The 20-year Impact of Pandemics on Households: A Local Projection Analysis for six European countries between 1870 and 2020

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Abstract

We study the short-, medium-, and long-run impact of pandemics on households by examining six macroeconomic indicators: inflation rate, age dependency ratio, labor productivity, real wages, real consumption per capita, and private savings ratio. We focus on six European countries (France, Germany, Italy, the Netherlands, Spain, and the United Kingdom) from 1870 to recent decades, based on data from existing databases. Using local projections, we estimate the impulse response of each outcome variable up to twenty years after eight pandemics. Our findings reveal that pandemics cause short- to long-term changes in household decisions and labor market conditions. Pandemics have a deflationary effect lasting about 10 years, followed by an increase in inflation. Age dependency ratio remains stable or declines slightly. Labor productivity increases by up to 3.5% compared to the absence of a pandemic but declines after 15 years. Real wages rise over 20 years post-pandemic, peaking at 11.9% above the expected level without pandemic. While real consumption increases and savings decrease in the short run, this trend reverses in the long run, beginning 12 years after a pandemic. We discuss the behavioral responses and economic mechanisms that likely determine the timing and magnitude of these effects. Overall, our findings provide evidence on the type and timing of economic policies that may mitigate the negative economic effects of pandemics.

JEL classification: E24. N33. I15. C32.

Keywords: Households, consumption, savings, inflation, wages, productivity, Local projections, Pandemics

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1 Introduction

The COVID-19 pandemic underscored the importance of understanding the economic impacts of pandemics, as it constituted both a public health crisis and a significant macroeconomic shock. During pandemics, policymakers address adverse health impacts while trying to minimize immediate economic damage. Yet, the negative economic effects of pandemics extend beyond short-term recessions and lockdown disruptions, leading to long-term consequences (Callegari and Feder, 2022). Moreover, economic downturns resulting from pandemics can, in turn, exacerbate public health outcomes (Banks, Karjalainen, and Propper, 2020). Therefore, a thorough understanding of the economic effects of pandemics is crucial for developing effective response and relief policies to mitigate both economic and public health repercussions of future outbreaks.

Although both academic and public interest in the economic consequences of pandemics have grown since COVID-19, our understanding remains incomplete in two key respects. First, studies have predominantly focused on GDP to assess the negative effects of pandemics (Noy and Uher, 2022), leaving other dimensions of the economy, particularly households, relatively underexplored. Households play an important role in economic dynamics, serving as primary agents of consumption and savings while supplying labor to the labor market. Adjustments in household consumption and savings patterns, labor market participation, and other behaviors in response to pandemics are significant determinants of the overall economic impact of such crises. Second, the long-term economic effects of pandemics have not been sufficiently studied. Much of the existing research on modern epidemics and pandemics has confined its scope to the short- to medium-term, focusing on direct and immediate impacts (Berbenni and Colombo, 2021). However, emerging literature (Kozlowski, Veldkamp, and Venkateswaran, 2020; Bonam and Smădu, 2021; Jordà, Singh, and Taylor, 2022) suggests the potential for long-run effects through various channels, such as demographic shifts, intertemporal optimization, human capital deterioration, and long-term belief scarring.

The objective of our study is to analyze how pandemics affect households in the long run, focusing on six macroeconomic indicators—inflation rate, age dependency ratio, labor productivity, real wages, real consumption per capita, and private savings ratio. These variables allow us to investigate different economic and behavioral mechanisms through which pandemics influence households: (i) economic recovery through inflation rate, (ii) the Malthusian effect and structural labor market changes through age dependency ratio, labor productivity, and real wages, and (iii) intertemporal substitution through real consumption per capita and savings ratio. We examine six major European countries (France, Germany, Italy, the Netherlands, Spain, and the United Kingdom) from 1870 to recent decades, drawing on data from existing databases.

We estimate the response of each macroeconomic indicator up to twenty years post-pandemic using local projections (Jordà, 2005), a well-established method for estimating impulse response functions in time series analysis. This technique employs a sequence of regressions to assess the dynamic effect of an intervention or shock—a pandemic with at least 100,000 deaths in this study—on a given variable over time.

We find that:

- Inflation: Pandemics have a deflationary effect lasting about 10 years, followed by an increase in inflation.
- Age dependency ratio: Age dependency ratio remains relatively stable or declines slightly, indicating a weak Malthusian effect.
- Labor productivity: Labor productivity increases by up to 3.5% compared to the absence of a pandemic but declines after 15 years.
- Real wages: Real wages rise over 20 years post-pandemic, peaking at about 11.9% above the expected level without pandemic.
- Consumption and savings: In the short run, real consumption shifts higher while savings shift lower relative to the situation without pandemic. This trend reverses in the long term, beginning 12 years after the pandemic.

We also compare the impact of pandemics with that of wars and financial crises, showing that wars have a more pronounced and longer-lasting effect on economic indicators than pandemics, while financial crises have a smaller impact. Overall, our findings contribute to a better understanding of the consequences of pandemics in the modern economy and help policymakers implement effective fiscal and monetary policies to mitigate and recover from future pandemic-induced economic disruptions.

The rest of the paper proceeds as follows. Section 2 reviews the literature on the economic impact of pandemics; Section 3 describes the data used in this study; Section 4 explains the empirical estimation strategy; Section 5 presents the results; Section 6 discusses the implications and limitations; Section 7 finally concludes.

2 Background

Pandemics are sudden, worldwide events that affect large populations and have severe, potentially long-lasting economic impacts. The Malthusian theory (Voigtländer and Voth, 2013; Madsen, Robertson, and Ye, 2019; Prados de la Escosura and Rodríguez-Caballero, 2022) proposes that population growth is checked by famine, disease, and other events that increase mortality. As sudden mortality shocks, pandemics reduce population levels, which can lead to temporary economic relief by easing pressure on resources. However, as became evident during the COVID-19 pandemic, the economic effects of modern pandemics may arise primarily through macroeconomic adjustments and changes in individual behavior rather than mortality (Noy and Uher, 2022).

Pandemics can affect households through the labor market, with effects that may persist over time. The theoretical literature tends to view pandemics as shocks to labor supply or labor productivity caused by sickness or fear of infection (Goenka, Liu, and Nguyen, 2014; Eichenbaum, Rebelo, and Trabandt, 2022; Boucekkine et al., 2024). Yet, these effects should normally last only during the pandemic and have limited impact on the long-term labor market structure once infections subside. The empirical analysis by Karlsson, Nilsson, and Pichler (2014) shows that the 1918 influenza pandemic (Spanish flu) had a negligible impact on earnings in Sweden, a country that had low mortality rates. Similarly, Basco, Domènech, and Rosés (2021) observe a short-lived reduction in real wages across different occupations in Spain from 1915 to 1930. However, other empirical studies underscore the long-lasting effects of pandemics on the labor market. For example, the bubonic plague, or the "Black Death," significantly reshaped labor markets in medieval times (Cohn, 2007; Jedwab, Johnson, and Koyama, 2022). Franck (2024) finds that the cholera outbreaks of 1832, 1849, and 1854 in France triggered technological adaptation and innovation in agriculture, whereas the industrial sector experienced the opposite effect. This highlights the role of labor-capital substitutability and the impact of pandemics on productivity. Basco, Domènech, and Rosés (2022) conclude that the 1918 influenza pandemic significantly affected labor market participation and its structure, heterogeneously by profession and region. In India, women's labor force participation increased in districts heavily affected by the flu (Fenske, Gupta, and Yuan, 2022). Using British data from 1310 to 2018, Jordà, Singh, and Taylor (2022) show that real wages increased by about 10% over a forty-year period following a pandemic. In tandem with these labor market dynamics, inflation serves as a key indicator of earnings and the evolution of the broader macroeconomic conditions (Benkovskis et al., 2011). In particular, Bonam and Smădu (2021) show that pandemics have a deflationary effect for over a decade, attributing it to weakened aggregated demand.

Another important channel through which pandemics transmit their economic impact is changes in households' consumption and savings decisions. In response to the infection or the fear of infection, households can either (i) reduce consumption to maintain high savings or (ii) reduce savings to compensate for income loss while maintaining consumption levels (Desmarchelier et al., 2022; Eichenbaum, Rebelo, and Trabandt, 2022). The evidence on which behavior prevails is mixed. Jordà, Singh, and Taylor (2022) identify a long-term decline in the natural rate of interest after pandemics, lasting up to forty years, which they attribute to reduced investment demand and increased precautionary savings. Karlsson, Matvieiev, and Obrizan (2023) show that the 1918 influenza pandemic led to a persistent reduction in consumption of 0.4336%. Similarly, Ma, Rogers, and Zhou (2023) find that modern pandemics lowered GDP per capita and consumption by about 2% to 1.8%, respectively, with a quick rebound one year after the pandemic. Moreover, it is unclear how persistent the effects on consumption and savings are. According to Kozlowski, Veldkamp, and Venkateswaran (2020) and Aassve et al. (2021), these changes may last longer than traditionally thought due to "scarring effects." While not specifically referring to health crises, Malmendier and Shen (2024) argue that negative experiences may have "scarring effects" on consumers, altering their consumption patterns. This view is supported by Ma, Rogers, and Zhou (2023), who suggest that pandemics may exert long-run effects through this channel.

We make several contributions to the literature. First, we provide a broad perspective on how key macroeconomic variables responded to pandemics over the period from 1870 to recent decades. This timeframe enables the observation of pandemics' impact in the post-Malthusian period. Second, we analyze how households' macroeconomic behavior and labor market conditions (consumption, savings, real wages and productivity) are affected by pandemics. We extensively discuss the underlying mechanisms of labor market adjustments and household reactions, from both macroeconomic and behavioral perspectives. Finally, our study extends the analysis beyond the usual focus on short-term effects by evaluating economic impacts of pandemics over a 20-year time-horizon, capturing short-, medium-, and long-term effects.

3 Data

We study the impact of pandemics on six macroeconomic indicators to provide a comprehensive picture of the economic conditions of households in six European countries (France, Germany, Italy, the Netherlands, Spain, and the United Kingdom) from 1870 onwards. Specifically, the six indicators and data sources we use are as follows:

- Inflation rate (available annually for 1870-2020): Rate of change in the price level of a basket of consumer goods and services over time. Inflation affects the cost of living by making everyday expenses such as groceries, housing, and utilities more expensive, which affects household budgets and savings. We calculate the inflation rate by first differencing the logarithm of the consumer price index (CPI). The CPI data are from Jordà, Schularick, and Taylor (2017). As the German interwar hyperinflation constitutes a very large outlier, we disregard the inflation rate for the period 1922-1924 for Germany.[1]

- Age dependency ratio (available annually for 1870-2011): Population of dependents (ages below 15 and above 64) relative to the working-age population (ages 15 to 64). A higher ratio indicates more dependents per worker, potentially increasing the financial burden on households. The data are from Madsen, Islam, and Doucouliagos (2018).

- Labor productivity (available annually for 1870-2020): Output (GDP) per hour worked. Higher productivity leads to economic growth, higher wages, and better living standards for households. The data are from Bergeaud, Cette, and Lecat (2016).

[1]We ignore the observations for the hyperinflation period and interpolate them using a state-space model. See Section 4.

- Real wages (available annually for 1870-2020): Wages adjusted for inflation, measuring the purchasing power of income earned from employment. Higher real wages allow households to afford more goods and services, improving their standard of living. We construct series of real wages using the CPI and nominal wages available from Jordà, Schularick, and Taylor (2017).

- Real consumption per capita (available annually for 1870-2020): Average value of goods and services consumed by each person in a household, adjusted for inflation. It reflects the standard of living and economic well-being of individuals. The data are from Jordà, Schularick, and Taylor (2017).

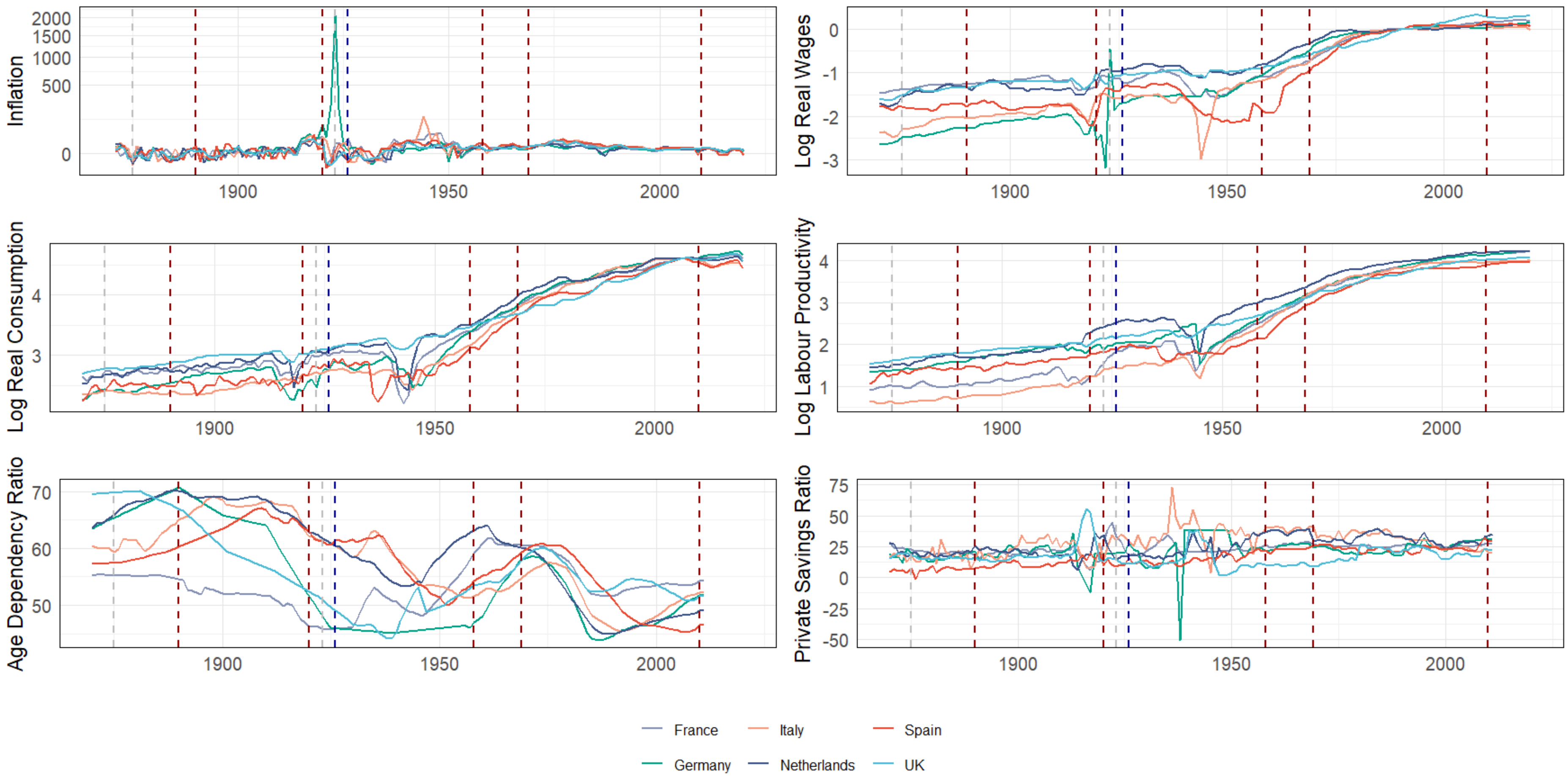
- Private savings Ratio (available annually for 1870-2011): Proportion of disposable income that households save rather than spend. A higher savings ratio suggests that households are preparing for future expenses or uncertainties, reflecting financial instability. The data are from Madsen, Islam, and Doucouliagos (2018).

We investigate time series by indicator and country, as well as an "Aggregate European" time series for each indicator by averaging across six countries with GDP share weights for each year (Bolt and van Zanden, 2024). To obtain the European inflation rate, we compute the European consumer price index and then take its log differences. Given the outlier represented by German interwar hyperinflation, we disregard the European inflation rate for 1924.[1]

The time frame from 1870 to either 2011 or 2020 is well-suited for informing future pandemic responses due to the availability of reliable data and its relevance to modern economic conditions. Detailed economic indicators have been collected in European countries since the second half of the 19th century, enabling robust statistical analysis and the identification of long-term trends and patterns. Figure 1 presents the time series of inflation rate, age dependency ratio, log labor productivity, log real wages, log real consumption per capita, and private savings ratio. Notice that indicators show greater variability across countries in the earlier years but converge towards the end of the study period. Also, The influence of the First and Second World Wars is clearly visible in the graph.

For this study, we define a pandemic as an epidemic resulting in at least 100,000 estimated deaths and affecting at least one of the six European countries under consideration (Jordà, Singh, and Taylor, 2022). As shown in Table 1, eight pandemics since 1870 meet this definition: the Fourth Cholera pandemic (1863-1875), the 1889–1890 pandemic, often referred to as the "Asiatic flu" or "Russian flu" (1889-1890), the Sixth cholera pandemic (1899-1923), the Encephalitis lethargica pandemic or "Economo's disease" (1915-1926), the 1918 influenza A (H1N1) pandemic (Spanish flu) (1918-1919), the influenza A (H2N2) pandemic or "Asian Flu" (1957-1958), the influenza A (H3N2) pandemic or "Hong Kong Flu" (1968-1969), and the 2009 influenza A (H1N1) pandemic or "Swine flu" (2009-2010). The yellow fever epidemic (1880-1900) is excluded as it primarily affected the Americas rather than Europe. Similarly, HIV/AIDS (1920-2020) is

Figure 1. Observed Timeline for Six Outcome Indicators, by Country, 1870-2020



Sources: Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018).
Dashed lines mark the end year of each pandemic. Red dashed lines indicate the 1918 influenza pandemic; gray dashed lines indicate cholera pandemics; blue dashed lines indicate other pandemics.

excluded because it is classified as endemic. Lastly, COVID-19 is not considered in this analysis as it is too recent to assess its long-term impact.

Table 1. List of pandemics at least 100,000 estimated deaths considered in this analysis, 1870-2020.

Name	**Date**	**Estimated deaths**
Fourth cholera pandemic	1863 - 1875	600,000
1889-1890 pandemic (Russian flu)*	1889 - 1890	1,000,000
Sixth cholera pandemic	1899 - 1923	800,000
Encephalitis lethargica pandemic	1915 - 1926	1,500,000
1918 influenza pandemic (Spanish flu)	1918 - 1920	58,500,000
H2N2 pandemic (Asian flu)	1957 - 1958	2,000,000
H3N2 pandemic (Hong Kong flu)	1968 - 1969	1,000,000
H1N1 pandemic (Swine flu)	2009 - 2010	364,000

Source: Cirillo and Taleb (2020).
Yellow fever (1880-1900), HIV/AIDS (1920-2020), and COVID-19 (2019-2020) are excluded, despite resulting in more than 100,000 estimated deaths. The reasons are, respectively, lack of relevance to the European context, being an endemic disease, and being too recent (see text).
*The 1889-1890 pandemic (Russian flu) might have been caused by coronavirus (Brüssow and Brüssow, 2021).

The eight pandemics had different impacts across the six countries and their populations. For instance, during the 1918 influenza pandemic, Spain and Italy experienced higher excess mortality rates than other countries (Beach, Clay, and Saavedra, 2022), with younger individuals being more affected than older ones (Johnson and Mueller, 2002). The duration of pandemics also varied by pathogen. Influenza pandemics typically lasted one to two years, whereas cholera and encephalitis lethargica pandemics persisted for one to two decades (Underwood, 1948; Bourdelais and Raulot, 1987). Influenza pandemics generally resulted in more fatalities than cholera, with the 1918 pandemic being the most devastating. Despite these differences, all pandemics represented a significant shock to the six countries considered and their economies, causing substantial morbidity and mortality (Alfani, 2024).

Pandemics were not the only events that severely affected households during the period under review. Wars and financial crises also had profound effects on the economies and populations of the six countries examined. As with pandemics, we use dummy variables to capture these events. For individual countries, years with more than 5,000 average annual casualties are considered wartime, with the dummy variable for war set to one. For aggregate Europe, the dummy variable equals one for all years with more than 20,000 average annual battle deaths (Jordà, Singh, and Taylor, 2022). The data on wars and the number of casualties come from Schmelzing (2020) and the Correlates of War database (Sarkees and Wayman, 2010).

Data on financial crises are collected from the Macrohistory Database by Jordà, Schularick, and Taylor (2017), which lists systemic banking crises in each nation from 1870 to 2020. The dummy variable for financial crises captures the years in which a systemic banking crisis occurred in a specific country. For aggregate Europe, financial crises are identified when two or more countries experienced crises either concurrently (overlapping years) or consecutively (back-to-back years). Appendices A1 and A2 specify the war and financial crisis events by country included in the analysis.

4 Estimation Strategy

We use local projections (Jordà, 2005) to estimate the impulse response function (IRF) of the six indicators to pandemics, up to twenty years after the end of the event. An IRF measures the impact of a specific shock on the variable of interest over time. Local projections estimate this impulse response by adopting a methodology analogous to the Rubin causal model (Rubin, 1974) used in policy evaluation, which contrasts the potential outcomes of the variable of interest under the presence and absence of an intervention (a pandemic in our case) (Jordà, 2023). The key distinction lies in its application to macroeconomic time series, where potential outcomes are derived from forecasts based on autoregressions. Specifically, this approach involves regressing the future outcome variable on the shock variable for each forecast horizon, incorporating lags of both the outcome and shock variables as covariates (Jordà and Taylor, 2024). Consequently, local projections compare the conditional means of the forecasted outcome variable under scenarios with and without a pandemic. The forecast in the absence of a pandemic serves as the control group, while the forecast in the presence of a pandemic serves as the treatment group.

Although multivariate vector autoregressions (VARs) have traditionally been the standard method in applied macroeconomics for estimating IRFs, Plagborg-Møller and Wolf (2021) and Montiel Olea and Plagborg-Møller (2021) demonstrate that local projections can be a robust alternative. Unlike VARs, univariate local projections do not require specifying the entire dynamic system in which the impulse response occurs. This simplicity, combined with their robustness to misspecification of the actual data generating process and flexibility to accommodate non-linearities (Jordà, 2005), makes local projections a valuable tool. As a result, this method has been employed in multiple studies to assess the economic impact of epidemics and pandemics (Bonam and Smădu, 2021; Cuesta Aguirre and Ahmed Hannan, 2021; Donadelli et al., 2021; Emmerling et al., 2021; Wang, Zhang, and Verousis, 2021; Furceri et al., 2022; Jordà, Singh, and Taylor, 2022; Barrett et al., 2023; Ma, Rogers, and Zhou, 2023; Furceri, Pizzuto, and Yarveisi, 2024).

We estimate the IRF of each of the six macroeconomic indicators (y_t^*) which is formulated as:

$$\tau(h) = E\left(y_{t+h}^* - y_{t-1}^* \mid P_t = 1, X_t\right) - E\left(y_{t+h}^* - y_{t-1}^* \mid P_t = 0, X_t\right), \tag{1}$$

where $h = 0, \ldots, 20$ denotes the forecast horizon, extending up to twenty years after a pandemic ends, and the subscript t indicates the actual year since 1870. $\tau(h)$ represents the response of y_t^*

over time, defined as the difference in expectations of $y^*_{t+h} - y^*_{t-1}$ with and without a pandemic in year t. $y^*_{t+h} - y^*_{t-1}$ is the change in the indicator of interest between the year a pandemic ends and h years into the future.[2] P_t is a dummy variable that equals 1 if a pandemic ends in year t and 0 otherwise. X_t represents the information available at time t, here denoting a vector that consists of past values of y_t and P_t along with the current and past values of other control variables. Following standard practice in the literature on the economics effects of pandemics, these control variables include dummies for years of wars and financial crises (Bonam and Smădu, 2021; Cuesta Aguirre and Ahmed Hannan, 2021; Donadelli et al., 2021; Furceri et al., 2022; Jordà, Singh, and Taylor, 2022; Barrett et al., 2023; Ma, Rogers, and Zhou, 2023), as well as a post-WW2 dummy to account for the post-war period after 1945, when major European economies experienced substantial growth alongside a surge in most macroeconomic indicators (Crafts, 1995; Toniolo, 1998). For the Netherlands, we incorporate an additional dummy to capture the famine of the winter of 1944-1945. Since wars, financial crises, and famines may have long-lasting effects as with pandemics, they are also lagged.[3]

Specifically, we estimate $\tau(h)$ using local projections specified as:

$$y^*_{t+h} - y^*_{t-1} = \alpha(h) + \tau(h)\, P_t + X_t'\beta(h) + e_{t+h}(h), \tag{2}$$

where $\alpha(h)$ is the intercept, $\beta(h)$ is a vector of estimated coefficients, and $e_{t+h}(h)$ is the error term, while the other variables are defined as above. The regressions are done with Newey-West standard errors to address autocorrelation and heteroskedasticity in the error terms. If a pandemic had a positive (negative) impact on the indicator h years after it ended, then $\tau(h)$ would be positive (negative). If there was no impact, $\tau(h)$ would be zero.

Our identification strategy relies on pandemics being fundamentally exogenous shocks. As established in the literature (Jordà, Singh, and Taylor, 2022; Ma, Rogers, and Zhou, 2023), pandemics function as natural experiments with no evident confounders at the macroeconomic scale. Normally, the economy does not evolve in anticipation of a pandemic; adjustments occur only after its onset. Within this framework, local projections can accurately estimate the IRF, allowing the regression coefficient $\tau(h)$ to be interpreted as having causal implications. Even if another exogenous event occurs between year t and $t + h$ (the forecast horizon) and potentially influences the forecast, its impact on $\hat{\tau}(h)$ remains limited. This is because such an incident would similarly affect both the counterfactual forecast (in the absence of a pandemic) and the factual forecast (in the presence of a pandemic). Furthermore, these impacts are likely to be mitigated by other pandemic events, as $\hat{\tau}(h)$ measures the average effect of pandemics.

Prior to implementing local projections, we use a state-space model to filter out stochastic

[2] We log-transformed outcome variables, except for rates and ratios, to express changes in percentage terms.
[3] We select 5 lags based on the literature and VAR model (Montiel Olea and Plagborg-Møller, 2021). Our results remain robust to variations in lag length, as shown in the appendix.

noise inherent in the time series data of our indicators. State-space models decompose observed time series (y_t) into their underlying signal (y_t^*) and noise components. By leveraging the Kalman filter, we extract a smoothed signal that more accurately reflects the true underlying dynamics of the macroeconomic indicators considered. This pre-processing step is crucial, as it enhances the reliability and precision of subsequent local projections by mitigating the effect of noise, ensuring that the estimated IRFs are robust and reflective of the genuine economic relationships. Smoothing also addresses missing values caused by German interwar hyperinflation (1922-1924 for Germany and 1924 for aggregate Europe). Specifically, we apply the state-space systems used by Jordà, Singh, and Taylor (2022). For variables that are rather volatile without showing long-term trends, namely inflation rate and private savings ratio, we make use of:

$$\begin{aligned} y_t &= y_t^* + \epsilon_{1,t}, \\ y_t^* &= y_{t-1}^* + \epsilon_{2,t}. \end{aligned} \tag{3}$$

For variables that exhibit more persistent patterns over time, we apply:

$$\begin{aligned} y_t &= y_t^* + \epsilon_{3,t}, \\ y_t^* &= y_{t-1}^* + g_{t-1} + \epsilon_{4,t}, \\ g_t &= g_{t-1} + \epsilon_{5,t}, \end{aligned} \tag{4}$$

where g_t is the growth rate of y_t^*.

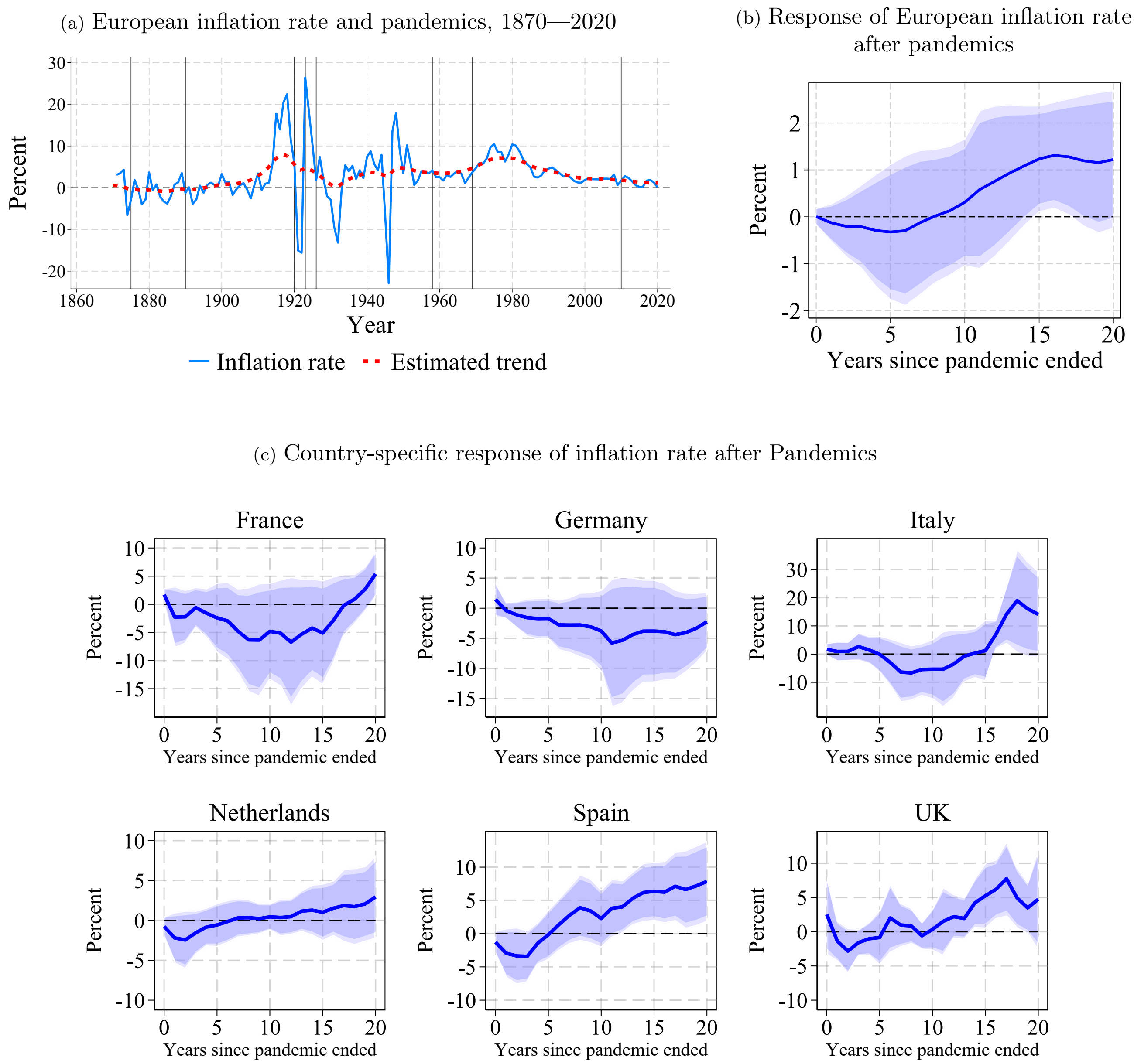
5 Results

For each indicator, we show a figure consisting of three panels: (a) the time series and smoothed time series at European level; (b) the estimated IRF at European level; and (c) the IRFs for each individual country.

5.1 Inflation Rate

Inflation directly impacts households by reducing their purchasing power, making goods and services more expensive over time. It can serve as a reliable proxy for understanding economic activity patterns (Benkovskis et al., 2011). Especially inflation is correlated with other macroeconomic variables such as production, savings, global consumption, investment, etc. (Benkovskis et al., 2011). Figure 2b shows that pandemics have on average a deflationary effect that last for about 10 year before an inflationary phase starts and persists for the remainder of the post-pandemic period.

Figure 2. Response of Inflation to 8 Pandemics, 1870-2020



Data are from Jordà, Schularick, and Taylor (2017). Trend of inflation rate is estimated using equation 3. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

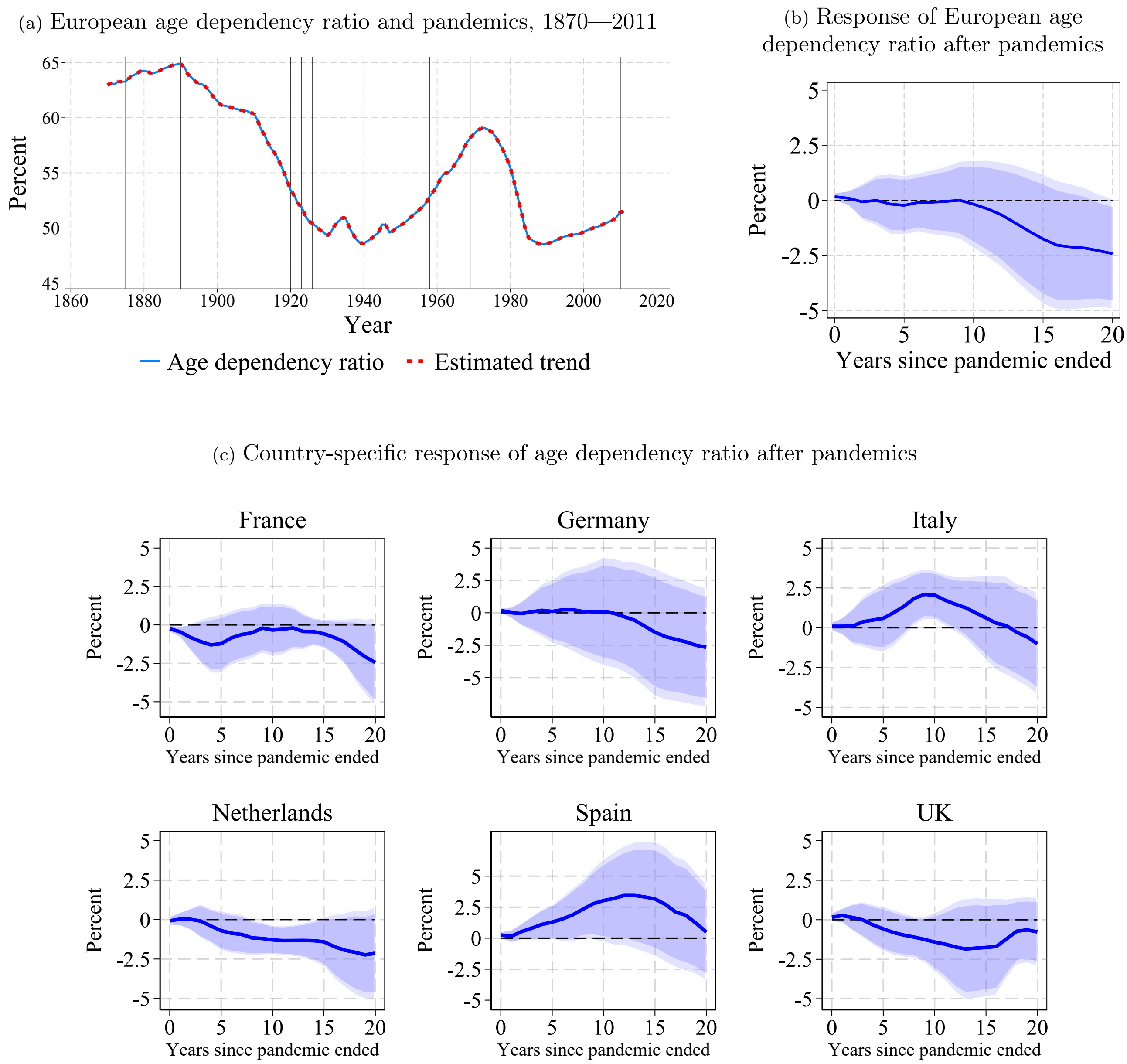
At the country level, results are heterogeneous (Figure 2c): an initial decline in inflation compare to the counterfactual of between 2.5 and 5 percentage points is observed within two years after a pandemic ends, with this effect lasting between 5 and 15 years depending on the country. After this initial phase, there is an inflationary effect that results in higher inflation compared to the no-pandemic counterfactual. Germany is the only country where pandemics decrease inflation for the whole post-pandemic study period.

According to the literature, these results highlight the suboptimal position of the economy resulting from the impact of pandemics prior to the start of the catch-up phase (Benkovskis et al., 2011). Our findings are in contrast to Bonam and Smădu (2021), who also find a decline in trend inflation, but no increase in inflation in the later periods. We should compare our findings with theirs cautiously, as their study also covers the pre-industrial period starting in 1314. Additionally, the prolonged initial negative effect—lasting over a decade (Figure 2b)—emphasizes the dominant role of demand shocks relative to supply shocks, as also discussed by Bonam and Smădu (2021) and Eichenbaum, Rebelo, and Trabandt (2022).

5.2 Age Dependency Ratio

The Age Dependency Ratio (ADR) reflects the relative size of the non-working population compared to the workforce, thereby capturing changes in population and labor market structure. Figure 3b shows that at the aggregate European level, the ADR is unchanged for up to 10 years after a pandemic. After that, it decreases until the end of the period. This suggests that, on average, modern pandemics do not significantly impact the population structure in the short to medium term, but they do in the long term, favoring the working population over the non-working population. These results underline that Malthusian effects are not automatic during modern pandemics.

Figure 3. Response of Age Dependency Ratio to 8 Pandemics, 1870-2011



Data are from Madsen, Islam, and Doucouliagos (2018). Trend of age dependency ratio is estimated using equation 4. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

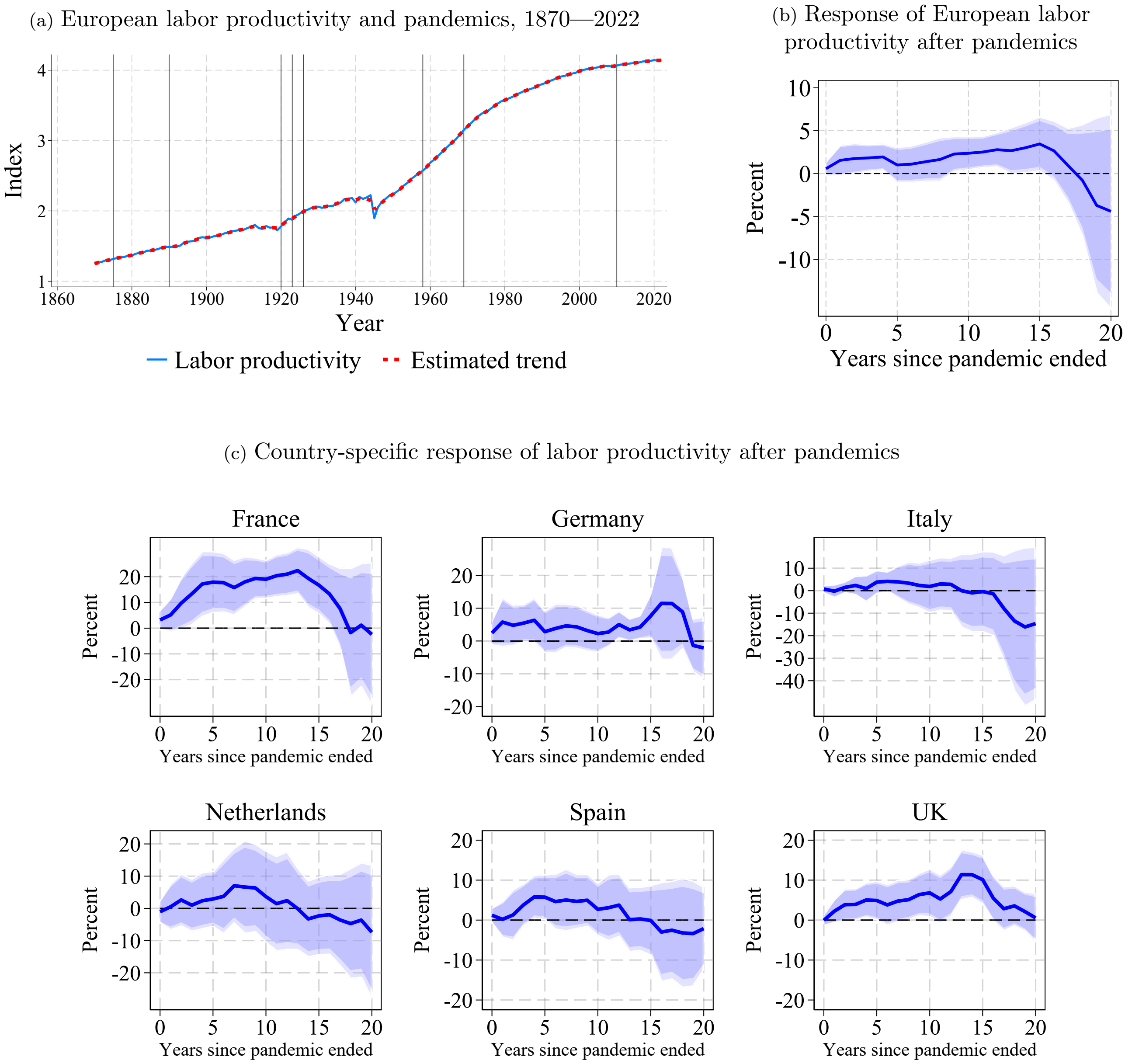
However, figure 3c shows heterogeneity at country level. The impact of pandemics might vary due to multiple factors such as the epidemiological features of the pathogen, e.g. different age-gradients in severity, or the way a pandemic is managed. Differences in population age distributions or efficacy of governance across countries would therefore either ameliorate or worsen the pandemics' impact. For instance, it is well established that the 1918 influenza pandemic predominantly affected younger individuals, which could positively impact this ratio by increasing mortality among the workforce (Johnson and Mueller, 2002). Conversely, the 1968

H3N2 pandemic mostly affected older individuals, and would have the opposite effect (Cockburn, Delon, and Ferreira, 1969). Here (Figure 3c), Italy and Spain are special cases. During the Spanish flu, we know that these two countries experienced the highest mortality burden among the European countries analyzed here (Johnson and Mueller, 2002). Furthermore, excess deaths from this pandemic in these two countries were higher than in the other analyzed countries (Ansart et al., 2009). These two factors could explain the unique increase in ADR for Spain and Italy compared to other European countries, as illustrated in Figure 3c.

5.3 Labor Productivity

Productivity is a crucial determinant of household income and overall economic welfare. Economic theory suggests that workers are paid at their corresponding marginal productivity. In Figure 4b we observe at the aggregated European level an overall increased labor productivity until 15 years after a pandemic, at which point labor productivity is 3.5 percentage points higher than expected under no pandemic. It then declines.

Figure 4. Response of Labor Productivity to 8 Pandemics, 1870-2020



Data are from Bergeaud, Cette, and Lecat (2016). Trend of labor productivity is estimated using equation 4. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

A more detailed analysis reveals that the impact of pandemics on labor productivity varies by country (Figure 4c). In the medium run, labor productivity tends to increases, by amounts that depend on the country.

The short to medium-term positive effect of pandemics on labor productivity is counterintuitive compared to prevailing theory. During the COVID-19 pandemic, for instance, models and empirical studies identified a decrease or a steadiness in productivity as a major feature of a pandemic (Eichenbaum, Rebelo, and Trabandt, 2022; Chan, 2022; Guimbeau, Menon, and

Musacchio, 2020; Fernald and Li, 2022). However, our analysis does not support this.

Two interpretations can explain the observed increase in productivity in the short to medium term:

- Compensation Effect: During a pandemic, the labor workforce typically shrinks, tightening the labor market and compelling individuals to work more efficiently to compensate.
- Technological Adoption and Organizational Restructuring: The tension in the labor market due to a pandemic can accelerate technological adoption and organizational restructuring, as identified in the literature for certain sectors (Wang, Zhang, and Verousis, 2021; Franck, 2024). Pandemics can thus be seen as events that force economic adaptation and modification.

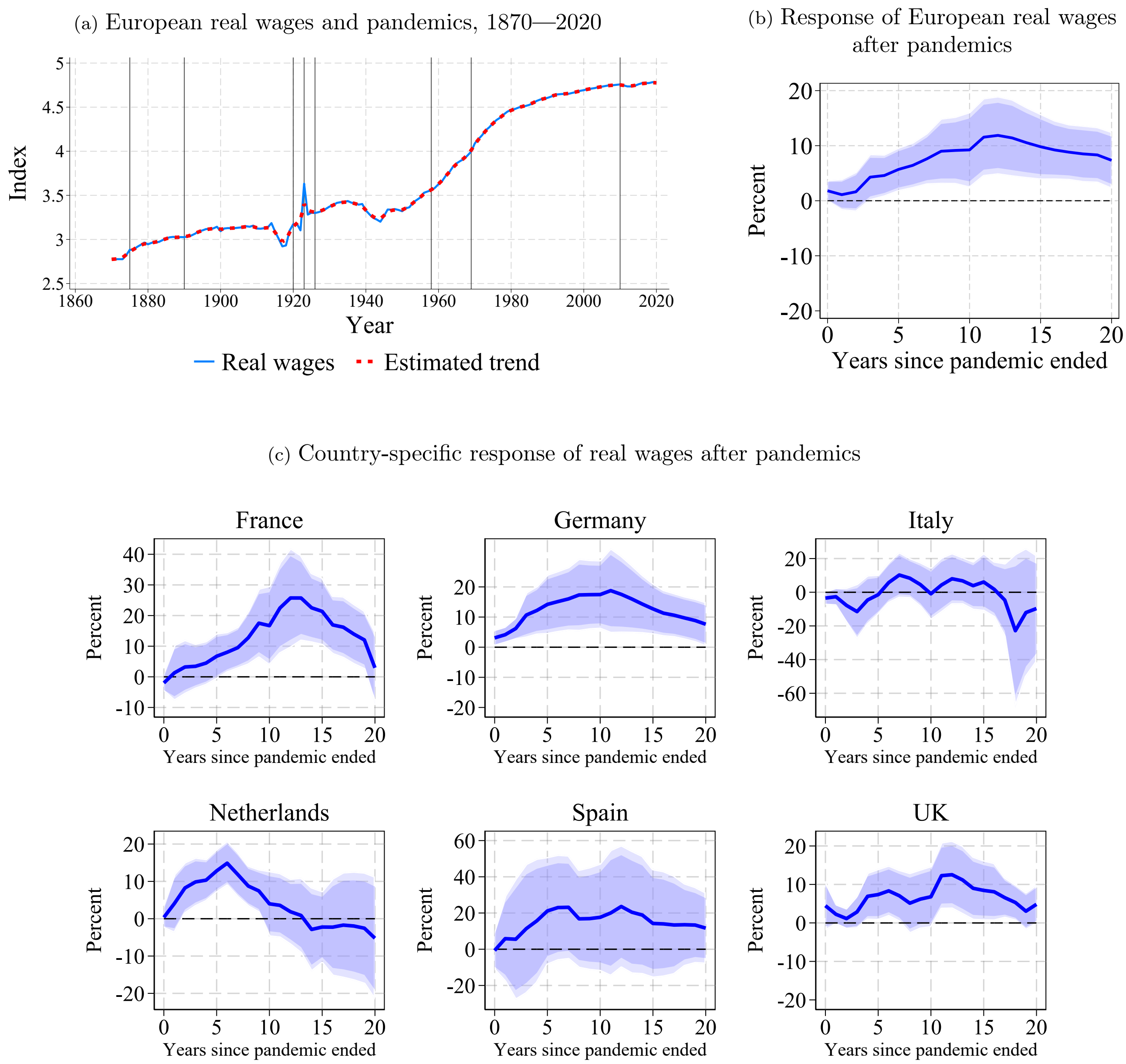
The decrease in productivity observed at the end of the estimation window in comparison with the no-pandemic counterfactual could be attributed to several factors, primarily the lasting demographic and extreme health shocks caused by a large pandemic (Alfani and Percoco, 2019; Guimbeau, Menon, and Musacchio, 2020). Two main drivers of this decline, particularly affecting the younger generations, are education quality and health frailty. The timing of the productivity decrease may indicate the arrival of a new generation of workers who are less productive than their predecessors. These new workers may have been affected in their youth by the infectious disease, impacting their level or quality of education, thus their productivity. Containment measures may have resulted in lower training/school attendance and hence reduced productivity when these individuals entered the labor market (Goulas and Megalokonomou, 2020). Additionally, higher adult mortality can disrupt knowledge transmission to subsequent generations and discourage innovation, as proposed by Bar and Leukhina (2010) in the context of the Black Death and England's long-run growth data. Individuals may also suffer long-term health issues following an infectious disease outbreak, reducing their productivity over time. Lin and Liu (2014) show a strong negative link between in utero exposure to the 1918 flu pandemic and the level of education attained, based on Taiwanese data. Similarly, Almond (2006) found that individuals exposed in utero to the 1918 flu pandemic experienced negative lifelong consequences, including lower education, more physical disabilities, lower income, lower socioeconomic status, and reliance on transfer payments. In other words, the long-term impact of pandemics on productivity is multifaceted.

5.4 Real Wages

Real wages are important for households because they determine the actual purchasing power of income, directly affecting the standard of living and economic well-being of individuals and families. This variable is also sensitive to the previously highlighted variables, together painting an overall picture of the labor market. Across Europe, pandemics lead to an increase in real wages, peaking after 12 years at nearly 12 percentage points above the expected level (Figure

5b). After this period of steady growth, a gradual decline begins, although real wages remain higher than they would have been without the pandemic.

Figure 5. Response of Real Wages to 8 Pandemics, 1870-2020



Data are from Jordà, Schularick, and Taylor (2017). Trend of real wages is estimated using equation 4. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

At the country level, the general pattern observed is similar (figure 5): after a pandemic, real wages increase for 7 to 14 years, depending on the country, followed by a decline that persists until the end of the observed period being sometimes negative. These findings are consistent with the existing literature, although, as previously noted by (Jordà, Singh, and Taylor, 2022) the underlying mechanisms are not clear (Basco, Domènech, and Rosés, 2021; Fenske, Gupta, and Yuan, 2022).

At both level of aggregations, during the initial period of our results, which spans 10 to 15 years, the general behavior of our IRFs can be attributed to three main mechanisms linked to each of our previously discussed variables. Firstly, contrary to the typical Malthusian perspective often used to explain movements in real wages for pre-industrial pandemics, our results may not be only explained by labor scarcity (Voigtländer and Voth, 2013; Alfani and Percoco, 2019). Indeed, we observe a decrease in the age dependency ratio, indicating that most countries experience an overall improvement in the relative size of the labor force after a pandemic (see section 5.2). Although, Italy is an exception, real wages exhibit a very weak medium-run response to past pandemics compared to other countries, while the age dependency ratio increases, which should theoretically increase real wages underlining other mechanisms at play. Secondly, the weakening of demand can contribute to an increase in real wages. A global decline in demand during a pandemic—caused by restrictive measures, the "distaste effect," or fear of infection—can lead to lower prices and economic activity (see section 5.1), which, in turn, positively impacts real wages (Bonam and Smădu, 2021). Thirdly, higher productivity may also influence real wages. If workers are compensated based on their marginal productivity, increased efficiency would result in higher real wages. As shown in section 5.3, productivity appears to increase after a pandemic, which contributes to the observed rise in real wages.

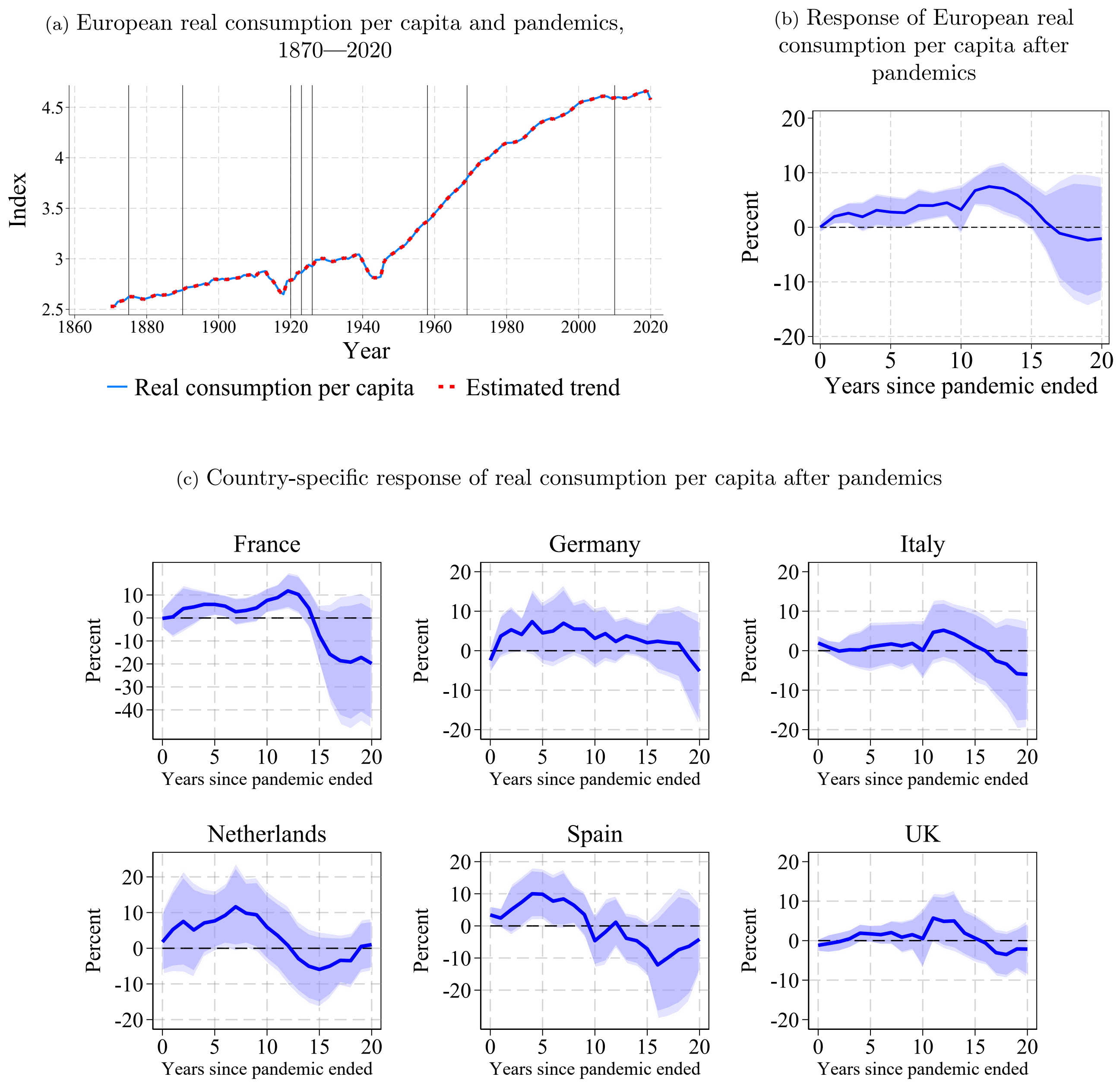
The second phase, characterized by a decrease or slowdown in the growth of real wages after 15 years, can be attributed to the catch-up effect of inflation, the decline in productivity, and the reduction of the ADR, as previously detailed (see Section 5.3, Section 5.1, Section 5.2). To explain the inversion of the curve, it is important to note that young workers affected by the disease in their youth may enter the labor market with lower levels of education and increased health frailty, which reduces their productivity and, consequently, their real wages (Lin and Liu, 2014). Additionally, economic recovery increases pressure on the economy, thereby driving up inflation. Finally, after some time, the population level may recover, reducing pressure on the labor market.

5.5 Real Consumption per Capita

Consumption is a critical component of household welfare and a key driver of economic growth. Consumption is strongly linked with real wages and private savings ratios (see Section 5.6). Regarding the effect at the European scale, a general increase in consumption per capita is observed compared to the no-pandemic counterfactual (Figure 6b). This increase peaks 12 years after a pandemic ends, reaching approximately 7.5 percentage points, before starting to decline and turning negative in the long run, around 16 years later.

On country level, this impact is seen in most countries, although the effect is weak in the UK and Italy (Figure 6c). The Netherlands, Spain, France and Germany experience an initial increase of about 5% to 12%, which fades after around 12 years.

Figure 6. Response of Real Consumption per Capita to 8 Pandemics, 1870-2022



(a) European real consumption per capita and pandemics, 1870—2020

(b) Response of European real consumption per capita after pandemics

(c) Country-specific response of real consumption per capita after pandemics

Data are from Jordà, Schularick, and Taylor (2017). Trend of real wages is estimated using equation 4. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

Explanation of the general steadiness and slow-growth of consumption in the short to medium term are manifold. Changes in real wages and inflation may modify the purchasing power of households. Indeed, the impulse response functions of real wages and inflation largely mirror that of consumption per capita during the pandemic (see sections 5.4 and 5.1). This suggests that the increase in real wages and the decrease in inflation helped sustain individual consumption at levels equal to or better than those observed during the pandemic.

Alternatively, Riefler, Büttner, and Davvetas (2024) show that consumers, after a pandemic, can either sustain consumption patterns adopted during the pandemic or engage in a temporary period of catch-up consumption in response to frustration with prior restrictions. However, this effect is normally short-lived and cannot not fully explain the observed 12-year peak without labor market changes.

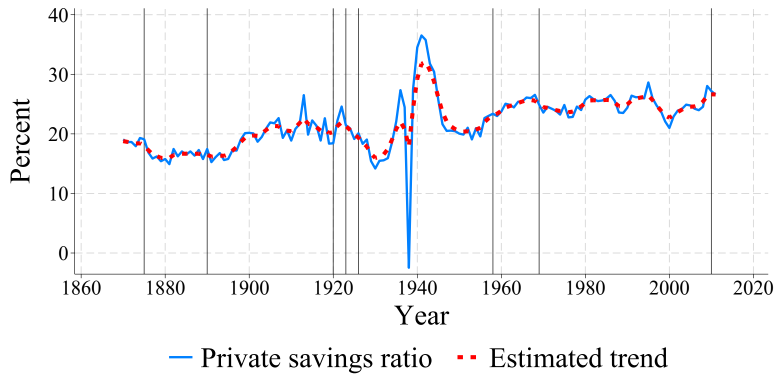
In the long term, the decline in consumption coincides with rising inflation, rising savings, slowing real wage and productivity growth. Along with this structural adjustments in labor markets, changes in precautionary savings behavior may reinforce this trend. The "scarring of belief" effect (Kozlowski, Veldkamp, and Venkateswaran, 2020; Aassve et al., 2021), suggests that households reassess risks following major health shocks, leading to a sustained increase in precautionary savings and a reduction in consumption over the long run (see Section 5.6). While behavioral factors, such as temporary indulgence along with an overall economic recovery, may contribute to short-term fluctuations, the long-run decline in consumption is more plausibly driven by labor markets adjustments, inflationary pressures, and shifts in savings behavior.

5.6 Private Savings Ratio

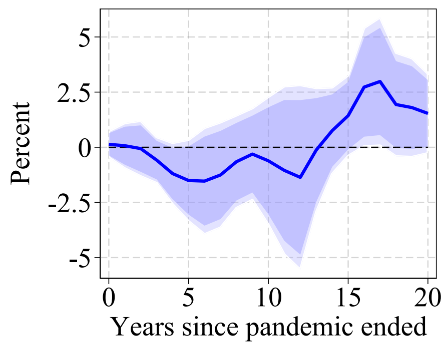
Like consumption, savings are fundamental components of household welfare and play a crucial role in economic stability and growth. From an aggregated point of view, the results display an opposite pattern of private saving ratio compared to consumption (see section 5.5) showing the existence of a real trade-off between consumption and saving. At the European level, a decrease of about -1.5pp is observed until 12 years, before starting to increase and starting to be positive after 13 years, with a peak at 3pp after 17 years. However, the disaggregated results reveal considerable heterogeneity.

Figure 7. Response of Private Savings Ratio to 8 Pandemics, 1870-2020

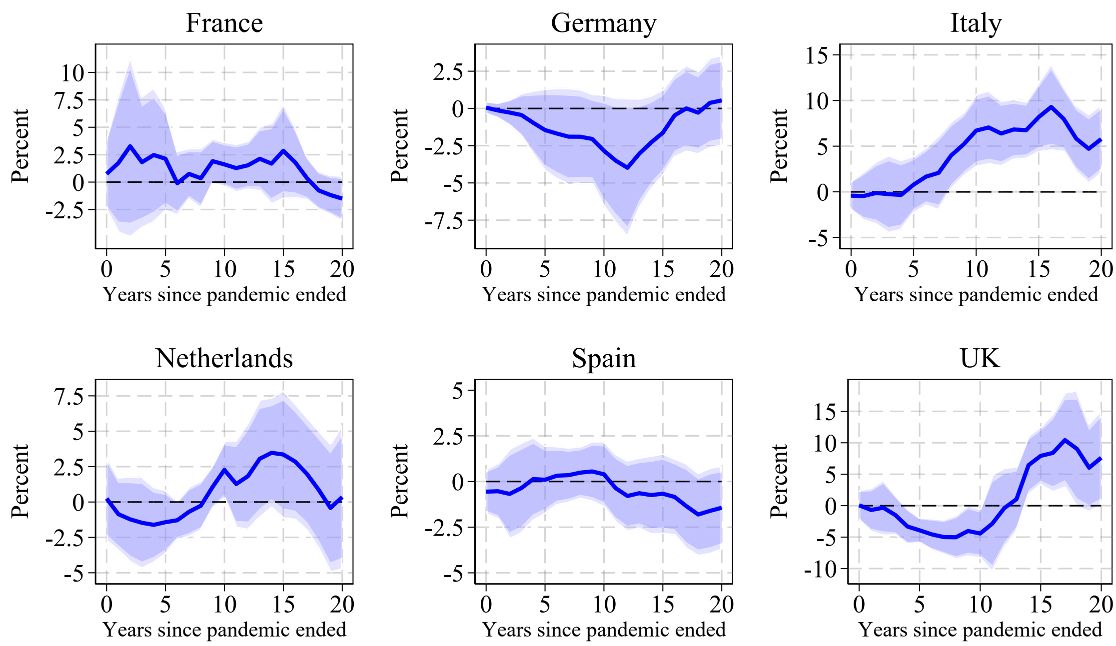
(a) European private savings ratio and pandemics, 1870-2011



(b) Response of European private savings ratio after pandemics



(c) Country-specific response of private savings ratio after pandemics



Data are from Madsen, Islam, and Doucouliagos (2018). Trend of private savings ratio is estimated using equation 3. Impulse response function is calculated from equation 2. See Table A3 for the exact coefficients of Panel (b)—response of aggregate Europe. Shaded areas represent 90% and 95% confidence intervals.

In the UK, Italy, the Netherlands, and Germany, the saving ratio gradually decreases and remains negative for a period of 7 to 15 years. It then increases for several years. The initial decrease in savings can be interpreted as an indicator of households imperfectly substituting their savings for consumption, a pattern extensively discussed in theoretical modelling (Ramsey, 1928; Eichenbaum, Rebelo, and Trabandt, 2022).

Notice that Real Consumption per Capita (see Section 5.5) moves in the opposite direction of the savings ratio. This pattern may reflect a short-term compensation effect, where households increase their consumption in response to pandemic-related frustration and delayed gratification, resulting in lower savings (Riefler, Büttner, and Davvetas, 2024). After 7 to 12 years, the savings ratio increases in most countries, while labor market indicators slow down. This shift can be interpreted as a rise in precautionary savings, reinforcing the idea of "scarring of belief" after an initial period of spending catch-up (Kozlowski, Veldkamp, and Venkateswaran, 2020). In other words, an extreme negative health shock can modify household behavior, making them more cautious and thereby explaining higher savings over the medium to long term.

France and Spain stand out. France exhibits a volatile saving ratio over a period of 17 years, eventually becoming negative. In contrast, Spain consistently shows a neutral or negative evolution of the saving ratio throughout the entire period. Notice that the private saving ratio and real consumption per capita in Spain and France either move in the same direction or show no significant interaction, indicating that the substitution between consumption and savings is not a general outcome.

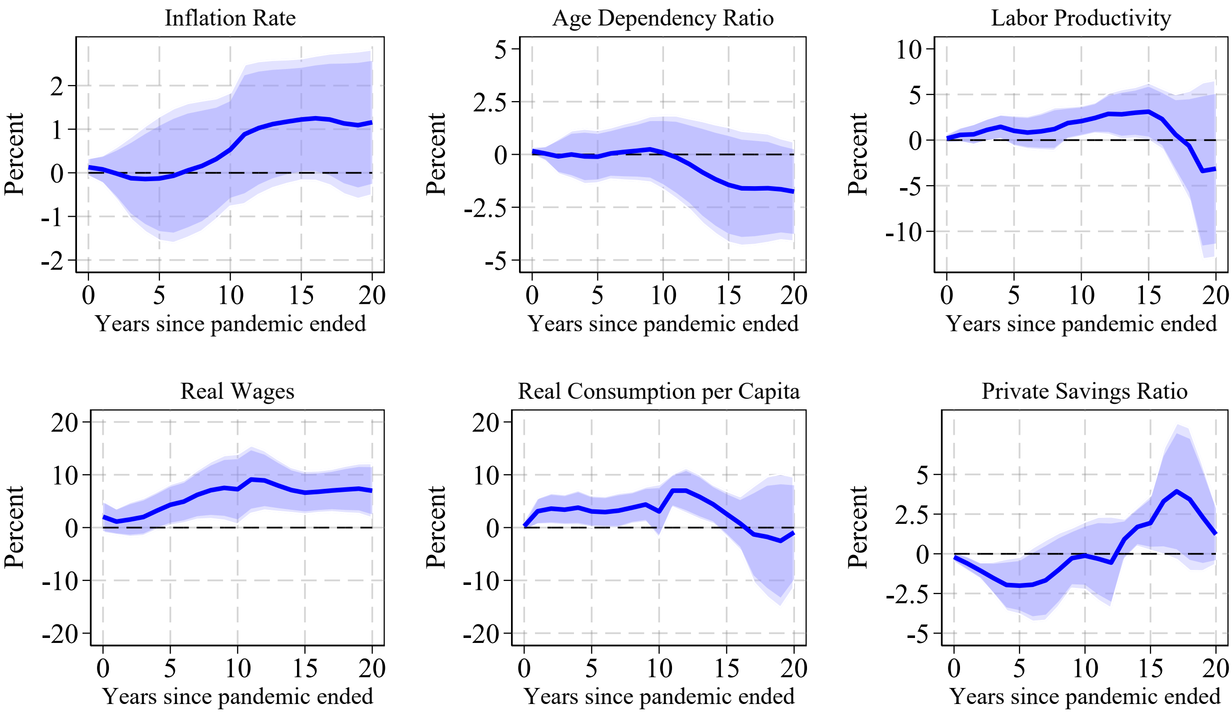
5.7 Robustness Checks

The 1918 flu pandemic was undoubtedly the largest and most deadly pandemic in the period investigated and it has the potential to drive our conclusions. Therefore, we explore whether the results obtained in the previous section are robust to the exclusion of the 1918 pandemic. Figure 8shows that at European level the overall long term impact of 7 pandemics (excluding the 1918) on the six indicators remain largely consistent with what was found in the previous sections.

Excluding all pandemics apart from those caused by influenza viruses, the results remain overall consistent with those previously described (see Figure 9). This suggests that our findings are predominantly driven by influenza, which accounts for 5 out of the 8 pandemics studied.

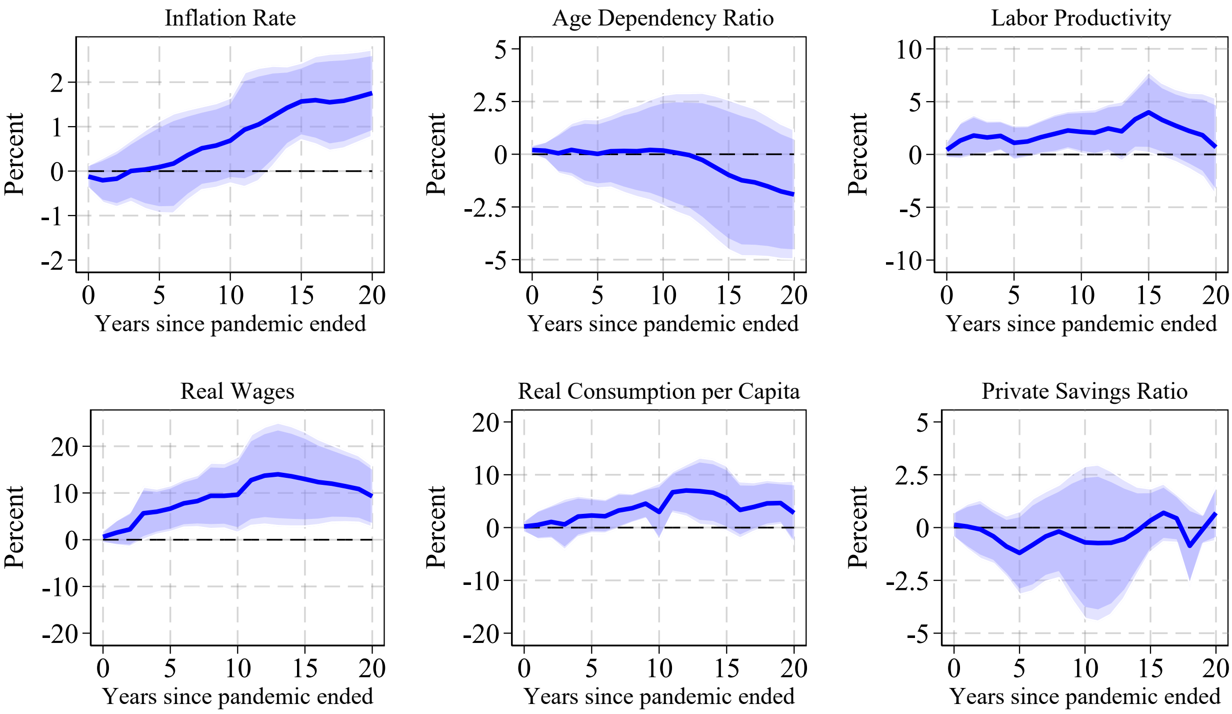
Different econometric specifications of the model with different number of lags, and without or with alternative adjustment for the German hyperinflation, lead to essentially the same results (see A2).

Figure 8. Responses of six Indicators to Pandemics excluding the 1918 influenza pandemic, 1870-2020, Aggregate Europe



Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

Figure 9. Responses of six Indicators to Pandemics caused by Influenza Viruses (excluding Cholera and Encephalitis Lethargica pandemics), 1870-2020, Aggregate Europe



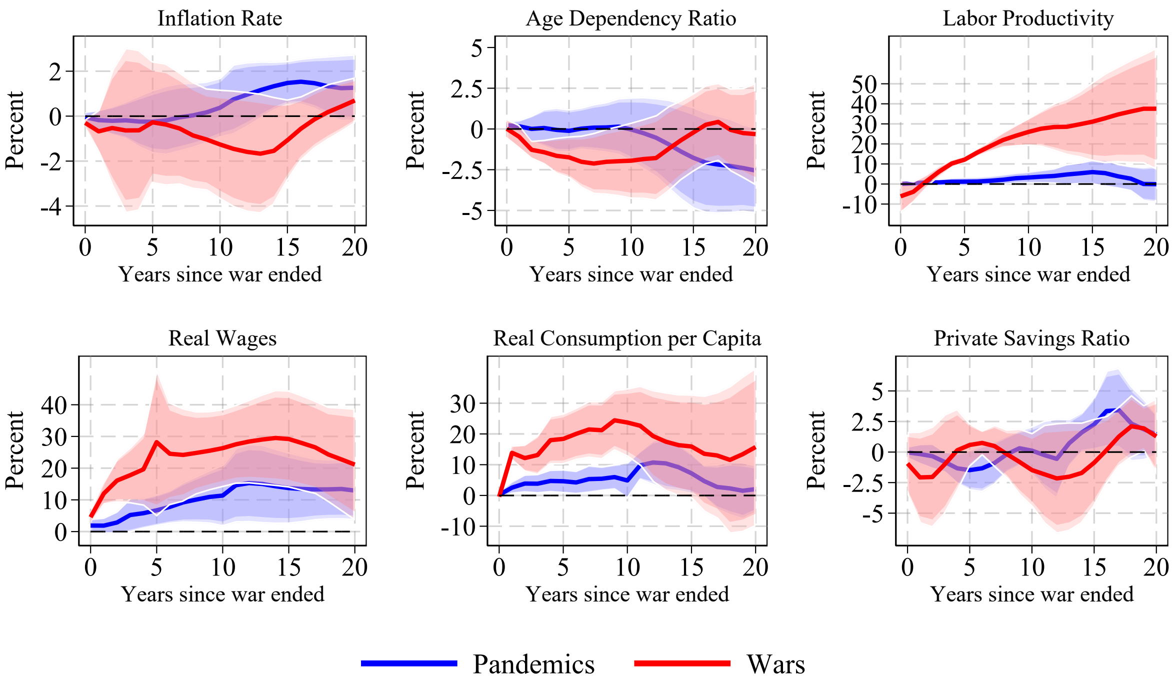
Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

5.8 Comparison to Wars and Financial Crises

In order to compare our results with other economic shocks, we compare the effects of pandemics on the six indicator with those of wars and financial crisis. To capture the effect of the wars, we consider the impact in the 20 years after the end of a war[4].

[4]The dummy for war in this section reflects the last year of war and not the full duration of wars, as in the specifications for pandemics.

Figure 10. Responses of six Indicators to Wars and Pandemics, 1870-2020, Aggregate Europe

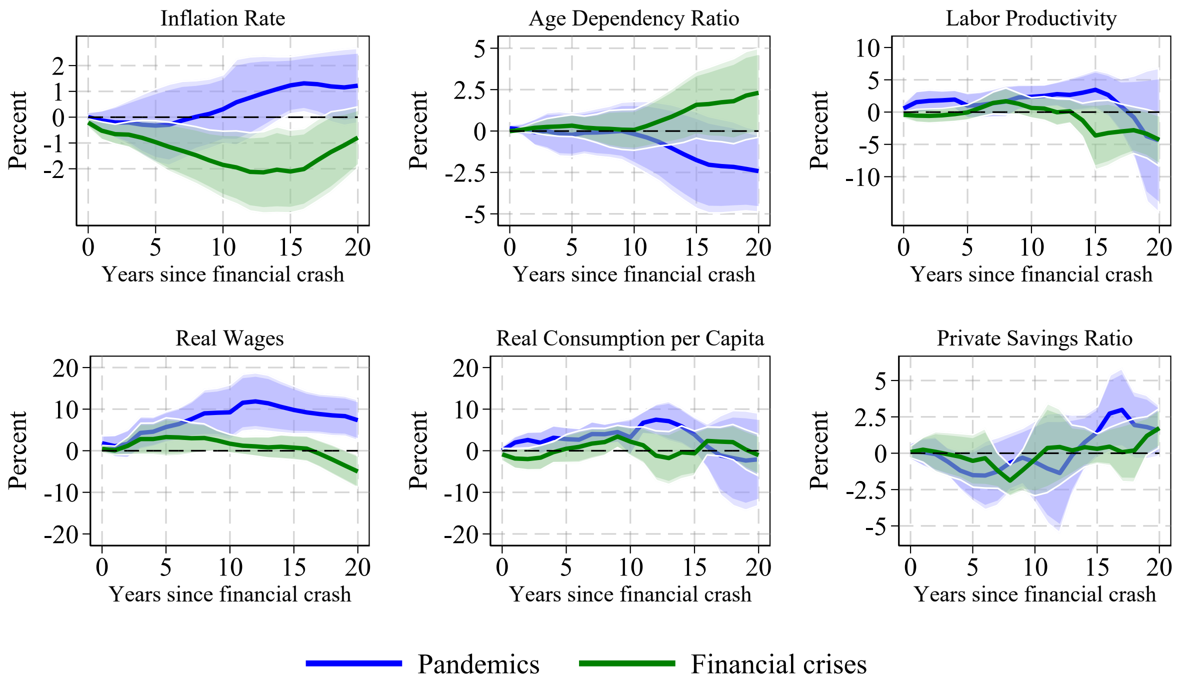


Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

Figure 10 shows that wars have a more pronounced effect than pandemics on the six indicatoars, both in terms of duration and magnitude. In particular, their impact on real wages, consumption, and productivity is significantly greater. Wars affect what is called "the essential of economic growth" (Kang and Meernik, 2005) by impacting on both fixed capital and the workforce, whereas pandemics primarily impact the latter. As a result, economic recovery after wars can be significantly longer.

Moreover, wars affect the structure of the labor market, for example by driving women to enter the workforce in large numbers to compensate for losses of men on the battlefield, and push toward a strong post-war economic recovery (Schweitzer, 1980). The post-war labor scarcity and high labor demand leads to increases in both productivity and consumption, a phenomenon particularly observed after World War II.

Figure 11. Responses of six Indicators to Financial Crises and Pandemics, 1870-2020, Aggregate Europe



Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome indicators is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

Figure 11 shows that financial crises have a smaller impact compared to pandemics, ranging between 0 and 5 percentage points. This can be attributed to the absence of fixed capital destruction or significant labor force losses, enabling a faster recovery after a financial crisis. In particular, financial crisis have a lesser impact on labor markets (e.g real wages). Hence, the recovery is less sharp especially concerning the inflation rate showing that pressure is not put on the same economic components. While pandemics will strongly affect labor markets pushing quickly real wages upward, the effects of financial crises are more subtle (Jordà, Schularick, and Taylor, 2013).

6 Discussion and Limitation

This paper examines the impact of significant modern pandemics that have occurred between 1870 and 2020 on households. We show that the short-run impacts of pandemics are significantly different - even opposed - compared to the long-run effects. By analyzing both the demand and supply aspects of household economic behavior the paper provides a comprehensive analysis of pandemic impacts.

The impact of pandemics differs in southern European countries (Spain and Italy) compared to northern European countries (Germany, the Netherlands and the UK), with France sharing characteristics of both. In summary, our findings indicate that real consumption per capita tends to increase in the medium run and this may be associated with both an increased (as in France, Italy) or a decreased (as in Germany, the Netherland and the UK) private saving ratio. This imperfect intertemporal substitution is primarily driven by behavioral components and labor market conditions, as documented in the literature (Kozlowski, Veldkamp, and Venkateswaran, 2020; Aassve et al., 2021; Ramsey, 1928). The higher real consumption per capita is associated with higher real wages. This is due to increased labor productivity as well as reduced inflation at least for a few years. However, the improved productivity vanishes in the long term. We hypothesize that this decline is due to the entry of new workers - affected by the disease in their youth - who experience greater health frailty and lower human capital. Although at European level the age dependency ratio is unaffected by a pandemic in the medium term and reduced in the long term, at country level the impact is not clearcut.

We rely exclusively on secondary sources. Even though the data used are from well-known sources in the literature, it is important to acknowledge that they are constrained by the choices made by primary and secondary data collectors. The data may contain sampling biases related to spatial, occupational, and temporal factors, especially for the 19th century.

The definition shock and control variables is based on thresholds. We control only for wars with more than 20, 000 deaths for wars at the European level and 5,000 at country level. We also chose to exclude endemic diseases such as HIV, despite their significant economic impact due to their length and their unclear ending year. Although our dataset spans the period 1870–2020, some variables (PSR and ADR) are not observed after 2011 and it may be difficult to fully capture the impact of the H1N1 pandemic.

The study only accounts for the end year of pandemics, but does not account for their severity or duration.

While the European-level results are very interesting in terms of interpretation and simplicity, they still should be taken with caution due to the heterogeneity of outcomes across different countries. Indeed, averaging the effect erase country heterogeneity depending on pathogen characteristics, historical conditions, pandemic management, and differences in overall economic structures.

7 Conclusion

The paper has studied the long-term economic impacts of pandemics on households in six European countries (France, Germany, Italy, the Netherlands, Spain, and the United Kingdom) from 1870 to 2020. The study uses local projections to estimate the effects of pandemics on six macroeconomic indicators: real wages, consumer price index (CPI), real consumption per capita, labor productivity, private savings ratio, and age dependency ratio.

Our results suggest that it is crucial to implement policies that prevent long-term productivity losses following a pandemic, as such reductions are linked to lower real wages and real per capita consumption, and ultimately lower economic welfare. This can be done by investing in human capital to prevent the long-term impact of educational losses on incomes and economic growth and overall welfare. By improving healthcare, the worst impacts on morbidity and population health can be averted. It is of course better to prevent outbreaks from developing into major pandemics in the first place. For example, cholera pandemics are easily preventable with sanitation and deaths can be averted with simple treatments. Even outbreaks caused by influenza and coronaviruses can often be successfully controlled, as the experience with the first coronavirus outbreak SARS-Cov-1 demonstrates. Relatively cost-effective measures such as surveillance, early containment measures including testing, contact tracing, isolation, quarantining, and pharmaceutical interventions most notably vaccinations are at our disposal nowadays. Investments into pandemic prevention, preparedness and response are likely to pay off many times over in averting the long-term economic damage to households that we have quantified here, and that has blighted societies in Europe and the world in the past.

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Appendix

List of Wars Included in the Analysis

Table A1. List of Wars Included in the Analysis.

Country	Name	Type	Start year	End year	Total deaths	Annual deaths (average)
Aggregate Europe	Franco-Prussian	inter-state	1870	1871	180,000	90,000
	World War I	inter-state	1914	1918	7,734,300	1,546,860
	World War II	inter-state	1939	1945	12,948,300	1,849,757
France	Franco-Prussian	inter-state	1870	1871	152,000	76,000
	Paris Commune War of 1871	intra-state	1871	1871	21,379	21,379
	Second Franco-Algerian	extra-state	1871	1872	2,686	1,343
	Moroccan Berber	extra-state	1913	1915	900	300
	World War I	inter-state	1914	1918	1,385,000	277,000
	Franco-Turkish	inter-state	1919	1921	5,000	1,667
	Franco-Syrian	extra-state	1920	1920	3,500	3,500
	Rif Rebellion	extra-state	1925	1926	10,000	5,000
	Franco-Druze	extra-state	1925	1927	4,000	1,333
	World War II	inter-state	1939	1945	213,324	30,475
	Franco-Thai	inter-state	1940	1941	700	350
	French-Indochina	extra-state	1946	1954	94,500	10,500
	Third Franco-Madagascan	extra-state	1947	1948	1,000	500
	Korean	inter-state	1951	1953	288	96
	Franco-Tunisian	extra-state	1952	1954	2,000	667
	Moroccan Independence	extra-state	1953	1956	2,000	500
	Third Franco-Algerian	extra-state	1954	1962	18,000	2,000
Germany	Franco-Prussian	inter-state	1870	1871	44,781	22,391
	World War I	inter-state	1914	1918	1,773,700	354,740
	Latvian Liberation	inter-state	1918	1919	1,200	600
	World War II	inter-state	1939	1945	3,500,000	500,000
Italy	World War I	inter-state	1915	1918	650,000	162,500
	World War II	inter-state	1940	1945	226,900	37,817
Netherlands	World War II	inter-state	1940	1940	7,900	7,900
Spain	First Spanish-Cuban	extra-state	1868	1878	100,000	9,091
	Third Carlist War of 1872-1876	intra-state	1872	1876	50,000	10,000
	Catonalist Uprising of 1873-1874	intra-state	1873	1874	2,000	1,000
	Second Spanish-Cuban	extra-state	1895	1898	59,000	14,750
	Spanish-Philippine	extra-state	1896	1898	4,000	1,333
	Spanish-American	inter-state	1898	1898	775	775
	Rif Rebellion	extra-state	1921	1926	50,000	8,333

Country	Name	Type	Start year	End year	Total deaths	Annual deaths (average)
	Spanish Civil War of 1936-1939	intra-state	1936	1939	309,400	77,350
UK	Second British-Afghan	extra-state	1878	1880	10,000	3,333
	Second British-Zulu	extra-state	1879	1879	2,500	2,500
	First Boer War	extra-state	1880	1881	900	450
	First British-Mahdi	extra-state	1881	1885	25,000	5,000
	Conquest of Egypt	inter-state	1882	1882	79	79
	Third British-Burmese	extra-state	1885	1889	3,000	600
	Second British-Mahdi	extra-state	1896	1899	1,200	300
	Second Boer War	extra-state	1899	1902	22,000	5,500
	Last Ashanti War	extra-state	1900	1900	1,000	1,000
	Boxer Rebellion	inter-state	1900	1900	34	34
	Somali Rebellion	extra-state	1901	1904	400	100
	World War I	inter-state	1914	1918	908,371	181,674
	British-Palestinian	extra-state	1936	1939	126	32
	World War II	inter-state	1939	1945	418,765	59,824
	Indonesian	extra-state	1945	1946	1,000	500

Sources: Schmelzing (2020); Sarkees and Wayman (2010).
For aggregate Europe, years with more than 20,000 average annual battle deaths are considered wartime. For individual countries, years with more than 5,000 average annual battle deaths are considered wartime. The start and end dates of each war are country-specific.

List of Financial Crises Included in the Analysis

Table A2. List of Financial Crises Included in the Analysis.

Country	Financial crisis (start year)
Aggregate Europe	1873, 1882-1883, 1889-1891, 1920-1921, 1930-1931, 1990-1991, 2007-2008
France	1882, 1889, 1930, 2008
Germany	1873, 1891, 1901, 1931, 2008
Italy	1873, 1887, 1893, 1907, 1921, 1930, 1935, 1990, 2008
Netherlands	1921, 2008
Spain	1883, 1890, 1913, 1920, 1924, 1931, 1977, 2008
UK	1890, 1974, 1991, 2007

Source: Jordà, Schularick, and Taylor (2017).
For aggregate Europe, financial crises are identified when two or more countries experienced crises either concurrently (overlapping years) or consecutively (back-to-back years).

Local Projections Results: Responses after Pandemics

Table A3. Responses of Different Outcome Variables after Pandemics—Aggregate Europe.

Horizon year	$h = 0$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$	$h = 6$	$h = 7$	$h = 8$	$h = 9$	$h = 10$
Inflation Rate	0.00364	-0.127	-0.203	-0.209	-0.291	-0.324	-0.296	-0.124	0.0149	0.130	0.310
	(0.0944)	(0.207)	(0.331)	(0.448)	(0.607)	(0.733)	(0.811)	(0.781)	(0.723)	(0.698)	(0.688)
N	145										
Age Dependency Ratio	0.167*	0.0967	-0.0681	-0.000625	-0.167	-0.227	-0.0983	-0.0858	-0.0476	0.00453	-0.176
	(0.0915)	(0.183)	(0.433)	(0.588)	(0.703)	(0.689)	(0.678)	(0.753)	(0.808)	(0.903)	(1.015)
N	136										
Labor Productivity	0.563	1.543*	1.746*	1.822**	1.940**	0.999	1.097	1.380	1.638	2.278**	2.369**
	(0.395)	(0.909)	(0.909)	(0.805)	(0.793)	(1.046)	(1.090)	(1.172)	(1.294)	(1.042)	(0.993)
N	147										
Real Wages	1.813*	1.104	1.629	4.290**	4.586**	5.697***	6.426***	7.620***	8.994***	9.138***	9.235***
	(0.965)	(1.417)	(1.811)	(2.110)	(1.914)	(1.986)	(2.077)	(2.338)	(2.984)	(3.072)	(3.444)
N	145										
Real Consumption per Capita	0.0379	1.987***	2.590**	1.922	3.124*	2.782*	2.666*	4.008**	3.974***	4.502***	3.228
	(0.503)	(0.757)	(1.039)	(1.457)	(1.588)	(1.560)	(1.471)	(1.638)	(1.346)	(1.386)	(2.358)
N	145										
Private Savings Ratio	0.134	0.0711	-0.0601	-0.582	-1.193*	-1.507	-1.533	-1.255	-0.654	-0.308	-0.614
	(0.303)	(0.519)	(0.635)	(0.526)	(0.702)	(0.932)	(1.216)	(1.204)	(1.058)	(1.049)	(1.461)
N	136										

This table presents the coefficients of Panel (b)—response of aggregate Europe—from Figures 5.1 to 5.6.
Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Standard errors are in parentheses. Statistical significance is denoted as * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Responses of Different Outcome Variables after Pandemics—Aggregate Europe (*Continued*).

Horizon year	$h = 11$	$h = 12$	$h = 13$	$h = 14$	$h = 15$	$h = 16$	$h = 17$	$h = 18$	$h = 19$	$h = 20$
Inflation Rate	0.580	0.754	0.929	1.086*	1.234**	1.311**	1.278**	1.194*	1.154	1.221
	(0.855)	(0.815)	(0.741)	(0.649)	(0.575)	(0.574)	(0.628)	(0.708)	(0.759)	(0.746)
N										
Age Dependency Ratio	-0.384	-0.657	-1.025	-1.404	-1.753	-2.034	-2.116	-2.164	-2.286*	-2.418*
	(1.124)	(1.215)	(1.340)	(1.424)	(1.496)	(1.490)	(1.449)	(1.395)	(1.302)	(1.273)
N										
Labor Productivity	2.507***	2.782***	2.663*	3.008**	3.451**	2.652	0.914	-0.801	-3.718	-4.406
	(0.937)	(1.025)	(1.367)	(1.491)	(1.601)	(1.764)	(2.214)	(3.287)	(5.152)	(5.721)
N										
Real Wages	11.55***	11.87***	11.41***	10.55***	9.808***	9.220***	8.824***	8.506***	8.323***	7.343***
	(3.553)	(3.567)	(3.516)	(3.237)	(2.997)	(2.692)	(2.541)	(2.577)	(2.536)	(2.588)
N										
Real Consumption per Capita	6.731***	7.465***	7.115***	5.870**	3.882*	1.005	-1.088	-1.753	-2.361	-2.065
	(1.448)	(2.000)	(2.508)	(2.288)	(2.247)	(2.875)	(4.890)	(5.863)	(6.112)	(5.699)
N										
Private Savings Ratio	-1.048	-1.364	-0.124	0.754	1.433	2.728**	2.984**	1.938	1.799	1.535*
	(1.922)	(2.110)	(1.416)	(0.988)	(0.920)	(1.353)	(1.464)	(1.183)	(1.128)	(0.909)
N										

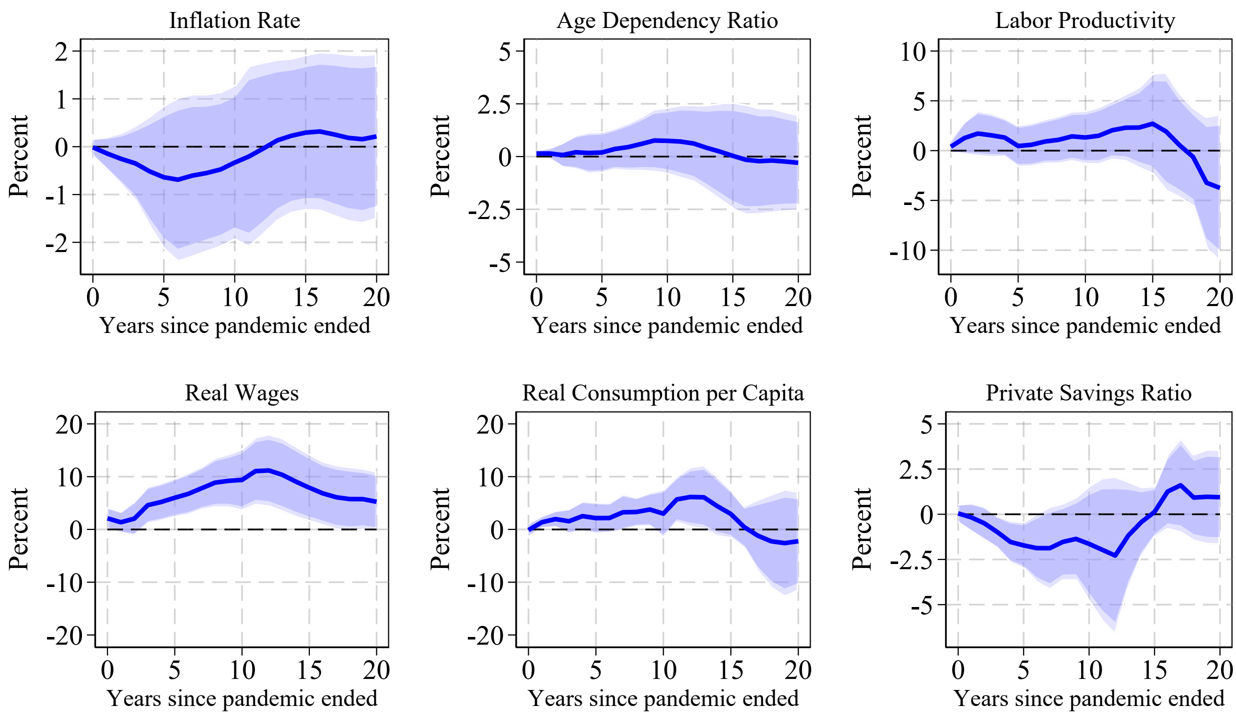
This table presents the coefficients of Panel (b)—response of aggregate Europe—from Figures 5.1 to 5.6.
Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Standard errors are in parentheses. Statistical significance is denoted as * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Results with Different Lag Lengths

The selection of lag length is based on the literature. We choose 5 lags, as this is closest to most estimates given by the VAR model. To test robustness, we present results with two fewer and two additional lags (5 ± 2).

First, with 3 lags:

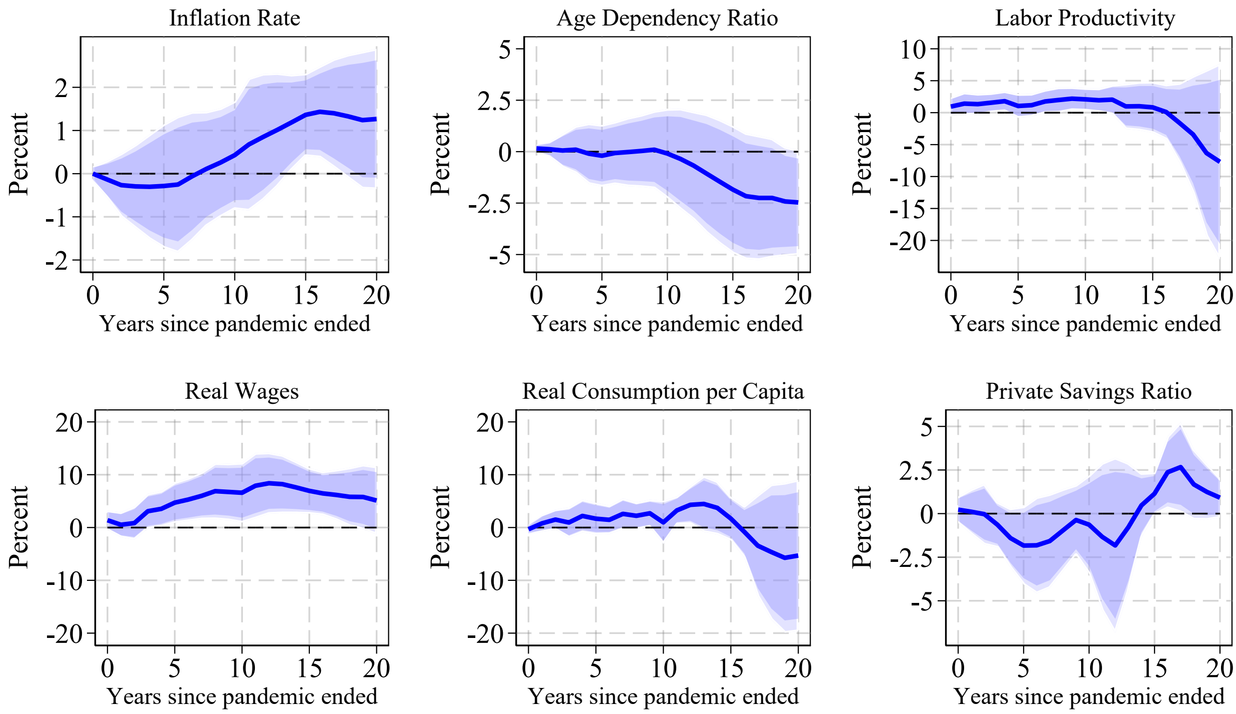
Figure A1. Using 3 lags:
Responses of Different Outcome Variables after Pandemics in Aggregate Europe



Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

Second, with 7 lags:

Figure A2. Using 7 lags:
Responses of Different Outcome Variables after Pandemics in Aggregate Europe



Data are from Jordà, Schularick, and Taylor (2017); Bergeaud, Cette, and Lecat (2016); Madsen, Islam, and Doucouliagos (2018). Trend of outcome variables is estimated using equations 3 and 4 (see text). Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

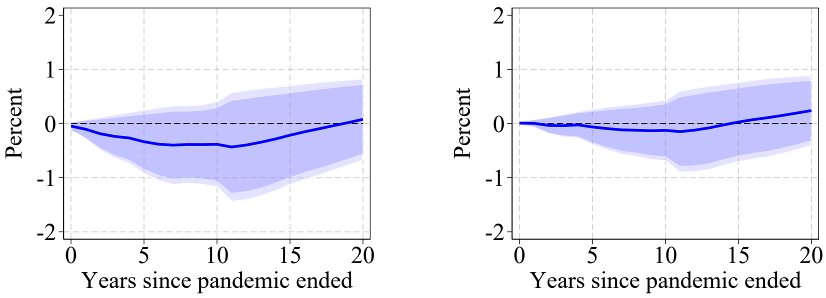
We can observe that our results are overall robust to changes in lag length.

Results with Different Specifications to Address Hyperinflation

Figure A3. Response of European Inflation after Pandemics,
Using Different Specifications to Address Hyperinflation.

(a) Without adjustment for hyperinflation

(b) Adding a dummy variable for year 1924 and its lags



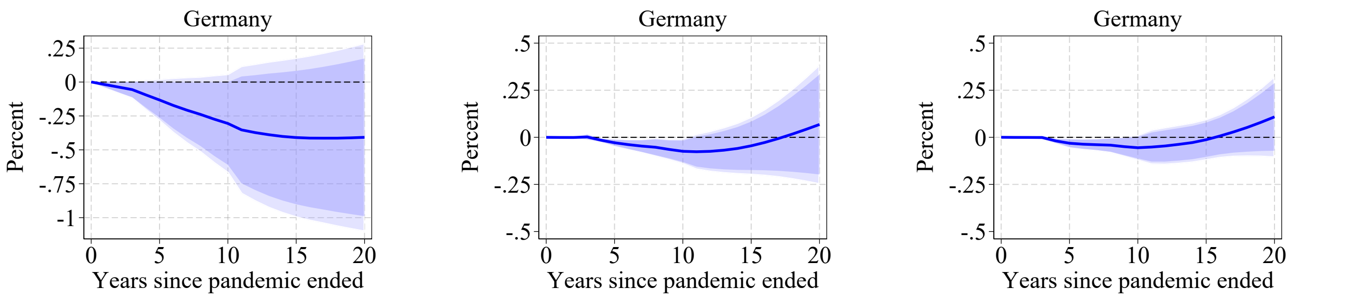
Data are from Jordà, Schularick, and Taylor (2017). Trend of inflation rate is estimated using equation 3. Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.

Figure A4. Response of German Inflation after Pandemics,
Using Different Specifications to Address Hyperinflation.

(a) Without adjustment for hyperinflation

(b) Adding a dummy variable for years 1922-24 and its lags

(c) Adding a dummy variable for each year of the period 1922-24 and its lags



Data are from Jordà, Schularick, and Taylor (2017). Trend of inflation rate is estimated using equation 3. Impulse response function is calculated from equation 2. Shaded areas represent 90% and 95% confidence intervals.