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UNCONVENTIONAL POLICY AND INFLATION

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ABSTRACT

We study the effects of unconventional monetary and fiscal policies on inflation dynamics. Using multiple complementary empirical approaches, including event studies, vector autoregressions, and regional panel regressions, we find little evidence that these policies contributed meaningfully to inflation in the past decades. The key economic mechanism operates through a disinflationary supply-side channel in the Phillips curve, which offsets the upward pressure on inflation from the usual demand channel. We demonstrate this mechanism both theoretically and empirically.

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1 Introduction

Popular media have attributed the 2021–2023 inflation surge to monetary and fiscal stimulus.[1] This view echoes a broader narrative that unconventional policy tools—whether used after the Great Recession or during the pandemic—are inherently inflationary. However, these claims are often made without systematic empirical analysis.

Our paper fills this gap by comprehensively assessing whether unconventional monetary and fiscal stimulus contributed to inflation dynamics over the past decades. We employ three complementary empirical strategies for comprehensiveness: event studies to capture the high-frequency response of financial markets, vector autoregressions to examine the dynamic macroeconomic effects of policy shocks, and regional panel regressions using granular data to exploit cross-state variation. Across all approaches, we establish a null result, finding no evidence that these policies contributed to inflation in an economically meaningful manner.

We begin by deploying event studies to examine the financial market's response to both monetary and fiscal policy interventions during the Great Recession and COVID-19 pandemics. Our monetary event sample comprises sixteen major quantitative easing (QE) announcements spanning QE1–QE4. The fiscal events consist of seven large stimulus acts, including Coronavirus Aid, Relief, and Economic Security Act (CARES Act), American Rescue Plan Act (ARPA), and Consolidated Appropriations Act (CAA). Using inflation swaps and Treasury Inflation-Protected Securities (TIPS), we analyze their movements in narrow windows around each event. Across all combinations of policy types, financial instruments, and maturities, we find no statistically significant changes in inflation expectations. This result is robust to alternative event-date choices and cannot be explained by anticipation, as Treasury yields and equity markets exhibit clear responses to these events.

Second, we use time-series data and estimate a vector autoregression (VAR) to com-

[1] Among many others, see Levitz (2020) in New York Magazine and Surz (2021) in Nasqad.

pare the dynamic effects of conventional and unconventional monetary policy on inflation. We proxy unconventional policy using the Leverage Index of the National Financial Conditions Index (NFCILEV). This measure is motivated by recent theoretical work (Gertler and Karadi, 2011; Sims and Wu, 2021; Sims, Wu, and Zhang, 2023; Wu and Xie, 2025) and has the advantage of a longer historical sample. For comparison, we also use the shadow federal funds rate of Wu and Xia (2016), a widely used benchmark for monetary policy at the zero lower bound. Consistent with the literature, an expansionary conventional monetary policy shock raises inflation, whereas the inflation response to an unconventional policy shock is much smaller and mostly statistically insignificant.

Third, we leverage granular regional data to assess the inflationary effects of fiscal transfers, focusing on the CARES Act, CAA, and ARPA, which distributed Economic Impact Payments (EIPs). Simple cross-sectional correlations at each point in time and pooled correlations using all observations show no stable or statistically significant relationship between transfers and inflation. We then formally estimate panel regressions with varying fixed-effect structures and lag specifications. Across all specifications, we find no consistent evidence that transfers increased inflation.

Thus, all three methodologies (event studies, vector autoregressions, and regional panel regressions) consistently show that unconventional monetary and fiscal policies did not make a statistically or economically significant contribution to inflation.

We employ a micro-founded tractable New Keynesian model to investigate the economic mechanism behind our finding. The model features a forward-looking IS curve to capture the demand side of the economy and a New Keynesian Phillips curve for the supply side, and it encompasses both QE and fiscal transfers.

The key implication of the model is that unconventional monetary and fiscal policies put downward pressure on inflation through the Phillips curve, which is the main driver of our general-equilibrium results. The negative supply channel itself does not necessarily imply that these policies are disinflationary overall, since they also exert inflationary effects through the usual demand channel. Ultimately, the theory is ambiguous on the net general-equilibrium effect, making our empirical investigation essential.

To further illuminate the mechanisms highlighted by the model, we next examine the Phillips curve empirically using both aggregate and regional data. First, we utilize the aggregate data and focus on QE. We use both ordinary least squares (OLS) and generalized method of moments (GMM), instrumenting QE shocks using high-frequency external instruments. Specifications differ by QE shocks, measures of economic slack, measures of inflation expectations, and whether we impose the coefficient in front of expected inflation to be one or estimate it freely. Across all specifications, we consistently find a negative coefficient on QE, with all GMM estimates statistically significant.

Further, we exploit regional variations in fiscal transfers. We vary whether we impose the coefficient in front of inflation expectations, whether we include time or state fixed effects, and which measures of economic slack we use. Across all these specifications, we again find a consistently negative coefficient on fiscal transfers, with all estimates statistically significant. Both results at the aggregate level and regional level support the theory and reinforce the mechanism underlying our general-equilibrium results.

The remainder of the paper, after a brief literature review, is organized as follows: Section 2 reports the general equilibrium results using event studies, vector autoregressions, and regional panel regressions. Section 3 presents the theoretical model to illustrate the key mechanism through the Phillips curve, while Section 4 examines this mechanism empirically. Section 5 concludes.

Literature. Our paper contributes to the large literature on QE. Previous empirical studies have primarily focused on QE's impact on the yield curve; for example, see Gagnon et al. (2011), Krishnamurthy and Vissing-Jorgensen (2011), Hamilton and Wu (2012), Wright (2012), Swanson and Williams (2014), and Rebucci, Hartley, and Jiménez (2022). A few papers examine QE's effects on the aggregate economy, but mainly focus on real activity (e.g., 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 impact of QE theoretically, suggesting a sizable real effect (e.g., Gertler and Karadi, 2013, 2015; Del Negro et al., 2016; Sims and Wu, 2020, 2021; Sims, Wu, and Zhang, 2023). Most of the existing literature, theoretical or empirical, examines QE's impact on the yield curve or real activity, whereas our paper focuses 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 U.S. government to individual households during the Great Recession and the COVID-19 pandemic. Pennings (2021) calculates cross-region transfer multipliers by exploiting U.S. 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 most of this literature, which typically reports fiscal multipliers, our paper focuses on the inflationary consequences of fiscal transfers.

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; Blanchard, Cerutti, and Summers, 2015; Coibion and Gorodnichenko, 2015; Barnichon and Mesters, 2020; Beaudry, Hou, and Portier, 2024). 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 aggregate and regional data. While the literature typically focuses on the slope of the Phillips curve, we introduce a novel term that captures unconventional monetary and fiscal policy and investigate its effect.

2 General-Equilibrium Effects on Inflation

This section addresses the key question of the paper: Do unconventional monetary and fiscal policies contribute to inflation? We employ three complementary empirical methodologies. Section 2.1 uses event studies to examine financial market responses to major QE announcements and large fiscal packages. Section 2.2 estimates VARs to compare the aggregate effects of conventional interest-rate policy shocks with those of unconventional monetary policy. Section 2.3 exploits regional variation in fiscal transfers to evaluate their impact on inflation.

2.1 Event Studies

This section leverages financial market data and employs event studies to estimate how inflation expectations respond to major announcements of QE and large fiscal packages. Our event sample spans the Great Recession through the pandemic period.

Table 1 provides the list of events. The top panel lists sixteen monetary policy announcements spanning QE1 through QE4. The first three rounds of QE were implemented in response to the Great Recession. QE1 began with the unprecedented announcement on November 25, 2008, at the height of the financial crisis, and unfolded over five major events through March 2009. During this period, the Fed launched and expanded large-scale purchases of agency mortgage-backed securities (MBS), agency debt, and longer-term Treasuries, ultimately committing up to $1.7 trillion in these assets. QE2 consisted of three events in late 2010 and involved $600 billion in longer-term Treasuries. In September 2011, the Federal Reserve also implemented Operation Twist (OT), a matu-

Table 1: Stimulus Events and Market Reactions

Type	Description	Date	ΔYld/S&P
QE1	buy up to $100B agency debt and up to $500B agency MBS	Nov 25, 2008	-0.22
	*could purchase longer-term Treasury securities...in substantial quantities	Dec 1, 2008	-0.19
	consider expanding agency security purchases and initiating long-term Treasury purchases	Dec 16, 2008	-0.26
	same as 16-Dec-08 announcement	Jan 28, 2009	0.14
	buy up to $300B of longer-term Treasuries, up to $200B agency debt, and up to $1.25T agency MBS	Mar 18, 2009	-0.47
QE2	keep constant the Federal Reserve's holdings of securities at their current level...	Aug 10, 2010	-0.07
	maintain its existing policy of reinvesting principal payments...prepared to provide additional accommodation...	Sept 21, 2010	-0.13
	purchase a further $600B of longer-term Treasuries at a pace of about $75B per month	Nov 3, 2010	-0.02
OT	announce operation twist (OT), a maturity extension program	Sept 21, 2011	-0.08
QE3	purchase additional agency MBS at a pace of $40B per month	Sept 13, 2012	-0.03
	purchase longer-term Treasuries at $45B per month, in addition to the existing monthly $40B agency MBS purchase	Dec 12, 2012	0.04
	maintain purchasing additional $40B agency MBS and $45B longer-term Treasuries per month	Jan 30, 2013	-0.01
	same as 30-Jan-13 announcement	Mar 20, 2013	0.06
	same as 30-Jan-13 announcement	May 1, 2013	-0.04
QE4	buy at least $500B Treasuries, at least $200B agency MBS	Mar 15, 2020	-0.24
	potentially unlimited MBS and Treasury purchases	Mar 23, 2020	-0.06
Mean			-0.10
			(0.04)
ESA	Economic Stimulus Act of 2008	Feb 7, 2008	0.34
ARRA	American Recovery and Reinvestment Act of 2009	Jan 28, 2009	1.43
FFCRA	Families First Coronavirus Response Act	Mar 13, 2020	3.86
CARES	Coronavirus Aid, Relief, and Economic Security Act	Mar 25, 2020	0.50
PPPHCEA	Paycheck Protection Program and Health Care Enhancement Act	Apr 17, 2020	1.15
CAA	Consolidated Appropriations Act	Dec 17, 2020	0.25
ARPA	American Rescue Plan Act of 2021	Mar 5, 2021	0.84
Mean			1.20
			(0.47)

Notes: QE event dates are FOMC announcements, except for December 1, 2008, which is dated by the Chair's speech (marked with an asterisk). Fiscal stimulus events are dated as the nearest preceding trading day to the date when the bill is first passed by either the Senate or the House, on which the S&P 500 Index posted a positive return. The last column reports the one-day change in the 10-year Treasury yield (for QE events) or the percentage change in the S&P 500 Index (for fiscal events). The event window is [-1, 0], where day 0 is the event date. The last two rows in each panel show the means with their standard errors.

rity extension program in which it sold short-term Treasuries and purchased longer-term Treasuries to lower long-term yields without increasing the size of the balance sheet. QE3 was initiated in September 2012 as an open-ended asset purchase program, with five major policy announcements through May 2013, ultimately totaling about $1.6 trillion in MBS and Treasury securities. QE4 was introduced during the global pandemic, with two announcements in March 2020 of potentially unlimited asset purchases. These purchases eventually amounted to over $3.3 trillion in Treasuries and agency MBS.

We assign QE event dates based on FOMC announcements, except for the December 1, 2008 event, which is dated by the Chair's speech. Our event list is comprehensive, encompassing all events included in Gagnon et al. (2011), Krishnamurthy and Vissing-Jorgensen (2011), Wright (2012), Greenlaw et al. (2018), and Rebucci, Hartley, and Jiménez (2022). Most of these papers cover a subset of events between QE1 and QE3, with the exception of the last, which focuses exclusively on the COVID-era QE4.

For the QE block, the last column of Table 1 reports the one-day change in the 10-year Treasury yield over the window [–1, 0], where day 0 corresponds to the event date shown in the table. On average, QE announcements lead to a statistically significant decline of 10 basis points in the 10-year Treasury yield, consistent with findings in the literature. Of the sixteen announcements, three are associated with a positive yield change; two of these simply reaffirmed ongoing asset purchases without introducing new policy actions (hereafter, "maintaining announcements"). Excluding all five maintaining announcements, the average change is -11 basis points, again statistically significant. For details, see Appendix A.1.

Next, fiscal transfers comprise seven events in the bottom panel of Table 1. They include the Economic Stimulus Act of 2008 ($152 billion), the American Recovery and Reinvestment Act of 2009 ($787 billion), the Families First Coronavirus Response Act ($192 billion), the Coronavirus Aid, Relief, and Economic Security (CARES) Act ($2.2 trillion), the Paycheck Protection Program and Health Care Enhancement Act ($483 billion), the

Consolidated Appropriations Act (CAA, \$900 billion), and the American Rescue Plan Act of 2021 (ARPA, \$1.9 trillion).[2]

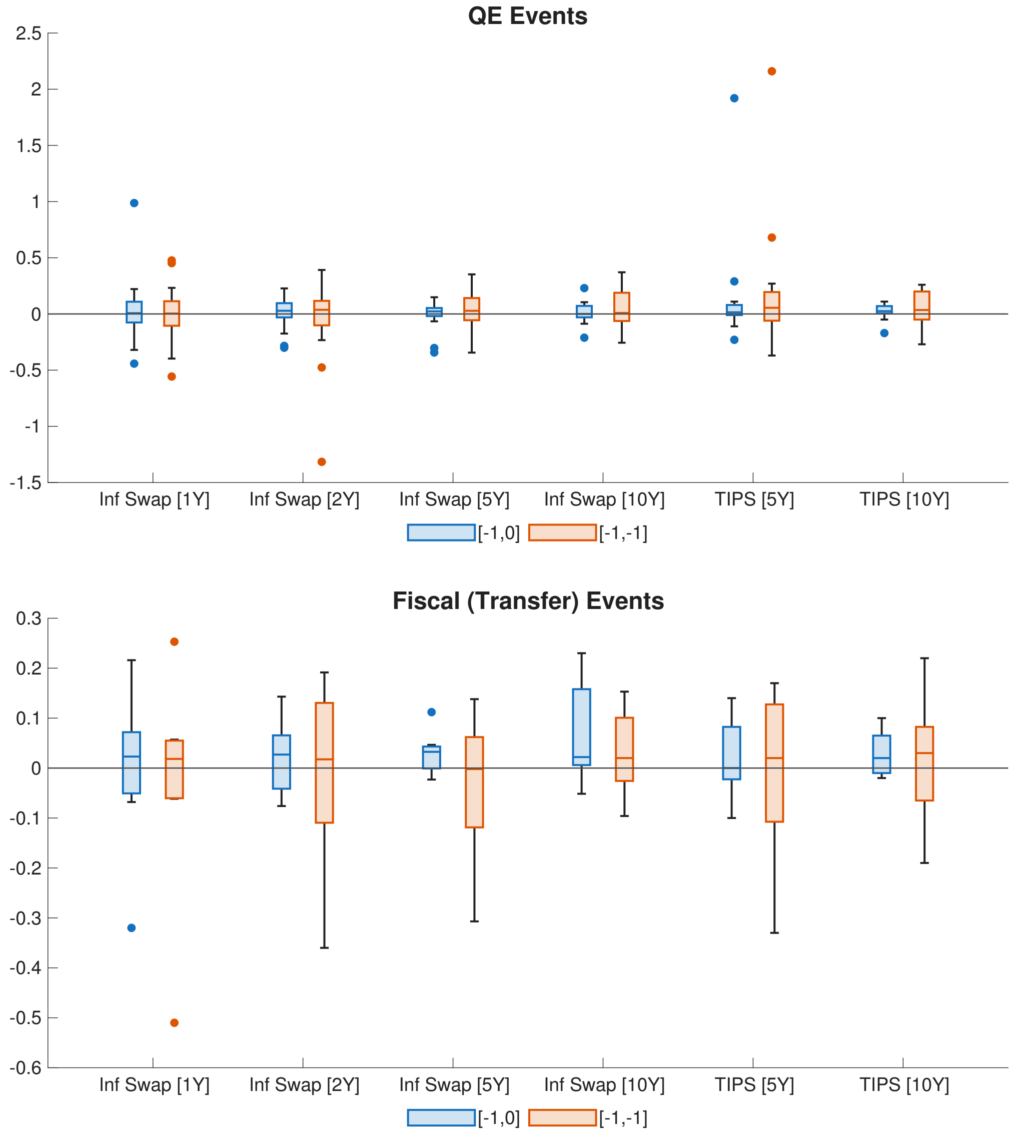
For each fiscal bill, we take the event date as the nearest preceding trading day with a positive stock market return relative to the first day the bill is passed by either the Senate or the House. This dating approach accounts for the possibility that markets partially anticipate fiscal measures during the legislative process, incorporating their effects prior to formal passage. In practice, these event dates typically coincide with or fall one to two trading days before the first passing date. This approach assumes that fiscal stimulus is viewed as positive news by market participants and that a positive return signals the incorporation of this information. The last column reports the one-day percentage change in the S&P 500 Index over the [-1,0] event window, which averages 1.2%. By construction, the stock market responds positively to fiscal aid bills around these event dates.

Having established that both QE announcements and fiscal stimulus events function as positive shocks—with QE announcements lead to declines in Treasury yields, and fiscal events lead to increases in the stock market—we now turn to the central question: do these events move inflation expectations? 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 $M = 1$, 2, 5, and 10 years. Additionally, 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 top panel plots QE events, and the bottom plots fiscal (transfer) events. The x-axis corresponds to different financial instruments: inflation

[2]We exclude the Coronavirus Preparedness and Response Supplemental Appropriations Act, which provided \$8.3 billion primarily for public health initiatives, vaccine development, and international aid. This amount is significantly smaller than the other programs and was not intended as a direct fiscal transfer to households or businesses.

Figure 1: **Change in Inflation Expectations Around QE and Fiscal Transfer Events**



Notes: Top: QE events; bottom: fiscal (transfer) events. Blue: $[-1, 0]$ window (event day $= 0$); red: $[-1, 1]$ window. x-axis: financial instruments; "Inf Swap": inflation swap. y-axis: percentage points. Box: 1st and 3rd quartiles and median; whiskers: range within 1.5 IQR; dots: outliers.

swaps at 1, 2, 5, and 10 years, and TIPS at 5 and 10 years. Each box plot displays the distribution of event-window changes for a given instrument, pooled across all events. We use two different window sizes: blue represents a one-day window (from the day before to the day of the event), and orange corresponds to a two-day window (from the day before to the day after).[3] All the market data are closing prices. Each box marks the 1^{st} and 3^{rd} quartiles and the median. Whiskers extend to the largest and smallest values within 1.5 times the interquartile range (IQR) from the box; values beyond this range are shown as dots and considered outliers.

For both QE and fiscal transfers, across all financial instruments, maturities, and event window sizes, we find that all box plots are statistically indistinguishable from zero. This suggests that these events do not move inflation expectations in either direction. Importantly, this null result cannot be attributed to markets fully anticipating the events, since the same announcements are evidently perceived as positive news, as reflected in the reactions of Treasury yields or the stock market index (see Table 1). As robustness checks, we (i) exclude maintaining announcements for QE, and (ii) date fiscal events by the first passing date; in both cases, the results remain unchanged. See Appendix A for further details.

2.2 Vector Autoregressions

This section applies a vector autoregression (VAR) model to compare the effects of conventional and unconventional monetary policy on inflation. For unconventional monetary policy, we introduce a new proxy motivated by recent theoretical work, and use the shadow federal funds rate of Wu and Xia (2016) as an alternative.

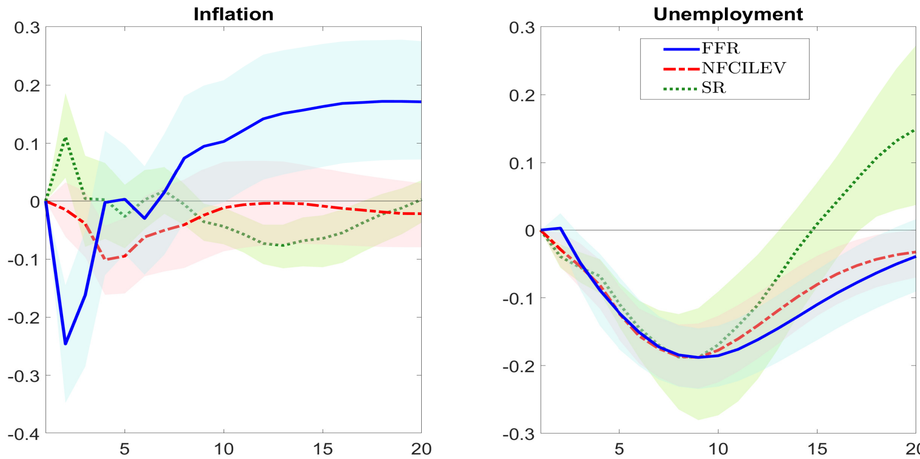
Specifically, we employ a workhorse three-variable VAR(4) of Stock and Watson (2001):

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

where Y_t is a 3×1 vector, which contains inflation (measured by the GDP deflator), the unemployment rate, and a monetary policy measure. Variables are from the FRED or

[3] 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.

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



Notes: Blue solid lines: 1% expansionary shock to the federal funds rate (FFR), identified by Cholesky decomposition, sample: 1960Q1 to 2007Q3. Red dashed dotted lines: an expansionary leverage shock (NFCILEV), identified by Cholesky decomposition, sample: 1971Q1 to 2023Q4. Green dotted lines: an expansionary shadow FFR rate shock, sample: 2008Q1 to 2015Q4. The shocks are normalized such that the maximum responses in the unemployment rate are the same. The lines are medians, 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); Wu-Xia shadow rate: https://sites.google.com/view/jingcynthiawu/shadow-rates.

otherwise specified and are demeaned. Φ_j is an autoregressive matrix. Following Stock and Watson (2001), we identify structural shocks ε_t though a Cholesky decomposition of the variance-covariance matrix, yielding a lower triangular Σ. Given the ordering of the variables, the last identified shock can be interpreted as the monetary policy shock.

To establish a baseline, we estimate the VAR with the effective federal funds rate to capture conventional monetary policy. The sample ranges from 1960Q1 to 2007Q3. We stopped the sample before the Great Recession and the subsequent period of a binding zero lower bound (ZLB). Figure 2 plots the impulse responses of inflation (left panel) and the unemployment rate (right panel), with the blue lines corresponding 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 in 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 a measure for unconventional monetary policy. Guided by theory, we propose a measure that fully utilizes the longer historical sample. In the line of research on modeling QE (e.g., Gertler and Karadi, 2011; Sims and Wu, 2021), QE stimulates aggregate demand by relaxing the leverage constraint of the financial intermediary. Furthermore, linear models in Sims, Wu, and Zhang (2023) and Wu and Xie (2025) 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 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 unconventional policy shock is normalized to produce the same maximum response in the unemployment rate as the conventional policy shock, which allows for direct comparison of the inflationary effects across different policy shocks. The impulse responses are in the red dash-dotted lines, and the corresponding shaded areas capture the confidence intervals.

We highlight three main findings. First, the inflation response to an unconventional monetary policy shock is smaller than to a conventional monetary policy shock. Second, the overall general-equilibrium effect of unconventional policy shocks on inflation is close to zero; if anything, it is slightly negative. Third, we observe a price puzzle following conventional policy shocks—a common result in the literature, which is no longer present under unconventional monetary policy using NFCILEV as the proxy.

As a robustness check, we also use the natural counterpart of the federal funds rate to measure unconventional policy: the shadow federal funds rate of Wu and Xia (2016), which is extracted from the term structure of the yield curve while respecting the ZLB. To isolate the effects of unconventional policy, we focus on the ZLB period from 2009Q1 to 2015Q4.[4] The green dotted lines and corresponding shaded areas in Figure 2 depict the

[4] Lagged variables begin in 2008Q1 in this exercise.

Table 2: Summary of Economic Impact Payments

Act	Total [$B]	Adult [$]	Dep. [$]	Phaseout	End	Dist.
CARES	300	1,200	500 (<17)	75k/112.5k/150k	99k/198k	Apr–May 2020
CAA/CRRSA	164	600	600 (<17)	75k/112.5k/150k	87k/174k	Jan–Feb 2021
ARPA	410	1,400	1,400 (all)	75k/112.5k/150k	80k/160k	Mar–Apr 2021

Notes: Dep. = payment per qualifying dependent (CARES/CAA: child <17; ARPA: all dependents). Phaseout (start) shown as single/head/joint. End = full phaseout (no dependents). The phaseout thresholds are based on the Adjusted Gross Income.

impulse responses. Our main results remain: unconventional policy is less inflationary than conventional policy, and its overall effect on inflation is essentially zero.

2.3 Regional Panel Data

This section analyzes granular data to investigate the question of interest. Whereas Section 2.2 focuses on QE, this section focuses on fiscal transfers, whose substantial cross-state variation allows us to exploit regional heterogeneity.

As summarized in Table 1, the U.S. government enacted five emergency relief bills during the COVID-19 pandemic that provided various forms of social benefits and support to individuals and households. Among these, three acts included direct stimulus payments to taxpayers, officially known as Economic Impact Payments: the CARES Act, the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSA, which is part of the CAA), and the ARPA.

This section examines transfers from these three acts, with their key features summarized in Table 2. Specifically, the CARES Act allocated approximately $300 billion in Economic Impact Payments to individuals and households. It provided a refundable tax credit of $1,200 to each eligible individual and $500 for each qualifying child under the age of 17. The payment amounts were based on income reported in 2019 or 2018 tax filings and phased out beginning at an income threshold of $75,000 for individuals, $112,500 for heads of household, and $150,000 for joint filers, at a rate of 5 percent per dollar of income above the threshold.[5] Most payments were distributed in April and May 2020.

The CAA, through its CRRSA provision, provided a second round of refundable tax credits, with direct payments of $600 per eligible individual and qualifying child, totaling approximately $164 billion. Most payments were distributed in January and February 2021. The same phaseout thresholds as in the CARES Act applied.[6]

The ARPA introduced a third round of Economic Impact Payments, allocating approximately $410 billion in total, with payments of $1,400 per eligible individual and dependent, including adult dependents. The phaseout thresholds were $\$75,000$ for individuals and $\$150,000$ for joint filers.[7] Most payments were distributed in March and April 2021.[8]

The regional variation in transfers arises from two primary sources. First, differences in state-level income distributions mean that in lower-income states, a larger share of residents qualify for the full payment, while in higher-income states, more individuals receive only partial payments or are phased out entirely. As a result, per capita transfers vary systematically across states. Second, to capture the relative economic significance of these payments, we normalize the transfers by state per capita GDP, following the literature. This adjustment accounts for the fact that a fixed dollar amount represents a larger boost to individual income in poorer states than in richer states. This variation enables us to identify the impact of transfers on inflation across states.

We begin our analysis by visualizing the relationship between inflation and fiscal transfers in scatter plots, as shown in Figure 3. The vertical axis shows state-level inflation, constructed by aggregating metropolitan-level cost of living indices (COLI) from the Council for Community and Economic Research (C2ER), weighted by Census population data (see Appendix B for details). The horizontal axis shows the change in state-level

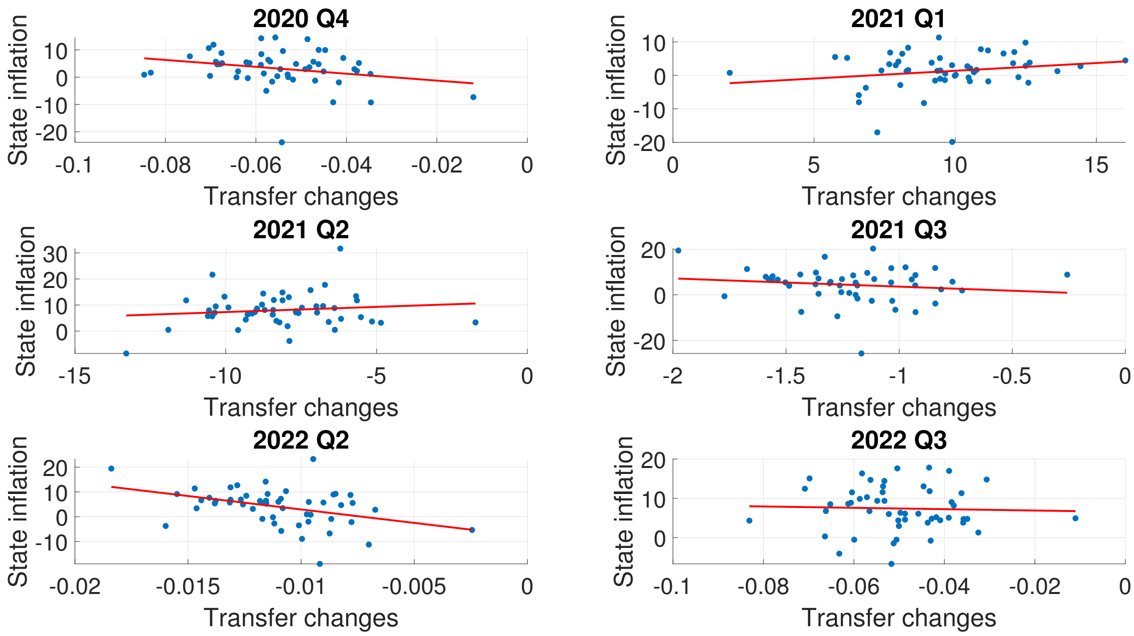
[5] The rebate phased out entirely for individuals earning more than $\$99,000$ and joint filers earning more than $\$198,000$, conditional on no qualifying dependents.

[6] The rebate phased out entirely at incomes exceeding $\$87,000$ for individuals and $\$174,000$ for joint filers with no qualifying dependents.

[7] Under ARPA, the payment phased out entirely at $80,000 for individuals and $160,000 for joint filers, with no payment above these amounts.

[8] A more detailed description of Economic Impact Payments for these three acts can be found at https://www.bea.gov/help/faq/1409.

Figure 3: **State Inflation and Fiscal Transfer: Cross Section**



Notes: x-axis: percentage change of the state-level lump-sum transfer normalized by lagged output; *y*-axis: annualized state inflation constructed from the cost of living index. Each panel represents a quarter.

lump-sum transfers, normalized by lagged state-level output. Transfers represent the total amount received by households in each state from federal emergency stimulus packages during the COVID-19 pandemic, as reported by the U.S. Bureau of Economic Analysis (BEA).[9] State-level output is measured by GDP, also from BEA. Each panel represents a single quarter in our sample from 2020Q1 to 2022Q4, subject to data availability.[10]

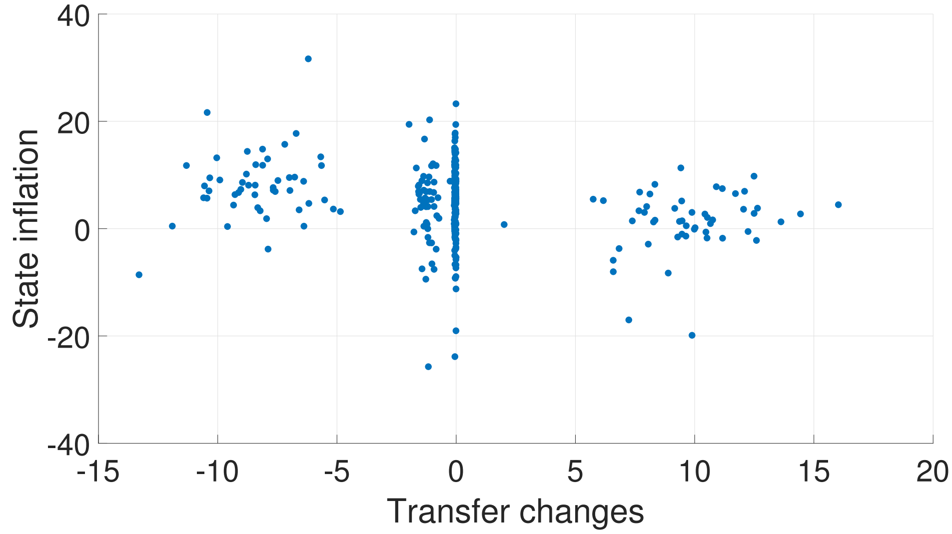
Figure 3 shows that the relationship between inflation and transfers fluctuates over time, shifting from positive to negative, indicating no stable or statistically robust association between the two variables. Figure 4 pools all data points from the six panels of Figure 3 into a single scatter plot, providing further evidence against the existence of a positive correlation between state inflation and fiscal transfers.

To formalize the analysis, we follow the empirical literature on estimating state-level

[9]The data are available from the BEA in the "COVID-19 and Recovery Archive" at `www.bea.gov/federal-recovery-programs-and-bea-statistics/covid-19-recovery`. See the quarterly "State Personal Income" spreadsheet for details.

[10]Inflation data for 2020Q2–Q3, 2021Q4, 2022Q1, and 2022Q4 are unavailable due to missing cost of living data for 2020Q2, 2021Q4, and 2022Q4; for details, see Appendix B.

Figure 4: **State Inflation and Fiscal Transfer Changes: Overall**



Notes: x-axis: percentage change of the state-level lump-sum transfer normalized by lagged output; *y*-axis: annualized state inflation constructed from the cost of living index.

fiscal multipliers (e.g., Nakamura and Steinsson, 2014; Pennings, 2021) and adopt the following regression specification to estimate the effect of fiscal transfers on inflation:

$$\pi_{i,t} = \alpha_i + \mu_t + \phi\pi_{i,t-1} + \beta_1 \frac{T_{i,t} - T_{i,t-1}}{Y_{i,t-1}} + \beta_2 \frac{T_{i,t-1} - T_{i,t-2}}{Y_{i,t-1}} + \epsilon_{i,t}, \tag{2.2}$$

where $\pi_{i,t}$ is annualized inflation in state i at time t. The variable $T_{i,t}$ measures the state-level transfer in real terms, where the nominal state-level transfer is normalized by the GDP deflator. We normalize the change in each state's transfers by its corresponding real output $Y_{i,t-1}$. α_i and μ_t represent state and time fixed effects, respectively.

Table 3 presents the estimation results with clustered standard errors. The top row with specifications (1)–(6) does not include the lagged transfer term; to allow for a lagged response of inflation, specifications (7)–(12) include lagged transfers. Specifications (1)–(3) and (7)–(9) do not include lagged inflation, while specifications (4)–(6) and (10)–(12) include it.

Specifications (1), (4), (7), and (10) do not include any fixed effects; notably, specifica-

Table 3: Regional Panel Regressions during COVID Episode

	(1)	(2)	(3)	(4)	(5)	(6)
Transfer	-0.329***	0.397	0.379	-0.318***	0.440	0.461
	(0.068)	(0.314)	(0.344)	(0.062)	(0.293)	(0.307)
Lag inflation				-0.191*	-0.201*	-0.376***
				(0.105)	(0.107)	(0.125)
Constant	4.719***	3.152***	3.206***	6.062***	-2.395	-2.589
	(0.392)	(0.932)	(0.814)	(0.646)	(3.004)	(3.166)
	(7)	(8)	(9)	(10)	(11)	(12)
Transfer	-0.295***	0.186	0.204	-0.331***	0.348	0.399
	(0.074)	(0.266)	(0.286)	(0.068)	(0.248)	(0.284)
Lag transfer	0.079	-0.499*	-0.414	-0.033	-0.211	-0.142
	(0.090)	(0.296)	(0.334)	(0.092)	(0.374)	(0.402)
Lag inflation				-0.200*	-0.195*	-0.371***
				(0.109)	(0.104)	(0.123)
Constant	4.777***	0.140	0.627	6.111***	-1.543	-1.992
	(0.376)	(2.006)	(2.230)	(0.684)	(2.628)	(2.981)
N	303	303	303	201	201	201
Time FE	No	Yes	Yes	No	Yes	Yes
State FE	No	No	Yes	No	No	Yes

Notes: The dependent variable is the state inflation constructed from the granular cost of living index; for details, see Appendix B. The regression specification follows (2.2). Columns (1), (4), (7), and (10) include no fixed effects; columns (2), (5), (8), and (11) include time fixed effects; and columns (3), (6), (9), and (12) include both time and state fixed effects. Transfer represents the change of state-level lump-sum transfer, normalized by lagged output. The sample period spans from 2019Q4 to 2022Q4. Robust standard errors are in parentheses (clustered at the state level). $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

tion (1) corresponds to the relationship depicted in Figure 4. We find a negative coefficient on transfers when we do not control for any fixed effects. Specifications (2), (5), (8), and (11) control for time fixed effects, while specifications (3), (6), (9), and (12) control for both time and state fixed effects. Once fixed effects are included, either time fixed effects alone or both time and state fixed effects, the relationship changes sign and becomes statistically insignificant.

When lagged transfers are included in the bottom panel, the contemporaneous transfer coefficients become smaller compared to the top row. Moreover, coefficients on the lagged terms mostly have the opposite sign and are insignificant. Summing the contemporaneous and lagged coefficients thus brings the combined effect even closer to zero.

Overall, using three empirical approaches consisting of event studies, vector autoregressions and regional panel regressions, and drawing on multiple specifications and robustness checks within each approach, we find no statistically or economically meaningful evidence that unconventional monetary or fiscal policies contributed to inflation.

3 Theory

Section 2 has established empirically that unconventional monetary and fiscal policies did not contribute to inflation dynamics, which begs the question why. This section illustrates a plausible economic mechanism for this result using a small-scale microfounded New Keynesian model that consists of an IS curve and a Phillips curve and features both unconventional monetary and fiscal policies. For microfoundation, see Appendix C. Note, the broader mechanism is consistent with a substantial line of research—for example, see Gertler and Karadi (2011), Sims and Wu (2021), Sims, Wu, and Zhang (2023), and Wu and Xie (2025). The majority of this literature, however, 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. As a result, the constrained household can borrow more and hence increase its consumption, which in turn stimulates the aggregate demand. This mechanism explains our choice to use the leverage condition index (i.e., NFCILEV) as a summary measure 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, however, they work differently. Whereas QE works through the financial sector, fiscal transfers do not. For model details and derivations, see Appendix C.

3.2 Linear Model

The tractable model consists of the following two main equations:

$$\text{IS curve:}\quad \hat{x}_t = \mathbb{E}_t\hat{x}_{t+1} - \frac{\vartheta}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1} - \hat{r}_t^*) + (1-\rho)(\widehat{qe}_t + \hat{\tau}_t), \tag{3.1}$$

$$\text{Phillips curve:}\quad \hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \gamma\zeta\hat{x}_t - \frac{\gamma\sigma}{\vartheta}(\widehat{qe}_t + \hat{\tau}_t), \tag{3.2}$$

where $\hat{x}_t$ is the output gap that measures economic slack, defined as the log deviation of output from its potential. $\hat{\pi}_t$ is inflation and $\hat{r}_t^*$ is the natural rate of interest. There are three policy instruments: $\hat{i}_t$ corresponds to the conventional interest rate policy, $\widehat{qe}_t$ is the central bank's holdings of long-term bonds (QE), and $\hat{\tau}_t$ is the 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 deviations from the non-stochastic steady state. For the micro-foundation and derivations, see Appendix C.

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, ρ is the persistence of QE and transfer shocks, 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, describing how the current output gap depends on expectations of future output gap and inflation, and policy interventions. It states that conventional monetary policy ($\hat{i}_t$), QE ($\hat{qe}_t$), and fiscal transfers ($\hat{\tau}_t$) can all be used to stimulate the aggregate output. Specifically, a lower interest rate or a larger $\hat{qe}_t$ or $\hat{\tau}_t$ corresponds to an expansionary policy. Equation (3.2) is the Phillips curve, which captures the supply side of the economy, relating inflation to expected future inflation, economic slack, and monetary and fiscal policies.

3.3 Inflation Implications

A key implication of the model in Section 3.2 is that only QE and transfers, and not conventional monetary policy, enter the Phillips curve, and they do so with a negative sign (see equation (3.2)). An immediate result follows:

Proposition 1 *Unconventional monetary and fiscal policies put downward pressure on inflation through the* ***Phillips curve****.*

This result provides an economic explanation for the null result we find empirically in Section 2.

The reason QE and transfers enter the Phillips curve with a negative sign stems from the wealth effect on labor supply of the unconstrained household. While QE and transfers effectively hand more resources to the constrained household who does not bear the associated tax burden, the unconstrained household faces or expects higher taxes to finance these policies. As a result, the wealth effect induces it to supply more labor, putting downward pressure on real wages and, consequently, the real marginal cost of production. This mechanism is consistent with recent empirical micro and macro evidence suggesting a sizable wealth effect on labor supply (e.g., Cesarini et al., 2017; Kindermann, Mayr, and Sachs, 2020; Faria-e-Castro and Jordan-Wood, 2023).

Proposition 1 does not necessarily mean QE and fiscal transfers are disinflationary. This is because these policies operate through both the highlighted disinflationary supply-side channel and the usual inflationary demand-side channel. The latter is captured by the IS curve: an expansionary policy intervention stimulates the economy through the demand channel, putting 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. Our empirical investigations in Section 2 find this effect to be nearly zero. However, a direct implication of Proposition 1 suggests that unconventional policy is less inflationary than conventional monetary policy, which we also confirm empirically in Figure 2.

4 Phillips Curve

Proposition 1 establishes the main economic mechanism underlying our result in Section 2: unconventional monetary and fiscal policies exert downward pressure on inflation through the Phillips curve. In this section, we put this mechanism to the test by analyzing both aggregate and regional Phillips curve evidence. Section 4.1 utilizes aggregate data to examine the effects of QE on inflation, whereas Section 4.2 exploits granular regional data to study fiscal transfers.

4.1 Aggregate

We begin by testing the sign of the policy instruments in equation (3.2) using aggregate time-series data. Our choice of variables generally follows the literature (e.g., McLeay and Tenreyro, 2020), but extends it by incorporating unconventional monetary policy, which is proxied by the NFCILEV index as discussed in Section 2.2.

The dependent variable is the year-over-year inflation rate, measured by the research series of the Core Consumer Price Index, which excludes food and energy for all urban consumers (R-CPI-U-RS), as reported by the U.S. Bureau of Labor Statistics (BLS). The advantage of the research series is that historical inflation is calculated using current methods, yielding a more time-consistent measure.

In Table 4, we use 10-year-ahead and 1-year-ahead inflation expectations from the Survey of Professional Forecasters (SPF), conducted by the Federal Reserve Bank of Philadelphia, as proxies for inflation expectations. We also include the 1-year-ahead inflation expectation from the Michigan Consumer Survey. Some previous studies use the inflation gap, the difference between actual inflation and expected inflation, as the dependent variable, assuming $\beta \approx 1$ in the model. This approach is applied in columns (1)-(3), (5), and (7) of Table 4. The remaining columns estimate β freely.

Consistent with prior work, we use both the output gap (top panel) and the unemployment gap (bottom panel) to measure economic slack. The output gap is defined as the difference between real GDP and potential GDP, both published by the U.S. Congressional Budget Office (CBO). The unemployment gap is calculated as the difference between the unemployment rate (BLS series "UNRATE") and the natural rate of unemployment estimated by the CBO (FRED series "NROU").

We estimate the Phillips curve using both ordinary least squares (OLS) and generalized method of moments (GMM), following Beaudry, Hou, and Portier (2024). Columns (1) and (2) report the OLS estimates. The reduced-form Phillips curve in equation (3.2) is subject to endogeneity concerns, as aggregate supply shocks may be correlated with economic slack and/or unconventional monetary policy, which itself serves as a stabilization tool. To address these issues, we employ GMM using exogenously identified high-frequency monetary policy shocks, specifically the QE shocks from Swanson (2021), as instruments in columns (3)–(8), following recent developments in the literature (e.g., Barnichon and Mesters, 2020). The sample period spans from 1990Q1 to 2023Q4.[11] It is

[11] We thank Eric Swanson for kindly sharing the updated shocks with us.

Table 4: Aggregate Phillips Curve Estimation

Panel A: Output Gap

	OLS		GMM					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output gap	0.162*	0.163*	0.443***	0.485***	0.232***	0.084**	0.200***	0.088***
	(0.083)	(0.085)	(0.078)	(0.015)	(0.072)	(0.037)	(0.040)	(0.028)
NFCILEV		-0.035	-0.744***	-0.890***	-0.539***	-0.332***	-0.494***	-0.337***
		(0.082)	(0.069)	(0.016)	(0.092)	(0.057)	(0.086)	(0.050)
SPF 10y	1	1	1	3.817***				
				(0.148)				
SPF 1y					1	1.979***		
						(0.123)		
Mich 1y							1	1.423***
								(0.083)
N	137	137	132	132	132	132	132	132

Panel B: Unemployment Gap

	OLS		GMM					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Unemp gap	-0.237**	-0.243**	-0.700***	-0.546***	-0.413**	-0.024	-0.464***	-0.377***
	(0.097)	(0.101)	(0.204)	(0.094)	(0.205)	(0.071)	(0.045)	(0.089)
NFCILEV		-0.077	-0.735***	-0.823***	-0.505	-0.348***	-0.474***	-0.411***
		(0.081)	(0.204)	(0.066)	(0.328)	(0.122)	(0.063)	(0.073)
SPF 10y	1	1	1	2.441***				
				(0.140)				
SPF 1y					1	2.011***		
						(0.201)		
Mich 1y							1	1.183***
								(0.177)
N	137	137	132	132	132	132	132	132

Notes: This table reports the parameter estimates and their standard errors (in parentheses) in the Phillips curve. The dependent variable is core CPI inflation. NFCILEV represents the financial conditions measured by the negative of Chicago Fed National Financial Condition Leverage Subindex. For the IV estimations, we use the large asset purchase shock constructed by Swanson (2021) as IV. Panels A and B use output gap and unemployment gap to proxy economic slack, respectively. The sample spans from 1990Q1 to 2023Q4. 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 $H = 12$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

important to note that our focus on unconventional monetary policy excludes many commonly used shocks in the literature, most of which are derived from the short end of the yield curve.

These shocks serve as valid instruments because they are, by construction, orthogonal to aggregate supply shocks, thereby satisfying the exogeneity condition. Moreover, they influence inflation, economic slack, and unconventional monetary policy, meeting the relevance condition. Together, these conditions form the basis of the moment conditions used in our GMM estimation.

Table 4 presents the estimation results. Panels A and B report results using the output gap and unemployment gap, respectively, as proxies for economic slack. The first two columns show OLS estimates, while columns (3) through (8) present the GMM estimates. When the inflation gap is used as the dependent variable, the coefficient for the corresponding inflation expectation measure is set to 1 without a reported standard error. Standard errors are shown in parentheses. For OLS estimates, we use Newey-West standard errors with a maximum lag of 12 quarters. For GMM estimates, standard errors are calculated using a HAC weighting matrix with the quadratic spectral kernel, where the lag order is selected according to the optimal lag-selection algorithm of Newey and West (1994).

The estimated coefficient on NFCILEV is consistently negative, and statistically significant at the 1% level in all GMM specifications but one. This result provides direct evidence for the disinflationary effect of unconventional monetary policy predicted by our theory (see Proposition 1) and reinforces the key supply-side mechanism underlying our main results in Section 2.

As a robustness check, we use an alternative instrument for unconventional monetary policy shocks, namely the large-scale asset purchases (LSAP) shock from Jarociński (2024). The results remain similar and robust; for details, see Appendix D.

4.2 Regional

This section explores the regional Phillips curve by exploiting cross-state differences in fiscal transfers during the COVID period. This variation provides a natural experiment to assess the disinflationary effects of fiscal transfer.

We use a specification similar to McLeay and Tenreyro (2020) and Hazell et al. (2022), which modifies (3.2) as follows:

$$\pi_{i,t} = \alpha_i + \mu_t + \beta \mathbb{E}_t \pi_{i,t+1} + \kappa x_{i,t} + \zeta \frac{T_{i,t-1}}{\bar{Y}_i} + \epsilon_{i,t}. \tag{4.1}$$

Similar to before, α_i and μ_t are state and time fixed effects. $\pi_{i,t}$, and $T_{i,t}$ are state-level (annualized) inflation and real transfers, respectively. These variables are constructed the same as in Section 2.3; for details on the state-level inflation, see Appendix B. 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. We use both the state-level unemployment rate and output growth as proxies for economic slack in $x_{i,t}$, and normalize the state-level transfer by each state's 2019 output, prior to COVID-19, to proxy for the steady-state output as prescribed by theory.

Table 5 summarizes the regression results. Panels A and B report results using the state-level unemployment rate and output growth as proxies for economic slack, respectively. Specifications (1) and (2) impose the coefficient in front of the inflation expectation to be $\beta = 1$, 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. Table 5 reports point estimates together with cluster-robust standard errors in parentheses.

Across different measures of economic slack, treatments of inflation expectations, and

Table 5: Regional Phillips Curve Estimation during COVID

Panel A: Unemployment

	(1)	(2)	(3)	(4)
Unemployment	-0.767**	-0.811	-0.779**	-0.821
	(0.278)	(0.436)	(0.300)	(0.455)
Transfer	-0.443**	-1.060**	-0.528***	-1.094**
	(0.116)	(0.360)	(0.109)	(0.354)
Inflation expectation	1	1	3.469**	2.776
			(1.001)	(1.450)
Constant	5.280**	5.144	-1.143	0.391
	(1.731)	(2.801)	(4.302)	(5.493)
N	303	303	303	303
Time FE	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes

Panel B: Output Growth

	(1)	(2)	(3)	(4)
Output growth	0.256	0.253	0.200	0.253
	(0.265)	(0.511)	(0.271)	(0.524)
Transfer	-0.283**	-1.007**	-0.360**	-1.039**
	(0.077)	(0.351)	(0.108)	(0.342)
Inflation expectation	1	1	3.271**	2.739*
			(1.018)	(1.292)
Constant	0.253	0.930	-5.664*	-3.772
	(0.493)	(1.138)	(2.746)	(4.015)
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). Panels A and B use the unemployment rate and output growth as the measure of economic slack, respectively. Inflation expectations are proxied by the one-year-ahead regional inflation expectation from the Michigan Consumer Survey. The transfer is the 1-quarter lagged lump-sum transfer per capita in each state normalized by its output per capita in 2019. 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 by state and time). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

mixes of time and state fixed effects, the estimated coefficients on transfers are negative and statistically significant (at least at the 5% level). These results for the state-level Phillips curve, together with findings from Section 4.1 using aggregate data, provides strong and robust evidence for the disinflationary effect of fiscal transfers, offering empirical support for the supply-side channel predicted by our theory in Section 3.

5 Conclusion

We assess the extent to which monetary and fiscal stimulus measures have shaped inflation dynamics in recent decades. Specifically, we employ three complementary empirical strategies: event studies that examine market price changes around policy announcements, a time-series VAR to analyze impulse responses, and a regional panel regression using granular data to exploit cross-state variation. All three methodologies, with various specifications explored within each, consistently indicate that these government policies did not play a meaningful role in driving inflation dynamics.

To account for our empirical findings, we present a microfounded, small-scale New Keynesian model featuring an IS curve and a Phillips curve, which incorporates both unconventional monetary and fiscal policies. This framework illustrates the underlying economic mechanism: in particular, the policies exert downward pressure on inflation through the supply side. Empirical examination of this disinflationary channel, using both aggregate and disaggregate data, and exploring various specifications within each, further confirms that this mechanism is evident in the data and plays a central role in our general-equilibrium results.

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Appendices

A Event Studies: Robustness

A.1 QE: Excluding Maintaining Announcements

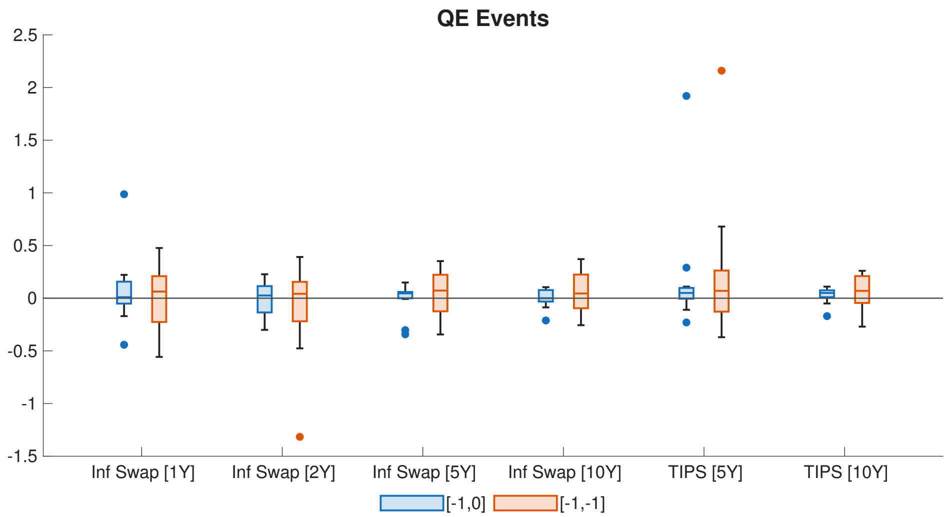
Table A.1 lists QE events with maintaining announcements excluded, reducing the number of QE events to eleven. Figure A.1 shows the changes in inflation expectation measures around the QE events using this set of dates.

Table A.1: QE Events: Excluding Maintaining Announcements

Type	Description	Date	ΔYld/S&P
QE1	buy up to \$100B agency debt and up to \$500B agency MBS	Nov 25, 2008	-0.22
	*could purchase longer-term Treasury securities...in substantial quantities	Dec 1, 2008	-0.19
	consider expanding agency security purchases and initiating long-term Treasury purchases	Dec 16, 2008	-0.26
	buy up to \$300B of longer term Treasuries, up to \$200B agency debt, and up to \$1.25T agency MBS	Mar 18, 2009	-0.47
QE2	maintain its existing policy of reinvesting principal payments...prepared to provide additional accommodation...	Sept 21, 2010	-0.13
	purchase a further \$600B of longer-term Treasuries at a pace of about \$75B per month	Nov 3, 2010	-0.02
OT	announce operation twist (OT), a maturity extension program	Sept 21, 2011	-0.08
QE3	purchase additional agency MBS at a pace of \$40B per month	Sept 13, 2012	-0.03
	purchase longer-term Treasuries at \$45B per month, in addition to the existing monthly \$40B agency MBS purchase	Dec 12, 2012	0.04
QE4	buy at least \$500B Treasuries, at least \$200B agency MBS	Mar 15, 2020	-0.24
	potentially unlimited MBS and Treasury purchases	Mar 23, 2020	-0.06
Mean			-0.11
			(0.06)

Notes: QE event dates are FOMC announcements, except for December 1, 2008, which is dated by the Chair's speech (marked with an asterisk). The last column reports the one-day change in the 10-year Treasury yield. The event window is [-1, 0], where day 0 is the event date. The last two rows in each panel show the means with their standard errors. We exclude maintaining events (those reaffirming ongoing asset purchases without new policy actions) from Table 1.

Figure A.1: **Change in Inflation Expectations Around QE Events: Excluding Maintaining Announcements**



Notes: Blue: $[-1,0]$ window (event day $=0$); red: $[-1,1]$ window. x-axis: financial instruments; "Inf Swap": inflation swap. y-axis: percentage points. Box: 1st and 3rd quartiles and median; whiskers: range within 1.5 IQR; dots: outliers. We exclude maintaining events (those reaffirming ongoing asset purchases without new policy actions) from Table 1.

A.2 Fiscal Transfers: Passing Dates

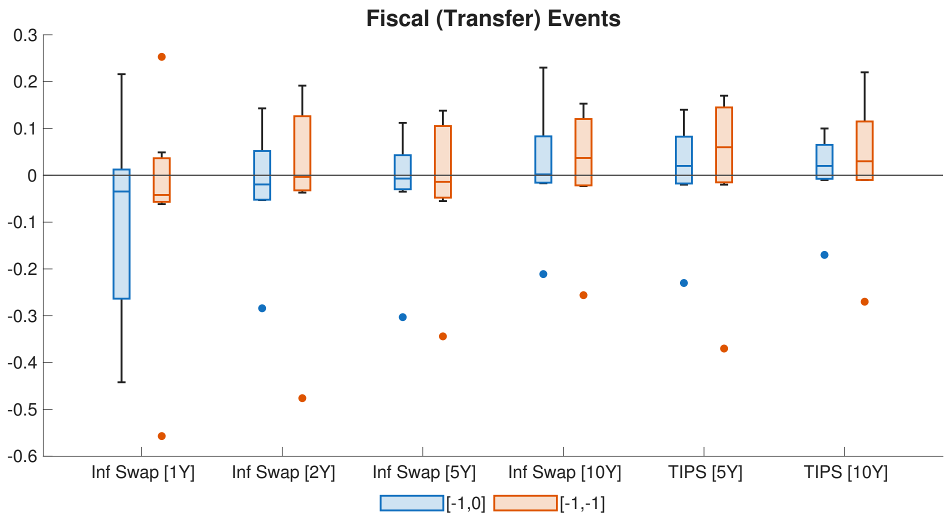
Table A.2 dates fiscal events on the first day a bill is passed by either the Senate or the House. Figure A.2 shows the changes in inflation expectation measures using this dating convention.

Table A.2: Fiscal Stimulus Events: Passing Dates

Type	Description	Date
Fiscal	Economic Stimulus Act of 2008 (ESA)	Feb 7, 2008
	American Recovery and Reinvestment Act of 2009 (ARRA)	Jan 28, 2009
	Families First Coronavirus Response Act (FFCRA)	Mar 14, 2020
	Coronavius Aid, Relief, and Economic Security Act (CARES Act)	Mar 25, 2020
	Paycheck Protection Program and Health Care Enhancement Act (PPPHCEA)	Apr 21, 2020
	Consolidated Appropriations Act (CAA)	Dec 21, 2020
	American Rescue Plan Act of 2021 (ARPA)	Mar 6, 2021

Notes: Dates for the fiscal aid bills are the first day a bill is passed by either the Senate or the House.

Figure A.2: **Change in Inflation Expectations Around Fiscal Transfer Events: Passing Dates**



Notes: Blue: $[-1, 0]$ window (event day $= 0$); red: $[-1, 1]$ window. x-axis: financial instruments; "Inf Swap": inflation swap. y-axis: percentage points. Box: 1^{st} and 3^{rd} quartiles and median; whiskers: range within 1.5 IQR; dots: outliers. Dates for the fiscal aid bills are the first day a bill is passed by either the Senate or the House.

B State-Level Inflation Construction

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. The matching is 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 B.3.

Next, we aggregate the metropolitan-level COLI data to the state level by taking a population-weighted average. 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 to obtain the state-level price index. We then calculate inflation as the percentage change in this index from the previous period.

B.2 General Matching Rules

This section starts with some general treatments we apply when matching the two datasets of COLI and population data.

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.1. 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.1: 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.2. 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.2: 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 Model Details and Derivations

In this section, we lay out the background model that gives the IS curve (3.1) and the New Keynesian Phillips curve (3.2). The setup is similar in essence to Wu and Xie (2025). The economy consists of two types of households: unconstrained and constrained. The unconstrained household consumes, works to earn income, saves with one-period riskless bonds, and pays a lump-sum tax. The constrained household borrows through long-term bonds to finance its consumption. It also receives lump-sum transfers from the government.

The financial intermediary (FI) performs maturity transformation between the two types of households while facing a leverage constraint. Firms produce consumption composites using labor input and are subject to price rigidities. The central bank sets the monetary policy on the short-term interest rate, and the fiscal authority specifies the fiscal transfer policy.

C.1 Households

C.1.1 Unconstrained Household

A representative household maximizes lifetime utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \psi \frac{L_t^{1+\chi}}{1+\chi} \right],$$

subject to the budget constraint:

$$P_t C_t + D_t = W_t L_t + I_{t-1} D_{t-1} + P_t T_t^{\mu}, \tag{C.1}$$

where $\beta \in (0, 1)$ is the subjective discount factor, $\sigma > 0$ is the inverse elasticity of intertemporal substitution, $\chi \geq 0$ is the inverse Frisch elasticity, and $\psi > 0$ is a scaling parameter. Variable C_t is consumption, L_t is labor supply, P_t is the nominal price, W_t is the nominal wage, D_{t-1} is the one-period nominal deposits from $t-1$ to t, and I_{t-1} is nominal gross interest rate on deposit D_{t-1}. T_t^{μ} represents the net transfer the unconstrained household receives, which is not choice variable for the household. It satisfies

$$P_t T_t^{\mu} \equiv \Phi_t + \Phi_t^{FI} - P_t T_t^{G} - P_t X_t^{C} - P_t X_t^{FI}, \tag{C.2}$$

where Φ_t denotes nominal dividends from firms, Φ_t^{FI} denotes nominal dividends from the financial intermediary, T_t^G is a real lump-sum tax paid to the government, X_t^C is a real transfer to the constrained household, and X_t^{FI} is a real transfer to the financial intermediary.

The first-order conditions of the household's optimality problem are

$$C_t^{-\sigma} = \beta I_t \mathbb{E}_t \left[\frac{C_{t+1}^{-\sigma}}{\Pi_{t+1}} \right], \tag{C.3}$$

$$C_t^{-\sigma} w_t = \psi L_t^{\chi}, \tag{C.4}$$

where $\Pi_t \equiv P_t / P_{t-1}$ is the gross inflation and $w_t \equiv W_t / P_t$ is the real wage.

C.1.2 Constrained Household

The constrained household does not work. It issues long-term bonds, together with its transfer income received from the government and the unconstrained household, to finance their consumption. Following Woodford (2001), we model long-term bonds as perpetuities with decaying coupon payments. One unit of perpetuity issued in period t pays one dollar in period $t+1$, k dollars in period $t+2$, k^2 dollars in period $t+3$, and so on.

Let B_{t-1} denote the total nominal liability on past issues due at date t. It can be written in terms of past new issues N_{t-j}:

$$B_{t-1} = \sum_{j=1}^{\infty} k^{j-1} N_{t-j}.$$

As a result, we have the time-t new issues given by

$$N_t = B_t - kB_{t-1}.$$

Let Q_t denote the price of a new issue, and then $k^j Q_t$ is the time-t price of the perpetuity that is issued in period $t-j$. The total value of all outstanding bonds is $Q_t B_t$. Therefore, we can use $\{Q_t, B_t, B_{t-1}\}$ to summarize the entire state related to the long-term bonds.

The constrained household maximizes

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \left(\beta^C\right)^t \frac{\left(C_t^C\right)^{1-\sigma} - 1}{1-\sigma},$$

subject to

$$P_t C_t^C + B_{t-1} = Q_t \left(B_t - kB_{t-1}\right) + P_t X_t^C + P_t T_t, \tag{C.5}$$

where β^C is the subjective discount factor of the constrained household and $\beta^C < \beta$. Variable B_{t-1} is the total coupon liability, $Q_t \left(B_t - kB_{t-1}\right)$ is value of newly issued private bonds, X_t^C is the transfer from the unconstrained household, and T_t is the transfer from the government.

The first-order condition of the constrained household's optimality problem is

$$\left(C_t^C\right)^{-\sigma} = \beta^C \mathbb{E}_t \left[\left(C_{t+1}^C\right)^{-\sigma} \frac{R_{t+1}}{\Pi_{t+1}}\right], \tag{C.6}$$

where

$$R_t = \frac{1 + kQ_t}{Q_{t-1}}. \tag{C.7}$$

C.2 Financial Intermediary

For tractability, we assume the financial intermediary (FI) only lives for one period. It receives the following transfers from the unconstrained household:

$$P_t X_t^{FI} = P_t \bar{X}^{FI} + kQ_t B_{t-1}^{FI},$$

where $P_t X_t^{FI}$ is total transfer from the unconstrained household as equity injection. It includes two components: $P_t \bar{X}^{FI}$ is a fixed amount of new equity and $kQ_t B_{t-1}^{FI}$ is the value of outstanding long-term bonds inherited from the previous intermediary.

The balance sheet condition of the FI is

$$Q_t B_t^{FI} + RE_t = D_t + P_t X_t^{FI}, \tag{C.8}$$

where $Q_t B_t^{FI}$ is the value of its long-term bond holdings, RE_t is the reserve on account with the central bank, and D_t is the deposits from the unconstrained household.

At the beginning of period $t+1$, the FI returns lump-sum dividends Φ_{t+1}^{FI} to the unconstrained household:

$$\Phi_{t+1}^{FI} = \left(R_{t+1} - I_t\right) Q_t B_t^{FI} + \left(I_t^{RE} - I_t\right) RE_t + I_t P_t X_t^{FI}, \tag{C.9}$$

where I_t^{RE} is the interest rate on reserves.

The FI faces an exogenous leverage constraint

$$Q_t B_t^{FI} \leq \Theta P_t \bar{X}^{FI}, \tag{C.10}$$

where Θ is the exogenous leverage ratio.

The FI maximizes the expected one-period ahead nominal dividends subject to the leverage constraint, discounting by the nominal stochastic discount factor of the unconstrained household:

$$\Lambda_{t-1,t} = \beta \left(\frac{C_t}{C_{t-1}}\right)^{-\sigma} \frac{1}{\Pi_t}. \tag{C.11}$$

The first-order conditions are

$$\mathbb{E}_t \left[\Lambda_{t,t+1} \left(R_{t+1} - I_t\right)\right] = \Omega_t, \tag{C.12}$$

$$\mathbb{E}_t \left[\Lambda_{t,t+1} \left(I_t^{RE} - I_t\right)\right] = 0, \tag{C.13}$$

where Ω_t is the Lagrange multiplier on the leverage constraint.

C.3 Firms

The supply side of the economy is the same as in a standard New Keynesian model, including two types of firms: intermediate goods producers and a representative final goods producer. The intermediate firms, indexed by $j \in [0,1]$, produce differentiated goods using labor as the input and sell them to the representative final good firm.

The final goods firm aggregates the differentiated intermediate goods $Y_t(j)$ into a final good composite according to the CES aggregator:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}},$$

where Y_t is the final good composite and ϵ is the elasticity of substitution across differentiated intermediate goods.

The static cost-minimization problem of the final goods firm yields the following demand function for each variety of intermediate goods:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\epsilon} Y_t,$$

where $P_t(j)$ is the price of each variety j and P_t is the aggregate price index satisfying

$$P_t = \left[\int_0^1 P_t(j)^{1-\epsilon} dj\right]^{\frac{1}{1-\epsilon}}.$$

The production function of each variety of intermediate goods is linear:

$$Y_t(j) = A_t L_t(j),$$

where A_t is the productivity and $L_t(j)$ is the labor input.

The intermediate goods firms face monopolistic competition. They are subject to price stickiness in the style of Calvo (1983). Speicifically, in any given period, each intermediate goods firm could reset its prices only with probability $1-\phi$, independently from the time since its last adjustment. Then in aggregation, a $1-\phi$ fraction of firms reset their prices in each period, while the rest have to keep their prices unchanged.

A firm that can re-optimize at time t chooses the real price p_t^* to maximize the present discounted value of expected profits, discounting using the unconstrained household's stochastic discount factor (C.11). The optimal reset price is common across all the firms due to symmetry:

$$p_t^* = \frac{\epsilon}{\epsilon-1}\frac{x_{1,t}}{x_{2,t}}, \tag{C.14}$$

where

$$x_{1,t} = \frac{w_t}{A_t}Y_t + \phi\mathbb{E}_t\left[\Lambda_{t,t+1}\Pi_{t+1}^{\epsilon+1}x_{1,t+1}\right], \tag{C.15}$$

$$x_{2,t} = Y_t + \phi\mathbb{E}_t\left[\Lambda_{t,t+1}\Pi_{t+1}^{\epsilon}x_{2,t+1}\right]. \tag{C.16}$$

The aggregate price index satisfies

$$P_t^{1-\epsilon} = \phi P_{t-1}^{1-\epsilon} + (1-\phi)\left(P_t^*\right)^{1-\epsilon},$$

which implies

$$1 = (1-\phi)\left(p_t^*\right)^{1-\epsilon} + \phi\Pi_t^{\epsilon-1}. \tag{C.17}$$

C.4 Central Bank and Fiscal Authority

The central bank sets the short-term interest rate following a standard Taylor rule:

$$\ln I_t - \ln\bar{I} = \phi_\pi\left[\ln\Pi_t - \ln\bar{\Pi}\right] + \phi_y\left[(\ln Y_t - \ln\bar{Y}) - (\ln Y_t^N - \ln\bar{Y})\right] + \hat{\delta}_{i,t}, \tag{C.18}$$

where variables with an upper bar denote the steady-state values, Y_t^N is the natural rate of output in the flexible-price equilibrium, and $\hat{\delta}_{i,t}$ is an exogenous monetary policy shock.[12]

The central bank holds a portfolio of long-term bonds by issuing reserves, and its balance sheet condition is

$$Q_t B_t^{CB} = RE_t. \tag{C.19}$$

We define QE as the real value of central bank bond holdings, that is,

$$QE_t = Q_t b_t^{CB}, \tag{C.20}$$

[12]Details of the definition of Y_t^N can be found in Appendix C.7.

where $b_t^{CB} = B_t^{CB}/P_t$.

The central bank returns its profit to the fiscal authority via a lump-sum transfer:

$$P_t T_t^{CB} = R_t Q_{t-1} B_{t-1}^{CB} - I_{t-1}^{RE} RE_{t-1}. \tag{C.21}$$

The fiscal authority's budget constraint is

$$\begin{aligned} P_t T_t &= P_t T_t^G + P_t T_t^{CB} \\ &= P_t T_t^G + R_t Q_{t-1} B_{t-1}^{CB} - I_{t-1}^{RE} RE_{t-1}, \end{aligned} \tag{C.22}$$

where T_t is the lump-sum transfer to the constrained household and T_t^G is the lump-sum tax collected from the unconstrained household. In this setup, the fiscal authority serves purely as a role of income redistribution.

C.5 Market Clearing Conditions

The market clearing condition for the long-term bonds is

$$B_t = B_t^{FI} + B_t^{CB}. \tag{C.23}$$

The market-clearing condition on final goods is

$$Y_t = C_t + C_t^C, \tag{C.24}$$

and the labor market clearing condition is

$$\int_0^1 L_t(j) = L_t.$$

The aggregate production of final goods satisfies

$$Y_t v_t = A_t L_t, \tag{C.25}$$

where $v_t \equiv \int_0^1 (P_t(j)/P_t)^{-\epsilon} dj$ is the price dispersion, satisfying

$$v_t = (1-\phi)(p_t^*)^{-\epsilon} + \phi \Pi_t^{\epsilon} v_{t-1}. \tag{C.26}$$

C.6 Simplifying Assumptions

Following Sims, Wu, and Zhang (2023) and Wu and Xie (2025), to close the model, we make the following "full bailout" assumption about the transfer between households:

$$X_t^C = (1 + kQ_t)\Pi_t^{-1} b_{t-1}.$$

That is, the direct transfer from the unconstrained household pays back the constrained household's outstanding debt from the last period.

Substituting X_t^C into the budget constraint of the constrained household (C.5), we have

$$P_t C_t^C = Q_t B_t + P_t T_t,$$

which implies

$$P_t C_t^C = Q_t B_t^{FI} + Q_t B_t^{CB} + P_t T_t. \tag{C.27}$$

Substituting the leverage constraint of the FI (C.10) and the definition of QE_t (C.20) into (C.27), we obtain

$$C_t^C = \Theta_t \bar{X}^{FI} + QE_t + T_t. \tag{C.28}$$

Equation (C.27) shows that an expansion in QE or an increase in fiscal transfer leads to a direct increase in the consumption of the constrained household. Under the "full bailout" assumption, the consumption of the constrained household can be solved statically, so that we do not need to carry around its forward-looking Euler equation, which helps reduce the equilibrium system.

C.7 The Flexible-Price Equilibrium

In the flexible-price economy, we abstract from the price stickiness and only consider the shock to productivity. Other model components remain the same as in the sticky-price case. We use superscript "N" to indicate variables in the flexible-price economy.

The first-order conditions of the unconstrained household now become:

$$(C_t^N)^{-\sigma} = \beta R_t^* \mathbb{E}_t (C_{t+1}^N)^{-\sigma}, \tag{C.29}$$

$$(C_t^N)^{-\sigma} w_t^N = \psi (L_t^N)^{\chi}, \tag{C.30}$$

where R_t^* is the real natural rate of interest.

Give the QE and fiscal transfer are fixed in the flexible-price equilibrium, the constrained household also consumes a fixed amount of final goods given by (C.28), same as its steady-state value. Thus, the resource constraint in this case is

$$Y_t^N = C_t^N + \bar{C}^C. \tag{C.31}$$

The production side of the economy is simply the production function:

$$Y_t^N = A_t L_t^N, \tag{C.32}$$

and the real wage rate equals the marginal cost of production:

$$w_t^N = A_t. \tag{C.33}$$

We define the output gap as the difference between output in the sticky-price economy and the potential output:

$$X_t = Y_t - Y_t^N. \tag{C.34}$$

C.8 Equilibrium Conditions

The equilibrium is fully characterized by the following system of equations:

1. the unconstrained household: (C.3)–(C.4);
2. the constrained household: (C.6)–(C.7) ;
3. the financial intermediary: (C.8) and (C.10)–(C.13);
4. firms: (C.14)–(C.17);
5. the central bank and fiscal authority: (C.18)–(C.20), and (C.22);
6. market-clearing conditions: (C.23)–(C.26);
7. the full bailout assumption: (C.28);
8. the flexible-price economy: (C.29)–(C.34).

Given the four exogenous processes of $\{A_t, QE_t, T_t, \hat{\delta}_{i,t}\}$, there are 28 equations for 28 variables $\{C_t, I_t, \Pi_t, w_t, L_t, C_t^C, Q_t, b_t, R_t, b_t^{FI}, re_t, d_t, T_t^G, \Lambda_{t-1,t}, \Omega_t, I_t^{RE}, x_{1,t}, x_{2,t}, Y_t, p_t^*, v_t, b_t^{CB}, Y_t^N, C_t^N, L_t^N, w_t^N, R_t^*, X_t\}$. Here $\{b_t, b_t^{FI}, b_t^{cb}, re_t, d_t\}$ denote the real variables of their nominal counterparts in capital letters, which are deflated by the aggregate price index P_t.

C.9 Log-Linearization

In this section, we log-linearize the equilibrium around the non-stochastic steady state. We assume the steady-state inflation and productivity are one, that is, $\bar{\Pi} = \bar{A} = 1$. Unless otherwise stated, we use letters with an upper bar to denote steady-state values and lowercase letters with a hat to denote the log-deviations from the steady-state values.

We define policy instruments and asset positions relative to the steady-state level of output, that is,

$$\hat{\tau}_t \equiv \frac{T_t - \bar{T}}{\bar{Y}}, \qquad \widehat{qe}_t \equiv \frac{QE_t - \bar{QE}}{\bar{Y}}, \qquad \hat{b}_t \equiv \frac{b_t - \bar{b}}{\bar{Y}},$$

$$\hat{d}_t \equiv \frac{d_t - \bar{d}}{\bar{Y}}, \qquad \widehat{re}_t \equiv \frac{re_t - \bar{re}}{\bar{Y}}.$$

In addition, define the share of constrained household consumption in total consumption as $z \equiv \bar{C}^C/(\bar{C} + \bar{C}^C)$.

The linearized system of equations in Section C.8 are:

$$-\sigma\hat{c}_t = -\sigma\mathbb{E}_t\hat{c}_{t+1} + \hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1} \tag{C.35}$$

$$\chi\hat{l}_t = -\sigma\hat{c}_t + \widehat{w}_t \tag{C.36}$$

$$\hat{r}_t = \frac{k}{\bar{R}}\hat{q}_t - \hat{q}_{t-1} \tag{C.37}$$

$$-\sigma\hat{c}_t^C = -\sigma\mathbb{E}_t\hat{c}_{t+1}^C + \mathbb{E}_t\hat{r}_{t+1} - \mathbb{E}_t\hat{\pi}_{t+1} \tag{C.38}$$

$$\hat{d}_t = \frac{(1-k)\bar{Q}\bar{b}^{FI}}{\bar{Y}}\hat{q}_t + \bar{Q}\hat{b}_t^{FI} - k\bar{Q}\hat{b}_{t-1}^{FI} + \frac{k\bar{Q}\bar{b}^{FI}}{\bar{Y}}\hat{\pi}_t + \widehat{re}_t \tag{C.39}$$

$$\frac{1}{\bar{Y}}\hat{q}_t + \frac{1}{\bar{b}^{FI}}\hat{b}_t^{FI} = 0 \tag{C.40}$$

$$\hat{\lambda}_{t-1,t} = -\sigma\left(\hat{c}_t - \hat{c}_{t-1}\right) - \hat{\pi}_t \tag{C.41}$$

$$\mathbb{E}_t\hat{\lambda}_{t,t+1} + \frac{\bar{R}}{\bar{R}-\bar{I}}\mathbb{E}_t\hat{r}_{t+1} - \frac{\bar{I}}{\bar{R}-\bar{I}}\hat{i}_t = \hat{\omega}_t \tag{C.42}$$

$$\hat{i}_t^{RE} = \hat{i}_t \tag{C.43}$$

$$\begin{aligned}\hat{x}_{1,t} =& (1-\phi\beta)\hat{w}_t - (1-\phi\beta)\hat{a}_t + (1-\phi\beta)\hat{y}_t \\ &+ \phi\beta\mathbb{E}_t\hat{\lambda}_{t,t+1} + \phi\beta(\epsilon+1)\mathbb{E}_t\hat{\pi}_{t+1} + \phi\beta\mathbb{E}_t\hat{x}_{1,t+1}\end{aligned} \tag{C.44}$$

$$\hat{x}_{2,t} = (1-\phi\beta)\hat{y}_t + \phi\beta\mathbb{E}_t\hat{\lambda}_{t,t+1} + \phi\beta\epsilon\mathbb{E}_t\hat{\pi}_{t+1} + \phi\beta\mathbb{E}_t\hat{x}_{2,t+1} \tag{C.45}$$

$$\widehat{p}_t^* = \widehat{x}_{1,t} - \widehat{x}_{2,t} \tag{C.46}$$

$$\hat{y}_t + \hat{v}_t = \hat{a}_t + \hat{l}_t \tag{C.47}$$

$$\hat{\pi}_t = \frac{1-\phi}{\phi}\hat{p}_t^* \tag{C.48}$$

$$\hat{v}_t = 0 \tag{C.49}$$

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_y(\hat{y}_t - \hat{y}_t^N) + \hat{\delta}_{i,t} \tag{C.50}$$

$$\frac{\bar{Q}\bar{b}^{CB}}{\bar{Y}}\hat{q}_t + \bar{Q}\hat{b}_t^{CB} = \widehat{re}_t \tag{C.51}$$

$$\widehat{qe}_t = \widehat{re}_t \tag{C.52}$$

$$\hat{\tau}_t = \hat{\tau}_t^G + (\bar{R} - \bar{I})\widehat{qe}_{t-1} + \frac{\bar{Q}E}{\bar{Y}}\left[\bar{R}\hat{r}_t - \bar{I}\hat{i}_{t-1} - (\bar{R} - \bar{I})\hat{\pi}_t\right] \tag{C.53}$$

$$\hat{b}_t = \hat{b}_t^{FI} + \hat{b}_t^{CB} \tag{C.54}$$

$$(1-z)\hat{c}_t + z\hat{c}_t^C = \hat{y}_t \tag{C.55}$$

$$z\hat{c}_t^C = \widehat{qe}_t + \hat{\tau}_t \tag{C.56}$$

$$-\sigma\hat{c}_t^N = -\sigma\mathbb{E}_t\hat{c}_{t+1}^N + \hat{r}_t^* \tag{C.57}$$

$$\chi\hat{l}_t^N = -\sigma\hat{c}_t^N + \widehat{w}_t^N \tag{C.58}$$

$$\hat{y}_t^N = \hat{a}_t + \hat{l}_t^N \tag{C.59}$$

$$w_t^N = \hat{a}_t \tag{C.60}$$

$$(1-z)\hat{c}_t^N = \hat{y}_t^N \tag{C.61}$$

$$\hat{x}_t = \hat{y}_t - \hat{y}_t^N. \tag{C.62}$$

To complete the model, we assume the exogenous variables follow an AR(1) process:

$$\hat{a}_t = \rho_a\hat{a}_{t-1} + s_a\varepsilon_{a,t} \tag{C.63}$$

$$\widehat{qe}_t = \rho_q\widehat{qe}_{t-1} + s_q\varepsilon_{q,t} \tag{C.64}$$

$$\hat{\tau}_t = \rho_\tau\hat{\tau}_{t-1} + s_\tau\varepsilon_{\tau,t} \tag{C.65}$$

$$\hat{\delta}_{i,t} = \rho_i\hat{\delta}_{i,t-1} + s_i\varepsilon_{i,t}. \tag{C.66}$$

Equations (C.35)–(C.66) is a system of 32 equations for 32 variables $\{\hat{c}_t, \hat{i}_t, \hat{\pi}_t, \hat{w}_t, \hat{l}_t, \hat{c}_t^C, \hat{q}_t, \hat{b}_t, \hat{\tau}_t, \hat{r}_t, \hat{b}_t^{FI}, \widehat{re}_t, \hat{d}_t, \hat{\tau}_t^G, \hat{\lambda}_{t-1,t}, \hat{\omega}_t, \hat{i}_t^{RE}, \hat{x}_{1,t}, \hat{x}_{2,t}, \hat{p}_t^*, \hat{a}_t, \hat{y}_t, \hat{v}_t, \hat{\delta}_{i,t}, \hat{b}_t^{CB}, \widehat{qe}_t, \hat{y}_t^N, \hat{c}_t^N, \hat{l}_t^N, \hat{w}_t^N, \hat{r}_t^*, \hat{x}_t\}$.

C.10 System Reduction

Next, we reduce the medium-scale equilibrium system and derive the IS curve (3.1) and the New Keynesian Phillips curve (3.2).

C.10.1 The IS curve

Combining (C.55) and (C.56) yields

$$\hat{c}_t = \frac{1}{\vartheta}\left(\hat{y}_t - \widehat{qe}_t - \hat{\tau}_t\right), \tag{C.67}$$

where $\vartheta \equiv 1 - z$. Plugging (C.67) into the Euler equation (C.35), we have

$$\hat{y}_t = \mathbb{E}_t\hat{y}_{t+1} - \frac{\vartheta}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1}) + (\widehat{qe}_t + \hat{\tau}_t) - \mathbb{E}_t\left[\widehat{qe}_{t+1} + \hat{\tau}_{t+1}\right]. \tag{C.68}$$

In the flexible-price equilibrium, combining (C.61) and (C.57) yields

$$\hat{y}_t^N = \mathbb{E}_t\hat{y}_{t+1}^N - \frac{\vartheta}{\sigma}\hat{r}_t^*, \tag{C.69}$$

where $\hat{r}_t^*$ is the natural rate of interest.

Subtracting (C.69) from (C.68), we obtain the New Keynesian IS curve:

$$\hat{x}_t = \mathbb{E}_t\hat{x}_{t+1} - \frac{\vartheta}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1} - \hat{r}_t^*) + (\widehat{qe}_t + \hat{\tau}_t) - \mathbb{E}_t\left[\widehat{qe}_{t+1} + \hat{\tau}_{t+1}\right].$$

With the assumption $\rho_q = \rho_\tau = \rho$, the IS curve can be simplified to

$$\hat{x}_t = \mathbb{E}_t\hat{x}_{t+1} - \frac{\vartheta}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1} - \hat{r}_t^*) + (1-\rho)(\widehat{qe}_t + \hat{\tau}_t), \tag{C.70}$$

which is the expression of the IS curve in (3.1).

C.10.2 The Phillips curve

Combining (C.44)-(C.46), as well as (C.48), yields the standard New Keynesian Phillips curve of the form

$$\hat{\pi}_t = \frac{(1-\phi)(1-\phi\beta)}{\phi}(\hat{w}_t - \hat{a}_t) + \beta\mathbb{E}_t\hat{\pi}_{t+1}.$$

Define $\gamma \equiv (1-\phi)(1-\phi\beta)/\phi$. We can rewrite the Phillips curve as

$$\hat{\pi}_t = \gamma\widehat{mc}_t + \beta\mathbb{E}_t\hat{\pi}_{t+1}, \tag{C.71}$$

where $\widehat{mc}_t \equiv \hat{w}_t - \hat{a}_t$.

We next unpack the expression of $\widehat{mc}_t$ in terms of output gap $\hat{x}_t$. Combining (C.36), (C.47), and (C.49), yields

$$\hat{w}_t = \chi(\hat{y}_t - \hat{a}_t) + \sigma\hat{c}_t. \tag{C.72}$$

Substituting (C.67) into (C.72), we have

$$\hat{w}_t = \zeta\hat{y}_t - \chi\hat{a}_t - \frac{\sigma}{\vartheta}\left(\widehat{qe}_t + \hat{\tau}_t\right), \tag{C.73}$$

where $\zeta \equiv \chi + \frac{\sigma}{\vartheta}$.

Further plugging $\hat{w}_t$ into (C.71), we obtain

$$\hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \gamma\zeta\hat{y}_t - \gamma(1+\chi)\hat{a}_t - \frac{\gamma\sigma}{\vartheta}\left(\widehat{qe}_t + \hat{\tau}_t\right). \tag{C.74}$$

Note that, combining (C.58)-(C.60) gives the natural rate of output in the flexible-price equilibrium as

$$\hat{y}_t^N = \frac{1+\chi}{\zeta}\hat{a}_t. \tag{C.75}$$

Thus, substitute $\hat{a}_t$ using (C.75) in (C.74) yields

$$\hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \gamma\zeta\hat{x}_t - \frac{\gamma\sigma}{\vartheta}\left(\widehat{qe}_t + \hat{\tau}_t\right), \tag{C.76}$$

which is the expression of the New Keynesian Phillips curve in (3.2).

C.11 Reduced System

The equilibrium can now be reduced to a three-equation system with endogenous variables $\{\hat{x}_t, \hat{\pi}_t, \hat{i}_t\}$:[13]

- IS curve
$$\hat{x}_t = \mathbb{E}_t\hat{x}_{t+1} - \frac{\vartheta}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1} - \hat{r}_t^*) + (1-\rho)(\widehat{qe}_t + \hat{\tau}_t); \tag{C.77}$$

- Phillips curve
$$\hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \gamma\zeta\hat{x}_t - \frac{\gamma\sigma}{\vartheta}\left(\widehat{qe}_t + \hat{\tau}_t\right); \tag{C.78}$$

- Taylor rule
$$\hat{i}_t = \phi_\pi\hat{\pi}_t + \phi_y\hat{x}_t + \hat{\delta}_{i,t}; \tag{C.79}$$

- Exogenous shock processes (C.63)–(C.66).

[13] See Wu and Xie (2025) for the determinacy condition of the reduced and full equilibrium systems.

D Aggregate Phillips Curve: Robustness

This section reports robustness checks for the aggregate Phillips curve in Table 4. We use the large-scale asset purchase (LSAP) shock constructed in Jarociński (2024) as the instrument, and report the results in Table D.1.

Table D.1: Aggregate Phillips Curve Estimation: Alternative IV

Panel A: Output Gap

	OLS		GMM					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output gap	0.162*	0.163*	0.307***	0.298***	0.234***	0.227***	0.209***	0.235***
	(0.083)	(0.085)	(0.005)	(0.061)	(0.007)	(0.022)	(0.001)	(0.001)
NFCILEV		-0.035	-0.357***	-0.366***	-0.438***	-0.427***	-0.546***	-0.449***
		(0.082)	(0.001)	(0.092)	(0.003)	(0.017)	(0.001)	(0.003)
SPF 10y				1.766***				
				(0.566)				
SPF 1y					1	0.946***		
						(0.063)		
Mich 1y							1	0.582***
								(0.004)
N	137	137	120	120	120	120	120	120

Panel B: Unemployment Gap

	OLS		GMM					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Unemp gap	-0.237**	-0.243**	-0.345***	-0.370***	-0.276**	-0.327***	-0.213***	-0.267***
	(0.097)	(0.101)	(0.114)	(0.114)	(0.122)	(0.103)	(0.006)	(0.013)
NFCILEV		-0.077	-0.287**	-0.301*	-0.336*	-0.325***	-0.439***	-0.307***
		(0.081)	(0.123)	(0.165)	(0.187)	(0.086)	(0.004)	(0.015)
SPF 10y	1	1	1	0.926***				
				(0.260)				
SPF 1y					1	0.743***		
						(0.135)		
Mich 1y							1	0.452***
								(0.012)
N	137	137	120	120	120	120	120	120

Notes: This table reports the parameter estimates and their standard errors (in parentheses) in the Phillips curve. The dependent variable is core CPI inflation. NFCILEV represents the financial conditions measured by the negative of Chicago Fed National Financial Condition Leverage Subindex. For the IV estimations, we use the LSAP shock constructed by Jarociński (2024) as IV. Panels A and B use output gap and unemployment gap to prox economic slack, respectively. The sample spans from 1990Q1 to 2023Q4. 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 $H = 12$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.