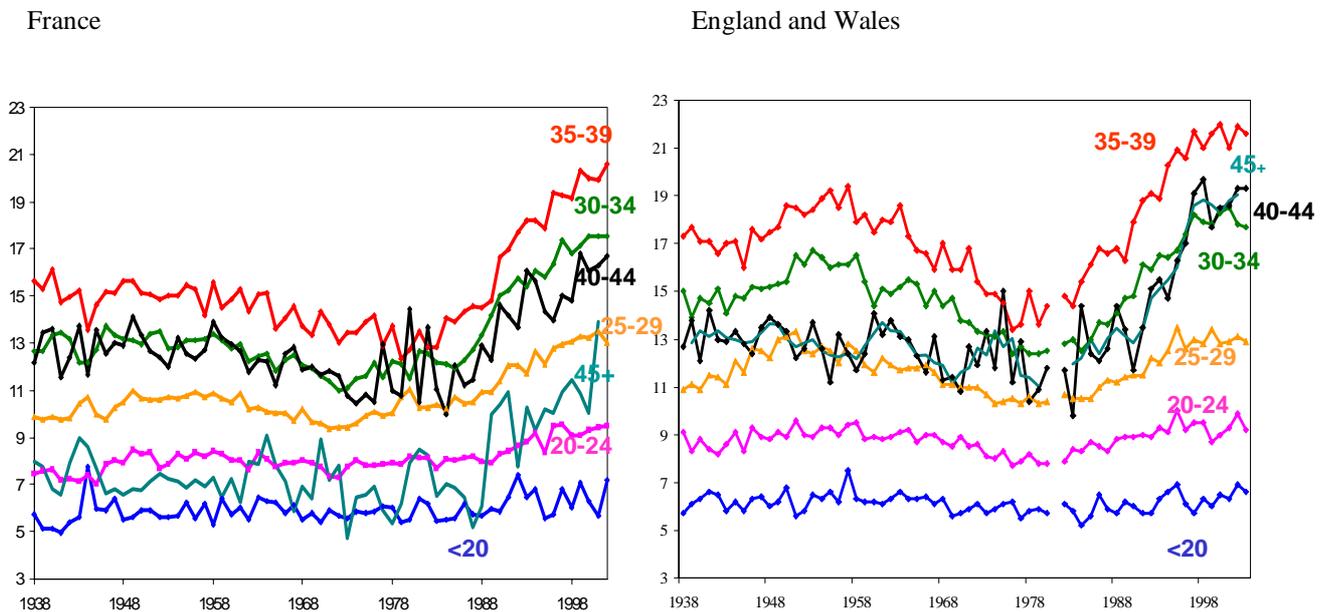
In France, and in England and Wales, age-specific rates have been reported to obtain a better understanding of the role of mother’s age and to neutralize the influence of birth timing on twinning rates (Figure 3).

The rates for the youngest maternal age groups (under 20 years old) remained nearly constant during the examined period both in France and in England and Wales. On the contrary, twinning and multiple rates for the age groups 35 to 39, 40 to 44 and 45+ significantly increased year by year.

The incidence of multiple births increases with the mother’s age, up to ages 35 to 39 years<sup>1</sup>, and in the last decade, it dramatically climbed among women aged up to 45. This sudden increase, already visible in France, has been even more striking in England and Wales.

<sup>1</sup> It has been attributed to the rise in the level of gonadotropin with age, with maximum stimulation of follicles occurring between ages 35 and 39 (Danforth, 1990).

**Figure 3** – Twinning rate in France and England and Wales by maternal age from 1938 to 2002 (for the age group 45+, moving averages over 3 years are shown).



Source: Pison & D’Addato, 2006.

This huge increase concerns not only twins but also triplets, quadruplets and higher order multiples, which are certainly more frequent in the oldest maternal age-groups.

Moreover, the strikingly high frequency of multiple deliveries among older women suggests that ovarian stimulants and, from the late 1982s onwards, assisted conception, had a considerable impact on the rate of multiple births. In fact, older women are more likely to utilize infertility treatments. The finding of a dramatic increase in multiple rates mainly among older women, strongly supports the link to fertility-enhancing treatments. To quantify the impact, however, more appropriate data that explicitly relate the use of these procedures to their outcome are needed.

Another hypothesis to partly explain the recent explosion of multiple births in the oldest maternal age groups may be related to the increasingly observed number of second marriages, which may reasonably be linked with a significant rise in the mean maternal age at childbirth<sup>2</sup> (Pison & D’Addato, 2006).

Maternal age rose in recent decades in most countries. In France, the rise was from 26.5 years of age in 1977 to 29.6 in 2004. The quantitative contribution of rising maternal age to the increase in multiple pregnancies has been estimated in several countries. In England and Wales, France, the United States and Sweden, one fourth to one third of the increase in twin or triplet pregnancies is attributable to the increase in maternal age (Blondel & Kaminski, 2002). The slightly higher twinning rate at each age, from 1946 to 1966 is most likely linked to the baby boom. Had the baby boom not taken place, it is conceivable that the twinning rate would have continued the slow

<sup>2</sup> However, the strong impression that twinning rates increase with the women’s age is only partly confirmed by a recent publication focusing on Sweden (Hoem & Strandberg, 2004). The authors of this study show that there is a simple but nonmonotonic association between age and twinning rates when one controls for parity, and also a nonmonotonic association between parity and twinning rates when one controls for the mother’s age.

decline observed in every age group in the inter-war period. This decline coincides with the drop in fertility and a smaller number of large families.

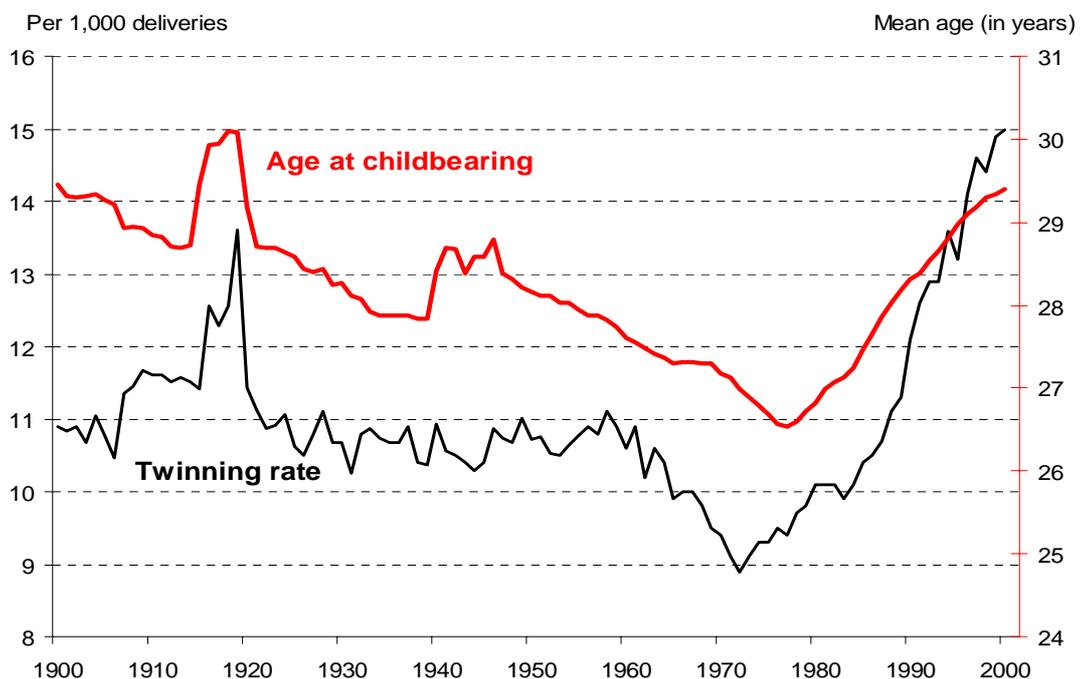
### 5. Changes in age at childbearing during the World War I: an incomplete explanation

In this second part of the paper we focus on the period around the World War I which represents an interesting and challenging scenario characterized by a big diversity in twinning rates along European countries.

Rising slowly from 10.5 to 11.5 per 1,000 since 1900, the proportion of twin births increased dramatically in France during World War I, and peaked to the record level of 13.6 per 1,000 in 1919, the year following the Armistice, and quickly returned to just under 11 per 1,000 after the war.

As we mentioned above, in general the twinning rate is influenced mainly by age at childbearing: older women tend to have twins more often than younger women. The twinning peak of World War I partly results from a rise in the mean age at childbearing, due to postponement or prevention of marriages by war: while the mean age of childbearing was close to 29 between 1910 and 1914, it increased sharply in 1915, remained at a level close to 30 during 1915-1919, then dropped back to pre-war levels (Figure 4).

**Figure 4** – Variation in twinning rate and in mean age at childbearing in France from 1900 to 2002.



Source: Pison & Couvert, 2004.

Many marriages were postponed by the war, due to the massive departure of men to the front. Most of the women who gave birth during wartime were already married before war began, and there were few young brides among them. Further, young women who were nonetheless able to marry during war had few children, since their (young) husbands were more at risk of being on the front than older ones (Pison & Couvert, 2004).

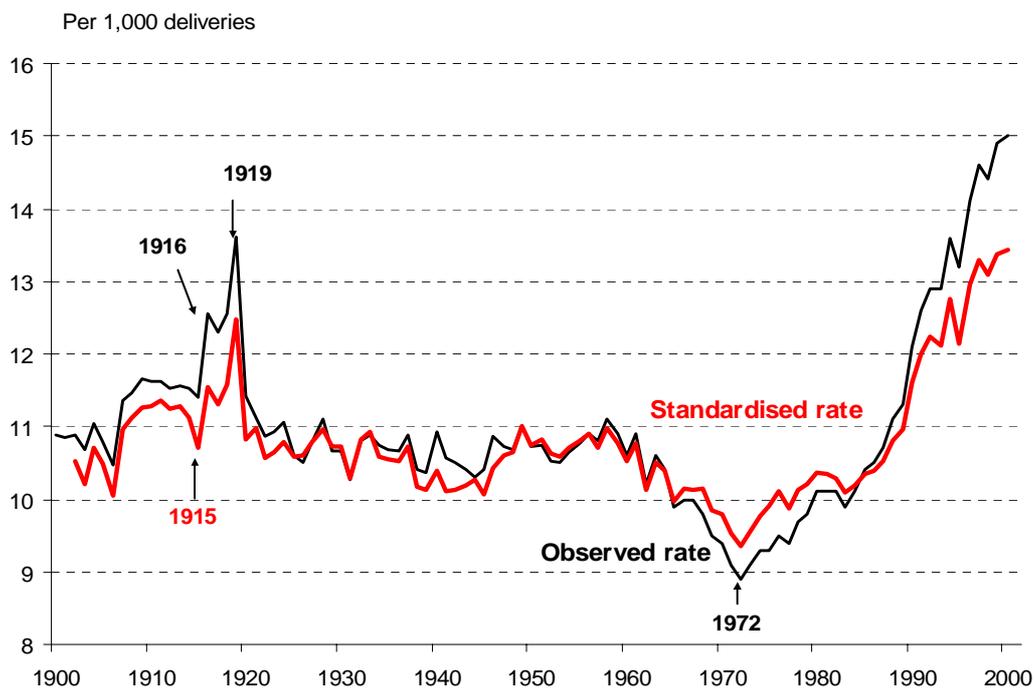
However, changes in age at childbearing are not sufficient to explain this peak, which remains visible even after controlling for its effect using a standard age distribution of mothers equal by convention to that of the year 1985 (Figure 5). The resulting curves still show a twinning peak during World War I, indicating that the temporary rise in age of childbearing is not the only factor involved. Similarly, the drop in the twinning rate in the 1960s and its renewed rise from 1972 are observed for almost all ages, thereby also affecting the standardized twinning rate.

Therefore, the twinning high of World War I is only partly due to the rise in the mean age of women at childbirth during wartime. Between 1972 and 2002, the twinning rate increased by 69%. If the age distribution of mothers had remained constant, it would have increased only by 43%. The postponement of childbearing explains one third of the increase.

Several hypotheses have been suggested to explain the increase in twinning rates around World War I. For instance, after deprivation women may have a higher polyovulation rate and better general conditions to carry through a multiple pregnancy.

It is also conceivable that women with a short waiting time to conception are more prone to produce DZ twins. Consequently, early conceptions after separation may be more likely to be twins. The rise of twinning rates at the end of World War I may be mainly associated with this natural mechanism of selection (Pison & Couvert, 2004).

**Figure 5** – Variation in twinning rate in France from 1900 to 2002, with constant age distribution of mothers (that of 1985).



Source: *Pison & Couvert, 2004.*

## 6. Selection by fecundity: the most fecund couples have a greater propensity to bear twins

We suggest that the twinning peak of World War I and 1919 is also due to a selection effect: couples who conceived during these years were among the more fecund. If hyper-fecund women

are effectively more at risk of having twins, then the twinning rate becomes higher (Pison & Couvert, 2004).

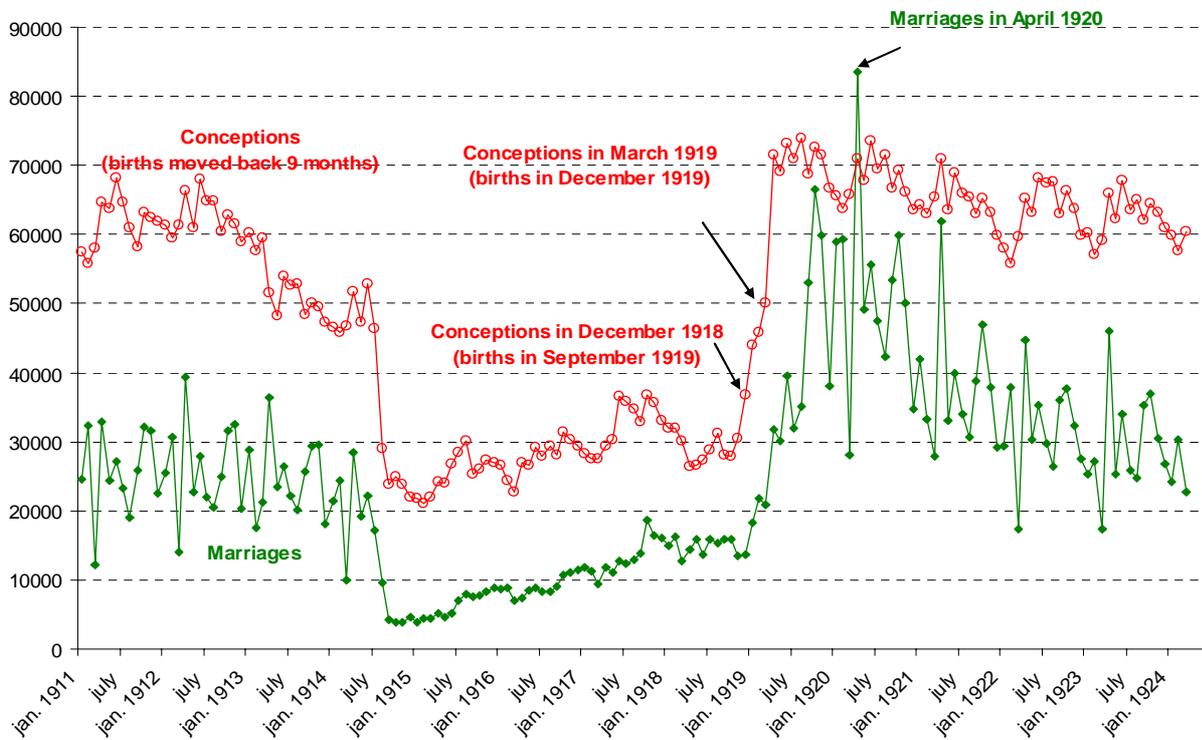
Many men were fighting at the front, and a high proportion of conceptions occurred during leaves. Periods of leaves were very short, and the couples that did manage to conceive were the most fecund ones. Children born to hyper-fecund women thus represented a larger proportion of births than they did in peacetime. As hyper-fecund women are more at risk to have twins, twinning rate is higher.

The twinning peak of 1919 results from two parallel phenomena: the formation of new married couples and the reuniting of previously married couples separated by war. It coincides, on one hand, with the return of already married soldiers at the end of the war, in November 1918: when soldiers returned back home at the end of the war, the first spouses to conceive were the highly fecund ones; on the other hand, it is related to the compensatory wave of marriages among young people who couldn't marry during wartime. The first couples to conceive were once again the highly fecund ones.

However, it is the reuniting of already married couples, rather than the wave of marriages, that mainly accounts for the 1919 peak in twin births.

Figure 6 shows the differential increases in the number of marriages and "conceptions": the number of marriages really took off in September 1919, with a record high in April 1920, while the rise in conceptions began sooner, in December 1918, immediately after Armistice, with a peak in April 1919. The figure shows the monthly variation in marriages and births in France from 1911 to 1924. The birth curve has been moved back by 9 months to give a clearer picture of the variation in conceptions. The number of marriages was very low during the war. After dropping sharply at the beginning, the number of marriages then progressively picked up again, though without returning to pre-war levels. After the Armistice of 11 November 1918, the number of marriages rose quite rapidly, but did not pick until one to two years later. This increase began in January 1919, but remained insignificant until April, May and June 1919. Even for people who had been engaged for a long time, weddings had to be prepared, and some waited for the right season to get married (April was traditionally the most popular month for weddings in France at the time). Further, people who had not been engaged or who had lost their fiancé during the war had to find a new partner. The number of marriages finally took off in September 1919, maintaining a very high level during the 12 following months, and reaching its record high in April 1920. The figure shows that the rise in conceptions began in December 1918, the month immediately following the Armistice, and reached its peak in April 1919, though the number of marriages recorded in that month was still small, lower than a normal pre-war month of April. In the figure, the number of "conceptions" is estimated on the basis of the number of births nine months later. The first wave of conceptions immediately after the war can thus be attributed to already married couples who had been separated during the war and who were reunited after demobilization. So it was the reuniting of already married couples, rather than the wave of marriages, that mainly accounts for the 1919 peak in twin births.

**Figure 6** – Monthly variation in marriages and “conceptions” in France from January 1911 to December 1924.



Source: INSEE.

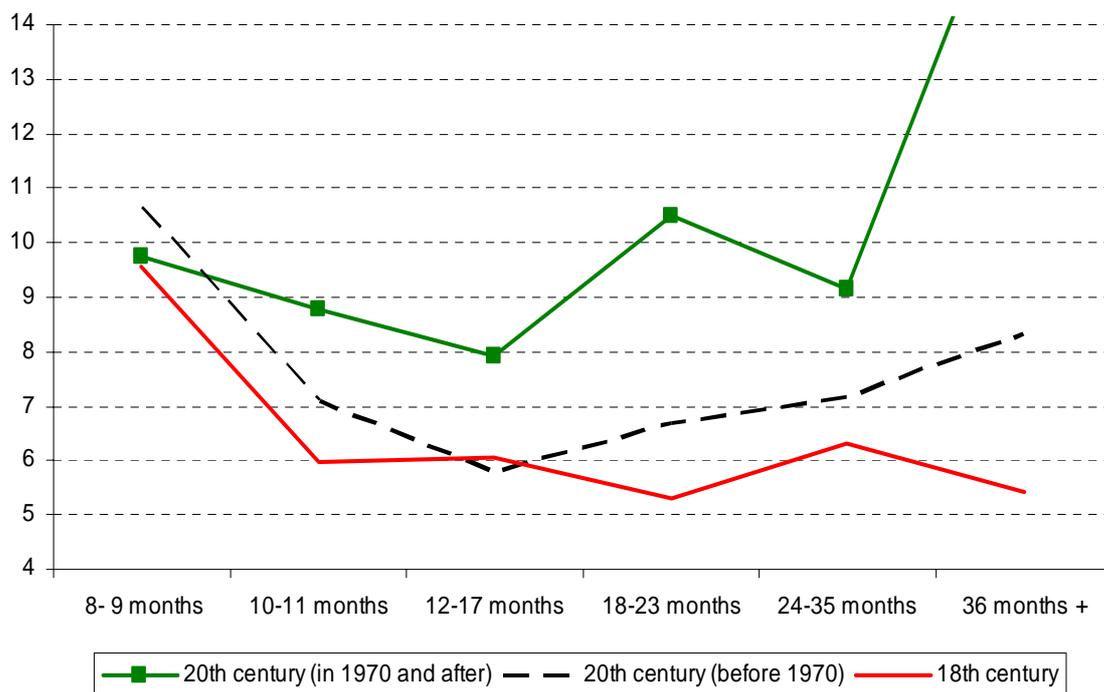
To use the selection of the most fecund couples as an explanation for the rise in twinning rates during the war years and the twinning peak of 1919, we must hypothesize a link between fecundity and a propensity to have twins. This hypothesis derives from the observation that for a woman to produce non-identical twins, she must have a double ovulation. This phenomenon is rare, and is an indicator of high fecundity. To test this hypothesis, we re-analyse data from the French family Surveys of 1975, 1982, 1990 and 1999 to examine whether, among newlyweds, those who achieved pregnancy more quickly had a higher rate of births than those who took longer to do so. The survey interviewed more than a million women, representative of the French adult female population. Data collected include a history of unions and births for each woman. Women born before 1920 were excluded to reduce the risk of bias; most of the first births analysed here thus took place between 1940 and 1999. Women were categorized according to the time between their marriage and the first birth, and according to the type of birth, single or twin. To calculate this interval, the duration of pregnancy is taken to be 38 weeks on average, close to 8 months and 3 weeks from fertilization to delivery. Counting from the first day of the last period to birth, the duration is extended by two weeks, to a total of 40 weeks. For twin pregnancies, birth takes place on average three weeks earlier, 8 months after conception. The first group considered is that of women whose first birth occurred between 8 and 9 months after the date of their first marriage. The other women were grouped into five categories according to their interval between their marriage and the first birth. Pre-1970 births – taking place between approximately 1940 and 1969 – were considered separately from post-1970 births – between 1970 and 1999 – to take two new trends into account. Firstly, the considerable changing relation between marriage and procreation in France in the last quarter of the

20<sup>th</sup> century: births out of wedding or preceding marriage represented less than one in every ten births until the end of the 1970s. Twenty years later, they represented two in every five years. Secondly, the last thirty years of the 20<sup>th</sup> century saw the development of hormonal infertility treatments on hypo-fecund couples who take a long time to conceive, they have modified the relation between time to conception and the risk of twin pregnancy by increasing the risk when time to conception is long.

The Figure 7 shows the variations in twinning rates according to the interval between the first marriage and the first birth, for the pre- and post- 1970 periods. The figure includes variations observed two to three centuries ago in France. Variations were estimated on the basis of data from the “Louis Henry” historical survey of France, and correspond to first marriages contracted between 1670 and 1829. Variations in the twinning rate in the eighteenth centuries (between 1670 and 1829) and in the twentieth century (between 1940 and 1969) are similar: in France, both in the 18<sup>th</sup> century and in 20<sup>th</sup> century, newly married couples who conceived rapidly – delivery 8 or 9 months after marriage – more frequently had twins than those who conceived later. This illustrates the strong link between fertility and risk of twin pregnancies.

Women who give birth more than three years after their first marriage more frequently have twins, a trend linked to hormonal infertility treatments.

**Figure 7** – Twinning rate for first births according to the time between marriage and childbirth. Comparisons between the 18<sup>th</sup> and 20<sup>th</sup> centuries in France.

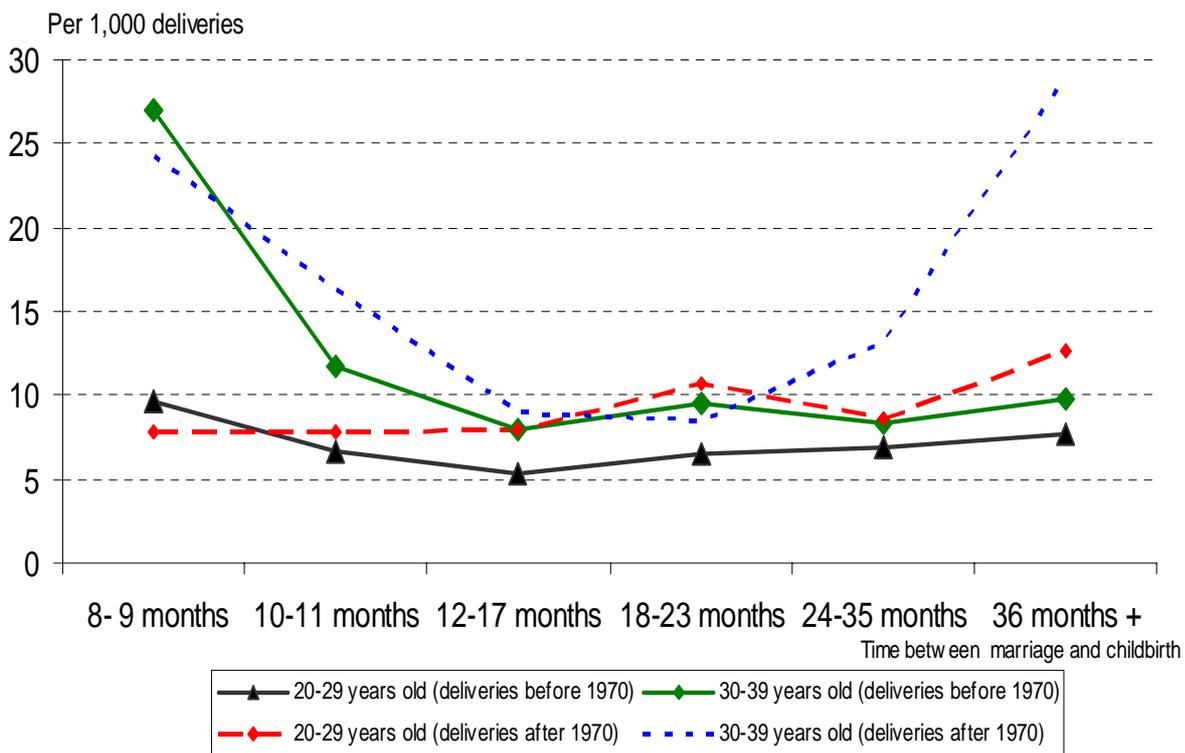


Source: Pison & Couvert, 2004.

The Figure 8 shows variations in the twinning rate for first births in the twentieth century by period (pre-1970 and post-1970) and according to the women’s age at the time of their first birth, i.e. between 20 and 30, or between 30 and 40. It confirms the influence of age on the twinning rate: married women who give birth for the first time at ages 30-39 more frequently have twins for this birth than women who do so at ages 20-29. Variations in twinning rate according to the interval

between marriage and delivery are more pronounced for the older age group than for the younger one. After 1970, differences follow the same pattern as before 1970. The novel aspect is the rise in the twinning rate for women who took a long time to conceive; it is particularly pronounced for women aged 30-39, who no doubt resort more frequently to infertility treatments.

**Figure 8 -** Twinning rate for first births by mother’s age, period and time elapsed between marriage and childbirth in the 20<sup>th</sup> century in France.



Source: Pison & Couvert, 2004.

The higher frequency of twin births among couples who achieve a pregnancy soon after marriage compared with those who took longer to conceive is thus observed for women of all ages and in all periods (between 1670 and 1829, between 1940 and 1969, between 1970 and 1999). Hyper-fecund couples do indeed have a greater propensity to produce twins than other couples. This confirms the hypothesis that selection of more fecund couples explains the peak in twinning rates observed during the First World War.

This fact remains true for women of specific age groups, but the differential risk of twin pregnancy increases with mother’s age up to age 40 (Figure 8).

The fact that the differential risk of twin pregnancy increases with mother’s age up to age 40 helps to explain why we mainly observe twinning peaks among older maternal age groups during wartime, but it also underlines the equally important role of selection by fecundity during First World War, heightened by the simultaneous rise in age at childbearing.

## 7. Discussion

Similar downward and upward trends were observed in most developed countries, even if the overall levels of twinning rates vary among them.

The proportion of twin births has varied continuously over the past century, due to changes in the age of childbearing, wars, voluntary birth control or, more recently, the advent of techniques to overcome infertility. The growing availability of infertility treatment in recent years is also one of the factors pushing up the twinning rate. Medicine is now interfering with biology and family behaviour, which, until recently, were the only factors affecting the twinning rate.

The rate of twin births is a valuable indicator of biological and social change.

Age at childbearing is not the only cause as witnessed by the rise in the twinning rate in France after adjusting for mother's age and rates by age. We have shown the hypothesis of selection through fecundity. In particular, we have focussed on the First World War period in which the rate of twin births attained surprisingly high levels in France. We explained that this phenomenon can be attributed to a selection effect on more fecund couples. As demonstrated through the study of cohorts of newlyweds, hyperfecund couples have a higher twinning rate than their less fecund counterparts.

This results in selection by fecundity, which pushes up the twinning rate. This mode of selection becomes apparent under certain specific circumstances, such as during the World War I, when many couples were only together for short periods of wartime leave and only the most fecund were able to conceive. The proportion of twin births increased as a consequence. When soldiers returned at the end of the war, selection once again came into play, resulting in a temporary increase in the twinning rate in the first few months after demobilization. This selection mechanism operates continuously without producing visible fluctuations in the twinning rate, since under normal circumstances the number of reunited couples or of marriages is not subject to sudden variation.

## 8. Twinning rates and World War I: European comparisons and open issues

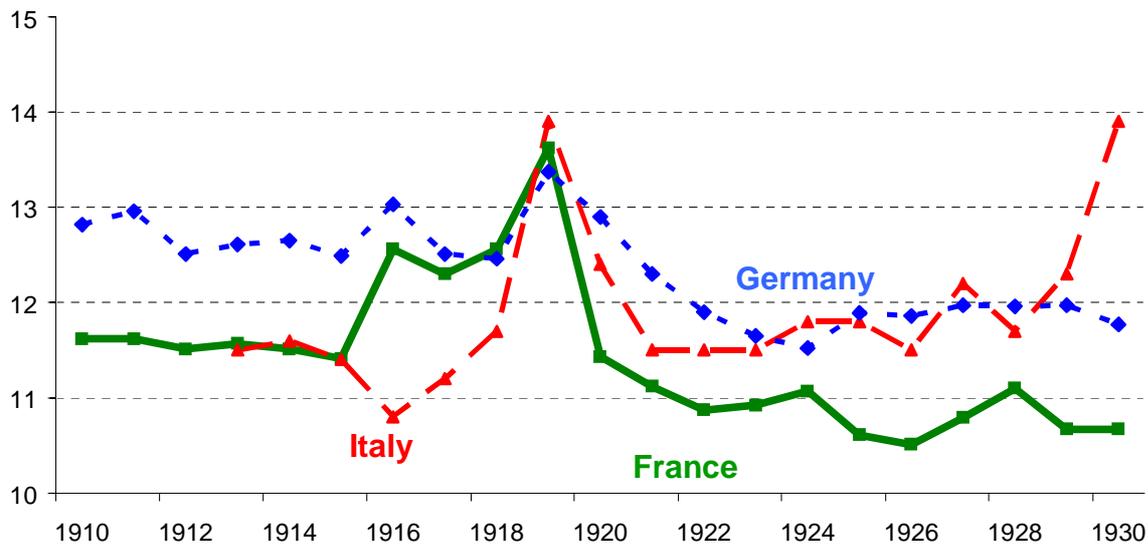
For its diversity, the World War I represents an interesting scenario in the evolution of twinning birth rates in Europe. In particular, a peak can be observed just after the end of World War I in Italy, France and Germany (Figure 9). The differences between these countries concern above all the France and Germany its intensity is a little less significant.

However, Nordic countries offer us a challenging comparative point of view because the trends are not homogeneous there (Figure 10).

In Denmark, Sweden and Norway, it seems that there was no twinning peak in wartime and in 1919, except a surprising intensive one for Sweden in 1916, which does not have an explanation yet. These countries seem to attest more or less important increases in twin births for the period 1920-23. The reason may be linked to their neutral position during the war, which makes their history different from the other countries.

As for Finland, the historical events characterizing this country, in particular the war with the Russians during the observed period, determined a different evolution of twinning rates. The twinning rate declined between 1916 and 1918. After 1918, however, the rate starts to increase reaching a maximum value in 1923.

**Figure 9** – Twinning rate: the peak of World War I in France, Italy and Germany.

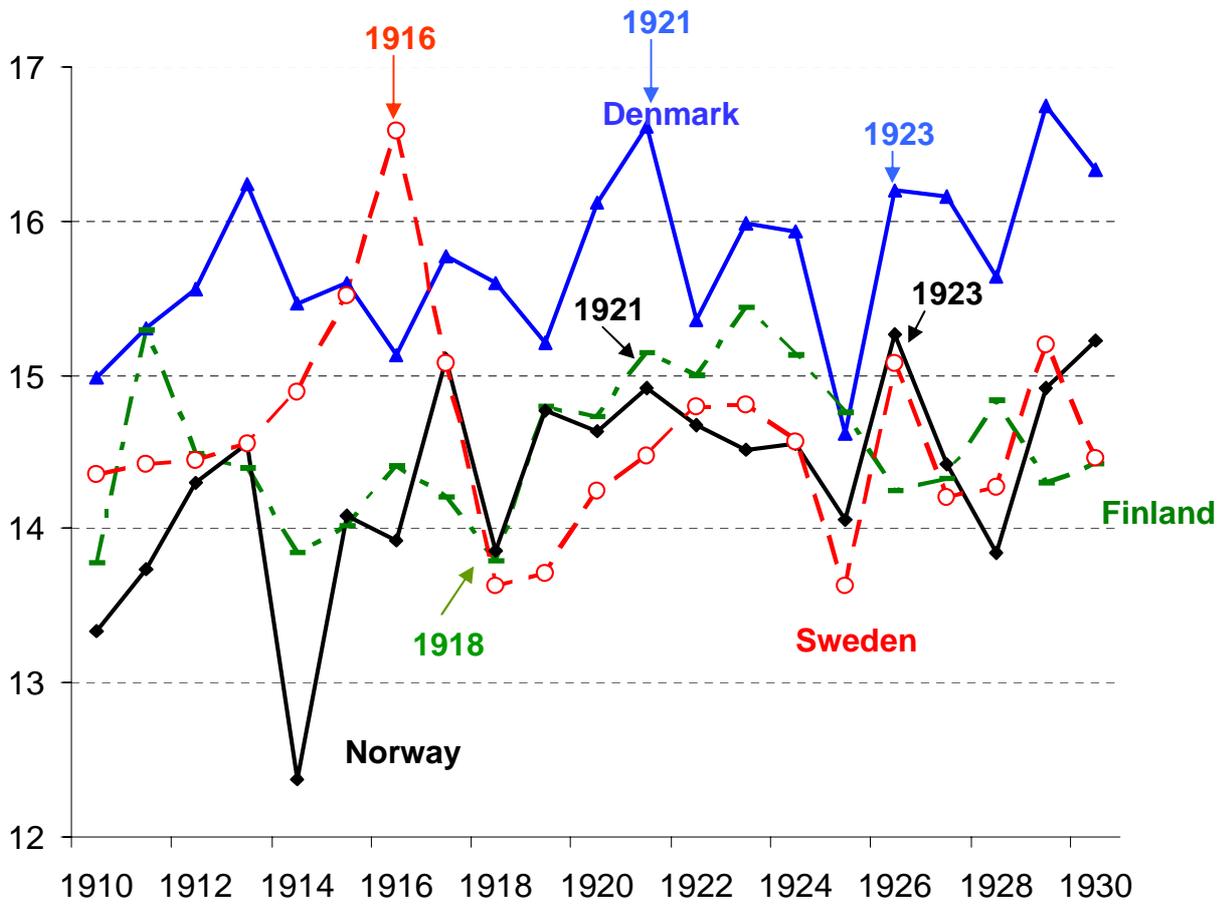


*Source: Own elaborations on National Vital Statistics, various years.*

None explanation seems to fit this situation. It is under question whether Spanish Influenza Pandemic has some link with these phenomena. Mamelund (2004) illustrates how pandemic explains drop in conceptions in 1918 and the following boom in conceptions in 1919 due to recovery of the “lost conceptions” of the previous year and replacement of dead children. In this context we can consider that couples from 1919 in Norway would also have experienced some selection by fertility, the first one conceiving being the most fertile and heightening twin births for the following year(s), in 1920 and maybe after.

By studying carefully demographic behavioral patterns in some countries during wartime and after, in particular concerning nuptiality and fertility, and by taking into account environmental elements as epidemics and war’s context, it would be possible to offer further elements of explanation and comparison to better understand European differences and similarities in the so contrasted evolution of twinning rates around World War I.

**Figure 10** – Twinning rate around World War I: Nordic countries.



*Source: Own elaborations on National Vital Statistics, various years.*

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