**Memory of Famine – Does Childhood Experience of Severe Food Shortage Affect Food Choice in Old Age?**

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# Memory of Famine – Does Childhood Experience of Severe Food Shortage Affect Food Choice in Old Age?

**Abstract:** Exploiting China's Great Famine (1959-1961) as a natural experiment, this paper estimates the causal impacts of childhood exposure to food shortage on elderly individual's dietary choices and explores how the impacts vary by the timing of exposure. Using data from the China Health Nutrition Survey (CHNS), which contains detailed information on one's daily food consumption, we exploit cohort and regional variations in one's famine exposure (proxied by regional excess death rates) to perform a difference-in-differences analysis. Our analysis reveals that those who experienced the Famine when they were of school age (7-18 years old) are significantly less likely to choose a diverse diet in old age, compared to those who had reached age 18 by the time of famine and those who were born after the Famine. These findings suggest that those who were old enough to consciously remember their famine experience but had not enough power to make intrahousehold food allocation decisions during the Famine are the most seriously affected cohort.

**Keywords:** Famine, Food shortage; Diet balance; China

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## 1. Introduction

The aged population is currently at its highest level in human history (United Nations, 2001; Sander et al., 2015). Except the 18 countries that are designated as "demographic outliers" by the United Nations, population aging is currently undergoing in every country in the world (UNDP, 2005). As the proportion of elderly individuals in a society rapidly rises, an adequate understanding of their socio-economic behaviors, as well as the determinants and implications of these behaviors, is certainly of both academic interest and policy relevance.

Elderly individuals' food consumption behavior is of particular interest, not only because food expenditure accounts for a large proportion of their budget (Zitter, 1988; Börsch-Supan, 1992; Abdel-Ghany and Sharpe, 1997; Harris and Blisard, 2002; Mao and Xu, 2014; Maharana and Ladusingh, 2014), but also because their food consumption behavior has important nutritional, health and welfare implications. Compared to their younger counterparts, elderly individuals have at least two notable patterns in food consumption. First, while elderly individuals spend significantly less on food than their younger counterparts (partly due to retirement), their budget share for food consumed at home is much larger than that for food consumed away from home (Harris and Blisard, 2002; Chen et al., 2017). Second, as income increases, the marginal propensities to consume for most food categories, including eggs, poultry products, fruits, fish/seafood, and processed fruits, are essentially zero for elderly individuals (Abdel-Ghany and Sharpe, 1997; Harris and Blisard, 2002; Liu et al., 2015). These two patterns imply a limited and monotonous diet adopted by the elderly, which is comprised mostly of low-priced, home-produced, necessity foods. For example, recent studies in different countries have revealed that a large number of elderly individuals consume fruit and vegetables below recommended levels (Riediger and Moghadasian, 2015; Cuervo et al., 2008; Appleton, McGill and Woodside, 2009). Such a diet structure naturally raises concerns about their dietary health and questions about the causes of such a diet. While the first pattern can be largely explained by factors such as income, retirement, aging, as well as other socio-economic factors, the second pattern cannot be easily explained by these factors. To help provide an explanation, this paper explores the role of psychological factors, as well as some root causes of these factors (e.g. life experience), in shaping elderly individuals' food choice.

Our analysis focuses on the case of rural China, where elderly individuals' consumption behavior is usually characterized as being frugal or even somewhat stingy (He, 2004; Zhang, 2008). More specifically, we estimate the impact of childhood exposure to serious food shortage on rural individuals' food choice in old age, exploiting a natural experiment generated by the Great Chinese Famine of 1959-1961, which claimed some 30 million excess deaths and 30 million lost births (Ashton et al., 1984; Banister, 1987). To the extent that childhood experience helps shape one's cognition and preference in adulthood (Becker, 1992; Gerrig and Zimbardo 2008; Gluckman et al., 2005), childhood exposure to the famine is expected to affect one's food consumption behavior in later life, consciously or unconsciously. In particular, we hypothesize that famine survivors tend to set higher priority to foods that are necessary for their survival during the famine (mostly carbohydrates); even in times when more foods are available and affordable, they tend to dwell on the most survival-needed foods given their famine experience.

To test this hypothesis, we exploit cohort and regional variations in Chinese residents' famine exposure to perform a difference-in-differences analysis, using data from the China Health Nutrition Survey (CHNS), which contain detailed information on respondents' food consumption behavior. Our analysis reveals that those who experienced severe famine during childhood tend to choose a less diverse diet in old age. More specifically, measured by the diet-balance index devised by the Chinese Nutrition Society (He et al., 2009), those who spent a number of years of their childhood (aged 17 and below) during the Famine have a significantly lower diet-balance score, compared to those who had reached age 18 by the time of famine and those born after the famine. Moreover, those who experienced the famine when they were of school age (7-17 years old) have the lowest diet-balance scores, suggesting that they adopt the least diverse diet. These findings suggest that those who were old enough to consciously remember their famine experience but had insufficient power to influence intrahousehold food allocation decisions during the Famine are the most seriously affected ones.

We further investigate potential mechanisms that drive the famine effects on food choice. First, given previous findings that the famine significantly undermined famine survivors' health (Chen and Zhou, 2007; Qian and Meng, 2009) and that health status affects one's diet choice (e.g. Zhao, Konishi and Glewwe, 2013; Lemon, Zapka and Clemow, 2004), the effects of the famine found on one's diet balance might be driven by its effects on one's health. However, famine effects on diet structure remain statistically significant after we control for one's health status, which rules out health as the main channel. Second, dire conditions during the famine might have affected famine survivors' risk preference. They are likely to be more risk averse, since securing resources for survival was of top priority under famine conditions. Assessing this possibility indirectly, we find that those with childhood famine exposure are significantly less likely to engage in non-agricultural business, which is usually deemed riskier than farming business. In other words, a higher level of risk aversion resulting from childhood famine exposure helps explain elderly Chinese individuals' limited diet to some extent.

The rest of this paper proceeds as follows. The next section introduces the Great Chinese Famine (1959-1961) and summarizes its impacts. Section 3 develops an empirical framework for assessing the effect of the famine on one's food consumption behavior in old age. Section 4 describes the data, sample and key variables. Section 5 presents and discusses estimation results. Section 6 examines several possible mechanisms through which famine exposure takes effects. Section 7 concludes this research and points out a number of directions for future research.

## 2. Great Chinese Famine (1959-1961)

### *2.1. The Famine*

The Great Chinese Famine of 1958-1961 followed immediately the Great Lead Forward (GLF) agricultural crisis in 1958.[1] A bumper harvest occurred in 1958, when the national grain output reached its peak of 200 million tons. However, in 1959 grain production dropped below the reference level in 1956-1957 in 21 out of the 28 provinces in mainland China with available data; the reduction was more than 10 percent in 12 provinces. The national grain output continued declining over the next few years, by 12 percent in 1959, 26 percent in 1960, and 24 percent in 1961, relative to the 1956-1957

[1] Discussions on the causes of the Famine can be found in Peng (1987), Lin (1990), Lin and Yang (1998), Kung and Lin (2003), among others.

reference level. China’s grain production recovered slowly starting in 1962, but not until 1965 did grain output return to the pre-GLF level (Peng, 1987).

In response to the sharp decrease in agricultural output, food allocation policies established during this period gave higher priority to urban grain supply. Despite the decline in grain output, procurement rates were raised. Heavy procurement deprived the rural population of access to food grains, exacerbating the original shock of output decline in rural areas (Lin and Yang, 2000). As a result of the GLF agricultural crisis and subsequent political decisions regarding interregional food allocation, famine occurred throughout the country in 1958-1961. A sharp increase in the national crude death rates (CDR) and a sharp decrease in crude birth rates (CBR) during 1958-1961 are clearly shown in Figure 1. It has been estimated that the famine claimed some 30 million excess deaths and about 30 million lost births (Ashton et al. 1984; Banister 1987). It has now been recognised as the most devastating famine in human history (Dikötter 2010).

[Figure 1 about here]

*2.2. Impacts of the Famine*

The famine has been found to have affected of famine survivors’ life in various aspects, including health, socioeconomic attainment, as well as behavioral outcomes. On health outcomes, previous studies found that exposure to the famine during fetal life or childhood is found to be associated with reduced height (e.g., Chen and Zhou, 2007; Gørgens et al. 2012; Meng and Qian, 2009), increased risks of diseases (e.g., Huang et al., 2010; Li et al., 2010; Shi et al., 2013), and worse subjective and mental health (St

Clair et al.; 2005; Song, Wang and Hu; 2009; Wang and Zhang, 2017; Fan and Qian., 2015). Famine exposure, especially prenatal or early childhood exposure, is found to reduce famine survivors' socio-economic attainment − it led reduced educational attainment, labor force participation, and farm income (Almond et al., 2007; Chen and Zhou, 2007; Meng and Qian, 2009). Exposure to the famine also exert long-term effects on individuals' behavior. For example, individuals who experienced the famine when they were of cognition- and preference-shaped age are more likely to mitigate risks and behave in a conservative way (Cheng and Zhang, 2011; Wang, Zhang and Liu, 2015; Zhao and Yan, 2015).

Despite the many studies that examine the long run impacts of the famine, however, the vast majority of them mainly focused on the impact of prenatal or early childhood exposure, largely ignoring the potential impact of during later childhood and adolescence. In addition, although a handful of studies investigated the impact of the famine on different behaviors, few have explored the impact of the famine on individuals' diet or food choice. The present study attempts to fill these gaps.

## 3. Empirical Framework

### *3.1. Conceptual framework*

Conceptually, there are at least two channels through which childhood famine experience may affect one's food consumption behavior in later life. The first is a psychological effect. Modern psychological research suggests that risk one's preference and personality are mostly formed during childhood and adolescence (Gerrig and Zimbardo, 2008). Thus, childhood exposure to severe food shortage during the famine may help shape one’s preference and risk attitude in later life. For example, Gluckmaner et al. (2005) find that survivors with childhood famine exposure developed a “compensation psychology”, which induces them to gormandize food in adulthood. Moreover, their fear of hunger formed during the famine years may also induce them to set high priority of hunger prevention and risk avoidance. Echoing this argument, famine survivors are found to have unreasonably high precautionary savings (Chen and Zhang 2011). Under these preferences shaped by their famine experience, the monotonous diet structure that famine survivors were forced to adopt under severe famine conditions may be preserved in their later life. Even when more food varieties become available and accessible, they may still be reluctant to switch to a more diverse diet structure.

The second channel is a health effect. Childhood famine exposure may seriously undermine famine survivors’ health capital, which in turn affects their food choice in later life. Chen and Zhou (2007), for example, find that compared to those who never experienced the famine and those who encountered the famine only in adulthood, those who encountered the famine in childhood are more likely to have chronical diseases such as hypertension and diabetes. To the extent that chronical diseases limit one’s food choice (Zhao, Konishi and Glewwe, 2013), childhood famine exposure may lead to a monotonous diet structure through its effect on one’s chronic health.

While both channels are expected to lead to a monotonous diet structure for elderly individuals who survived the famine during childhood, exposure to the famine in different stages of childhood (e.g. early childhood, pre-school age, school age, etc.) may have different impacts. The next subsection develops an empirical model to explore these impacts.

*3.2. Empirical model*

Our empirical model is in the spirit of difference-in-differences (DID), which exploits time and regional variations in the severity of famine (and hence food shortage) to achieve identification. The basic idea is to compare differences in the diet structure between individuals with and without childhood famine exposure across areas with different levels of food-shortage severity during the famine. As a starting point, suppose that we have information on the severity of food shortage ($S$) one experienced, i.e. severe ($S = 1$) and not severe ($S = 0$), and information on one's childhood famine exposure ($C$), i.e. whether one's childhood was exposed to the famine ($C = 1$) or it was not ($C = 0$). Then, a sensible way to estimate the impact of the famine on one's diet structure ($D$) is to construct the following DID estimator:

$$\delta = \{E[D|\, C = 1, S = 1] - E[D|\, C = 0, S = 1]\} - \{E[D|\, C = 1, S = 0] - E[D|\, C = 0, S = 0]\}. \quad (1)$$

Focusing on areas with severe food shortage ($S = 1$), the first difference certainly captures the impact of the famine, but it also captures some cohort differences in diet structure, as individuals with $C = 1$ and those with $C = 0$ were born in different years. The second difference, in contrast, captures mostly (the undesired) cohort differences and influences of factors other than the famine as this difference focuses on areas without severe food shortage ($S = 0$). Thus, the double-differencing operation in Equation (1) helps to isolate the impact of the famine from cohort effects and non-famine effects. As is well-known, the parameter of interest in Equation (1), δ, can be obtained by estimating the following linear regression model:

$$D = \alpha + \beta S + \gamma C + \delta (C \times S) + u \ , \qquad (2)$$

under the assumption that E[$u$| $S$, $C$] = 0.

In reality, there are more variations in one's famine exposure than those captured by the dummies $C$ and $S$. For example, among individuals with childhood famine exposure, some encountered the famine when younger while others older. To explore how being exposed to the famine in different childhood stages affects one's diet structure in later life, we replace $C$ with a set of indicators of birth cohorts: $Cohort_{ic}$ = 1 if person $i$ was born in Cohort $c$. More specifically, the "treatment" group (i.e. those with $C$ = 1) consists of individuals born before 1962, who exposed at least part of their life to the famine. This group consists of four subgroups: those born in 1958-1961 (Cohort 1: early childhood (ages 0-3) exposure), 1954-1957 (Cohort 2: pre-school-age childhood (ages 4-7) exposure), 1943-1953 (Cohort 3: school-age childhood (ages 8-18) exposure) and before 1942 (Cohort 4: young adulthood exposure). The "control" group (i.e. those with $C$ = 0) is defined as those born in or after 1962 (Cohort 0: no exposure), who were never exposed to the famine in their entire life because the famine ended in 1961.

Similarly, even for individuals born in a given cohort, the level of food-shortage severity they endured may differ substantially across regions. As shown in Figure 2, there are nontrivial variations in death rates during the famine years across provinces. To further explore variations in food-shortage severity for identification, we follow Chen and

Zhou (2007) and replace *S* in Equation (1) with the excess death rate (*EDR*) of the province where one was residing. The *EDR* is defined as the difference between the average death rate (*DR*) over the three famine years (1959-1961) and that during the three normal years prior to the famine (1956-1958) in a given region, i.e.

$$EDR_k = (\sum_{t=1959}^{1961} DR_k)/3 - (\sum_{t=1956}^{1958} DR_k)/3, \text{ for region } k. \quad (3)$$

Further adding a set of covariates vector of personal and household characteristics **X** to the model as yields the following estimating equation:

$$D_{ick} = \alpha + \sum_{c=1}^{4} \beta_c Cohort_{ic} + \gamma_k EDR_k + \sum_{c=1}^{4} \delta_c (Cohort_{ic} \times EDR_k) + \mathbf{X}_{ick}\boldsymbol{\eta} + u_{ick}, \quad (4)$$

where $D_{ick}$ is some measure of the diet structure for individual *i* born in cohort *c* in region *k* (see Section 4 for more details). The coefficients $\delta_c$ on the interaction terms between excess death rates ($EDR_k$) and birth cohort dummies ($Cohort_{ic}$) capture the effect of the famine on the diet structure of individuals belonging to different cohorts.

[Figure 2 about here]

## 4. Data

### *4.1 Survey and sample*

Our empirical analysis draws on data from the China Health and Nutrition Survey

(CHNS). The CHNS is an ongoing panel survey project conducted in collaboration between the Caroline Population Center at the University of North Carolina and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention. For the purpose of the paper, we supplement the CHNS data with information from Peng (1987) and Lin and Yang's (2000) studies.

The main survey covered nine provinces, namely, Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou (Figure 3). The CHNS target provinces vary substantially in geographical, social, and economic characteristics, which are usually considered to be broadly representative of China as a whole. A multistage, clustered, random sampling procedure was applied in the first round of survey in 1989 to select sample households. Follow-up surveys were conducted in 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011 and 2013. Currently, there are around 4,400 households participating in the survey, involving some 25,000 individuals.

The CHNS collected detailed information on sampled households, all of their members, and the communities where they reside. As discussed above, our main analysis focuses on a sub-sample of adults residing in rural areas who were born in a range of years before and after the famine period. The total sample includes those who were born before 1962 as the treatment groups, and individuals were born after 1963, which are treated as the control groups. The analytical sample includes 4,188 observations.

[Figure 3 about here]

*4.2 Measures of diet structure*

One unique feature of the CHNS is that it collected rich information on individuals' consumption of more than 1,500 food items during an interview period of three consecutive days. The information on individuals' food consumption allows us to construct a dietary-diversity score (DDS) and a diet-balance index (DBI) to measure (partially) elderly individuals' diet structure.

The DDS evaluates a person's dietary diversity by summing the *number* of food categories this person consumed during the past 24 hours, out of a total of 11 categories chosen with reference to guidelines provided by the FAO (2008) and recommendations by the Chinese Nutrition Society (He et al., 2009; Xu et al., 2015).[2] If the amount of food consumed in a particular category exceeds the minimum quantity recommended for this category (i.e. 5g for soybean and 25g for any other category),[3] this category is assigned a score of one; otherwise, it is assigned a score of zero. Thus, the DDS ranges from 0 to 11.

Unlike the DDS, the DBI not only counts the *number* of food categories one consumes but also takes into account the actual *amount* of food consumed. The DBI was developed by researchers at the Chinese Center for Disease Control and Prevention and the Chinese Nutrition Society based on the 'Chinese Dietary Guidelines' (Table A1) and the 'Chinese Food Pyramid' (He et al., 2005; He et al., 2009), with reference to the method of constructing indices commonly used to evaluate diet quality of the American population, such as the Healthy Eating Index (HEI) and the Diet Quality Index (DQI).

More specifically, the DBI assesses how balanced an individual's diet is given the recommended level of energy intake determined by this individual's gender, age and

[2] These 11 categories are cereals, starchy roots and products, dark-colored vegetables, light-colored vegetables, fruits, soybean and soybean products, milk and dairy products, red meat and meat products, poultry and games, eggs, as well as fish and shellfish.
[3] These minimum quantities are chosen based on results from previous studies on Chinese residents' diet (Stookey et al., 2000; He et al., 2009; Xu et al., 2015).

daily physical activities (Appendix Table A2). The BDI scores are computed in two steps. In the first step, a score is assigned to a person's consumption of a given food item, say, aquatic products. The score is positive if this person consumes more of that food than the energy-based recommended level and negative if the opposite is true. Appendix Table A3 illustrates the case for the recommended level of 2000-2200 kcal. In the second step, the sum of the positive step-one scores is computed as the Higher Bound Index (DBI-H) to reflect over-consumption of foods. Similarly, the Lower Bound Index (DBI-L) reflecting inadequate consumption of foods is constructed as the absolute value of the sum of all negative step-one scores. In the second step, a sum of step-one scores is computed as the overall DBI (DBI-T). Since overconsumption of some foods and inadequate consumption of other foods may jointly yield a DBI that appears to be well-balanced, we also compute DBIs to separately reflect adequate consumption (DBI-H) and inadequate consumption (DBI-L) of foods: DBI-H (DBI-L) is computed as the weighted average of all positive (negative) step-one scores.

Given the purpose of our study place on the diet structure of elderly individuals, we exclude components related to salt, alcoholic beverage, and drinking water, because elderly individuals in China rarely consume these categories. Finally, since the CHNS collected information on food consumption over three consecutive days, we use the three-day averages of DDS and DBI scores as the outcome variables of interest in the analysis reported below.

*4.3. Distributions of diet-structure measures*

Table 1 presents summary statistics of the DDS and DBI scores, as well as a set of socio-demographic characteristics of elderly individuals in the analytical sample. The average DDS score is about 3.3 (out of 11), indicating a quite limited diet diversity among rural elderly individuals in general. Echoing the pattern of DDS scores, the overall DBI scores (DBI-T) are all negative for the rural elderly in China, indicating significant under-consumption of certain food categories. Moreover, both DDS and DBI-T scores decline as one ages (e.g. moving from Cohort 1 to Cohort 4), suggesting that aging itself may lead to a more limited diet structure. Most importantly, the DBI-L score is higher for who encountered the famine in childhood (Cohorts 1-3) in absolute values than those born after the famine (Cohort 0) and those experienced the famine in adulthood (Cohort 4), meaning that Cohorts 1-3 are more likely to under-consume certain foods than the other two cohorts. While this observation matches our proposed hypothesis well, the extent to which this observation is causal should be determined by more rigorous analysis that controls for potential founding factors.

[Table 1 about here]

## 5. Results

### *5.1 Effects of childhood famine exposure on diet structure in old age*

Columns (1)-(4) of Table 2 present the results of estimating effects of the famine on various measures of rural Chinese individuals' diet structure. As discussed in Section 3, the coefficients of primary interest are those of the interactions between excess death rates (*EDR*) and cohort dummies. Results reported in Table 2 indicate that while most of these coefficients are negative, only those of the interaction between *EDR* and Cohort 3 are statically significant in these models. More specifically, column (1) suggests experiencing the famine in school age reduces one’s DDS score in old age by 0.02 standard deviations, a statistically significant impact (at the 5% level). Column (2), which examines the case of the overall DBI score, yields a similar result. Further disaggregating the impact of childhood famine exposure on the overall DBI into impacts on the over-consumption dimension (DBI-H, column 3) and the under-consumption dimension (DBI-L, column 4) reveals that the impact on the overall DBI is mainly driven through under-consumption dimension − experiencing the famine in school age reduces one’s DBI-L score in old age by 0.03 standard deviations.

[Table 2 about here]

While these findings do suggest that childhood famine exposure can lead to negative impacts on one’s dietary balance and diversity, it is interesting to see that only Cohort 3, i.e. those whose school age was exposed to the famine were affected, but those who encountered the famine in a younger or older age. One explanation is that Cohort 3 were old enough to remember their famine experience but did not have sufficient power to affect food allocation of with their household. In contrast, younger individuals (Cohorts 1 and 2) might be too younger to remember their own famine experience; older individuals (Cohort 4) might have had enough power to gain more food during the famine, as they were already adults when the famine occurred.

*5.2. Cohort effects?*

Note that the DID-type design employed above relies heavily on cohort variations to achieve identification of famine effects. A related concern is thus that the above results may be merely reflecting cohort differences, rather than effects of the famine, even though we have controlled for individuals' age in the regressions. To examine this issue, we perform a placebo test by re-estimating Equation (4) using a sample of individuals who were born after the famine (1963-1991). Since none of these cohorts were ever exposed to the famine, the coefficients of the EDR by Cohort interactions should capture only cohort effects. Thus, finding significant interaction effects in this sample will cast serious doubt on the famine effects found above. However, as shown in Table 3, for both the DDS (columns 1-2) and the overall DBI (columns 3-4) scores, none of the cohort dummies is statistically significant, with and without controlling for individuals' socio-economic characteristics in the model, which greatly helps strengthen the validity of our findings reported in Table 2.

[Table 3 about here]

### *5.3 Influences of migration*

Another threat to the validity of our findings in Table 2 is the potential influence of migration. If a sampled individual migrated to another location, our measure of food shortage severity (*EDR*) may be assigned to a wrong individual. Thus, migration tends to introduce measurement errors to our assigned food shortage severity measure. To assess how serious this problem could be, we exclude individuals residing in Heilongjiang province, which has the highest rate of migration (> 10%) among the CHNS provinces according to the fifth National Population Census of China. Results reported in Table 4 indicate that the results remain quite similar to those reported in Table 2 – in fact, the point estimates became slightly larger than their counterparts reported in Table 2. This suggests that if we were able to completely address the issue of measure errors due to migration, we would find more significant impacts of the famine.

[Table 4 about here]

*5.3. Potential effect through health*

Another concern is that the above findings may mostly reflect the health effects of the famine, since many previous studies (e.g. Chen and Zhou, 2007; Meng and Qian, 2009; Xu et al., 2016) have found that the famine has a significantly negative impact on famine survivors' health status, which in turn plays an important role on one's nutrition intakes (Zhao, Konishi and Glewwe, 2013). To examine this possibility, we re-estimate Equation (4), this time controlling for a set of variables that capture individuals' health status, including self-reported health status (columns 2 and 6), BMI (columns 3 and 7) and height (columns 4 and 8). Yet as shown in Table 5, regardless of which health indicator is being used, the results remain very similar to those reported in Table 2. This suggests that the impacts of childhood famine exposure reported in Table 2 are unlikely to merely reflect the health impact of the famine.

[Table 5 about here]

*5.4. Potential mechanism through risk preference*

Although we have ruled out health as the main channel through which childhood famine exposure takes effects, risk preference remains as a possible channel. To the extent that childhood experience of severe food shortage caused one to develop aversion to uncertainty of food availability in later life, this person may be risk averse in many aspects of life. Although our data do not allow us to construct direct measures of one's risk preference, we examine this channel indirectly by estimating the impact of childhood famine exposure on individuals' entrepreneurship − more specifically, on their engagement in small household handicraft business or other businesses (e.g. restaurants, shops, family hotel, family clinic, etc.). Since many individuals who encountered the famine were no longer in the labor force in 2011, we focus our analysis on data from the 2000 wave. Results reported in Table 5 suggest that those who experienced severe famine during their school age are more likely to be risk averse than those experienced the famine when either younger or older. This echoes the finding of Wang et al. (2015) that individuals who experienced the famine are less willing to engage in self-employment.

## 6. Conclusion

Using data from the China Health Nutrition Survey, we exploit cohort and regional variations in one's famine exposure (proxied by regional excess death rates) to examine how childhood famine exposure affects one's diet structure in old age. Our analysis reveals that those who experienced the famine when they were of school age (8-18 years old) have the lowest diet-balance scores. This suggests that those who were old enough to consciously remember their famine experience but had not enough power to affect intrahousehold food allocation decisions during the famine are the most seriously affected cohort. Our further investigation of the potential driving channel of the famine effects rules out health as the main channel but provides evidence that the famine effects work through famine survivors’ risk preferences. In other words, a higher level of risk aversion resulting from childhood famine exposure helps explain elderly Chinese individuals’ limited diet to some extent.

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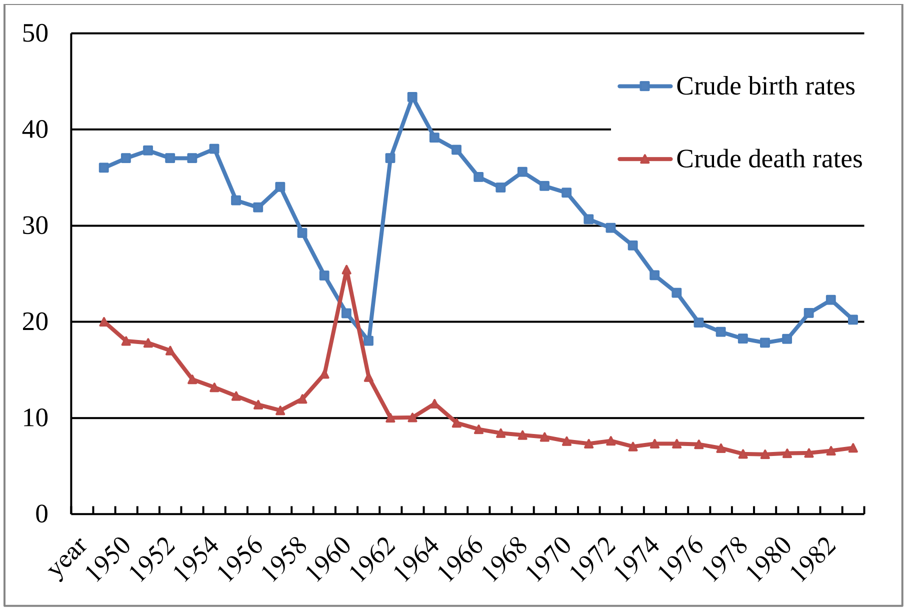
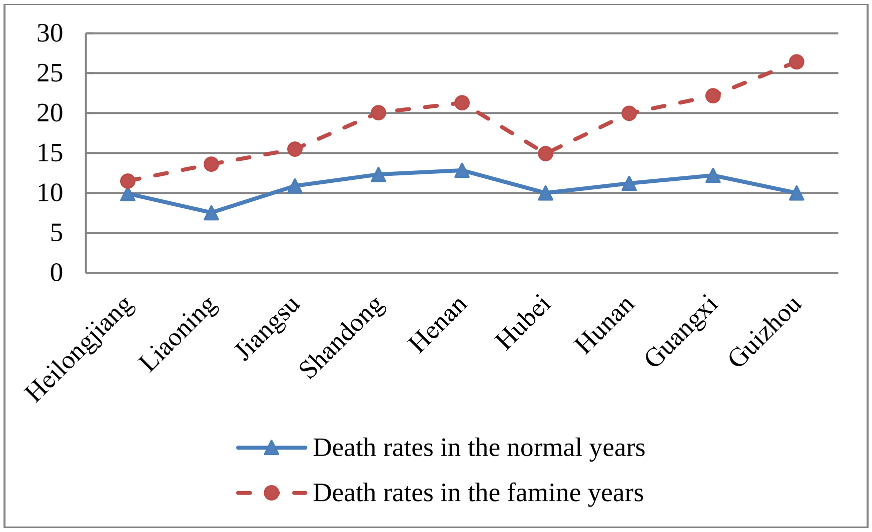



Sources: China Compendium of Statistics 1949-2004

**Figure 1: Crude Birth Rates and Crude Death Rates in China: 1949-1983**




Notes: Data are taken from Lin and Yang (2000). Excess death rates are calculated as the differences between death rates in famine years (1959-1961) and the average of death rates in 1956-1958 in the CHNS provinces.

**Figure 2: Normal and Excess Death Rates in CHNS Provinces**


Source: http://www.cpc.unc.edu/projects/china/about/proj_desc/chinamap

**Figure 3: Provinces participating in the China Health and Nutrition Survey**

**Table 1. Definitions and Summary Statistics of Variables**

| Cohort | | Cohort 0 | Cohort 1 | Cohort 2 | Cohort 3 | Cohort 4 | Total |
|---|---|---|---|---|---|---|---|
| Birth year: | | 1962-1966 | 1958-1961 | 1954-1957 | 1943-1953 | 1938-1942 | |
| *A. Diet structure* | | | | | | | |
| DDS | Diet diversity score | 3.39 | 3.40 | 3.35 | 3.35 | 3.25 | 3.36 |
| DBI-T | Diet-balance index | -17.88 | -18.18 | -18.11 | -18.34 | -18.11 | -18.15 |
| DBI-H | Over consumption index | 7.15 | 6.90 | 7.14 | 6.90 | 7.02 | 7.01 |
| DBI-L | Under-consumption index | -32.29 | -32.31 | -32.58 | -32.61 | -32.72 | -32.61 |
| *B. Socio-economic characteristics* | | | | | | | |
| Age | Age in years | 46.69 | 51.42 | 55.26 | 62.07 | 70.50 | 56.85 |
| Gender | Dummy, 1 = male | 0.48 | 0.48 | 0.47 | 0.48 | 0.49 | 0.48 |
| Ethnicity | Dummy, 1 = Han | 0.90 | 0.89 | 0.86 | 0.83 | 0.86 | 0.86 |
| Education | Years of education | 8.14 | 7.79 | 6.33 | 5.17 | 3.82 | 6.25 |
| Income | Annual household income (yuan) from all sources | 14368.8 | 14864.5 | 13216.8 | 12230.1 | 11089.8 | 13109.4 |
| Health status | Dummy, 1= being ill/injured during the past 4 weeks | 0.12 | 0.10 | 0.15 | 0.18 | 0.26 | 0.16 |
| Household size | The number of household members who usually have dinner together | 2.62 | 2.57 | 2.67 | 2.75 | 2.55 | 2.66 |
| Observations | | 955 | 524 | 729 | 1,577 | 729 | 4,188 |

Source: Author's calculation using the CHNS data. Income is adjusted using CPI in 2011.

**Table 2. Effects of Famine Exposure on Diet Structure**

| Variables | (1)<br>DDS | (2)<br>DBI-T | (3)<br>DBI-H | (4)<br>DBI-L |
|---|---|---|---|---|
| Cohort 1 | 0.001 | -0.025 | -0.031 | 0.011 |
| | (0.129) | (0.133) | (0.128) | (0.121) |
| Cohort 2 | -0.146 | -0.269 | -0.382** | -0.073 |
| | (0.180) | (0.196) | (0.185) | (0.174) |
| Cohort 3 | 0.054 | 0.031 | -0.132 | 0.153 |
| | (0.126) | (0.139) | (0.127) | (0.130) |
| Cohort 4 | -0.275 | -0.374 | -0.609** | -0.057 |
| | (0.274) | (0.249) | (0.236) | (0.237) |
| EDR | -0.031** | -0.009 | -0.019 | -0.001 |
| | (0.012) | (0.015) | (0.016) | (0.013) |
| Cohort 1×EDR | -0.008 | -0.017 | -0.020 | -0.009 |
| | (0.017) | (0.017) | (0.017) | (0.015) |
| Cohort 2×EDR | 0.003 | -0.001 | 0.007 | -0.004 |
| | (0.011) | (0.015) | (0.017) | (0.012) |
| Cohort 3×EDR | -0.019** | -0.024* | -0.003 | -0.029** |
| | (0.009) | (0.013) | (0.012) | (0.012) |
| Cohort 4×EDR | 0.002 | 0.002 | 0.019 | -0.011 |
| | (0.013) | (0.014) | (0.018) | (0.013) |
| Age | 0.014* | 0.023*** | 0.020*** | 0.014** |
| | (0.008) | (0.007) | (0.007) | (0.007) |
| Gender | -0.108*** | -0.271*** | -0.069*** | -0.282*** |
| | (0.024) | (0.027) | (0.025) | (0.026) |
| Education | 0.036*** | 0.044*** | 0.010 | 0.053*** |
| | (0.009) | (0.009) | (0.006) | (0.009) |
| Ethnicity | 0.062 | 0.030 | -0.009 | 0.060 |
| | (0.096) | (0.084) | (0.086) | (0.087) |
| Household income | 0.131*** | 0.094*** | 0.020 | 0.122*** |
| | (0.018) | (0.020) | (0.014) | (0.022) |
| Household size | 0.122*** | 0.062*** | -0.000 | 0.093*** |
| | (0.020) | (0.020) | (0.022) | (0.018) |
| Constant | -2.201*** | -2.203*** | -0.799** | -2.435*** |
| | (0.421) | (0.411) | (0.391) | (0.390) |
| Covariates | Yes | Yes | Yes | Yes |
| Observations | 4,188 | 4,188 | 4,188 | 4,188 |
| R-squared | 0.116 | 0.069 | 0.013 | 0.117 |

Notes: Standard errors in parentheses, adjusted for clustering at the community level. Covariates include age, gender, education, ethnicity, family size and income.
*** p<0.01, ** p<0.05, * p<0.1.

**Table 3. Results of Placebo Tests**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Variables | DDS | | DBI-T | |
| | | | | |
| Cohort 11 (1983-1986) | 0.140 | -0.112 | 0.196 | 0.010 |
| | (0.224) | (0.215) | (0.273) | (0.270) |
| Cohort 21 (1979-1982) | 0.163 | -0.158 | 0.551** | 0.328 |
| | (0.213) | (0.207) | (0.233) | (0.249) |
| Cohort 31 (1968-1978) | -0.232 | -0.601*** | 0.093 | -0.233 |
| | (0.165) | (0.187) | (0.199) | (0.247) |
| Cohort 41 (1963-1967) | -0.301* | -0.825*** | -0.060 | -0.520* |
| | (0.175) | (0.233) | (0.228) | (0.303) |
| EDR | -0.058** | -0.057*** | -0.028 | -0.026 |
| | (0.022) | (0.020) | (0.026) | (0.026) |
| Cohort 11×EDR | 0.003 | 0.013 | 0.003 | 0.011 |
| | (0.026) | (0.026) | (0.030) | (0.030) |
| Cohort 21×EDR | -0.005 | 0.001 | -0.036 | -0.032 |
| | (0.023) | (0.021) | (0.026) | (0.025) |
| Cohort 31×EDR | 0.025 | 0.026 | 0.004 | 0.007 |
| | (0.020) | (0.019) | (0.023) | (0.023) |
| Cohort 41×EDR | 0.023 | 0.025 | 0.014 | 0.016 |
| | (0.020) | (0.019) | (0.026) | (0.025) |
| Covariates | No | Yes | No | Yes |
| | | | | |
| Observations | 3,187 | 3,187 | 3,187 | 3,187 |
| R-squared | 0.037 | 0.109 | 0.019 | 0.050 |

Notes: Standard errors in parentheses, adjusted for clustering at the community level.
Covariates include age, gender, education, ethnicity, family size and income.
*** p<0.01, ** p<0.05, * p<0.1.

**Table 4. Results Obtained Excluding Individuals from Heilongjiang Province**

| Variables | (1)<br>DDS | (2)<br>DBI-T | (3)<br>DBI-H | (4)<br>DBI-L |
|---|---|---|---|---|
| Cohort 1 | -0.099 | 0.107 | 0.104 | 0.073 |
| | (0.155) | (0.147) | (0.162) | (0.131) |
| Cohort 2 | -0.023 | -0.057 | -0.215 | 0.087 |
| | (0.208) | (0.199) | (0.195) | (0.190) |
| Cohort 3 | 0.102 | 0.185 | -0.090 | 0.323** |
| | (0.161) | (0.166) | (0.154) | (0.146) |
| Cohort 4 | -0.115 | -0.160 | -0.421* | 0.092 |
| | (0.298) | (0.251) | (0.246) | (0.239) |
| EDR | -0.024 | 0.019 | 0.016 | 0.010 |
| | (0.015) | (0.013) | (0.017) | (0.013) |
| Cohort 1×EDR | 0.006 | -0.029 | -0.031 | -0.014 |
| | (0.019) | (0.018) | (0.020) | (0.016) |
| Cohort 2×EDR | -0.007 | -0.020 | -0.008 | -0.018 |
| | (0.014) | (0.015) | (0.019) | (0.014) |
| Cohort 3×EDR | -0.023* | -0.038*** | -0.007 | -0.045*** |
| | (0.012) | (0.014) | (0.014) | (0.013) |
| Cohort 4×EDR | -0.010 | -0.015 | 0.003 | -0.022* |
| | (0.015) | (0.014) | (0.019) | (0.013) |
| Covariates | Yes | Yes | Yes | Yes |
| Observations | 3,785 | 3,785 | 3,785 | 3,785 |
| R-squared | 0.123 | 0.078 | 0.010 | 0.131 |

Notes: Standard errors in parentheses, adjusted for clustering at the community level.
Covariates include age, gender, education, ethnicity, family size and income.
*** p<0.01, ** p<0.05, * p<0.1.

**Table 5. Results Conditional on Health**

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | DDS | | | | DBI-T | | | |
| EDR | -0.031** | -0.031** | -0.031** | -0.030** | -0.009 | -0.009 | -0.009 | -0.006 |
| | (0.012) | (0.012) | (0.013) | (0.013) | (0.015) | (0.015) | (0.015) | (0.015) |
| Cohort 1×EDR | -0.008 | -0.008 | -0.008 | -0.008 | -0.017 | -0.017 | -0.017 | -0.017 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) |
| Cohort 2×EDR | 0.003 | 0.003 | 0.003 | 0.003 | -0.001 | -0.000 | -0.001 | -0.000 |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.015) | (0.015) | (0.015) | (0.015) |
| Cohort 3×EDR | -0.019** | -0.019** | -0.018* | -0.018* | -0.024* | -0.024* | -0.023* | -0.022* |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.013) | (0.013) | (0.013) | (0.013) |
| Cohort 4×EDR | 0.002 | 0.002 | 0.003 | 0.003 | 0.002 | 0.002 | 0.003 | 0.004 |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.014) | (0.014) | (0.014) | (0.014) |
| Health status | | 0.002 | | | | -0.106* | | |
| | | (0.043) | | | | (0.054) | | |
| BMI | | | 0.007 | | | | 0.011* | |
| | | | (0.004) | | | | (0.006) | |
| Height | | | | 0.005 | | | | 0.009** |
| | | | | (0.003) | | | | (0.004) |
| Covariates | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 4,188 | 4,188 | 4,188 | 4,188 | 4,188 | 4,188 | 4,188 | 4,188 |
| R-squared | 0.116 | 0.116 | 0.117 | 0.117 | 0.069 | 0.070 | 0.070 | 0.071 |

Note: Standard errors in parentheses, adjusted for clustering at the community level.

Covariates include age, gender, education, ethnicity, family size and income.

*** p<0.01, ** p<0.05, * p<0.1.

**Table 6. Mechanism: Risk Preference**

| | (1) | (2) |
|---|---|---|
| Variable | Handicraft | Business |
| Cohort 1×EDR | -0.034 | -0.072 |
| | （0.070） | （0.071） |
| Cohort 2×EDR | -0.061 | -0.009 |
| | (0.008) | (0.007) |
| Cohort 3×EDR | -0.015* | -0.024* |
| | (0.009) | (0.015) |
| Cohort 4×EDR | 0.006 | -0.037 |
| | (0.013) | (0.042) |
| Covariates | Yes | Yes |
| | | |
| Observations | 1,405 | 1,390 |
| R-squared | 0.006 | 0.010 |

Notes: Standard errors in parentheses, adjusted for clustering at the community level.
Covariates include age, gender, education, ethnicity, family size and income.
*** p<0.01, ** p<0.05, * p<0.1.

**Table A1. Dietary Guidelines for Chinese Residents and the Corresponding Components for the Diet Balance Index (DBI)**

| Dietary guidelines for Chinese residents | Corresponding component(s) in the DBI |
|---|---|
| 1. Eat a variety of foods, with cereals as the staple and include a certain amount of coarse grains. | Diet variety, cereals |
| 2. Consume plenty of vegetables, fruits and tubers. | Vegetables, fruits |
| 3. Consume milk, soybean, or dairy products every day. | Dairy, soybean |
| 4. Consume appropriate amounts of fish, poultry, eggs and lean meat. | Animal food |
| 5. Reduce cooking oil; choose a light diet that is also low in salt. | Cooking oil, salt |
| 6. Avoid over eating, exercise every day, to maintain a healthy body weight. | |
| 7. Rationally distribute the daily food intake among the three meals. If you take snacks, do so appropriately. | |
| 8. Drink sufficient water every day; rationally choose beverages. | Drinking water |
| 9. If you drink alcoholic beverages, do so in limited amounts. | Alcoholic beverages |
| 10. Avoid unsanitary and spoiled foods. | |

Source: He *et al*. (2009).

**Table A2. Recommendations of Food Intake (g/day) for Different Energy Intake Groups**

| Food category | Energy intake groups | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1600 kcal | 1800 kcal | 2000 kcal | 2200 kcal | 2400 kcal | 2600 kcal | 2800 kcal |
| Cereals | 225 | 250 | 300 | 300 | 350 | 400 | 450 |
| Soybean and products | 30 | 30 | 30 | 40 | 40 | 50 | 50 |
| Vegetables | 300 | 300 | 350 | 400 | 450 | 500 | 500 |
| Fruits | 200 | 200 | 300 | 300 | 400 | 400 | 500 |
| Meat and meat products | 50 | 50 | 50 | 75 | 75 | 75 | 75 |
| Milk and dairy products | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| Egg | 25 | 25 | 25 | 50 | 50 | 50 | 50 |
| Fish and shellfish | 50 | 50 | 75 | 75 | 75 | 100 | 400 |

Source: Chinese Dietary Guideline 2007 (He et al., 2009).

**Table A3. DBI Scoring Criteria for the 2000-2200 kcal Energy Intake Group**

| Components | Score Range | Score for different amount of food intake | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | -12 | -10 | -8 | -6 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| Cereals | -12-12 | < 25 | [25-75) | [75-125) | [125-175) | [175-225) | | [225-275) | | [275-325) | | [325-375) | | [375-425) | [425-475) | [475-525) | [525-575) | ≥ 575 |
| Vegetables | -6-0 | | | | < 1 | [1-175) | | [175-350) | | ≥ 350 | | | | | | | | |
| Fruits | -6-0 | | | | < 1 | [1-150) | | [150-300) | | ≥ 300 | | | | | | | | |
| Dairy | -6-0 | | | | [1-100) | [100-200) | | [200-300) | | ≥ 300 | | | | | | | | |
| Soybean | -6-0 | | | | < 1 | [1-20) | | [20-40) | | ≥ 40 | | | | | | | | |
| Meat | -4-4 | | | | | < 1 | | [1-25) | | [25-75) | | [75-125) | | ≥ 125 | | | | |
| Fish and shrimp | -4-0 | | | | | < 30 | [30-45) | [45-60) | [60-75) | ≥ 75 | | | | | | | | |
| Egg | -4-4 | | | | | < 1 | | [1-25) | | [35-50) | | [50-75) | | ≥ 75 | | | | |
| Oil | 0-4 | | | | | | | | | ≤ 25 | | (25-50] | | > 50 | | | | |
| Salt | 0-4 | | | | | | | | | ≤ 6 | | (6-12] | | > 12 | | | | |
| Alcohol (Men) | 0-4 | | | | | | | | | ≥ 50 | | (50-100] | | ≥ 100 | | | | |
| Dietary variety | -12-0 | For each food subgroup, score ‘0’ for consumption of greater than 25g (soybean is 5g), otherwise score is ‘-1’ | | | | | | | | | | | | | | | | |
| Drinking water | -12-0 | Score ‘0’ for consumption of greater than 1200 ml, score ‘-12’ for consumption of less than 100 ml. Score decreased 1 with intake amount decrease 100 ml from 0 to -12 | | | | | | | | | | | | | | | | |

Note: Criteria for other energy intake groups have been described in He et al. (2009).