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IRRADIATION IN EARLY LIFE, CHILDHOOD SOCIO-ECONOMICSTATUS AND LATER HEALTH OUTCOMES: EVIDENCE FROM A QUASI-EXPERIMENT

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The course of industrialization offered researchers an important source of environmental shocks to investigate – pollutants, the long-term influence of which seems to be underexplored. Epidemiologists launched research on the effects of pollutants at a time with other life course scholars, and likewise supported the importance of early life factors (Mann et al, 1992). The findings of early scholars that the long term biological mechanism of pollutants is purely inflammatory (Ophuls, 1921), have been revitalized by current researchers (Finch &Crimmins, 2006). Cohort and case epidemiological studies showed that the series of responses caused by pollution inflammogens are dependent on the dose of exposure, but at any dose they can be stored in bodies for a long time and persistently affect health (Pellmar&Ledney, 2005). Recently, economic historians have begun to investigate the long term effects of early life exposure to toxins with individual level data. The studies, often based on natural experiments of exposure, indicate the negative effects for those exposed either in-utero (Almond et al, 2009, Sanders, 2011, Black et al, 2013) or during early childhood (Nilsson, 2009, Yemeluanauet al 2012).

The Chernobyl radioactive fallout, which irradiated the entire Ukrainian population, has been chosen in this paper as a quasi-experiment in early life exposure to radiation. Based on individual-level cross-sectional data coming from a recent wave of national surveys, we are able to match the varying irradiation in early life among different birth cohorts to health outcomes in their young adulthood. The richness of data allows us to control for potential confounders, such as migration and place of birth, as well as to identify the socio-economic status of the individual at the exposure period in early life. In this study, we will also incorporate regional level information on radiation doses received due to the accident, and then estimate the effects for birth cohorts

irradiated at low dose levels. An exposure to radionuclides released after the Chernobyl accident had long since decayed to negligible levels. Among radioisotopes, which covered the entire Ukraine, iodine isotopes decomposed in a three-month period, whereas cesium isotopes were available in the topsoil during eight months, and in some regions will continue to irradiate for decades to come. To account for this, we will first establish exposure period at a physical life of iodine radionuclides, and then lengthen it to eight months to consider an exposure to cesium radionuclides. The use of two exposure periods will enable us to identify the potential downward bias in our results related to this peculiarity of exposure.

This paper is not only seeking to explore biological pathway from exposure to Chernobyl radiation. Instead, following the economic literature, we argue that, if any, health responses from this exogenous insult might have been conditioned by the socio-economic status of an exposed individual at the time of accident. In other words, to the extent that individuals at particular periods of their early life were environmentally vulnerable, early life events could be mediated by socio-economic environment at a household level. Conceptually, there are several reasons why this mediation is possible (Almond & Currie 2011, Heckman 2007). On the one hand, parents can distribute more resources to their children in order to compensate for negative outcomes of exposure. On the other hand, individuals from more affluent families may originally experience a weaker effect from negative insults due to high initial level of available resources, and they may potentially be subject to less and smaller early shocks than children from poor families.

Chernobyl accident provides a natural experiment in radiation exposure of the population in Ukraine. The Chernobyl accident that occurred in 1986 allows us to match varying exposure to radiation throughout Ukraine among different birth cohorts to their health outcomes observed at least 18 years later. Due to the acknowledged differences in the impact of most influential Chernobyl isotopes on child health, in the study we distinguish two exposure periods with regard to the relative contribution of these radionuclides to the exposure. Considering all aspects, in order to create a random experimental group, the period of exposure to iodine in Ukraine can be stated from the beginning of accident up to three months term, while cesium irradiation should be captured until the end of 1986.

In the current paper, the nationally representative Ukrainian Longitudinal Monitoring Survey is used as a data source. This is the only available data for the most affected countries, Ukraine, Belarus and Russia, that allow to identify adult health outcomes and child socio-economic status, as well as individual location at the time of accident. Among all the survey waves, the 2007 wave contains the data fulfilling all the age requirements for the individuals which come from the research question and context. Additional regional-level data on the radiation dosage has been compiled from the national reports of Ukraine on the consequences of the Chernobyl disaster published in 2006 and 2011. The reports are the official national documents on the environmental and health outcomes of the accident conducted under the auspices of the United Nations' organizations.

The sample selected for the study consists of approximately 1,100 individuals born between 1981 and 1989, chosen to represent the groups with varying radiation exposure. For the two approaches with regard to different exposure periods, individuals will be allocated differently among birth groups, albeit not for all groups. According to our research question, one treatment birth group is under the particular focus in this study – those children being during infancy at the exposure period. This study group consists of those individuals who were born before, but not more than a year before April 26, 1986 (exposed during infancy). Other groups are also under attention, such as individuals who were exposed to radiation while in-utero and after first year of life. The in-utero group is selected within nine months after the radiation exposure period (exposed in-utero). To compose birth groups properly, those who were born during the radiation exposure period, which were subject to exposure both during infancy and in-utero, are also distinguished (exposed during infancy and in-utero). The remaining exposed birth group represents individuals who were between the ages of one and five at the exposure period and thus completes the groups of exposed during early life (exposed between the ages of one and five). The reference group consists of individuals who were born after nine months of the radiation exposure period and up to 1989, and therefore conceived after the end of the radiation exposure period.

The main outcome variable used in the current study is constructed from self-reported health (*Good health* and *Bad health*). By its construction, self-perceived health variable measures in one single index the adult health experience, and it can capture the systemic influence of the radiation on the human bodies. In this study, self-estimated health from five-point scale is recoded into a binary variable. The data also contains information on the prevalence of chronic diseases that we further utilize (*Any chronic diseases* and *No chronic diseases*).

Among other hypotheses, the current study investigates the differences in adult health outcomes as regards individual socio-economic status in childhood which is measured by parental education. We choose the variable on parents' educational status as the most appropriate for our analytical purposes.

The distinction between those who had at least higher education and those with completed lower levels of education reflects particularly well the socio-economic structure of the Ukrainian society in 1980s. Originally, the variable on education of parents indicates the highest schooling attained at different levels, as well as information on whether the parent was not living with a respondent. In the study, responses on incomplete higher education, higher education, and doctoral degree are recoded as high education, and other responses are considered as low education. We also observe parental educational status only in 2007, but not at birth or childhood of individuals. According to available data, the average age of giving birth in Ukraine during the study period was 25 years, and for the first birth 23 years. Therefore, at the age of 23, at child's birth or childhood, at least non-full higher education can be assumed as being completed or close to completed.

In addition to the main hypotheses, the health outcomes for individuals with different intensity of the exposure will be tested by using radiation dosage. To obtain the

dose-dependent effects, official regional radiation data is matched in the study to individual's place of residence (birth) in 1986. Average effective total exposure doses, which reflect the amount of energy absorbed by human body, are chosen for the study (Baloga et al. 2006).

In our analysis, the focus is given to the estimates for the selected birth cohorts. Since the health outcome is defined as the self-reported bad health or presence of any chronic diseases at a time of the interview, each individual will contribute with one observation. In this study, binary logistic regression models are used because of the dichotomous nature of the dependent variable.

The study follows the regression discontinuity design with age and its polynomial as a forcing variable (Geido& Lemieux 2008). The discontinuity in health outcomes is observed for the composed birth cohorts irradiated at different stages of their early lives – those in-utero, during both in-utero and during infancy, during infancy and up to five years old.

Based on the estimated models, we predict the absolute probabilities of negative health outcome in adulthood for all birth cohorts with regard to their socio-economic status in early life. The data from Figure shows that individuals who lived with single mothers and exposed at any age during early life experience on average higher probability of having bad health in adulthood than those originated from families with less educated fathers. At most, this probability reaches 0.6 units for those exposed both during infancy and in-utero. We observe here the largest probabilities of bad health in adulthood for the individuals who were irradiated both during infancy and in-utero and solely during infancy. The predicted probabilities suggest possible selection mechanisms in data for the exposed in-utero, as they are larger for the more affluent group. For other birth cohorts the predicted values correspond to the a-priori expectations. The data suggest the lowest probability of having bad health for those who were irradiated to iodine during first year of life and originated from wealthier families. The predicted value goes down to 0.14 units and thereby appears to be the lowest among all groups in both models.

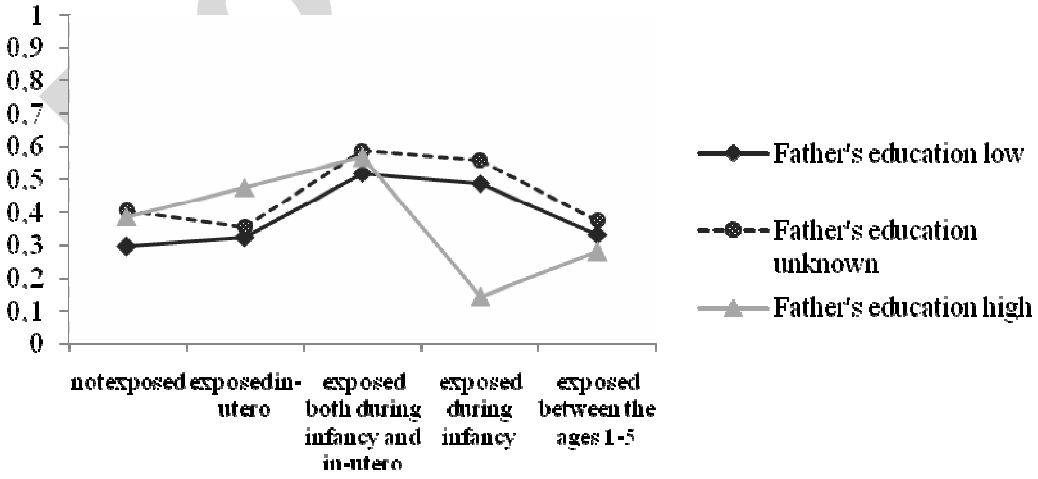

Fig. Predicted probabilities of *having bad health* for an average individual with different child socio-economic origin due to exposure to *iodine radiation* in early life

The results from cesium irradiation models are in line with the previous models. The models with self-reported chronic diseases as an outcome variable allows to obtain significant results for those who were irradiated between ages one and five. Again, there is a socio-economic gradient in the effect: individuals originated from families where mothers had low education and exposed to radiation in early childhood have more than two times higher probability to have chronic diseases later compared to those from families with more educated mothers and no affected. Results for the father's education are similar.

Given all, our results strongly supportthat within early life infancy is of the greatest importance. The largest responses, in both relative and absolute terms, have been captured for those who were irradiated during first year of life, regardless of how long the exposure period is established. According to our expectations, the more distinctly a control group is selected from the time of exposure, as it is shown with the model for exposure to cesium, the stronger impact for the exposed during infancy can be indicated. Additionally, the results for this birth group are the only stable when socio-economic variable is changed. Again, the more distinct socio-economic groups are allocated, for instance with selection of a group whose fathers did not leave with individuals, the larger is the effect for the irradiated after birth. The environmental vulnerability appears to gradually decrease when an individual ages. Thus, albeit being much smaller than those estimated for individuals who were exposed during infancy, the probabilities for the exposed between the ages one and five are found to be also large, in absolute and relative sizes. The estimates for this birth group keep statistical significance across different specifications.

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ЭЛЕКТРОННАЯ КОММЕРЦИЯ: ПРОБЛЕМЫ И НАПРАВЛЕНИЯ РЕГУЛИРОВАНИЯ

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Неотъемлемой составляющей современной экономики является наличие электронной среды как результата развития информационных и телекоммуникационных технологий.

Информационно-коммуникационные технологии таят немалые возможности для повышения конкурентоспособности и развития производственного потенциала экономики. Они могут способствовать новаторству и повышению производительности труда, могут снижать трансакционные издержки, предоставлять доступ к мировым знаниям, стимулируя тем самым развитие и экономический рост.

Распространение сети Интернет и совершенствование информационных технологий привели к формированию нового вида экономической деятельности – электронной коммерции. В целом электронную коммерцию можно характеризовать как «общую концепцию, включающую в себя любые формы деловых операций, осуществляемых электронным способом, и использующую разнообразные телекоммуникационные технологии» [3].

Электронная коммерция, представляет собой совокупность элементов, образующих систему с многосторонними связями. К составляющим электронной коммерции относят электронные платежи и расчеты, информационную продукцию, электронные деньги, интернет-магазины, сетевые сообщества, Web-сайты, сайты для B2B каналов и дилеров, мобильные сайты и приложения, Call-центры и центры торговых агентов, инфокиоски, системы обработки заказов, электронную почту и другое. Электронная коммерция – это единая платформа для взаимодействия ее участников, где деловые операции могут осуществляться непо-