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Nadine Geiger, Sebastian Wichert

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Abstract

While World War II (WWII) is often employed as natural experiment to identify long-term effects of adverse early-life and prenatal conditions, little is known about the short-term effects. We estimate the short-term impact of the onset of WWII on newborn health using a unique data set of historical birth records ranging from December 1937 to September 1941. Furthermore we investigate the heterogeneity of this effect with respect to health at birth and for different social groups. To evaluate potential channels for our results, we explore how birth procedures changed. While we do not find any effects on birth weight and asphyxia, perinatal mortality increases immediately after the onset of WWII. The mortality effect is driven by live births and strongest for very low birth weight infants. A decline in quality of medical care due to the sudden conscription of trained physicians to military service is the most likely mechanism for our findings.

JEL-Codes: I100, I180, N340, N440.

Keywords: infant mortality, early-life health, health care supply.

Nadine Geiger
LMU Munich
Munich / Germany
nadine.geiger@econ.lmu.de

Sebastian Wichert
Ifo Institute – Leibniz Institute for Economic Research at the University of Munich / Germany
sebastian.wichert@econ.lmu.de

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1 Introduction

Early childhood and the time in utero may be one of the most critical time periods in life (Almond and Currie 2011; Almond et al. 2018). To establish a causal effect of adverse early-life environment on later life outcomes, a growing literature exploits historical shocks like natural disasters, recessions, famines and wars. The by far greatest shock that has affected living cohorts in Western Europe is World War II (WWII). Individuals exposed to WWII in utero or early-life have been shown to have higher morbidity and mortality rates, worse socio-economic outcomes and even a modified behavior at older ages (see e.g. Atella et al. 2017; Jürges 2013; Kesternich et al. 2014, 2015; Van den Berg et al. 2016). These findings are based on samples of the surviving population. If individuals who survive infancy during the war do systematically differ from survivors of other cohorts, estimates of long term effects may be biased (see e.g. Lindeboom and Van Ewijk 2015; Van Ewijk and Lindeboom 2017). As historical individual level data on birth outcomes are hardly available,[1] it is unclear whether the negative effects of WWII remained latent until later life or were already present at time of birth.

The aim of this research project is to estimate the short-term effects of the onset of WWII on perinatal health and mortality of infants. To explore, how war induced changes in perinatal infant mortality are related to individual characteristics associated with outcomes later in life, we estimate heterogeneous treatment effects by social group and infant health. Furthermore we investigate several mechanisms through which the onset of WWII may affect a newborn's health. We collected an entirely new data set of historical clinical birth records from the largest birth hospital in Munich, Germany. Our unique data contain around 10,000 births and miscarriages which took place in hospital between December 1937 and September 1941. Besides a rich set of demographic variables, our data set contains detailed socio-economic information. In our empirical strategy we exploit the unexpected onset of WWII as natural experiment.

[1] A rare exception is the "Dutch Famine Birth Cohort Study". See Lumey et al. (2011) for an overview.

Even 60 years after the end of WWII, its consequences continue to shape individual life outcomes. Kesternich et al. (2014) analyze retrospective life data and document that individuals exposed to WWII during childhood are more likely to suffer from diabetes and depression at old ages. Atella et al. (2017) investigate the impact of WWII on health in an Italian context. They can link stress in early life caused by exposure to intense conflicts to depression, while exposure to famine appears to increase the probability of diabetes in later life. A number of research projects exploit WWII to study the long-term consequences of hunger in early life. For example Van den Berg et al. (2016) provide causal evidence that hunger leads to a decrease in adult height and Kesternich et al. (2015) show that individual behavior can serve as a pathway between early life shocks and later life health. Similarly, the small literature drawing on historical birth records to study the short-term impact of WWII on health at birth mainly focuses on the role of nutritional shortage during gestation. Stein et al. (2004) find those individuals affected by the Dutch Hunger Winter 1944/1945 during the third trimester to have decreased birth weight and birth size. No effect is found for individuals exposed during earlier stages of pregnancy. Using data similar to ours, Floris et al. (2016) study how birth weight evolves over the course of WWI in one Swiss hospital. In their setting food rationing during the end of the war leads to a decrease in birth weight for children from medium SES families. By contrast, high SES families can compensate price shocks and low SES families benefit from public interventions. Our work is also related to a strand of literature investigating the impact of (unexpected) shocks in utero and maternal stress using modern data. This literature exploits a variety of shocks, for example natural disasters (Currie and Rossin-Slater 2013; Torche 2011), terrorist attacks (Quintana-Domeque and Ródenas-Serrano 2017) or mass layoffs (Carlson 2015). Most of these studies can document a small decrease birth weight following an external shock. An exception is Currie and Rossin-Slater (2013) who do not find a change in birth weight, but show that stress in utero affects more extreme health outcomes.

Finally, in our discussion of potential mechanisms, we connect to the literature evaluating the causal effects of early-life medical supply. Using a regression discontinuity design Almond et al. (2010) for example show for the US that additional medical treatment around birth decreases infant mortality for very low birth weight newborns. Additionally Bharadwaj et al. (2013) (for Chile and Norway) and Breining et al. (2015) (for Denmark) show that additional medical treatment for these newborns increases test scores and even benefits siblings, respectively. In a more narrow sense, this paper is most closely related to the literature on physician supply. Daysal et al. (2019) show that physician supervision of birth reduces perinatal mortality in the Netherlands today. In contrast Liebert and Mäder (2018) draw on historical data and exploit the sudden expulsion of Jewish doctors in Nazi Germany as natural experiment. They find a decrease in regional physician coverage to have substantial detrimental effects on infant mortality.

While we do not find any sizable effects of the onset of the war on health measured as birth weight or asphyxia, we can document a strong, robust increase perinatal infant mortality. This mortality effect can mainly be attributed to live born children who die in hospital prior to being discharged. Perinatal mortality increases for all social classes and disproportionally for very low birth weight infants. Previous literature relating WWII to health outcomes often focuses on extreme effects of the war like bombings, hunger, combat and dispossession. Similarly to Lindeboom and Van Ewijk (2015) and Van Ewijk and Lindeboom (2017), we study less extreme war-related events. We focus on the first two years of WWII, a period when military operations took place outside of Germany and there was no nutritional shortage. Our main contribution is to document an effect of WWII on perinatal child mortality even in the absence of extreme conditions. The onset of WWII acted as shock to individuals and the public health system, which initially led to a jump in perinatal mortality and then gradually faded out. This interpretation is consistent with historical evidence, showing that the onset of the war caused turmoil in the health system and disrupted daily life.

Two mechanisms are potentially driving our results. First, high maternal stress levels may contribute to an increase in infant mortality, as the onset of a war comes a long with great uncertainty and many husbands were drafted. Second, a sudden shortage of doctors can lead to a decrease in medical quality. With the onset of WWII, large scale conscription reduced the number of doctors considerably and put the hospital under strain. We find the mortality effects to be stronger, where medical quality should matter. Therefore we conclude the decline in medical quality to be the more important channel.

Our results have important implications for the literature on long-term effects of WWII. We document a disproportional increase in mortality for very low birth weight infants, suggesting that studies using samples of the surviving population provide a lower bound for the true effect.

The remainder of the paper proceeds as follows: Section 2 provides more detailed information on the historical background. Section 3 describes our data, the way we constructed our variables and presents first descriptive analyses. We explain our empirical strategy in Section 4 and present our results in Section 5. Section 6 concludes.

2 Historical and institutional setting

2.1 General historical background

Events leading to WWII

When Hitler and the Nazi Party seized power in 1933, the transformation from a weak democracy to an autocratic dictatorship began immediately. Within months, public institutions, local and regional authorities, judicature and even private clubs were brought under the control of the Nazi party. Non Aryan Germans were dismissed from jobs in the civil service and whoever publicly raised criticism became subject to brutal repression (Evans 2004, pp. 498-509). Against the terms of the treaty of Versailles the Nazis also launched the rearmament of the German military. In 1935 a military law made all male

Germans between 18 and 45 liable to military duty. Nevertheless, neither the German public nor other European powers were aware of the imminent threat of a war. When Hitler began with the restoration and expansion of Germany, he did so using massive political pressure on foreign governments instead of using military force. Between 1935 and 1938 three former German territories, separated after WWI, were reintegrated into Germany (Territory of the Saar Basin by referendum, Rhineland and Memel Territory by occupation, Austria by voluntary annexation). The first military aggression took place in 1938 when Germany occupied the Sudeten German territories in Czechoslovakia. The essential powers in Europe - Great Britain, France, Italy - tolerated this aggression to appease Hitler and to avoid a new war in Europe. Even when Hitler violated previous agreements again in 1939 by occupying the rest of Czechoslovakia, they did not intervene in any military way.

After these successes Hitler and the Nazi state were celebrated by the majority of the German population, who perceived Germany to be a world power again. The general public hoped that wars could be avoided in the future as well - either because Hitler had already achieved his goals or because his political measures were sufficient to do so (see Frei 2013, p. 150).

World War Two

WWII began with the invasion of Poland on September 1st, 1939. For the first time the German military experienced resistance, and Poland's guarantor powers - France and Great Britain - declared war on Germany. This had been unexpected by the German public, to whom it was clear quickly that this conflict would be different from any other conflict since 1918. There was a great feeling of uncertainty and no euphoria among the population, since most people had experienced the negative consequences of the previous war. Prior to 1942, military operations (i.e. air strikes or combat) mainly took place outside of Germany (see Permooser 1997). Therefore the German population was initially not subject to direct effects of the war like hunger and bombings. Nevertheless, the onset of WWII marked a distinct break in the daily routine. First, conscription affected a great number of men who were subsequently absent from their families and workplaces. At the end of 1939 around 4.2 million men out of a male population of 33.8[2] million were serving the military, another 3.5 million men were drafted in 1940 (Overmanns 2009, p. 217).[3] Men were drafted based on their year of birth and previous military experience without social class dependent privileges or exceptions (Absolon 1960, pp. 4, 152–153).[4] Second, to prioritize production for military purposes, the economy was transformed into a wartime economy. Three days before Germany invaded Poland, the regime announced the introduction of ration stamps for food and other commodities like fabric, leather and soap. The local population in Munich responded to the introduction of ration stamps with a rush to the shops and officials were not well prepared to manage the new circumstances.[5] While there is no evidence suggesting that the population was affected by serious hardship during the first two years of the war, daily life became more complicated. Long queues in front of shops were common especially in the first weeks of the war and commodities like furniture and bedding eventually became objects of speculation. There was no general shortage of food.[6] However, food quality declined and availability of certain categories of food varied. Pregnant women received preferential treatment. Unlike the general population they were allocated whole milk and when coal was in short supply in February 1940, pregnant women were eligible for extra rations. Records of the hospital our data come from, do not indicate any problems with the catering of patients or shortage of fuel.

The German health system entered the war ill-prepared. No comprehensive concept existed on how to operate medical services for the civil population. Instead the military was

[2]German Reich as of 1937.

[3]Poland was already defeated (with minor German military losses) in October 1939 and lots of soldiers returned on furlough. However, the atmosphere in Germany remained tense as there was a constant threat that soldiers, who had just returned, would be sent to war again.

[4]Only certain conscripts were (temporarily) exempt if their specific occupation duty was classified - again on a case-by-case basis - as indispensable for "homeland defence".

[5]Confidential quarterly reports by the Economic Department give a detailed account of the Economic situation in Munich (Stadtarchiv München 1939-1940).

[6]Daily food rations were sufficient until the end of 1944 (see Jürges 2013; Kesternich et al. 2015).

given full priority. The army made frequent use of its authority to dispose all resources of the civil health system. Besides confiscations of local hospitals, large scale drafting of physicians lead to conflicts between the military and the civil sector. Already in fall of 1939 one third of all available physicians were in military service. To mitigate the shortage of physicians, the state granted final year medical students their approbations prematurely. Turmoil in the health system was greatest during the first weeks of the war[7], while the situation remained tense throughout (Christians 2013, pp. 237-244; Süß 2003, pp. 181-212).[8]

Fertility and childbirth under Nazi rule

Childbirth was no longer considered a private matter in Nazi Germany. Between 1900 and 1933 the number of yearly births in Germany had fallen by more than 50% (Sensch 2006), an unacceptable state for a regime adhering to a pro-natalist ideology. However, as the Nazis' world view was based on eugenics, their goal was not to increase everybody's fertility. The regime used brutal repression to prevent reproduction among those considered to deteriorate the gene pool (Fallwell 2013). To boost birthrates among healthy "Aryan" Germans, the Nazis combined family propaganda, a ban of voluntary abortion[9] and material incentives.[10] Indeed, the absolute number of births was increasing in the years prior to WWII.

Even the choice of location of delivery became infused with political agenda. The Nazi regime was heavily opposed to the increasing trend towards hospital birth. While the concept of women giving birth at home within their family members fitted in perfectly with the Nazi ideology, home births also spared the resources of the health system. Ef-

[7]Even high ranking Nazi officials had to acknowledge this tense situation (König 1939, pp. 385-386; KVD Bayern 1939, p. 387).

[8]A notable exception was the constant supply of pharmaceuticals, which was secured during the first years of WWII due to large production capacities (Süß 2003, p. 197).

[9]In the late 1920's Germany was given of the most liberal abortion policy in the developed world (Usborne 2011).

[10]For example, eligible newly wed couples received marriage loans, whose repayment was reduced with each child born.

forts to propagate home births climaxed in the so called "midwife edict" of September 1939 (RMI 1939). This edict requested hospitals to reject pregnant women without medical or social indication for hospital births. The hospital our data come from was a teaching hospital and therefore exempt from this rule. Due to decisive resistance of the association of gynecologists the "midwife edict" was modified in 1940, granting women a choice over the location of delivery (Zander and Goetz 1986). Official statistics indicate that the proportion of hospital births in Germany was growing during the Nazi era despite all otherwise attempts. In 1935, 25% of live births took place within a hospital compared to 38% in 1940 (Statistisches Reichsamt 1933-1940).[11]

2.2 The hospital

The hospital *Frauenklinik Maistrasse* is the oldest and one of the largest gynecological hospitals in Munich. It was founded as a state-run university hospital in 1884, succeeding the municipal birth house. In its first years the hospital mainly served lower-class and often single mothers. Women of higher social status traditionally gave birth at home. However, after moving into its current venue in 1916, the *Frauenklinik Maistrasse* became one of the leading gynecological hospitals in Germany and attracted patients among all social classes. The hospital was divided into a general and a private ward. Most patients were admitted to the general ward and their treatment was completely covered by public health insurance. The private ward enabled the hospital to extract rents from more affluent, often privately insured patients. These patients received special attention by the senior staff.[12] Deliveries were supervised by both doctors and midwives, but only doctors carried out surgeries and medical procedures. With the onset of WWII the conscription of physicians heavily affected the daily routine. The director of the hospital frequently complained in

[11]Before 1935 official statistics only counted the number of births within maternity clinics. In urban areas the proportion of hospital births was even higher.

[12]The hospital was only allowed to charge a publicly regulated daily rate for patients in the general hospital with no extra fees for treatments. In private ward, on the other hand, there were extra fees for treatment on top of a higher daily rate.

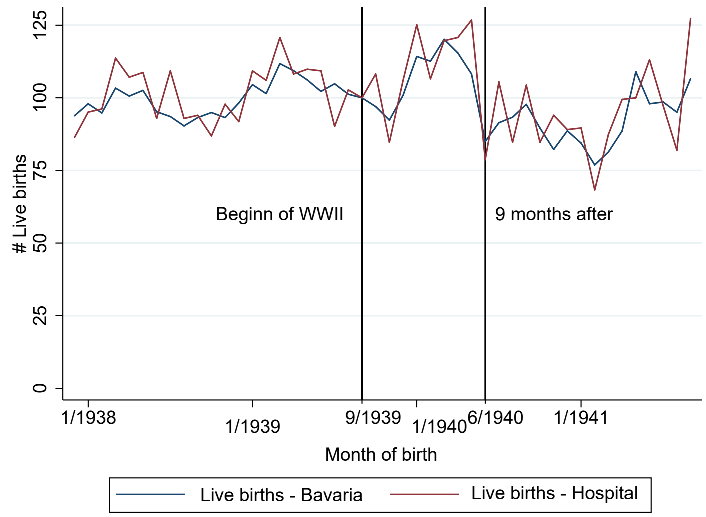
letters to the state administration and applied for exemptions from military service for many of his doctors. For example, in a letter from December 1939 he stated that already seven of his doctors were serving the military and several more had received draft calls. Much of the workload was shifted to recent graduates and unpaid trainees. In the Nazi era, the hospital carried out large numbers of forced abortions and sterilizations on women who allegedly suffered from hereditary diseases.[13]

Two groups of births are likely to be oversampled in our data: births of mothers with very low socio-economic status and pathological births. Home birth was no option for women living under crowded or unsanitary conditions. Often these women would seek admittance to the hospital weeks before delivery, where they acted as teaching material for medical students and midwives in training. Women in risk of a pathological birth were referred to hospital by midwives and gynecologists. Still, as hospital births had become quite common especially in big cities by 1937, our sample is broad enough to draw conclusions also for other groups. Around half of our observations equal at least a status of a skilled worker and almost 60% of women entered the hospital without any pre-existing risk factors. Between 1938 and 1940 around 17% of all Munich live births took place in the Frauenklinik Maistrasse (see Table A.2 in the Appendix).

Figure 1 shows the monthly trend in the number of live births for our hospital and the whole state of Bavaria, normalized for September 1939. Both trends match quite well and no structural breaks (e.g. at the begin of the war or due to the "midwife edict") point to any differential selection into our hospital.

[13]Most such records state the women suffered from "hereditary feeble-mindedness". Since the 1990's the hospital has endeavored to shed light on its role during the Nazi era (Stauber 2012).

Figure 1: Number of live births in Bavaria and hospital



Notes: Number of live births in Bavaria and our hospital by month of birth, with the number of births in September 1939 being normalized to 100.
Source: Bayerisches Statistisches Landesamt 1937-1942

3 Data

3.1 Sample selection and variables

Sample selection

We digitized the universe of entries in the hospital's birth records from December 1937 to September 1941 (see Appendix A). The 10,325 observations consist of live- and stillbirths, miscarriages and a small number of other conditions.[14] Other conditions comprise women who came to the hospital post birth, women receiving treatment during pregnancy, medically induced interruptions as well as forced abortions and sterilizations. We do not consider these 196 observations in our analysis.

In our definition of live births, stillbirths and miscarriages, we maintain the categorization found in the clinical records. A law of 1935 required midwives and physicians to report all miscarriages to the authorities who were wary of illegal abortions.[15] In our birth re-

[14] A twin birth results in two observations.

[15] *Vierte Verordnung zur Ausführung des Gesetzes zur Verhütung erbkranken Nachwuchses.* Vom 18. Juli 1935. In: RGB1 I Nr. 82, 25. Juli 1935.

cords around 1,200 observations are marked as miscarriage. These mostly lack information on the child such as weight, length and sex. Miscarriages mostly took place outside the hospital and women only went to the hospital to seek treatment afterwards. Patterns of selection into the hospital are very likely to vary between women who intend to give birth and women who are treated after a miscarriage. Therefore we exclude miscarriages from our main analysis.[16]

Outcome and control variables

Our primary outcomes are perinatal infant mortality, measured as whether an infant left the hospital alive, and birth weight. Birth weight is an overall measure of health at birth (McIntire et al. 1999), while also being a predictor of future life outcomes, for example educational attainment and adult height (Behrman and Rosenzweig 2004). Currie and Rossin-Slater (2013) find that birth weight is not affected by exposure to stress in utero, while there is an effect for more extreme measures of newborn health. Therefore we also analyse asphyxia and maturity. Asphyxia is caused by deprivation from oxygen during the process of birth. It often results in the death of the infant and can cause long term damage to surviving infants. Maturity is an indicator whether the birth takes place at full term. It is assessed by the appearance of the infant.[17]

Our control variables include characteristics of the mother, namely age, the number of previous pregnancies and most importantly a measure of social status which is derived from the occupational information in the birth records. We categorize this occupational information according to HISCLASS, a validated measure of historical social classes. Each occupation is assigned one out of 12 social classes defined as "a set of individuals with the same life chances" (Van Leeuwen and Maas 2011, p. 18). In our empirical analysis we

[16]Entries marked as stillbirth, on the other hand, almost always include characteristics of the child but do not generally contain a gestational age. Partly the definitions of stillbirth and miscarriage seem to overlap since weight and gestational age of "miscarriages" exceeds 1,000 grams and the fifth month in individual cases, while stillbirths" encompass a few infants with a birth weight below 1,000 grams.

[17]To assess maturity, midwives checked the colour of skin, body hair, ear conch and the appearance of genitals.

rely on the previous literature and use a compressed 7-class version of HISCLASS (Abramitzky et al. 2011; Schumacher and Lorenzetti 2005).[18] For each observation, the birth record contains either the occupation of the father or the occupation of the mother. If the occupation of the mother is given, the entry uses the female version of the occupation in German language. Otherwise the male version is used, mostly with a suffix like -wife, -daughter or -widow. We classify women accordingly as "working", "wife" or "single". Note that this approach assumes that the categories are mutually exclusive, while in reality a married women may also work. Further control variables include the sex of the infant, multiple births and the fetal position. Fetal malpositions and malpresentations are among of the most frequent reasons for complications at birth. As these can be diagnosed prior to birth easily, we expect births with an abnormal fetal position to be overrepresented in our data. Several factors, such as tumors, maternal anatomy or high parity are associated with fetal position in full term births (Mackenzie 2006). Still it is unclear why the onset of the war should causally affect the composition of fetal positions in the population. Consequently we think of fetal position as a proxy for the risk a birth can be associated with ex ante.

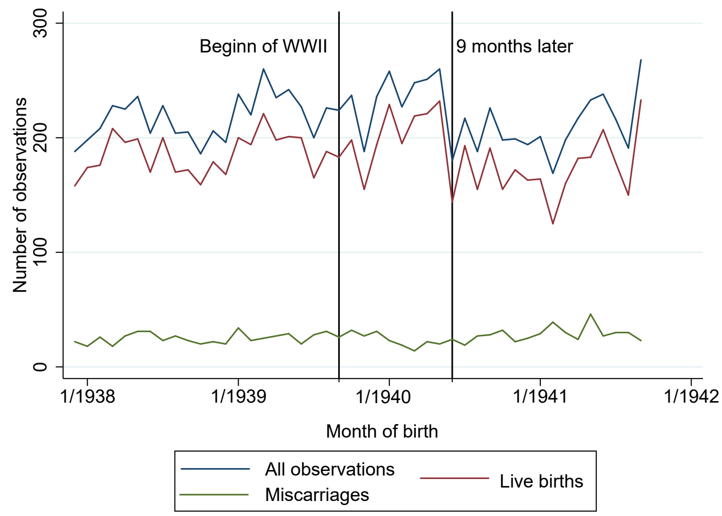
Descriptive statistics

Figure 2 displays the number of total observations, the number of live births and the number of miscarriages over our period of observation. The graph shows a distinctive drop in the number of births in June 1940 - nine months after the begin of the war, when many men were drafted for the invasion of Poland. Similarly another drop occurred in February 1941, 9 months after the begin of the invasion of France. In mid 1940 many of the German soldiers were granted furlough, leading to an increased number of births towards the end of the observation period.

Table 1 shows that 96% of the births in our sample are live births. In 93.5% of all

[18] This simplifies the interpretation of regression coefficients, attenuates possible coding errors and increases sample size within classes. A detailed description of the occupational coding can be found in Appendix B.

Figure 2: Timeline of observations in hospital



Notes: Number of all observations, live births and miscarriages by month of birth.

births the infant left the hospital alive,[19] implying that in addition to the 4% stillborn children, 2.5% of infants died in hospital after birth. Most births (93%) took place in the general ward. The mothers in our sample are on average 28 years old and experience their second pregnancy, 30% of the women in our sample report an own occupation. Unreported analyses show that lower classes are overrepresented among these working women.

[19]The median newborn stayed in hospital for 9 days after birth.

Table 1: Descriptive statistics - Births

General characteristics	N	Mean	SD	Min	Max
Birth after 9/1939	8828	0.543	0.498	0	1
General ward	8828	0.931	0.253	0	1
Length of stay	8769	12.704	11.934	0	379
Live birth	8828	0.960	0.195	0	1
Infant leaves hospital alive	8828	0.936	0.246	0	1
Regular fetal position	8688	0.919	0.273	0	1
Mother	N	Mean	SD	Min	Max
Age of mother	8828	27.921	6.211	14	50
Parity	8826	2.208	1.804	1	19
Status is wife	8828	0.651	0.477	0	1
Status is own job	8828	0.310	0.462	0	1
Status is single, divorced or widowed	8828	0.031	0.173	0	1
Social status	N	Mean	SD	Min	Max
Higher managers & professionals	8500	0.069	0.253	0	1
Lower managers & professionals, cleric	8500	0.194	0.396	0	1
Foremen & skilled workers	8500	0.225	0.418	0	1
Farmers	8500	0.072	0.259	0	1
Lower skilled workers	8500	0.133	0.340	0	1
Unskilled workers	8500	0.281	0.450	0	1
Farm workers	8500	0.025	0.157	0	1
Infant	N	Mean	SD	Min	Max
Male	8822	0.527	0.499	0	1
Birth weight	8820	3218.620	601.065	280	5510
Length of infant	8815	49.998	3.108	19	61
No. of infants	8828	1.027	0.164	1	3
Asphyxia	6784	0.023	0.148	0	1

Notes: Descriptive statistics of births in sample (excluding miscarriages).

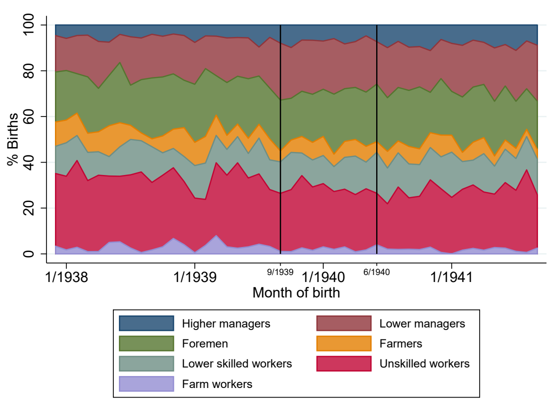
Table 2: Mean comparison - Births

General characteristics	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
General ward	0.952	0.914	-0.0374***	0.005	0.000	4035	4793
Length of stay	12.560	12.824	0.2639	0.256	0.303	3979	4790
Live birth	0.966	0.956	-0.0098*	0.004	0.019	4035	4793
Infant leaves hospital alive	0.949	0.924	-0.0247***	0.005	0.000	4035	4793
Regular fetal position	0.920	0.918	-0.0020	0.006	0.728	3954	4734
Mother	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Age of mother	27.845	27.985	0.1406	0.133	0.289	4035	4793
Parity	2.188	2.224	0.0356	0.039	0.356	4035	4791
Status is wife	0.614	0.682	0.0675***	0.010	0.000	4035	4793
Status is own job	0.339	0.285	-0.0533***	0.010	0.000	4035	4793
Status is single, divorced or widowed	0.037	0.026	-0.0108**	0.004	0.003	4035	4793
Social status	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Higher managers & professionals	0.055	0.080	0.0253***	0.006	0.000	3878	4622
Lower managers & professionals, cleric	0.174	0.212	0.0375***	0.009	0.000	3878	4622
Foremen & skilled workers	0.226	0.224	-0.0020	0.009	0.826	3878	4622
Farmers	0.084	0.062	-0.0222***	0.006	0.000	3878	4622
Lower skilled workers	0.123	0.141	0.0178*	0.007	0.016	3878	4622
Unskilled workers	0.305	0.261	-0.0434***	0.010	0.000	3878	4622
Farm workers	0.032	0.019	-0.0130***	0.003	0.000	3878	4622
Infant	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Male	0.525	0.529	0.0042	0.011	0.696	4033	4789
Birth weight	3227.907	3210.802	-17.1054	12.847	0.183	4031	4789
Length of infant	50.198	49.830	-0.3674***	0.066	0.000	4030	4785
No. of infants	1.028	1.026	-0.0019	0.004	0.583	4035	4793
Asphyxia	0.021	0.023	0.0028	0.004	0.483	1991	4793

Notes: T-tests on the equality of means by war (excluding miscarriages). Significance levels: ***$p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

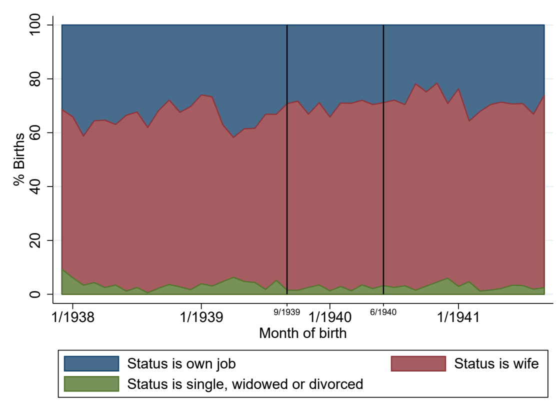
We conduct simple t-tests to check for changes from the prewar and to the war period (see Table 2). There is no difference in terms of age and parity of mother, as well as maturity and weight of the infant. The proportion of regular fetal positions does also not change significantly. Since the proportion of regular fetal positions in the population is unlikely to be affected by the war, this suggests that women at risk of a complicated birth were not sent to the hospital more frequently during the war. On the other hand, the composition of mothers in terms of social status, labor force participation and marital status does show some changes. This highlights the importance of controlling for socio-economic characteristics. When examining how the socio-economic composition evolves over time, we find no abrupt break occurs with the begin of the war (see Figures 3 and 4). We also test whether the war had an impact on length of stay in hospital measured in days

Figure 3: Composition in terms of social classes over time



Notes: Proportion of mothers by social class by month of birth.

Figure 4: Composition in terms of marital and working status over time



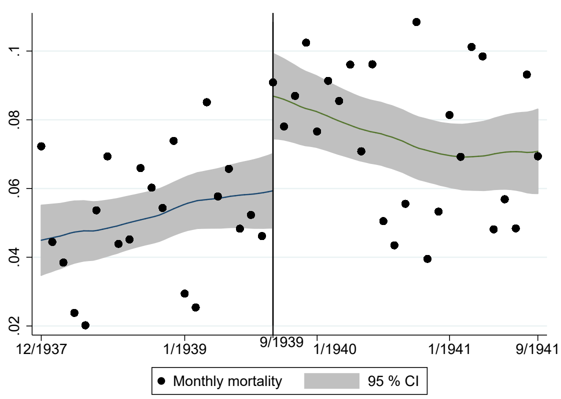
Notes: Proportion of mothers by marital and working status by month of birth.

after birth. The probability of observing a mortality event increases mechanically, when mother and infants remain in the hospital for a longer period. However, both before and during the war mothers and infants stayed on average in the hospital for almost 13 days. Finally we look at perinatal mortality. We find the unadjusted perinatal mortality rate to be significantly higher during the war. Descriptive statistics and mean comparisons for miscarriages can be found in Table A.3 and A.4 in the Appendix. Women who suffer a miscarriage are on average older and have more previous pregnancies than women who give birth.

3.2 Graphical analysis

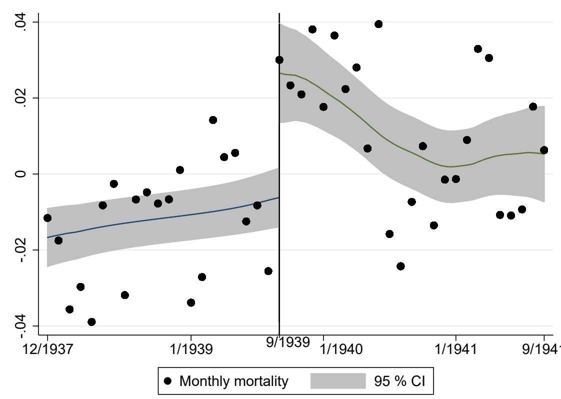
We begin our analysis by documenting the effect of WWII on perinatal mortality and health graphically. The monthly trend of perinatal infant mortality is presented in Fig-

Figure 5: Raw perinatal mortality by month of birth - All births



Notes: Perinatal death rates (monthly averaged) and local linear regressions with a ROT bandwidth and an Epanechnikov kernel separately for the pre-war and the war period.

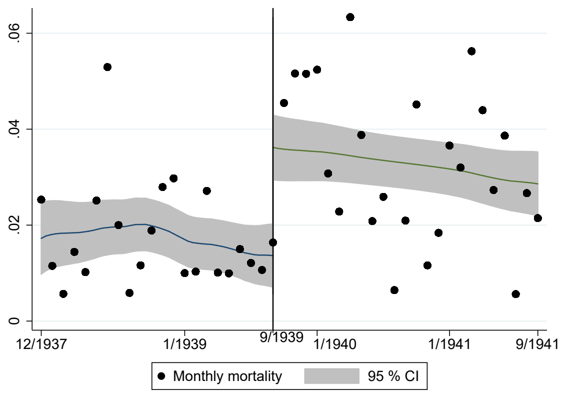
Figure 6: Adjusted perinatal mortality by month - All births



Notes: Regression residuals (monthly averaged) from regressions of perinatal mortality on social status, mother's age, parity, primipara, twinning status, infant's gender, marital status, a dummy for general ward, normal fetal position and working status.

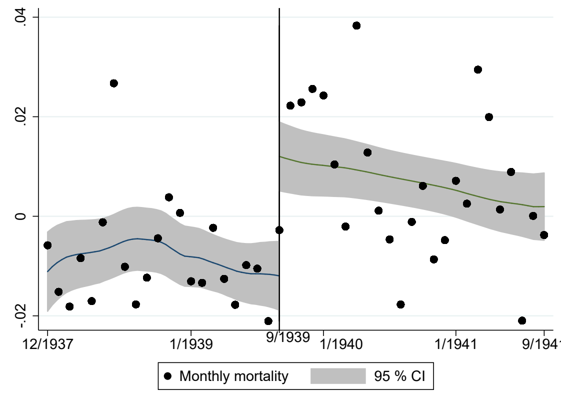
ure 5. The dots denote the raw monthly mortality rate. We fit local linear regressions separately for the pre-war and the war period. The graph documents a significant jump in perinatal mortality in September 1939. During the following months average perinatal mortality decreases gradually, but remains above pre-war levels. In a next step we adjust for observable characteristics. Figure 6 displays the monthly averages of residuals obtained from regressions of perinatal mortality on all maternal characteristics given in Table 1, infant gender and a dummy for regular fetal position. The jump at the threshold provided by the onset of the war remains significant. The decline in the mortality rate during the war period is slightly more pronounced compared to the graph without adjustment and

Figure 7: Raw perinatal mortality by month - Live births



Notes: Perinatal death rates (monthly averaged) and local linear regressions with a ROT bandwidth and an Epanechnikov kernel separately for the pre-war and the war period for live births.

Figure 8: Adjusted perinatal mortality by month - Live births



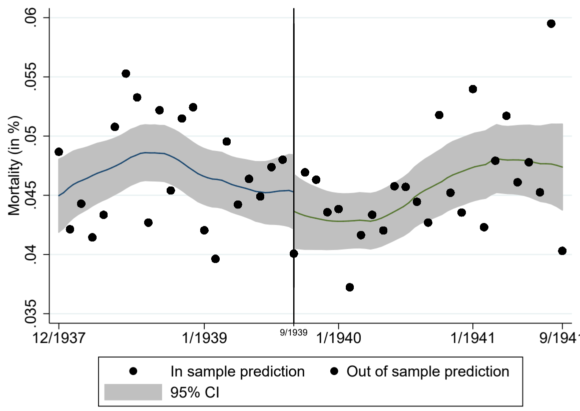
Notes: Regression residuals (monthly averaged) from regressions of perinatal mortality on social status, mother's age, parity, primipara, twinning status, infant's gender, marital status, a dummy for general ward, normal fetal position and working status for live births.

the mortality rate in 1941 is no longer significantly greater than in the months preceding the war.

To explore whether the overall increase in perinatal mortality rate is driven by stillborn infants or by live born infants who die in hospital after birth, we repeat the analysis for live births in Figure 7 and Figure 8. Again we see a significant jump in September 1939 followed by a linear decline in mortality. This suggest that a large part of the overall mortality effect is driven by live born children.

If conditions become worse permanently because of the war, one would expect the effect to stay constant or even accumulate. Our graphical results point to another interpretation. The onset of WWII might have provided a one time shock, which initially led to a jump in perinatal mortality and then gradually faded out. This explanation is consistent with the evidence presented in Section 2.1. The onset of the war was unexpected by the general public and affected the daily routine of individuals. Furthermore, a shift of resources towards the military caused turmoil in the unprepared health sector. Yet, prior to 1942 living conditions were not as severe as that it was impossible for individuals and

Figure 9: Predicted mortality



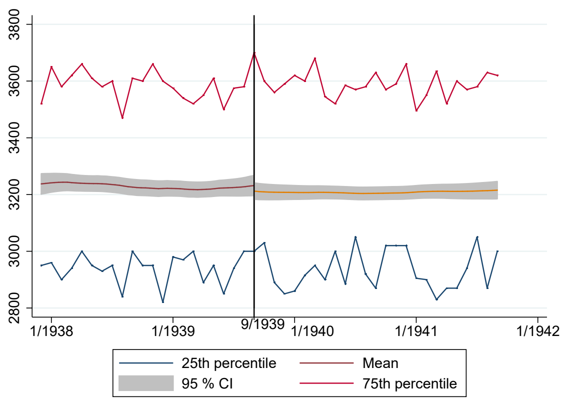
Notes: Predicted mortality (monthly averages) from regressions of perinatal mortality on social status, mother's age, parity, primipara, twinning status, infant's gender, marital status, a dummy for general ward, normal fetal position and working status.

organizations to adapt.

Given the duration of pregnancy, it is unlikely that the composition of mothers changes abruptly around our threshold. Still, we cannot rule out that mothers who give birth during the war are different from mothers who gave birth prior to the war. Therefore we investigate whether changes in observable characteristics can explain the increase in infant mortality. We regress perinatal infant mortality on our control variables using only observations from the pre-war period. We then use the estimated coefficients to predict perinatal infant mortality for the whole sample. If women who give birth during the war, are simply more risky in terms of observable characteristics, we would also expect to see an increase in predicted mortality after the onset of the war. The resulting timeline of predicted infant mortality is displayed in Figure 9. We do not find any significant change around the threshold. In fact, predicted mortality is at its lowest level in the last quarter of 1939, the time period right after the onset of WWII. On the other hand we see an increase in predicted mortality after the first quarter of 1940, while actual mortality is decreasing during this time period.

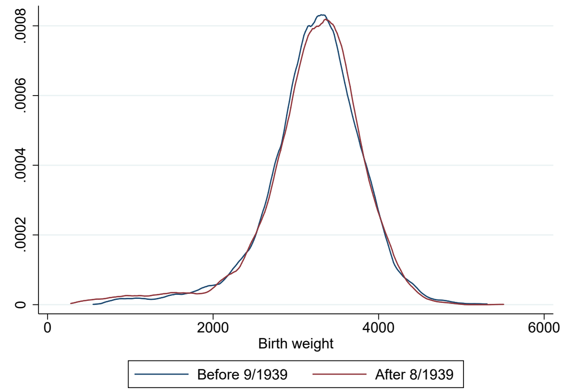
Finally, we turn to measures of perinatal health. Features of the distribution of birth

Figure 10: Birth weight by month of birth



Notes: 25th percentile, mean and 25th percentile of birth weight.

Figure 11: Birth weight distribution



Notes: Kernel density estimate of birth weight by war status.

weight are presented in Figure 10. Average birth weight stays almost constant during our whole observation period. Rather than on the average birth, war might have an impact on more extreme cases. We add lines of the 25th and 75th percentiles of monthly birth weight to our plot to investigate trends for children with higher or lower birth weight. Again, we do not see any trend. Similarly, kernel estimates of the density of birth weight do not indicate that any part of the distribution of birth weight was affected by the war (see Figure 11). Graphs for asphyxia and maturity are given in Figures A.1 and A.2 in the Appendix.

4 Empirical strategy

The aim of this work is to estimate the effect of the onset of WWII on perinatal health and mortality of infants. In our identification strategy we exploit the onset of WWII as a natural experiment. There is no evidence that anticipation of a coming war affected fertility patterns before September 1939 (see Section 2.1). Hence we argue that the onset of the war constitutes an unexpected shock for women already pregnant in September 1939. After September 1939 fertility decisions may be affected by the war. Therefore we conduct our analysis using both our whole observation period (1/1938- 9/1941) and a restricted observation period (12/1937- 5/1940). All full term births that occurred during the restricted observation period were conceived before the onset of the war. However, given that our data do not contain a reliable measure of gestational age, we cannot exclude preterm births conceived during the war period from the restricted sample. Preterm births are associated with a higher risk of perinatal mortality. While preterm birth itself can be a consequence of war, and therefore part of the effect we want to capture with our war dummy, our results will overestimate the true effect on mortality if women with an ex ante high risk of a preterm birth increase their fertility relative to other women during the war. Although we cannot generally rule out such concerns, we argue that an increased share of premature births should be reflected in an on average lower birth weight. Our descriptive analysis of trends in birth weight in Section 3.2 does not indicate any change. Additionally we run all our regressions also on a sample restricted to live births, assuming that the share of preterm births is lower among live births.[20]

Our baseline results are obtained estimating the following equation:

$$y_i = \alpha + \beta \texttt{war}_i + \kappa C_i + u_i \tag{1}$$

y_i is the outcome (infant mortality, birth weight, maturity, asphyxia), `war` is an indicator whether birth took place after the begin of WWII (i.e. in or after 9/1939), and C_i is a set of control variables. Specifically, we control for maternal age, number of pregnancy, a dummy for first pregnancy, (birth of) multiples, infant's sex, whether the mother is married, or working, a dummy for regular fetal position and a dummy for general ward. The coefficient β captures the mean difference between the treatment and the control group conditional on observable characteristics.

In Section 3.2 we present graphical evidence that the onset of the war rather than the war as permanent condition constitutes the shock actually driving our results. Therefore, as a

[20]As explained in Section 3.1 we generally exclude miscarriages.

next step, we include a time trend and its interaction with the treatment dummy in our regression equation:

$$y_i = \alpha + \delta \texttt{war}_i + \lambda_0 \phi(\tilde{t_i}) + \lambda_1 \phi(\tilde{t_i}) * \texttt{war}_i + \kappa C_i + \pi_i + u_i \tag{2}$$

$\tilde{t_i}$ denotes the time trend centered around the onset of the war. In the reported regressions we use a quadratic time trend, such that $\lambda_0 \phi(\tilde{t_i}) = \lambda_{01} \tilde{t_i} + \lambda_{02} \tilde{t_i}^2$.[21] π_i captures seasonality effects. The coefficient δ captures the jump in mortality at the threshold.

As shown in Figures 5 to 8 the time trend of infant mortality differs between the prewar and the war period. We also saw some differences the composition of treatment and control group in terms of social groups and the war might also change the structural relationship between socio-economic class, observed characteristics and outcomes. For example the war might have increased the mortality risk disproportionally for working mothers. To answer the question, by how much the war increases mortality for those who actually give birth during the war, we additionally estimate an "Average Treatment Effect on the Treated" (ATET) using regression adjustment.[22] This approach is equivalent to estimating Equation 2 separately for the treatment and the control group and then taking the difference in predicted outcomes under both sets of estimated coefficients for the treatment group. The ATET is constructed as follows:

$$\gamma_{\texttt{war}}^{\texttt{ATET}} = (\hat{\theta_0}^{\texttt{war}} - \hat{\theta_0}^{\texttt{nowar}}) + \frac{1}{N^{\texttt{war}}} \sum_{\texttt{i in war}} X_i (\hat{\theta}^{\texttt{war}} - \hat{\theta}^{\texttt{nowar}}) \tag{3}$$

X_i denotes all controls and the time trend. $\hat{\theta}^{\texttt{war}}$ and $\hat{\theta}^{\texttt{nowar}}$ are the estimated coefficients from the prewar and the war regression. $\gamma_{\texttt{war}}^{\texttt{ATET}}$ measures the average difference between the predicted effect for the treatment group and the predicted treatment effect for the treatment group if the treatment group had given birth before the war.

[21] We also used a linear time trend and obtained similar results.

[22] For an explanation of regression adjustment see for example Uysal (2015).

5 Results

5.1 Effect of war on perinatal health

Table 3, 6 and 8 present the effect of war on three measures of perinatal health, *birth weight*, *asphyxia* and *infant maturity*. Panel A shows regression estimates using the full sample (i.e. all births excluding miscarriages), while Panel B restricts the sample to live births. Results in columns (1)-(4) are based on the entire observation period from 12/1937-9/1941, whereas columns (5)-(8) use only births likely to be conceived before the onset of WWII. We cluster all standard errors at birth level to adjust for twin births. ATETs estimated for the same outcome variables using regression adjustment are reported in separate tables below (see Tables 4, 7 and 9 respectively). For neither sample we find any effect of the onset of the war on birth weight. The estimated coefficients are small in size and insignificant in all but two specifications. This is in line with the descriptive analysis presented in Section 3.2 above. As intrauterine growth takes place during the whole

Table 3: Effect of war - Birth weight

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	-17.1	-21.3*	-19.8	-28.8	-21.5	-27.3*	-8.74	3.34
	(13.3)	(12.3)	(37.5)	(38.7)	(17.4)	(16.1)	(46.5)	(49.4)
Observations	8820	8361	8361	8361	5942	5624	5624	5624
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	4.98	-8.24	-3.28	-18.0	-7.40	-18.0	18.8	27.5
	(12.2)	(11.5)	(35.5)	(36.2)	(16.2)	(15.2)	(42.5)	(44.9)
Observations	8472	8069	8069	8069	5717	5433	5433	5433
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Controls include social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

Table 4: Effect of war - Birth weight - Regression adjustment

	All observations		Observations before 6/1940	
	(1) All births	(2) Live births	(3) All births	(4) Live births
ATET				
Born after 9/1939	-81.5	-43.4	-42.8	-25.9
	(149.4)	(142.4)	(60.5)	(58.1)
Observations	8361	8069	5624	5433

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender, dummy variables for regular fetal position and general ward and a quadratic time trend fitted on each side of the threshold separately.

Table 5: Effect of war by time of birth - Birth weight

Panel A	All observations		Live births	
Born 9-11/1339	10.9	-9.68	31.5	7.39
	(28.8)	(27.2)	(25.7)	(25.2)
Born 12/1939-2/1940	-30.2	-42.0*	-26.3	-40.9*
	(26.4)	(24.5)	(24.7)	(23.3)
Born 3-5/1940	-39.6	-32.2	-21.0	-18.9
	(26.4)	(23.0)	(24.5)	(21.8)
Born after 5/1940	-14.2	-16.1	13.2	-1.08
	(15.4)	(14.1)	(13.9)	(13.0)
Observations	8820	8361	8472	8069
Controls	No	Yes	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

course of pregnancy, the war might manifest itself in lower birth weight only with a delay rather than the day after the war started. Furthermore, if we view the onset of the war as a shock, the impact of this shock may be related to the stage of pregnancy at which it occurred. Therefore we split the treatment variable into four categories, depending on whether the onset of the war occurred during late pregnancy (infants born 9-11 1939), during middle pregnancy (infants born 12/1939-2/1940), during early pregnancy (infants born 3-5 1940) or before the pregnancy even started. Again our results do not provide evidence for an effect of the onset of WWII on birth weight (Table 5). In specifications with controls, we see a small significant decrease in birth weight in case of births for which the start of the war fell into the second trimester. However, the level of statistical significance is only at 10% and moreover, we cannot use a reliable measure of gestation in these regressions. Therefore, we are not confident to conclude that the shock provided by the onset of the war reduced birth weight for pregnancies affected in the second semester.

Asphyxia was only consistently recorded after November 1938. Therefore we use a

Table 6: Effect of war - Asphyxia

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.0028	0.0034	0.00064	-0.0061	-0.0018	-0.00089	0.012	0.0094
	(0.0039)	(0.0040)	(0.014)	(0.016)	(0.0044)	(0.0047)	(0.015)	(0.020)
Observations	6784	6440	6440	6440	3906	3703	3703	3703
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.0039	0.0045	0.000035	-0.0076	-0.00069	0.00040	0.0094	0.0080
	(0.0039)	(0.0041)	(0.014)	(0.016)	(0.0045)	(0.0047)	(0.015)	(0.019)
Observations	6495	6196	6196	6196	3740	3560	3560	3560
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Controls include social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

smaller sample when estimating the effects for asphyxia presented in Table 6. As in the case of birth weight we find a zero effect.

Table 7: Effect of war - Asphyxia - Regression adjustment

	All observations		Observations before 6/1940	
	(1) All births	(2) Live births	(3) All births	(4) Live births
ATET				
Born after 9/1939	0.072	0.045	0.015	0.0098
	(0.16)	(0.17)	(0.045)	(0.046)
Observations	6440	6196	3703	3560

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender, dummy variables for regular fetal position and general ward and a quadratic time trend fitted on each side of the threshold separately.

Results for infant maturity are mixed (see Table 8 and 9). There is no significant difference in conditional and unconditional means between the treatment and the control sample. However we find evidence of a drop in the proportion of mature infants at the onset of the war. This may be the result of a higher number of pre-term births during the first months of the war. The estimates for the ATET in Table 9 are larger than the estimated regression coefficients.

Table 8: Effect of war - Maturity

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.00044	-0.0047	-0.058***	-0.054**	0.00048	-0.0062	-0.061**	-0.044
	(0.0076)	(0.0075)	(0.021)	(0.022)	(0.0098)	(0.0097)	(0.025)	(0.027)
Observations	8814	8350	8350	8350	5937	5614	5614	5614
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.0075	-0.00017	-0.051**	-0.051**	0.0055	-0.0020	-0.053**	-0.039
	(0.0073)	(0.0073)	(0.021)	(0.021)	(0.0095)	(0.0095)	(0.024)	(0.025)
Observations	8463	8058	8058	8058	5709	5423	5423	5423
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Controls include social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

Table 9: Effect of war - Maturity - Regression adjustment

	All observations		Observations before 6/1940	
	(1) All births	(2) Live births	(3) All births	(4) Live births
ATET				
Born after 9/1939	-0.23**	-0.23***	-0.11***	-0.11***
	(0.090)	(0.087)	(0.035)	(0.034)
Observations	8350	8058	5614	5423

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender, dummy variables for regular fetal position and general ward and a quadratic time trend fitted on each side of the threshold separately.

5.2 Effect of war on perinatal mortality

We use the same specifications as in the previous subsection to estimate linear probability models for the effect of war on perinatal mortality. The results are presented in Table 10 and Table 11.

Table 10: Effect of war - Mortality

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.025***	0.025***	0.047***	0.048***	0.035***	0.038***	0.035*	0.031
	(0.0053)	(0.0052)	(0.016)	(0.016)	(0.0075)	(0.0073)	(0.020)	(0.021)
Observations	8828	8363	8363	8363	5950	5626	5626	5626
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.016***	0.016***	0.040***	0.040***	0.024***	0.026***	0.030**	0.026**
	(0.0035)	(0.0036)	(0.0099)	(0.010)	(0.0053)	(0.0055)	(0.012)	(0.012)
Observations	8477	8071	8071	8071	5722	5435	5435	5435
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Controls include social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

Table 11: Effect of war - Mortality - Regression adjustment

	All observations		Observations before 6/1940	
	(1) All births	(2) Live births	(3) All births	(4) Live births
ATET				
Born after 9/1939	0.049	0.086***	0.040*	0.053***
	(0.057)	(0.033)	(0.023)	(0.013)
Observations	8363	8071	5626	5435

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender, dummy variables for regular fetal position and general ward and a quadratic time trend fitted on each side of the threshold separately.

Overall, perinatal infant mortality increases significantly after the onset of WWII. Panel A presents results when the sample is not restricted to live births. Deaths in Panel A of Table 10 are therefore made up of stillborn children as well live born children who die in hospital after birth. While 5% of births do not result in a living infant leaving the hospital in the pre-war sample, this number increases to 7.5% in the war sample. Once we do not compare mean differences but the jump at the threshold in Column (3) and Column (4), the effect becomes even stronger. If we restrict the sample and drop all births which took place after May 1940, we see a larger difference in the means but a smaller jump. The ATET is larger than the regression coefficients in size but only significant in the restricted sample.[23] Altogether these results support our interpretation that the onset of the war provided a shock which faded out gradually.

Effect of war by social class

We investigate, whether the effect of war on mortality is heterogeneous with respect to social class. Parental social status is highly predictive of future live outcomes. If the war affects the composition of the population through the channel of selected mortality, this will be reflected in the live outcome of affected cohorts. The results displayed in Table 12 are based on specifications, where we omit the overall war dummy. Instead we report the estimated coefficients of interaction terms between the war dummy and the class-indicator for all social classes.

The onset of the war has a non negative effect on mortality for all social groups. Higher professionals and managers - which constitute our highest social class - do suffer from the war, but also do lower skilled workers. There does not seem to be a gradient with respect to social class. Unskilled workers as well as Foremen & skilled workers appear to be most severely affected.

[23]The ATET contrasts predicted outcomes for the group of births that took place during the war with the hypothetical predicted outcomes based on estimated coefficients from the pre-war sample. We saw in Figure 9 that births in the first months of the war have a slightly lower predicted mortality risk than pre-war observations, while births later in the war do not. Since mortality rates are higher mainly at the beginning of the war, it is not surprising that we do not find an significant ATET for the whole sample.

Table 12: Effect of war by social class - Mortality

Panel A	All observations			Born before 6/1940		
	(1)	(2)	(3)	(4)	(5)	(6)
War * Higher managers & professionals	0.0096	0.019	0.042**	0.048*	0.046**	0.040
	(0.015)	(0.015)	(0.021)	(0.026)	(0.023)	(0.029)
War * Lower managers & professionals, cleric	0.032***	0.031***	0.053***	0.023	0.025*	0.019
	(0.012)	(0.011)	(0.018)	(0.015)	(0.014)	(0.024)
War * Foremen & skilled workers	0.027**	0.028***	0.051***	0.055***	0.056***	0.050**
	(0.011)	(0.010)	(0.018)	(0.017)	(0.015)	(0.024)
War * Farmers	0.060**	0.055**	0.077***	0.058*	0.052*	0.046
	(0.024)	(0.023)	(0.028)	(0.031)	(0.029)	(0.036)
War * Lower skilled workers	0.0060	-0.0048	0.018	0.0053	0.0031	-0.0031
	(0.014)	(0.013)	(0.020)	(0.019)	(0.018)	(0.026)
War * Unskilled workers	0.032***	0.029***	0.051***	0.045***	0.044***	0.038
	(0.011)	(0.010)	(0.019)	(0.016)	(0.015)	(0.025)
War * Farm workers	0.034	0.0075	0.031	0.058	0.051	0.046
	(0.039)	(0.036)	(0.039)	(0.068)	(0.064)	(0.067)
Observations	8500	8363	8363	5729	5626	5626
Panel B	Live births			Live births born before 6/1940		
War * Higher managers & professionals	0.0076	0.010	0.034**	0.018	0.018	0.018
	(0.011)	(0.013)	(0.016)	(0.018)	(0.018)	(0.020)
War * Lower managers & professionals, cleric	0.018**	0.018**	0.041***	0.017	0.018*	0.019
	(0.0082)	(0.0081)	(0.012)	(0.011)	(0.010)	(0.016)
War * Foremen & skilled workers	0.019**	0.022***	0.046***	0.037***	0.040***	0.040***
	(0.0074)	(0.0072)	(0.012)	(0.012)	(0.012)	(0.016)
War * Farmers	0.039**	0.031*	0.055***	0.031	0.018	0.018
	(0.016)	(0.016)	(0.018)	(0.021)	(0.017)	(0.020)
War * Lower skilled workers	0.0065	0.0055	0.029**	0.012	0.013	0.013
	(0.0091)	(0.0090)	(0.013)	(0.014)	(0.013)	(0.017)
War * Unskilled workers	0.014**	0.014**	0.038***	0.029**	0.029***	0.029**
	(0.0069)	(0.0068)	(0.012)	(0.011)	(0.011)	(0.015)
War * Farm workers	0.016	0.0093	0.034	0.052	0.046	0.048
	(0.025)	(0.023)	(0.026)	(0.059)	(0.053)	(0.055)
Observations	8164	8071	8071	5512	5435	5435
Controls	No	Yes	Yes	No	Yes	Yes
Trend	No	No	Yes	No	No	Yes
Seasonality	No	No	Yes	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

Effect of war by birth weight

Just like social class, birth weight is highly correlated with later life outcomes. If low birth weight infants are more likely to die as a consequence of the war, negative effects of war on later live outcomes will be underestimated in studies based on surviving individuals. To explore heterogeneity by birth weight, we split our sample at 2,000 grams, 2,500 grams

Table 13: Effect of war by birth weight - Mortality

Panel A	All observations			Born before 6/1940		
	(1)	(2)	(3)	(4)	(5)	(6)
War*Birth weight below 2000 grams	0.13**	0.14**	0.15**	0.18***	0.19***	0.18***
	(0.055)	(0.058)	(0.059)	(0.062)	(0.065)	(0.066)
War*Birth weight 2000-2499 grams	0.054	0.059	0.068*	0.049	0.054	0.043
	(0.036)	(0.036)	(0.038)	(0.048)	(0.048)	(0.051)
War*Birth weight 2500-3999 grams	0.039***	0.036***	0.046***	0.045***	0.046***	0.035
	(0.010)	(0.010)	(0.016)	(0.015)	(0.015)	(0.022)
War*Birth weight 3000 grams and above	0.0049	0.0087**	0.019	0.012**	0.017***	0.0065
	(0.0040)	(0.0040)	(0.013)	(0.0057)	(0.0058)	(0.017)
Observations	8820	8361	8361	5942	5624	5624
Panel B	Live births			Live births born before 6/1940		
War*Birth weight below 2000 grams	0.14*	0.15*	0.16**	0.25***	0.24***	0.24***
	(0.075)	(0.077)	(0.077)	(0.086)	(0.088)	(0.088)
War*Birth weight 2000-2499 grams	0.022	0.025	0.041	0.050	0.045	0.048
	(0.028)	(0.028)	(0.029)	(0.041)	(0.041)	(0.040)
War*Birth weight 2500-3999 grams	0.022***	0.020***	0.036***	0.035***	0.034***	0.036***
	(0.0068)	(0.0069)	(0.010)	(0.011)	(0.011)	(0.013)
War*Birth weight 3000 grams and above	0.0083***	0.0088***	0.025***	0.0080***	0.0098***	0.012
	(0.0021)	(0.0023)	(0.0080)	(0.0030)	(0.0033)	(0.0096)
Observations	8472	8069	8069	5717	5433	5433
Controls	No	Yes	Yes	No	Yes	Yes
Trend	No	No	Yes	No	No	Yes
Seasonality	No	No	Yes	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

and 3,000 grams. Table 13 displays the estimated treatment effects for all four groups. We find a clear gradient with respect to birth weight in the effect of the war. In any of the specifications, the magnitude of the estimated coefficient of the interaction term between the war dummy and the birth weight-group dummy, the effect increases when birth weight decreases. However, as the number of low birth weight infants is relatively small, we lack the statistical power to detect a significant reduction in mortality for children whose birth weight is below the common low birth weight threshold at 2,500 grams but above 2,000 grams. For very low birth weight children with less than 2,000 grams at birth, the effect is largest. The probability to leave the hospital alive decreases by more than 10 percentage points.[24] Also children born between 2,500 and 3,000 grams are affected to a larger extent than the group of children above 3,000 grams.

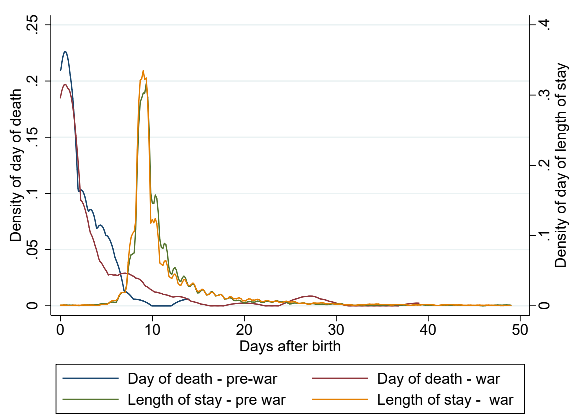
5.3 Robustness

Length of stay

While the conventional definition of neonatal mortality includes deaths up to 28 days after birth (WHO 2006), we only observe newborns until they leave the hospital. As long as the day of discharge and the treatment are independent, our definition of infant mortality will not pose a threat to identification. Figure 12 shows the distribution of the length of stay in hospital after birth and length of life in days for live born children separately for the pre-war and the war period.[25]

First we notice that there is hardly any difference in the distribution of the length of

Figure 12: Length of stay and day of death



Notes: Distribution of length of stay in hospital and length of life in days for live born children.

stay in hospital after birth in our treatment and control group. Most observations stay in hospital for around 9-10 days after birth and only 1.5% of live born children are discharged

[24]A surprisingly large number of infants below 2,000 grams survives. We checked the most extreme cases in the birth records carefully but found no sign of misreporting. In one case we found a letter stating that a child born at around 1,300 grams had left the hospital and was doing well.

[25]To facilitate legibility, we exclude a small number of observations who stayed in hospital for more than 50 days.

before completing the first week of life. Neonatal deaths on the other hand mostly occur within the first four days after birth. Since mothers received postnatal care in hospital, the death of an infant does not automatically lead to a discharge of the mother. As a robustness check we estimate the regression models used for analysis with a modified versions of infant mortality. We define an infant to have died if the death occurred either in the first 5 days (see Table 14) or the first 7 days (see Table 15) after birth. In these specifications we exclude all observations which left the hospital before that specific day. Although the coefficients become smaller in size, we still see a significant effect of the onset of the war on perinatal infant mortality.

Temperature

In the first two months of 1940, Munich was hit by a particularly low temperatures (Stadtarchiv München 1939-1940). To rule out, that the effect we measure is in fact a shock caused by low temperatures, we include the average monthly temperatures in Munich as additional control variables. The results are presented in Table 16. The estimated coefficients hardly change compared to the baseline estimates. This suggests that temperature does not confound our baseline estimates.

Structural break

In our empirical specification we estimate infant mortality as a function of maternal characteristics and time variables. In the regression adjustment we allow this function to differ between the pre-war and the war period. To investigate whether such a structural break actually took place in September 1939, we investigate whether allowing for a structural break in September 1939 leads to a better fit than allowing for a structural break in any other month. For each month between January 1938 and September 1941, we estimate Equation 1 (without the war dummy) separately to both sides of the respective month. We calculate the total residual sum of squares, that is the sum of residuals sum of squares

Table 14: Effect of war - Mortality - Death within 5 days

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.019***	0.019***	0.036**	0.036**	0.025***	0.026***	0.038*	0.033
	(0.0050)	(0.0050)	(0.015)	(0.015)	(0.0069)	(0.0067)	(0.020)	(0.021)
Observations	8762	8305	8305	8305	5907	5589	5589	5589
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.0085***	0.0086***	0.026***	0.024***	0.011**	0.012***	0.031***	0.024**
	(0.0031)	(0.0032)	(0.0090)	(0.0090)	(0.0043)	(0.0044)	(0.011)	(0.011)
Observations	8426	8023	8023	8023	5689	5404	5404	5404
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, parity, primipara, twinning status, infant's gender, marital status, a dummy for general ward and working status; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth. Only observations staying in the hospital at least five days.

Table 15: Effect of war - Mortality - Death within 7 days

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.020***	0.020***	0.039**	0.038**	0.028***	0.030***	0.034*	0.029
	(0.0050)	(0.0050)	(0.015)	(0.016)	(0.0070)	(0.0069)	(0.020)	(0.021)
Observations	8669	8219	8219	8219	5836	5523	5523	5523
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.0093***	0.0097***	0.029***	0.026***	0.014***	0.015***	0.029**	0.021*
	(0.0032)	(0.0033)	(0.0093)	(0.0094)	(0.0046)	(0.0047)	(0.011)	(0.012)
Observations	8343	7944	7944	7944	5625	5344	5344	5344
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, parity, primipara, twinning status, infant's gender, marital status, a dummy for general ward and working status; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth. Only cases staying in the hospital at least seven days.

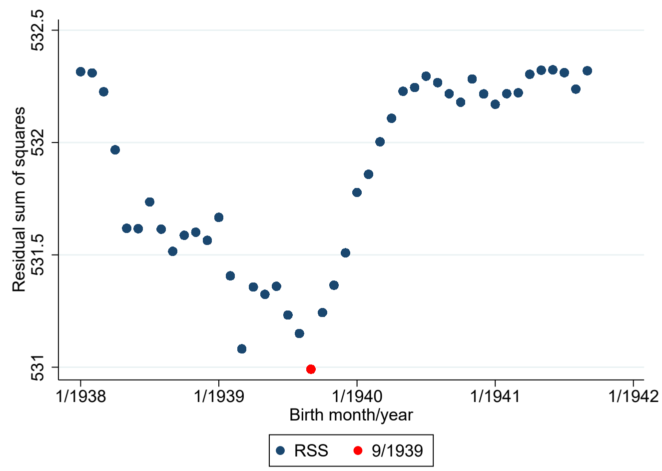
Table 16: Effect of war - Mortality - Robustness check: Monthly temperature

Panel A	All observations				Born before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.025***	0.025***	0.044***	0.047***	0.035***	0.038***	0.035*	0.031
	(0.0053)	(0.0052)	(0.016)	(0.016)	(0.0075)	(0.0075)	(0.020)	(0.021)
Observations	8828	8363	8363	8363	5950	5626	5626	5626
Panel B	Only live births				Only live births born before 6/1940			
Birth after 9/1939	0.016***	0.016***	0.038***	0.040***	0.024***	0.026***	0.030**	0.026**
	(0.0035)	(0.0036)	(0.010)	(0.010)	(0.0053)	(0.0056)	(0.012)	(0.012)
Observations	8477	8071	8071	8071	5722	5435	5435	5435
Temperature	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position, general ward and the average temperature in Munich for the current month; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

of models from either side of the threshold. If no structural break occurred during our period of observation, the total residual sum of squares would not exhibit any systematic pattern (Hansen 2001). However, Figure 13 depicts a clear trend. The residual sum of squares decreases when shifting the separating month from January 1938 to September 1939 to reach a minimum in September 1939. When shifting the separating month further into the war period, the residual sum of squares increases again. This indicates that the begin of WWII indeed marked a breakpoint, changing the relationship between maternal characteristics and infant mortality.

Figure 13: Structural break analysis - Mortality



Notes: Residual sum of squares for infant mortality. We estimate the regression model $\texttt{Death}_i = \texttt{Controls}_i\beta + \epsilon_i$ separately for all births prior to month m and births in month m or later. m is shifted from January 1938 to September 1941. RSS denotes the combined sum of residual sum of squares.

5.4 Mechanisms

In our setting, we can rule out direct effects of the war like hunger, bombing or displacement.[26] Furthermore, archival records of the hospital do not indicate any problems with the catering of patients or any shortage of fuel or pharmaceuticals. To explain the increase in perinatal mortality, we focus on two potential channels already present in fall of 1939 - maternal stress and a decline in the quality of medical care.

First, for the local population the onset of the war came along with changes in the daily routine: the economy was transformed into a planned war-time economy and and conscription took a large number of men away from their families. All these factors are likely to contribute to a feeling of uncertainty and to elevate stress levels among pregnant women. Uncertainty and maternal stress during pregnancy have been shown to affect a newborn's health negatively in the short-run (see Bozzoli and Quintana-Domeque 2014; Carlson 2015; Currie and Rossin-Slater 2013), and might also drive mortality in our setting.

Second, the onset of the war did not only put a strain on individuals, but the conscription

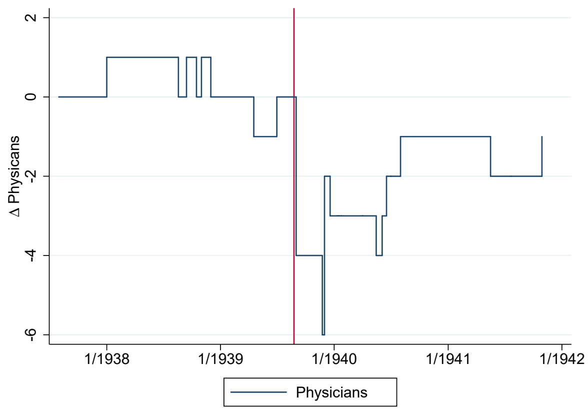
[26] The severe food crisis only started towards the end of WWII and there was not yet any military action in Munich (see Section 2.1).

of experienced physicians led to staff shortage in the hospital. This phenomena was not restricted to the hospital *Frauenklinik Maistrasse*, but shared by family practices and hospitals in Munich and elsewhere (Christians 2013, p. 243; Miller 1964, p. 29; Eckart et al. n.d., pp. 26, 868; Boberach 1984). To our knowledge, all physicians working at the hospital *Frauenklinik Maistrasse* in August 1939 were male and therefore potentially liable to military duty. In frequent letters to the state administration, the director of the hospital raised alarm. He warned that, the hospital routine threatened to break down and proper patient care was in jeopardy. To aggravate the situation, conscription foremost targeted experienced doctors. Local hospitals were supposed to fill vacant positions temporarily with inexperienced graduates and - often unpaid - trainees. Fierce competition among local hospitals about these replacements, led to a high turnover in staff. Especially when the first physicians left in 1939, it came as an unexpected shock for the hospital, while it could prepare for further drafts. On the other hand, there is no indication for a shortage of midwives or nurses in letters or archival records.[27]

While clinical records and a large number of letters and official documents have been preserved in the hospital or state archives, staff records have not. Therefore it is impossible for us to reconstruct the in- and outflow of physicians exactly. To give an approximate picture of the staff situation over time, we combine information from letters and documents found across various hospital, university and state archives. These documents typically do not mention the overall number of physicians, but tell the date of conscription. Figure 14 shows our reconstructed timeline of how the number of physicians evolves over time. We normalize the stock of doctors at the beginning of the war to zero. Right after the onset of, the number of physicians drops by four. After several weeks, the hospital is able to find replacements and the number of physicians increases again. After mid 1941 the number of physicians working at the hospital falls below the number of physicians in 1939 by one or two. As replacements were typically less experienced than the actual physicians, these

[27]In the hospital nursing care was exclusively provided by nuns.

Figure 14: Staff changes in hospital



Notes: Number of physicians from December 1937 to September 1941 normalized to zero at the onset of the war. In- and outflows are reconstructed from letters between the hospital administration and several official government bodies archived at the Archives of the LMU and the Archives of the Bavarian State.

numbers do not necessarily reflect the quality of medical care.

We cannot fully quantify these mechanisms. However, in the following we argue that our results are mainly driven by a decline in medical quality. We show that the mortality effect is stronger, where medical quality should matter and furthermore we document a change in provision of certain medical procedures.

Unlike birth weight which is measured at birth and miscarriage, survival of life born children is partly under the control of the medical personnel. If live born children are disproportionally affected by the war, this will hint to a decline in medical care. Maternal stress on the other hand should lead to an increase in stillbirths and miscarriages. Panel B of Table 10 conducts the regression analysis for the sample of live born children. Given the low baseline mortality of live born children before the war of 1.8 % the effect of the war is surprisingly large. Between 9/1939 and 5/1940 the mortality of live born children almost doubles compared to the prewar period. Again we find that the jump around the threshold is larger than the differences in means.

The proportion of stillborn children also increases after the onset of WWII (see Panel A of Table 17). However, the effect is less than the increase in mortality of live born children and not robust to the inclusion of a time trend and seasonality effects. Therefore our overall effects seem to be driven by children who die in hospital after birth. While we did exclude miscarriages from the main analysis, we estimate the effect of war on the probability of miscarriage in Panel B of Table 17. We do not find any evidence that the onset of WWII lead to an increased number of miscarriages. A shortage of physicians is

Table 17: Effect of war - Mortality - Non-livebirths

Panel A: Stillbirth	Births				Births before 6/1940			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Birth after 9/1939	0.0098**	0.013***	0.012	0.012	0.012**	0.015***	0.014	0.013
	(0.0042)	(0.0043)	(0.014)	(0.014)	(0.0057)	(0.0058)	(0.018)	(0.019)
Observations	8828	8499	8499	8499	5950	5728	5728	5728
Panel B: Miscarriage	All observations				Observations before 6/1940			
Birth after 9/1939	0.0074	0.0036	-0.018	-0.023	-0.015*	-0.015*	0.018	0.013
	(0.0065)	(0.0066)	(0.021)	(0.021)	(0.0081)	(0.0081)	(0.025)	(0.027)
Observations	10022	9617	9617	9617	6689	6416	6416	6416
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Trend	No	No	Yes	Yes	No	No	Yes	Yes
Seasonality	No	No	No	Yes	No	No	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the following controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status and a dummy variable for general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by a set of month dummies.

likely to shift work from physicians to female midwives. Whereas midwives are able to supervise normal deliveries, only physicians can carry out surgeries like caesarean sections. We test whether women who should receive a caesarean section by modern standards are less likely to receive a caesarean section during the first months of the war. We construct a measure of whether a women has an indication for caesarean section based on a guideline described in Mylonas and Friese (2015).[28] As shown in columns (1)-(2) of Table 18, the proportion of women with an indication for caesarean section does not change with the onset of the war. However, women with an indication are less likely to actually have a section performed. Instead we see the performance of another procedure. Symphysiotomy

[28]We assume a women to have an indication if one of the following conditions is present: Non regular fetal position, eclampsia, placenta previa, disproportion of pelvis and child, uterine rupture. We do not include the condition umbilical cord prolapse, since none of the cases with umbilical cord prolapse is treated with caesarean section in our sample.

is an operation to widen the pelvis that can be carried out by non-specialist doctors and experienced midwives (see Monjok et al. 2012). It was frequently used in the 19th century, when caesarean section was a high risk for mothers. Due to negative consequences for maternal health today's WHO guidelines recommend the use of symphysiotomy only, when safe caesarean section is not available (WHO 2003). This result shows that the hospital replaced procedures in need of an experienced surgeon by simpler procedures. We also investigate how the use of medical procedures changes in less severe cases. We look at episiotomy, a simple procedure to prevent perineal tear. While perineal tear can be painful for the mother, it is not a live threatening condition. Columns (7)-(8) of Table 18 show a small decrease in the use of this procedure, but this is not reflected in a higher incidence of perineal tear.

Table 18: Effect of war - Medical procedures - Births before 6/1940

	Indication		Caesarean sectio		Symphysiotomy		Episiotomy		Perineal tear	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Birth after 9/1939	-0.00044	-0.013	0.00021	0.017*	-0.0014**	0.0093	-0.0054	-0.031**	-0.0096	-0.014
	(0.0040)	(0.013)	(0.0013)	(0.0090)	(0.00066)	(0.0075)	(0.0042)	(0.015)	(0.0088)	(0.025)
Indication for caesarean			0.22***	0.22***	0.093***	0.093***				
			(0.041)	(0.041)	(0.029)	(0.029)				
War * Indication			-0.046*	-0.046*	0.045*	0.044*				
			(0.028)	(0.028)	(0.024)	(0.024)				
Observations	5626	5626	5626	5626	5626	5626	5626	5626	5626	5626
Trend + Seasonality	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes

Notes: (Clustered) Standard errors in parentheses; Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; All regressions include the follwing controls: Social status, mother's age, marital status, working status, parity, primipara, twinning status, infant's gender and dummy variables for regular fetal position and general ward; Trend denotes a quadratic time trend fitted on each side of the threshold separately; Seasonality is captured by quarter of birth.

6 Conclusion

In this work, we investigate the effects of the onset of WWII on health at birth and perinatal mortality. We use a unique data set of historical birth records from Munich's largest birth hospital covering the period 1937-1941. Exploiting the onset of WWII as natural experiment, we show that the onset of the war had no effect on health at birth measured by birth weight, maturity and asphyxia. However, we document an increase in perinatal mortality. This effect is strongest at the beginning of the war and fades out gradually. Additional analyzes reveal that perinatal mortality increases after the begin of the war for all social classes and especially for newborns below 2000 grams.

Since the data cover only the onset of WWII, we can rule out direct effects of the war, like hunger, bombings or flight in our setting. We discuss two potential mechanisms to explain the increase in mortality. On the one hand increased uncertainty and conscription of husbands are likely to increase stress levels of pregnant women and may therefore lead to this mortality increase. On the other hand according to letters from the head physician the conscription of experienced physicians led to severe staff shortage and later to a decrease in the quality of medical care due to the replacement with untrained medical students. To evaluate the importance of each mechanism we investigated whether war affected the proportion of women with an indication for a caesarean section, which was not the case. However women with an indication, are less likely to actually have a section performed. Instead the probability of other less complicated birth procedures increases which can be performed by auxiliary medical staff, but which are less safe. In combination all these results point to the deterioration of the quality of medical inputs (i.e. doctors) as the main driver of our results.

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Appendix

A Birth records

Almost all birth records since the foundation of the hospital in 1884 have been preserved. Birth records span around four to eight pages and generally contain background information on the mother, information on the pregnancy, medical examinations, a labour protocol including detailed notes, characteristics of the newborn child and observations during childbed. A compressed version of the birth records is provided by two series of journals, called birth journals and main journals. Birth journals have been filled in by midwives shortly after childbirth. Main journals make a more official appearance, suggesting that they were kept by a hospital clerk. Both journals contain the birth number, name, age and parity of the mother, the date of birth, sex, length and weight of the child, and short notes on medical issues. Main journals additionally give the date of discharge and the fetal position. Birth journals include information on the socio-economic status, mostly in form of the occupation of either the father or the mother. Main journals are only available for the common section. We digitized the information contained in the main journal and birth journals for a period starting in November 1937 and ending in October 1941. Since main journals do not exist for the private section, the date of discharge and the fetal position were added from the birth records. Apart from birth records, parts of the correspondence of the management of the hospital have been preserved in archives and the hospital itself. We use this material to corroborate our findings with qualitative evidence.

B HISCO-HISCLASS

As mentioned in the main text the birth journals - both from the general and private ward - contain parental status and/or occupation. This allows us to derive a measure of social classes which will be explained in this section. These specific occupations were originally recorded by hospital personnel with additional (grand-)parental socio-economic information in the medical files to ensure Aryan ancestry and the patient's health insurance among other things.[29] If fatherhood is known and stated in the medical files, usually the (civil) profession of the child's father (e.g. grocer, in German "Krämer") or her relation to him (e.g. grocer's wife, in German "Krämersfrau") was registered in the birth journals.[30]
In a first step we standardized the spelling of the occupations (to the male form) and separated non-occupational information. In the following step we assigned a numerical 5-digit code according to the "Historical International Classification of Occupations" (HISCO) which was developed by Van Leeuwen et al. (2002) and is provided as an online database

[29]Due to data privacy regulations we were not able to use this valuable information.

[30]In very rare cases the relation of the pregnant woman to her father's occupation (e.g. grocer's daughter in German "Krämerstochter") was entered if she was too young to have a own job and most likely unwed. In other cases the female notation of an occupation was recorded (e.g. in German "Krämerin"). This is a sign that the pregnant woman is unwed, but in some cases it might just indicate her job. For some observations more and/or other non-occupational information is recorded, e.g. "unwed", "student" or "housewife". If just "housewife" was recorded, a cross-check with the medical files most often revealed the relevant occupation.

called "History Of Work Information System".[31] HISCO combines information on occupational tasks and duties and forms a system of 1675 historical and international comparable occupations. It was developed upon ILO's modern-day "International Classification of Occupations"' from 1968 (ISCO68) and adjusted with 18th-20th century occupations from several countries in Europe and America. HISCO's hierarchical structure - similar to ISCO68 - into 9 major groups, 76 minor groups, 296 unit groups and finally 1675 occupations has descriptions for each level and therefore allows comparisons to modern-day occupational groups and professions as well. HISCO has three additional variables (Status, Relation, Product) from which the variable "Status" is the most important one. It contains information about supervisory tasks and skill levels within an occupation (e.g. master backer, journeyman baker, apprentice baker, baker's helper) which would otherwise be lost because HISCO codes only incorporate the raw definition of an occupation (e.g. baker).
In a last step we translated the HISCO into HISCLASS codes, the measure of social status which we will later use in our empirical analysis.[32] The Historical International Social Class Scheme (HISCLASS) invented and explained by Van Leeuwen and Maas (2011) builds upon HISCO, assigns each occupational code one out of 12 social classes, and defines a social class as "a set of individuals with the same life chances" (Van Leeuwen and Maas 2011, p.18). These social classes are derived in the following step-wise procedure: First Van Leeuwen and Maas (2011) identified (1)"type of work" (manual vs. non-manual), (2) "skill level" (4 levels), (3) "supervisory tasks" (yes vs. no) and (4) economic sector (primary vs. other sectors) as the four relevant dimensions of social class through an intensive literature review of existing historical class/status schemes. Second they used the American Dictionary of Occupational Titles (DOT) to grade the 1675 HISCO occupations along these dimensions. Third if there is additional information over and above the simple occupation name (e.g. baker) in the "Status" variable mentioned before (e.g. master, apprentice, helper, etc.) this is taken into account by promoting or demoting individuals into a higher/lower social class respectively. Since the DOT was constructed for modern-day occupations these grades were adjusted with help of expert historians which was only necessary in a few cases and finally led to 12 distinct social classes. In our empirical analysis we rely on the previous literature and use a compressed 7-class version of HISCLASS (see Abramitzky et al. (2011) and Schumacher and Lorenzetti (2005) and references therein). This simplifies the interpretation of regression coefficients, attenuates possible coding errors and increases sample size within classes. Table A.1 in the appendix shows the original and compressed HISCLASS versions along with the underlying dimensions of social class and the number of observations in each class.
To adjust HISCO/HISCLASS to the specific Bavarian background and our data set sometimes we had to refine or deviate from the suggested coding procedure by Van Leeuwen and Maas (2011) and Van Leeuwen et al. (2002). First and foremost we had to rely on the occupational information about the child's father/ pregnant woman's husband in most

[31] http://historyofwork.iisg.nl

[32] For the actual translation we relied on a SPSS program provided in the "History Of Work Information System" database (http://historyofwork.iisg.nl/docs/hisco_hisclass12_book@_numerical.inc) which we corrected and translated into a Stata. A commented do-file is available on request from the authors.

cases, because either the pregnant women were not working at all or their own job was not recorded in the birth journals. This is in contrast to Van Leeuwen and Maas (2011) who don't assign a HISCLASS code to them at all. Nevertheless we are confident that this measure captures the relevant social class of a family since - as mentioned in Section 2.1 - Nazi-propaganda promoted housewife-dom and the husband was the head of the most households. Secondly due to the fact that Munich is a state capital, there are a lot of public sector occupations which were strictly hierarchically ranked according to the "Führerprinzip" and comparable to military ranks.[33] This allowed us to use equivalent HISCLASS codes of military ranks as a benchmark for police, postal, railway, educational and other governmental HISCO codes and adjust the previously assigned HISCLASS codes if there were large discrepancies.

[33] In English: "leader principle" (see Frei 2013)

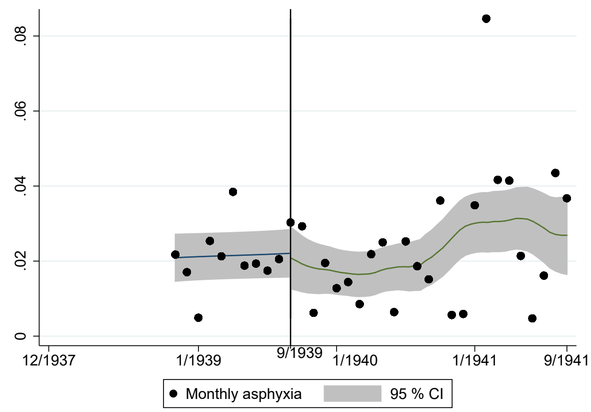
Table A.1: Original and compressed HISCLASS

HISCLASS				Dimensions of social class				# of obs. in data set
Original classification		Compressed classification		Type of work	Skill level	Supervisory tasks	Economic sector	
Nr	Name	Nr	Name					
1	Higher managers	1	Higher managers & professionals	non-manual	high	yes	mainly other	292
2	Higher professionals					no		397
3	Lower managers	2	Lower managers clerical and professionals, clerical and sales		medium	yes		554
4	Lower professionals and clerical and sales personnel					no		507
5	Lower clerical and sales personnel				low			968
6	Foremen	3	Skilled workers	manual	medium	yes		222
7	Medium skilled workers					no		2,014
8	Farmers and fishermen	4	Farmers and fishermen				primary	664
9	Lower skilled workers	5	Lower-skilled workers		low		other	1,343
10	Lower skilled farm workers	6	Farm workers				primary	118
11	Unskilled workers	7	Unskilled workers		unskilled		other	2,719
12	Unskilled farm workers	6	Farm workers				primary	115

Source: In style of Schumacher and Lorenzetti (2005) and Van Leeuwen and Maas (2011) **Notes:** Other economic sector refers to the industrial or service sector. Classes 1 and 3 of the original HISCLASS system contain only 3 occupations which are in the primary sector.

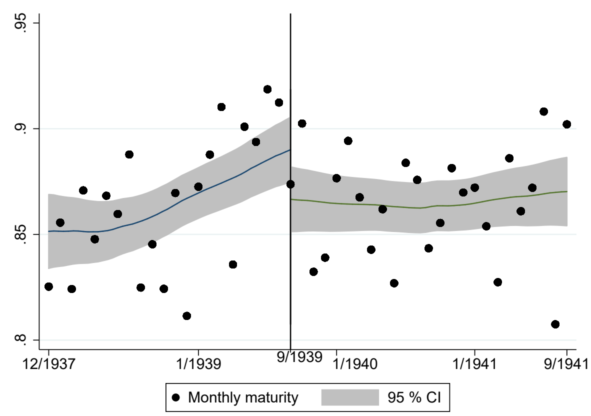
C Additional Figures and Tables

Figure A.1: Raw asphyxia rates by month of birth



Notes: Asphyxia rates (monthly averaged) and local linear regressions with a ROT bandwidth and an Epanechnikov kernel separately for the pre-war and the war period.

Figure A.2: Raw average maturity by month of birth



Notes: Maturity (monthly averaged) and local linear regressions with a ROT bandwidth and an Epanechnikov kernel separately for the pre-war and the war period.

Table A.2: Livebirths 1938-1940

	Hospital	Munich	Bavaria
1938	2171	12164	168391
1939	2297	13028	179129
1940	2269	13741	174311

Source: Bayerisches Statistisches Landesamt (1937-1942)

Table A.3: Descriptive statistics - Miscarriages

General characteristics	N	Mean	SD	Min	Max
Birth after 9/1939	1194	0.560	0.497	0	1
General ward	1194	0.956	0.204	0	1
Mother	N	Mean	SD	Min	Max
Age of mother	1194	29.775	6.364	14	48
Parity	1184	2.994	2.308	1	18
Status is wife	1194	0.680	0.467	0	1
Status is own job	1194	0.270	0.444	0	1
Status is single, divorced or widowed	1194	0.033	0.178	0	1
Social status	N	Mean	SD	Min	Max
Higher managers & professionals	1125	0.063	0.243	0	1
Lower managers & professionals, cleric	1125	0.276	0.447	0	1
Foremen & skilled workers	1125	0.238	0.426	0	1
Farmers	1125	0.028	0.166	0	1
Lower skilled workers	1125	0.156	0.363	0	1
Unskilled workers	1125	0.228	0.419	0	1
Farm workers	1125	0.012	0.107	0	1
Infant	N	Mean	SD	Min	Max
Male	174	0.667	0.473	0	1
Birth weight	146	389.322	272.975	20	1870
Length of infant	178	24.458	8.197	9	90
No. of infants	1194	1.020	0.140	1	2

Notes: Descriptive statistics of miscarriages.

Table A.4: Mean comparison - Miscarriages

General characteristics	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
General ward	0.950	0.961	0.0107	0.012	0.371	525	669
Mother	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Age of mother	29.667	29.859	0.1928	0.371	0.603	525	669
Parity	3.033	2.964	-0.0689	0.135	0.611	518	666
Status is wife	0.632	0.717	0.0851**	0.027	0.002	525	669
Status is own job	0.310	0.238	-0.0728**	0.026	0.005	525	669
Status is single, divorced or widowed	0.036	0.030	-0.0063	0.010	0.544	525	669
Social status	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Higher managers & professionals	0.077	0.052	-0.0249	0.015	0.089	493	632
Lower managers & professionals, cleric	0.252	0.294	0.0428	0.027	0.111	493	632
Foremen & skilled workers	0.209	0.261	0.0522*	0.026	0.042	493	632
Farmers	0.037	0.022	-0.0144	0.010	0.151	493	632
Lower skilled workers	0.152	0.158	0.0061	0.022	0.780	493	632
Unskilled workers	0.260	0.203	-0.0571*	0.025	0.023	493	632
Farm workers	0.014	0.009	-0.0047	0.006	0.464	493	632
Infant	Mean before war	Mean after war	Diff	SD	p	N before war	N after war
Male	0.609	0.724	0.1149	0.071	0.109	87	87
Birth weight	392.877	385.767	-7.1096	45.336	0.876	73	73
Length of infant	24.333	24.585	0.2519	1.232	0.838	90	88
No. of infants	1.019	1.021	0.0019	0.008	0.819	525	669

Notes: T-tests on the equality of means by war. Only miscarriages. Significance levels: ***p < 0.01, ** p < 0.05, and * p < 0.1.