Pasteurization and Public Health: A study of city milk supply and infant mortality in the US 1920 to 1930

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Abstract

Infant mortality rate is an indicator of public health and social welfare (Preston 1975; Haines 1985, 2011; Lee 1991). In the US and some European countries, urban infant mortality rates have been gradually declining since the middle 1800s. Several factors accounted for this trend, e.g. the economic growth, improved public sanitation and medical provisions, spread of child care knowledge, and better food and nutrition conditions (McKeown 1976; Preston and Haines 1991; Fogel 1994; Millward and Bell 1998; Cutler and Miller 2005; Lee 2007). Specifically, the improvement of city milk supply was emphasized a lot by some researchers, as adulteration and contamination were two fatal milk problem to infants in those years (Beaver 1973; Selitzer 1976; Meckel 1990; Block 1999; Atkins 2003; Lee 2007; Tunick 2009). Fortunately, milk adulteration was largely controlled after many cities introduced municipal pure milk regulations around 1890s (Law 2003). Another threat, the bacterial contamination, was also noticeably reduced with the spread of pasteurization in early 1900s. Thus, some researchers like Beaver (1973), Block (1999), Atkins (2003) and Lee (2007) argued the improvement in market milk quality was the critical factor led to decline in urban infant mortality rate.

As an remarkable technical breakthrough in the dairy industry, the public health impacts of pasteurization have been an important topic in epidemiology, food science and nutrition, and public policy since early 1900s. However, there are two major limitations in prior studies. First, most of them were in a narrative nature. There were no persuasive quantitative methods to measure the number of infants were saved by the technology from serious milk diseases, such as diarrhea, typhoid fever and tuberculosis. Second, this question became more complicated because of the endogeneity problem. In history, income or economic condition was an important sources of endogeneity, since it decided both sides of the extent of pasteurized milk in market and the status of public health in cities. For example, Lee (2007) referred income as “a mediating factor in diarrheal infant mortality”. Even some literature noticed the problem, no effort has been made to separate the impacts of income in previous discussions. The share of pasteurized milk was related with income because certain costs arose in process of pasteurization and bottling. Moreover, pasteurized milk production also was related with the manufacture in cities. Even some of above literature mentioned the problem, no effort has been made to separate the impacts of income in previous discussions.

This paper contributes to existing knowledge in three aspects. First, it focuses on the measurement of the public health impact of pasteurization instead of just narrating the historical facts. Consequently, some important data were first explored. For example, the US Public Health Service (US
PHS) 1931 survey reported the percentage of pasteurized milk across 484 cities, which included much more observations than earlier surveys in 1920s. And the dependent variable is derived from the statistics of Bureau of the Census in 1931, which contained more observations than others annual mortality statistics. Secondly, to obtain a clear casual impact of pasteurized milk, this study solves the endogeneity of income, pasteurization and infant mortality. The remedies are adding variables to control income factors as well as applying the instrumental variable (IV) approach. Thirdly, this study estimates the long-term health impacts of milk pasteurization. Obviously, infant mortality was gradually declining in 1920 to 1930. But the weight of improved market milk supply was still less clear. A panel estimation using the fixed effect (FE) model helps to reveal the impact of pasteurization in that period.

Empirically, the instrument for the share of pasteurized milk in the market is the status of municipal ordinance for pasteurization reported in the 1931 US PHS survey. At that time, the extent of pasteurization in the market was under much influence of economic condition and income factors. In contrary, the status of regulation was relatively stable. A good example, the US Public Health Service 1936 survey recorded the average share of pasteurized milk in cities over 10,000 population in that year was lower than 1931, instead of an expected increase. During the economic depression, many farmers chose to “unload the milk as raw” (Fuchs and Frank 1938). Another rationale for using this IV is the reported status of municipal milk ordinance cannot directly influence public health. Apparently, the influence of such regulation changes to infant mortality could be only indirectly via the milk for drinking. Last, reverse causation is not a problem in this study. Similar to the city water treatment case in Cutler and Miller (2005), the paper discusses the sequencing of milk pasteurization and infant mortality.

Results of the cross-sectional estimation of city milk pasteurization and infant mortality under 1 year in 1931 suggest the effects of pasteurization were consistent and significant across various models. However, the coefficient is much higher in the IV models than the ordinary least square (OLS) ones. That is to say, the role of pasteurization could be underestimated if the influence of income is not squeezed out. Some similar biased OLS estimation caused by endogeneity in recent health economics literature can be found in Fletcher (2010) and Cawley and Meyerhoefer (2011). With controlling other demographic factors, including gender (share of female population), age groups (portion of under 5-year old population) and ethnic groups (black and white population), the IV models are estimated. For robustness, the instrument passed the validity and regressor endogeneity tests. As for panel models, they support milk pasteurization significantly contributed to the drop of infant mortality in the period 1920 to 1930. Finally, this study provides some evidence to evaluate the health effects of milk pasteurization in other countries in history, such as Britain, France and Germany (Beaver 1973; Preston and van de Walle 1978; Woods, Watterson and Woodward 1988; Atkins 1992; Vögele and Woelk 2002).
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