

Teng-Jen Chang**Essays in the Effect of Early Radiation Exposure on Human Outcomes**

My dissertation studies the effect of early radiation exposure to human outcomes. In the middle to late 20th century, significant nuclear-related events made either one-off or continuous impacts on the environmental radiation in the United States. The data presenting shocks of these events serve as basis for my analysis on long-run and short-run outcomes of the 1960s and 1980s cohort population experiencing different level of prenatal radiation exposure due to their timing and places of birth. The objective of my research is to contributes to the comprehensive understanding of the effect of low-dose ionizing radiation on human outcomes in the United States.

My job market paper, “Testing the Fetal Origin Hypothesis: The Case of the U.S. Prenatal Radiation Exposure in 1960s,” studies the effect of prenatal radiation exposures on education attainments and the live-birth sex ratio. The phase-in and out of above-ground nuclear testing by nuclear powers in 1960s is considered as a natural experiment contributing exogenous and continuous shocks to the environmental radiation. Using the Radiological Health Data issued by the U.S. Department of Health, Education and Welfare, the chronic and spatial variation of radiation in the air is constructed, and matched to cohort samples born in different states at different timing from the U.S. Census and Natality data. The radiation exposure on the cohort members at their various prenatal stages can thus be identified and utilized to test two hypotheses: (1) Radiation exposure affects negatively on the fetus in cognitive outcomes, with the most radiosensitive prenatal stage being the 8th to the 25th gestational week; and (2) male embryos are more likely to be spontaneously aborted in response to general external shocks, causing the live-birth sex ratio to fall. This paper finds that the radiation in the second prenatal quarter, which covers the most radiosensitive gestational periods, is associated with a significant decrease in education attainments. Analysis on male and female genders shows a larger magnitude of the negative effect on females, but the difference between genders is statistically insignificant. It is also found that the live-birth sex ratio following an year with higher radiation exposure drops significantly, supporting the theory of the gender-biased spontaneous abortion. This U.S. case study contributes to the understanding of the effect of prenatal radiation exposure on cognitive outcomes. The effects can be observed even when the exposure is identified in average based on the cohort members’ states and quarters of birth. The findings also suggest that the gender difference should be explicitly addressed in relative studies.

The second chapter, “The Impact of the Chernobyl Accident on the U.S. Newborns,” makes use of the Chernobyl Accident on April 1986 to evaluate the one-off shock to prenatal radiation exposure on the instant outcomes of newborns in the U.S. One key difference from my job market paper is that the radiation exposure on different gestational months in selected counties can be identified due to the nature of the data. In this paper, two hypotheses are tested: (1) Probability of miscarriage increases when radiation exposure occurs at early stage of pregnancy; and (2) birth weight is negatively associated with radiation exposure in the early-mid stage of pregnancy, when main body parts are formed. The Environmental Radiation Data from the U.S. Radiation Protection Agency is used to present radiation in air across the country in 1980s. National representative cohort samples are extracted from the U.S. Vital Statistics. For each reported occurrence of live-birth and fetal death, I am able to locate the gestational month whether and when the Chernobyl shock took place. By matching the counties of the occurrence of live-birth and fetal death, and the local record of radiation, I analyze the association between various newborn outcomes and the relevant radiosensitive gestationalstages. I find that the Chernobyl shock is associated with lower birth weight with significant gender differences. These findings also provide evidence that the prenatal radiation exposure shifts distributions of the embryo health by gender.