The German Birth Order Register - Order-Specific Data Generated from Perinatal Statistics and Statistics on Out-of-Hospital Births 2001-2008

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Abstract: Until 2008, Germany's vital statistics did not include information on the biological order of each birth. This resulted in a dearth of important demographic indicators, such as the mean age at first birth and the level of childlessness. Researchers have tried to fill this gap by generating order-specific birth rates from survey data, and by combining survey data with vital statistics. This paper takes a different approach by using hospital statistics on births to generate birth order-specific fertility rates for the period 2001 to 2008. Hospital statistics include information on births that took place in German hospitals. Out-of-hospital deliveries, which account for about two percent of all births, are not included in the hospital data. In a sensitivity analysis, we show how robust our estimates are to the inclusion of out-of-hospital births. Our general assessment is that the hospital data are a valuable source for generating order-specific fertility rates, regardless of whether out-of-hospital births are included.

Keywords: Birth order, fertility, Germany, Eastern and Western Germany

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1   Introduction

Across Europe, we have witnessed a postponement of first-time motherhood, and an increase in the share of women who remain childless throughout their lives. Despite the obvious importance of these social changes, it is amazing to recall that, until very recently, vital statistics did not provide sufficient information to document this change in behavior. Important demographic indicators, such as the mean age at first birth or the share of permanently childless women, were not available for countries such as Austria, Belgium, Luxembourg, Switzerland, Germany, France and the UK. Most countries have since reformed their vital statistics and statistical offices have started collecting births by biological order. Austria did so in 1984; France in 2001/2; Germany in 2008[1]; and England and Wales are expected to ratify a regulation that stipulates that order-specific data can be collected from 2011 onwards. As a result, order-specific birth information will soon be available for most European countries. However, we still lack order-specific fertility information for the past. Researchers have tried to fill this gap by drawing on other sources. Order-specific fertility information has been generated from survey data (Toulemon 2001; Smallwood 2002). Others have tried to combine survey data with vital statistics (Birg et al. 1990; Kreyenfeld 2002; Handcock et al. 2000).

This paper contributes to existing attempts to provide order-specific birth rates for Germany by using hospital records provided by the *Bundesgeschäftsstelle Qualitätssicherung* (BQS) (BQS Institute for Quality and Safety). We will refer to this data as 'Perinatal Statistics' in the following. This data has primarily been used in the field of medicine, but some few demographic studies exist that used these data for analyzing birth behavior (Voigt and Hullen 2005; Birg and Flöthmann 1996). These previous studies were, however, only able to draw on data from selected federal states, while this studies uses perinatal data for the whole of Germany. The Perinatal Statistics are part of the hospital statistics, and they include clinical records for all children who were delivered in German hospitals. To our knowledge, it is the only data source that contains information on the biological order of each birth at a population level for Germany. This paper describes how the Perinatal Statistics can be used to generate order-specific fertility rates. Furthermore, we try to assess the bias caused by the fact that out-of-hospital births are not included in the hospital data. About 98 percent of all children are

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1   Unfortunately, because data quality in the first year after the implementation of the new regulation was not good enough, the German Statistical Office has not yet published this data.

born in hospitals, which suggests that the bias might be small. However, out-of-hospital births differ in terms of the age of the mother and birth order, and excluding them might distort the picture. Therefore, it seems important to ask how sensitive the analyses are to the inclusion of out-of-hospital births.

We have structured the paper as follows. In Part 2, we give a detailed account of the Perinatal Statistics provided by the *Bundesgeschäftsstelle Qualitätssicherung* (BQS). Part 3 explains the method used to generate age- and order-specific fertility rates with this data. In addition, we provide some initial results on order-specific fertility behavior in Germany. Part 4 provides a sensitivity analysis that also draws upon data on home births provided by the *Gesellschaft für die Qualität in der außerklinischen Geburtshilfe e.V.* (QUAG). Part 5 summarizes the findings and concludes. The appendix to this paper contains most of the data that we have generated. We also plan to make the data available online in a 'German Birth Order Register' stored within the Fertility Data Collection of the Max Planck Institute for Demographic Research in Rostock.

2   Data and Variables

2.1   General Description of the Perinatal Statistics

Data for this investigation comes from the *Bundesgeschäftsstelle Qualitätssicherung* (BQS). The BQS is an institution that monitors the quality of care in German hospitals. One of its responsibilities is to collect the clinical records of the maternity wards of all German hospitals. This initiative dates back to the *Münchner Perinatalstudie,* which was conducted in the period 1975-1977. The main goal of this study was to report on the quality of the maternity wards of all the clinics in Munich. The *Münchner Perinatalstudie* was the first step towards introducing a systematic approach to recording the characteristics of a clinical birth, i.e., whether it was a stillbirth, whether a cesarean was conducted, and whether other complications occurred during the delivery or during pregnancy. This procedure was gradually implemented throughout Bavaria, and was adopted in the other federal states over the course of the 1980s (Bundesgeschäftsstelle Qualitätssicherung 2002: 190). After German unification, the Eastern German federal states joined the Perinatal Statistics (Projektgeschäftsstelle Qualitätssicherung bei der Sächsischen Landesärztekammer 2000: 1). While it was initially voluntary to collect this type of data, it became compulsory for the

hospitals to register these data in 1995 (Bundesgeschäftsstelle Qualitätssicherung 2008: 196). At that time, data collection was still organized on a federal level, and no central register had been implemented. Finally, in 2001, the BQS was assigned the task of establishing a nationwide registry (Bundesgeschäftsstelle Qualitätssicherung 2008: 105f.). Since this time, it has been mandatory for all public and private hospitals to document all births (both still and live), and make these records available to the BQS, which stores this information in a data file called *Datensatz Geburtshilfe*. We refer to this file as Perinatal Statistics.

Data for the Perinatal Statistics are collected by the staff of the hospital where the woman delivers the child (for the questionnaire, see Figure 6 in the appendix). These statistics represent a particularly rich source of information for medical research in the field of perinatology, since they include detailed information on the duration of, and problems experienced during each pregnancy; and on the state of health of individual newborn children. The characteristics of a newborn, such as weight, sex and physical condition, are taken from the medical records of the child. Information on the medical background of current and previous pregnancies is copied from the pregnancy record (*Mutterpass*) of the mother (Jahn and Berle 1996: 132; Reime et al. 2008). Other information (such as smoking habits) is collected by the nurses upon admission to the hospital (Voigt et al. 2006; Schneider et al. 2008).

The Perinatal Statistics provide a rich set of variables for medical and demographic research. However, we should also point out some shortcomings of the data. First, the Perinatal Statistics do not include deliveries that take place at home, in birth centers, or in the offices of midwives.[2] The share of out-of-hospital deliveries is, at about two percent of all births, very low (see Table 5). However, the fact that these births are not included in the Perinatal Statistics is a potential problem because women who opt for an out-of-hospital birth differ in several ways from women who choose the 'standard' path of delivering their children in the hospital. Since women only rarely choose to have their first child at home or in a birth center, out-of-hospital births are often births to older women who already have at least one child (Loytved and Wenzlaff 2007). We will turn to this issue again later on in a sensitivity analysis (Part 4).

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2   If delivery was planned at home or at a birth center, but the woman was transferred to the hospital during the process of giving birth, the birth was entered into the Perinatal Statistics. Loytved and Wenzlaff (2007: 9) show that in roughly 12 percent of all cases in which a birth was intended to occur at home or in a birth center, the mother was transferred to a hospital. From the perspective of the Perinatal Statistics, about one percent of all deliveries in hospitals were originally expected to occur at home or in a birth center (BQS-Bundesauswertung 2007: 103).

Another problem with the Perinatal Statistics is that data quality varies quite substantially between years. Although it is mandatory for all hospitals to provide information on all births since 2001, the Perinatal Statistics do not cover all hospital births and all federal lands in the early years. For 2001, Hesse, Schleswig Holstein and Saarland did not provide any data to the central register of the BQS. Furthermore, some hospitals failed to provide information in the first few years after the central register was established. These gaps have closed over the years. Since 2004, almost all clinical births have been covered in the Perinatal Statistics.

2.2   Selection of Sample

For this study, we use the Perinatal Statistics for the period 2001-2008.[3] Since women can have multiple births, there are different observation units possible. It is possible to conduct investigations at the 'mother level', at the 'child level', or using singletons only (Krafczyk 2007). For our investigation, the observation unit is the child. This corresponds to the vital statistics, which mainly count live-born children (and not births). The total number of valid live-born children in the Perinatal Statistics for the period 2001 to 2008 is 4,982,707. In a few cases, it was not possible to identify the year of birth, the order of the birth or the age of the mother.[4] These cases were deleted from the analysis. Furthermore, births in which the mother was older than age 50 were also omitted. This leaves us with 4,978,381 live-born children in the final data set.

Table 1 displays the number of births in our sample and compares it with data from the vital statistics. As can be seen in the table, differences between the vital statistics and the Perinatal Statistics are large in 2001 and 2002, but they decline over the years. The great difference in coverage in the year 2001 can largely be attributed to the fact that Hesse, Schleswig-Holstein and Saarland failed to deliver their data.

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3   The Perinatal Statistics were assessed through remote execution by sending syntax scripts to the BQS by email.

4   There were some cases for which no year of birth was available. For these cases, the BQS applied a manual recoding method by using the year of discharge from the hospital. When the delivery and the year of discharge differed (for births that occurred end of the year), no recoding was done. These cases were omitted from our analyses.

Table 1: Coverage of Births in the Perinatal Statistics

	2001	2002	2003	2004	2005	2006	2007	2008	Total
Births in Perinatal Statistics	452,826	608,122	590,293	671,228	665,718	655,951	667,016	667,227	4,978,381
Births in Vital Statistics	734,475	719,250	706,721	705,622	685,795	672,724	684,862	682,514	5,591,963
Perinatal Statistics/ Vital Statistics	0.62	0.85	0.84	0.95	0.97	0.98	0.97	0.98	0.89

Source: Statistisches Bundesamt (2009a), BQS Perinatal Statistics (own estimates)

2.3   Variables

The variables used in our analysis are age, birth order and region. The age of the mother was generated by the *Bundesgeschäftsstelle Qualitätssicherung* (BQS), which delivered the data. It was generated by subtracting the birth year of the child from the year of birth of the mother. Age is used in single age categories. We also distinguish between Western Germany and Eastern Germany, the latter one including the city-state of Berlin. Our key variable of interest is the order of birth, which is broken down into the following categories: first-, second-, third-, fourth- and higher-order births. The order of the birth was generated by adding a one to the number of live-born children.[5] One aspect that required special attention was multiple births. Multiple births are counted as separate children when the number of previous live-born children is assessed. However, this does not apply to the current birth. Luckily, we have information on multiple births in the data set that allowed us to account for this aspect.[6]

Table 2 tabulates the distribution of births by calendar year in our final data set. The table shows that about 50 percent were first-; 35 percent second-; 10 percent third-; and five percent fourth- and higher-order children.

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[5]   For about 25 percent of the cases, the number of live-born children was left blank. We assumed here that these are nuliparous women. We checked this imputation strategy by drawing on additional information on prior pregnancies. For 99.9 percent of the cases, the assumption was correct.

[6]   We first generated a 'master table' that contained the number of all children by order, age and region. Furthermore, we generated a 'multiple birth table' that contained multiple births by order, age and region. From the master table, we subtracted half of all multiple births of a given order. These children were then added to the next birth order. For simplicity, we assumed that all multiple births are twin births.

Table 2: Number of Live-Born Children by Birth Order, Absolute Numbers and Column Percent

	2001	2002	2003	2004	2005	2006	2007	2008	Total
Absolute									
1st child	220,525	294,635	285,152	324,693	321,622	315,772	324,234	325,759	2412,390
2nd child	156,934	211,359	206,091	233,625	231,540	226,136	228,948	228,698	1723,330
3rd child	51,166	69,566	67,159	77,217	76,703	77,599	77,577	76,900	573,885
4th+ child	24,202	32,563	31,893	35,693	35,854	36,444	36,258	35,870	268,777
Total	452,826	608,122	590,293	671,228	665,718	655,951	667,016	667,227	4,978,381
Column %									
1st child	49%	48%	48%	48%	48%	48%	49%	49%	48%
2nd child	35%	35%	35%	35%	35%	34%	34%	34%	35%
3rd child	11%	11%	11%	12%	12%	12%	12%	12%	12%
4th+ child	5%	5%	5%	5%	5%	6%	5%	5%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: BQS Perinatal Statistics (own estimates)

3   Method and First Results

3.1   Estimating Order-Specific Fertility Rates from Perinatal Statistics (Method 1)

Our main goal is to use the Perinatal Statistics to generate age- and order-specific fertility rates for Germany. Since fertility patterns in Eastern and Western Germany continue to differ (Konietzka and Kreyenfeld 2007), we will generate separate fertility rates for Eastern Germany (including Berlin) and Western Germany (excluding Berlin). In order to generate fertility rates, the number of births and the base population of women are needed. Data on the number of women by age and region (Eastern and Western Germany) come from German vital statistics. A problem arises when calculating fertility rates because the Perinatal Statistics does not include all births. In order to calculate birth rates, we weighted the data of the Perinatal Statistics to match the total number of births in Germany.

We have constructed a weighting factor that considers age, year and region (Eastern and Western Germany). Let B^V be the number of births in the vital statistics, B^P be the number of births in the Perinatal Statistics, $\hat{B}$ be our estimated number of births, i be the order of the births, and w be the weighting factor. The weight accounts for age *(a),* year (*t*) and region (*r*).

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It is generated by the ratio of the number of births in the vital statistics and the number of births in the Perinatal Statistics:

$$w(a,t,r) = \frac{B^V(a,t,r)}{B^P(a,t,r)} \qquad (1)$$

In the next step, the number of births by order *(i)*, age *(a)*, year *(t)* and region *(r)* from the Perinatal Statistics are multiplied by the weights. This gives the estimated number of births:

$$\hat{B}_i(a,t,r) = B_i^P(a,t,r) \times w(a,t,r) \qquad (2)$$

In order to generate age- and order-specific fertility rates, the estimated births are related to the number of woman by age, region and calendar year.

3.2 Preliminary Results on Order-Specific Fertility Behavior in Germany

It is beyond the scope of this paper to provide a comprehensive overview of Eastern and Western German fertility dynamics. However, we still seek to provide some basic demographic indicators based on the Perinatal Statistics. Table 3 displays the order-specific TFR, while Table 4 shows the mean ages at childbirth. Figures 1 and 2 graph the indicators. Without going into the details of German fertility dynamics, we will briefly put these figures into context. The most remarkable finding for Western Germany is the change in the age at first birth. In 2001, Western German women were, on average, 27.4 years of age at first birth; by 2008, they were 28.7 years old. Since we are considering a very short time frame of seven years, an increase of more than one year is remarkable. This finding also suggests that the trend towards postponing the first birth has not yet halted, despite the fact that West Germany was one of the countries where fertility postponement started rather early. Ages at second birth have increased to a lesser extent than ages at first birth. For higher-order births, there is basically no change over time in the mean age at childbirth. The results also showed that the order-specific TFRs did not change much between 2001 and 2008.

In Eastern Germany, we observe an increase in the age at first birth of about 1.5 years between 2001 and 2008. However, East German women are still one year younger at first birth than their counterparts in the West in 2008. East-West differences in the age at second birth are smaller, which suggests that East Germans space first and second births farther apart

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than West Germans. The most surprising finding for Eastern Germany is that of the strong increase in the TFR for second births. Given that second birth rates dropped radically in Eastern Germany after unification (Sackmann 1999; Huinink 2005; Kreyenfeld 2008), this result could represent a first indication of a recuperation of second birth rates. Compared to the pattern in Western Germany, one still needs to draw attention to the low progression ratios to the third child. During GDR-time, third and higher order birth rates were rather low (Kreyenfeld 2004). Our investigation suggests that low progression ratios to the third child are still a characteristic of contemporary Eastern German fertility.

Please also note that the tables include indicators from the vital statistics. There are no differences between our estimates and the one from the German Statistical Office. This is not surprising since our weighting factor takes the vital statistics as a benchmark. However, it still seems worth pointing that both data sources comply with each other.

Table 3: Order-Specific TFR (Ages 15-44)

Eastern Germany	2001	2002	2003	2004	2005	2006	2007	2008
1st child	0.66	0.66	0.67	0.69	0.67	0.67	0.69	0.71
2nd child	0.38	0.39	0.40	0.42	0.41	0.42	0.45	0.46
3rd child	0.11	0.11	0.11	0.12	0.12	0.13	0.13	0.14
4th+ child	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.07
Total	1.21	1.21	1.23	1.28	1.26	1.28	1.34	1.38
TFR (vital statistics)	1.21	1.21	1.23	1.28	1.26	1.28	1.34	1.38
Western Germany	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1st child	0.69	0.68	0.67	0.67	0.66	0.65	0.67	0.67
2nd child	0.48	0.47	0.48	0.48	0.47	0.46	0.47	0.47
3rd child	0.15	0.15	0.15	0.16	0.15	0.16	0.16	0.16
4th+ child	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total	1.38	1.37	1.36	1.37	1.35	1.34	1.37	1.38
TFR (vital statistics)	1.38	1.37	1.36	1.37	1.35	1.34	1.37	1.38
Germany	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1st child	0.68	0.67	0.67	0.68	0.66	0.65	0.67	0.68
2nd child	0.46	0.46	0.46	0.47	0.46	0.46	0.47	0.47
3rd child	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16
4th+ child	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07
Total	1.35	1.34	1.34	1.36	1.34	1.33	1.37	1.38
TFR (vital statistics)	1.35	1.34	1.34	1.36	1.34	1.33	1.37	1.38

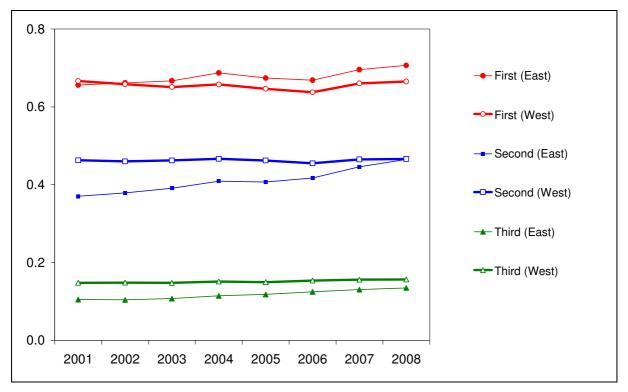Source: BQS Perinatal Statistics (own estimates), Statistisches Bundesamt (2009a)

Table 4: Mean Age at Childbirth by Birth Order (Ages 15-44)

Eastern Germany	2001	2002	2003	2004	2005	2006	2007	2008
1st child	26.12	26.35	26.60	26.85	26.97	27.07	27.29	27.47
2nd child	29.32	29.54	29.66	29.86	29.94	30.10	30.45	30.67
3rd child	31.42	31.64	31.62	31.62	31.63	31.83	32.07	32.21
4th+ child	33.15	33.23	33.09	33.00	33.10	33.21	33.08	33.34
All births	27.94	28.14	28.34	28.55	28.68	28.85	29.10	29.30
All births (vital statistics)	27.94	28.14	28.34	28.55	28.68	28.85	29.10	29.30
Western Germany	2001	2002	2003	2004	2005	2006	2007	2008
1st child	27.43	27.57	27.74	27.95	28.10	28.26	28.49	28.69
2nd child	29.88	30.04	30.15	30.30	30.43	30.57	30.78	30.98
3rd child	31.46	31.57	31.65	31.79	31.87	31.96	32.19	32.35
4th+ child	33.06	33.09	33.19	33.26	33.32	33.41	33.49	33.56
All births	28.99	29.14	29.28	29.46	29.60	29.76	29.97	30.15
All births (vital statistics)	28.99	29.14	29.28	29.46	29.60	29.76	29.97	30.15
Germany	2001	2002	2003	2004	2005	2006	2007	2008
1st child	27.14	27.32	27.50	27.73	27.87	28.02	28.25	28.45
2nd child	29.81	29.96	30.08	30.23	30.35	30.49	30.72	30.92
3rd child	31.51	31.58	31.66	31.76	31.83	31.94	32.17	32.33
4th+ child	33.12	33.12	33.19	33.21	33.28	33.37	33.41	33.52
All births	28.80	28.96	29.11	29.29	29.43	29.59	29.80	29.99
All births (vital statistics)	28.80	28.96	29.11	29.29	29.43	29.59	29.80	29.99

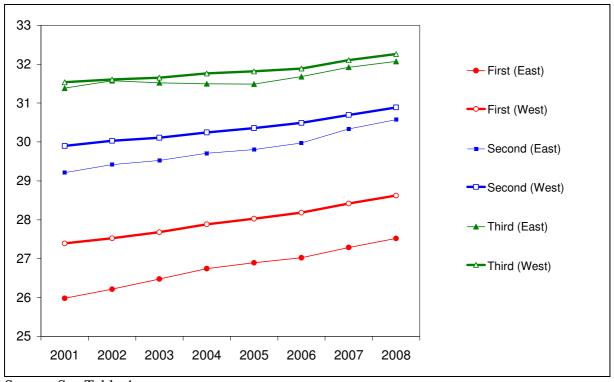Notes: Mean ages were generated based on age-specific fertility rates.
Source: BQS Perinatal Statistics (own estimates), Statistisches Bundesamt (2009a)

Figure 1: Order-Specific TFR (Ages 15-44)

Source: See Table 3

Figure 2: Mean Age at Childbirth by Birth Order (Ages 15-44)

Source: See Table 4

4 Sensitivity Analysis

4.1 Statistics on Out-of-Hospital Births (QUAG Statistics)

A key question for our analyses is how robust the estimated births are given the fact that the Perinatal Statistics do not include all births. In particular, the question arises of whether the results are biased because home births are not included. Until recently, no information on out-of-hospital births has been available, and medical as well as epidemiological studies used only hospital births for their investigations. In 1999, however, the midwives founded the *Gesellschaft für Qualität in der außerklinischen Geburtshilfe e.V.* (QUAG). The aim of QUAG, like the BQS, is to monitor the quality of medical care. A questionnaire similar to the one used in collecting the Perinatal Statistics is conducted for out-of-hospital births. Participation is voluntary, but about 80 percent of all out-of-hospital births are covered in this data source, which we refer to as QUAG Statistics in the following (Loytved 2009a: 6). Because the questionnaire is almost the same as the one used in the Perinatal Statistics, the two sources can be combined in a straightforward manner. Variables could also be generated in a manner similar to the one employed for the Perinatal Statistics.

An essential quality indicator for the QUAG Statistics is how many of all out-of-hospital births are included in the data set. There are no official numbers available on the total number of out-of-hospital births. However, there is rough information on the number of hospital births given by the *Gesundheitsberichterstattung des Bundes* (Statistisches Bundesamt 2009b). With this data, the number of out-of-hospital births can be estimated based on the difference between the total numbers of births (from the vital statistics) and the number of hospital births provided by the *Gesundheitsberichterstattung des Bundes*. We should note, however, that this is probably the upper benchmark for the number of out-of-hospital births (Loytved 2009a: 6).

Table 5 compares the number of births in the QUAG Statistics with the calculated total number of out-of-hospital births in Germany. As can be seen from this table, coverage of the out-of-hospital births in the QUAG statistics ranges from 68 to 91 percent. This is substantially lower than the coverage for the Perinatal Statistics. However, the sample size is still high enough to give us a reasonable estimate of the age and parity distribution of out-of-hospital births.

Table 5: Coverage of Births in QUAG-Statistics

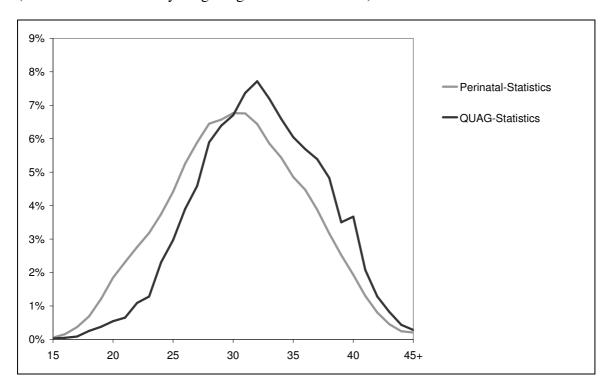|	2001	2002	2003	2004	2005	2006	2007	2008
Number of births in QUAG Statistics	8,245	8,219	8,561	8,686	8,305	8,315	8,188	8,280
Out-of-hospital births in Germany*)	9,841	11,236	9,415	12,130	12,260	10,859	10,997	9,799
Number of births in Germany	734,475	719,250	706,721	705,622	685,795	672,724	684,862	682,514
Coverage of out-of-hospital births in QUAG Statistics	84%	73%	91%	72%	68%	77%	74%	84%
Share of out-of-hospital births out of all births in Germany	1%	2%	1%	2%	2%	2%	2%	1%

Notes: *) The number of out-of-hospital births was generated as the difference between the number of births in the vital statistics and the number of hospital births taken from the *Gesundheitsberichterstattung des Bundes* (Statistisches Bundesamt 2009b).

Source: BQS Perinatal Statistics and QUAG Statistics (own estimates), Statistisches Bundesamt (2009a;b)
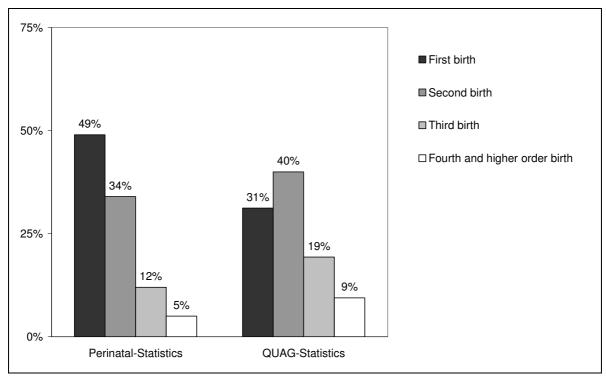
4.2 Age Structure of Out-of-Hospital Births

The share of out-of-hospital births is, at one to two percent of all births, rather low (see Table 5). However, out-of-hospital births differ from hospital births strongly by order and the age of the mother. This can be discerned from Figure 3 and Figure 4 for the year 2008. Figure 3 plots the age pattern of births in the Perinatal Statistics and in the QUAG Statistics. The figure supports previous findings that out-of-hospital births are mostly births to older women (Loytved and Wenzlaff 2007). Figure 4 plots the distribution of births by birth order in both the Perinatal and the QUAG Statistics. This figure shows that out-of-hospital births are far more likely than hospital births to be higher-order births. Only 17 percent of births in the Perinatal Statistics of 2008 were of order three and higher, compared with 28 percent of all births in the QUAG Statistics.

Figure 3: Age Pattern of Births in Perinatal and QUAG Statistics in 2008
(Percent of All Births by Single Ages out of All Births)

Source: BQS Perinatal-Statistics and QUAG-Statistics (own estimations)

Figure 4: Distribution of Births by Order in Perinatal Statistics and QUAG Statistics in 2008

Source: BQS Perinatal Statistics and QUAG Statistics (own estimates)

Note: If percent do not add up to 100, this needs to be attributed to rounding errors.

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4.3 Estimating Order-Specific Fertility Rates from Perinatal Statistics and QUAG Statistics (Method 2)

The differences in the age structure between hospital and out-of-hospital births raise the question of to what extent our results are affected by the omission of out-of-hospital births. In the following, we address this issue by using additional information on out-of-hospital births. For this purpose, we have constructed a similar weighting factor as before (see Section 3). However, instead of just using the births from the Perinatal Statistics, we also accounted for the births in the QUAG Statistics. Let B^V be the number of births in the vital statistics, B^Q be the number of births in the QUAG-statistics, B^P be the number of births in the Perinatal Statistics, i be the order of the births, and $w*$ be the new weighting factor. The weight again accounts for age (a), year (t) and region (r). It is generated by dividing the number of births from the vital statistics, by the sum of the number of births in the Perinatal and the QUAG Statistics:

$$w^*(a,t,r) = \frac{B^V(a,t,r)}{B^P(a,t,r) + B^Q(a,t,r)} \qquad (3)$$

In the next step, the number of births by order (i), age (a), year (t) and region (r) from the Perinatal and the QUAG Statistics are multiplied by the weights to obtain the estimated number of births:

$$\hat{B}_i^*(a,t,r) = \left[B_i^P(a,t,r) + B_i^Q(a,t,r)\right] \times w^*(a,t,r) \qquad (4)$$

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**4.4	Comparison of Estimates from Method 1 and Method 2**

Table 6 displays estimates of the mean age at childbirth by birth order. In the first half of the Table (under the heading 'Method 1'), the estimates that we derived from the Perinatal Statistics are displayed. In the second part of the table (under the heading 'Method 2') are the estimates based on the Perinatal Statistics and the QUAG Statistics. The last part of the table gives the difference between both estimates. The comparison shows that both methods provide similar results. Differences in the mean ages at childbirth never exceed the value of 0.02 years.

Tabel 7 compares the TFR from Methods 1 and 2. For the TFR as well, we observe hardly any differences between the two methods. Thus, we can conclude that measures of centrality, like the mean age at childbirth or the TFR, are not affected by the fact that the Perinatal Statistics do not include births that have not occurred in hospitals.

Finally, Figure 5 displays how the age pattern of births differs between the two methods in the year 2008. Here, we generated a ratio; i.e., we divided the number of births from Method 1 by the number of births from Method 2 for each age. As can be seen from the figure, differences between the two methods increase at higher ages. This is compatible with the idea that Method 2, unlike Method 1, accounts for out-of-hospital births, which are more prevalent at higher ages. However, the ratio is mostly between 0.99 and 1.01, which means that the differences in the number of births between both methods does not exceed one percent. It is only for the ages below 20 and above 40 that the differences can increase to up to two percent.

Table 6: Mean Ages at Childbirth by Birth Order (Ages 15-44), Comparison of Method 1 and Method 2

Method 1	2001	2002	2003	2004	2005	2006	2007	2008
1st child	27.144	27.325	27.502	27.726	27.875	28.017	28.251	28.446
2nd child	29.814	29.960	30.076	30.229	30.348	30.492	30.723	30.919
3rd child	31.505	31.582	31.662	31.764	31.830	31.940	32.169	32.331
4th+ child	33.120	33.115	33.189	33.213	33.280	33.369	33.415	33.519
Method 2	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1st child	27.128	27.312	27.489	27.714	27.862	28.003	28.237	28.432
2nd child	29.813	29.958	30.074	30.227	30.346	30.492	30.722	30.916
3rd child	31.514	31.592	31.673	31.773	31.840	31.948	32.183	32.346
4th+ child	33.140	33.129	33.201	33.223	33.295	33.387	33.430	33.533
Method 2-Method 1								
1st child	-0.016	-0.013	-0.013	-0.011	-0.013	-0.014	-0.014	-0.014
2nd child	-0.001	-0.002	-0.002	-0.002	-0.002	0.000	-0.001	-0.003
3rd child	0.009	0.011	0.011	0.009	0.011	0.008	0.013	0.014
4th+ child	0.019	0.014	0.012	0.010	0.015	0.018	0.015	0.014

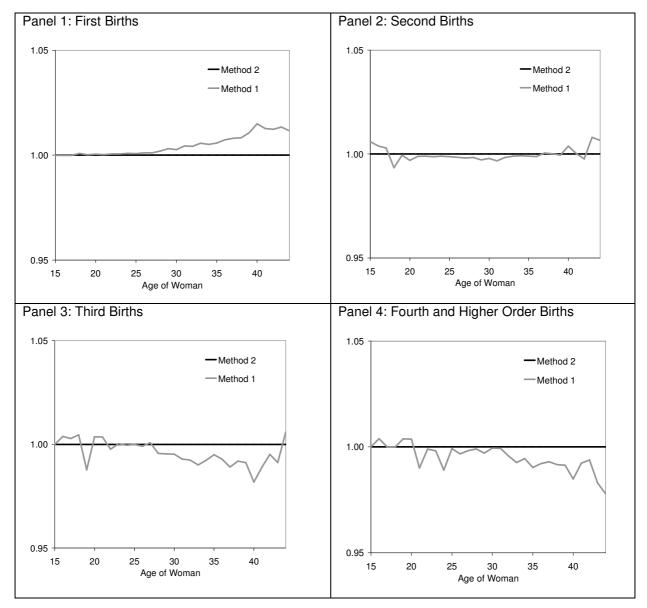*Notes:* Mean ages were generated based on age-specific fertility rates.
Source: QUAG Statistics and Perinatal Statistics (own estimates)

Table 7: TFR by Birth Order (Ages 15-44), Comparison of Method 1 and Method 2

Method 1	2001	2002	2003	2004	2005	2006	2007	2008
1st child	0.683	0.675	0.669	0.676	0.663	0.652	0.675	0.680
2nd child	0.456	0.457	0.460	0.467	0.462	0.456	0.469	0.472
3rd child	0.142	0.144	0.144	0.148	0.147	0.152	0.155	0.155
4th+ child	0.065	0.065	0.065	0.065	0.066	0.068	0.070	0.070
Method 2	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1st child	0.681	0.673	0.667	0.675	0.661	0.651	0.673	0.678
2nd child	0.458	0.458	0.461	0.468	0.462	0.457	0.470	0.473
3rd child	0.143	0.145	0.144	0.149	0.148	0.152	0.155	0.156
4th+ child	0.065	0.065	0.066	0.066	0.066	0.069	0.070	0.071
Method 2-Method 1	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1st child	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
2nd child	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001
3rd child	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4th+ child	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: QUAG Statistics and Perinatal Statistics (own estimates)

Figure 5: Ratio of Estimated Births from Method 2 and Method 1 by Single Ages, Germany 2008

Notes: Method 1: Estimates based on Perinatal Statistics; Method 2: Estimates based on Combination of Perinatal Statistics and QUAG Statistics (own estimates)

5 Summary and Conclusions

The main goal of this paper was to delineate how data from the German Perinatal Statistics can be used to construct a 'German Birth Order Register'. This Birth Order Register has been established by weighting the Perinatal Statistics in such a way that they match the number of births from the vital statistics. Based on these estimates and additional data on the population of females, we have generated age- and order-specific fertility rates for Eastern and Western Germany, as well as for Germany in total. In another step, we have tried to assess the size of the bias created by the fact that out-of-hospital births, which account for about two percent of all births in Germany, are not included in the Perinatal Statistics. Our sensitivity analysis has shown that the inclusion of out-of-hospital births does not have a noticeable impact on our estimates. In particular, measures of centrality, like the mean age at childbirth or the TFR by order, are not affected by the inclusion of out-of-hospital births. Apparently, the share of out-of-hospital births is too small to affect our estimates to a significant degree.

6 Acknowledgment

7   References

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8 Appendix

8.1 Questionnaires

Figure 6: Extract from Questionnaire Perinatal Statistics

Source: Bundesgeschäftsstelle Qualitätssicherung (2009)

Figure 7: Questionnaire QUAG Statistics

Source: Loytved (2009b: 7)

8.2   Tables

Table 8: Estimated Number of First Births, Eastern Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	152	150	130	132	118	112	111	97
16	423	441	430	408	340	373	277	253
17	885	988	904	872	836	754	700	631
18	1647	1522	1490	1481	1349	1281	1238	1209
19	2544	2408	2259	2127	2148	2147	2025	1831
20	3175	3058	2908	2782	2906	2806	2818	2657
21	3950	3650	3567	3434	3386	3134	3119	3014
22	4099	4034	3886	3770	3573	3522	3401	3398
23	4344	4318	4284	3996	3988	3819	3754	3532
24	4763	4707	4379	4721	4231	4223	4099	4054
25	4674	4900	4934	4993	4928	4460	4721	4569
26	4810	4878	5258	5236	5020	5164	5065	5087
27	4601	4530	4653	5283	5057	4945	5437	5129
28	4390	4408	4402	4728	4811	4858	5053	5342
29	4302	3941	3980	4194	4186	4565	4749	4903
30	4309	3845	3591	3660	3600	3834	4450	4610
31	3498	3690	3241	3187	3104	3219	3592	4062
32	2689	2776	2938	2846	2634	2560	2769	3166
33	1997	2157	2397	2592	2279	2139	2363	2406
34	1604	1659	1831	2025	2120	1861	1858	2002
35	1165	1297	1466	1494	1644	1683	1634	1655
36	797	996	1142	1226	1293	1282	1448	1410
37	641	761	777	943	904	869	1038	1174
38	476	488	541	655	704	716	807	845
39	327	357	410	435	533	492	567	633
40	200	266	286	328	370	374	398	490
41	113	130	178	191	216	236	252	261
42	73	86	90	105	104	122	147	163
43	39	35	50	68	63	67	73	88
44	15	20	31	25	25	22	55	43

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 9: Estimated Number of Second Births, Eastern Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	0	3	2	0	4	1	0	0
16	11	10	5	5	10	9	4	7
17	41	44	36	38	38	32	25	33
18	114	131	127	131	125	102	81	95
19	346	296	282	278	286	266	265	243
20	492	497	522	559	542	588	524	488
21	859	815	847	820	778	791	781	756
22	1071	1092	1129	1107	1132	1059	1064	990
23	1410	1327	1461	1409	1395	1335	1320	1225
24	1676	1614	1637	1687	1642	1593	1566	1434
25	1824	1850	1884	1956	1975	2020	1893	1963
26	1931	2010	2187	2281	2230	2349	2105	2228
27	2335	2294	2329	2588	2493	2517	2624	2589
28	2691	2558	2601	2669	2779	2829	2902	3050
29	3053	2926	2816	2872	2786	3114	3323	3298
30	3651	3089	2917	2811	2839	2848	3344	3504
31	3522	3635	3086	2933	2850	2937	3215	3592
32	3306	3406	3313	3080	2827	2763	2953	3298
33	2985	2959	3038	3132	2785	2545	2799	2956
34	2567	2607	2638	2803	2754	2283	2597	2621
35	2075	2097	2255	2331	2258	2369	2366	2324
36	1552	1587	1707	1853	1709	1910	2197	2099
37	1081	1286	1262	1360	1361	1443	1682	1811
38	786	873	846	951	972	1103	1208	1314
39	491	570	585	762	726	800	902	990
40	338	359	424	483	475	536	615	666
41	187	198	283	286	295	341	363	470
42	76	106	161	164	201	181	214	270
43	66	61	62	75	98	107	122	126
44	21	31	42	38	43	63	50	53

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 10: Estimated Number of Third Births, Eastern Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	0	0	0	0	0	0	0	0
16	0	1	0	0	0	0	0	0
17	0	0	2	2	1	0	1	1
18	10	6	4	9	7	4	5	6
19	26	27	17	31	17	28	31	18
20	66	49	57	57	58	51	69	60
21	128	120	126	110	145	145	128	129
22	201	196	190	233	208	175	208	215
23	264	248	276	296	326	293	275	306
24	357	305	344	407	361	415	399	343
25	373	374	430	456	477	448	450	437
26	424	395	409	461	544	569	523	500
27	470	434	510	513	606	618	595	637
28	548	537	503	619	655	690	663	708
29	664	580	617	625	598	735	745	761
30	700	709	636	662	685	734	804	809
31	849	822	773	735	733	730	795	832
32	942	847	861	758	769	780	756	846
33	1007	881	849	907	806	753	862	832
34	928	992	883	835	877	841	811	874
35	956	961	885	901	811	922	827	829
36	913	873	808	871	827	830	934	835
37	744	740	761	711	739	759	789	792
38	610	640	652	627	625	669	680	724
39	442	453	483	511	505	465	583	589
40	332	329	353	398	380	408	428	429
41	195	203	230	240	272	317	320	307
42	120	123	137	172	144	181	194	197
43	74	80	85	94	96	112	106	120
44	33	41	35	50	54	61	59	68

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 11: Estimated Number of Fourth- and Higher-Order Births, Eastern Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	1	0	1	0	0	0	0	0
19	1	2	3	1	1	2	1	0
20	7	8	2	6	10	8	7	8
21	26	20	13	22	17	11	22	19
22	26	35	37	56	44	43	42	45
23	73	61	85	87	71	87	85	67
24	97	90	102	138	111	116	129	124
25	147	144	153	161	162	179	183	148
26	180	148	179	210	204	224	255	233
27	231	192	224	243	273	269	307	245
28	236	232	236	248	284	304	329	359
29	308	238	289	268	317	323	364	361
30	342	315	283	326	332	336	368	385
31	372	357	349	340	316	338	351	393
32	428	395	423	390	346	338	379	379
33	518	430	415	445	343	452	361	423
34	519	427	440	414	389	412	407	391
35	497	474	470	443	452	449	390	424
36	541	479	471	462	459	426	428	401
37	556	462	495	463	431	496	440	440
38	427	439	421	423	447	406	394	404
39	409	383	406	396	385	378	376	378
40	343	301	279	299	333	341	303	324
41	261	249	274	208	240	259	258	246
42	176	152	146	197	177	197	204	206
43	87	102	98	136	105	105	115	117
44	58	66	59	64	68	93	76	78

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 12: Estimated Number of First Births, Western Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	295	295	272	242	259	206	220	215
16	923	970	906	876	842	811	753	777
17	2267	2241	2194	1995	2030	1831	1792	1700
18	4139	4048	3910	3708	3459	3400	3249	3087
19	7362	6740	6447	6133	6065	5795	5699	5299
20	9933	9464	8588	8138	7933	7903	7539	7537
21	11760	11499	10525	9976	9479	9010	9073	8665
22	12553	12725	12325	11784	10505	10095	9837	9571
23	13252	13238	13255	12768	12243	11186	10963	10353
24	13831	13824	13708	14204	13651	12818	12138	11771
25	15371	14776	14767	15006	14835	14374	14345	13458
26	15706	15771	15722	15995	15396	15814	15955	15812
27	16872	16030	16404	16411	16255	15847	17290	17037
28	17598	16965	16363	16960	16455	16569	17351	18157
29	19127	17331	17018	16750	17189	16875	17609	18064
30	20736	18484	16944	17114	16505	16931	17971	18283
31	19823	19344	17543	16438	16215	15772	17207	17600
32	18757	17191	16788	16134	14727	14607	15121	16050
33	16359	16112	15082	15213	13978	12540	13462	13669
34	13771	13555	13304	13121	12813	11655	11499	11771
35	10730	11396	11427	11493	10888	10656	10448	10059
36	8342	8953	9111	9489	9216	8793	9320	8815
37	6198	6400	6826	7243	7212	7043	7332	7195
38	4247	4507	4828	5201	5481	5462	5649	5708
39	2803	3184	3419	3747	3918	4203	4314	4444
40	1903	2088	2298	2571	2600	2978	3170	3513
41	1240	1361	1371	1512	1691	1799	2084	2248
42	652	710	817	870	942	1011	1177	1251
43	377	360	429	485	527	605	639	729
44	144	210	200	228	232	243	318	357

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 13: Estimated Number of Second Births, Western Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	7	6	2	7	3	3	8	5
16	25	34	35	33	17	21	23	17
17	106	130	115	112	84	79	67	98
18	352	335	318	339	297	271	250	266
19	1008	876	852	826	876	728	757	667
20	2127	1848	1751	1669	1674	1518	1524	1446
21	3432	3289	3166	2733	2712	2677	2549	2486
22	4723	4690	4723	4380	4136	3804	3676	3557
23	6155	5976	6046	6040	5605	5136	4855	4702
24	7608	7308	7160	7586	7008	6785	6102	5875
25	8714	8642	8631	8437	8711	8304	7805	7061
26	9987	9827	9888	9610	9706	9619	9486	8732
27	11165	10854	11042	10916	10881	10656	10861	10464
28	12233	12269	11916	12067	11699	11405	11508	11755
29	14583	13448	13117	12910	12514	12125	12529	12312
30	16268	14793	13702	13490	13048	13118	13033	12838
31	17383	16088	15137	14076	13826	12959	13685	13597
32	18270	16967	16187	15030	13607	13351	13394	13937
33	18081	17244	15909	15971	14084	13052	13584	13202
34	16269	16025	15500	14748	14151	12832	12460	12750
35	13718	14025	14153	13794	12668	12229	12037	11287
36	10671	11028	11443	11690	11439	10699	10764	10529
37	7905	8419	8849	9202	9316	8993	9054	9058
38	5693	5934	6301	6885	7256	7200	7320	7310
39	3771	4179	4569	4798	5204	5367	5621	5661
40	2442	2706	2973	3244	3526	3615	4008	4258
41	1447	1696	1689	1937	2013	2216	2426	2708
42	819	904	976	1074	1222	1323	1431	1570
43	398	481	543	502	602	717	792	822
44	189	217	203	256	310	331	386	421

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 14: Estimated Number of Third Births, Western Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	0	1	0	0	0	0	0	0
16	4	2	1	1	0	1	2	1
17	7	4	12	5	1	5	1	4
18	24	20	24	22	29	18	12	11
19	104	106	72	69	50	67	47	43
20	238	211	209	158	173	177	151	162
21	512	440	417	405	382	361	367	346
22	851	771	779	737	642	699	667	621
23	1223	1213	1175	1192	1119	1042	1073	1005
24	1702	1613	1582	1710	1597	1489	1362	1293
25	2087	2152	2062	1957	2140	2079	1870	1733
26	2697	2624	2481	2515	2503	2657	2480	2305
27	3283	3085	3035	3064	2975	2924	3014	2935
28	3501	3474	3431	3378	3356	3418	3345	3461
29	4051	4016	3948	3860	3741	3898	3794	3630
30	4635	4462	4262	4294	3950	4265	4109	4099
31	5027	5111	4575	4496	4525	4524	4391	4260
32	5738	5189	5122	4834	4508	4561	4500	4548
33	5819	5604	5380	5146	4923	4668	4771	4673
34	5851	5831	5462	5336	5107	4719	4733	4690
35	5782	5513	5451	5400	4810	4907	4889	4631
36	4926	5111	5048	5061	4903	4501	4715	4516
37	4187	4330	4302	4502	4095	4227	4141	4091
38	3415	3356	3394	3600	3545	3603	3623	3602
39	2328	2530	2546	2787	2836	2944	3020	2993
40	1704	1738	1758	2040	2032	2135	2228	2264
41	1012	1111	1192	1266	1348	1402	1600	1586
42	609	695	678	733	765	893	908	1029
43	351	353	398	392	517	506	540	575
44	173	195	218	219	238	247	297	321

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)

Table 15: Estimated Number of Fourth- and Higher-Order Births, Western Germany

Age	2001	2002	2003	2004	2005	2006	2007	2008
15	0	0	0	0	0	1	0	0
16	0	0	0	0	0	1	0	1
17	0	0	0	0	0	0	0	0
18	2	2	1	3	1	1	0	0
19	7	12	6	8	12	5	4	3
20	28	30	31	14	25	19	18	13
21	63	78	73	61	56	52	38	55
22	171	159	139	145	136	105	113	124
23	289	305	253	288	243	244	211	226
24	462	443	427	423	395	391	369	360
25	658	739	618	605	594	597	590	512
26	858	840	794	758	815	784	808	736
27	1115	1090	1046	1036	955	997	1090	994
28	1398	1320	1290	1189	1253	1268	1216	1305
29	1652	1506	1465	1475	1433	1430	1433	1403
30	1902	1767	1782	1664	1584	1638	1647	1672
31	1923	1994	1931	1837	1786	1789	1721	1844
32	2241	2165	2104	1940	1937	1987	1951	1911
33	2318	2263	2242	2079	2072	2119	2143	2058
34	2401	2402	2291	2300	2253	2171	2098	2144
35	2570	2453	2450	2364	2337	2248	2199	2127
36	2619	2618	2438	2372	2309	2286	2289	2148
37	2359	2354	2333	2241	2193	2215	2234	2090
38	2050	2141	2180	2153	1949	2006	1990	1924
39	1721	1734	1861	1854	1842	1814	1804	1723
40	1404	1484	1474	1541	1556	1535	1483	1477
41	1054	1069	1089	1143	1138	1239	1284	1176
42	642	733	750	733	833	850	896	916
43	420	485	499	540	519	577	536	585
44	249	265	279	289	332	332	335	363

Notes: Estimates are based on Method 1 (see Section 3 for further explanation)
Source: Perinatal Statistics (own estimates)