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Household Income and Spending in the United States During the 1918 Influenza Pandemic*

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Abstract

How did the 1918 influenza outbreak, the deadliest pandemic of the twentieth century, affect household income and spending in the United States? Using the 1917–1919 BLS cost of living survey, we compare households in 99 cities observed at different stages of the pandemic. We find a six percent decrease in real income, driven by cities with higher mortality. Men's wages fell, but more women worked. People spent less on nondurable goods and services, about the same on durables, and more on medicine. Spending varied by region, age, and affluence. Government-imposed non-pharmaceutical interventions had little correlation with consumer behavior.

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INTRODUCTION

On September 28, 1918, Philadelphia held a parade – "to be the greatest parade in Philadelphia's history" (Barry 2020, 205) – to entice liberty loan purchases. In a campaign to raise funds in support of the war against Germany, each city had to sell a quota of liberty loans, and the parade was Philadelphia's big push. But there was a problem. A severe form of influenza had appeared in the Philadelphia Navy Yard. By mid-September, more than six hundred sailors and soldiers had already been hospitalized. Philadelphia public health director, Wilmer Krusen, did not cancel the parade, despite several attempts from medical personnel to persuade him to do so. While military officials were imposing quarantines, Krusen resisted any action. According to historian John Barry (2020, 202), "Krusen publicly denied that influenza posed any threat to the city. He seemed to believe that, for he made no contingency plans in case of emergency." The parade was a spectacle, but also, in today's parlance, a super-spreader event. Three days later, every bed in each of the city's 31 hospitals was filled. Philadelphia soon had among the highest mortality rates of any city; October would become Black October.

What was happening in Philadelphia was happening all across the country. Influenza had already reached New Orleans by September 4, carried by three seaman who had arrived from Boston (Barry 2020, 191). In the next few days it arrived at ports along the Atlantic and Gulf coast. It then rapidly spread inland, following the rivers and the railways. By October, it had spanned the entire country, with devastating consequences (Sydenstricker 1918). From March 1918 through March 1920, the pandemic killed between 500,000 and 675,000 Americans and between 50 and 100 million people worldwide (Patterson and Pyle 1991; Killingray and Phillips 2003) – a broad range, as Laura Spinney (2017, 10) observes, "that reflects the uncertainty that still surrounds it."

Uncertainty surrounds not only the death count but also the economic effects. Some evidence suggests mild economic effects. Burns and Mitchell (1946, 109) find a recession of "exceptional brevity and moderate amplitude". Velde (2020) finds a sharp but short-lived decline in industrial output, little effect on retail, and no evidence of increased business failures or a stressed financial system. Baker et al. (2020a) find no evidence that the pandemic can explain any of the 23 daily stock market jumps between March 1918 and June 2020. Arthi and Parman (2021, footnote 39), in a review of lessons from the pandemic, refer to the "relatively mild and short-lived

effects on the economy." The same mild or, at best, ambiguous effects on economic activity are found elsewhere in the world (De Kadt et al 2021; Guimbeau et al. 2020; Karlsson et al. 2014).

Not all agree, though. Correia et al. (2020) use manufacturing censuses to show that cities that were more severely affected by the influenza experienced sharp and persistent declines in economic manufacturing activity; at the mean level of exposure, manufacturing output declined by 18 percent. Bank charge-offs increased more in worse affected areas. Bodenhorn (2020) uses weekly quantitative and qualitative information from trade publications in the South to show a decline in retail sales and manufacturing activity, with greater influenza-related mortality associated with larger numbers of business failures. Bodenhorn argues that these changes were largely the result of supply- rather than demand-side shocks: worker absenteeism due to illness or fear of illness reduced output between 10 and 20 percent.

It is in the context of this mixed macroeconomic evidence that we investigate household-level income and spending behavior during the pandemic in the United States. Using a cost of living survey administered in late 1918 and early 1919 by the Bureau of Labor Statistics, we compare households located in cities that were surveyed before, during, and towards the end of the largest wave of deaths. These cities had parallel trends in manufacturing wages in the decade and a half leading up to the pandemic. We find six percent lower real income for households observed during the later stages of the largest wave of deaths. Lower wages earned by husbands explains this decline, although this decrease was partially offset by greater labor force participation by wives. These changes were greatest in the cities with the worst mortality. We also investigate the relationship between government interventions and income. Lengthier school closures, bans on public gatherings, and isolation and quarantine measures reduced the mortality rates (Markel et al. 2007), and we find that these measures had no negative effect on income. Had director Wilmer Krusen known this, he might have cancelled the fateful September 28 liberty loan parade, saving thousands of lives. Our source also allows us to differentiate different types of spending. We find heterogeneous effects. Spending on durable goods changed little, but spending on nondurable goods and services fell by up to 12 percent. Cluster analysis allows us to identify the household characteristics jointly associated with large spending declines: older, wealthier households and those located in the Midwest and West. Finally, saving declined by 42 percent, driven by declining purchases of liberty bonds.

Our results contribute to at least three important literatures. First, we add to the literature on the effects of the 1918 influenza pandemic in the United States, a literature rekindled by the arrival of Covid-19. We now know that the 1918 pandemic mortality was correlated with air quality (Clay, Lewis and Severnini 2018), that it caused social mistrust (Aassve et al 2021), that it had statistically significant but small effects on electoral outcomes (Arroyo Abad and Maurer 2021), that bans of public gatherings and other interventions caused innovation (Berkes et al. 2020), and that school closures had no effect on 1920 school attendance and little effect on 1940 long-run schooling or labor market outcomes (Ager et al 2020). This evidence stands on the shoulders of a literature that shows the long-run, persistent individual outcomes of pandemics (Almond 2006).

Second, we add to a recent literature on the economic consequences of pandemics and, more broadly, health shocks. Noteworthy pandemics in history – from the Black Death in Europe to the plague in India to the Ebola outbreak in West Africa – have been used to study the long-term consequences of mortality shocks (Alfani 2020; Alfani and Percoco 2019; Jedwab et al 2019; Gonzalez-Torres and Esposito 2016; Tumbe 2020). The lesson is that pandemics can have "extremely important and potentially permanent asymmetric economic consequences" (Alfani 2020, 197). High, sudden mortality not only shapes long-term economic trajectories but also forces short-term income and spending adjustments. In some developing economies, for example, health shocks have been shown to adversely affect household vulnerability and consumption smoothing (Wagstaff 2007; Genoni 2012; Khan, Bedi and Sparrow 2015).

And third, we add to a new literature on Covid-19 and its effects on consumer spending. Arthi and Parman (2021) argue that "the way in which [Covid-19] is unfolding also provides fresh perspective with which to revisit the past." Chen et al. (2020), Chetty et al. (2020), Baker et al. (2020b), and others use new datasets to analyze changes in consumer spending during the Covid-19 pandemic. We provide a historical example of such shifts in consumer behavior, allowing us to, as Arthi and Parman advise, focus on the differences rather than seek out the similarities. Mortality was much higher in the United States in the 1918 influenza pandemic than in the Covid-19 pandemic, and our evidence suggests that the economic effects on income and spending were correspondingly more pronounced in 1918.

THEORY

Income could change during a pandemic for several reasons. There would be little direct effect of a disease that tends to kill small children and elderly, non-earning dependents. But the 1918 influenza outbreak killed mostly working-age adults. Income inevitably declines, at least temporarily, for households in which an income earner falls sick or dies. Mortality and morbidity, and concerns about them, could reallocate income within a household as its members leave or enter the labor force. If businesses suffer from lack of buyers or are compelled by governments to close, they may cut wages or even fire otherwise healthy workers.

We therefore measure changes in overall income and in the components of income. Our sample consists of households in which a husband and wife were present. If enough workers fall sick, have their wages cut, or lose their jobs, we would expect income in our sample to fall. However, it is possible that a sufficiently large decline in the labor supply would increase wages. This could produce compensatory changes within households: if wages earned by the principal wage earner (in this sample, husbands) decline, we would expect their wives to be more likely to enter the labor force. On the other hand, increasing wage rates would raise the opportunity cost of women not working, and could therefore also draw women into the labor force. Government interventions to curtail business activity could directly lead businesses to fire workers or cut wages. But, if these interventions also limit the severity of the pandemic, they might prevent otherwise larger declines in income.

There are also several reasons why spending might change during a pandemic. Most directly, spending on medical care and funeral services could increase. Given that we only observe households in which a husband, wife, and child were present, we expect an increase in medical care costs related to morbidity but less of an increase in funeral costs related to mortality. Spending on life insurance may increase as mortality risks of a pandemic become evident. Spending that carries particular risk of disease transmission via social contact, such as in-person services and the products associated with it, like alcohol, may decrease.

DATA AND IDENTIFICATION STRATEGY

BLS Cost of Living Survey

From July 1918 through February 1919, the Bureau of Labor Statistics (BLS) administered a cost of living survey to 12,817 households in 99 cities across 42 states.[1] The survey, designed in part to help construct a consumer price index, collected information about sources of income and amounts spent on various goods and services over the previous twelve months. The households were selected because they reflected "typical" working-class families in industrial locales: every family had at least one wage earner or salaried worker, and every family consisted of a husband, a wife, and at least one child. The survey excluded households that had recently moved or that had recently immigrated and did not speak English. It included few black households outside of the South. Each household was observed once, and all households in a city were typically observed in the same month.[2] Figure 1 shows the rollout of the survey. It was first administered in Baltimore in July, then elsewhere in the Northeast in August, after which it expanded to the West Coast, and then broadly across the Midwest and South by early 1919.

The average household had 4.5 members, measured as the total number of person-years spent in the household by all household members.[3] Beyond the husband, wife, and child present in every household, 1.3 of the additional 1.5 members on average was a child. Less than one-quarter of households had an additional adult present, while more than half had an additional child present. The average household received $1,667 in income and spent $1,586, saving just under five percent of the income. Wage earnings accounted for 96 percent of total income. The largest single item of spending, housing rent, accounted for nine percent of total spending on average.

The survey offers several advantages for studying changes in income and spending during the 1918 influenza pandemic. First, it was administered throughout much of the largest wave of deaths, which lasted from September 1918 through April 1919. The survey therefore observed

[1] In Appendix A, we describe the source of these survey data and all other data used in this paper.
[2] Month of observation is not recorded for 15 households, and 50 households were observed in a month different from most of the other households in their city. Our final sample of 12,731 excludes these households, as well as 21 others that do not have race recorded.
[3] Person-years is a more precise measure of household size that accounts for people who lived only part of the year in the household.

households with a range of exposure to the pandemic, from those who were unaffected to those for whom half of their year's income and spending, September 1918 to February 1919, occurred during the pandemic. Second, the survey recorded person-level labor market information (weeks worked and wages earned by every household member) and identifies 422 separate categories of spending. This detailed information allows us to measure the relationship between quantity of labor supply and wage rates, between income and spending, and between categories of spending. Our micro-level analysis therefore complements Velde (2020) and other studies of macro-level changes during and after the pandemic.

The survey has several limitations. First, its rollout from the Northeast to the West and then Midwest and South means that it offers a non-random cross-section of the country at any particular time. For example, if households observed early on lived in cities with generally higher income, then income would appear to decline as the pandemic progressed. We adjust for pre-existing differences in income using average city-level manufacturing wages in 1914. Second, the survey's sample of households with a husband, wife, and child present excludes families in which one of the principal members had died during the pandemic. We therefore measure changes only in households not directly affected by death during the pandemic by the time of survey. Third, the survey's exclusively urban sample means that our findings may not apply to the half of the population living in rural areas.

Identification Strategy

The nature of the pandemic and the BLS cost of living survey guide our choice of identification strategy. The survey observed all households in a city in the same month, so we cannot measure changes within a city as the pandemic progressed. The survey also does not record when in a month a household was observed, so we have little opportunity to compare households observed in the days before or after the flu spread to their city. What is more, the survey measured income and spending over the past year, blunting any observable changes in income and spending that were due to a few days' difference in timing of the pandemic.

Rather, we use the six-month rollout of the survey to compare households observed at different times during the pandemic. Households surveyed in July and August earned all income and completed all spending before the main wave of the pandemic. Households surveyed in

September experienced at most one month of the pandemic, while for households surveyed in February half of the past year's income and spending took place during the pandemic. If exposure to the pandemic led to a one-time change in income or spending, we would expect the annual values recorded to fall in September and October and then remain constant. If economic consequences compiled as deaths remained high into spring 1919, changes in annual income and spending would appear larger for households surveyed later.

We use the following specification to measure changes in total household income during the pandemic:

$$Income_{hcm} = \alpha + \beta_1 SepOct_{hc} + \beta_2 NovDec_{hc} + \beta_3 JanFeb_{hc} + \theta Wage1914_c + \gamma Lat_c + \eta Lon_c + \lambda Draft_c + \mu Casualty_c + \delta Race_{hcm} + \rho Size_{hcm} + \varepsilon_{hcm}. \quad (1)$$

Income records the total income received by household h in city c observed in month m. Because the survey was administered in only a few cities in some months, we group month of observation as July-August 1918, September-October 1918, November-December 1918, and January-February 1919. The main estimated coefficients of interest, β_1 through β_3, estimate the change in average income between households observed in the three final month groups and households observed in July-August. Households observed later in the pandemic earned a greater share of their income during the pandemic. A finding of $0>\beta_1>\beta_2>\beta_3$ would therefore indicate that income declined as the pandemic progressed, while $0<\beta_1<\beta_2<\beta_3$ would indicate that income rose. Non-monotonic changes across the estimated coefficients would indicate that income rose and then fell, or vice versa. Because income is recorded for the past year and the largest wave of the pandemic began in September, even households observed in February earned income for half a year before the pandemic began. These coefficients may therefore underestimate the actual changes in income during the pandemic.

We control for pre-pandemic income. Without this control, any changes in income during the pandemic could be explained by pre-existing differences in income. The 1914 Census of Manufactures offers the best source of pre-pandemic city-level earnings (Garrett 2009). The census recorded the number of manufacturing workers and their total yearly wage earnings, allowing us to calculate wage earnings per worker in the city, *Wage1914*. Figure 2 shows average earnings per worker in cities in each pair of months in 1914, as well as corresponding values from the two earlier surveys in 1904 and 1909. In cities observed by the BLS cost of living survey in July and August 1918, the average worker earned $900 in 1904. Average earnings in 1904 were $60 higher

in cities later observed in November and December 1918, $100 higher in cities observed in January and February 1919, and $130 higher in cities observed in September and October. These differences persisted. In all groups of cities, average earnings rose by between $60 and $110 by 1909, and then changed little between 1909 and 1914. This evidence of parallel trends in earnings leading up to the pandemic supports the identifying assumption that pre-pandemic differences in income would have persisted without the pandemic. Any deviation from these trends in 1918 and 1919 can then be attributed to the pandemic.

Equation 1 includes as controls several other city-level factors that may be related to household income. *Lat* and *Lon* record the city's latitude and longitude. The national mobilization for World War I, during which the pandemic began, may have affected labor market conditions, so we include city-level draft and casualty rates, *Draft* and *Casualty*. We include household-level factors that may be related to household income: *Race* equals one if the household head is white, and *Size* records the number of person-years spent in the household by all household members.

We use the same specification, with alternative dependent variables, throughout the rest of the paper. All dollar values are converted to real, January 1919 dollars using the monthly consumer price index. Although we do not cluster standard errors for the findings presented in the body of the paper, in Appendix B we report the main findings when standard errors are clustered at the city level. In general, confidence intervals widen and some of the findings lose statistical significance.

CHANGES IN INCOME

Newspaper reports provide anecdotal evidence of how the pandemic affected the labor market. In a January 30, 1919 article entitled "Senate Is Told Idleness Grows", the Philadelphia *Evening Public Ledger* (1919c) reported that Department of Labor spokesmen Jesse Evans told a senate committee that unemployment throughout the country was increasing rapidly. He had seen the number of unemployed men at 123 industrial centers increase from 10,000 in early December, 1918, to 212,000 a month later. An article in the *Ledger* two months later, "Industries Here Maintain Wages", suggests that the higher unemployment did not translate into lower wages (Evening Public Ledger 1919a). On March 17, 1919, the *Ledger* reported on a business survey conducted by the Federal Reserve Board in which only seven percent of companies reported a

decline in wages. Such reports, though, offer only a glimpse of the possible effects on household income. The BLS cost of living survey allows us to provide a more complete picture.

Changes in Total Household Income

Average yearly income for households observed in July and August was $1,686. Average income was $46 higher for households observed in September and October, $53 lower for households observed in November and December, and $74 lower for households observed in January and February. The first series in Figure 3 presents these unconditional changes. The remaining series present estimates of β_1 through β_3 as additional covariates are added. Pre-pandemic differences in city-level earnings explain the apparent increase in income for households observed in September and October. Once pre-existing differences in earnings are accounted for, household income falls more sharply over time. Latitude and longitude explain some of this decline, while World War I draft and casualty rates have little relationship with changes in income. Controlling for race and household size again amplifies the changes. The 95-percent confidence intervals in the final, preferred specification show that average income in September and October was between $7 and $61 lower than average income in July and August, at most a small change of 3.6 percent. Average income fell by between $51 and $107 in November and December and between $72 and $134 in January and February, declines of up to 7.9 percent from July and August. Average household income fell during the pandemic.

Mortality and Changes in Income

An important question is whether influenza mortality affected income. Annual Mortality Statistics reports published by the Census Bureau record the number of deaths, by month, for 470 cities between 1914 and 1922. Seventy-two of these cities were included in the BLS cost of living survey. For each city, we measure "excess" deaths during each month of the pandemic as the difference between the number of deaths that month and the median number of deaths in the same month in 1914, 1915, 1916, 1917, 1921, and 1922.[4] These newly transcribed records allow us to

[4] In Appendix A we compare this method of calculating pandemic mortality to an alternative method for measuring deaths by cause available for a smaller set of cities.

confirm Sydenstricker's (1918) assertion that the autumn wave of the pandemic quickly spread across the country. Panel (a) of Figure 4 shows the number of excess deaths in each city in each month, from July 1918 through February 1919. The surge in mortality that began in a few cities in September intensified nationwide in October; in each of the 72 cities, excess deaths were higher in October than in September. Cities observed by the BLS cost of living survey in July and August had 340 excess deaths on average in October, and then the death rate declined sharply. Cities observed in September and October had nearly identical death rates on average. Cities observed later, which tended to be located in the South and Midwest, had lower peak mortality in October but a more gradual decline in deaths in late 1918 into early 1919.

We sum these excess deaths from the start of the largest wave of the pandemic in September 1918 through the end of the survey period in February 1919. Cumulative excess deaths ranged from 167 per 100,000 population in Grand Rapids, Michigan, to 1,818 in Bakersfield, California. We split the survey cities evenly into those with below-median mortality of less than 560 deaths per 100,000 population, and those with above-median mortality. Panel (b) of Figure 4 shows the locations of the two groups of cities. Cities with higher mortality are concentrated in the Northeast, deep South, and West.

To determine how changes in income depended on pandemic mortality, we repeat Figure 3, but now split the sample into cities with low mortality (167–556 deaths per 100,000) and high mortality (564–1,818 deaths per 100,000). As panel (c) of Figure 4 shows, for cities with low mortality, household income remained nearly constant at about $1,750 from July and August through September and October. Income similarly remained constant at about $1,650 for cities with high mortality. The two groups of cities then diverged. Average income was $23 lower in low-mortality cities in November and December, and then rebounded in January and February. In high-mortality cities, average income was $61 lower in November and December and dropped by an additional $36 January and February. As the pandemic progressed, income fell by more in cities with worse mortality.

Public Policy and Changes in Income

Despite the urging of medical personnel in September 1918, the public health director of Philadelphia resisted the imposition of quarantines and restrictions on public gatherings, with

deadly consequences. We want to know whether the speed and breadth of such public interventions affected income on average. To do so, we turn to information collected by Markel et al. (2007). Using newspapers and other records, they document policy response to the 1918 pandemic in 43 cities, 33 of which were included in the BLS cost of living survey. They focus on three categories of "non-pharmaceutical interventions:" school closures, bans on public gatherings, and isolation and quarantine measures. They identify the timing of the first intervention in each city, and the total number of days interventions were imposed.[5] In this section, we study how incomes changed depending on the timing and duration of these interventions.

Panel (a) of Figure 5 compares the timing and duration of interventions. The x-axis shows the number of days that elapsed between the day that mortality in a city first rose to twice its normal rate and the day that the first intervention was imposed. (Negative numbers indicate that interventions preceded the surge in deaths.) The y-axis shows the number of days of interventions. Fourteen cities had swift, comprehensive interventions that began within nine days of the surge in mortality and lasted at least 116 days. Fifteen cities had slow, narrow interventions that began at least a week after the surge and lasted at most 82 days. Panel (b) of Figure 5 shows the geographic distribution of these two groups of cities. Cities in the Midwest and West responded more swiftly and comprehensively and had lower mortality; those in the Northeast responded more slowly and narrowly and had more deaths. For the rest of this section, we omit the four cities that fall outside these two groups: Chicago, Cleveland, New York, and St. Paul.

Panel (c) of Figure 5 separately measures changes in income for the two groups of cities. Because the sample is restricted to just 29 cities, we group cities observed July through September, October through November, and December through February. Because deaths did not begin to surge until late September, the households observed July through September were largely unaffected. The average household observed in July through September in cities with swift, comprehensive interventions had $1,726 in income. Average income was $126 lower for households observed in October and November, and then barely changed for households observed

[5] Markel et al. (2007) report days of interventions with all categories grouped together, so days of interventions equals the cumulative number of days across each of the three categories. This approach double- or triple-counts days in which two or three categories of intervention were imposed, and therefore measures a combination of the duration and breadth of interventions. We have separately identified the number of days of school closures and the number of days of bans on public gatherings in each city, and in Appendix A we show that our findings are similar if we instead consider each of these alone.

in December through February. The average household observed in July through September in cities with slow, narrow interventions had $1,679 in income. Income barely changed for households observed in October and November, and then was $159 lower for households observed in December through February.

Swift, comprehensive interventions were associated with earlier but more moderate declines in income. This finding suggests that interventions protected against large income losses and aligns with previous studies of the macroeconomic consequences of interventions. Bodenhorn (2020) shows that interventions were associated with fewer business failures. Correia et al. (2020) show earlier interventions were associated with greater growth in manufacturing employment after the pandemic. Interventions restricted the opportunity for people to congregate and businesses to operate normally, but the lower mortality that accompanied interventions may have helped offset any economic harm they caused. However, interventions did not vary randomly across cities. Cities predisposed to certain interventions may have had other characteristics that influenced income during the pandemic, and income changes may have influenced policymaking. This evidence therefore does not isolate the causal effect of interventions on income.

Changes in Labor Market Activity

The BLS cost of living survey offers two particular advantages for examining how the components of wage earnings varied during the pandemic: it allows us to decompose wage earnings into quantity of labor supplied and wage rate received, and it allows us to compare the labor market activity of men and women. We focus on the 97 percent of households in which the husband and wife were both present for a full year (at least 48 weeks) and provided complete answers to the labor market questions.

We repeat equation 1 using four different dependent variables: wage earnings, whether the person worked, weeks worked if the person worked, and weekly wage rate. Panel (a) of Figure 6 shows changes in total wage earnings for husbands and wives together. Since wage earnings comprised 96 percent of total income, changes in these earnings closely mirror those for total income. Compared to households observed in July and August, wage earnings fell by $35 on average for households observed in September and October, and in January and February they had fallen by $93, a decline of 6.3 percent.

Panel (b) shows that either the husband or the wife worked in nearly all households, regardless of month of survey. Panel (c) shows that the average husband and wife observed in July and August had together worked 54.1 weeks in the past year. This total rose by half a week for households observed in September and October and then fell by up to 1.2 percent. These small differences indicate little change in quantity of labor supplied by people who survived as the pandemic progressed. Again, though, the survey excluded households in which a principal wage earner had died.

Panel (d) shows that the average weekly wage rate was $28.4 for households observed in July and August. This wage then fell by up to $1.4, or 4.9 percent, for households observed later. As the pandemic progressed, the quantity of labor supplied declined slightly, but wage rates declined more substantially. This decline in wage rates therefore explains much of the decline in wage earnings, and therefore household income.

The remaining panels of Figure 6 present the same estimates separately for husbands and wives. More than 99 percent of husbands but less than 14 percent of wives worked for wages, so the labor market experience of husbands drives the overall household-level changes. A small decline in weeks worked by husbands and a larger decline in the wage rate earned by husbands explains the nearly $100 decline in husbands' wage earnings. Compared to wives observed in July and August, wives observed in September and October were up to 2 percentage points (or 17 percent) more likely to work, worked slightly more hours, and earned slightly lower wages. These differences persisted in the months to follow. As their husbands earned lower wages, wives were more likely to enter the labor force, even though the wage rate they received also declined.[6]

CHANGES IN SPENDING AND SAVING

Because of the slow public health response, Philadelphia suffered severely from the pandemic. By January 1919, the Woman's Exchange in the *Evening Public Ledger* (1919b) made evident the urgent need to adjust spending to the changing circumstances: "Times have changed, and the good old days of something for next to nothing at the butcher shop are gone. Even the dog

[6] In Appendix C we measure changes in wages and hours worked separately for households in cities with below-median and above-median mortality, and in cities with swift and with slow interventions. As with total household income, the changes in wage earnings and its components were generally largest in cities with higher mortality and narrower interventions.

cannot have his daily portion without an appreciable excursion to the bottom of the purse. There then are the days when we treat the family dollar in a different way. For instance, the national industrial conference board reports that last year it took from 40 to 45 per cent of the small income for food. Here is the new year ahead of us. Food has not gone down in price. To tide the year successfully then it will be necessary to do some careful planning."

Changes in Total Household Spending and Saving

Household income and spending remained closely tied throughout the pandemic. Panel (a) of Figure 7 shows average household spending for households grouped by income, from $800 through $2,600, roughly the 5th and 95th percentiles of household income. Each city is depicted with a thin line, with the thicker lines showing the average across all cities observed in the same pair of months. There is substantial variation between cities, but little between the groups of cities. Households spent about $6 of every additional $7 of income on average, and this marginal propensity to consume did not change during the pandemic.

The consistency of the consumption function during the pandemic suggests that changes in income translated into similar changes in spending. Panel (b) of Figure 7 confirms this. The first series presents changes in income for households observed in each pair of months, compared to July and August. These estimates are the same as in the final specification shown in Figure 3. The second series presents equivalent estimates for household spending, estimated using equation 1, with total household spending as the dependent variable. Average spending fell by slightly larger amounts than income in September through December, and by a smaller amount in January and February. The third series presents estimates of saving, measured as income minus spending. Compared to households observed in July and August, average saving rose slightly for households observed later in 1918, but was $25 lower for households observed in early 1919, a 41 percent decline. This evidence contradicts *The Economist*'s (2021b) assertion that families "stashed away more cash" during the pandemic.

Waning purchases of liberty bonds explain much this decline in saving for household observed in early 1919. The United States government began issuing liberty bonds in 1917 to finance its involvement in World War I, and two-thirds of households would come to own the bonds by 1919 (Sutch 2015; Hilt and Rahn 2020). Households observed by the BLS cost of living

survey in July and August spent $53 on average on liberty bonds. Purchases remained roughly constant for households observed through the end of the year, then fell by $14 for households observed in January and February, after the November armistice. This 26 percent decline in purchases of liberty bonds explains half of the $25 average decline in saving for households observed in January and February.

Changes in Categories of Spending

The BLS cost of living survey recorded spending in several hundred separate categories. We group the categories several ways. First, we compare changes in spending on durable goods, nondurable goods, and services, as shown in Figure 8. Durable goods, including jewelry and furniture, accounted for less than five percent of spending, and this spending changed during the pandemic. Nondurable goods, including food and clothing, accounted for more than 60 percent of spending, and this spending fell by $13 in September and October, and an additional $26 in November through February. Spending on household rent, transportation, and other services fell by an even larger $30 in September and October and an additional $30 in November and December, before rebounding slightly. Nondurable goods and services explain the decline in total spending during the pandemic, with services explaining the small rebound for households observed in January and February.

Second, we compare changes in broad categories of goods. Food accounted for more than 40 percent of household spending in July and August. Spending on food fell by up to $48 as the pandemic progressed. Spending on clothing and housing rent also fell. Spending on home ownership, fuel and lighting, and furniture and furnishings rose.

Third, we compare changes in individual categories. Spending on life insurance fell, and in the next section we decompose this change by type of life insurance. Medical spending rose by 11 percent. Funeral expenses stayed constant, as expected given that the sample consisted of intact families. Spending on amusement and vacations also changed little. Spending on liquor declined by nearly 50 percent, while spending on tobacco rose slightly.

A concern with these estimates is that they reflect general differences is spending levels between cities observed at different times. Although these groups of cities had similar consumption functions, spending on particular items could vary considerably. We account for this pre-existing

variation by including pre-pandemic spending as a covariate in equation 1. The closest comparable measurement of spending by category of which we are aware is another BLS cost of living survey administered in 1888. This survey was administered only in the Northeast, Midwest, and South, and recorded only the state the respondent lived in, not the city. For each category of spending, we add to equation 1 average spending on that item, statewide, in 1888. We present these estimates in Appendix D. Spending changes substantially, but most of this change is because the 1888 survey included only 57 of the 99 cities in the 1918–1919 survey. Within this restricted sample, including 1888 spending as a covariate changes the estimate little, suggesting that the changes in spending as the pandemic progressed that we observe in the full sample are not due to pre-existing differences in spending levels between cities.

Changes in Life Insurance Spending

Again, total spending on life insurance declined as the pandemic progressed, and this decline was not due to pre-existing lower spending on life insurance spending in cities surveyed later in the pandemic. In this section, we decompose this total spending on life insurance into its components: old-line, industrial, fraternal, establishment, other types, and life insurance purchased for a person not in the family. Figure 9 shows changes in spending on each type, again estimated using equation 1. We focus on old-line, industrial, and fraternal insurance, which together accounted for 94 percent of spending on life insurance.

Old-line life insurance consisted of whole-life policies, the value of which the insured person could borrow against (Kantor and Fishback 1996). Industrial life insurance consisted of smaller-scale policies, the fees for which were collected door-to-door on a weekly basis. Fraternal life insurance was offered through religious, occupation, or other affiliation groups. Households surveyed in July and August spent $14.4 on old-line policies. Spending declined to $11.9 for households observed in September and October, rose again to $14.4 for households observed in November and December, then fell to $12.8 for households observed in January and February. Spending on industrial policies fell from $28.3 in July and August to $21.3 in January and February. Spending on fraternal policies rose from $5.0 to $7.8. Because of their weekly, door-to-door sales, industrial policies required just the kind of close contact that may have contributed to the spread of influenza. Declining spending on industrial but not the other types of policies is

therefore consistent with an explanation in which households increasingly tried to avoid close contact with others.

Changes in Spending by Household Clusters

We use a two-step machine learning process to identify household characteristics that jointly explain changes in spending during the pandemic. We divide households that spend similarly to one another across all individual spending categories into two clusters and then use a classification tree to identify the combinations of household characteristics that explain membership in the two clusters.[7] Households in the first cluster were generally located in the Northeast or South Census regions, with a wife under age 35 or household income below $1,591. Those in the second cluster were generally located in the Northeast or South with a wife aged 35 or older and income above $1,591, or were located in the Midwest or West.

Figure 10 compares changes in spending in these clusters. Because the survey moved inland from the coasts, some regions have only a few cities observed in a given pair of months, so we again group months into three rather than four. We find little difference in average total household spending between households observed in the Midwest and West in July through September and those observed in the Northeast and South. By October and November, spending fell slightly more in the Northeast and South than in the Midwest and West, but these regions again had similar spending in December through February. Variation by region alone does not explain the decline in spending as the pandemic progressed. Wife's age alone also does not explain the decline. Although households with younger wives generally spent less than those with older wives, this difference did not change much. Both these groups spent less as the pandemic progressed. Household income also does not explain the decline in spending.

The distinction between groups emerges when we consider these three characteristics jointly. Among households in the Northeast or South with a younger wife or with lower income, spending declined by about $50 for households observed after mortality surged in October compared with those observed before mortality surged. Among all other households (with an older wife, or higher income, or located in the Midwest or West), spending was more than $150 lower

[7] We describe the setup for this cluster analysis in greater detail in Appendix E.

for households observed after mortality surged compared to households observed before mortality surged. This comparison highlights a contribution of using cluster analysis to study changes in spending over time. By using a range of household characteristics to identify households that spend similarly to one another, we are able to identify a set of characteristics that jointly explain the decline in spending during the pandemic, even though none of the characteristics individually explain the decline.

COMPARISON WITH THE COVID-19 PANDEMIC

How do earnings and spending respond to the shock of a pandemic? This question has attracted much attention since Covid-19 spread across the globe. Covid-19 is, of course, not the first pandemic to affect labor markets or consumer behavior. In this study we borrow from some recent work on Covid-19 to help us assess how the influenza of 1918, and the government's response to it, affected income and spending patterns. How were workers and consumers a century ago affected by an even deadlier pandemic? We focus on four areas of comparison: changes in income, differences in labor market participation by gender, non-pharmaceutical interventions, and shifting consumer priorities.

First, we use the BLS cost of living survey from July 1918 to February 1919, which recorded household income and spending over the previous year. Because only part of this period overlapped with the surge in deaths, our findings are probably lower bounds on changes during the pandemic. For example, households observed in September and October, for whom the survey covers up to two months of the largest wave of the pandemic, earned $34 less than households observed in July and August. Multiplied by six, this change suggests $204 lower income. Similar annualized estimates from households observed in November through February suggest $316 and $206 lower income, declines of between 12 and 19 percent from an average income of $1,686 earned by households observed in July and August. These declines in income are much larger than those shown in early evidence from Covid-19. Because of government support for people who lost wages, Covid-19 reduced wages in the United Kingdom by just one percent in the early months of the pandemic. Likewise, government stimulus payments helped raise disposable income in the United States by more than 10 percent (Bureau of Economic Analysis 2021, *Economist* 2021a). There was no equivalent widespread fiscal or labor market support in the United States in 1918.

Second, wage earnings accounted for nearly all of the income earned by households in our sample. During the 1918 pandemic, husbands were not less likely to work or to work less, but received up to a five percent lower wage rate on average. This decline in the wage rate explains nearly all of the decline in household income, but was partially offset by an increase in wives' labor market participation. As their husbands earned less, wives were up to 20 percent more likely to work, changes that were concentrated in cities with the highest mortality. These findings are in contrast to changes during the Covid-19 pandemic. Albanesi and Kim (2021) show that women, particularly women with children, accounted for nearly two-thirds of the reduction in employment and labor force participation during the Covid-19 pandemic in the United States. Women today account for a much larger share of the labor force, and appear more susceptible to pandemic-induced job losses.

Third, we show that government-mandated school closures, bans on public gatherings, and other non-pharmaceutical interventions in 1918 had little evident correlation with changes in income. These interventions restricted business activity, typically for several weeks or months at a time, so we might expect that they would be associated with lower income. That this was not the case could suggest that the interventions in fact helped soften the effects of the pandemic in other ways, such as by limiting deaths. Correia et al. (2020) and Velde (2020) reach similar conclusions. Research during the Covid-19 pandemic do so too. Goolsbee and Syverson (2020) find that government restrictions accounted for less than 15 percent of the declines in economic activity in the early months of the Covid-19 pandemic. Using Google searches for unemployment insurance, Kong and Prinz (2020) find that limitations on numbers of patrons in restaurants and non-essential business closures explain six percent of unemployment insurance claims. Other non-pharmaceutical interventions had no effect on claims. They therefore attribute the surge in claims to other factors, notably declines in consumer demand.

Fourth, pandemics shift consumer priorities. We show that, in 1918, consumer spending on durable goods remained steady, but spending on nondurable goods and, especially, services declined. For example, spending on life insurance issued by fraternal organizations rose by nearly 50 percent, but households spent 25 percent less on industrial life insurance sold door-to-door. The availability of high frequency transaction-level data has made it possible to observe these shifts in real time during the Covid-19 pandemic. One of the first to use such data, given that China was the first country to experience a rapid spread of the Covid-19 virus, was a study of Chinese

consumers. Using daily transaction data across 214 cities, Chen et al. (2020) calculate that offline consumption fell by 42 percent during the eight-week period between January and March 2020. Dining and entertainment (72 percent) and travel (64 percent) saw the largest declines. For the United States, Baker et al. (2020b) use transaction-level household financial data to investigate spending changes in anticipation of and during the Covid-19 pandemic. They find declines in overall spending but increases in spending on groceries, changes that were largest in states that issued shelter-in-place orders. Chetty et al. (2020) use daily statistics on consumer spending, business revenues, employment rates, and other key indicators disaggregated by ZIP code, industry, income group, and business size to investigate not only the initial response but also the recovery. They show that spending fell sharply as Covid-19 spread, particularly in regions with high infection rates. State-ordered reopening of economies had only small impact on spending and employment.

Much of the existing evidence of the economic consequences of the 1918 influenza has been macroeconomic. For example, Velde (2020) uses high-frequency data to document a short-lived recession. Brainerd and Siegler (2003), Garrett (2009), and Correia et al. (2020) use state or city-level aggregate data to document an economic boom after the pandemic. Our study contrasts with these in focusing on microeconomic, household-level changes during the 1918 pandemic. We find large declines in men's earnings, increases in women's labor force participation, and reallocations of household spending. The rollout of the BLS cost of living survey allows us to measure these changes as the pandemic progressed. Our paper therefore demonstrates the complementary value of microeconomic and macroeconomic evidence for studying the immediate and longer-run consequences of the 1918 influenza pandemic.

APPENDIX A: DATA SOURCES

1917–1919 BLS Cost of Living Survey

In 1918 and 1919, the Bureau of Labor Statistics conducted a cost of living survey. (The survey is identified as having begun in 1917 because the retrospective annual income and spending covered parts of 1917 for households observed in 1918.) The Inter-university Consortium for Political and Social Research (ICPSR) maintains two records of the survey: ICPSR 8299 (Bureau of Labor Statistics 1992), which provides most variables, recording household characteristics, income, and spending, and ICPSR 6276 (Olney 2006), which provides additional variables about spending and saving, compiled by Martha Olney.

1888-1890 Cost of Living Survey

In 1888 through 1890, the US government, in coordination with governments in Belgium, France, Germany, Great Britain, and Switzerland, conducted a cost of living survey of 8,544 industrial workers. ICPSR 7711 (Haines 2006) maintains survey records. In Appendix D we use records from the 5,635 workers in the United States living in households that have a husband, wife, and at least one child present (a sample comparable to the 1917–1919 BLS cost of living survey).

Census of Manufactures

The Census Bureau administered a Census of Manufactures every five years between 1904 and 1919 and every two years thereafter. Table 193 of United States Census Bureau (1923a) records characteristics of the manufacturing industry, including total number of wage earners and total wages earned, for cities with 10,000 or more people. We calculate the average annual wage rate in 1904, 1909, and 1914 as total wages earned divided by the number of wage earners.

World War I

Ferrara and Fishback (2020) measure county-level World War I draft and casualty rates. The draft rate is the number of people inducted divided by the number of men of voting age. The casualty rate is the number of war deaths divided by the number of men of voting age. Both rates are then multiplied by 100,000, so they represent the number of draftees or deaths per 100,000 men. We thank Ferrara and Fishback for generously sharing the data with us. For each city, we use the rates for the county in which the city is located, identified using a 1910 county shapefile (United States Census Bureau 2021b). For the following five cities, county-level draft information is not recorded, so we use the statewide average: Baltimore, Maryland; St. Louis, Missouri; New York, New York; Richmond, Virginia; and Roanoke, Virginia.

Consumer Price Index

Inflation in the late 1910s was high, at around 16 percent per year. The BLS cost of living survey reports income and spending by each household over the past 12 months. Because households were observed at different times, we adjust for inflation so that all values we use in the analysis are in real, January 1919 dollars. We do so using the monthly nationwide consumer price index for all urban consumers (United States Bureau of Labor Statistics 2021). We do not know when in the past 12 months each household earned income and spent money, so we convert the amounts to real values assuming that they were spread evenly over this period.

Wages recorded by the Census of Manufactures apply to full calendar years. The 1888 cost of living survey records spending over the past 12 months, but does not record month of survey. For these two sources, we therefore adjust for inflation using an annual consumer price index (Federal Reserve Bank of Minneapolis 2021), converting all values to real, 1919 dollars.

Latitude and Longitude

Our records of each city's latitude and longitude are from SimpleMaps (2021).

State Boundaries

We use a state boundary shapefile provided by United States Census Bureau (2021a).

Mortality

During most of the 1910s, about 130 out of every 100,000 people died per month during autumn and winter. In the autumn and winter of 1918 and 1919, this nationwide death rate rose to as many as 356 deaths per 100,000 people. Deaths due to influenza and pneumonia accounted for nearly all of this increase. Because the virus was not directly detectable in 1918, the standard way of measuring mortality during the pandemic is to calculate "excess" deaths due to influenza and pneumonia, in each month of the pandemic compared to the median earlier in the decade (see, for example, Acuna-Soto et al. 2011, Barro 2020, and Bodenhorn 2020). This approach relies on monthly cause of death records in annual Mortality Statistics reports published by the Census Bureau (United States Census Bureau 1913–1925; the records are in Table 10 in each year, except for 1911, where they are in Table 8, and 1912 and 1913, where they are in Table 3), compiled by Collins et al. (1930). These statistics record deaths by cause and month for 50 of the largest cities, only 37 of which were included in the BLS cost of living survey.

We alternatively use counts of deaths, from all causes, by month, recorded in Table 1 of the same reports. These data are available each year between 1914 and 1922 for a larger group of 72 cities included in the BLS cost of living survey (see panel (a) of Figure A.1). We calculate excess deaths during each month of the pandemic as the difference between the number of deaths that month and the median number of deaths in the same month in 1914, 1915, 1916, 1917, 1921, and 1922. Again, because nearly all of the additional deaths were due to influenza and pneumonia, this all-cause approach estimates a number of excess deaths similar to the more traditional cause-of-death approach, as shown in panel (b) Figure A.1. Each axis of panel (b) measures cumulative excess deaths between September 1918 and February 1919. The x-axis measures deaths due to influenza and pneumonia in excess of the median between 1910 and 1916, as calculated from the Mortality Statistics reports by Collins et al. (1930). The y-axis measures deaths due to all causes in excess of the median in 1914, 1915, 1916, 1917, 1921, and 1922, as calculated from the same reports by us and used in this paper. The diagonal line provides the line of equality between the

two measures. Each dot represents one of the 37 cities for which both measures of excess deaths are available. Grand Rapids had the lowest mortality rate according to both measures, and Pittsburgh had the highest. The difference between the two measures is largest for Indianapolis and Cambridge, but is generally quite small, on average less than nine percent of the number of excess deaths measured either way. This comparison demonstrates that all-cause excess deaths are similar to excess deaths due to influenza and pneumonia. Again, we use all-cause excess deaths because it is available for additional cities in which by-cause death records are not available.

Non-pharmaceutical Interventions

Markel et al. (2007) collected information about the public policy response to the 1918 pandemic in 43 cities, 33 of which were included in the BLS cost of living survey. They focus on three categories of non-pharmaceutical interventions: school closures, bans on public gatherings, and isolation and quarantine measures. Table 1 of their paper reports the timing of the first intervention in each city and the total number of days interventions were imposed. This total number of days equals the cumulative number of days across each of the three categories. If two or three categories of intervention were in effect on the same day, the day is double or triple counted. In our main findings, we use this cumulative measure of days.

J. Alexander Navarro and François R. Velde generously provided data that allows us to separately measure the number of days of school closures and number of days of bans on public gatherings. Panel (a) of Figure A.2 reproduces the scatterplot in panel (a) of Figure 5 of total days of interventions by timing of the first intervention. Panels (c) and (e) repeat this scatterplot for school closures and bans on public gatherings in the same 33 cities, again identifying two groups of cities in which interventions were generally of longer or shorter duration. (The composition of the two groups varies by type of intervention. Those identified with diamonds do not fit neatly into either cluster. There were no school closures in Chicago.) School closures were generally imposed earlier and lasted longer than bans on public gatherings. Panel (b) of Figure A.2 reproduces the household income change estimates from panel (c) of Figure 5 in the two groups of cities. Again, cities with slower and narrower interventions saw a greater decline in wages in December through February than in July through September. Panels (d) and (f) repeat these estimates for school closures and bans on public gatherings. Both have a similar relationship with income: in cities with

swifter and more comprehensive interventions, income fell substantially early in the pandemic but then no further; in cities with slower and narrower interventions, income remained steady early in the pandemic before falling substantially in late 1918 and early 1919.

APPENDIX B: CLUSTERED STANDARD ERRORS

All analyses in this paper use the regression specification in equation 1, without clustered standard errors. Rollout of the BLS cost of living survey occurred by city. Figure B.1 compares several of the main findings when standard errors are clustered by city. The darker 95-percent confidence intervals are those used in the body of the paper, and the lighter 95-percent confidence intervals are those using clustered standard errors. Clustering does not change the point estimates but widens the confidence intervals, generally by a factor of two or three. For example, as shown in panel (a) and repeated from panel (c) of Figure 4, the main estimates suggest that there were no statistically significant changes in average household income as the pandemic progressed in cities with below-median mortality. In cities with above-median mortality, declines in income were statistically significant. The wider 95-percent confidence intervals using clustered standard errors suggests that this decline for households observed in November and December was not statistically significant. Subsequent panels of Figure B.1 show that clustering standard errors eliminates the statistical significance of some, but not all, of the changes in income by characteristics of non-pharmaceutical interventions; of the overall changes in income, spending, and saving; and of the changes in spending on durable goods, nondurable goods, and services.

APPENDIX C: CHANGES IN LABOR MARKET ACTIVITY, BY MORTALITY AND NONPHARMACEUTICAL INTERVENTIONS

In the body of the paper, we measure changes in wage earnings and hours worked for husbands and wives. In this appendix, we repeat those estimates, for households in cities with below or above-median mortality, and for households in cities with narrow or comprehensive non-pharmaceutical interventions. As shown in Figure C.1, for households in cities with low mortality, the small changes in earnings are due to a decline in weeks worked of up to 3.6 weeks per household, and an increase in the wage rate by up to $2.2 per week. For households in cities with

high mortality, quantity of labor supplied changed little, but the wage rate fell as the pandemic progressed, by up to $2.2 per week. Different experiences of men and women drive these changes. Women drive the decline in weeks worked in cities with low mortality, while men drive the decline in the weekly wage rate. Nearly all men worked for wages, but the share of women who worked for wages changed substantially, falling as the pandemic progressed in cities with low mortality, and rising in cities with high mortality. In cities with low mortality, men's wage rates rose, and women's labor force participation fell. In cities with high mortality, men's wage rates fell, and women worked more.

As shown in panel (a) of Figure C.2, total wage earnings in cities with either slow and narrow or swift and comprehensive interventions changed in a similar fashion to total household income, shown in panel (c) of Figure 5. Panels (b) and (c) show that there was little change in the share of households with a wage earner as the pandemic progressed, and also little change in average weeks worked per household. Panel (d) shows that it was the wage rate, rather than quantity of labor supplied, that explains the changes in wage earnings: the wage rate dropped in both groups of cities as deaths first surged, but this decline then worsened only in cities with slow and narrow interventions. Again, husbands drove these changes: there was little change in quantity of labor supplied, and instead evidence of a decrease in the wage rate, particularly in cities with slow and narrow interventions. In both groups of cities, wives were more likely to work and to work more weeks, but these increases were largest in cities with slow and narrow interventions. The wage rate earned by wives also declined least in cities with slow and narrow interventions.

APPENDIX D: STATE-LEVEL SPENDING IN 1888

In the body of the paper, we use equation 1 to estimate changes in various categories of spending. A concern with these estimates is that they reflect general differences is spending levels between cities observed at different times. In this section, we additionally control for pre-existing differences in spending on many of these categories. The closest comparable measurement of spending by category of which we are aware was another cost of living survey administered in 1888 (Haines 2006). This survey was administered only in the Northeast, Midwest, and South, and only records the respondent's state, not city. Figure D.1 shows the 57 cities included in the 1917–1919 BLS cost of living survey that are located in states in which the 1888 survey was conducted.

For each category of spending, we additionally include in equation 1 average spending on that item, statewide, in 1888. Figure D.2 shows these estimates. There are three series. The first series estimates changes in spending using equation 1 and the full 99-city sample. The second series again estimates changes in spending using equation 1, but just for the 57 cities in the 1888 survey states. The third series additionally includes the 1888 state-level average spending as a covariate in these regressions. Average total spending was $1,626 for all households observed in July and August. Spending was $42 lower for households observed, and fell further by about the same amount into late 1918 and early 1919. For households in in the 1888 survey states, the change in September and October was similar, but there was little subsequent decline, and in fact a small increase in spending in January and February. When average state-level spending in 1888 is included as a covariate, these estimates barely change.

Most of the other categories of spending exhibit a similar pattern: little difference between the three series in September and October, but much smaller changes thereafter in the second and third series than in the first. Only for sickness and death (the sum of medical and funeral categories in Figure 8) do the estimated changes increase substantially. This comparison suggests that it is across the full, nationwide 1917–1919 BLS cost of living survey sample that changes in spending during the pandemic are observable, and not just in the Northeast and Southeast. Pre-existing differences in spending on particular categories does not appear to drive the findings.

APPENDIX E: CLUSTER ANALYSIS

Section 5.4 introduces a two-step machine learning process that we use to identify household characteristics that explain clusters of spending. First, we use k-means clustering to group households into two clusters based on spending across all individual categories of spending. This clustering begins with two means, then adds cities to the cluster it is most similar to (as measured using Euclidian distance), re-calculating the mean of each cluster after every city is added. This first step yields two clusters, of 3,252 households and 9,479 households.

Second, we use a classification tree to identify the household characteristics that best explain membership in each cluster. Because the clusters are unbalanced, we triplicate every observation in the smaller cluster so that the clusters are of roughly even size. We then consider the following characteristics observed for every household: Census region, race, person-years

spent in the household by all members, age of the husband, age of the wife, and income. We use 10-fold cross-validation to prune and identify the tree of optimal complexity. This tree determines that households located in the Northeast with either a wife under age 35 or income under $1,591 tend to spend similarly to one another, while all other households tend to spend similarly to one another.

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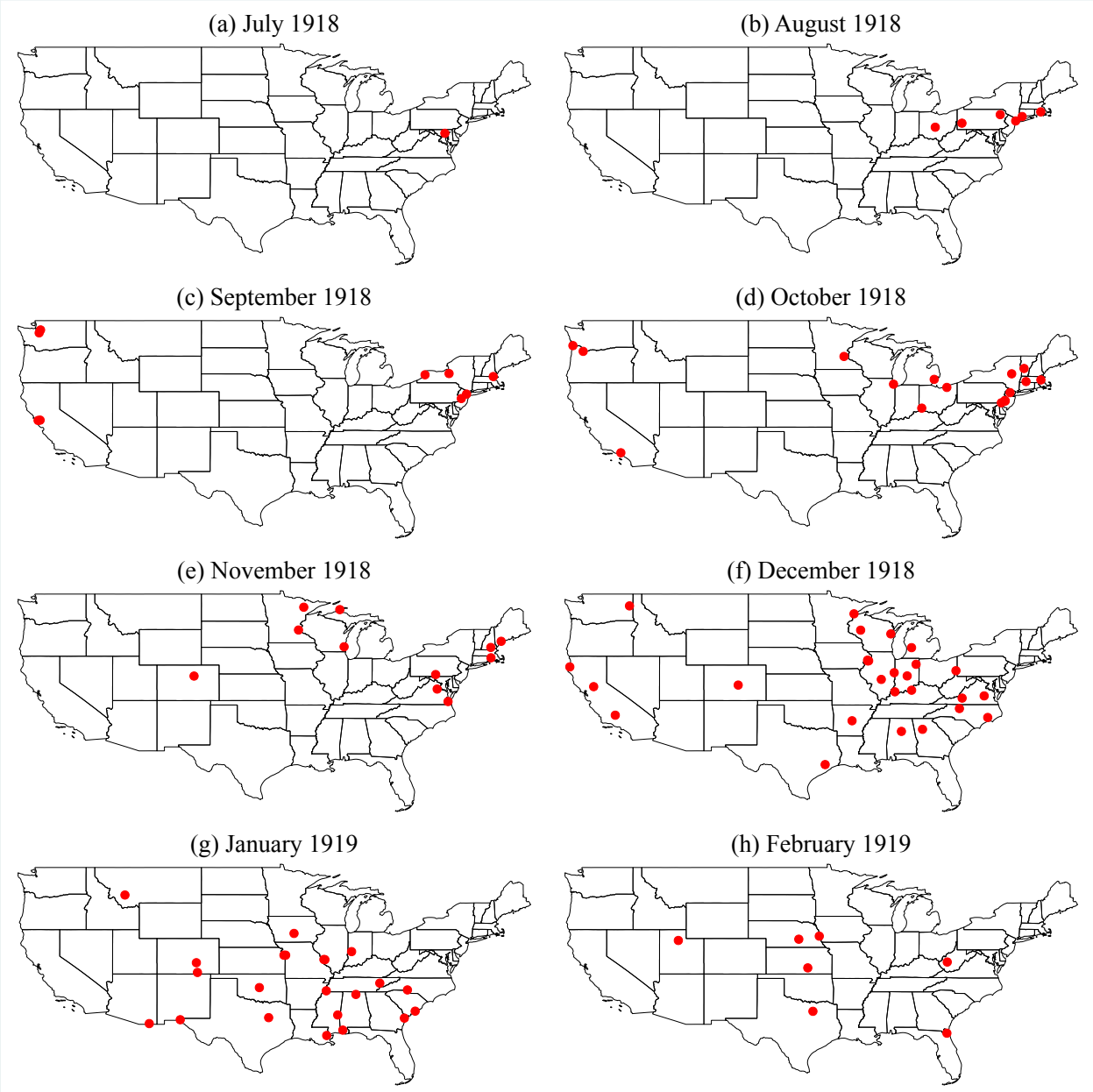
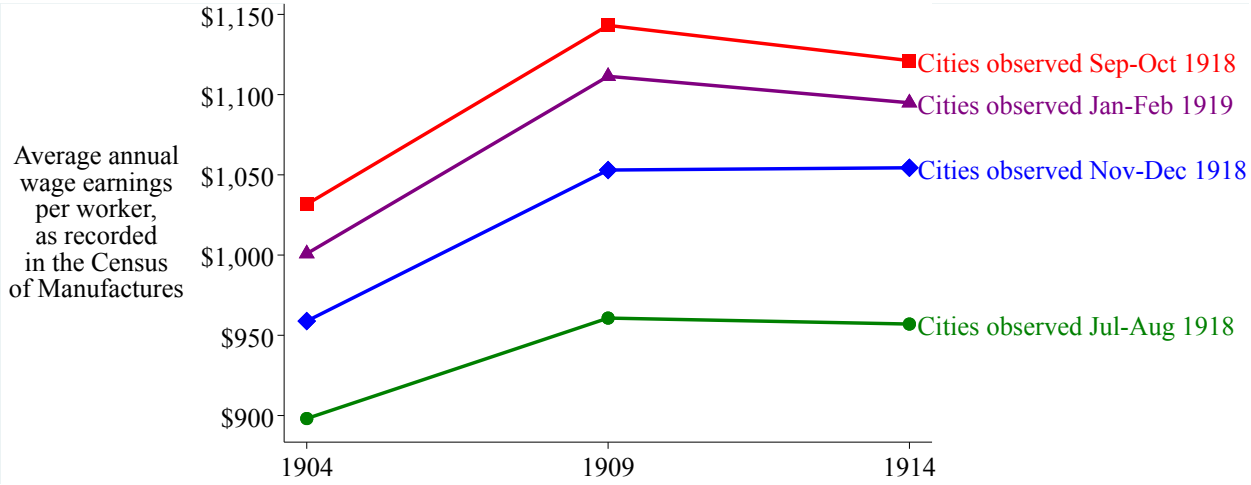
Figure 1: Cities included in BLS cost of living survey, by month



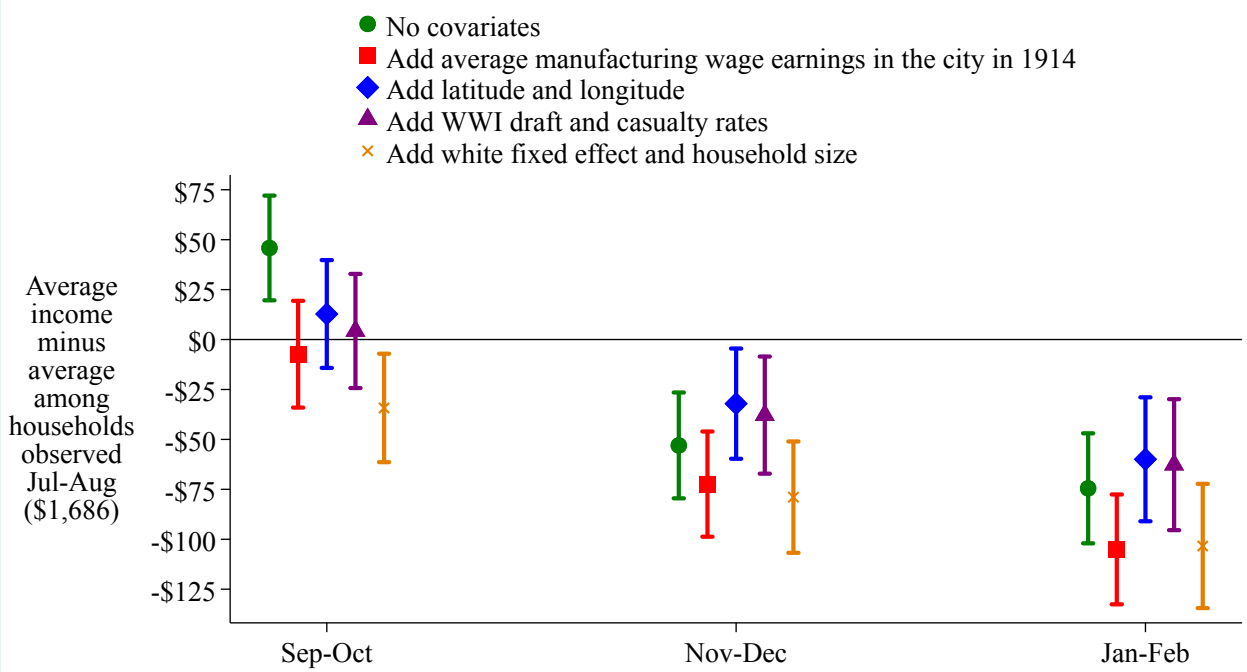
Notes: For each city, this figure identifies the month in which all or most surveys were collected. In a few cities, a handful of households were surveyed outside of the indicated month. Those 65 households are excluded from all analyses. See Appendix A for sources of BLS cost of living survey and other data.

Figure 2: Average earnings per worker, 1904–1914



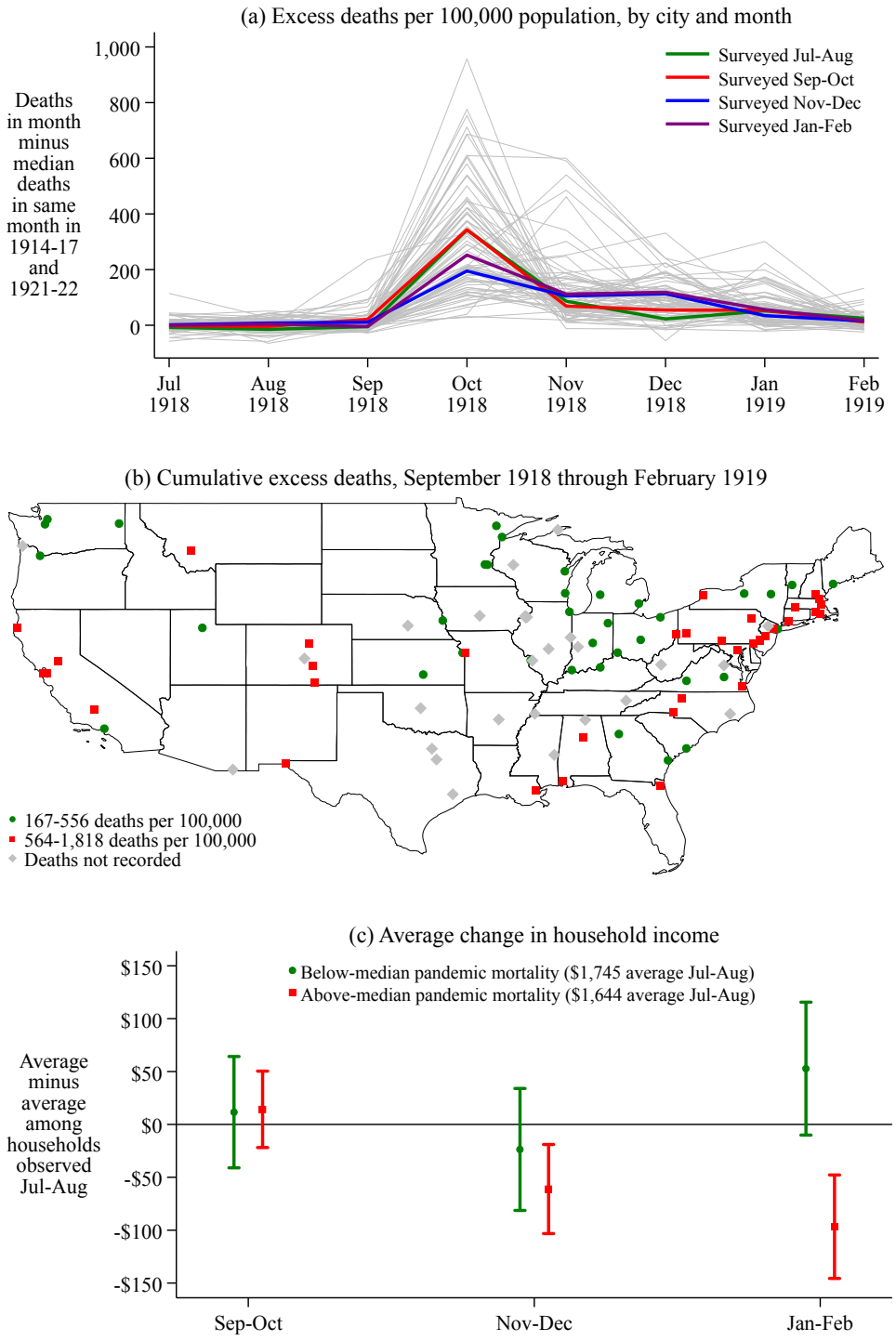
Notes: Average wage earnings per worker are calculated as total wages to paid to all workers in manufacturing divided by the number of workers. Cities are paired according to month of observation in the BLS cost of living survey. The sample consists of all 99 BLS cost of living survey cities in 1909 and 1914, and all cities except Bisbee, Arizona, in 1904. Dollar values are adjusted to real, January 1919 dollars. See Appendix A for sources of Census of Manufactures and other data.

Figure 3: Average change in household income across five specifications



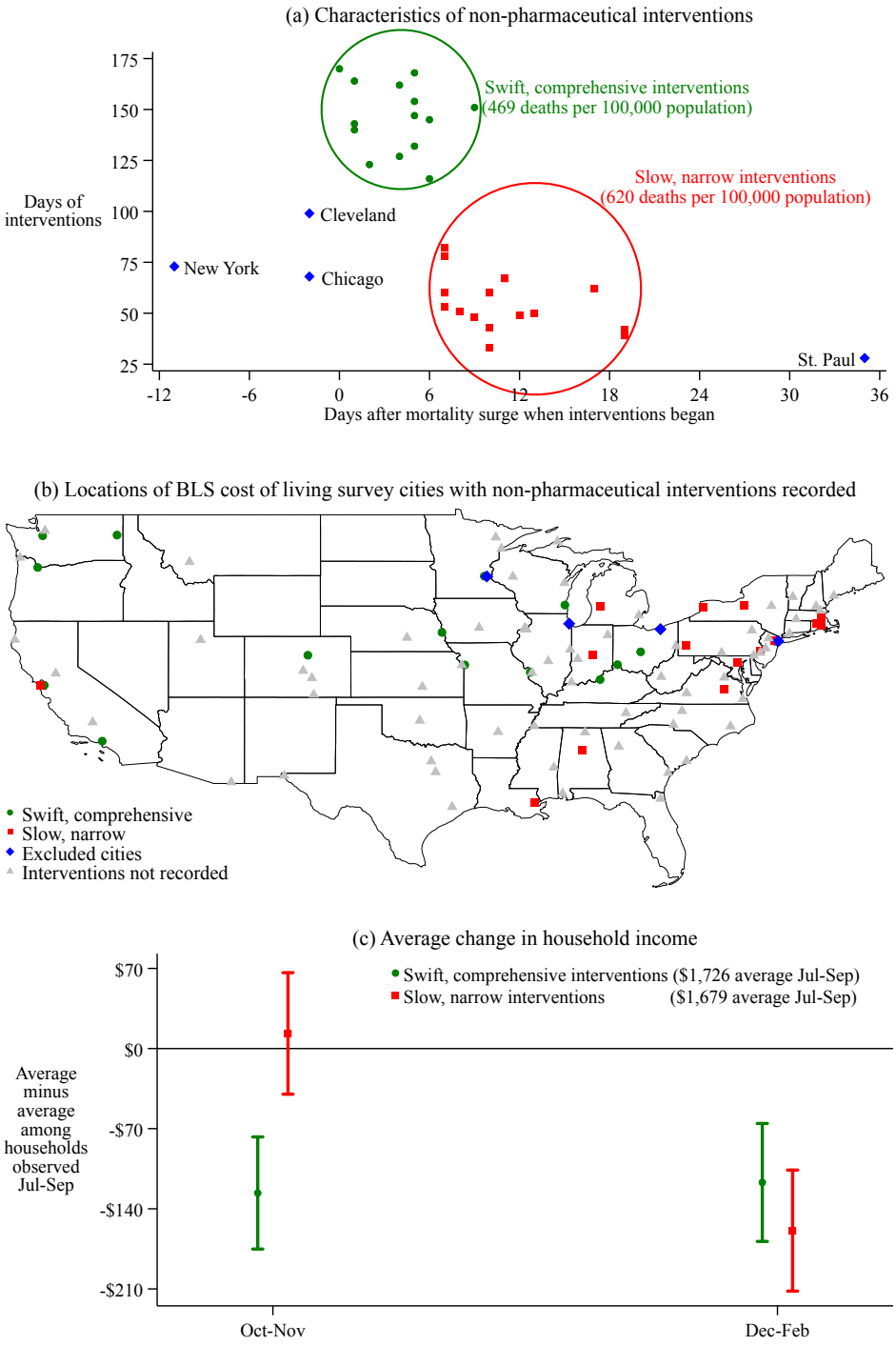
Notes: The first series plots the estimated coefficients from a regression of real household income (in January 1919 dollars) on month-cohort of observation, with 95-percent confidence intervals, and are interpreted as average income for households observed in each pair of months minus the average among households observed in July and August. Subsequent regressions add additional covariates, with the final series representing the specification given in equation 1. Dollar values are adjusted to real, January 1919 dollars. See Appendix A for sources of BLS cost of living survey and other data.

Figure 4: Pandemic mortality



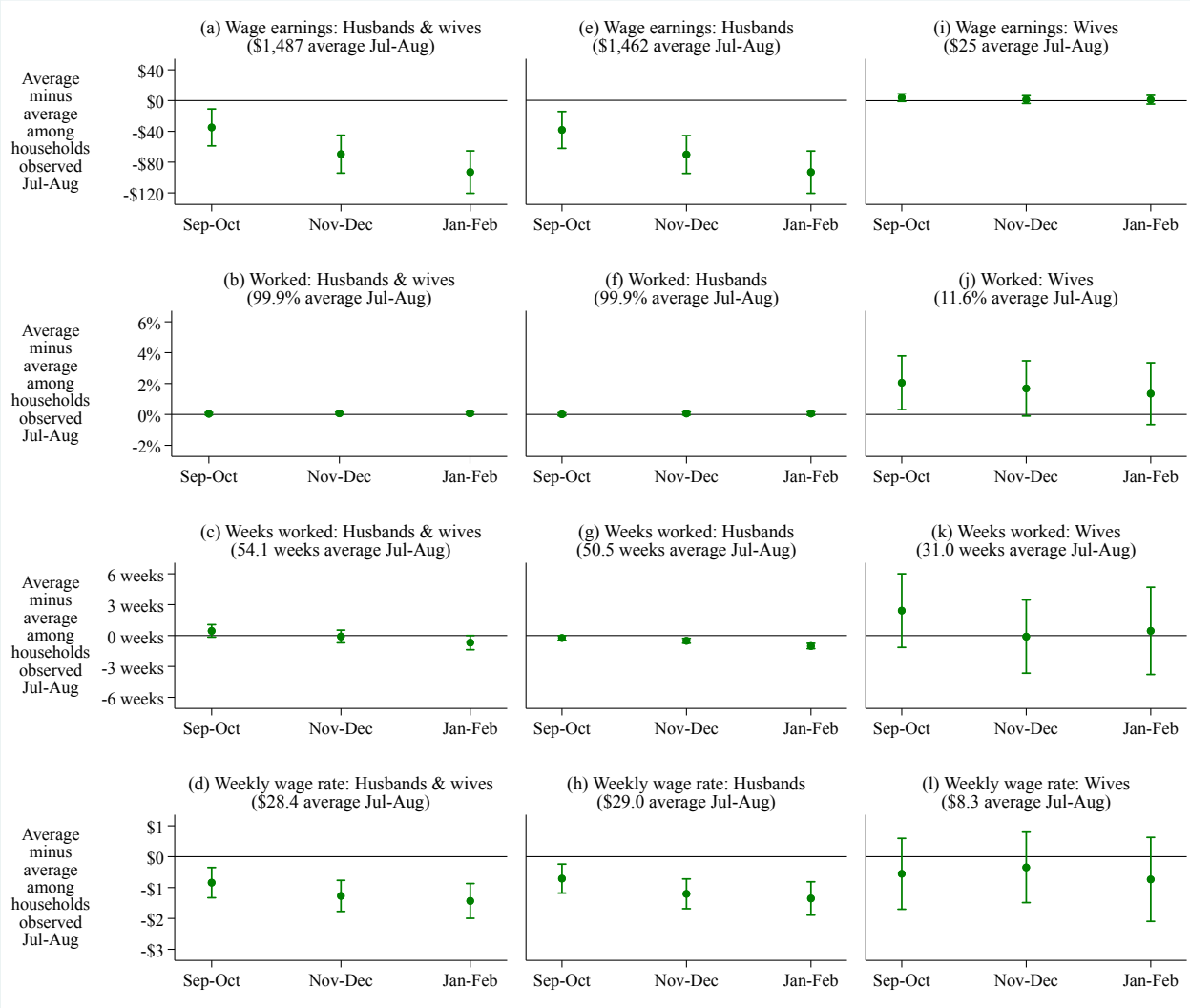
Notes: Pandemic mortality recorded as cumulative deaths between September 1918 and February 1919, in excess of the monthly median deaths (due to all causes) in the same month in 1914, 1915, 1916, 1917, 1920, and 1921. Of the 72 cities in which this measure of mortality is available, 36 had 556 or fewer deaths, and 36 had 564 or more. Regressions in panel (c) are performed separately for cities with above and below-median mortality. Regressions are performed according to equation 1, with 95-percent confidence intervals. See Appendix A for sources of BLS cost of living survey and other data.

Figure 5: Non-pharmaceutical interventions



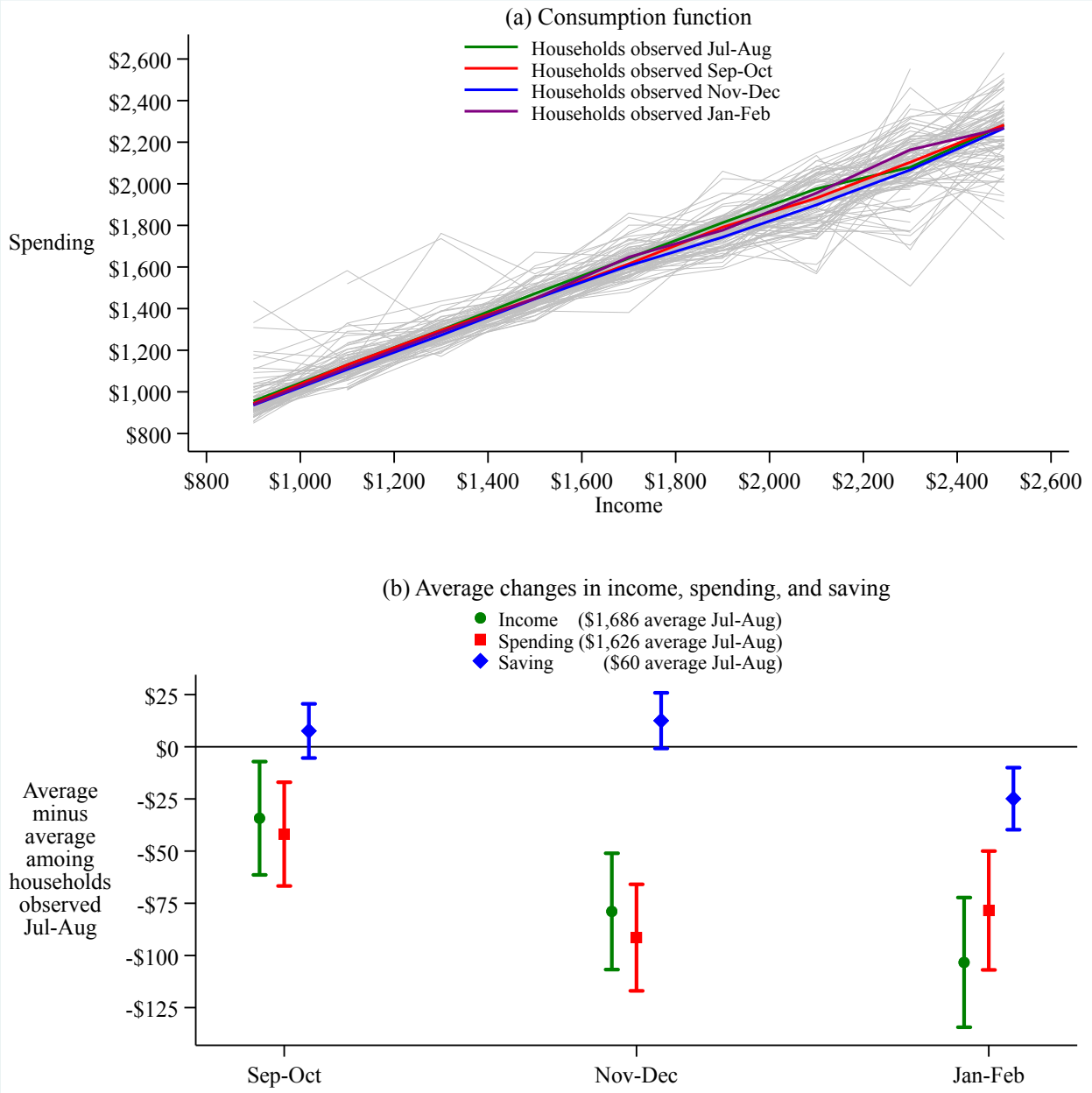
Notes: Timing of mortality surge identified as the date when deaths first doubled the baseline death rate. Days of interventions recorded as cumulative days of school closures, bans on public gatherings, and isolation and quarantine measures. These interventions are recorded for 33 of the BLS cost of living survey cities. The cities fall largely into two clusters: cities with swift, comprehensive interventions, located mostly in the Midwest and west; and cities with slower, more narrow interventions, located mostly in the northeast and Midwest. Chicago, Cleveland, New York, and St. Paul fall outside of these clusters. Regressions are performed according to equation 1, with 95-percent confidence intervals. See Appendix A for sources of BLS cost of living survey and other data.

Figure 6: Average change in wages and hours worked, by gender



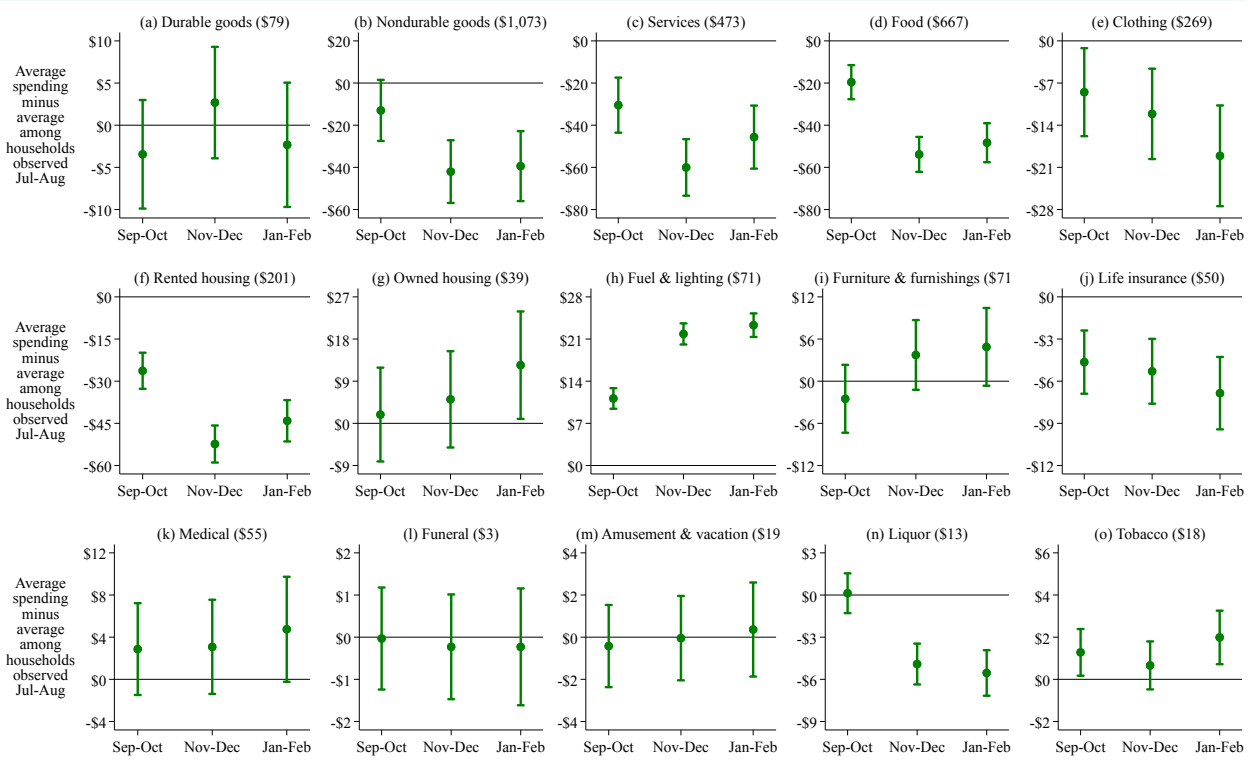
Notes: Weeks worked and weekly wage are calculated for people who worked. Regressions are performed according to equation 1, with 95-percent confidence intervals. See Appendix A for sources of BLS cost of living survey and other data.

Figure 7: Total household spending



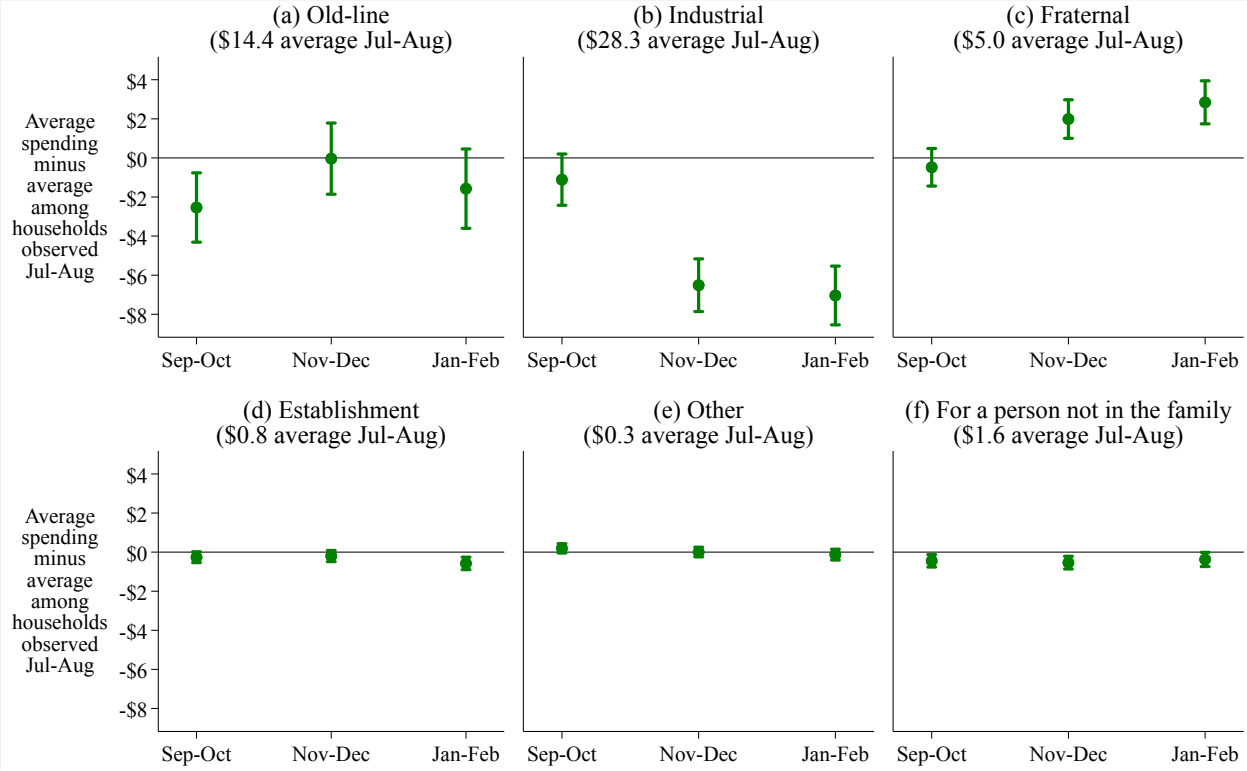
Notes: Panel (a) shows average yearly spending for households grouped according to yearly income in $200 ranges, from $800 to $2,599. The 99 gray lines each correspond to a single BLS cost of living survey city, and the colored lines to cities paired by month of observation. The sample excludes the roughly five percent of households with income below $800 and the five percent with income above $2,600. Panel (b) measures average changes in household income, spending, and saving. Regressions are performed according to equation 1, with 95-percent confidence intervals. See Appendix A for sources of BLS cost of living survey and other data.

Figure 8: Average change in household spending, by spending category



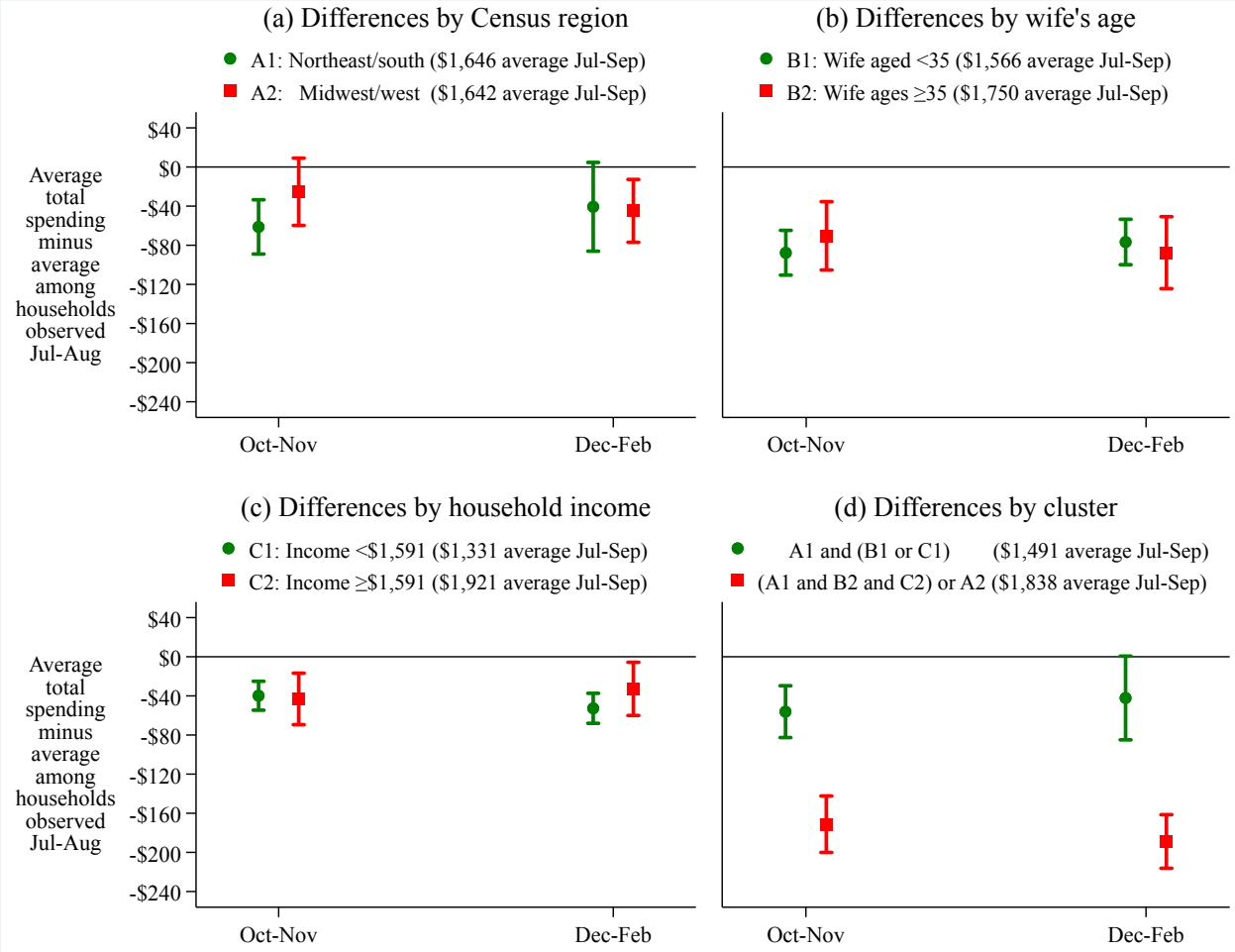
Notes: Regressions are performed according to equation 1, with 95-percent confidence intervals. Average spending by households observed in July and August are provided in parentheses. See Appendix A for sources of BLS cost of living survey and other data.

Figure 9: Average change in life insurance spending, by type



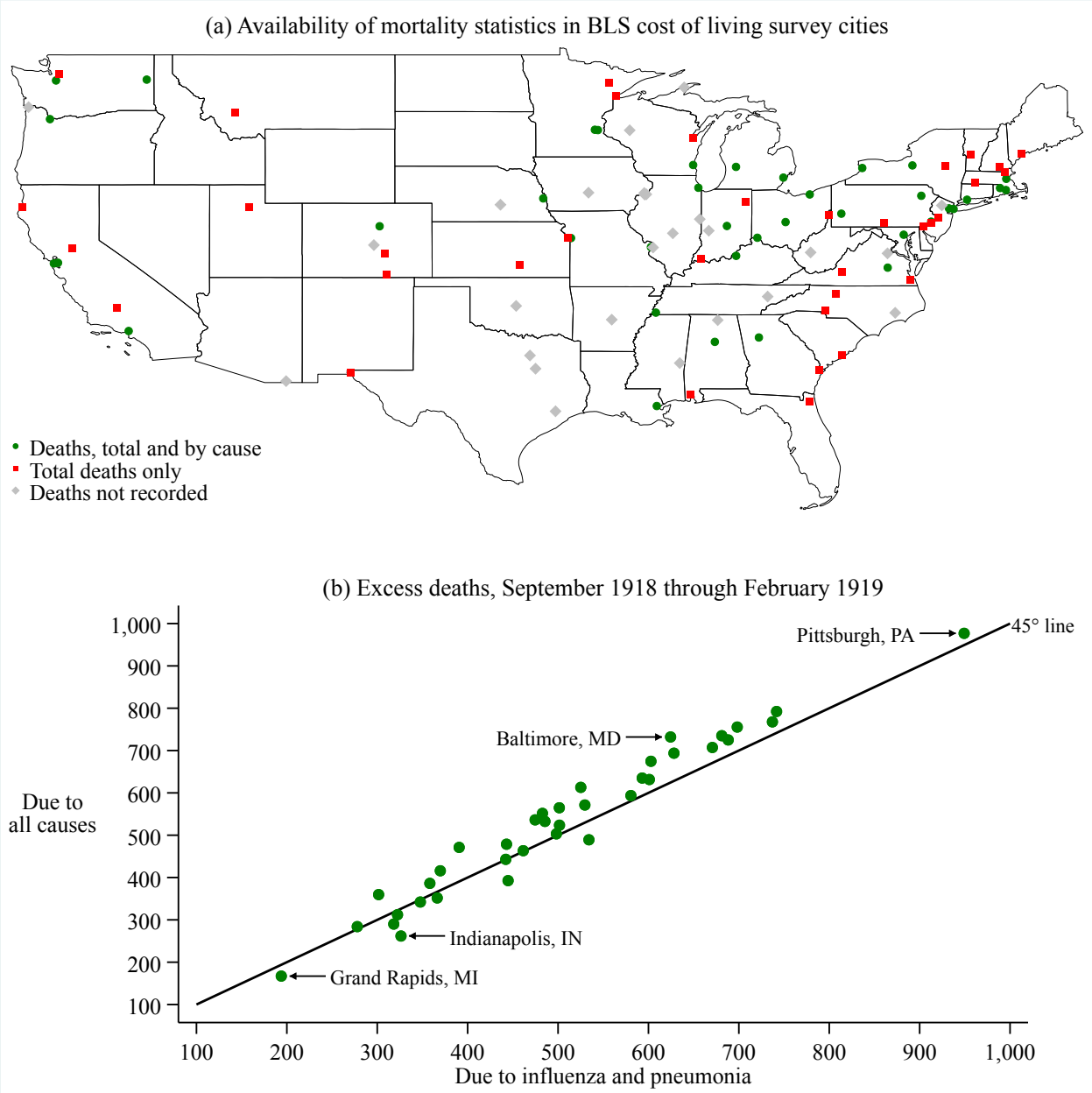
Notes: Regressions are performed according to equation 1, with 95-percent confidence intervals. Average spending by households observed in July and August are provided in parentheses. See Appendix A for sources of BLS cost of living survey and other data.

Figure 10: Change in total household spending, by cluster



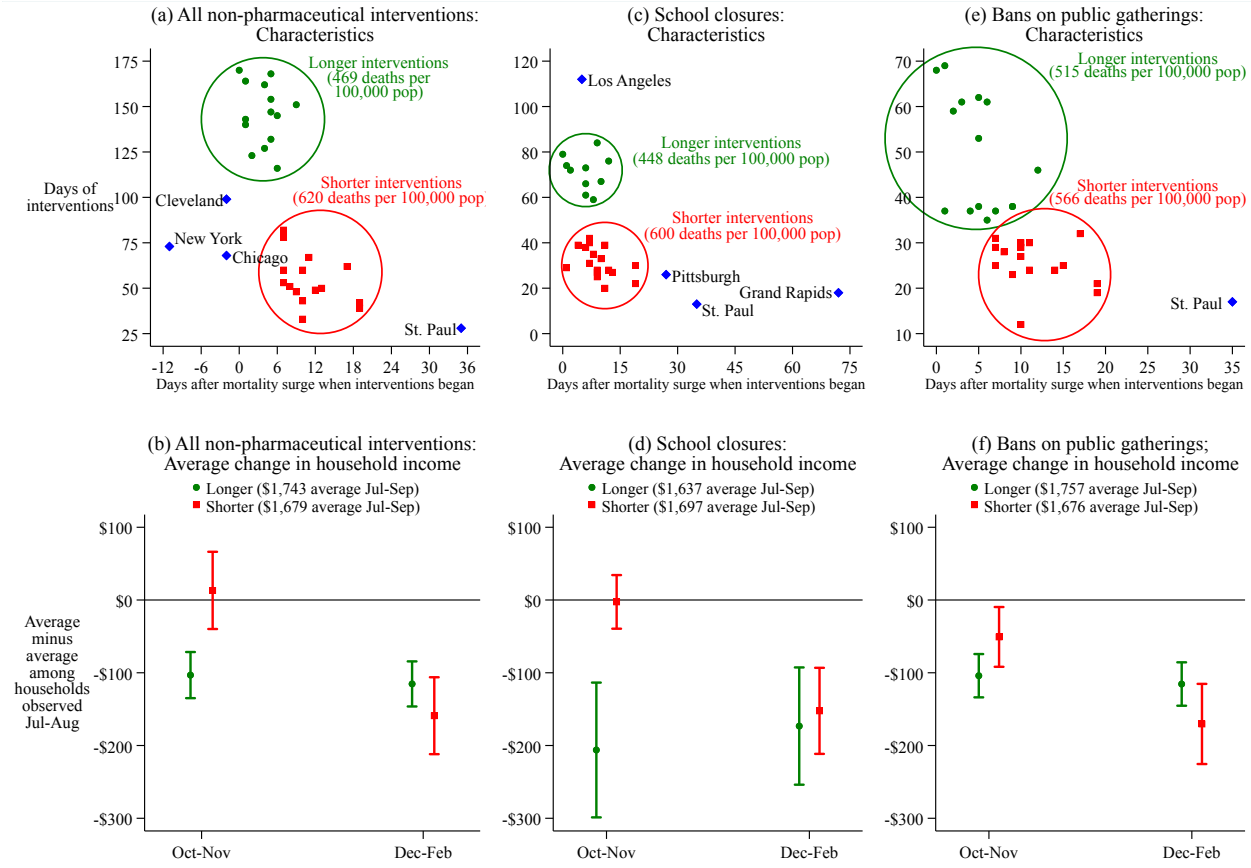
Notes: Regressions performed according to equation 1, with 95-percent confidence intervals. See Appendix A for sources of BLS cost of living survey and other data.

Figure A.1: Deaths during the pandemic



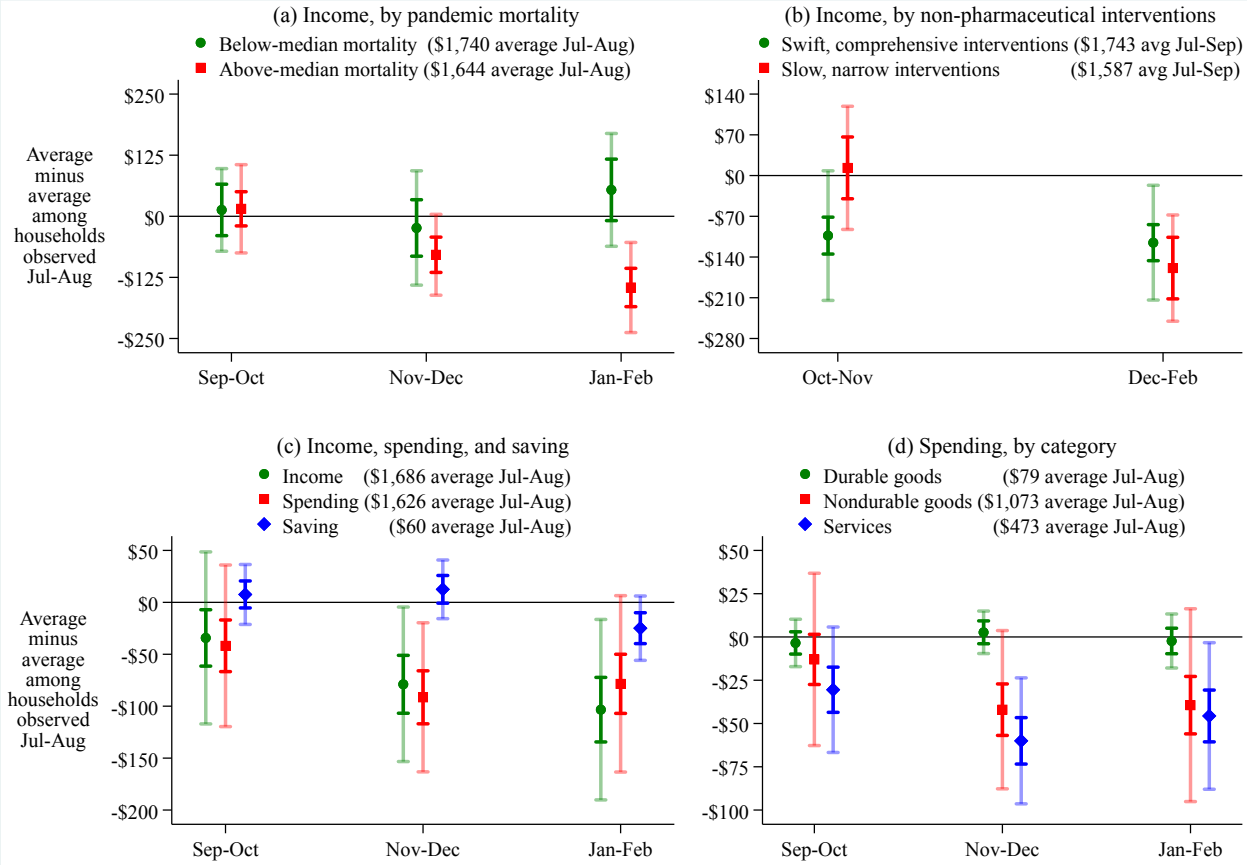
Notes: Pandemic mortality recorded as cumulative excess deaths between September 1918 and February 1919. Deaths due to all causes are recorded in excess of monthly median deaths in the same month in 1914, 1915, 1916, 1917, 1920, and 1921. Deaths due to influenza and pneumonia are recorded in excess of monthly median deaths in the same month in 1910 through 1916. Panel (c) records excess deaths due to all causes, with gray lines corresponding to individual cities and colored lines to cities grouped by paired months of observation. See Appendix A for sources of BLS cost of living survey and other data.

Figure A.2: Characteristics of non-pharmaceutical interventions and changes in wage earnings



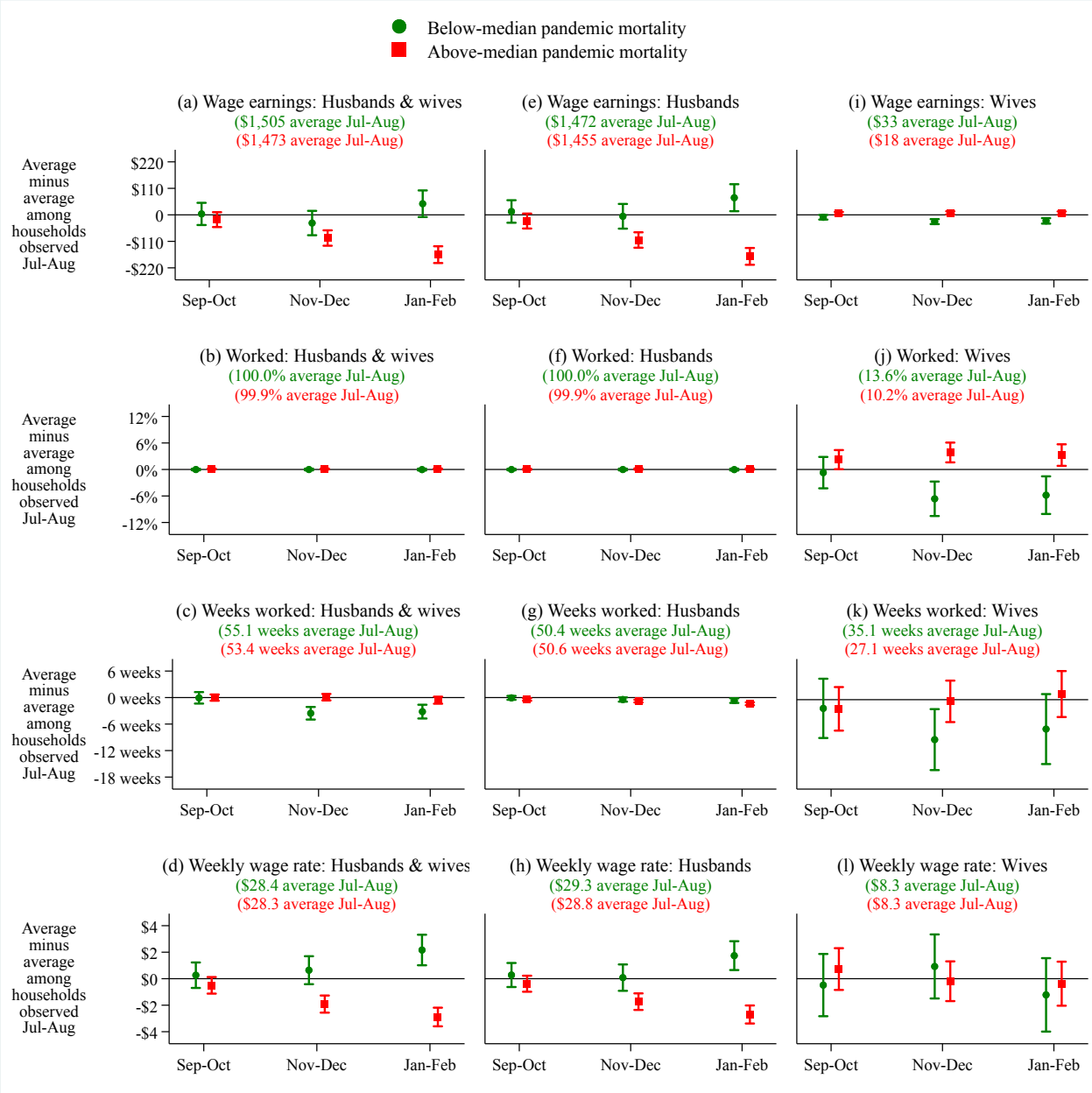
Notes: All non-pharmaceutical interventions include school closures, bans on public gatherings, and isolation and quarantine measures. Panel (a) is the same as panel (a) in Figure 5, and panel (d) is the same as panel (c) in Figure 5. Regressions performed according to equation 1, with 95-percent confidence intervals. Weeks worked and weekly wage rate are calculated only for people who worked. See Appendix A for sources of BLS cost of living survey and other data.

Figure B.1: Main estimates, with and without standard errors



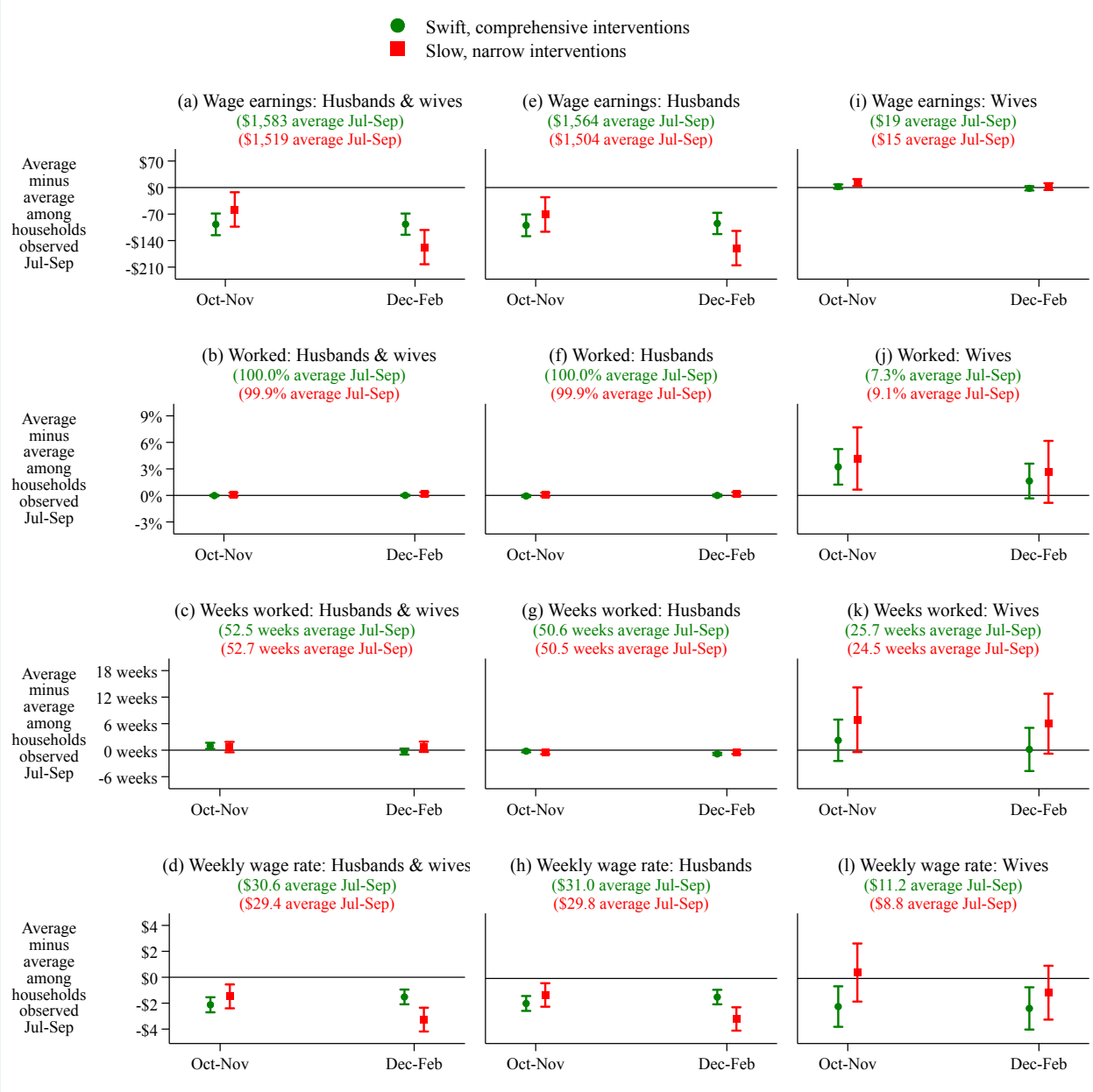
Notes: Regressions performed according to equation 1. The dark lines provide 95-percent confidence intervals without clustered standard errors, and the light lines with standard errors clustered by city. See Appendix A for sources of BLS cost of living survey and other data.

Figure C.1: Average change in wages and hours worked, by gender and mortality



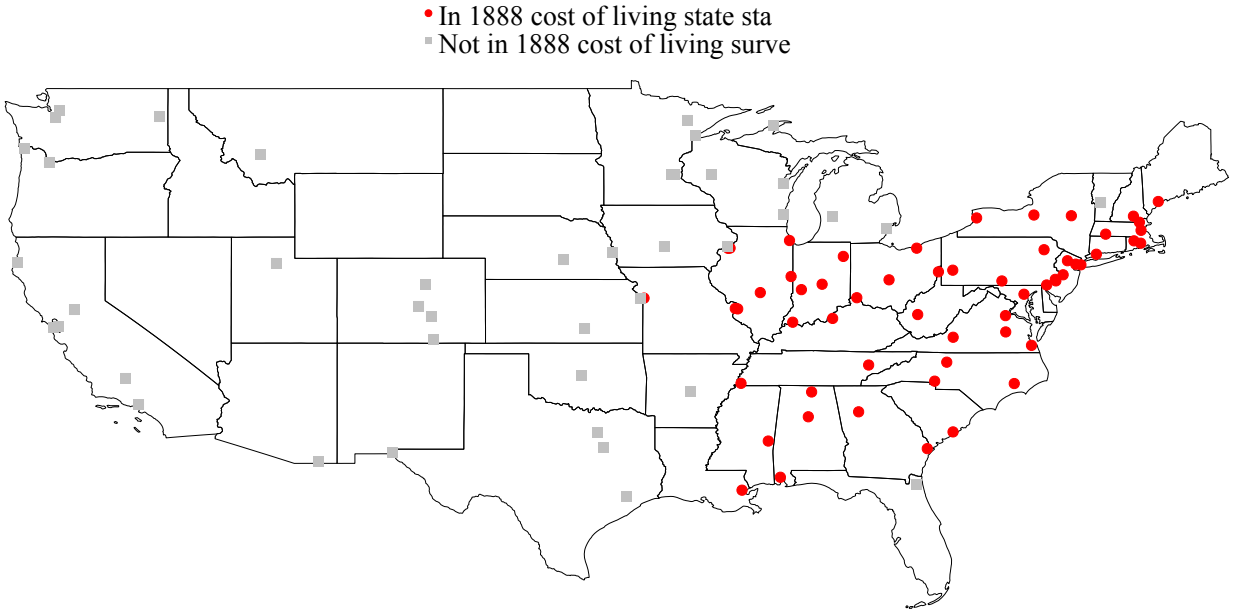
Notes: Regressions performed according to equation 1, with 95-percent confidence intervals. Weeks worked and weekly wage rate calculated among people who worked. Median pandemic mortality is 560 deaths per 100,000 residents between September 1918 and February 1919, in excess of the monthly median deaths (due to all causes) in the same month in 1914, 1915, 1916, 1917, 1920, and 1921. See Appendix A for sources of BLS cost of living survey and other data.

Figure C.2: Average change in wages and hours worked, by gender and non-pharmaceutical interventions



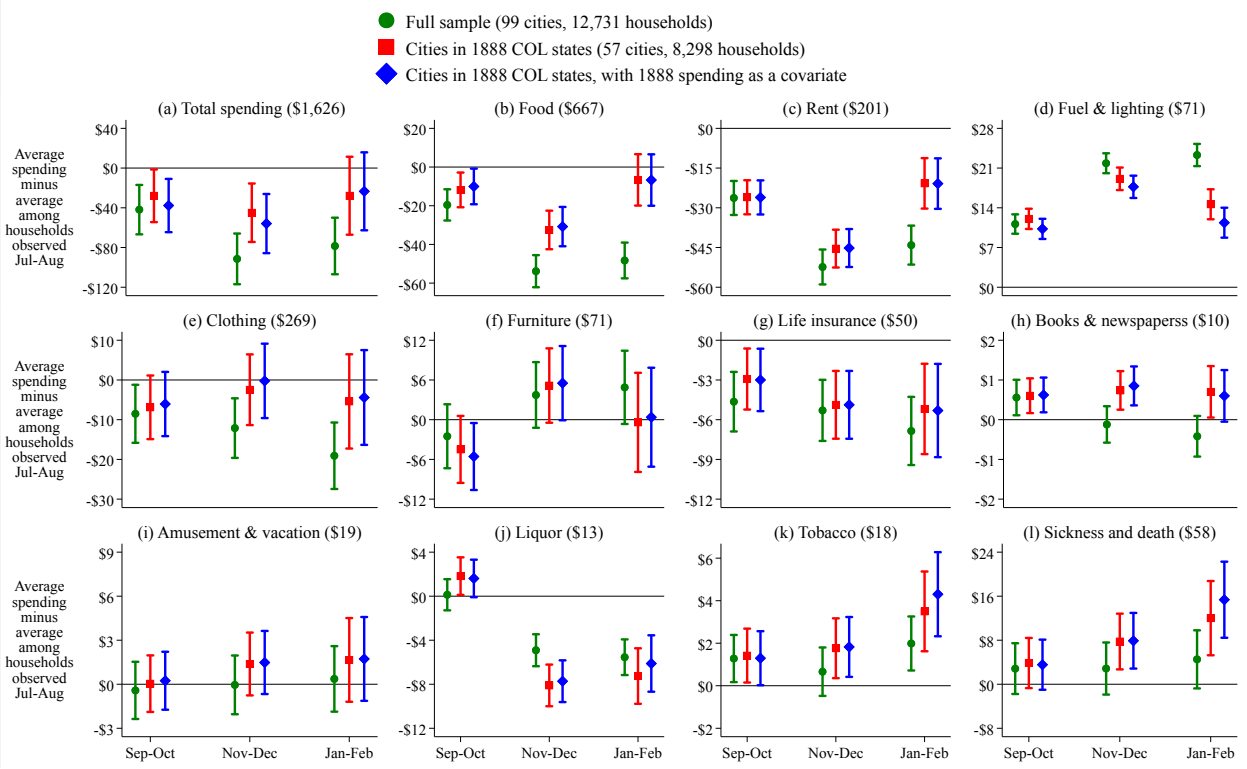
Notes: Regressions performed according to equation 1, with 95-percent confidence intervals. Instead of the paired months, households are grouped as observed in July-September, October-November, and December-February. Weeks worked and weekly wage rate calculated for people who worked. Cities with swift, comprehensive interventions or slow, narrow interventions are identified in Figure 5. See Appendix A for sources of BLS cost of living survey and other data.

Figure D.1: Cities in the 1917–1919 BLS cost of living survey located in states covered by the 1888 cost of living survey



Notes: See Appendix A for sources of 1917–1919 BLS cost of living survey, 1888 cost of living survey and other data.

Figure D.2: Changes in spending during the pandemic, accounting for state-level spending in 1888



Notes: Regressions performed according to equation 1, with 95-percent confidence intervals. Average value for households observed in July and August given in parentheses. See Appendix A for sources of 1917–1919 BLS cost of living survey, 1888 cost of living survey and other data.