What Do Long Data Tell Us About the Inflation Hike Post COVID-19 Pandemic?*

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Abstract

To what extent is the recent spike in inflation driven by a change in its permanent component? We estimate a semi-structural model of output, inflation, and the nominal interest rate in the United States over the period 1900–2021. The model predicts that between 2019 and 2021 the permanent component of inflation rose by 55 basis points. If instead we estimate the model using postwar data (1955–2021), the permanent component of inflation is predicted to have increased by 237 basis points. A possible interpretation of this finding is that the model estimated on the shorter sample assigns a larger increase in the permanent component of inflation because the period 1955–2021 does not contain sudden sparks in inflation like the one observed in the aftermath of the COVID-19 pandemic, but only gradual ones—the great inflation of the 1970s took more than 10 years to build up. By contrast, the period 1900–1954 is plagued with sudden inflation hikes—including one around the 1918 Spanish flu pandemic—which the estimated model endogenously recalls and uses to interpret inflation around the COVID-19 episode. This result suggests that prewar data might be of use to understand recent inflation dynamics.

JEL classification: E31, E37, E52.
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1 Introduction

In the aftermath of the COVID-19 pandemic, the United States, like other advanced economies, experienced inflation at levels not seen for the past 40 years. In this note, we address a key question raised by this development. Namely, to what extent the recent spike in U.S. inflation is driven by a change in its permanent component.

To this end, we use a semi-structural model of output, inflation, and short-term interest rates to identify the permanent component of inflation. When we estimate the model on data for the period 1900 to 2021, it predicts a modest increase in the permanent component of inflation between 2019 and 2021 of 55 basis points. By contrast, when we estimate the model using postwar data (1955 to 2021), the permanent component of inflation is predicted to have increased between 2019 and 2021 by 237 basis points.

Our interpretation of this result is that the postwar data, dominated by the great inflation of the 1970s, which was slow in building up, leaves not much choice to the model but to interpret the 2021 inflation as also driven by low-frequency factors. By contrast, the pre-war era is rich in large and short-lived inflationary spikes, including the one around the Spanish flu pandemic of 1918. Since a key characteristic of the 2021 increase in inflation was its speed and size, the model estimated on long data naturally associates it more with the pre-war inflation spikes than with the great inflation of the 1970s.

We believe that this result is important for three reasons. First, most modern applied models of inflation dynamics are estimated on postwar data. The economic consequences of the COVID-19 crisis, however, are not like anything we saw after World War II. As a consequence, it is conceivable that postwar data may contain little information useful for understanding economic outcomes of unusual events like the recent pandemic. Second, having a clear idea of the extent to which a given deviation of inflation from its intended target is driven by its permanent component is important for policymaking, as it informs the timing, size, and communication of the corresponding policy response. Third, it is becoming increasingly plausible that climate change will open an era of larger economic fluctuations. Until enough data has accumulated under such new regime, the volatile pre-war period may offer useful information for understanding and forecasting business cycles to come.

The remainder of this note proceeds in three sections. Section 2 presents the model and briefly discusses data and estimation. A more detailed presentation of these issues can be found in Schmitt-Grohé and Uribe (2022) from which this note draws heavily. Section 3 presents the main result of the paper, namely, the behavior of the permanent component of inflation around the COVID-19 pandemic and how it depends on whether the model is estimated on data starting at the beginning of the twentieth century or only after World

War II. Section 4 concludes.

2 The Empirical Model

The model structure is based on Schmitt-Grohé and Uribe (2022), which in turn builds on Uribe (2022). Here we briefly outline its key components. The log of real output per capita, y_t, the inflation rate, π_t, and the nominal interest rate, i_t are assumed to be nonstationary. Output is assumed to be cointegrated with a nonstationary productivity shock, X_t, and with a nonstationary natural rate shock, X_t^r. Inflation is assumed to be cointegrated with a nonstationary inflation-target shock, X_t^m, and the nominal interest rate is assumed to be cointegrated with the nonstationary inflation-target shock and the natural rate shock. Accordingly, the cyclical components of output, inflation, and the nominal interest rate, denoted $\hat{y}_t$, $\hat{\pi}_t$ and $\hat{i}_t$, are given by

$$\hat{y}_t = y_t - X_t - \delta X_t^r,$$

$$\hat{\pi}_t = \pi_t - X_t^m,$$

and

$$\hat{i}_t = i_t - X_t^m - X_t^r,$$

where δ is an estimated parameter.

The focus of the present paper is the behavior of the latent variable X_t^m representing the permanent component of inflation.

The law of motion of the cyclical components is assumed to take the form

$$\begin{bmatrix} \hat{y}_t \\ \hat{\pi}_t \\ \hat{i}_t \end{bmatrix} = B \begin{bmatrix} \hat{y}_{t-1} \\ \hat{\pi}_{t-1} \\ \hat{i}_{t-1} \end{bmatrix} + C \begin{bmatrix} \Delta X_t^m \\ z_t^m \\ \Delta X_t \\ z_t \\ \Delta X_t^r \end{bmatrix},$$

where z_t^m and z_t represent a stationary monetary shock and a stationary real shock, respectively. The matrices B and C are estimated.

The exogenous shocks follow univariate AR(1) processes,

$$\begin{bmatrix} \Delta X^m_{t+1} \\ z^m_{t+1} \\ \Delta X_{t+1} \\ z_{t+1} \\ \Delta X^r_{t+1} \end{bmatrix} = \rho \begin{bmatrix} \Delta X^m_t \\ z^m_t \\ \Delta X_t \\ z_t \\ \Delta X^r_t \end{bmatrix} + \Psi \begin{bmatrix} \epsilon^{X^m}_{t+1} \\ \epsilon^{z^m}_{t+1} \\ \epsilon^{X}_{t+1} \\ \epsilon^{z}_{t+1} \\ \epsilon^{X^r}_{t+1} \end{bmatrix}, \tag{1}$$

where ρ and Ψ are estimated diagonal matrices and ϵ^s_t, for $s = X^m, z^m, X, z, X^r$, are i.i.d. disturbances distributed $N(0, 1)$. All variables of the model are unobservable.

The model is estimated using data on output growth, Δy_t, the change in consumer price inflation, $\Delta\pi_t$, and the change in the short-term nominal interest rate, Δi_t. The consumer price index for a given year is computed as the arithmetic average of monthly observations. The following identities serve as observation equations:

$$\Delta y_t = \hat{y}_t - \hat{y}_{t-1} + \Delta X_t + \delta \Delta X^r_t + \mu^y_t,$$

$$\Delta \pi_t = \hat{\pi}_t - \hat{\pi}_{t-1} + \Delta X^m_t + \mu^\pi_t,$$

and

$$\Delta i_t = \hat{i}_t - \hat{i}_{t-1} + \Delta X^m_t + \Delta X^r_t + \mu^i_t,$$

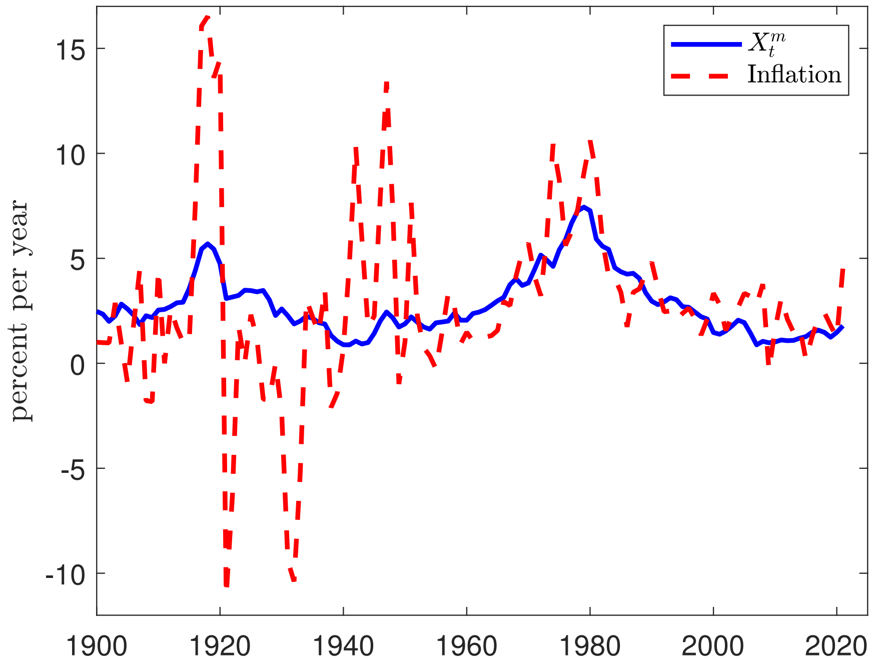
where μ^s_t, for $s = y, \pi, i$, are normally distributed mean-zero i.i.d. measurement errors whose variances are estimated.

The model is estimated on annual U.S. data spanning the period 1900 to 2021. The data source for the period 1900 to 2017 is Jordá et al. (2017). Details on the data sources for the period 2018 to 2021, the identification scheme, priors, and the estimation technique can be found in Schmitt-Grohé and Uribe (2022).

3 The Permanent Component of Inflation

Figure 1 plots the estimated path of the permanent component of inflation, X^m_t, over the period 1900 to 2021, as predicted by the model. The path of X^m_t was obtained by setting the vector of estimated parameters equal to its posterior mean and then applying two-sided smoothing using the Kalman filter. This technique yields X^m_t up to a constant. In the figure, we arbitrarily pick this constant to ensure that the mean of X^m_t over the estimation sample matches that of actual inflation. For comparison, the figure also plots the actual inflation rate.

Figure 1: Inflation and Its Permanent Component: Sample 1900 to 2021

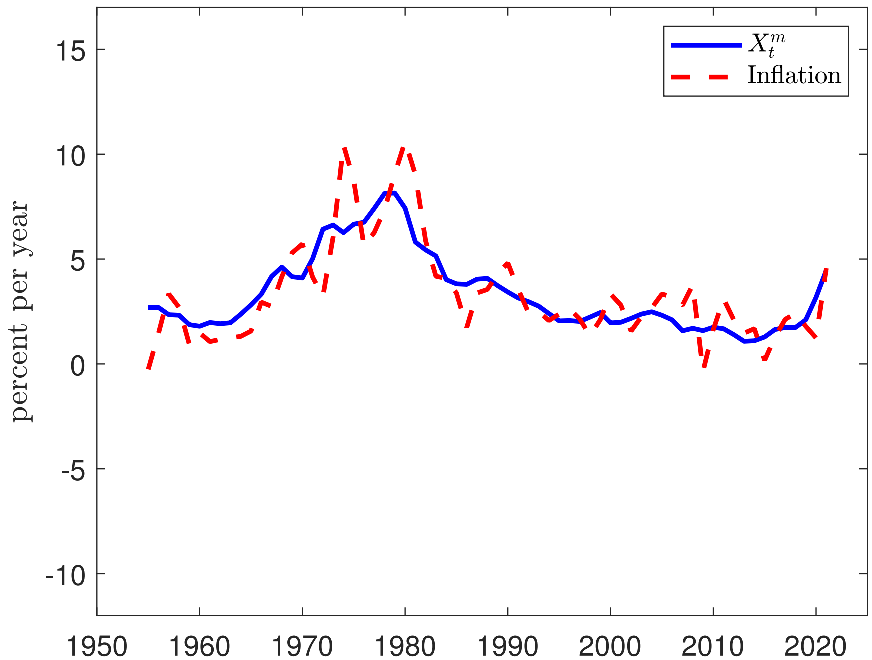


Notes. The permanent component of inflation, X_t^m, is computed by two-sided smoothing using the Kalman filter. It is normalized by adding a constant to match the sample mean of inflation.

Observed inflation displays distinct characteristics in the pre- and postwar periods. In the pre-war period, inflation is highly volatile and spikes in inflation and deflation are typically short lived. As a result, the model interprets these episodes as mostly transitory, that is, not primarily driven by movements in the permanent component of inflation, X_t^m. A case in point is the observed inflation spike around the 1918 influenza pandemic. Between 1915 and 1918 inflation increased from 1 percent to 17 percent and then fell quickly to -11 percent by 1921. At the same time, X_t^m was relatively little changed; it increased by 2.1 percentage points between 1915 and 1918 and then fell by 2.6 percentage points between 1918 and 1921.

Figure 1 further shows that the dynamics of inflation and its trend component are quite different in the postwar pre-COVID-19 era. This period is dominated by the great inflation of the 1970s. Contrary to what happened during the pre-war period, this inflation episode was slow in building up. Inflation began to increase from a level of 2 percent in the mid 1960s to a peak of 10 percent in 1980. The figure shows that inflation accelerated for about 15 years. The return of inflation to the levels observed in the mid 1960s took another six years. To a large extent, the model accounts for the great inflation of the 1970s with a significant movement in the permanent component of inflation, X_t^m. Between 1960 and 1980 the model estimates that X_t^m rose 5.2 percentage points. In fact, the largest increase in X_t^m over the

Figure 2: Inflation and Its Permanent Component: Sample 1955 to 2021



Notes. The permanent component of inflation, X_t^m, is computed by two-sided smoothing using the Kalman filter. It is normalized by adding a constant to match the sample mean of inflation.

entire 1900 to 2021 sample takes place during this episode.

A key characteristic of the post-COVID-19 inflation hike is its speed. From 2019, the year before the onset of the pandemic, to 2021, the annual rate of inflation rose by 277 basis points. The model interprets this sudden spike in inflation as being more akin to those observed in the pre-war period than to the great inflation of the 1970s. Specifically, of the 277 basis point increase in inflation observed between 2019 and 2021, X_t^m accounts for only 55 basis points. Thus, according to the model the 2021 inflation burst was not predominantly driven by an increase in the permanent component of inflation.

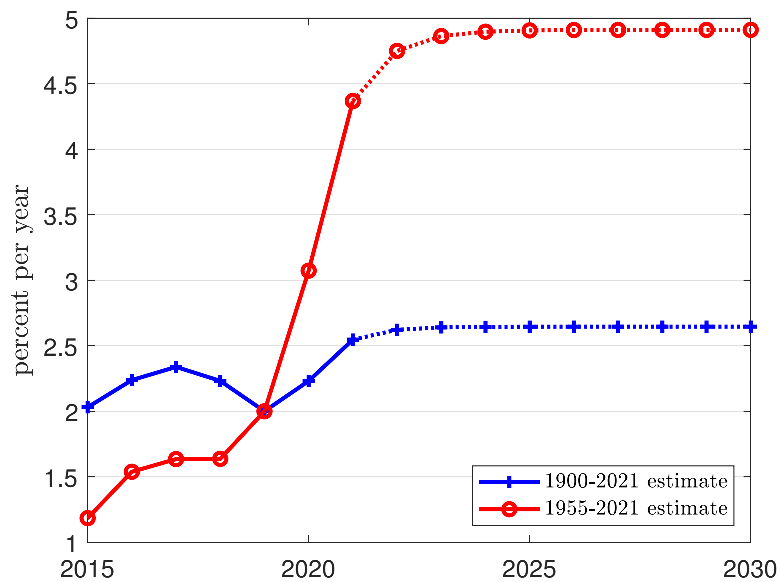
How important is the inclusion of pre-war data in arriving at this conclusion? This question is relevant because most of the existing literature on the joint behavior of inflation, output, and the nominal interest uses data that starts only after World War II. We therefore next examine the predictions of the model when estimated on postwar data. Specifically, we reestimate the model on a sample starting in 1955. In keeping with much of the related literature, we start the postwar sample a few years after the actual end of World War II. Figure 2 displays the inferred path of the permanent component of inflation, X_t^m, and actual inflation. As in the estimate using data since 1900, the inflation of the 1970s is interpreted by the model as having a large permanent component. The key difference of this estimate relative to the one obtained when the model is estimated over the sample beginning in 1900 is that now almost all of the COVID-19 inflation spike is attributed to the permanent component of inflation X_t^m. Specifically, between 2019 to 2021 the permanent component of inflation increases by 237 basis points, which is more than eighty percent of the total observed inflation increase of 277 basis points. So according to the model estimated on postwar data, the inflation burst associated with COVID-19 was to a large extend driven by the permanent component of inflation.

This result is robust to allowing for heteroskedasticity in measurement errors. Specifically, if in the estimation using data from 1900 to 2021 measurement errors are allowed to explain a fraction of the variance of the data twice as large pre 1955 than post 1955, then of the 277 basis-point actual increase in inflation between 2019 and 2021, the model attributes 98 basis points to the permanent component X_t^m. While this is larger than the 55 basis points obtained in the absence of heteroskedasticity, it is still less than half of the 237 basis points attributed to X_t^m when the model is estimated on the 1955–2021 sample.

Which of the two interpretations of the inflation hike of 2021 makes more economic sense? Neither the model nor the data can answer this question. We believe, however, that the more compelling view is the one that emerges from the estimation including the pre-war data. The reason is that the economic developments triggered by the COVID-19 pandemic are of a nature not seen since the end of World War II. So it is conceivable that postwar data does not have that much to say about such event. By contrast, the pre-1955 period was littered with economic crises that came with large swings in the rate of inflation, including a pandemic similar to the COVID-19 one. It seems therefore reasonable that data from that early period may provide useful information for understanding the economic predicament in which the economy found itself in the aftermath of the global health crisis caused by the COVID-19 pandemic.

Including the pre-war period in the estimation of the model also matters for the forecasted level of the permanent component of inflation. Figure 3 displays X_t^m for the period 2015 to 2021 (solid lines) and its forecast for the out-of-sample period 2022 to 2030 (dotted lines) under the two estimations considered, namely, 1900 to 2021 and 1955 to 2021. In the figure the level of X_t^m is normalized to 2 percent in 2019. The figure shows that, as discussed earlier, when the model is estimated on the shorter sample, X_t^m is predicted to have increased during COVID-19 more than four times as much as when the model is estimated on the longer sample. This difference in the importance attributed to the permanent component of inflation is also present in out of sample forecasts. The model assumes that the change in the permanent component of inflation follows a univariate first-order autoregressive process (see equation 1). For the estimate based on data from 1900 to 2021, and using the mean of

Figure 3: Forecasts of the Permanent Component of Inflation, X_t^m



Notes. Forecasts are computed using the mean of the posterior parameter distribution. For 2015 to 2021, the two-sided smoothed values of X_t^m, normalized to 2 percent in 2019, are shown and for 2022 to 2030 the forecasted values.

the posterior estimate of ρ and the smoothed value for ΔX_{2021}^m, the out-of-sample forecast for X_t^m by 2030 is only 10 basis points higher than its 2021 value. For the estimate of the model based on the shorter sample, X_t^m is forecasted to be 54 basis points above its 2021 value by 2030. This difference is explained mainly by the difference in the estimated values of ΔX_{2021}^m rather than in the estimated values of ρ.

In sum, the estimates based on the long sample imply that by 2030 the permanent component of inflation will exceed its 2019 value by 65 basis points whereas estimates based on the short sample suggest that by 2030 the permanent component of inflation will exceed its 2019 level by 291 basis points. This means that according to the estimates based on the long sample the inflation spike that arrived with the COVID-19 pandemic is largely temporary whereas according to the estimates based on the short sample it is largely permanent.

4 Conclusion

Modern business cycle analysis is a story told with postwar data. Before the COVID-19 pandemic this approach made sense. The volatile pre-war data seemed out of touch with the unprecedented stability witnessed in the postwar period and in particular since the Great Moderation. This note suggests that the COVID-19 pandemic has called this approach into question and has given renewed value to the information contained in pre-war macroeconomic indicators. It is now the postwar data that seem out of touch with current developments.

The analysis conducted in this note serves as a proof of concept. Seen from the perspective of a model estimated on postwar data, the 2021 inflation spur is interpreted to be caused by a large increase in the permanent component of inflation. The reason is that the model was given little chance to conclude otherwise; the only other major prior inflation increase during this sample period turned out to be a protracted one, which naturally is ascribed to the permanent component—not just by the present model but also by the majority of existing models of U.S. inflation. However, once the sample is expanded to include the sudden, large, and short-lived swings in inflation observed in the first half of the 20th century, the same model attributes a major fraction of the post COVID-19 inflation to its transitory component.

Looking ahead, recent studies point in the direction that climate change will raise economic volatility around the globe. Thus, until sufficient data accumulates under this seemingly emerging new regime, long historical time series data could be a valuable input to business cycle analysis.

References

Jordá, Óscar, Moritz Schularick, and Alan M. Taylor, "Macrofinancial History and the New Business Cycle Facts," in Martin Eichenbaum and Jonathan A. Parker (eds.), *NBER Macroeconomics Annual 2016, Volume 31,* Chicago: University of Chicago Press, 2017, 213-263.

Schmitt-Grohé, Stephanie and Martín Uribe, "The Macroeconomic Consequences of Natural Rate Shocks: An Empirical Investigation," NBER Working Paper 30337, August 2022.

Uribe, Martín, "The Neo-Fisher Effect: Econometric Evidence from Empirical and Optimizing Models," *American Economic Journal: Macroeconomics 14,* July 2022, 133–62.