The Social Gradient in the Impact of the Chernobyl Accident: The Case of Austria*

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1 Introduction

The importance of early-life conditions for outcomes in later life is now widely recognized among scholars in different disciplines. Economists are particularly interested in the effect of early events on the accumulation of human capital (Almond and Currie, 2011). However, several factors complicate the isolation of causal effects in this context. Ideally, one would observe a link between an early exogenous shock and later outcomes in a large-scale micro data set. For instance, Almond, Edlund and Palme (2009) interpret the radioactive fallout from the Chernobyl accident in 1986 as an early shock to study the role of latent variables in human capital formation. They find that Swedish children in low-educated families born in fall 1986 that where prenatally exposed to radioactive fallout had significantly lower grades in compulsory school at the age of 16. In contrast, for children in highly-educated families no comparable effect is observable. For neither group they detect any corresponding health damage. These estimates are identified by the difference in rainfall levels while the radioactive plume was over Sweden; which led to stark geographic variation in the levels of radioactive fallout.[1]

While this research design is in principle very appealing the estimated long-term effects are still hard to interpret. The estimated effects may not only entail the biological effect of the shock, but also the parental response to it. Parents may either make compensating or reinforcing investments in the child's human capital. In the presence of asymmetric parental investments along different dimensions of human capital, such reduced-form estimates cannot be even unambiguously interpreted as upper or lower bounds of the biological effect (Conti, Heckman, Yi and Zhang, 2011). Thus, in order to fully understand the effect of early-life conditions for outcomes in later life, it is crucial to examine also the parental responses. In the case of the social gradient in the impact of the Chernobyl accident it is possible that highly-educated parents had a larger compensatory (or smaller reinforcing) response compared to low-educated parents.

In this paper we study the short and long-run effects of the Chernobyl accident on the Austrian fall 1986 cohort with a special focus on the response behavior of treated parents.[2] We aim to contribute to a better understanding of the reduced form estimates of early childhood events on later outcomes, and to uncover the sources of social gradients in these effects. Therefore, we extend the research design of Almond, Edlund and Palme (2009) along several important dimensions.

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[1] Whether radioactive fallout from the Chernobyl accident in 1986 had detrimental effects on individuals living in Western European countries or not is still a controversial question. While this is an inherently medical question, the clean identification strategy of Almond, Edlund and Palme (2009) distinguishes this paper from earlier studies (summarized in Appendix A).

[2] Austria ranks among the countries that received the most radioactive fallout. Differences in rainfall immediately after the accident caused substantial geographic variation in ground deposition of Caesium-137 fallout (half-life of 30 years) with maximum values of nearly 200 kilobecquerels per square meter. Only Russia, Ukraine, Belarus and some parts of Scandinavia had fallout values higher than 200 kilobecquerels per square meter; see Figure 3.5. in IAEA (2006).

First, we pay special attention to the tension between so-called *culling* and *scarring* effects.[3] In particular, we provide empirical strategies to check whether radioactive exposure led to early (fetal) death, and whether these effects vary across low and highly-educated families. In the presence of culling, estimated effects (on the surviving population) may underestimate the true impact of the early shock. Second, we do not only consider prenatal radiation effects (i. e. the true causal effect of radioactive fallout), but we also aim to quantify non-radiation effects resulting from prenatal behavioral adjustment.[4] Potential parents in treated but also in control regions — both unaware of the actual local level of radioactive exposure — may have changed their behavior in response to the accident. This may generate a selected sample of children conceived and/or born, as well as directly affect live births of this cohort. Again, this early response may differ across educational groups. Third, we re-examine the impact of the radioactive exposure (and the accident more general) on children's health at birth and later in life. Fourth, we examine the postnatal responsive investment behavior of parents. Therefore, we match information on parents' parental leave behavior, on further fertility behavior and on labor market outcomes for the time span of over 25 years after the accident. This set of outcomes should be very informative about parents' compensating versus reinforcing investments in their children's human capital. Fifth, we estimate the effect of the early shock on labor market outcomes of the treated cohort; who arrived by now on the labor market. This reveals the impact of the accident (sum of biological effect and parental response) on the productivity of treated children across socio-economic backgrounds. Finally, we carry out an equivalent analysis for siblings of the fall 1986 cohort. Any difference between siblings of treated and control children allow further inference on parents response behavior.

We find that *in utero* exposure to radiation levels (commonly considered harmless) increased the incidence of early fetal death. This culling was more pronounced among low-educated families and also for boys (i. e. we find a significant effect on the sex-ratio). As a consequence, the surviving population exhibits better health outcomes at birth and has a lower likelihood of infant mortality. There is also evidence for prenatal non-radiation effects; highly-educated mothers (in treated and control regions) adjusted their behavior in a way that further distorted the sex-ratio and resulted in a lower weight at birth. We find evidence consistent with negative scarring effects of radiation. In particular we find that mothers of treated children have less post-treatment fertility and reduce their labor supply. Both effects indicate that affected children needed more attention, and parents responded with compensating investment. Especially intriguing is the fact that

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[3] See Bozzoli *et al.* (2009) for a simple model of culling (selection) and scarring.

[4] The identification of the radiation effects relies on random variation in the exposure to radioactive fallout (over time and) between municipalities due to geographic differences in precipitation after the accident. The identification of non-radiation effects rest upon the assumption that behavioral adjustment did not vary with the exposure to radioactive fallout. While the former assumption seems in any case indisputable, the latter assumption can be justified by the fact that actual level of *local* radioactive fallout was verifiably not known at the time of the accident.

the labor supply effect kicks in only after school enrollment. This is consistent with reduced cognitive abilities of treated children and in line with the findings of Almond, Edlund and Palme (2009). This suggests that exposure to radiation entails a positive culling effect on physiological health, and negative scarring effects on cognitive abilities. Results on the labor market outcomes of treated children (and their siblings) are not available yet.

Our results (so far) show that there is a potential large social gradient in the short-run and long-run effects of early-life events that complicate the interpretation of reduced-form estimates. In the case of the Chernobyl accidents we observe three important sources of this social gradient. First, the early shock led to more pronounced culling among low-educated families; which results in unequally selected samples to study later outcomes. Second, (untreated) parents with low and high education processed the emerging uncertain health risk information differently. Third, we observe some differences in the responding investment behavior of parents (of surviving children) across different education groups.

Our findings have important ramifications for the economic literature interested in the effects of early events on the accumulation of human capital. For instance, consider the literature on environmental justice — studying the disproportionately high exposure of individuals with low income to environmental hazards and the resulting impact on their health and economic well-being. Our research design provides the unique opportunity to observe randomly assigned environmental hazards free of any Tiebout sorting on endogenous socio-economic characteristics.[5] Our findings of substantial treatment effect heterogeneity — where detrimental effects decline along the educational distribution — further suggest that in case of conventional environmental hazards (such as air pollution as a byproduct of its production of a marketable good) the average treatment effect on the treated should be higher than the average treatment effect. That means, even results from empirical papers that have a fully credible research design to identify the average treatment effect on the treated (as for instance, based on a difference-in-differences approach; see examples in Greenstone and Gayer (2009)) can not be generalized.

Our results also hold important implications for public policymakers. An informed discussion about the efficiency of nuclear power requires knowledge about the full cost of nuclear and radiation accidents. At least, after the accident in the Fukushima Daiichi Nuclear Power Plant in March 2011, there are serious doubts that even an advanced economy can master nuclear safety. The benefits of nuclear power due to comparable low emissions have to be contrasted not only with the private and social cost involved in the normal operation, but also with the expected total cost of a nuclear accident. Our estimation results provide evidence that accidents in nuclear power planets have large and

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[5] This literature typically faces the econometric challenge that exposure to environmental hazards is correlated with a host of confounding factors (Banzhaf and Walsh, 2008) that if unaccounted for lead to an upward bias in the estimates.

long-lasting negative externalities (due to radioactive fallout) even for individuals living about $1,000$ miles away; which even translate into reduced economic productivity and income many years after an accident.

The remainder of the paper is organized as follows. Section 2 describes the Chernobyl accident and the resulting radioactive contamination of the western part of the former Soviet Union and Europe. Section 3 presents our identification strategy, the data used, and the econometric specification. Section 4 discusses our findings. Finally, Section 5 concludes the paper.

2 Radioactive contamination of the environment due to the nuclear accident of Chernobyl

On April 26, 1986 at 1:23 A.M. an accident occurred during a systems test at the Chernobyl nuclear power plant in Ukraine (officially the Ukrainian Soviet Socialist Republic) that caused the worst nuclear power plant accident in history. An explosion and fire released large quantities of radioactive contamination into the atmosphere that was not stopped until May 6, 1986.[6] As a result a plume of highly radioactive fallout spread over an extensive geographical area and drifted in the following days over large parts of the western part of the former Soviet Union and Europe.[7] The radioactive particles were subsequently removed from the atmosphere solely due to gravitation (*dry deposition*) or by any form of precipitation (*wet deposition*). Given that wet disposition is by far a more efficient deposition mechanism (compared to dry deposition), the level of radioactive material deposited on soil and other surfaces (so-called *ground deposition*) was predominantly determined by the presence or absence of precipitation during the passage of the plume (Clark and Smith, 1988).

Radionuclides can enter the human body through inhalation, ingestion, and absorption through the skin. The IAEA (2006, Chapter 5) describes four main pathways by which humans were exposed to the radioactive material released by the accident: (i) external dose from cloud passage, (ii) internal dose from inhalation of the cloud and resuspended material, (iii) external dose from ground deposition, and (iv) internal dose from the consumption of contaminated food and water. The latter two exposure pathways are considered as the most important. That means, humans where exposed to high levels of

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[6] This incidence was not immediately announced by the authorities of the Soviet Union, but has been detected after radiation levels set off alarms at a nuclear power plant in Sweden located over one thousand kilometers away from the Chernobyl. The world learned officially about the accident (two days later) on April 28, 1986 through a 20 second announcement by the state television broadcaster in the Soviet Union.

[7] The following link provides a computerized graphic reconstruction of the path of the first 14 days of the radioactive plume, tracking the release of Caesium-137, created by the *Institut de Radioprotection et Sûreté Nucléaire*: `http://www.irsn.fr/FR/popup/Pages/tchernobyl_animation_nuage2.aspx`.

radiation if they were located in areas with high levels of ground deposition and/or if they consumed large quantities of contaminated food and water. While it is not observable who consumed large quantities of contaminated food and water, the external dose from ground deposition should be highly correlated with the local level of ground deposition at individuals' place of residence. From a researcher's point of view the Chernobyl disaster provides, therefore, an ideal natural experiment to study the effect of the exposure to radioactive ground deposition, since it seems save to assume that the spatial distribution of precipitation during the passage of the plume was random.

The implementation of this research design is facilitated by the wide availability of data on local levels of radioactive ground deposition. In the aftermath of the accident the level of ground deposition of Caesium-137 (henceforth ^{137}Cs) and other radionuclides was measured comprehensively on the soil surface in most European countries (European Commission, 1998). In the mapping of the deposition the focus was on ^{137}Cs, because it is easy to measure (*ex post*), and because of its radiological significance. It turned out that the three countries (based on current borders) most heavily affected are Belarus, the Russian Federation, and Ukraine. However, Austria, Sweden and Finland also contain some heavily contaminated areas (see, for instance, Figure 3.5. in IAEA (2006)).

3 Research design

In this section we first present the Austrian radiation data we use to distinguish between treated and control units. Then, we present the two most important innovations of our research. First, we highlight the crucial tension between culling and scarring effects that has to be considered in the interpretation of empirical estimates of the effect of the Chernobyl accident, in order *not* to underestimate the true impact. Second, we discuss the potential importance of non-radiation effects of the Chernobyl accident due to behavioral adjustment (of parents). Following that we provide details on the outcomes under consideration, and explain how we translate our research design into a regression framework.

3.1 Radiation data

In Austria radioactive fallout (due to Chernobyl) was measured at 1881 sites, which provides on average of one sample per 45 square kilometers (Bossew *et al.*, 1996, 2001). Radioactive fallout is measured as ground deposition of ^{137}Cs (half-life of 30 years) and ^{134}Cs (half-life of 2 years) in kilobecquerels (kBq) per square meter (m^2).[8] We focus on average level of ground deposition of ^{137}Cs and aggregate measurements to the community-level. This provides us with data for 925 (out of $2,357$) communities, where each data

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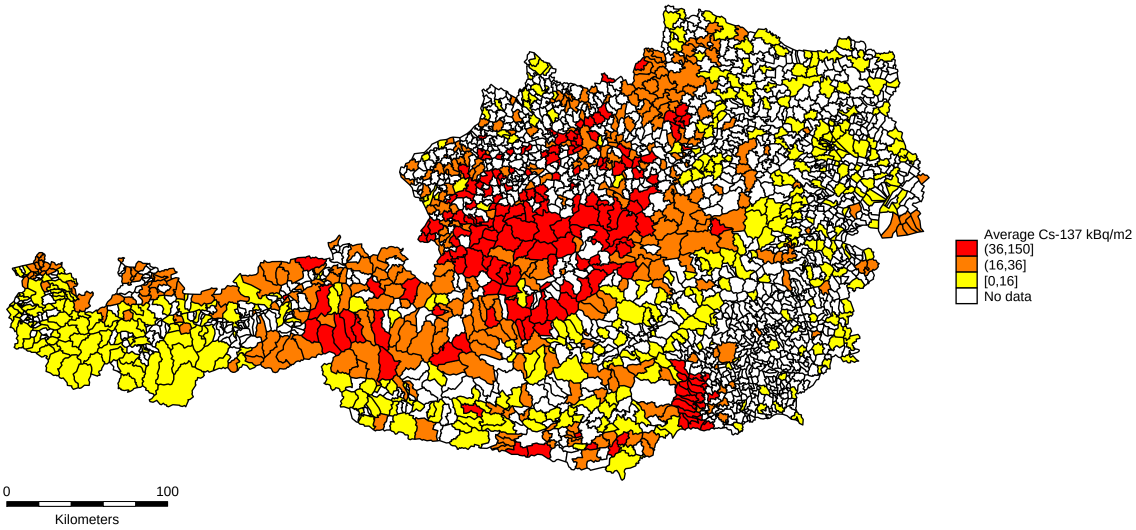
[8] Dose rate measurements of gamma radiation (in millisievert) immediately after the arrival of the radioactive cloud (based on 336 dose rate meters distributed over the territory of Austria) show a high correlation of dose rates with the deposition measurements of ^{137}Cs and ^{134}Cs.

point refers to May 1, 1986.[9]

Figure 1 depicts the spatial distribution of contamination, where we distinguish between communities with a ground deposition of ^{137}Cs below 17 kBq/m^2, between 17 and 36 kBq/m^2, above 36 kBq/m^2, and communities without data.

Figure 1: **Average Caesium-137 ground deposition in Austria on May 1, 1986**



UNSCEAR (2000) considers regions with 37 kBq/m^2 of ^{137}Cs ground deposition or more as contaminated. In Austria, the average level of contamination was around 23 kBq/m^2. Communities with the lowest level of contamination recorded only 0.7 kBq/m^2, while the most contaminated areas had values of about 150 kBq/m^2. It is this wide range of (within country) variation in radioactive fallout (which is the result of the very local presence or absence of precipitation during the passage of the plume) that makes the Austrian case so particularly well suited for studying the impact of the Chernobyl accident.

In order to define treated and control units, we distinguish between communities (and their residing population) who were exposed to different levels of radioactive fallout. We follow the criteria suggested by UNSCEAR (2000) and define the 175 communities in our sample with 37 kBq/m^2 of ^{137}Cs ground deposition or more as treatment group 1 ($T1$). We specify two further treatment groups with higher levels of contamination. To the 130 communities with 42 kBq/m^2 of ^{137}Cs ground deposition or more we refer as treatment group 2 ($T2$), and to the 93 communities with 47 kBq/m^2 of ^{137}Cs ground deposition or more we refer as treatment group 3 ($T3$). As a control group (C) we use (in each case) the 428 communities with 16 kBq/m^2 of ^{137}Cs ground deposition or less. Communities with medium levels of ^{137}Cs ground deposition (i. e. between 17 and 36/41/46 kBq/m^2)

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[9] Note, the accident happened on April 26, however, the radioactive plume arrived on April 29 in Austria.

are excluded from the analysis. Table 1 summarizes this grouping of communities.

Table 1: Definition of treatment and control groups

Group	Acronym	Average level of ^{137}Cs ground deposition (in kBq/m^2)	No. of communities	Mean ^{137}Cs
Control group	C	less than 17	428	9
Excluded[a]		between 17 and 36/41/46	322/367/404	26/27/29
Treatment group 1	$T1$	37 ore more	175	51
Treatment group 2	$T2$	42 ore more	130	56
Treatment group 3	$T3$	47 ore more	93	60

[a] The cutoff-value, number of communities and mean level of ^{137}Cs depend on the treatment group.

3.2 Estimation strategy

It is conjectured that radiation exposure is especially critical at a prenatal stage. While a human embryo or fetus is protected in the uterus, and the radiation exposure to a fetus should be lower than the dose to its mother, a embryo or fetus is particularly sensitive to ionizing radiation. The empirical evidence on the effects of prenatal exposure on child health is either based on case studies of children born to women who had been treated with high doses of medical radiation while pregnant (De Santis, Di Gianantonio, Straface, Cavaliere, Caruso, Schiavon, Berletti and Clementi, 2005) or on children who have been prenatally close to the hypocenter of the atomic bomb explosions in Hiroshima and Nagasaki (Otake and Schull, 1998; Yamazaki and Schull, 1990).

The possible effects of prenatal radiation exposure include immediate effects (such as fetal death or malformations) or increased risk for cancer later in life. The *Centers for Disease Control and Prevention (CDC)* concludes that gestational age and the radiation dose determine the non-cancer health effects, while the carcinogenic risks are assumed to be constant throughout the pregnancy. Radiation-induced non-cancer health effects are especially detrimental in the first weeks after conception, since an embryo is made up of only a few cells. A damage to one cell (the progenitor of many other cells) may cause the death of the embryo, and the blastocyst will fail to implant in the uterus. Non-cancer health risks are supposed to decrease with gestation length. Beyond about 26 weeks, the fetus is believed to be 'relatively radio-resistent' (i. e. equally sensitive to radiation as a newborn). Given this medical evidence we follow Almond *et al.* (2009) and focus on the impact of prenatal exposure to radiation. However, we do not restrict our sample to children of gestational age 8 to 25 weeks at the time of the accident, but include the entire fall 1986 birth cohort in our analysis.

3.2.1 Radiation & non-radiation effects

There are at least two channels through which the Chernobyl accident may have affected the fall 1986 birth cohort. First, there might be a true causal effect of exposure to radioactive fallout. Second, parents (and potential parents) may have changed their behavior due to the Chernobyl accident. We refer to the former as *radiation effects*, and to the latter as *non-radiation effects*.

A likely behavioral reaction may have been an adaption in fertility behavior. It is plausible that some potential parents decided, due to fear or anxiety after the accident, to postpone family formation by avoiding conception, or even by inducing an abortion. Most likely, already pregnant women where extremely stressed and anxious in the aftermath of the accident, which may had detrimental effects on the embryo or fetus. Experimental evidence from animal studies suggests a link between exogenous in-utero exposure to maternal stress (measured by cortisol levels) and poor offspring outcomes (Kaiser and Sachser, 2005). Aizer *et al.* (2009) show that exposure to elevated levels of the stress hormone cortisol in-utero negatively affects offspring educational attainment and the probability of a severe chronic health condition and verbal IQ at age 7. Currie and Rossin-Slater (2012) finds some evidence for complications of labor and delivery but no effect on birth weight and gestation.

In the case of radiation effects one would expect variation in the estimated effects according to the degree of exposure to radioactive fallout. In the case of non-radiation effects, it is *a priori* not clear whether the degree of behavioral adjustment should vary with exposure. However, given that individuals have not been aware of the local level of ground deposition a uniform response across regions can be expected.

3.2.2 Culling & scarring effects

Radioactive exposure and/or non-radiation effects experienced *in utero* may do more than 'scar' survivors. That means, Chernobyl may have also increased fetal mortality as well as early life mortality rates ('culling'). Survivors exposed to Chernobyl are thus a potentially selected sample, where selection is endogenous to the same adverse events as the scarring effect. This tension between culling and scarring effects has been long recognized in epidemiology. While the scale of the selective mortality is hard to assess we have a clear expectation for its direction. It seems plausible that mortality tends to eliminate those in poor health. In other words, survivors of Chernobyl should generally be positively selected. That means, for the interpretation of the estimated effects we have to keep in mind that negative scarring effects have to be sufficiently strong among the survivors to exceed the positive effect of culling. In order to understand the full impact of Chernobyl we do not only look at the outcomes (of the potentially selected sub-sample) of born children, but we also try to infer the effect on the incidence of conceptions, miscarriages, abortions, stillbirths, and live births.

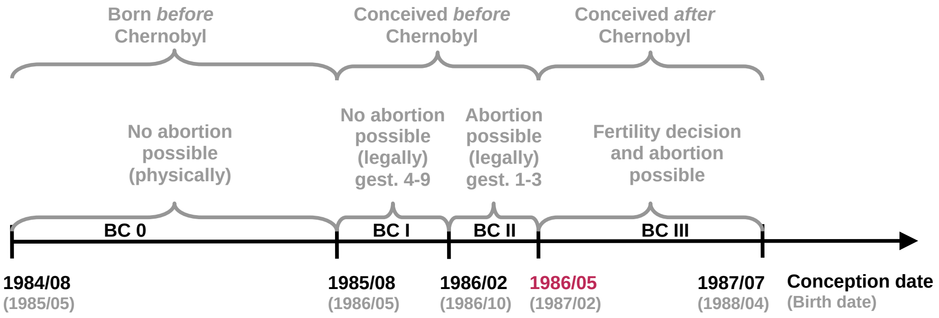
Clearly, we do not have information on the incidence of sexual intercourse and conceptions. We also do not observe the incidence of miscarriages (medically termed spontaneous abortion). Very early miscarriages (so-called early pregnancy losses) happen in many cases before a woman may know she is pregnant and, therefore, without clinical recognition. Later miscarriages, which occur after the sixth week since the woman's last menstrual period (so-called clinical spontaneous abortion) are unfortunately not universally documented in Austria. Still, miscarriages are a very common phenomena; the incidence of spontaneous abortion is widely believed to be 50 percent of all pregnancies. Unfortunately, we also do not have access to information on induced abortions. As in most countries, Austria begins its comprehensive documentation of fetal mortality with stillbirths. The definition of stillbirths (in particular, the differentiation to miscarriages) varies somewhat across countries. In Austria, a stillbirth is defined as birth of a child of at least 35 centimeter of length, without vital signs. Smaller fetus are categorized as miscarriages, and therefore, not universally documented. Finally, live births are very well documented in the *Austrian Birth Register* which comprises individual-level data on the parents and the new-born.

In order to infer on the effects of Chernobyl on miscarriages we offer different (complementary) strategies. First, we follow Sanders and Stoecker (2011) and use the sex-ratio of live (and still) births as a metric of fetal death. This methodology is based on an evolutionary theory advocated by Trivers and Willard (1973). The so-called *Trivers-Willard Hypothesis* states that the population sex-ratio responds to parental conditions. In order to maximize the reproductive success of the offspring mothers in good conditions are expected to have more sons, while mothers in poor conditions should have more daughters. This prediction can be rationalized by the assumption that the relationship between health and mating success is less pronounced for women (compared to men). Put differently, since males can in principle have children with multiple women, healthy males could secure several mates, while males in poor health secure none. In contrast, in the case of females, mating with healthy men is also possible for females in poor health.

The precise mechanism how mothers (or their reproductive system) favor either female or male offspring, depending on their condition, is still debated. As prenatal mechanisms, researchers discuss the prevention of the implantation of embryos of certain sex, or the increased likelihood of certain fetal loss. In any case, there exists robust empirical evidence (see, for instance, Almond and Edlund (2007); Catalano, Bruckner, Anderson and Gould (2005); Hansen, Møller and Olsen (1999)) that women in poor health (or under less favorable conditions) are more likely to have female offspring. In our empirical analysis we associate an increased probability of female births with an increase in miscarriages.

Second, we examine all conceptions between August 1, 1984 and July 31, 1987 and distinguish between four different birth cohorts, where some of them are by definition not affected by Chernobyl via conceptions and/or induced abortions. This is depicted by Figure 2. Birth cohort 0 (BC_0) includes all children who were conceived before August 1, 1985 and most likely born before the Chernobyl accident.In particular, we define birth cohort I (BC_I) as those children who were conceived between August 1, 1985 and January 31, 1986. These children have been *in utero* for more than 3 months at the time of the accident (second & third trimester), which ruled out the option of a induced abortion (except for health-related reasons). That means, BC_I can not be affected by a behavioral response (at the extensive margin) that works through an adapted fertility and/or induced abortion behavior. Children belonging to birth cohort II (BC_{II}) were conceived between February 1, 1986 and April 30, 1986. Since they have been *in utero* for less than 3 months at the time of the accident (first trimester) a behavioral response at the extensive margin via an induced abortion was possible. Children from birth cohort III (BC_{III}) were conceived between May 1, 1986 and July 31, 1987. For these birth cohort a behavioral response at the extensive margin via contraception and/or induced abortion was possible.

Figure 2: Cohorts



Naturally, we do not observe the exact day of conception in our data. Based on the stated gestation length measured in commenced weeks (gl) and the birth day (bd) we compute the conception day (cd) as follows $cd = bd - 7 * (gl - 0.5)$. That means, we assume that a pregnancy with a stated gestation length of 38 weeks has lasted 38.5 weeks or 269.5 days. We exclude conceptions 7 days before and after each cutoff date in order to minimize errors in group assignment.[10] Moreover, we exclude teenage and older mothers and focus on children born to mothers between the age of 20 and 40.

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[10] Since we classify individuals by conception date (which is measured with error) we can not preclude that, for instance, some children assigned to birth cohort 0 are born after the Chernobyl accident (those with 40 or more weeks of gestation). Excluding conceptions 7 days before and after each cutoff date should minimize this problem.

3.2.3 Outcome variables

The set of outcome variables covered in our estimation analysis allows us to comprehensively evaluate (the social gradient in) the impact of Chernobyl on the outcomes of children born in fall 1986. We examine (all available) health and human capital outcomes that allow us to infer on the effects of the accident at a prenatal stage, at birth, during adolescence, and early adulthood. Furthermore, we examine the postnatal investment behavior of parents (mothers). Therefore, we match data from five main sources of data: (i) The *Austrian Birth Register* includes the universe of all births in Austria with individual-level information on socioeconomic characteristics and birth outcomes. We use this data to quantify the (socioeconomic group-specific) incidence of live births on a community-level. On an individual-level we examine a set of health indicators including the child's sex, gestation length, birth weight and Apgar scores. (ii) Combining information from the *Austrian Death Register* allows us to estimate the incidence of stillbirths and infant mortality on the individual-level. (iii) For two Austrian states we have access to the databases of the respective statutory health insurance funds (that cover all private sector employees and their dependents) that allows us to quantify individual health care utilization during adolescence and early adulthood (age 12 to 22 for the cohort *in utero*). (iv) Data from the *Austrian Social Security Database* allows us to analyze human capital formation and labor market outcomes in early adulthood. In particular, we obtain individual-level information on employment, broad occupation, apprenticeship training, wages and sick leave.

3.2.4 Econometric specification

For all outcomes that are measured on an individual-level our research design translates into the following regression framework, which is performed for each definition of the treatment group $T\#$ ($T1$, $T2$ and $T3$):

$$\begin{aligned} Outcome_{i,c} = \beta_0 + \beta_1 BC_I + \beta_2 BC_{II} + \beta_3 BC_{III} + \beta_4 T\#_{i,c} \\ + \beta_5 BC_I \times T\#_{i,c} + \beta_6 BC_{II} \times T\#_{i,c} + \beta_7 BC_{III} \times T\#_{i,c} \\ + \mathbf{X}_{i,c} + \gamma_y + \delta_m + \theta_c + \epsilon_{i,c} \end{aligned} \quad (1)$$

In this equation i denotes individual and c denotes community. This *difference-in-differences* (DiD) estimation framework includes binary variables BC_I, BC_{II} and BC_{III} to distinguish between the three birth cohorts as defined above, a binary variable indicating the treatment status of each individual's community ($T\#_{i,c}$), and an interaction term between each birth cohort indicator and the treatment status variable. Further, we control for conception year fixed-effects (γ_y), conception month fixed-effects (δ_m) and community fixed-effects (θ_c).[11]

The parameters β_1, β_2, and β_3 give the estimated non-radiation effects for the three different birth cohorts, which differ in scope of potential behavioral adjustment. Therefore, β_1 gives the estimated non-radiation effects (for BC_I) that work through miscarriages. β_2 gives the estimated non-radiation effects (for BC_{II}) due to miscarriages and induced abortions, and β_3 gives the estimated non-radiation effects (for BC_{III}) due to miscarriages, induced abortions and conceptions. That means, if the non-radiation effects on miscarriages would be equal for BC_I and BC_{II}, then the difference between β_2 and β_1 would give us the abortion effect. Equivalently, if non-radiation effects on miscarriages and induced abortions would be equal for BC_{II} and BC_{III}, then the difference between β_3 and β_2 would give us the conception effect. Given that non-radiation effects are constant across treated and control communities, the parameters β_5, β_6, and β_7 provide the estimated radiation effects for the different birth cohorts.

For the outcome that is measured on a monthly community-level (i. e. live births) we drop the index i from the regression framework presented in equation (1).

4 Preliminary estimation results

Please note this section is not fully written up yet, and the estimations for some outcomes (see comments below) are still under progress.

4.1 Fertility and perinatal outcomes

4.1.1 Live births & fetal death

Table 3 summarizes the estimated effects on live births from monthly community-level regressions. We exploit the available information on mother's education to split the sample into children born to low educated mothers (with compulsory schooling or less) and children born to highly educated mothers (with an educational attainment higher than compulsory schooling). We do not find any statistically significant non-radiation effects. However, for BC_{II} (which were in the first trimester post conception at the time of the accident) we find a statistically significant negative radiation effect for low educated mothers. The effect amounts to 8.6 to 11.1 percent fewer live births in exposed communities and is significant for all three definitions of exposure to radiation (T_1 - T_3). If we further split the sample by sex of the child we find a negative (although less significant) effect for both sexes.[12] The radiation effect is smaller and less significant for children in the second

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[11] Note that the treatment indicator $T\#_{i,c}$ is dropped because of perfect collinearity with the community fixed-effects θ_c.

[12] These results are available upon request.

or third trimester post conception (BC_I) which is consistent with the existing evidence on the heterogenous impact of radioactive exposure over the gestation period (see above).

A reduced incidence of live births suggests strong culling. In other words, this would imply that either some children are stillbirths or that embryos and/or fetus die at an earlier stage (or both), and the surviving population is positively selected. Table 4 summarizes the estimated effects on stillbirths from individual-level regressions. We do not find any statistically significant effects, neither radiation nor non-radiation effects. This last result suggests that radioactive exposure should lead to a higher incidence of fetal death. While we can not directly observe early fetal death, we can use the sex-ratio as a proxy variable. As the results summarized in Table 5 show we indeed find a statistically significant negative effect on the sex-ratio in BC_{II}. Within the group of low educated mothers, exposure to radiation in the first trimester post conception leads to 4.2 to 8.8 percentage points fewer male births. The size and significance of the effect increases with the level of radiation. Following the literature and interpreting this as evidence for miscarriages, this finding is consistent with the negative effect on live births (and the zero effect on stillbirths).

These results further suggest that the relevant prenatal mechanism that distorts the sex-ratio is male fetal loss and not the prevention of the implantation of embryos of a certain sex. If male fetus (embryos) die at a very early stage – i. e. the mother's body already prevents the implantation of male embryos – then the male embryos can get replaced (without much time lag) by a female embryo at the next conception, and the sex-ratio may change with leaving the incidence of live births constant. However, if the sex-ratio gets distorted at a later stage via male fetal loss, the incidence of live births should decrease, as we observe.

In sum this set of results provides robust evidence that prenatal radiation exposure (of about ^{137}Cs ground deposition of 37 kBq/m^2 or higher) increases the likelihood of prenatal death, and supports existing medical literature. Our analysis reveals that male embryos and fetus are more vulnerable to radiation compared to female ones, and prenatal radiation exposure distorts the sex-ratio substantially. Notably, the detrimental effects of prenatal radiation exposure on prenatal mortality seem to include a social gradient. We find very robust evidence that the decrease in the number of live births and the decreased likelihood of male live births (our proxy for prenatal death) prevails only among low educated mothers. The finding that radiation seems to harm (in this dimension) only mothers from a lower socio-economic background is consistent with research on differences in the reaction of low and highly educated individuals to emerging health risk information. For instance, Aizer and Stroud (2010) show that highly educated women immediately reduced smoking in response to the 1964 Surgeon General Report on Smoking and Health while the low educated did not, and Anderberg, Chevalier and Wadsworth (2011) find evidence for a differential response of low and highly educated parents to the measles, mumps and rubella (MMR) controversy in the UK.

4.1.2 Health at birth

In order to evaluate the impact of Chernobyl on the health at birth we have individual-level data on gestation length, birth weight, and Apgar scores after one, five and ten minutes available.[13] For the interpretation of this set of health outcomes we have to keep the tension between culling and scarring effects in mind. Since we only observe the survivors—the most likely positively selected group of healthier newborns—our estimated radiation (and non-radiation) effects reflect the sum of a positive culling and a negative scarring effect. Positive estimates would reflect a very strong culling which overcompensates possible scarring effects. Negative estimates would indicate the dominance of scarring. Statistically insignificant effects could either mean that culling and scarring cancel each other out, or the lack of any causal effect of Chernobyl.

The estimation results on the effects on gestation length (see Tables 6 and 7) and birth weight (see Tables 9 and 8) provide evidence for a positive culling through radiation effects (that overcompensates any scarring effects, if existent). Most consistent with the results on live births and fetal death we find that children born to low educated mothers are about 3 percentage points less likely to be preterm births, i. e. born before a gestational age of 37 weeks. The effect is less strong for total gestation length in days and amounts to 1.5 additional days of gestation on average. In the case of birth weight, culling is less evident. Children of low educated mothers do not have a significantly higher birth weight or a lower probability of having low birth weight (defined as weighing less than 2500 grams).

Somewhat surprisingly, for some outcomes a similar pattern is also observed among children born to highly educated mothers. For all birth cohorts we see a radiation effect of about an additional day of gestation; the exact point estimates tend to increase with the level of radioactive exposure. Again, this results suggests that culling effects dominate. However, we find no evidence for a decreased probability of preterm birth. In the case of birth weight the positive effects are concentrated at BC_{II} with estimated effects of 4-6 decagrams—depending on the level of radioactive exposure.

For children born to highly educated mothers we also find some evidence for non-radiation effects. Our estimation results suggest that behavioral adjustments resulted in a lower sex-ratio and a lower birth weight in BC_I.[14] We find that children form this birth cohort exhibit (uniformly across regions with different levels of contamination) a reduced birth weight of minus three decagrams. This might be the result of a changed diet of pregnant women and is consistent with evidence for a higher responsiveness of birth weight to nutritional changes in the third trimester of pregnancy (e. g. Painter *et al.*, 2005).

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[13] The Apgar score is based on five criteria (appearance, pulse, grimace, activity and respiration) and ranges from zero to ten.

[14] The effect on birth weight in BC_I is not due to the lower likelihood of having a male child and is still significant if we condition on the sex of the child.

For the Apgar scores (in the paper we present detailed output for the score after ten minutes, see Table 10) we find little evidence for radiation or non-radiation effects for neither socioeconomic group. For BC_I we find some evidence for scarring of children of highly educated mothers in communities with comparably higher levels of radioactive exposure.

In sum these results indicate that the surviving population of children seem to be positively selected with respect to health at birth.

4.1.3 Infant mortality

Please note the estimation results on the effect on infant mortality are available in Tables 11 to 14. This subsection, however, still needs to be written up.

4.2 Parental investments

Tables **??** to 19 provide evidence for postnatal responsive investment behavior of the surviving kids' mothers. More to follow.

4.3 Child outcomes later in life

This section is still in progress.

5 Conclusions

This section is still in progress.

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6 Tables and Figures

Table 2: Potential outcomes

Outcome	**Level of available data**	**Measurements**	**Data source**
Conceptions	not observable	-	-
Live births	community	absolute number per 1,000 female inhabitants aged 15-39 in 1981 (in the respective education group)	*Austrian Birth Register*
Stillbirth	individual	binary variable	*Austrian Birth Register*
Spontaneous abortions	not observable	proxied by sex-ratio	*Austrian Birth Register*
Induced abortions	not observable	-	-
Health at birth	individual	gestation length, weight, Apgar scores, etc.	*Austrian Birth Register*
Infant mortality	individual	binary variables that indicate whether child is still alive after 24 hours/7 days/1 month/1 year	*Austrian Birth & Death Register*
Health later in life	individual	health care utilization	*Health Insurance Funds*
Labor market (c, m)	individual	employment, occupation, wages	*Austrian Social Security Database*
Pre-birth maternity leave	individual	length in days	*Austrian Social Security Database*
Post-birth maternity leave	individual	length in days	*Austrian Social Security Database*
Parental leave	individual	length in days	*Austrian Social Security Database*
Post-treatment fertility	individual	number of children	*Austrian Birth Register/* *Austrian Social Security Database*

Table 3: The effect of the accident on live births (elasticities)

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.034	0.034	0.036	-0.101	-0.084	-0.109
	(0.033)	(0.034)	(0.035)	(0.076)	(0.079)	(0.081)
BC II	0.035	0.035	0.034	0.058	0.080	0.030
	(0.057)	(0.060)	(0.062)	(0.129)	(0.134)	(0.137)
BC III	0.066	0.062	0.064	-0.158	-0.128	-0.187
	(0.066)	(0.070)	(0.073)	(0.151)	(0.158)	(0.161)
T# x BC I	-0.044	-0.082*	-0.092	0.036	0.083	-0.003
	(0.040)	(0.046)	(0.058)	(0.086)	(0.101)	(0.125)
T# x BC II	-0.086**	-0.111**	-0.106*	-0.060	0.053	-0.025
	(0.042)	(0.049)	(0.057)	(0.125)	(0.152)	(0.177)
T# x BC III	0.021	0.006	0.023	0.130**	0.144**	0.136*
	(0.029)	(0.032)	(0.038)	(0.066)	(0.068)	(0.076)
Abortion effect	0.001	0.000	-0.002	0.159	0.164	0.139
P-value	0.985	0.995	0.966	0.146	0.146	0.232
Conception effect	0.031	0.028	0.030	-0.216	-0.208	-0.217
P-value	0.359	0.433	0.411	0.014	0.020	0.018
Obs.	21636	20016	18684	21600	19980	18648
Mean (absolute)	3.031	3.066	3.076	8.918	8.902	8.873

This table summarizes estimation results based on monthly community level data computed from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to the number of live births per 1,000 female inhabitants aged 15-39 in 1981 (in the respective education group) divided by the sample mean. Method of estimation is least squares. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for the number of inhabitants, community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 4: The effect of the accident on stillbirths (elasticities)

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.001	0.001	0.002	0.002	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
BC II	-0.006	-0.004	-0.004	-0.001	-0.001	-0.001
	(0.006)	(0.005)	(0.006)	(0.003)	(0.003)	(0.003)
BC III	-0.006	-0.003	-0.003	0.000	-0.000	-0.000
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
T# x BC I	0.000	0.001	0.001	0.001	0.000	0.000
	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
T# x BC II	0.004	0.009	0.009	-0.001	0.000	-0.002
	(0.005)	(0.007)	(0.008)	(0.002)	(0.002)	(0.002)
T# x BC III	0.000	0.003	0.004	-0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)
Abortion effect	-0.008	-0.005	-0.005	-0.002	-0.003	-0.003
P-value	0.134	0.295	0.280	0.356	0.284	0.240
Conception effect	0.001	0.000	0.001	0.001	0.001	0.001
P-value	0.837	0.887	0.842	0.627	0.617	0.524
Obs.	25986	24163	22917	71695	65610	61914
Mean	0.005	0.005	0.005	0.004	0.004	0.004

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to one if the child is a stillbirth and zero if the child is a live birth. Method of estimation is a LMP. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 5: The effect of the accident on the probability of a male birth

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.005	0.006	0.016	-0.020*	-0.024**	-0.022*
	(0.018)	(0.018)	(0.018)	(0.012)	(0.012)	(0.012)
BC II	0.040	0.043	0.056	0.022	0.013	0.016
	(0.034)	(0.035)	(0.036)	(0.023)	(0.023)	(0.023)
BC III	0.017	0.020	0.041	-0.017	-0.025	-0.021
	(0.033)	(0.034)	(0.035)	(0.024)	(0.024)	(0.024)
T# x BC I	0.006	0.009	0.007	-0.007	-0.005	0.001
	(0.022)	(0.026)	(0.033)	(0.013)	(0.016)	(0.021)
T# x BC II	-0.042	-0.074*	-0.088**	-0.014	-0.005	-0.015
	(0.036)	(0.039)	(0.040)	(0.019)	(0.022)	(0.026)
T# x BC III	0.008	0.008	0.012	-0.007	0.001	0.000
	(0.018)	(0.021)	(0.024)	(0.010)	(0.011)	(0.013)
Abortion effect	0.035	0.038	0.040	0.042	0.037	0.038
P-value	0.243	0.224	0.202	0.019	0.044	0.039
Conception effect	-0.023	-0.023	-0.015	-0.039	-0.038	-0.037
P-value	0.252	0.258	0.463	0.000	0.000	0.001
Obs.	25861	24050	22810	71436	65374	61691
Mean	0.511	0.511	0.511	0.514	0.515	0.514

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to one if the child is male, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, conception-year and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 6: **The effect of the accident on the likelihood of premature birth (gestation < 37 weeks)**

	Low educated mothers			**Highly educated mothers**		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.003	0.005	0.005	-0.004	-0.004	-0.003
	(0.010)	(0.010)	(0.010)	(0.006)	(0.007)	(0.007)
BC II	0.003	0.001	0.004	-0.008	-0.006	-0.003
	(0.016)	(0.016)	(0.017)	(0.008)	(0.009)	(0.009)
BC III	0.005	0.006	0.009	-0.015	-0.014	-0.010
	(0.020)	(0.021)	(0.022)	(0.011)	(0.012)	(0.012)
T# x BC I	0.007	-0.001	-0.000	-0.005	-0.006	-0.009
	(0.011)	(0.012)	(0.014)	(0.006)	(0.007)	(0.008)
T# x BC II	-0.026**	-0.025**	-0.030**	-0.008	-0.009	-0.011
	(0.011)	(0.013)	(0.014)	(0.008)	(0.009)	(0.010)
T# x BC III	0.009	0.007	0.004	-0.000	-0.002	0.003
	(0.007)	(0.009)	(0.010)	(0.004)	(0.005)	(0.006)
Abortion effect	0.000	-0.003	-0.001	-0.004	-0.001	0.001
P-value	0.999	0.827	0.948	0.570	0.848	0.944
Conception effect	0.003	0.005	0.005	-0.007	-0.008	-0.007
P-value	0.829	0.682	0.691	0.337	0.245	0.314
Obs.	25861	24050	22810	71436	65374	61691
Mean	0.057	0.056	0.057	0.047	0.046	0.046

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to one if the gestation period is below 37 weeks, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC II was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC III was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, year and month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 7: The effect of the accident on the gestation length (in days)

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.529	-0.540	-0.601	-0.357	-0.321	-0.310
	(0.537)	(0.556)	(0.570)	(0.268)	(0.277)	(0.280)
BC II	-0.233	-0.113	-0.267	-0.584	-0.709	-0.726
	(0.844)	(0.889)	(0.922)	(0.457)	(0.475)	(0.481)
BC III	-0.450	-0.356	-0.505	-0.080	-0.130	-0.139
	(1.092)	(1.147)	(1.193)	(0.521)	(0.556)	(0.566)
T# x BC I	-0.301	-0.189	-0.038	0.943***	1.019**	1.029**
	(0.636)	(0.727)	(0.853)	(0.333)	(0.416)	(0.483)
T# x BC II	1.664**	1.402	1.551	0.857**	0.907**	0.958*
	(0.766)	(0.856)	(0.943)	(0.396)	(0.460)	(0.507)
T# x BC III	0.067	0.136	0.316	0.683***	0.731***	0.542*
	(0.493)	(0.489)	(0.568)	(0.234)	(0.282)	(0.317)
Abortion effect	0.297	0.427	0.334	-0.227	-0.388	-0.416
P-value	0.695	0.589	0.683	0.573	0.346	0.315
Conception effect	-0.217	-0.243	-0.237	0.503	0.578	0.587
P-value	0.716	0.691	0.706	0.095	0.062	0.063
Obs.	25861	24050	22810	71436	65374	61691
Mean	273.164	273.218	273.215	273.815	273.856	273.889

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to the gestation length in days, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC II was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC III was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, year and month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 8: The effect of the accident on the birth weight (in decagram)

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-1.246	-0.282	-0.719	-3.131***	-3.464***	-3.350***
	(2.425)	(2.508)	(2.595)	(1.102)	(1.136)	(1.142)
BC II	5.721	7.962*	7.526*	-1.016	-2.239	-2.451
	(3.954)	(4.085)	(4.224)	(1.843)	(1.904)	(1.953)
BC III	0.952	3.400	2.836	-2.461	-3.740*	-3.729*
	(4.708)	(4.943)	(5.135)	(2.053)	(2.137)	(2.174)
T# x BC I	-3.678	-3.818	-3.207	1.892	2.395	2.045
	(2.514)	(3.265)	(3.468)	(1.291)	(1.616)	(1.691)
T# x BC II	0.738	0.219	3.640	3.859**	6.071***	5.828**
	(3.003)	(3.529)	(3.788)	(1.922)	(2.332)	(2.575)
T# x BC III	0.198	0.778	2.326	0.971	0.553	-0.214
	(1.851)	(1.991)	(2.344)	(1.126)	(1.429)	(1.388)
Abortion effect	6.967	8.243	8.245	2.116	1.225	0.899
P-value	0.031	0.014	0.016	0.207	0.482	0.619
Conception effect	-4.769	-4.561	-4.690	-1.445	-1.501	-1.278
P-value	0.041	0.060	0.059	0.271	0.268	0.353
Obs.	25861	24050	22810	71436	65374	61691
Mean	325.355	325.339	325.142	327.580	327.505	327.453

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to the birth weight in decagram, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC II was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC III was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, year and month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 9: The effect of the accident on the likelihood of low birth weight (< 2500 grams)

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.005	-0.004	-0.001	0.007	0.008	0.007
	(0.010)	(0.010)	(0.011)	(0.005)	(0.006)	(0.006)
BC II	-0.020	-0.027	-0.019	-0.001	0.003	0.003
	(0.018)	(0.019)	(0.019)	(0.008)	(0.009)	(0.009)
BC III	-0.008	-0.011	-0.002	-0.001	0.003	0.002
	(0.024)	(0.026)	(0.027)	(0.010)	(0.010)	(0.010)
T# x BC I	0.019	0.014	0.015	-0.011*	-0.008	-0.003
	(0.012)	(0.015)	(0.017)	(0.007)	(0.008)	(0.009)
T# x BC II	-0.012	-0.009	-0.020	-0.026***	-0.032***	-0.028***
	(0.013)	(0.015)	(0.016)	(0.007)	(0.008)	(0.009)
T# x BC III	0.007	0.008	0.013	-0.004	-0.002	0.005
	(0.008)	(0.010)	(0.012)	(0.005)	(0.007)	(0.006)
Abortion effect	-0.016	-0.022	-0.018	-0.008	-0.004	-0.004
P-value	0.275	0.135	0.244	0.313	0.591	0.644
Conception effect	0.013	0.016	0.017	-0.000	-0.001	-0.001
P-value	0.302	0.200	0.182	0.963	0.913	0.839
Obs.	25861	24050	22810	71436	65374	61691
Mean	0.067	0.067	0.067	0.054	0.054	0.055

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to one if the birth weight is lower than 2500 grams, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC II was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC III was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, year and month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 10: The effect of the accident on the Apgar score 10

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.006	-0.000	-0.007	-0.004	-0.006	-0.003
	(0.023)	(0.024)	(0.024)	(0.013)	(0.014)	(0.014)
BC II	-0.019	-0.016	-0.024	0.013	0.006	0.008
	(0.039)	(0.040)	(0.040)	(0.021)	(0.022)	(0.022)
BC III	0.002	0.002	-0.008	0.019	0.013	0.017
	(0.045)	(0.047)	(0.048)	(0.023)	(0.024)	(0.025)
T# x BC I	-0.012	-0.004	-0.008	-0.024	-0.050**	-0.071**
	(0.029)	(0.033)	(0.043)	(0.019)	(0.022)	(0.027)
T# x BC II	0.026	0.007	-0.014	0.021	0.025	0.024
	(0.047)	(0.054)	(0.068)	(0.017)	(0.021)	(0.027)
T# x BC III	-0.009	-0.013	0.009	0.008	-0.002	-0.001
	(0.021)	(0.025)	(0.028)	(0.011)	(0.012)	(0.015)
Abortion effect	-0.025	-0.015	-0.017	0.017	0.012	0.011
P-value	0.492	0.688	0.653	0.345	0.501	0.544
Conception effect	0.021	0.017	0.016	0.007	0.007	0.010
P-value	0.488	0.584	0.620	0.643	0.628	0.544
Obs.	25372	23572	22343	70293	64265	60603
Mean	9.868	9.869	9.869	9.897	9.896	9.895

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dep. var. is equal to the Apgar score after ten minutes, and zero otherwise. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC II was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC III was conceived after Chernobyl (between 05/1986 and 07/1987). Each DiD specification controls for community, conception-year and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level.

Table 11: Probability of being still alive 24 hours after birth

	Low educated mothers			**Highly educated mothers**		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.001	-0.001	-0.002	-0.001	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
BC II	0.005	0.002	0.001	0.001	0.000	0.001
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
BC III	0.006	0.003	0.002	-0.001	-0.001	-0.000
	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)
T# x BC I	-0.001	-0.001	-0.004	-0.004*	-0.004	-0.007*
	(0.004)	(0.004)	(0.005)	(0.002)	(0.003)	(0.004)
T# x BC II	-0.008	-0.013	-0.017	0.002	0.001	0.003*
	(0.007)	(0.009)	(0.011)	(0.002)	(0.003)	(0.002)
T# x BC III	-0.000	-0.005	-0.007*	-0.000	-0.001	-0.001
	(0.003)	(0.003)	(0.004)	(0.001)	(0.002)	(0.002)
Abortion effect	0.006	0.004	0.003	0.002	0.002	0.002
P-value	0.297	0.521	0.556	0.463	0.542	0.435
Conception effect	0.001	0.001	0.001	-0.001	-0.001	-0.001
P-value	0.676	0.732	0.742	0.548	0.562	0.559
Obs.	25986	24163	22917	71695	65610	61914
Mean	0.993	0.993	0.993	0.995	0.995	0.995

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to one if the child is still alive 24 hours after birth. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 12: Probability of being still alive 7 days after birth

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.000	-0.000	-0.001	-0.001	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
BC II	0.006	0.004	0.001	0.002	0.002	0.002
	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
BC III	0.008	0.005	0.002	0.001	0.001	0.001
	(0.008)	(0.009)	(0.009)	(0.004)	(0.005)	(0.005)
T# x BC I	-0.001	-0.003	-0.003	-0.004	-0.005*	-0.010**
	(0.005)	(0.005)	(0.007)	(0.003)	(0.003)	(0.004)
T# x BC II	-0.007	-0.013	-0.011	0.002	0.003	0.005**
	(0.008)	(0.010)	(0.011)	(0.003)	(0.003)	(0.002)
T# x BC III	0.003	-0.001	-0.002	0.001	-0.000	-0.001
	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)	(0.002)
Abortion effect	0.006	0.004	0.002	0.004	0.004	0.004
P-value	0.338	0.527	0.731	0.270	0.274	0.218
Conception effect	0.001	0.001	0.001	-0.001	-0.001	-0.002
P-value	0.769	0.808	0.804	0.570	0.527	0.462
Obs.	25986	24163	22917	71695	65610	61914
Mean	0.990	0.990	0.990	0.992	0.992	0.992

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to one if the child is still alive 7 days after birth. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 13: Probability of being still alive 1 month after birth

	Low educated mothers			**Highly educated mothers**		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.000	-0.000	-0.001	-0.002	-0.003	-0.003
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
BC II	0.008	0.006	0.004	0.002	0.002	0.001
	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
BC III	0.008	0.006	0.003	-0.000	-0.001	-0.002
	(0.009)	(0.009)	(0.009)	(0.005)	(0.005)	(0.005)
T# x BC I	-0.003	-0.001	-0.003	-0.004	-0.006*	-0.009**
	(0.005)	(0.006)	(0.007)	(0.003)	(0.003)	(0.004)
T# x BC II	-0.006	-0.011	-0.010	0.002	0.004	0.006**
	(0.008)	(0.010)	(0.011)	(0.003)	(0.003)	(0.002)
T# x BC III	0.001	-0.003	-0.006	0.002	-0.000	-0.000
	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)	(0.003)
Abortion effect	0.008	0.006	0.005	0.005	0.005	0.005
P-value	0.268	0.396	0.482	0.178	0.186	0.204
Conception effect	0.000	-0.000	-0.000	-0.002	-0.003	-0.003
P-value	0.999	0.964	0.922	0.300	0.255	0.227
Obs.	25986	24163	22917	71695	65610	61914
Mean	0.988	0.989	0.989	0.991	0.991	0.991

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to one if the child is still alive 1 month after birth. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 14: Probability of being still alive 1 year after birth

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.000	0.001	-0.000	-0.003	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
BC II	-0.002	-0.000	-0.002	0.001	0.002	0.001
	(0.010)	(0.010)	(0.010)	(0.005)	(0.005)	(0.005)
BC III	0.006	0.007	0.005	-0.002	-0.001	-0.001
	(0.010)	(0.011)	(0.011)	(0.005)	(0.005)	(0.006)
T# x BC I	-0.004	-0.004	-0.004	-0.003	-0.006	-0.010*
	(0.006)	(0.007)	(0.008)	(0.003)	(0.004)	(0.005)
T# x BC II	0.004	-0.004	-0.003	0.001	0.005	0.006
	(0.009)	(0.011)	(0.013)	(0.004)	(0.004)	(0.004)
T# x BC III	-0.000	-0.003	-0.004	0.002	-0.001	-0.001
	(0.005)	(0.005)	(0.006)	(0.002)	(0.003)	(0.003)
Abortion effect	-0.002	-0.001	-0.001	0.004	0.005	0.004
P-value	0.805	0.920	0.865	0.267	0.245	0.304
Conception effect	0.008	0.007	0.007	-0.003	-0.003	-0.002
P-value	0.167	0.238	0.252	0.298	0.349	0.398
Obs.	25986	24163	22917	71695	65610	61914
Mean	0.983	0.983	0.983	0.988	0.988	0.988

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to one if the child is still alive 1 year after birth. Method of estimation is a LPM. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 15: Mothers' post-treatment fertility

	Low educated mothers			Highly educated mothers		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.028	-0.037	-0.045	-0.004	-0.012	-0.012
	(0.031)	(0.030)	(0.031)	(0.019)	(0.020)	(0.020)
BC II	-0.021	-0.029	-0.053	-0.039	-0.040	-0.040
	(0.063)	(0.066)	(0.068)	(0.037)	(0.039)	(0.041)
BC III	-0.084	-0.097	-0.126*	-0.032	-0.042	-0.045
	(0.069)	(0.073)	(0.075)	(0.037)	(0.040)	(0.041)
T# x BC I	-0.028	-0.032	-0.036	0.014	0.011	0.009
	(0.040)	(0.046)	(0.058)	(0.019)	(0.024)	(0.026)
T# x BC II	-0.159***	-0.200***	-0.185**	0.011	-0.024	-0.059
	(0.061)	(0.061)	(0.073)	(0.033)	(0.036)	(0.044)
T# x BC III	-0.020	-0.001	0.002	-0.012	-0.011	-0.024
	(0.034)	(0.040)	(0.049)	(0.016)	(0.020)	(0.022)
Abortion effect	0.007	0.008	-0.008	-0.034	-0.028	-0.028
P-value	0.892	0.891	0.885	0.282	0.398	0.415
Conception effect	-0.063	-0.068	-0.073	0.006	-0.002	-0.005
P-value	0.116	0.093	0.076	0.757	0.929	0.794
Obs.	20464	19010	18003	58175	53254	50286
Mean	0.703	0.705	0.708	0.712	0.713	0.713

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to the number of children born to a mother after the pivotal child (i.e. the child assigned to one of the three birth cohorts). Method of estimation is OLS. Mothers are assigned to the control cohort or the treatment cohort depending on the conception date of the pivotal child. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects as well as mother's age dummies. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 16: Low educated mothers' post-treatment fertility

	Boys: low educated			**Girls: low educated**		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.026	0.021	0.006	-0.121**	-0.134**	-0.141**
	(0.049)	(0.050)	(0.051)	(0.056)	(0.056)	(0.057)
BC II	0.067	0.043	0.001	-0.145*	-0.141	-0.158
	(0.096)	(0.100)	(0.101)	(0.087)	(0.092)	(0.096)
BC III	0.008	-0.016	-0.064	-0.220**	-0.226**	-0.247**
	(0.102)	(0.107)	(0.108)	(0.104)	(0.110)	(0.115)
T# x BC I	0.002	-0.019	0.054	-0.054	-0.032	-0.118
	(0.064)	(0.079)	(0.096)	(0.062)	(0.075)	(0.093)
T# x BC II	-0.197*	-0.315***	-0.281***	-0.128	-0.106	-0.128
	(0.110)	(0.087)	(0.094)	(0.084)	(0.085)	(0.103)
T# x BC III	-0.017	-0.017	-0.016	-0.039	-0.006	-0.022
	(0.049)	(0.058)	(0.072)	(0.047)	(0.055)	(0.065)
Abortion effect	0.041	0.022	-0.005	-0.024	-0.007	-0.017
P-value	0.622	0.795	0.955	0.768	0.933	0.841
Conception effect	-0.059	-0.058	-0.065	-0.075	-0.085	-0.089
P-value	0.332	0.345	0.298	0.184	0.141	0.131
Obs.	10490	9747	9239	9974	9263	8764
Mean	0.690	0.689	0.691	0.718	0.722	0.725

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to the number of children born to a mother after the pivotal child (i.e. the child assigned to one of the three birth cohorts). Method of estimation is OLS. Mothers are assigned to the control cohort or the treatment cohort depending on the conception date of the pivotal child. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects as well as mother's age dummies. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 17: Highly educated mothers' post-treatment fertility

	Boys: highly educated			Girls: highly educated		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	-0.033	-0.044*	-0.049*	0.028	0.025	0.033
	(0.025)	(0.026)	(0.027)	(0.028)	(0.029)	(0.030)
BC II	-0.111**	-0.118**	-0.125**	0.043	0.046	0.053
	(0.051)	(0.053)	(0.055)	(0.054)	(0.057)	(0.059)
BC III	-0.083	-0.101*	-0.118*	0.028	0.026	0.038
	(0.056)	(0.060)	(0.062)	(0.062)	(0.066)	(0.068)
T# x BC I	0.047*	0.068*	0.085**	-0.015	-0.042	-0.057
	(0.028)	(0.035)	(0.043)	(0.030)	(0.037)	(0.040)
T# x BC II	0.063	0.054	0.026	-0.042	-0.107**	-0.146**
	(0.047)	(0.054)	(0.066)	(0.040)	(0.046)	(0.060)
T# x BC III	0.002	0.016	0.010	-0.025	-0.035	-0.055
	(0.023)	(0.028)	(0.035)	(0.023)	(0.031)	(0.034)
Abortion effect	-0.079	-0.074	-0.076	0.015	0.021	0.020
P-value	0.071	0.099	0.100	0.755	0.673	0.691
Conception effect	0.029	0.016	0.007	-0.015	-0.019	-0.015
P-value	0.351	0.599	0.833	0.616	0.537	0.641
Obs.	29854	27315	25785	28321	25939	24501
Mean	0.713	0.712	0.713	0.711	0.714	0.714

This table summarizes estimation results based on individual-level data from the *Austrian Birth Register* in the period from 08/1984 through 07/1987. The dependent variable is equal to the number of children born to a mother after the pivotal child (i.e. the child assigned to one of the three birth cohorts). Method of estimation is OLS. Mothers are assigned to the control cohort or the treatment cohort depending on the conception date of the pivotal child. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects as well as mother's age dummies. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 18: Low educated mothers' labor force participation eight years after childbirth

	Boys: low educated			Girls: low educated		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.033	0.015	0.008	0.009	0.025	0.022
	(0.053)	(0.053)	(0.054)	(0.053)	(0.055)	(0.057)
BC II	0.104	0.082	0.064	0.039	0.065	0.046
	(0.069)	(0.071)	(0.073)	(0.073)	(0.074)	(0.076)
BC III	0.091	0.074	0.043	0.065	0.095	0.081
	(0.087)	(0.091)	(0.094)	(0.086)	(0.088)	(0.091)
T# x BC I	0.008	-0.015	-0.060	-0.017	0.006	0.040
	(0.038)	(0.041)	(0.047)	(0.031)	(0.032)	(0.039)
T# x BC II	-0.118**	-0.129**	-0.125*	0.038	0.041	0.017
	(0.054)	(0.059)	(0.070)	(0.044)	(0.052)	(0.063)
T# x BC III	0.032	0.010	0.010	-0.013	-0.003	-0.025
	(0.025)	(0.027)	(0.034)	(0.029)	(0.032)	(0.039)
Obs.	9943	9226	8741	9431	8755	8273
Mean	0.529	0.528	0.530	0.514	0.516	0.516

This table summarizes estimation results based on individual-level data from the *Austrian Social Security Data.* The dependent variable is equal to one if the mother of the pivotal child (i.e. the child assigned to one of the three birth cohorts) participates in the labor force eight years after childbirth. Method of estimation is LPM. Mothers are assigned to the control cohort or the treatment cohort depending on the conception date of the pivotal child. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects as well as mother's age dummies. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Table 19: Highly educated mothers' labor force participation eight years after childbirth

	Boys: highly educated			Girls: highly educated		
	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2	37 kBq/m^2	42 kBq/m^2	47 kBq/m^2
BC I	0.025	0.016	0.016	0.017	0.017	0.026
	(0.026)	(0.027)	(0.028)	(0.030)	(0.032)	(0.033)
BC II	0.065*	0.049	0.040	0.002	-0.006	-0.001
	(0.034)	(0.035)	(0.036)	(0.041)	(0.043)	(0.043)
BC III	0.065	0.044	0.032	-0.004	-0.022	-0.010
	(0.043)	(0.044)	(0.045)	(0.048)	(0.049)	(0.050)
T# x BC I	0.019	0.022	0.043	-0.000	0.003	-0.019
	(0.021)	(0.028)	(0.035)	(0.018)	(0.023)	(0.026)
T# x BC II	-0.039*	-0.053*	-0.061*	-0.011	-0.052	-0.051
	(0.023)	(0.029)	(0.035)	(0.036)	(0.035)	(0.040)
T# x BC III	0.006	0.009	0.013	0.004	0.011	-0.007
	(0.014)	(0.018)	(0.021)	(0.014)	(0.017)	(0.021)
Obs.	29011	26538	25047	27512	25210	23813
Mean	0.570	0.570	0.571	0.569	0.569	0.570

This table summarizes estimation results based on individual-level data from the *Austrian Social Security Data*. The dependent variable is equal to one if the mother of the pivotal child (i.e. the child assigned to one of the three birth cohorts) participates in the labor force eight years after childbirth. Method of estimation is LPM. Mothers are assigned to the control cohort or the treatment cohort depending on the conception date of the pivotal child. The control cohort was conceived between 08/1984 and 07/1985 and was born before the Chernobyl accident. BC_I was conceived between 08/1985 and 01/1986 and was between 4 and 9 months post conception at the time of the accident. BC_{II} was conceived between 02/1986 and 04/1986 and was between 0 and 3 months post conception at the time of the accident. BC_{III} was conceived after Chernobyl (between 05/1986 and 07/1987). Each specification controls for community, conception-year, and conception-month fixed-effects as well as mother's age dummies. Robust standard errors in parentheses. *, ** and *** indicate statistical significance at the 10-percent level, 5-percent level, and 1-percent.

Appendix A Existing evidence on the effects of the Chernobyl accident on reproductive outcomes

The International Commission on Radiological Protection (ICRP) considers an effective dose of 100 mSv as a threshold for effects after in utero exposure to ionizing radiation, including the induction of cancer. Whether the Chernobyl accident caused any negative health effects on individuals living in European countries is still under debate, despite the much lower radiation dose those individuals were exposed to. (See for example the recent debate in The Lancet (Holt, 2010).)

The existing evidence on the health impact of in utero exposure to the Chernobyl accident (summarized below) is mainly based on epidemiological studies analyzing time trends (across differently exposed regions[1]) in the rates of live births, stillbirths, spontaneous (and induced) abortions, infant mortality and perinatal and postnatal outcomes (e. g. pre-term birth, low birth weight, congenital malformations, incidence of specific diseases). Any (short-term) deviations from the long-run trend after the Chernobyl accident are cautiously interpreted as evidence for radiation-related health effects. However, most authors acknowledge the limited power of their studies to detect small effects and emphasize that causal inference is hardly possible based on ecological studies. In light of these limitations, most reviews of the existing evidence conclude that there is no consistent evidence of detrimental effects of the Chernobyl disaster except for an increase in thyroid cancer for individuals exposed in childhood, particularly in Belarus, Ukraine and Russia. (e.g. Little, 1993; WHO, 2006; UNSCEAR, 2000).

There is some evidence for an increase in the proportion of stillbirths and the early infant (or perinatal) mortality rate after the Chernobyl accident in Germany.[2] However, these results have been challenged by other studies using German data and studies for other countries (e.g. Finland, Sweden).[3] Furthermore, there is no evidence for a significant relationship between the level of fallout and the rate of spontaneous abortions, congenital malformations or other postnatal outcomes (pre-term birth, low birth weight, childhood cancer).[4] In contrast, there is some evidence for a decrease in the birth rate (independent of the fallout level) 9-11 months after the accident in Sweden, Finland, Norway and Italy and a temporary increase in the rate of induced abortions in Greece, Italy and Sweden.[5]

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[1] However, this is not done in a difference-in-difference framework.

[2] See Lüning *et al.* (1989); Scherb *et al.* (1999); Körblein and Küchenhoff (1997); Scherb *et al.* (2000).

[3] See Blettner (2000); Grosche *et al.* (1997); Auvinen *et al.* (2001); Ericson and Kallen (1994).

[4] See Auvinen *et al.* (2001); Ericson and Kallen (1994); Irgens *et al.* (1991); Haeusler *et al.* (1992); Harjulehto *et al.* (1989).

[5] See Auvinen *et al.* (2001); Ericson and Kallen (1994); Bertollini *et al.* (1990); Irgens *et al.* (1991); Trichopoulos *et al.* (1987). Haeusler *et al.* (1992) find no effect on the counseling rate at pregnancy termination clinics in southern Austria.

Both effects may be attributed to the conflicting information in the media and the anxiety of pregnant women in the first month after the Chernobyl accident.