"For Want of a Cup: The Rise of Tea and the Impact of Water Quality on Mortality in England"

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PRELIMINARY AND INCOMPLETE, NOT FOR CITATION

While it is now well accepted that access to clean water plays an important role in public health and economic development, there is little historical evidence for the role that clean water played in the development of the now-rich world. I investigate this question by exploiting a natural experiment on the effects of water quality on mortality—the advent of tea consumption in 18th century England. The custom of tea drinking spread rapidly throughout England, even among lower classes, and resulted in an unintentional increase in consumption of boiled water. Preliminary results suggest that yearly shocks in tea imports had a negative effect on mortality rates and areas with lower initial water quality had larger declines in mortality rates in years following larger importations of tea. Finally, I discuss the broader impact of this accidental improvement in public health which occurred at the same time that people were crowding into cities, thus providing the labor needed for industrialization.

JEL Classification: N53, Q25, Q56

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I. Introduction

The importance of access to clean water for economic development has recently received considerable attention. Policy-makers raised the issue as a priority worthy of inclusion in the Millennium Development Goals. While leaders have now met the global target of expanding access to safe drinking water, an estimated 780 million people still lack access to an improved drinking water source (WHO/UNICEF 2012). At the same time, researchers have continued to estimate the impact of water interventions on health and mortality (Kremer et al. 2011, Galiani et al. 2005) as well second-order effects, such as happiness and quality of life (Devoto et al.). Although these studies underscore the important role that access to clean water plays in economic development, much less is known about the role that water played in the development of the now-rich world. I investigate this question by exploiting a natural experiment on the effects of water quality on mortality—the advent of tea drinking in 18th century England. I hypothesize that the main mechanism behind this relationship operated through the increased consumption of boiled water. Since boiling water is necessary for brewing tea, the rise of tea consumption in 18th century England would have resulted in an accidental improvement in the relatively poor quality of water available at the time. To what extent can this explain the drop in mortality rates seen over this period?

I put forth two empirical strategies to estimate the causal relationship between tea consumption and mortality rates in England. The first is a differences-in-differences model that compares the period before and after tea was first introduced to England across areas that vary in their initial levels of water quality. This is similar to the approach used by Nunn and Qian (2011), who exploit regional variation in the suitability of land for potato cultivation to estimate

the impact of the potato on population. The second model employed here uses actual tea import data at the national level interacted with measures of water quality that vary across England. Thus, I investigate whether positive shocks to tea imports resulted in larger declines in mortality rates in areas where water quality was initially worse.

As expected, preliminary results (not reported here) suggest that the introduction of tea resulted in larger declines in mortality rates in areas that had worse water quality to begin with. Yearly shocks in tea imports also had a negative impact on subsequent mortality rates and areas with lower initial water quality appear to have had larger declines in mortality rates in years following relatively high tea imports. Finally, I discuss the broader impact of this accidental improvement in public health which occurred at the same time that people were crowding into cities, thus providing the labor needed for industrialization.

The remainder of this paper is organized as follows. Section 2 provides some background on the historical context surrounding the introduction of tea to England. Section 3 presents the empirical strategy including the two estimating equations described above. Section 4 describes the data used in the analysis. Section 5 concludes.

II. Background

Several historians have suggested that the custom of tea drinking may have been instrumental in curbing deaths from water-borne diseases and thus sowing the seeds for economic growth. MacFarlane (1997) draws comparisons between the experiences of England and Japan in this respect. Mair and Hoh (2009, p.198) write that without "boiled beverages such as tea, the crowding together in immense cities caused by the migration from field to factory would have unleashed devastating epidemics." Similarly, Standage (2006, p.201) writes that the popularity of

tea "allowed the workforce to be more densely packed in their living quarters around factories in the industrial cities…without risk of disease." This view is echoed by Johnson (2006, p. 95), who writes that "largely freed from waterborne disease agents, the tea-drinking population began to swell in number, ultimately supplying a larger labor pool to the emerging factory towns...."

Tea was first imported to England from China in 1689 (Mair and Hoh, 2009) and its popularity increased rapidly throughout the following century, growing from roughly six tons at the beginning of the 18th century to eleven thousand at the end (Johnson, 2006). The English East India Company had a long-running monopoly on tea imports that lasted throughout the period considered here. While the link between increased tea consumption, population, and growth has been the subject of some speculation, to my knowledge this is the first paper to provide quantitative evidence on this relationship.

III. Data

The mortality rates and parish characteristics used in the analysis are constructed from Schofield and Wrigley's (2003) collection of records on burials, baptisms, and marriages for 404 English parishes over the years 1538-1849. The water quality measures used in the analysis are based on parish altitude and initial population density in the parish at a point in time prior to the advent of tea consumption. It is believed that parish altitude should be positively correlated with water quality because parishes at higher elevation would have been less likely to be subjected to water contamination from surrounding areas. Similarly, a steeper terrain would have meant that water would be less likely to pool or stand and thus provide fewer sources for contamination. Thus, further research will include measures of the average slope in the parish based on GIS coordinates to more accurately describe this relationship. The correlation between initial

population density and water quality, however, is expected to be negative, as a denser parish would have posed greater challenges for disposing of human waste and thus providing greater sources for contamination. This is particularly true for this period prior to the widespread acceptance of the germ theory of disease and the public health movement that began later in the 19th century (Johnson 2006).

The data on national-level tea imports come from the East India Company records available from Bowen (2007) and cover the years 1761-1834. Unfortunately, the data on tea are not available at the parish level. Preliminary results show a negative correlation between tea imports and national mortality rates provided by Wrigley and Schofield (1981, p.531-534). This relationship is illustrated in Figure 1.

IV. Empirical Strategy

To measure the effect of tea drinking on mortality rates in England, I begin by comparing the mortality rates across areas that varied in initial water quality before and after the advent of tea consumption. This is estimated via the following regression model:

$$DeathRate_{it} = \alpha + \gamma(WaterQuality_i \times PostTeaIntroduction_t) + \boldsymbol{X_{it}\beta} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where the dependent variable is the number of deaths per thousand people in parish *i* in year *t*. The independent variable of interest, $WaterQuality_i \times PostTeaIntroduction_t$, is an interaction term between the initial water quality in parish *i* and a dummy variable indicating the period is after the introduction of tea to the population of England. I begin by using 1700 as the date when tea first made inroads into the drinking customs in England, and test whether the results are robust to the use of alternative dates, such as the drop in tariff rates occurring around

1784. All regressions include parish fixed effects (μ_i) and year fixed effects (δ_t). $\boldsymbol{X_{it}}$ includes controls for other parish characteristics that vary over time. Standard errors are clustered at the parish level. Equation (1) is estimated on all of the available data as well as a subset of years more closely surrounding the advent of tea consumption.

To provide further evidence of the impact that tea consumption had on mortality rates, I utilize actual tea import data to compare the impact of national tea imports on mortality rates in areas that varied in their level of initial water quality:

$$DeathRate_{it} = \alpha + \gamma(WaterQuality_i \times TeaImports_{t-1}) + \boldsymbol{X_{it}\beta} + \mu_i + \delta_t + \varepsilon_{it} \qquad (2)$$

where the independent variable of interest, $WaterQuality_i \times TeaImports_{t-1}$, is the interaction term between initial water quality in parish *i* and national-level tea imports in year *t-1*. The use of lagged tea imports reflects the fact that tea imports arriving in London may not have reached the final consumer until the following year. In further work, I use a simple moving average of tea imports to address the possibility that the accumulation of tea inventories smoothed consumption of tea over time. All remaining variables are as specified above. Preliminary results (not reported here) suggest that areas with worse initial water quality had larger declines in mortality in years following large importations of tea.

To further bolster the evidence that the mechanism behind these results was the improvement in water quality, in the future I will use cause-specific death rates from London over this time period (available in Marshall,1832) to investigate whether the advent of tea consumption and shocks to tea imports resulted in fewer deaths related to water-borne diseases such as dysentery. I also plan to use data on infant and child mortality rates from London (available in Marshall,

1832), as infants and children are thought to be more sensitive to water-borne diseases (MacFarlane 1997). Falsification tests will also be run to show that shocks to tea imports did not affect air-borne diseases such as tuberculosis and smallpox. This is similar to the approach used by Galiani et al. (2005), with the obvious drawback that cause-specific mortality rates are not available across parishes, thus eliminating the possibility of a differences-in-differences strategy. In addition, I will perform falsification tests to show that unlike tea, other imported goods did not have a similar impact on mortality rates.[1] This will add weight to the causal interpretation for the special role that tea played in decreasing mortality.

V. Conclusion

Preliminary results (not presented here) on the link between tea and mortality rates suggest that the advent of tea consumption in 18th century England resulted in larger declines in mortality rates in areas that had worse water quality to begin with. Areas with lower initial water quality also appear to have experienced larger declines in mortality rates in years following relatively high tea imports. While the broader impact of tea consumption on mortality rates at the dawn of the Industrial Revolution has been hypothesized by the historians noted above, to my knowledge this paper provides the first quantitative evidence on this relationship. Consequently, this paper has the potential to make a significant contribution to the literature on the origins of the Industrial Revolution. The article would also make a significant contribution to the field of economic development which has recently seen a surge in attention devoted to improvements in water quality in currently developing countries. While the literature has primarily focused on evaluations of policy interventions and randomized trials, this paper is an important exception. Here, I present a case in which water quality was improved without concerted intervention, but

[1] Data on several other East India Company imports are available along with the tea data in Bowen (2007).

instead through a custom that ultimately may have proved critical for long-run economic development.

References

Bowen, H., *East India Company: Trade and Domestic Financial Statistics, 1755-1838* [computer file]. Colchester, Essex: UK Data Archive [distributor], September 2007. SN: 5690, http://dx.doi.org/10.5255/UKDA-SN-5690-1.

Devoto, Florencia, Esther Duflo, Pascaline Dupas, William Parienté, and Vincent Pons. 2012. "Happiness on Tap: Piped Water Adoption in Urban Morocco." *American Economic Journal: Economic Policy*, 4(4): 68–99.

Galiani, Sebastian, Paul Gertler and Ernesto Schargrodsky. 2005. "Water for Life: The Impact of Privatization of Water Services on Child Mortality." *The Journal of Political Economy*, 113(1): 83-120.

Johnson, Steven. 2006. The Ghost Map. Penguin Group: New York.

Kremer, Michael, Jessica Leino, Edward Miguel, and Alix Peterson Zwane. 2011. "Spring Cleaning: Rural Water Impacts, Valuation, and Property Rights Institutions." *The Quarterly Journal of Economics*, 126(1): 145-205.

Mair, Victor H. and Erling Hoh. 2009. *The True History of Tea*. Thames and Hudson: London.

MacFarlane, Alan. 1997. *The Savage Wars of Peace: England, Japan, and the Malthusian Trap.* Blackwell: Oxford, UK; Cambridge, MA.

Marshall, J. 1832. *Mortality and the Metropolis.* J. Haddon: London.

Nunn, Nathan and Nancy Qian. 2011. "The Potato's Contribution to Population and Urbanization: Evidence from a Historical Experiment." *The Quarterly Journal of Economics*, 126(2): 593-650.

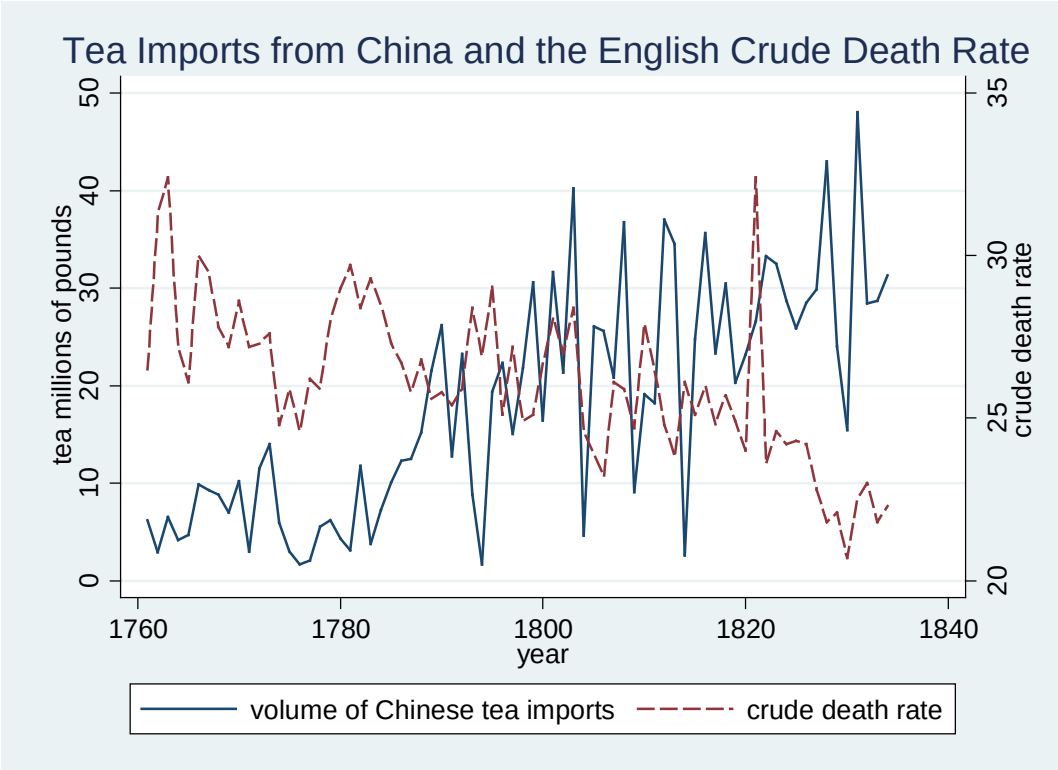
Schofield, R.S. and Wrigley, E.A., *Parish Register Aggregate Analyses, 1662-1811; 404 Data* [computer file]. Colchester, Essex: UK Data Archive [distributor], April 2003. SN: 4491, http://dx.doi.org/10.5255/UKDA-SN-4491-1.

Standage, Tom. 2006. *A History of the World in Six Glasses.* Walker Publishing: New York.

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. 2012. "Progress on Drinking Water and Sanitation: 2012 Update." UNICEF and World Health Organization.

Wrigley, E.A. and R.S. Schofield. 1981. The Population History of England, 1541-1871: A Reconstruction. Harvard University Press: Cambridge, MA.

Figure 1


Tea Imports from China and the English Crude Death Rate
tea millions of pounds
0
10
20
30
40
50
crude death rate
20
25
30
35
1760
1780
1800
1820
1840
year
volume of Chinese tea imports
crude death rate