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Does Unconventional Monetary and Fiscal Policy Contribute to the COVID Inflation Surge in the US?

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Abstract

We assess whether unconventional monetary and fiscal policy implemented in response to the COVID-19 pandemic in the U.S. contribute to the 2021-2023 inflation surge through the lens of several different empirical methodologies—event studies, vector autoregressions, and regional panel regressions using granular data—and establish a null result.

The key economic mechanism works through a disinflationary channel in the Phillips curve while monetary and fiscal stimuli put positive pressure on inflation through the usual demand channel. We illustrate this negative supply-side channel both theoretically and empirically.

Topics: Inflation and prices; Monetary policy; Fiscal policy; Business fluctuations and cycles; Central bank research
JEL codes: E31, E52, E63

Résumé

Nous évaluons si les politiques monétaire et budgétaire non conventionnelles mises en œuvre aux États Unis en réponse à la pandémie de COVID-19 ont contribué à la poussée de l'inflation observée de 2021 à 2023. Pour ce faire, nous utilisons différentes méthodes empiriques, notamment des études d'événements, des vecteurs autorégressifs et des régressions sur données de panel régionales, et nous arrivons à un résultat nul.

Le mécanisme économique principal passe par un canal désinflationniste de la courbe de Phillips tandis que les mesures de relance monétaires et budgétaires mettent des pressions positives sur l'inflation par l'intermédiaire du canal habituel de la demande. Nous illustrons ce canal négatif du côté de l'offre de façon théorique et empirique.

Sujets : Inflation et prix ; Politique monétaire ; Politique budgétaire ; Cycles et fluctuations économiques ; Recherches menées par les banques centrales
Codes JEL : E31, E52, E63

1 Introduction

Popular narratives have partially attributed the 2021-2023 inflation surge during the COVID-19 pandemic to monetary and fiscal stimuli. For example, citing an article published by the New York Magazine titled "We're Paying for Coronavirus Stimulus by Printing Money. And That's Fine!"[1] and a Nasdaq article titled "Money Printing and Inflation: COVID, Cryptocurrencies and More,"[2] the Wikipedia page states:[3]

> *"Among the factors contributing to the surge of inflation were the unprecedented levels of fiscal and monetary stimulus enacted to sustain household incomes and the liquidity of financial institutions in the 2020-2021 period. Many governments around the world adopted such stimulatory actions early in the COVID-19 pandemic..."*

Many politicians—Republicans, in particular—believe fiscal transfers during COVID-19 could have contributed to damaging inflation. For example, quoting the article from the New York Times titled "Republicans Say Spending Is Fueling Inflation," "They [Republicans] denounced the 1.9 trillion economic aid package he [President Biden] signed into law early in 2021 and warned it would stoke damaging inflation."[4]

Our paper aims to assess whether monetary and fiscal stimuli in response to the COVID-19 pandemic contributed significantly to the inflation surge between 2021 and 2023, as believed by popular public media. To alleviate potential identification concerns associated with various methods, and to leverage different aspects of data, we employ three different empirical strategies.

First, we deploy event studies to investigate the financial market's response to both

[1] https://nymag.com/intelligencer/2020/05/were-paying-for-coronavirus-stimulus-by-printing-money.html.

[2] https://www.nasdaq.com/articles/money-printing-and-inflation:-covid-cryptocurrencies-and-more.

[3] https://en.wikipedia.org/wiki/2021-2023_inflation_surge.

[4] https://www.nytimes.com/2023/03/23/us/politics/republicans-inflation-federal-reserve-powell.html

monetary and fiscal stimuli during the Great Recession and COVID-19. We use both inflation swaps and Treasury Inflation-Protected Securities (TIPS) of different maturities, and apply both one-day and two-day windows. We find in all combinations, none of the financial instruments move in response to policy shocks in a significant manner. Second, we use time-series data and employ vector autoregressions (VAR) to compare between conventional and unconventional monetary policy, and observe that the impulse response of inflation to a policy shock is smaller for unconventional monetary policy than for conventional monetary policy. Moreover, the inflation response to an unconventional monetary policy shock is close to zero. Third, we further explore granular data to leverage regional variations and tease out inflation consequences of fiscal transfers, and we find transfers do not move inflation in a significant manner. Therefore, all three distinct methodologies reach the same conclusion: unconventional monetary and fiscal policy barely moves inflation.

We resort to a small-scale tractable New Keynesian model to investigate the economic mechanism behind this finding. The model features an IS curve and a Phillips curve, and encompasses both quantitative easing (QE) and fiscal transfers, which is similar to the micro-founded model of Wu and Xie (2024).

The key implication of the model and the main driver of our general-equilibrium results is that unconventional monetary and fiscal policies put downward pressure on inflation through the Phillips curve. This result does not necessarily mean these policies are disinflationary overall, thanks to their inflationary effects through the usual demand side. On net, the theory does not provide guidance on their general-equilibrium effects, and our empirical studies fill this gap.

Motivated by the theory, we inspect the Phillips curve empirically with two different methods. First, we utilize the aggregate data and focus on QE. We use both ordinary least squares (OLS) and generalized method of moments (GMM). For the latter, we instrument monetary policy shocks with two popular measures in the literature, namely, Gertler and Karadi (2015) and Swanson (2021). They both identify monetary policy shocks through high-frequency identification. With different methods and instruments, we find a universal negative sign in front of QE, and all the GMM estimates are statistically significant. Further, we exploit regional variations in fiscal transfers. With different treatments to inflation expectations and different combinations of time and state fixed effects, again, we find a universal negative sign in front of the key variable, namely, fiscal transfers, and all the estimates are statistically significant. Results from both of aggregate and regional Phillips curves withstand various robustness checks.

Overall, we conclude that COVID-era monetary and fiscal stimuli do not contribute to the subsequent inflation surge, and the main transmission mechanism is their disinflationary effects through the supply side of the economy.

Literature. Our paper contributes to the large literature on QE. Previous empirical studies have primarily focused on QE's impact on the yield curves; for example, see Gagnon et al. (2011), Hamilton and Wu (2012), Krishnamurthy and Vissing-Jorgensen (2011), Wright (2012), Swanson and Williams (2014), and Rebucci, Hartley and Jiménez (2022). Some papers focus the discussion on the aggregate demand; for example, see Wu and Xia (2016). The empirical literature employs both event studies and time-series methods. On the theory side, a strand of work employs DSGE models to study the quantitative impact of QE, suggesting a sizable real effect (e.g., Gertler and Karadi, 2013, 2015; Del Negro et al., 2016; Sims and Wu, 2021; Sims, Wu and Zhang, 2023). However, most of the existing literature does not focus on inflation.

Our paper also contributes to the growing empirical literature that studies the macroeconomic consequences of fiscal transfers. Parker et al. (2013), Broda and Parker (2014), and Parker et al. (2022) employ the household Consumer Expenditure Surveys released by the U.S. Bureau of Labor Statistics and Nielsen Consumer Panels, and document increased household consumption and spending in response to emergency stimulus paychecks issued by the US government to individual households during the Great Recession and the COVID pandemic. Pennings (2021) calculates cross-region transfer multipliers by exploiting US regional variations in temporary stimulus payments and permanent Social Security benefits. Mendes et al. (2024) finds a positive effect of cash transfers to households on regional outputs in Brazil. Unlike the literature, which typically reports multipliers, we focus on inflation implications.

This paper also relates to the extensive literature that estimates the Phillips curve empirically. See McLeay and Tenreyro (2020) for a comprehensive survey of the existing literature. Some studies estimate the aggregate Phillips curve using time-series data (e.g., Ball and Mazumder, 2011; Coibion and Gorodnichenko, 2015; Blanchard, Cerutti and Summers, 2015; Barnichon and Mesters, 2020). Another strand of literature estimates a regional Phillips curve, utilizing regional variations to address the potential endogeneity issues of the aggregate supply shock and monetary policy (e.g., Fitzgerald and Nicolini, 2014; Babb and Detmeister, 2017; Hooper, Mishkin and Sufi, 2020; Hazell et al., 2022). Following both parts of the literature, we utilize both the aggregate and regional level data. The literature is typically interested in the slope of the Phillips curve, whereas we introduce a novel term that represents unconventional monetary and fiscal policy and investigates its sign.

2 General-Equilibrium Effects on Inflation

This section seeks to address the key question of the paper: Does COVID-era monetary and fiscal policy contribute to the subsequent inflation surge? If so, by how much? We adopt three different empirical methodologies. Section 2.1 uses event studies to investigate the financial market's responses to QE and fiscal stimuli provided by the Fed and Treasury during the Great Recession and COVID-19. Section 2.2 employs autoregressions to compare the aggregate implications of shocks to conventional interest rate policy and unconventional monetary policy. Section 2.3 exploits regional variations to estimate the effects of fiscal transfers on inflation.

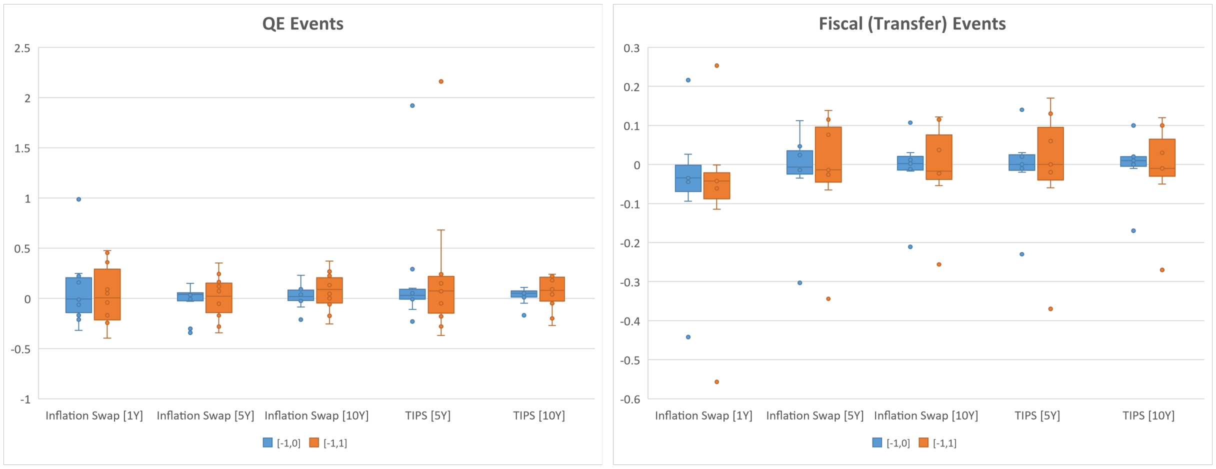
2.1 Event Studies

This section leverages data from the financial market and implements event studies to estimate how inflation expectations respond to fiscal and monetary stimuli implemented in response to the Great Recession and COVID-19 pandemic. For monetary interventions, we include various announcements about QE1-4. The first three rounds of QE were implemented in response to the Great Recession, whereas QE4 was deployed amid the global pandemic. We date QE events by announcements made by the Federal Open Market Committee (FOMC) or chairs' speeches. We take QE1-3 events from Krishnamurthy and Vissing-Jorgensen (2011), and QE4 events from Rebucci, Hartley and Jiménez (2022). For fiscal transfers, we include the Economic Stimulus Act of 2008 ($152 billion), the Coronavirus Preparedness and Response Supplemental Appropriations Act (Total $8.3 billion), the Families First Coronavirus Response Act ($192 billion), the Coronavirus Aid, Relief, and Economic Security Act ($2.1 trillion), the Paycheck Protection Program and Health Care Enhancement Act ($483 billion), the Consolidated Appropriations Act ($900 billion), and the American Rescue Plan Act of 2021 ($1.9 trillion). Fiscal transfers are dated as the first day a bill is passed by either the Senate or House. For the details of events, see Appendix A.

To measure market expectations of inflation, we use both inflation swaps and TIPS. We collect inflation swap rates from Bloomberg under the ticker "USSWIT[M] BGN Curncy," where [M] is the maturity in years. We use maturities of $M = 1$, 5, and 10 years. We download daily breakeven inflation rates from Federal Reserve Economic Data (FRED), which are calculated as the difference between the yields of nominal Treasury Securities and TIPS. The series is denoted as "T[M]YIE," where [M] is the maturity in years. We obtain the data series for $M = 5$ and $M = 10$.

Figure 1 summarizes our results. The left panel plots QE events, and the right does fiscal transfer events. The x-axis corresponds to different financial instruments. Box plots summarize the movements of these instruments before and after each event. We use two different window sizes: blue represents a one-day window (from the day before to the day

Figure 1: **Change in Inflation Expectation around the QE and Fiscal Aid Events**



Notes: [-1,0] and [-1,1] denote the event window, where date 0 represents the event day. The y-axis is reported in percentage points.

of the event), and orange corresponds to a two-day window (from the day before to the day after).[5] All the market data are closing prices. Each box marks the 1^{st} and 3^{rd} quartiles as well as the median. The whiskers mark the largest and smallest values excluding outliers, which are defined as exceeding 1.5 times the interquartile range (the distance between the 1^{st} and 3^{rd} quartiles) above and below the box.

Across various financial instruments, for both QE and fiscal transfers, and over different window sizes, we find all the box plots are not statistically different from 0, which implies these events do not move inflation expectations in either direction. Note this null result cannot be explained by these events being fully anticipated. Krishnamurthy and Vissing-Jorgensen (2011) illustrate this point by using a similar event study that focuses only on QE with a shorter sample, and they find QE announcements have a significant impact on the yield curve.

[5]If the beginning of the event window falls on a weekend or holiday, we replace it with the last trading day before it; if the end of the window falls on a weekend or holiday, we replace it with the first trading day after it.

2.2 Vector Autoregressions

This section takes a time-series approach. Specifically, we employ a workhorse three-variable VAR(4) of Stock and Watson (2001):

$$Y_t = \sum_{j=1}^{4} \Phi_j Y_{t-j} + \Sigma \epsilon_t, \tag{2.1}$$

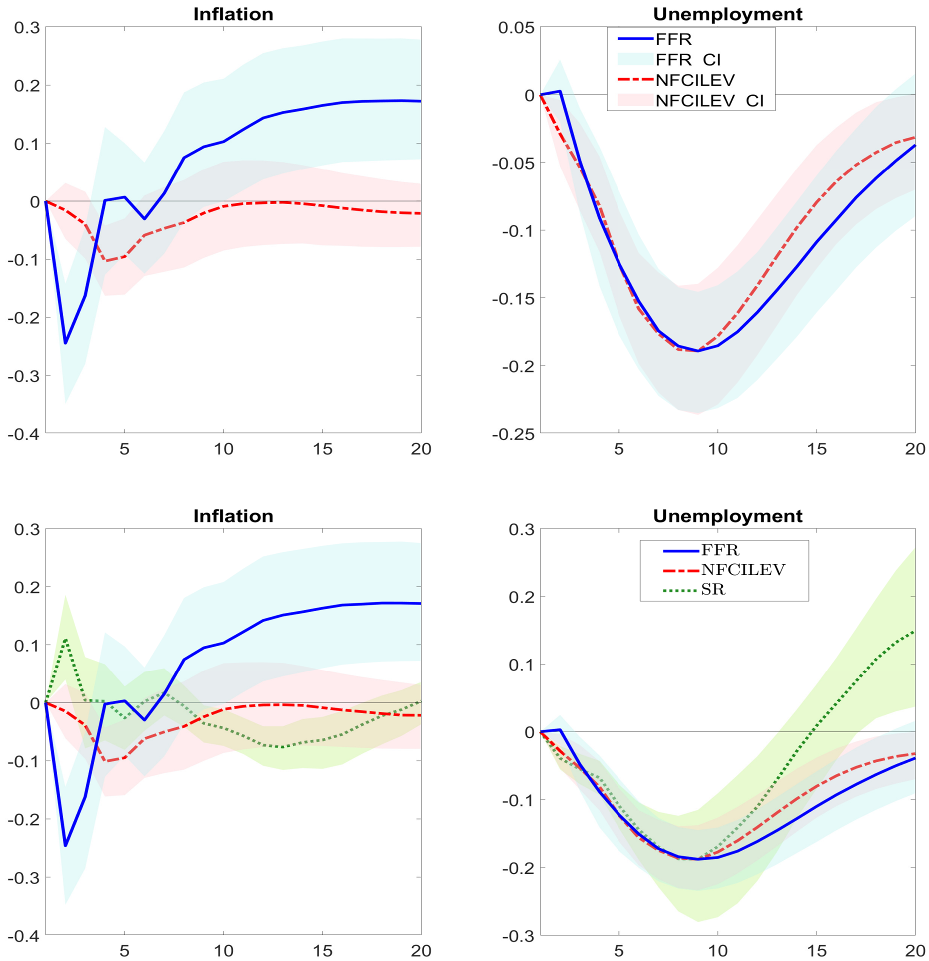
where Y_t is a 3×1 vector, which contains inflation (measured by the GDP deflator), the unemployment rate, and a monetary policy measure, and all the variables are demeaned. Φ_j is an autoregressive matrix. We identify structural shocks ϵ_t by imposing Σ to be the Cholesky decomposition of the variance-covariance matrix. Given the ordering of the variables, the last component of ϵ_t can be interpreted as the monetary policy shock.

To establish a baseline, we estimate the VAR with the effective federal funds rate to capture the conventional monetary policy. The sample ranges from 1960Q1 to 2007Q3. We stopped the sample before the Great Recession and the subsequent period of binding zero lower bound (ZLB). Figure 2 plots the impulse responses of inflation (left panel) and the unemployment rate (right panel), and blue lines correspond to an expansionary conventional monetary policy shock of 1%. The shaded areas are the 68% confidence intervals. The results are consistent with the literature: in response to an expansionary monetary policy shock, the unemployment rate decreases and inflation increases. The initial decrease of inflation reflects the price puzzle, which is a standard result in the VAR literature.

To address the question of interest, we next repeat the same VAR but with measures for unconventional monetary policy. First, we use the natural counterpart of the federal funds rate: the shadow federal funds rate of Wu and Xia (2016). To single out unconventional policy, we focus on the ZLB sample from 2009Q1 to 2015Q4.[6] The green dashed lines and corresponding shaded areas in Figure 2 capture the impulse responses. Second, guided by theory, we use an alternative measure that leverages the longer historical data. In the line

[6] Lagged variables start from 2008Q1.

Figure 2: **Impulse Responses of Inflation and Unemployment**



Notes: This figure plots the impulse responses of inflation and unemployment in a three-variable VAR. Blue solid lines: 1% expansionary shock in the federal funds rate (FFR) with the sample from 1960Q1 to 2007Q3. Green dotted lines: an expansionary shadow FFR rate shock with the samples from 2008Q1 to 2015Q4. Red dashed dotted lines: an expansionary leverage shock (NFCILEV) with the sample from 1971Q1 to 2023Q4. The shocks are normalized such that the maximum responses in the unemployment rate are the same. The lines are mediums, and the shaded areas are the corresponding 68% confidence intervals. X-axis: horizon in quarters; Y-axis: percentage changes. Data source: Federal Reserve Economic Data (FRED), and Wu and Xia (2016) for the shadow rate: https://sites.google.com/view/jingcynthiawu/shadow-rates.

of research on modeling QE, QE stimulates the aggregate demand by relaxing the leverage constraint of the financial intermediary.[7] Furthermore, Sims, Wu and Zhang (2023) and Wu and Xie (2024) illustrate that under some simplifying assumptions, QE and other factors that affect the leverage condition can be summarized by a sufficient statistic. To capture this

[7]For example, see Gertler and Karadi (2011), Sims and Wu (2021), Sims, Wu and Zhang (2023), and Wu and Xie (2024).

notion, we use the Leverage Index of the National Financial Conditions Index (NFCILEV) published by the Chicago Fed. This index allows us to start the sample from 1971Q1, and our sample ends in 2023Q4. The impulse responses are in the red dash dotted lines. For both specifications, we normalize the shock size such that the peak response of the unemployment rate coincides with the blue line.

We highlight two results. First, the inflation response to an unconventional policy shock is smaller than to a conventional monetary policy shock. Note that due to the price puzzle, we focus the comparison on the medium run. Second, the overall general-equilibrium effect of unconventional policy shocks on inflation is close to zero. If anything, it's slightly negative.

2.3 Regional Panel Regressions

This section further dives into granular data and investigates the question of interest through regional panel regressions. Whereas Section 2.2 focuses on QE, this section focuses on transfers, because QE does not exhibit any regional variations. We follow the methodology in the empirical literature that estimates the fiscal multiplier at the state level (e.g., Nakamura and Steinsson, 2014; Pennings, 2021), and adopt the following regression specification to estimate how fiscal transfer affects inflation:

$$\pi_{i,t} = \alpha_i + \mu_t + \phi\pi_{i,t-1} + \beta\frac{\tau_{i,t} - \tau_{i,t-1}}{Y_{i,t-1}} + \epsilon_{i,t}, \tag{2.2}$$

where $\pi_{i,t}$ is inflation in state i at time t, which is constructed by aggregating the metropolitan-level cost of living index (COLI) from the Council for Community and Economic Research (C2ER) weighted by population data from the Census; for details, see Appendix B.

Variable $\tau_{i,t}$ measures the total transfers that individual households within state i received from the federal government as part of the emergency stimulus packages during the COVID-19 pandemic, which is downloaded from the U.S. Bureau of Economic Analysis (BEA). The data are available from 2020Q1 to 2022Q4, which determines our sample period. We normalize the change in each state's transfers by its corresponding output $Y_{i,t-1}$, which is also obtained from the BEA. α_i and μ_t represent state and time fixed effects, respectively.

Table 1: Regional Panel Regressions during COVID

	(1)	(2)	(3)	(4)
Transfer	0.369	0.352	0.409	0.428
	(0.291)	(0.320)	(0.272)	(0.285)
Lagged inflation			-0.201*	-0.376***
			(0.107)	(0.125)
Constant	3.152***	3.206***	-2.397	-2.591
	(0.932)	(0.814)	(3.004)	(3.166)
N	303	303	201	201
Time FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes

Notes: The dependent variable is the state inflation constructed from the granular cost of living index; for details, see Appendix B. Regression specification: (2.2). Transfer represents the change of state-level lump-sum transfer, normalized by lagged output. The sample period spans from 2019Q4 to 2022Q4. Standard errors in parentheses are cluster-robust (clustered at the state level), which allows for heteroskedasticity and arbitrary serial correlation. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 1 shows the estimation results. Specifications (1)-(2) do not include the lagged inflation, whereas specifications (3)-(4) do. Specifications (1) and (3) only control for the time fixed effects, and the other two control for both time and state fixed effects. The point estimates of β are positive but insignificant across all specifications.

Overall, with three different empirical strategies (event studies, VAR, and regional panel regressions), we conclude unconventional monetary and fiscal policies implemented during the COVID era did not contribute much to the subsequent inflation surge.

3 Theory

Section 2 has established empirically that unconventional monetary and fiscal policies did not contribute to the COVID-pandemic inflation surge, which begs the question why. This section illustrates the economic mechanism of this result using a small-scale New Keynesian model. The model is similar to Wu and Xie (2024), who microfound a tractable model that consists of an IS curve and a Phillips curve and features both unconventional monetary and fiscal policies. Note the qualitative results we illustrate in this section is not specific to the setup of Wu and Xie (2024). More broadly, they are consistent with the entire line of research; for example, see Gertler and Karadi (2011), Sims and Wu (2021), and Sims, Wu and Zhang (2023). However, the majority of this literature limits its scope to QE only.

3.1 Microfoundation and Unconventional Policies

In the background, there are two types of households: unconstrained and constrained. The unconstrained household is standard: it consumes, works, saves with one-period bonds, and pays a lump sum tax. The constrained household borrows through long-term bonds to finance its consumption. It also receives government transfers. The financial intermediary (FI) performs maturity transformation between the two types of households while facing a leverage constraint.

How does QE work? When the central bank purchases long-term bonds, it relaxes the leverage constraint of the FI. Therefore, the constrained household can borrow more and hence increase its consumption, which in turn stimulates the aggregate demand. This mechanism explains our choice of using the leverage condition index (i.e., NFCILEV) as the summary for QE in Section 2.2.

Fiscal transfers also allow the constrained household to consume more by handing it resources directly. In aggregate, QE and fiscal transfers have similar implications for inflation and output. Economically, they work differently. Whereas QE works through the financial sector, fiscal transfers don't.

3.2 Linear Model

For illustration purposes, we present a simplified model that focuses on the policies that are relevant for the COVID episode, namely, QE and fiscal transfers:

$$\text{IS curve:} \quad x_t = \mathbb{E}_t x_{t+1} - \frac{\vartheta}{\sigma}(i_t - \mathbb{E}_t \pi_{t+1} - r_t^*) + [qe_t + \tau_t]\,, \tag{3.1}$$

$$\text{Phillips curve:} \quad \pi_t = \beta \mathbb{E}_t \pi_{t+1} + \gamma \zeta x_t - \frac{\gamma \sigma}{\vartheta}[qe_t + \tau_t]\,, \tag{3.2}$$

where x_t is the output gap that measures economic slack, defined as the log deviation of output from its potential. π_t is inflation and r_t^* is the natural rate of interest. There are three policy instruments: i_t corresponds to the conventional interest rate policy, qe_t is the central bank's holdings of long-term bonds (QE), and τ_t is tax-financed transfer. QE and transfer are defined as the ratio between the change from their steady state relative to the steady-state output. All other variables are in the log deviation from the non-stochastic steady state.

The parameter ϑ measures the steady-state fraction of the unconstrained household's consumption in total output. σ is the inverse elasticity of intertemporal substitution, and β is the discount factor. γ captures the elasticity of inflation with respect to the real marginal cost, and ζ is the elasticity of the real marginal cost with respect to output, which depends on ϑ.

The IS curve in (3.1) summarizes the demand side of the economy, and it states that conventional monetary policy (i_t), QE (qe_t), and fiscal transfers (τ_t) can all be used to stimulate the aggregate output. Note, a lower interest rate or a larger qe_t or τ_t corresponds to an expansionary policy. (3.2) is the Phillips curve, which captures the supply side of the economy.

3.3 Inflation Implications

One key implication of (3.2) is that only QE and transfers enter the Phillips curve and with a negative sign. An immediate result follows:

Proposition 1 *Unconventional COVID-era government policy puts downward pressure on inflation through the* ***Phillips curve****.*

This result provides an economic explanation behind the null result we find empirically in Section 2, and challenges the conventional wisdom and popular narratives that the COVID-era emergency stimulative policies were a main driver of the inflation hike.

Proposition 1 does not necessarily mean QE and fiscal transfers are disinflationary. The usual inflationary channel through the demand side remains, which we can see from the IS curve: an expansionary policy intervention stimulates the economy through the demand channel, which puts an upward pressure on inflation.

The theory does not make a qualitative prediction regarding whether the disinflationary supply channel or the inflationary demand channel dominates. Therefore, the overall general-equilibrium effect of unconventional monetary and fiscal policy on inflation is an empirical matter, and we found it is almost zero in our empirical investigations in Section 2. The theory does suggest unconventional policy is less inflationary than conventional monetary policy, which is an immediate result of Proposition 1, and we can see this result empirically in Figure 2. Specifically, in the left panel, the inflation response to a shock to the conventional monetary policy (blue solid line) is larger than to the unconventional policy (red dashed line).

4 Phillips Curve

Proposition 1 suggests the main economic mechanism for our result in Section 2 is the negative inflation pressure of unconventional monetary and fiscal policies through the Phillips curve. This section inspects this mechanism. Section 4.1 utilizes the aggregate data and focuses on QE, whereas Section 4.2 exploits granular regional data to study fiscal transfers.

4.1 Aggregate

We first test the negative sign in front of the policy instruments in equation (3.2) using aggregate time-series data. The choices of variables follow the literature (e.g., McLeay and Tenreyro, 2020) except that we include the new variable NFCILEV to captures unconventional monetary policy, which is discussed in Section 2.2.

Following the literature, the dependent variable is the inflation gap, which is defined as the difference between inflation and inflation expectation, by assuming $\beta \approx 1$ in the model. We calculate the year-over-year inflation rate using the research series of Core Consumer Price Index that excludes food and energy of all urban consumers, which is labeled by the US Bureau of Labor Statistics (BLS) as "R-CPI-U-RS." As suggested by Bernanke (2007) and Yellen (2015), we proxy inflation expectation with the 10-year-ahead inflation expectation from the Survey of Professional Forecasters (SPF), conducted by the Federal Reserve Bank of Philadelphia. Following the literature, we use the unemployment gap to proxy for economic slack; see, for instance, McLeay and Tenreyro (2020), Hazell et al. (2022), and Fitzgerald et al. (2024). The unemployment gap is calculated as the difference between the unemployment rate, which is published by the BLS under "UNRATE," and the Congressional Budget Office's (CBO) estimate of the natural rate of unemployment, which is available at FRED under "NROU."

We estimate the Phillips curve using both OLS and GMM, where the latter utilizes the high-frequency identified monetary policy shocks. For GMM, we instrument monetary policy shocks with two popular measures in the literature, both of which are constructed via high-frequency identification. The first measure is Barnichon and Mesters's (2020) extension of Gertler and Karadi's (2015) monetary policy shocks, which tracks the total changes in the three-month-ahead fed funds futures and the 10-year Treasury yield around FOMC

Table 2: Aggregate Phillips Curve

	(1) OLS	(2) OLS	(3) GMM-GK	(4) GMM-ES
Unemp gap	-0.238**	-0.244**	-0.325***	-0.213***
	(0.098)	(0.102)	(0.002)	(0.004)
NFCILEV		-0.080	-0.254***	-0.084***
		(0.084)	(0.004)	(0.004)
Constant	-0.000	-0.000	-0.002***	-0.003***
	(0.003)	(0.003)	(0.000)	(0.000)
N	136	136	109	100

Notes: This table reports the baseline parameter estimates and their standard errors (in parentheses) in the Phillips curve. The dependent variable is the inflation gap that is measured by core CPI inflation less SPF 10-year-ahead inflation expectations. NFCILEV represents the financial conditions measured by the negative of Chicago Fed National Financial Condition Leverage Subindex. "GK" indicates using the high-frequency identified monetary policy shocks constructed by Gertler and Karadi (2015) as IVs, whereas "ES" indicates using the large asset purchase shock constructed by Swanson (2021) as IVs. The sample is from 1990Q1 to 2023Q4 subject to availability. For the OLS estimations, standard errors are calculated as Newey-West standard errors with a maximum lag of 12 quarters. For the IV estimations, the Phillips curve parameters are estimated using GMM, with an HAC weighting matrix using the quadratic spectral kernel where the lag order is selected using the Newey and West (1994) optimal lag-selection algorithm. The number of lags for these structural shocks as instruments is H = 12. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

announcements. The second instrument is the QE shocks of Swanson (2021). Table 2 delivers the estimation results. The sample starts from 1990Q1 when the high-frequency monetary policy shocks are available and ends in 2023Q4 subject to data availability.[8] Results from OLS are in specifications (1) and (2). Results from GMM with the monetary policy shocks of Gertler and Karadi (2015) and Swanson (2021) are in specifications (3) and (4), respectively. Standard errors are in the parentheses. For the OLS estimates, we present Newey-West standard errors with a maximum lag of 12 quarters. For GMM, they are calculated using the HAC weighting matrix with the quadratic spectral kernel where the lag order is selected using the Newey and West (1994) optimal lag-selection algorithm.

The sign in front of the key variable NFCILEV is unanimously negative, and all of the GMM estimates are statistically significant at the 1% level. This result confirms Proposition 1 and rationalizes our result in Section 2. For robustness, we repeat our exercises

[8] The QE shocks of Swanson (2021) are available from 1991Q3 to 2019Q2. The Gertler and Karadi (2015) shocks are available through 2020Q1.

by replacing the unemployment gap with the output gap, and focusing only on the Great Recession and COVID periods. Our main result holds under both alternatives; for details, see Appendix C.1.

4.2 Regional

This section explores the regional variation in the Phillips curve. Similar to Section 2.3, we focus on fiscal transfers. We use a specification similar to McLeay and Tenreyro (2020) and Hazell et al. (2022), which modifies (3.2) as follows:

$$\pi_{i,t} = \alpha_i + \mu_t + \beta \mathbb{E}_t \pi_{i,t+1} + \kappa x_{i,t} + \zeta \frac{\tau_{i,t-4}}{Y_{i,t-4}} + \epsilon_{i,t}. \tag{4.1}$$

Similar to before, α_i and μ_t are state and time fixed effects. $\pi_{i,t}$, $\tau_{i,t}$, and $Y_{i,t}$ are state-level inflation, transfers, and output, respectively, all of which are constructed the same as in Section 2.3; for details, see Appendix B. We use lagged transfer from one year ago following Hazell et al. (2022) and check the robustness of our results with one quarter lag in Appendix C.2. The inflation expectation $\mathbb{E}_t \pi_{i,t+1}$ is proxied by the one-year-ahead regional inflation expectation from the Michigan Consumer Survey. The Michigan Survey publishes data for four broad geographical regions: the North East, North Central, South, and West. We assign each state to its corresponding region.

Variable $x_{i,t}$ represents the output gap in state i and is defined as the difference between the state-level real GDP and its potential output. We construct the state potential output by multiplying the state-share of population by the potential nominal GDP of the entire country and dividing by the national GDP deflator. We use the output gap as our main specification because the state-level natural rate of unemployment is not available. Using the national potential to construct the state-level unemployment gap loses some regional heterogeneity and is equivalent to using the unemployment rate outright with a time fixed effect. As a robustness check, in Appendix C.2, we report the results using the unemployment rate.

Table 3: Regional Phillips Curve during COVID

	(1)	(2)	(3)	(4)
Output gap	0.048***	0.095	0.047***	0.095
	(0.009)	(0.104)	(0.010)	(0.101)
Transfer	-0.440***	-0.432***	-0.440***	-0.432***
	(0.108)	(0.123)	(0.107)	(0.123)
Inflation expectation	1	1	2.007	0.997
			(1.550)	(2.229)
Constant	-2.784***	-8.037	-5.864	-8.029
	(0.856)	(7.119)	(4.665)	(9.936)
N	252	252	252	252
Time FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes

Notes: The dependent variable is the state inflation constructed from the granular cost of living index; for details, see Appendix B. Regression specification: (4.1). We use the output gap as the measure of economic slack. Inflation expectations are proxied by the one-year-ahead regional inflation expectation from the Michigan Consumer Survey. The transfer is the 4-quarter lagged lump-sum transfer per capita in each state normalized by its output per capita. The sample period spans from 2019Q4 to 2022Q4. Columns (1) and (2) impose the coefficient in front of the inflation expectation to be $\beta = 1$. Standard errors in parentheses are cluster-robust (clustered at the state level), which allows for heteroskedasticity and arbitrary serial correlation. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 summarizes the regression results. Specifications (1) and (2) impose the coefficient in front of the inflation expectation to be $\beta = 1$, which is the same treatment as in Section 4.1, whereas specifications (3) and (4) estimate this coefficient. Specifications (1) and (3) only introduce time fixed effects, whereas specifications (2) and (4) control for both fixed effects. We find the coefficients on transfer are universally negative and all significantly different from zero at the 1% level.

Appendix C.2 reports two sets of robustness checks. First, we use the unemployment rate instead of the output gap. Second, we use one-quarter lagged transfer instead of one-year lagged transfer. Our result is robust across these alternative specifications.

5 Conclusion

We investigate whether government stimuli provided by the Federal Reserve and the Treasury in response to the COVID-pandemic caused the subsequent inflation surge, as suggested by a popular view in the public media, and the answer is no. Formally, we adopt three different empirical strategies: event studies that record the changes in market prices around announcements, a time-series VAR that tracks impulse responses, and a regional panel regression that utilizes granular data. All three methodologies point to a unanimous conclusion that these government policies are not the driver of the inflation hike between 2021 and 2023.

Next, we use a small-scale New Keynesian model that features an IS curve and a Phillips curve and encompasses both unconventional monetary and fiscal policies to highlight the economic mechanism. It works through the supply side, where these policies put downward pressure on inflation. We further examine this disinflationary channel through the Phillips curve empirically using both the aggregate and disaggregate data. Both point to the same conclusion, which is consistent with the theory.

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A Events

Table A.1: QE and Fiscal Stimulus Events

Type	Event	Date
QE	QE1: buy up to \$100B agency debt and up to \$500B agency MBS	Nov 25, 2008
	*Chairman Bernanke's speech: the Fed "could purchase longer-term Treasury securities...in substantial quantities"	Dec 1, 2008
	the FOMC was considering expanding agency security purchases and initiating long-term Treasury purchases	Dec 16, 2008
	same as 16-Dec-08 announcement	Jan 28, 2009
	buy up to \$300B of longer term Treasuries, up to \$200B agency debt, and up to \$1.25T agency MBS	Mar 18, 2009
	QE2: "The [FOMC] Committee will keep constant the Federal Reserve's holdings of securities at their current level..."	Aug 10, 2010
	the FOMC "maintain its existing policy of reinvesting principal payments...prepared to provide additional accommodation..."	Sept 21, 2010
	QE3: maturity extension program (or operation twist) announced	Sept 21, 2011
	QE4: buy at least \$500B Treasuries, at least \$200B agency MBS	Mar 15, 2020
	potentially "unlimited" MBS and Treasury purchases	Mar 23, 2020
Fiscal	Economic Stimulus Act of 2008	Feb 7, 2008
	Coronavirus Preparedness and Response Supplemental Appropriations Act	Mar 04, 2020
	Families First Coronavirus Response Act	Mar 14, 2020
	Coronavius Aid, Relief, and Economic Security Act (CARES Act)	Mar 25, 2020
	Paycheck Protection Program and Health Care Enhancement Act	Apr 21, 2020
	Consolidated Appropriations Act	Dec 21, 2020
	American Rescue Plan Act of 2021	Mar 06, 2021

Notes: QE events are dated by FOMC announcements except for December 1, 2008, which is dated by the chair's speech. Fiscal stimulus events are dated as the first day a bill is passed by either the Senate or the House.

B State-Level Inflation

This appendix documents the steps, details, and exceptions for how we construct the state-level inflation data.

B.1 Data Construction Steps

First, we match the metropolitan-level cost of living index (COLI) from the Council for Community and Economic Research (C2ER: https://www.coli.org) with population data from the Census, using the core-based statistical area (CBSA) code, which defines geographic regions of the U.S. by the Office of Management and Budget (OMB) in 2000. For the details on data merging, including rules and exceptions, see Appendix B.2 and Appendix B.3. Next, we aggregate the metropolitan-level COLI data to the state level by taking a weighted average weighting by the population. To translate the state-level COLI to a price level, we repeat the previous step but aggregate COLI to the national level instead. Finally, we divide the state-level COLI by the national-level COLI and multiply by the U.S. Core CPI, which yields the state-level price index. Finally, We calculate inflation as the percentage change of the state-level price index from the last period.

B.2 General matching rules

This section starts with some general treatments we apply when matching the two datasets.

1. *Missing data in COLI:* We treat missing data as Not a Number (NaN). The COLI systematically misses Q4 except for 2020, when Q2 is missing.

2. *Multiple entries with the same CBSA code at both Metropolitan and county levels in Census data:* See an example in Table B.2. Four entries have the same CBSA code, 10180. The top entry, "Abilene TX," is an metropolitan statistical area and has a population of 172,060. The next three entries are three counties within this metropolitan area. The populations of the three counties add up to the population associated with Abilene, TX. To best match the COLI data, we drop the observations at the county-level in the Census data, which can be identified by entries with a STCOU (state-county) code.

Table B.2: Multiple Entries with the Same CBSA Code at both Metropolitan and County Levels in the Census Data

CBSA	STCOU	NAME	LSAD	2019 Population
10180		Abilene TX	Metropolitan Statistical Area	172,060
10180	48059	Callahan County TX	County or equivalent	13,943
10180	48253	Jones County TX	County or equivalent	20,083
10180	48441	Taylor County TX	County or equivalent	138,034

3. *Multiple entries with the same CBSA code in COLI, all at the county level*: See two examples in B.3. In the top panel, both Los Angeles-Long Beach CA and Lancaster-Palmdale CA are associated with the same CBSA code (31084), and both areas are

located inside California. In the bottom panel, both Covington KY and Cincinnati OH are associated with CBSA code of 17140. But they belong to two different states. In both cases, instead of matching the population with the CBSA code at the metropolitan level, which is our default method, we match the population of each entry with its associated county population by name.

Table B.3: Multiple Entries with the Same CBSA Code in COLI

TIME	URBAN AREA NAME	CBSA
2012 Q3	Los Angeles-Long Beach CA	31084
2012 Q3	Lancaster-Palmdale CA	31084
2010-2022	Covington KY	17140
2010-2022	Cincinnati OH	17140

B.3 Individual cases

Next, we explain how we handle individual special cases.

1. Both St. Louis MO-IL and St. Charles County MO appear in the COLI dataset with the same CBSA code, and St. Charles County MO is one of the counties in the St. Louis MO-IL Metropolitan area. This case is similar to rule #2 in Appendix B.2 except that this is in the COLI dataset. We follow a similar rule and only keep the entry of St. Louis MO-IL to match the Metro population.

2. The CBSA codes of two entries in COLI do not find a match in the Census data. They are Bethesda-Gaithersburg-Frederick MD and Dayton-Kettering OH. We match them to the population data manually by name.

3. In the COLI dataset, New York City is divided into Manhattan, Queens, and Brooklyn. We match them to the corresponding population for these districts from https://datacommons.org/place/geoId/3606144919.

C Robustness Checks

This appendix presents various robustness checks for Section 4.

C.1 Aggregate Phillips Curve

This section reports robustness checks for the aggregate Phillips curve in Table 2. First, we use the output gap as the measure of economic slack rather than the unemployment gap in Table C.1. Second, Table C.2 uses a shorter sample than in our main specification.

Table C.1: Aggregate Phillips Curve: Output Gap

	(1) OLS	(2) OLS	(3) GMM-GK	(4) GMM-ES
Output gap	0.059**	0.060**	-0.168***	0.127***
	(0.028)	(0.028)	(0.004)	(0.000)
NFCILEV		-0.011	-0.882***	-0.111***
		(0.059)	(0.006)	(0.000)
Constant	-0.003***	-0.003***	-0.005***	-0.003***
	(0.001)	(0.001)	(0.000)	(0.000)
N	127	127	109	100

Notes: This table reports the parameter estimates and their standard errors (in parentheses) in the Phillips curve. The dependent variable is the inflation gap that is measured by the research series core CPI inflation less SPF 10-year-ahead inflation expectations. NFCILEV represents the financial conditions measured by the negative of Chicago Fed National Financial Condition Leverage Subindex. “GK” indicates using the high-frequency identified monetary policy shocks constructed by Gertler and Karadi (2015) as IVs, whereas “ES” indicates using the large asset purchase shock constructed by Swanson (2021) as IVs. For the OLS estimations, standard errors are calculated as Newey-West standard errors with a maximum lag of 12 quarters. For the IV estimations, the Phillips curve parameters are estimated using GMM, with an HAC weighting matrix using the quadratic spectral kernel where the lag order is selected using the Newey and West (1994) optimal lag-selection algorithm. The number of lags for these structural shocks as instruments is $H = 12$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: Aggregate Phillips Curve Estimation: Post-2008 Sample

	(1) OLS	(2) OLS	(3) GMM-GK	(4) GMM-ES
Unemp gap	-0.361**	-0.358**	-0.290***	-0.177***
	(0.170)	(0.169)	(0.001)	(0.000)
NFCILEV		0.043	-0.051***	-0.035***
		(0.118)	(0.001)	(0.000)
Constant	0.005	0.005	-0.000***	-0.002***
	(0.005)	(0.005)	(0.000)	(0.000)
N	64	64	49	46

Notes: This table reports the parameter estimates and their standard errors (in parentheses) in the Phillips curve. The dependent variable is the inflation gap that is measured by core CPI inflation less SPF 10-year-ahead inflation expectations. NFCILEV represents the financial conditions measured by the negative of Chicago Fed National Financial Condition Leverage Subindex. "GK" indicates using the high-frequency identified monetary policy shocks constructed by Gertler and Karadi (2015) as IVs, whereas "ES" indicates using the large asset purchase shock constructed by Swanson (2021) as IVs. The sample starts from 2008Q1 to 2023Q4 subject to availability. For the OLS estimations, standard errors are calculated as Newey-West standard errors with a maximum lag of 12 quarters. For the IV estimations, the Phillips curve parameters are estimated using GMM, with an HAC weighting matrix using the quadratic spectral kernel where the lag order is selected using the Newey and West (1994) optimal lag-selection algorithm. The number of lags for these structural shocks as instruments is $H = 12$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

C.2 Regional Phillips Curve

This section reports robustness checks for regional Phillips curves in Table 3. First, we replace the output gap with the unemployment rate from the BLS. Results are in Table C.3. Next, we replace the 4-quarter lagged transfer with 1-quarter lagged transfer and show results in Table C.4.

Table C.3: Regional Phillips Curve during COVID: Unemployment Rate

	(1)	(2)	(3)	(4)
Unemployment	-0.746**	-0.764	-0.725**	-0.762
	(0.334)	(1.0063)	(0.338)	(1.000)
Transfer	-0.221**	-0.436***	-0.230**	-0.436***
	(0.094)	(0.124)	(0.092)	(0.124)
Inflation expectation	1	1	2.618*	1.055
			(1.480)	(2.192)
Constant	2.335	1.677	-2.768	1.493
	(1.791)	(4.265)	(5.025)	(7.836)
N	252	252	252	252
Time FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes

Notes: The dependent variable is the state inflation constructed from the granular cost of living index; for details, see Appendix B. Regression specification: (4.1). We use the unemployment rate as the measure of economic slack. Inflation expectations are proxied by the one-year-ahead regional inflation expectation from the Michigan Consumer Survey. The transfer is the 4-quarter lagged lump-sum transfer per capita in each state normalized by its output per capita. The sample period spans from 2019Q4 to 2022Q4. Standard errors in parentheses are cluster-robust (clustered at the state level), which allows for heteroskedasticity and arbitrary serial correlation. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.4: Regional Phillips Curve during COVID: Different Lag

	(1)	(2)	(3)	(4)
Output gap	0.042***	0.012	0.040***	0.003
	(0.009)	(0.068)	(0.009)	(0.065)
Transfer	-0.404***	-0.405**	-0.412***	-0.412***
	(0.130)	(0.153)	(0.128)	(0.150)
Inflation expectation	1	1	2.896**	2.610
			(1.235)	(1.746)
Constant	-0.327	0.410	-5.285	-3.342
	(0.970)	(5.020)	(3.402)	(7.065)
N	303	303	303	303
Time FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes

Notes: The dependent variable is the state inflation constructed from the granular cost of living index; for details, see Appendix B. Regression specification: (4.1). We use the output gap as the measure of economic slack. Inflation expectations are proxied by the one-year-ahead regional inflation expectation from the Michigan Consumer Survey. The transfer is the one-quarter lagged lump-sum transfer per capita in each state normalized by its output per capita. The sample period spans from 2019Q4 to 2022Q4. Standard errors in parentheses are cluster-robust (clustered at the state level), which allows for heteroskedasticity and arbitrary serial correlation. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.