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Long-run effects of gestation during the Dutch Hunger Winter famine on labor market and hospitalization outcomes☆

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ABSTRACT

The Dutch Hunger Winter (1944/45) is the most-studied famine in the literature on long-run effects of malnutrition in utero. Its temporal and spatial demarcations are clear, it was severe, it was not anticipated, and nutritional conditions in society were favorable and stable before and after the famine. This is the first study to analyze effects of in utero exposure on labor market outcomes and hospitalization late in life, and the first to use register data covering the full Dutch population to examine long-run effects of this famine. We provide results of famine exposure by sub-interval of gestation. We find a significantly negative effect of exposure during the first trimester of gestation on employment outcomes 53 or more years after birth. Hospitalization rates in the years before retirement are higher after middle or late gestational exposure.

1. Introduction

The Dutch Hunger Winter famine (December 1944–April 1945) is by far the most-studied famine in the epidemiological literature on long-run effects of in utero malnutrition (see Lumey et al., 2011, for an excellent survey). The reason for this is that this famine is uniquely suited as an instrument to assess the presence of such causal long-run effects. As has been well-documented (see Section 2), it is sharply defined in time and space, it was severe, it was not anticipated, it was embedded within an era with affluent nutritional conditions, and it occurred in a society with reliable data registration.

By now, long-run effects of exposure to the Dutch Hunger Winter famine have been found for a number of health outcomes later in life (see again Lumey et al., 2011). These results contribute to the overwhelming evidence on long-run health effects of early-life conditions in general (see e.g. the overviews in Pollitt et al., 2005; Barker, 2007; Lawlor, 2008). These effects are typically explained by

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reference to Barker's fetal origins or fetal programming hypothesis (see e.g. Barker, 1994). In particular, effects of fetal undernutrition on metabolic adaptation in utero may affect the phenotype such that the risk of diseases later in life is increased (Hales and Barker, 1992; Bateson, 2001; Gluckman and Hanson, 2004), notably cardiovascular diseases, diabetes and hypertension. Underlying this model is the idea that several critical periods in utero influence the development of humans. During these periods, developing systems modify their settings in response to social and biological cues (Kuzawa and Quinn, 2009). This includes durable epigenetic changes that modify gene expressions. Of course, severely adverse nutritional conditions may also directly affect the build-up of organs and other body parts. All these biological causal pathways may potentially be influenced by events and decisions throughout life.

This paper is the first study to analyze effects of in utero exposure to the Hunger Winter famine on individual economic outcomes late in life. We consider three such outcomes. Two of these (annual labor earnings and employment) are labor market outcomes. The third, hospitalization, is an indicator of costly health care usage and as such combines information on health with information on its costs. In fact, we examine hospitalization occurrences by type of disease, notably for cardiovascular diseases and for cancer. Studying long-run effects on labor market outcomes is informative on the determinants of well-being of elderly workers and on the economic inequality among them.[1] Moreover, in the light of recent increases in mandatory retirement ages in many European countries, it is interesting to know to what extent the elderly can be expected to remain productive at high ages or whether adverse conditions in utero on average cause adverse economic conditions later in life. The Hunger Winter famine enables us to address the latter while filtering out the effects of other systematic determinants of late-life conditions.

We connect our results to those in the literature on long-run health effects of conditions in utero, and to those in the Hunger Winter famine literature in particular. To shape thoughts, one could postulate the following chain of events: [in utero exposure to the famine] → [in utero malnutrition] → [adverse health later in life] → [adverse economic outcomes later in life]. This chain takes long-run health effects to translate into effects on individual economic outcome variables. In particular, concerning the third arrow, notice that unfavorable health conditions (whether observed or not) may negatively affect productivity, for example through mental performance or physical strength or through spells of sickness absence, while productivity in turn affects labor market outcomes. It is also possible that in utero malnutrition causes disadvantages in childhood, for example at school, and this in itself may hurt economic and health outcomes later in life as well.

There are two additional reasons why our analysis is novel. First, we provide results of famine exposure by sub-interval of gestation. This allows us to examine the presence of critical periods in utero for economic outcomes late in life. Secondly, we are the first to use register data covering the entire Dutch population to examine long-run effects of this famine. These data contain the month and municipality of birth as well as the above-mentioned economic outcomes.

The identification strategy exploits variation in the moment and place of birth. Those exposed to the famine in utero may be compared to two "control groups": those born in the famine-stricken area before and/or after the famine, and those born in similar but non-stricken areas during the famine. We distinguish between famine exposures by pregnancy trimester, and we assign trimester treatment statuses in accordance to the epidemiological literature of the famine. As the famine mostly affected urban areas in the Western part of the country, we restrict our sample to individuals born in cities.

A few famine-based studies exist that focus on economic outcomes as well. Neelsen and Stratmann (2011) use the Greek 1941–1942 famine to examine long-run effects on economic outcomes at high ages. The other existing studies consider economic outcomes at prime ages (up to 45) rather than high ages. Specifically, Almond et al. (2010), Chen and Zhou (2007) and Meng and Qian (2009) use the Chinese 1959–1961 famine, while Jürges (2013) relates the German 1945–1948 famine to outcomes in 1970 and 1987. Cutler et al. (2007) examine long run effects of adverse nutritional conditions in the Great Depression in the mid 1930s in America's Dust Bowl and do not find effects on disability and a range of health outcomes. These studies provide important insights into long-run effects of major and prolonged disruptive time periods in society (below we summarize results that are particularly relevant for our purposes). However, the study of these famines also poses a number of challenges in terms of empirical implementation. First, the famines are not as sharply defined in time and space as the Dutch Hunger Winter famine. Therefore, it is harder to distinguish between exposure in different intervals in gestation, and hence to identify critical periods in utero. It is also more difficult to distinguish between exposure in utero and exposure after birth. Secondly, these famines took place in less stable societies. Notably, the Chinese famine was followed some years later by the so-called Cultural Revolution (1966–1976). This potentially increases the risk of confounding and cohort effects.[2] Thirdly, the data are often less detailed. In some cases, the month of birth is not observed or used,[3] exacerbating the complications with exposure mapping. In some cases, the birth place is not observed, and the city or area of residence in adulthood is used as an indicator of location at birth. Fourthly, obviously, studies where the number of years between famine and outcomes is less than 50 cannot address long-run effects and hence the connection to the epidemiological literature on long-run effects is more complex. In terms of findings, the studies of the Chinese famine generally demonstrate adverse effects on labor market status, wealth and marital outcomes. Jürges (2013) finds effects on the level of education and on annual income, for a subset of the cohorts born in the famine (namely, those whose gestation started in the first part of the first winter in the famine). Neelsen and Stratmann (2011) do not find substantial effects of exposure to the Greek famine.

The remainder of this paper is structured as follows. Section 2 describes the famine and mentions epidemiological studies on health outcomes due to exposure to the famine. Section 3 describes the data. Section 4 presents the estimation results. We also provide a range of sensitivity analyses and we address the often-discussed issue that birth cohorts of individuals exposed to a famine in utero may on average be less frail than other birth cohorts, leading to possible selection biases. Section 5 discusses the results. We relate

[1] Long-run effects of hunger early in life on late-life health and labor market outcomes are of obvious relevance for developing countries. But in developed countries poor children may also face hunger spells, and households may rely on programs like the "Women, Infants and Children program" for additional nutritional aid. This WIC-program provides aid to approximately 9.1 million individuals in the US in 2009 and has a budget of 6.9 billion dollars (see Food and Nutrition Service, 2009). In addition, qualitative hunger, i.e. lack of appropriate nutrients, may have adverse effects on the fetus.

[2] There is evidence that long-run effects of reduced nutrition in utero may be stronger if the affected individuals are exposed to a much more favorable environment in childhood (Schulz, 2010).

[3] For instance, Chen and Zhou (2007) and Neelsen and Stratmann (2011) use annual information to define cohort exposure