Research in Progress

Folate

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1. Motivation and Research Question

U.S. government spends over 100 billion dollars on food and nutrition programs every year.

For the longest time, food assistance programs focus on nudging consumers into healthier foods, which has proved to be inefficient because consumers are usually reluctant to change their consumption behaviors.

Allcott et al. (QJE, 2019) finds that only 10% of nutritional inequality can be explained by exposure to healthier foods and the remaining 90% is driven by difference in demand.

Reformulation, on the other hand, targets making existing diet more nutritious without asking for behavioral change.

This paper studies a special case of reformulation: food fortification, an intervention that adds nutrients to existing foods. Specifically, I focus on folic acid fortification of enriched grain products in the late 90s.

1. Motivation and Research Question

Folate is a critical micronutrient for fetal neurodevelopment. Folate deficiency is associated with cognitive impairment (Roth et al., 2011; Irvine et al., 2022). Severe folate deficiency can lead to birth defects and fetal death.

In the early 90s, more than 4,000 fetuses (approximately 1 in 1000 fetuses) each year were diagnosed with birth defects associated with folate deficiency in the U.S., about one-third of which were lost due to selective or spontaneous abortions.

To prevent folate deficiency, in March 1996, US Food and Drug Administration (FDA) mandated fortification of enriched grain products including flour, pasta, rice, and breakfast cereals with folic acid, the synthetic form of folate (140μg/100g products) (FDA, 1996).

Science literature focuses on its short run health effects, usually based on small samples. Folic acid fortification receive little attention from economists. Evidence on long run socioeconomic effects is lacking.

Research question: What are the short and long run effects of folic acid fortification?

Example of enriched grain products fortfied with folic acid.

Figure 1: Chips with Enriched Wheat Flour as an Ingredient

Fortification sharply increases folate content in a wide variety of foods.

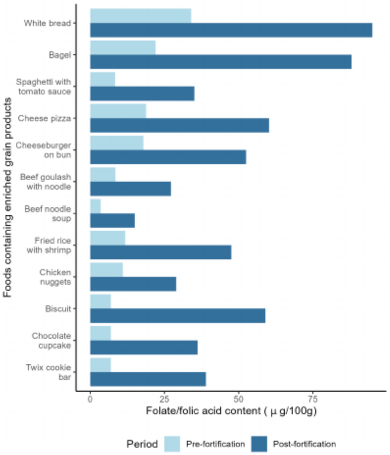

FIGURE 2: CHANGES IN FOLATE CONTENTS IN SELECTED FOODS DUE TO FORTIFICATION

2. Data

Vital Statistics Natality Data

- Birth defects associated with folate deficiency (congenital anomalies of central nervous system, or CNS anomalies), 1989-1993.6, as a proxy for pre-existing folate deficiency;
- Birth outcomes and maternal characteristics, 1993.7-2002, to study short run effects of fortification.

American Community Surveys PUMS

- School enrollment, labor participation, and wage, 2017-2019 & 2021-2022, to study long run effects of fortification.

3. Methods

I link data on birth defects associated with folate deficiency from vital statistics data to outcome data from vital statistics data and American Community Surveys via place and time of birth so I can compare cohorts exposed and unexposed to folic acid fortification across regions with different pre-existing folate deficiency.

I follow the following cohort event study model:

$$Y_{cjt} = \sum_{\gamma=1992, \gamma \neq 1995}^{2002} \beta_{\gamma} \text{CNS anomaly rate}_j \times \mathbf{1}\{t \in \gamma\} + \mu_c + \lambda_t + C_{cjt} + \varepsilon_{cjt},$$

where Y_{cjt} is mean outcomes of interest for births in county-of-maternal-residence i and quarter-and-year of birth t, CNS anomaly rate_j is CZ-by-state-level pre-existing CNS anomaly rate, μ_c is county fixed-effect, λ_t is quarter-and-year-of-birth fixed effect, C_{cjt} is a set of control variables, and ε_{cjt} is an error term.

3. Methods

The model for long run effects are similar to the one for short run effects except unit is individuals and CNS anomaly rate is aggregated at state-of-birth level:

$$Y_{is\tau} = \sum_{\gamma=1992,\gamma\neq 1995}^{2002} \beta \text{CNS anomaly rate}_s \times \mathbf{1}\{\tau \in \gamma\} + \mu_s + \lambda_\tau + C_{is\tau} + \varepsilon_{is\tau},$$

where $Y_{is\tau}$ is outcome of individual i who born in state s and quarter-and-year τ, CNS anomaly rate_s is state-level pre-existing CNS anomaly rate, $Post_{is}$ is share of births whose first trimester ends before authorization of folic acid fortification in state s and in quarter-and-year of birth τ, μ_s is state fixed-effect, λ_τ is quarter-and-year-of-birth fixed effect, $C_{is\tau}$ is a set of control variables, and $\varepsilon_{is\tau}$ is an error term. $C_{is\tau}$ includes gender, race dummies, and Hispanic origin of individual i, and state-of-residence-by-survey-year fixed-effect, in addition to everything in C_{cjt} but at state level.

4. Short run effects

Fortification increases shares of births given by disadvantaged mothers, likely through improved fetal survival rate.

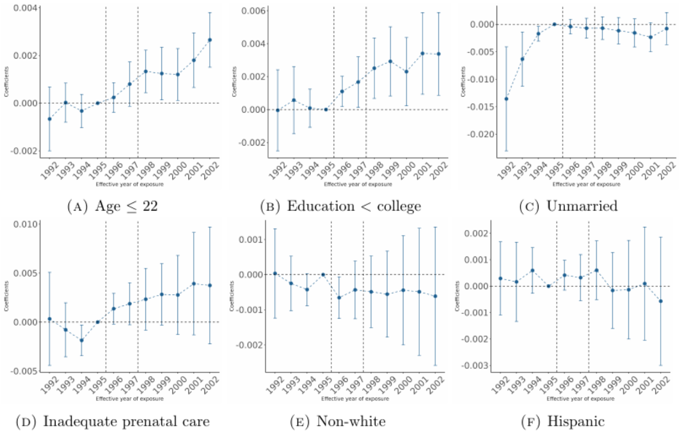

Figure 2: Dynamic Effects of Folic Acid Fortification on Maternal Characteristics

5. Long run effects

Maternal exposure to folic acid fortification increases probability of young adults enrolling in college or graduate/professional schools.

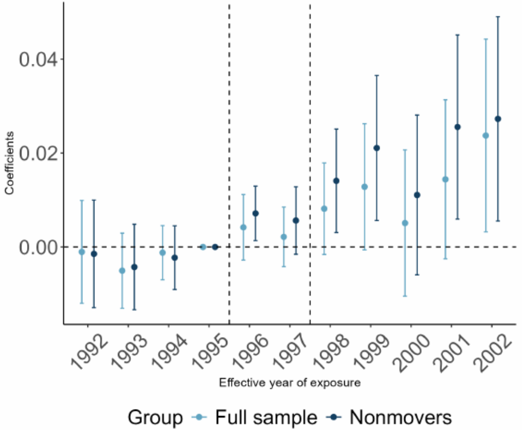

Figure 4: Dynamic Effects of Folic Acid Fortification on School Enrollment of Young Adults

7. Discussion: Policy Implication

Effects of maternal nutrition.

- Broad: not just instant infant health, but also cognitive development;
- Long-lasting: maternal nutritional shock would affect outcomes in young adulthood.

Rethink role of reformulation such as food fortification in food assistance policy portfolio.

- How reformulation can compensate existing food assistance programs to improve dietary and health outcomes?

Thank you!

Feel free to reach out to me via wjzhan@ucdavis.edu for any questions.