Working Paper 23-1

Fighting the Pandemic Inflation Surge of 2021-2022

William R. Cline[1]
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ABSTRACT

The Covid-19 pandemic, aggravated by the Russia-Ukraine war, unleashed the worst inflation in four decades in the United States and other advanced economies. This study reviews the contributions of supply shortages and excess demand to the inflation surge. It argues that too little attention was given to the need to finance pandemic relief through higher taxes, and to focus relief expenditures efficiently. Only about 40 percent of pandemic fiscal relief was focused on sectors and recipients most affected by the pandemic. The analysis posits a "fiscal quantity theory" whereby, under constrained supply, an increased fiscal deficit causes increased inflation proportionate to the resulting rise in demand relative to GDP. Calculations applying this approach to the timing of increased demand from fiscal relief, under alternative assumptions about severity of the supply constraints to US supply, find that fiscal pandemic relief contributed one-third to two-thirds of the total cumulative pandemic price shock amounting to 7.7 percentage points above baseline inflation over 2020-2022. The analysis urges greater attention to 6-month annualized inflation as a metric for monitoring progress in fighting inflation. This measure shows that trend US inflation fell from a peak of about 7½ percent in June 2022 to about 4½ percent in January 2023. As a possible supplementary policy instrument to curb still high inflation if needed, it suggests a contingent version of the income-tax surcharge employed in the United States in the late 1960s.

Keywords: Inflation, Pandemic
(JEL E31, E62)

[1] President, Economics International Inc., and Senior Fellow Emeritus, Peterson Institute for International Economics. For comments on an earlier version of this paper, I thank without implicating Laurence Ball, Olivier Blanchard and Joseph Gagnon.

Introduction

In 2021 and 2022, inflation reached unacceptably high levels in the United States and several other major advanced economies. In the 12 months ending December 2022, seasonally adjusted consumer prices rose 6.44 percent in the United States (BLS, 2023b). Consumer prices not seasonally adjusted rose 11.7 percent in Italy, 10.4 percent in the United Kingdom, 8.5 percent in Germany, 6.4 percent in Canada, and 5.8 percent in France. From November to November, consumer prices rose 3.8 percent in Japan (BIS, 2023). Trend US inflation as measured by the 6-month annualized rate eased to 3.5 percent by December 2022 (average of four main measures) but rebounded to 4.6 percent in January 2023. The central question now remains whether the pandemic shocks of reduced supply and increased demand from fiscal relief stimulus, combined with the food and energy shocks from the Russia-Ukraine war, have caused the major economies to pass a tipping point into a new regime marked by inflation and stagflation.

This study first traces the time path of the recent inflationary outbreak, which broadly peaked in June 2022 and then moderated in the second half of 2022. For emerging market and developing economies, estimates by the International Monetary Fund (IMF) of prospective annual inflation in 2022, and comparison against pre-Covid rates in 2019, provide an indication of the extent of increase in inflation. Estimates of the Organization for Economic Cooperation and Development (OECD) provide a decomposition of total measured inflation into the contributions from food, from energy, and from all other price increases for the 12 months ending September 2022.

The discussion then turns to the causes of the surge in inflation, first noting the early view that the increase was only a transitory consequence of disruption from Covid, and also noting the tendency of inflation expectations in household and even professional surveys to show relatively prompt reversion to lower inflation. A similar pattern in the break-even spreads for Treasury Inflation Protected Securities (TIPs) is also noted. The issue of supply versus demand shifts is then considered. In particular, the discussion invokes a strand of pandemic economics that argues that the proper policy response is higher taxes on the population little affected to pay for relief transfers to the seriously affected population. Otherwise, generalized transfers and resulting fiscal expansion will cause inflationary pressure in the face of supply constraints from lockdowns and supply-chain disruptions.

The discussion considers the large fiscal relief expenditures, especially in the United States. Recent studies of the decomposition of US price increases into supply reductions as opposed to demand increases are reviewed.

The study then turns to consideration of the inflationary impact of fiscal expansion when the economy is supply-constrained. I suggest a concept of "Fiscal Quantity Theory" that considers the translation of an increased deficit to increased demand and higher prices under these circumstances. I use CBO estimates of the fiscal impact of the four largest pandemic relief spending programs, combined with corresponding time paths of increased household spending,

to estimate the resulting boost to inflation in each year during 2020-2022, and find that one-third to two-thirds of the pandemic inflation shock resulted from excess demand from relief expenditures. The analysis also examines the composition of the pandemic fiscal relief spending and finds that at least 60 percent did not meet the criterion of pandemic economics that such relief be focused on the sectors and populations most affected.

The analysis reviews the Philips Curve and Beveridge Curve model estimates, and notes the emerging divergence between the recent moderation in the trend of US inflation and the high inflation predicted by some of these models. The study closes with a review of experience with the income tax surcharge enacted in 1968 as a possible instrument for use if inflation significantly above 3 percent persists, and considers the case for raising the target inflation rate from 2 percent to 3 percent.

The Inflationary Outbreak of 2021-2022

The usual practice of tracking the most recent 12-month increase in the consumer price index as the main indicator of inflation may be misleading as an indicator of where inflation is headed. Yet diagnosing that direction becomes especially important in a period of possible regime-change in expectations and even parameter magnitudes in the framework determining inflation. A useful supplementary metric is six-month inflation at an annual rate.[2] Figure 1 shows both measures for the United States using the seasonally adjusted consumer price index (CPI) and the personal consumption expenditure (PCE) index, as well as the versions of these two indices excluding food and energy ("xFE").

The popular early diagnosis of merely "transitory" high inflation from the Covid-19 shock looked plausible through late 2021, as suggested by the paths of three of the four 6-month annualized inflation measures in panel B of Figure 1. However, in the first half of 2022 these measures showed either sharp further increases (CPI, PCE) or stubborn persistence at a high plateau of about 4½ to 5½ percent (CPIxFE, PCExFE). Six month annualized inflation peaked in June 2022 at 10.1 percent for the CPI and 8.0 percent for the PCE.

In contrast, there was major progress in reducing inflation in the second half of 2022. The seasonally adjusted, six-month annualized rate fell to 2.9 percent in December for the CPI, although this rate rebounded to 4.1 percent in January 2023.[3] The corresponding rates excluding food and energy showed moderate progress, falling from 6.3 percent in June to 5.1 percent in December before edging back up to 5.3 percent in January. For the PCE, the six-month annualized rate fell from a peak of 8.0 percent in June to 2.1 percent in December but

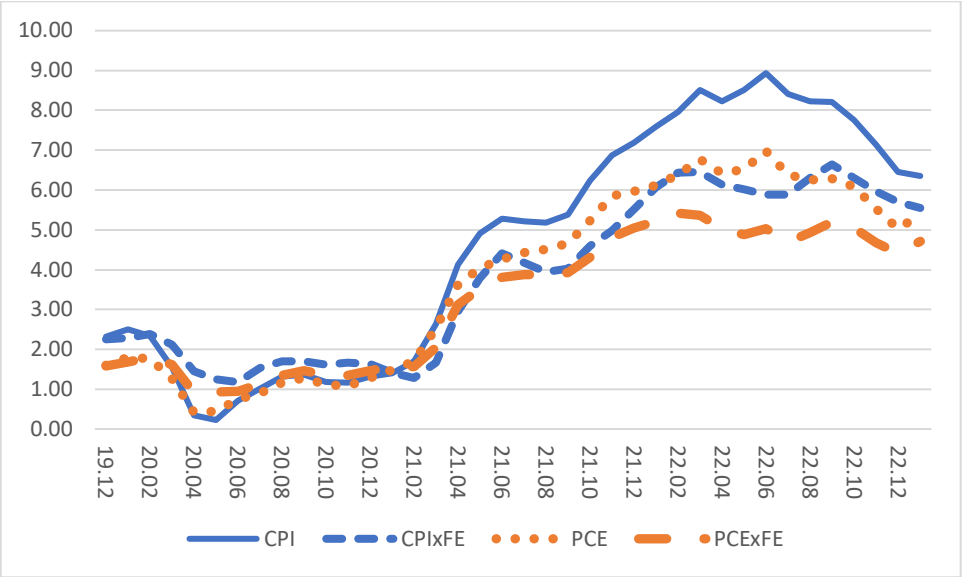
[2] Average 6-month inflation at an annual rate is calculated as: $100 \times [(p_t / p_{t-6})^2 - 1]$, where p is the price index and *t* is the month.

[3] An important reason for the sharp decline through December was a major 6-month decline in energy prices. West Texas International oil fell from $115 per barrel in June to $76 per barrel in December (EIA, 2023a). Average US prices for regular gasoline, which had risen from $2.96 per gallon in December 2021 to $4.76 in June 2022, fell to $3.08 per gallon in December 2022. (EIA,2023b)

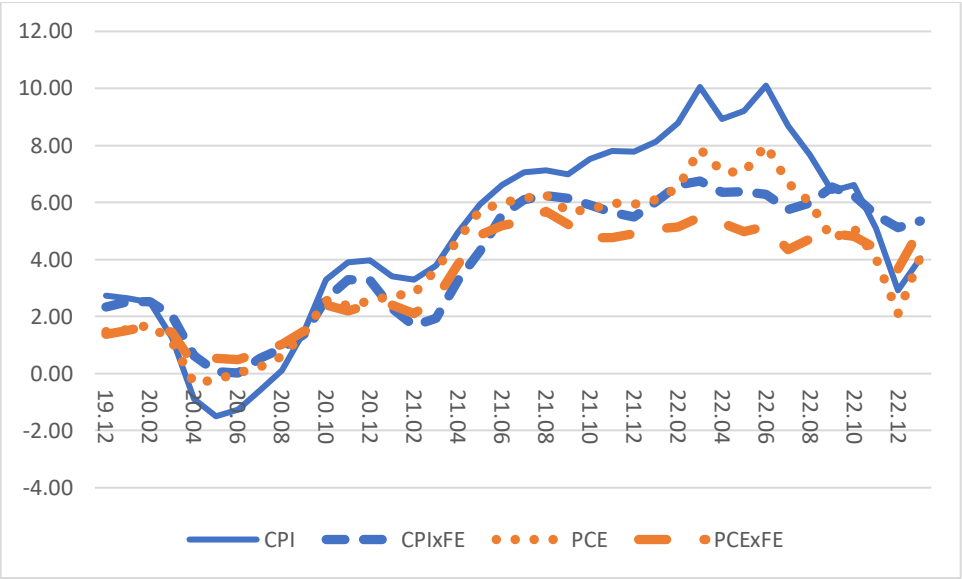
rebounded to 4.1 percent in January. Excluding food and energy, the corresponding decline was from 5.2 to 3.7 percent, followed by a rebound to 5.1 percent.

Figure 1. US Inflation, Annual Rate (Percent)

A. Past 12 months



B. Past 6 months, annualized rate



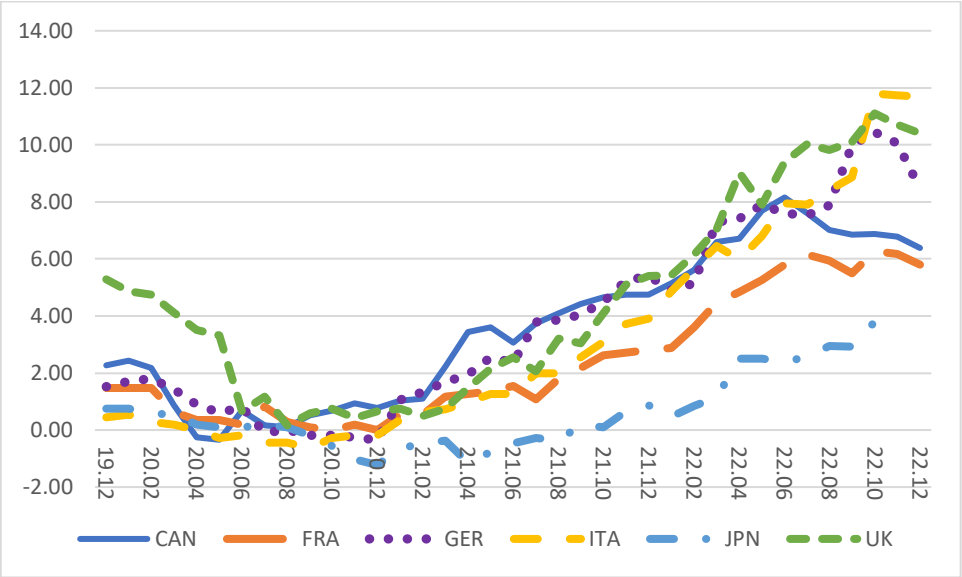
Source: BLS (2023b,c); FRED (2023, series PCEPI and PCEPILFE)

If the *average of the four measures* (CPI, CPIxFE, PCE, PCExFE) is taken as a summary metric, and using the 6-month annualized rate as more indicative of trends than the 12-month rate, *US inflation fell from a peak pace of 7.4 percent in June 2022 to 3.5 percent in December but rebounded to 4.6 percent in January 2023.* Progress has been made in curbing US inflation, but there remains a considerable distance to go.

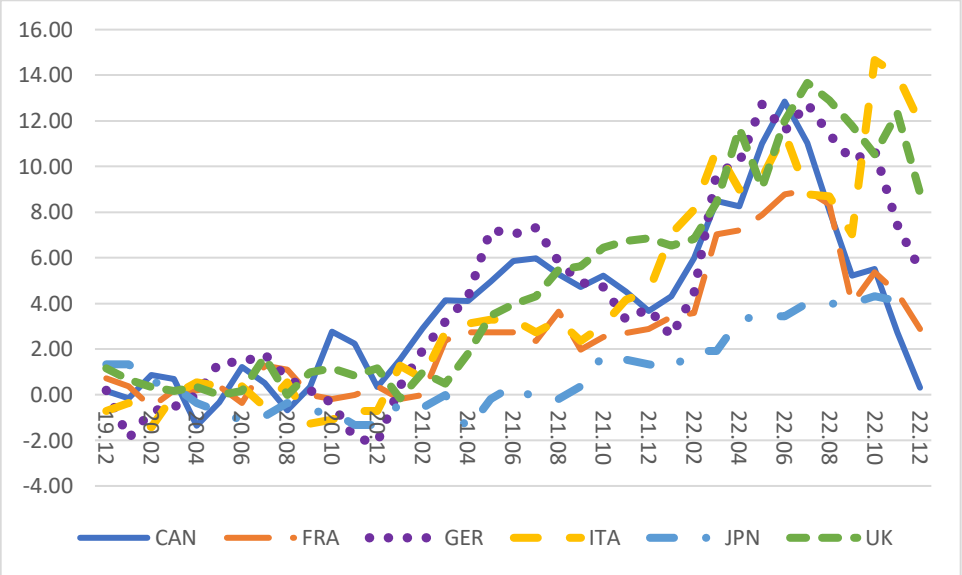
For the six other advanced economies of the Group of Seven, there was a similar surge to extremely high levels by mid-2022, with some tapering off by the third quarter (figure 2) and considerably more deceleration by the fourth for especially Canada, France, and Germany.

Figure 2. Six Advanced Economies: Consumer Price Inflation
Annual Rate (Percent)

A. Past 12 months



B. Past 6 months, annualized rate



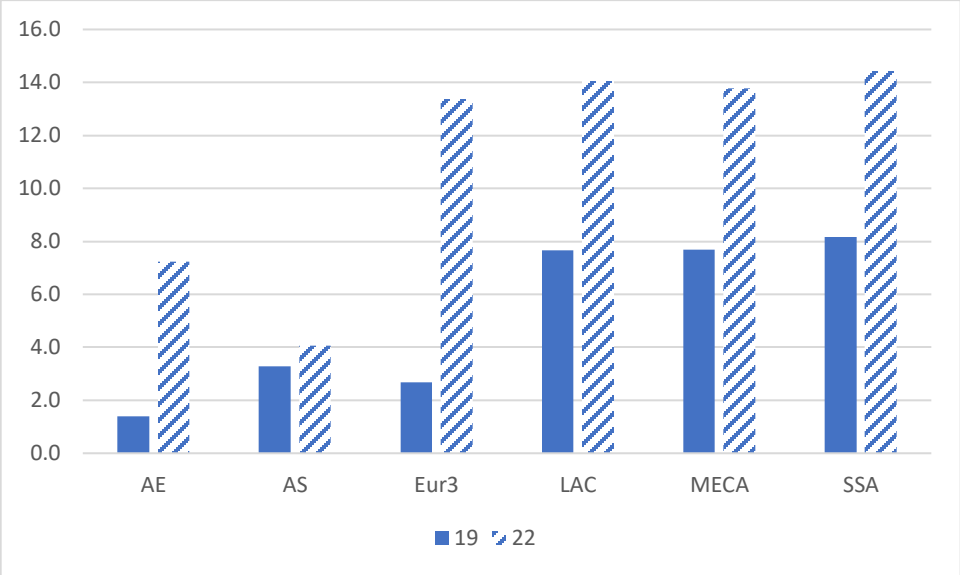
Source: BIS (2023)

The six-month pace of consumer price inflation at an annual rate reached 12.9 percent for Canada in June before plunging to 0.3 percent by December. For Germany and the UK, the

6-month annualized pace peaked in July at 12.8 percent and 13.7 percent, respectively, and by December eased to 5.5 percent and 8.8 percent respectively. For France this rate peaked at 9 percent in July and fell to 2.9 percent by December. Japan's pace was much lower all along but by November still stood approximately at the 4 percent pace reached in July. For Italy, the annualized 6-month rate peaked at 14.7 percent in October and remained high at 11.9 percent in December.[4]

Although the increase in inflation in 2022 was widespread, the rise was proportionately more moderate in most emerging market and developing economies than in the major advanced economies. The IMF (2022d) has projected that whereas advanced economies' average inflation will have risen from 1.4 percent in 2019 to 7.2 percent in 2022, average inflation will have risen from 3.3 percent in 2019 to 4.1 percent in 2022 in Asian emerging market and developing countries. For China inflation will have fallen from 2.9 percent to 2.2 percent, and for India, it will have risen only from 4.8 percent to 6.9 percent.

Figure 3
Average Inflation in 2019 and 2022 for Emerging Market and Developing Countries



AE: advanced economies Emerging market and developing – AS: Asia
Eur3: Bulgaria, Hungary, Poland LAC: Latin America and Caribbean
MECA: Middle East and Central Asia SSA: Sub-Saharan Africa
Source: IMF (2022d).

As shown in figure 3, the corresponding comparison for other emerging market and developing country regions shows a nearly uniform rise from regional averages of about 8

[4] Italy's energy price inflation over one year earlier had reached 44.5 percent in September and surged to 73.2 percent in October. Antonella Cinelli and Gavin Jones, "Italian Inflation Surges in October ahead of Euro Zone Figures," *Reuters*, October 28, 2022.

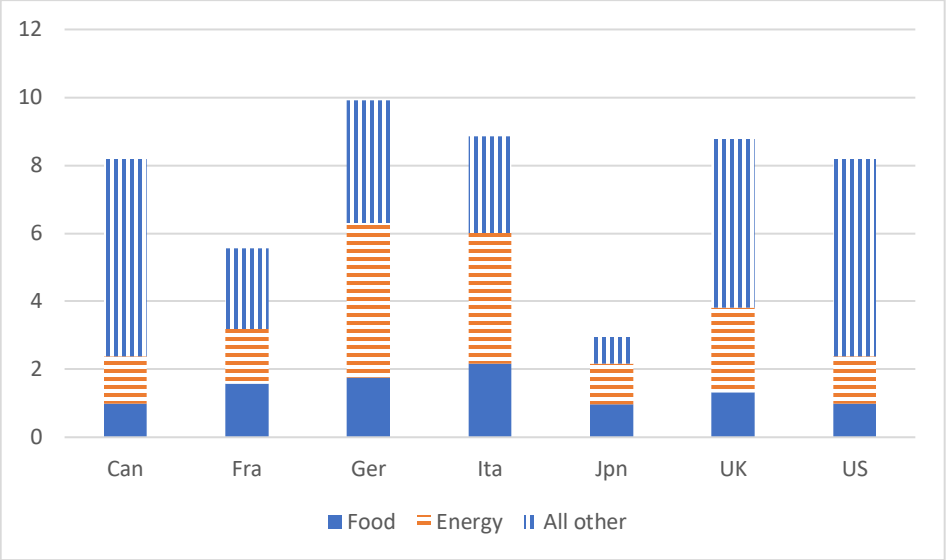
percent inflation in 2019 to about 14 percent in 2022, for Latin America and the Caribbean, Middle East and Central Asia, and Sub-Saharan Africa.

An increment of six percentage points from a base of 8 percent inflation is arguably less of a shock than a rise of about six percentage points from a base of about 1-1/2 percent in the advanced economies, where firms and households have not faced major inflation for decades.[5] The only emerging market region with a sharp surge from low inflation is that of three European economies shown in the figure: Bulgaria, Hungary, and Poland. There the rise from 2.7 percent in 2019 to 13.4 percent in 2022 reflects the energy and food price shocks from the Russia-Ukraine war.[6]

For the major advanced economies, the role of food and energy price shocks has been the largest in Europe, reflecting the Russia-Ukraine war.

Figure 4

Contribution of Food, Energy, and All Other Price Increases to Total CPI Inflation
(Percent, Sept. 2022 over Sept. 2021)



Source: OECD (2022)

[5] As an indication of ability to cope with inflation in Latin America, historically a venue for high inflation (and still so for Argentina and especially Venezuela), in Brazil the six-month annualized inflation rate peaked at 18.9 percent in March, was down to 8.6 percent by July, and was only 1 percent by September 2022. (Calculated from BIS, 2023.)
[6] The rise from 15 percent to 73 percent in Türkiye reflected idiosyncratic monetary policy far more than regional shocks.

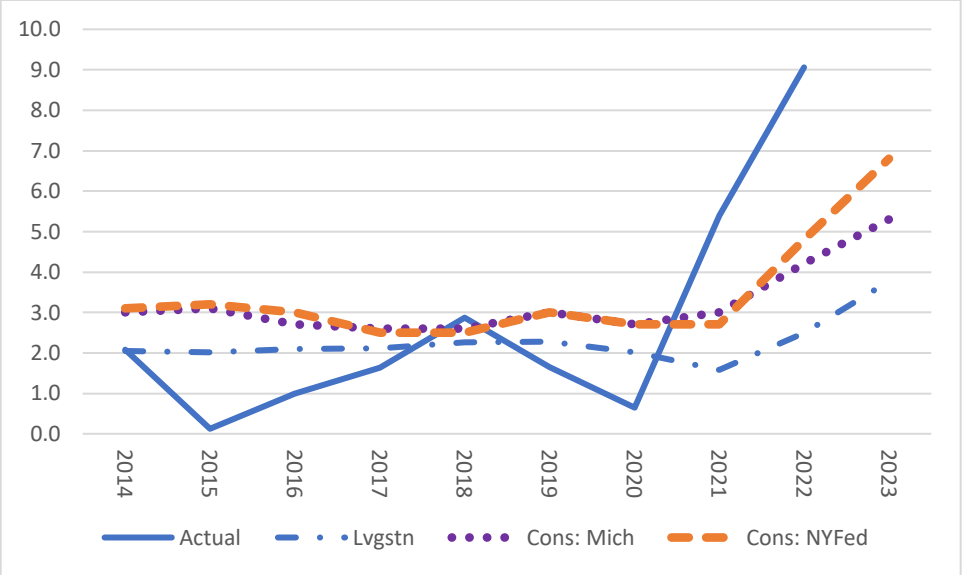
As shown in figure 4, in Germany, of a total increase in the consumer price index by 10 percent from September 2021 to September 2022, almost half (4.5 percentage points) came from the increase in energy prices.[7]

Inflation Expectations

Data on inflation expectations provide additional information on the outbreak of inflation. In part because of the central role of the "expectational anchor" on inflation in some (typically Phillips-Curve) macro-economic models, these indicators warrant consideration despite their inherently intangible nature.

Figure 5

Consumer Price Inflation, 12 months ending June:
Actual and year-before forecasts (percent)



Source: BLS (2023b), FRBPhil (2022a), FRBNY (2022a), FRED (2023)

Figure 5 shows the actual US CPI inflation for the 12 months ending June of each year (solid line).[8] In comparison, it shows the 12-month inflation to June that was forecast in expectational surveys in June of the previous year. One of the forecasts is by professionals and

[7] The OECD provides sectoral detail on consumer price indices of member countries. The large impact of energy in Germany reflects both a remarkably high rise in energy prices (45 percent) and a relatively high weight of energy in the CPI (10.4 percent). In comparison, for the US the rise in energy prices was 19.8 percent and the weight of energy in the index is 5.4 percent. (OECD, 2022a, b).

[8] Note that the collapse of inflation in 2015 was driven by the plunge in oil prices (from $93 per barrel for West Texas Intermediate to $49; FRED, 2022, series WTId). The US consumer price index excluding food and energy rose slightly more in 2015 than in 2014 (1.83 percent versus 1.75 percent; BLS, 2023c).

the other two are surveys of consumer expectations by the New York Federal Reserve Bank and by the University of Michigan (FRB-NY, 2022; and as reported by FRED, 2022[9]).

As shown in the figure, the surge in US inflation in 2021 and especially the first half of 2022 caught the forecasters by surprise. Professional forecasters surveyed by the Philadelphia Federal Reserve (in its "Livingston Survey") had expected 12-month CPI inflation for June 2021-June 2022 to be only 2.5 percent; instead, it was 9.1 percent (FRB-Phil, 2022; BLS, 2023b). Although households surveyed by the New York Federal Reserve did a better job of anticipating high inflation, as their June 2021 forecast for inflation over the subsequent 12 months was 4.8 percent, the actual outcome was far higher (FRBNY, 2022a). The other consumer survey shown also came closer to the actual outcome than the professionals, as the University of Michigan survey in June 2021 found expected inflation for the next 12 months to reach 4.2 percent.

For the 12 months from June 2022 to June 2023, the June 2022 forecasts ranged from 3.8 percent in the Livingston Survey to 5.3 percent in the University of Michigan survey and 6.8 percent in the New York Fed survey. For their part, members of the Federal Reserve Board's Federal Open Market Committee in June 2022 expected inflation from 2022 to 2023 to be only 2.6 percent (median estimate) (FOMC, 2022). By September the 12-month expectation of consumers had eased to 5.4 percent in the New York Fed survey and to 4.7 percent in the Michigan survey. In comparison, Figure 1 shows that 6-month trend inflation in September 2022 for both the CPI and the CPIxFE stood at slightly above 6 percent.

Overall, the 2021-22 shock of inflation to levels well above what had been expected, including by professional forecasters and by the Federal Reserve, can only have eroded the "expectational anchor" of inflation. It is unclear how severe that erosion might become, and at least so far the same surveys shown for one-year-ahead expectations in figure 5 show more benign patterns for three-year-ahead expectations.[10] As discussed below, the macroeconomic policy stakes are high in preserving the anchor of low inflation expectations that characterized the period of at least two decades before the Covid-19 pandemic.[11]

In principle, the financial markets also provide a measure of inflationary expectations, in the form of the "break-even" rate representing the difference between the interest rate on a normal Treasury obligation and the interest rate on Treasury Inflation Protected Securities (TIPs). A challenge in using this metric, however, is that the information provided in official statistics concerns the five-year TIP and the longer maturities, and it is difficult to track a meaningful break-even inflation rate for a TIP with a residual maturity of 1 or 2 years, for comparison with typical horizons for inflation forecasts.

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[9] Series MICH.

[10] Thus, the September New York Fed survey of consumer expectations placed the average rate over the next three years at only 2.9 percent (FBRNY, 2022).

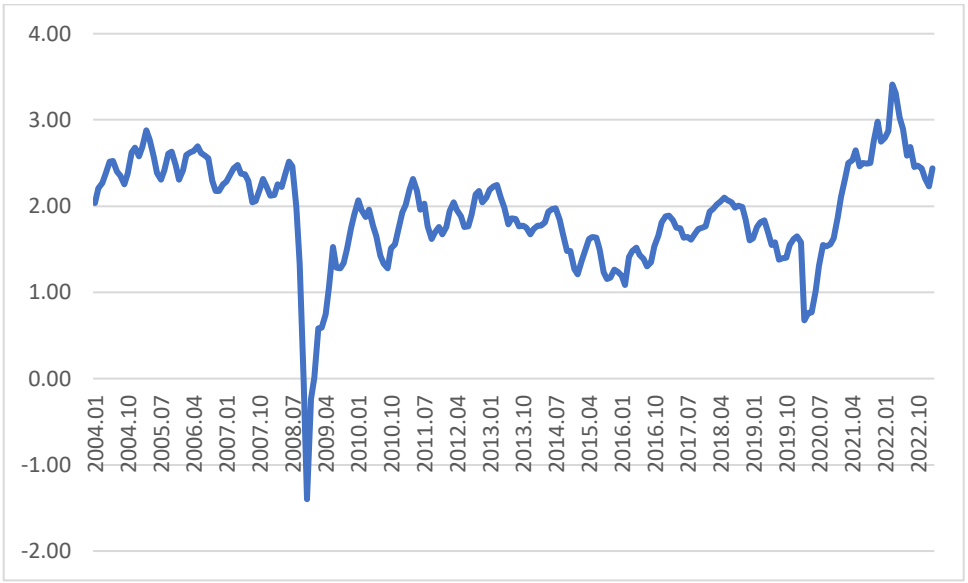
[11] In the Livingston Survey, the average 12-month inflation forecast was 2.1 percent in the 1960s, 6.2 percent in the 1970s, 4.8 percent in the 1980s, 2.9 percent in the 1990s, 2.1 percent in 2001-10, and 2.0 percent in 2011-19. Calculated from FRB-Phil (2022).

Figure 6 shows the break-even inflation rate on the 5-year TIP since 2004, the first full year after its introduction. As shown in the figure, in March 2022 this rate reached an all-time high of 3.41 percent. Although this rate may not sound particularly high, the fact that it represents a five-year average rate implies a considerable period of time with inflation well above the Federal Reserve's 2 percent target. For example, if the rate were interpreted as representing target inflation of 2 percent in years 3-5, by implication the market would be seen as expecting inflation to average 5.6 percent annually in 2022 and 2023.[12]

On balance, the recent professional forecasts and TIPs break-even rates may still tend to be under- rather than over-predicting the pace of inflation. However, the under-prediction seems likely to be far smaller than occurred in year-before predictions for 2022 (figure 5). The Federal Reserve of Philadelphia's November 2022 quarterly survey found that professional forecasters expect the annual rate of PCE inflation from fourth quarter to fourth quarter to fall from 5.9 percent in 2022 to 2.9 percent in 2023 (FRBPhil 2022b). As noted above, the average of four measures of 6-month annualized inflation was down to 3.5 percent in December 2022 but rebounded to 4.6 percent in January (figure 1).

Figure 6

Break-even Inflation Rate on 5-year TIPs (percent)



Source: FRED (2023)[13]

[12] That is, at the end of 5 years prices would be higher by a ratio of 1.0341^5=1.11825. The final 3 years would contribute a multiple of 1.02^3=1.0612. The first two years would contribute a multiple of 1.114, with the annual multiple contributing 1.114^0.5 or 1.0556.

[13] Series T5YIE.

Causes of the Inflation Surge

A Simple Supply-Demand Framework

It is a useful thought experiment to consider what would be an appropriate answer to the following question on an introductory economics examination: What would happen to prices in an economy in which war-time diversion of labor to the army cut normal output supply available by x percent while the government sent solidarity bonus checks to the population amounting to z percent of GDP? A reasonable answer would be that prices could be expected to rise by x + z percent. That is, if spending capacity rose z percent but output quantity fell x percent, absorbing the total spending would require each unit of (reduced) output to be x + z percent more costly than before.

A more sophisticated answer would add that the price rise might be moderated by two considerations. First, households might cut their normal consumption voluntarily to do more saving in view of greater uncertainty. Second, households would likely save some of the windfall bonus payments. Indeed, in a rational-expectations framework, they would only slightly increase their annual consumption, by the amount of the bonus divided by the remaining number of years in the life expectancy of the heads of household. In practice, a plausible phasing of their extra spending from the bonus might be over, say, three years (as discussed below in light of excess saving during the pandemic). If so, and if potential output remained x percent below normal, then the price level could be expected to rise by [x+(z/3)] percent by the end of the first year, and by the full [x+z] percent by the end of the third year.[14]

In terms of the aggregate supply and demand curves, the wartime shortages would have shifted the upward sloping supply curve to the left (lower quantity on the horizontal axis for any given price on the vertical axis) and the bonuses would have shifted the downward sloping demand curve to the right, raising the equilibrium price. Moreover, under conditions in which higher output is not possible, the aggregate supply curve would turn vertical, such that additional output could not be coaxed out of the economy by rising prices.

A "Fiscal Quantity Theory of Inflation" for the Supply-constrained Economy

In monetary economics there has long been the Quantity Theory of Money, which holds that the price level times the quantity of real output equals the quantity of money times the average velocity of its turnover.[15] In this framework, prices rise in proportion to the excess of the growth in the money supply over growth of real output.

When the economy is already at potential output and there is an adverse shock to supply, conditions are conducive to what might be called a "Fiscal quantity theory of inflation."

[14] Or by somewhat less, depending on the additional curb on consumption from extra saving induced by higher uncertainty., and after taking account of growth in GDP over years 2 and 3.
[15] PQ = MV.

Namely, the increase in prices above baseline will be equal to the quantity of the fiscal stimulus, properly calibrated to take account of delayed phase-in of the household consumption response to windfall social transfer income, divided by the quantity of GDP. In such a framework, over a specified time horizon the cumulative increase in the price level would be the expected baseline increase anticipated before the supply shock and fiscal stimulus; plus the rise in relief- and stimulus-induced demand relative to the GDP base; plus the magnitude of the supply shortfall relative to the GDP base. That is, the price shock would equal the stimulus demand shock plus the proportionate supply reduction.

Table 1 compares actual US growth and inflation during 2020-2022 to the baseline CBO projections in January 2020 (CBO, 2020). For the full 3-year period, the CBO had expected that the consumer price index would rise by a cumulative 7.69 percent, and real GDP would grow by a cumulative 5.9 percent. The actual outcome was a rise in the CPI by a cumulative 15.43 percent, and cumulative real growth of 5.16 percent.[16] The cumulative unanticipated shock to output was relatively small, at -0.75 percent by the end of 2022. However, the cumulative unanticipated shock to prices was relatively large, reaching 7.74 percent by the end of 2022.

Table 1

Expected versus Actual US Growth and Inflation, 2020-2022 (percent)

	2020	2021	2022	2020-2022
Expected[a]				
Growth	2.2	1.9	1.7	5.91
Inflation	2.4	2.5	2.6	7.69
Actual				
Growth	-2.77	5.95	2.08	5.16
Inflation	1.28	7.10	6.42	15.43
Actual - Expected				
Growth	-4.97	4.05	0.38	-0.75
Inflation	-1.12	4.60	3.82	7.74

a. Projected by the CBO in early 2020.

Source: CBO (2020a), BEA (2023), BLS (2023b)

As developed below, the Fiscal Quantity Theory can be applied to examine the extent to which the price shock was caused by excess demand from fiscal stimulus responding to the pandemic. Before turning to this estimation, however, it is important to consider the proper theoretical framework for how fiscal policy should respond to a pandemic (or wartime increase in spending needs combined with reduction in supply available for public consumption).

[16] Actual inflation is the CPI, December over December.

Pandemic Economics

In their analysis of pandemic economics, Romer and Romer (2022) raise serious doubts about the "extraordinary" fiscal response in the United States and other countries as the means of addressing the Covid-19 crisis. They argue that:

> Conventional Keynesian models of fiscal policy … and policy prescriptions don't hold in a pandemic recession. … Some types of economic activity – such as in-restaurant dining and cruise travel – simply can't take place safely. As a result, broad stimulus measures like one-time payments or tax cuts can do little to put workers in those industries back to work. … [O]ptimal policy involves the government taxing those in the unaffected sector and providing income support for those in the sector that is shut." Romer and Romer (2022, pp. 3-4).

Although the authors do not say so, the same considerations imply that adopting large aggregate fiscal stimulus rather than focused redistribution (social insurance) in a pandemic recession invites inflation.

However, Guerrieri, Lorenzoni, Straub, and Werning (2022) propose "a theory of Keynesian supply shocks … that reduce potential output in a sector of the economy but that, by reducing demand in other sectors, ultimately push aggregate activity below potential" (p. 1437). Their theoretical model does not provide quantitative estimates of how large such demand stimulus might need to be despite the negative supply-side shock from the Covid-19 pandemic.[17]

There was indeed a sectoral concentration of output damage from Covid-19. At the level of 417 detailed sectors, in 2020 about one-fourth, accounting for one-sixth of gross output, experienced an output decline of 10 percent or more in nominal gross output. Their combined nominal gross output fell 26 percent from 2019 levels, whereas that of all other sectors rose by 1.6 percent. In 2021, nominal gross output returned to approximately its 2019 level for the

[17] The primarily theoretical purpose of the study is illustrated by its formulation of the economy as "populated by a unit mass of infinitely lived consumers …" (p. 1443). A key finding is that with complete markets, Keynesian demand deficiency induced by a negative supply shock occurs when the intertemporal elasticity of substitution for consumption of all goods exceeds the intra-temporal elasticity of substitution between the goods of the pandemic-affected sector and those of the non-affected sector (p. 1446). Under those conditions, the dominant response is to defer consumption (including of goods in the non-affected sector), leaving deficient demand for the still-open sector. Romer and Romer agree, but argue that with appropriate social insurance channeled to workers in the closed sector, "consumption of the output of the sector that stays open is the same as in normal times" (Romer and Romer 2022, p. 11), so additional demand stimulus will be inappropriate. By implication, a central question is whether pandemic relief transfers are carefully focused on workers in the closed sector. Note further that Guerrieri et al concluded "[T]he fact that CPI dynamics have been subdued, in spite of substantial stimulus, seems broadly consistent with our view …"(p. 1471). However, their manuscript was submitted in September 2021, and by publication in May 2022, CPI dynamics had become anything but subdued (see figures 1 and 2).

severely affected group, and rose to 12 percent above the 2019 level for the rest of the economy.[18]

The group of most seriously affected sectors included numerous manufacturing categories (iron and steel, aluminum, other metal sectors; several motor vehicle and parts manufacturing sectors; chemicals). In services, they included clothing, furniture, and electrical product stores; air, rail, and water transportation; motion picture and video industries; travel services; dentists' offices; and numerous leisure and entertainment sectors, as well as accommodation and full-time restaurants.

Too Much Stimulus?

If only one-sixth of the output base comprised the most adversely affected portion of the economy, and if the damage in 2020 to that damaged sector was a decline of about 25 percent, fiscal relief might have been expected to be on the scale of 4 percent of GDP. Instead, for the United States, as reviewed below it reached about $5 trillion, or almost one-fourth of the 2020 GDP base.

Large fiscal spending on Covid-19 relief and recovery became the norm for many economies, led by the United States. Several major factors contributed to this outcome. First, for more than a decade, the problem had not been too much inflation but too little, because there was a "zero-bound" to reducing interest rates if monetary stimulus was needed. Second, in the United States there was a dominant perception that too little stimulus had been undertaken to bring the economy out of the Great Recession of 2007-09, leading to a long and slow recovery. Third, there was a dominant perception that "recession" was synonymous with "deficient demand" whereas the pandemic output loss and unemployment surge stemmed in the first instance from a wartime-like loss of available resources due to lockdowns and social distancing. Fourth, there had been a growing sense that there was a fiscal free lunch, because interest rates tended to be lower than the growth rate, so rising public debt would not be a problem given an even more rapidly rising nominal GDP base (Cline, 2021, p. 482).

A prominent warning of an outbreak of inflation from excessive fiscal stimulus in response to the pandemic came in early February 2021 from Lawrence Summers, Harvard economist and former US Treasury Secretary.[19] He estimated that the pending $1.9 trillion covid-19 relief plan of President Biden would add $150 billion per month to demand, far exceeding the existing gap between potential output and demand ($50 billion per month and on a path declining to $20 billion by end-2021 in CBO estimates). He warned of "inflationary pressures of a kind we have not seen in a generation …" After passage of the American Rescue

[18] Calculated from BEA (2022b). Nominal gross product was $6.24 trillion in 2019 for the 113 sectors in the severely affected group, and $31.5 trillion for the rest of the economy. (Note that data on real, rather than nominal, output are not available at this level of sectoral detail.)

[19] Lawrence H. Summers, "The Biden Stimulus is Admirably Ambitious. But It Brings Some Big Risks, Too." *Washington Post*, February 4, 2021.

Plan in early March, 2021, he stated that "I think this is the least responsible macroeconomic policy we've had in the last 40 years."[20]

Several studies have found that fiscal demand stimulus has indeed contributed to the inflationary outbreak of 2021-2022. Research completed at the Federal Reserve Bank of San Francisco in March 2022 concluded that: "since the first half of 2021, U.S. inflation has increasingly outpaced inflation in other developed countries. Estimates suggest that fiscal support measures designed to counteract the severity of the pandemic's economic effect may have contributed to this divergence by raising inflation about 3 percentage points by the end of 2021" (Jordà, Óscar, Celeste Liu, Fernando Nechio, and Fabiàn Rivera-Reyes, 2022.). The authors compare the path of core CPI in the United States to that in other OECD economies. They highlight the surge in US disposable income in two peaks associated with the CARES Act of March 2020 and the American Rescue Plan about a year later. Separating the OECD economies into either a policy-active or policy-passive group, they calculate that by the fourth quarter of 2021 core inflation would have been about 2 percent rather than the actual 5 percent if the US had been in the policy passive rather than active group.

A subsequent study issued by the San Francisco Fed in mid-2022 applied detailed sectoral price data to determine the respective roles of supply shock and demand stimulus as causes of the inflationary outbreak (Shapiro, 2022). Using data on the more than 100 categories of goods and services in the PCE index, Shapiro distinguishes those in which both the price and quantity shifted upward, reflecting increased demand, from those in which the price moved up but the quantity moved down, reflecting a supply shock.[21] He concludes that as of April 2022, about half of the difference in 12-month PCE inflation from pre-pandemic levels was explained by supply factors; demand factors were responsible for about one-third of the difference (and "diminishing more recently"); and the remainder was due to ambiguous factors.[22] The analysis uses 10-year rolling regressions for both price and quantity to identify the baselines against which the unexpected changes from trend occur.

Researchers at the Federal Reserve Board have come to a similar conclusion on a major role of fiscal expansion in contributing to the inflationary outbreak. De Soyres, Santacreu, and Young (2022) estimate that government fiscal spending in 2020 was higher than would have been projected based on 2015-19 trends by about 18 percent in the United States, about 15-17 percent in Canada, the UK, and Japan; about 6-7 percent in Italy, Australia, and Germany; and

[20] Jordan Williams, "Larry Summers blasts $1.9 T stimulus as 'least responsible' economic policy in 40 years," *The Hill*, March 20, 2021 (report of a Bloomberg Television interview on March 18).

[21] The demand curve slopes downward, and the supply curve slopes upward. A shift of the supply curve to the left on the quantity axis, representing an adverse supply shock, causes the equilibrium point to move upward to the left on the demand curve, so price is rising as quantity is falling. Conversely an outward shift of the demand curve causes the equilibrium price to rise along the unchanged supply curve, such that quantity and price move in the same direction.

[22] Thus, with PCE 12-month inflation at 6.3 percent in April 2022, compared to its pre-pandemic rate of 1.5 percent, Shapiro attributes 2.5 percentage points to supply-driven inflation, accounting for about half of the 4.8 percentage point increment.

about 3 percent in France and Sweden. Defining "excess inflation" as the rate in the 12 months to the fourth quarter of 2021 (before the Russia-Ukraine shock) minus the 2015-2019 average rate, they find that "excess inflation is significantly correlated with each country's domestic stimulus". They also find an influence of exposure to stimulus in trading partners, with especially large effect for Canada. They place the impact of domestic stimulus at a 2.5 percentage point increase in US inflation from trend, and a 1.8 percentage point increase in the Euro Area. Research issued at the Federal Reserve Bank of New York in mid-2022 similarly found that demand stimulus played a larger role in the United States than in the Euro Area in the period from the fourth quarter of 2019 to the fourth quarter of 2021 (preceding the shock from the Russia-Ukraine war).[23]

Size and Timing of US Relief and Stimulus Expenditures

Table 2 reports the CBO estimates of the magnitudes and timing of net expenditures of the major Covid-19 relief and other recent major US spending initiatives over the past three fiscal years (ending September). Table 3 reports the CBO's compilation of outlays over this period for the major categories that include pandemic-related spending.

The March 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act, April 2020 Paycheck Protection Program, end-2020 additional coronavirus relief, and March 2021 American Rescue Plan Act together provided net fiscal expansion of approximately $5 trillion over the course of fiscal years 2020, 2021, and 2022. The stimulus flow amounted to 9.7 percent of GDP in FY2020, 10.4 percent in FY 2021, and 1.9 percent in FY2022.

[23] Julian di Giovanni et al (2022). The authors find that "… sectoral labor shortages (supply chain 'bottlenecks') explain around *one-half* of observed inflation in the Euro Area, while these shocks explain only around *one third* of inflation in the US. The remaining part of inflation is explained by the demand side, with aggregate demand playing a larger tole than sectoral demand shifts. … Euro Area-only shocks can only explain roughly one-half of observed inflation. This result confirms the importance of international spillovers in driving the observed 2019Q4-2021Q4 inflation episode and in particular the role of foreign cost shocks in driving Euro Area inflation." (pp. 6-7).

Table 2

Net Increases in US Federal Budget Deficit from Major Spending Initiatives
Fiscal Years 2020-25 ($ billions)

	2020	2021	2022		2020-22	2023-25
Coronavirus Aid, Relief, and Economic Security	1,606	448	-116		1,938	-163
(CARES) Act HR 748. 3-27-20						
Paycheck Protection Program and Health Care	434	0	0		434	0
Enhancement Act, HR 266. 4-21-20						
Coronavirus Response & Relief Consolidated		737	74		811	54
Appropriation Act, PL116-260. 12-27-20						
American Rescue Plan Act 3-6-21		1,164	529		1,693	205
Infrastructure Investment Jobs Act. 11-15-21			-5		-5	134
CHIPS and Science Act. 8-9-22					0	16
PACT Act (veterans). 8-15-22					0	119
Inflation Reduction Act. 8-16-22					0	3
						(-14 a)
TOTAL	2,040	2,349	482		4,871	368
Memorandum: GDP	21,021	22,569	25,000		68,590	…

a. Counting unscored IRS revenue enhancement

Source: CBO (2020b,c; 2021a,b; 2022a,b,c); Zandi and Yaros (2021)

Table 3

US Outlays for Major Budget Categories that Include Pandemic-Related Spending
Fiscal Years 2020, 2021, and 2022 ($billions)

	FY20	FY21	FY22	FY20-22
Refundable Tax Credits	414	778	291	1483
Small Business Administration	577	323	23	923
Unemployment Compensation	476	397	22	895
Coronavirus Relief	149	243	106	498
total	1616	1741	442	3799

Source: CBO (2022e)

Failure to Focus Pandemic Relief

Regarding the Romer and Romer (2022) principle that pandemic fiscal relief should be sharply focused on those employed in affected sectors, the fiscal initiatives in 2020 and early 2021 shown in table 2 broadly did not comply. The signature measure of the CARES act was a "refundable tax credit" (i. e. a credit payable even if there were no income taxes against which to deduct the credit) that varied solely by income and family size, without regard to sector of activity.[24] Refundable tax credits amounted to $230 billion in 2019 (CBO, 2021c).[25] The extra refundable tax credits of the covid-19 relief thus appear to have added about $800 billion to what would have been a baseline total of about $690 billion in this category over the three fiscal years.

The surge in Small Business Administration outlays to a total of $873 billion in FY2020 and FY2021 largely reflected the Paycheck Protection Program. Autor et al (2022) concluded that this program's "meteoric scale-up" reflected its "feature that made it potentially the most problematic: the program was essentially untargeted, aside from excluding firms with more than 500 workers" (p. 2).[26]

The surge in unemployment benefits in FY2020 and FY2021 and sharp decline in FY2022 reflected "enhanced benefits enacted earlier in the pandemic [that] expired in September 2021" as well as fewer unemployed in FY2022 (CBO, 2022e, p. 5). Higher unemployment benefits during the pandemic have a more natural presumption of focusing on those disproportionately affected by disruption from it than outlays in the first two categories of table 2. Although the budgetary title of the fourth category in the table is "coronavirus relief", the relief payments in question were distributed broadly to states and local governments, so this category also is not particularly focused on those most affected.

Table 2 also shows four major spending initiatives enacted in late 2021 through August 2022: the Infrastructure Investment and Jobs Act, CHIPS and Science Act, PACT Act, and Inflation Reduction Act. It is striking that the deficit impact of these four initiatives through fiscal years 2023-2025 amounts to only $272 billion, less than 6 percent of the amount over the

[24] The credit was $1,200 per individual ($2,400 for married taxpayers filing jointly) plus $500 per child. Phaseout began at adjusted gross income of $75,000 per individual ($150,000 per married couple). Congressional Research Service (2020).

[25] The refundable tax credits comprised $114 billion for the child tax credit, $67 billion for the earned income tax credit, and $50 billion for the "premium tax credit" subsidizing purchase of health insurance under the Affordable Care Act.

[26] The authors find that "[A] large fraction of the first two tranches of $525 billion in PPP loan dollars went to businesses that would have remained viable and retained their employees even absent PPP … [but] Congress explicitly targeted the final tranche ($285 billion) in PPP loans in 2021 toward firms that had experienced revenue losses." (p. 23).

three fiscal years 2020-2022 from the first four initiatives shown in the table. By implication, inflationary pressure from fiscal stimulus seems on track to decline sharply.[27]

Table A.1 in Appendix A provides supplementary functional detail on the uses of the four main US fiscal stimulus initiatives shown in table 2. This compilation is from the Pandemic Response Accountability Committee, established in the CARES act. The table shows that the PPP function, in particular, was about equally distributed across the three major initiatives in 2020, rather than being confined to the act specifically named for PPP, for a total of almost $800 billion. Of a total of $5 trillion in spending initiatives, $1.1 trillion went to "individuals", reflecting the large role of the refundable tax credits. About $700 billion went to state and local governments. Combined with the $778 billion that went to PPP, and considering that PPP turned out to be largely unfocused on firms that would have collapsed from pandemic disruption without it (Autor et al, 2022), a total of $2.6 trillion for these three functions (more than half of the overall total) went to generalized stimulus rather than in support focused on sectors and individuals most subject to economic shock from the pandemic.

Two large categories, unemployment and health care, can be interpreted as potentially having been the most focused on those dislocated by the pandemic, at $1.0 trillion and $351 billion respectively. Together they represent one-third of the total in table A.1. If one divides the remaining functional category totals evenly between focused and unfocused, as a working estimate *only about 40 percent of special fiscal expenditure was focused on sectors and populations most subject to economic shock from the pandemic.*[28]

Fiscal Contribution to Inflation

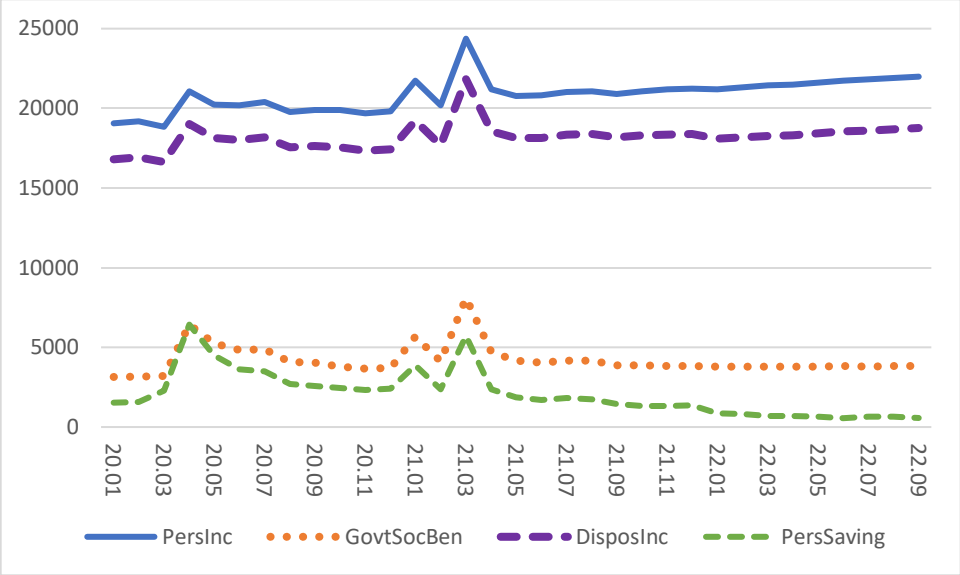
The CBO estimates of the amounts and timing of deficit impacts of the pandemic relief and recovery initiatives provide a basis for quantifying the role of fiscal policy in contributing to the outbreak of inflation in 2021-22, within the framework of the simple Fiscal Quantity Theory suggested above. To analyze the inflationary effect, however, it is necessary to translate the timing of the fiscal outlays into the corresponding timing of increased spending by households.

[27] The table omits future revenue loss of about $400 billion from executive action canceling some student loan debt (CBO, 2020d), as the action is under review by the Supreme Court. Adam Liptak, "Supreme Court to Hear Student Debt Forgiveness Case," *New York Times*, Dec. 1, 2022.

[28] More specifically, 62 percent was unfocused, and 38 percent focused.

Figure 7

US Personal Income, Government Social Benefits, Disposable Income,
And Personal Saving ($ billions)[a]



a. Monthly at seasonally adjusted annual rates
Source: BEA (2022)

Figure 7 shows the paths of monthly personal income, disposable (after-tax) income, government social benefits, and personal saving from January 2020 through September 2022. The sharp surges in early 2020 and early 2021 reflect the timing of the CARES act, the supplementary Coronavirus Relief enacted in December 2020, and the American Rescue Plan. Whereas monthly saving was about $1.5 trillion in January and February of 2020, by April it rose to $6.4 trillion before gradually easing to $2.4 trillion in December 2020. Personal saving then surged again to $5.7 trillion in March 2021, eased to $2.4 trillion by April, and then gradually fell to $1.4 trillion by September 2021 and eventually to only $0.6 trillion by September 2022. Compared to pre-pandemic levels, there has been dissaving for more than one year, as households have run down excess savings from the pandemic relief measures.

As shown in Figure 7, the monthly rate of excess saving peaked in March 2021, at the time of the enactment of the American Rescue Plan. Aladangady et al (2022) estimate that the cumulative stock of excess savings peaked in the third quarter of 2021, and will be exhausted by the first quarter of 2024.[29] On this basis, the time span from enactment of the initiative to exhaustion of induced spending from it would be three years.

[29] Their figure 4 estimates that the stock of cumulative excess savings reached $1.54 trillion in the second quarter of 2021; peaked at $2.26 trillion in the third quarter of 2021; and by the first half of 2022 was falling at a rate of $230 billion per quarter. At that pace the stock of excess savings would be exhausted by the first quarter of 2024.

Table 4 converts the annual totals of the deficit impacts from table 3 into corresponding imputed annual flows in increased aggregate demand. If the initiatives had all been in the form of direct government purchases of goods and services, their demand impact would have been in the same year as their budgetary effect. Instead, as a first approximation the major pandemic recovery initiatives were transfer programs. Households receiving the transfers phased their extra spending over a number of years, not all in the year of the initiative.

Table 4

US Pandemic Fiscal Deficit Impacts and Phasing of Their Impact on Household Consumption
(Fiscal Year, $ billions)

	2020	2021	2022	2023	2024
Deficit Impact	2,040	2,349	482		
Spending Impact from:					
2020	679	679	679		
2021		783	783	783	
2022			160	160	160
total	679	1462	1622	945	160
GDP[a]	21,021	22,569	25,000	26,240	27,291
Spending as % GDP	3.23	6.48	6.49	3.60	0.59

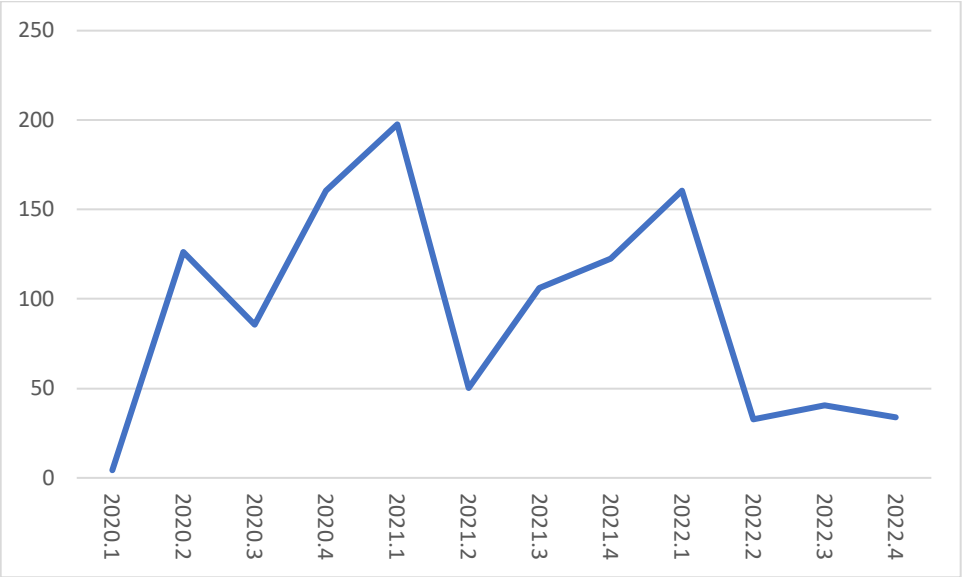
Source: Table 2 and author's calculations.

The Fiscal Quantity Theory approach can then examine inflationary consequences of excess demand from pandemic fiscal stimulus by comparing the time path of their resulting flow of additional household expenditures against output potential over the period in which it is considered that output was supply-constrained. A narrow measure of the constrained period can be set by considering the acute phase of health impact and supply-chain bottlenecks. A broad measure of the supply-constrained period would be to treat the entire period for FY2020 through FY2022 as supply-constrained because in the later part of the three years unemployment was down to a level at or below the natural rate of unemployment and the vacancy rate was high.

Regarding the narrow basis, figure 8 shows the quarterly number of US deaths from Covid-19 during the course of the pandemic. Quarterly deaths peaked at 200,000 in the first quarter of 2021. After declining to 50,000 in 2021:2, deaths were high again in a range of 100,000 to 150,000 quarterly during 2021:3 through 2022:1. Since then the deaths have fallen to a plateau of approximately 35,000 per quarter.

Figure 8

Number of US Deaths from Covid-19
(thousands, quarterly)



Source: calculated from Worldometers (2023)

The "supply constrained economy" from the lockdown and social distancing standpoint was most acute in the first phase, through 2021:1, most importantly because vaccines only became available in early 2021. However, as shown in figure 10 below, supply-chain problems stemming from the pandemic persisted longer, approximately through mid-2022. A "pandemic supply constraint coefficient" might reasonably be set at unity in the first period (through 2021:1), and then at one-half during 2021:2 through 2022:2, and zero thereafter. Applying these coefficients to timing of the phased household spending of pandemic fiscal relief shown in table 4, total excess demand from fiscal initiatives occurring under conditions of constrained supply amounted to $2.0 trillion during 2020-2022.[30] Total GDP in FY2020 through FY2022 was $68.6 trillion. On this basis, the inflationary impact of excess demand under the Fiscal Quantity Theory would have been to increase prices by $2.0 trillion/ $68.6 trillion, or by 2.9 percentage points.

Under the broader approach treating the entire period as supply-constrained because low unemployment and high vacancy rates imposed constraint on supply after health hazard and supply-chain bottlenecks eased, the entire amount of phased spending would be included with a coefficient of unity, amounting to $3,763 billion over FY2020-FY2022 (table 4).[31] This

[30] Applying the respective coefficients of 1 and 0.5, and after taking account of conversion from fiscal year (October to September) to calendar year, the excess demand amounts to $679 billion x 1 + $1,462 billion x 0.5 + $1,622 billion x 0.375 = $2,108 billion.

[31] After surging to 14.7 percent in April 2020, US unemployment was back down to 3.9 percent by December 2021 and 3.6 percent by March of 2022 and after. (FRED, 2023, series UNRATE).

excess demand stimulus would have represented a price increase impact of 5.5 percent under the Fiscal Quantity Theory ($3.76 trillion/ $68.6 trillion). Compared to the cumulative pandemic price shock of 7.74 percentage points (table 1), *the excess demand from pandemic fiscal relief under constrained supply contributed one-third to two-thirds of the total pandemic price shock.*[32]

Additional Demand Still in the Pipeline

Table 4 shows that in 2023 and 2024 the remaining installments of extra demand from the major fiscal relief and stimulus initiatives in 2021 and 2022 will amount to 3.6 percent and 0.59 percent of GDP, respectively. Applying the Fiscal Quantity Theory (FQT) framework proposed above, inflation during the course of 2023 would be expected to reach the pre-pandemic baseline of 2.5 percent for that year (CBO, 2020a), plus 3.6 percent, for a high 6.1 percent from these two influences alone. However, the sharp turn to monetary tightening in 2022 is likely to provide a substantial offsetting reduction in demand from levels it otherwise would have reached in 2023. The spending of the remaining portions of the pandemic stimulus seem more likely to moderate the size of a potential growth slowdown from monetary tightening rather than provide another round of major price increases in 2023 and beyond.[33]

Commodity Prices

The deceleration in inflation following a mid-2022 peak reflects in part the path of major commodity prices. Figure 9 shows the remarkable rise in several of these prices from late 2020 through the second quarter of 2022, followed by partial reductions by late 2022. Translated to December 2019 as the pre-pandemic base, the International Monetary Fund's index for food prices reached 155 in April 2022 before easing to 130 by October (IMF, 2022e).[34] Wheat (especially affected by the Ukraine war) peaked at 250 and eased only to about 200. Only beef was little changed by the end of this period, following a major decline during 2020.

[32] That is: 0.37 to 0.71 of the total price shock.

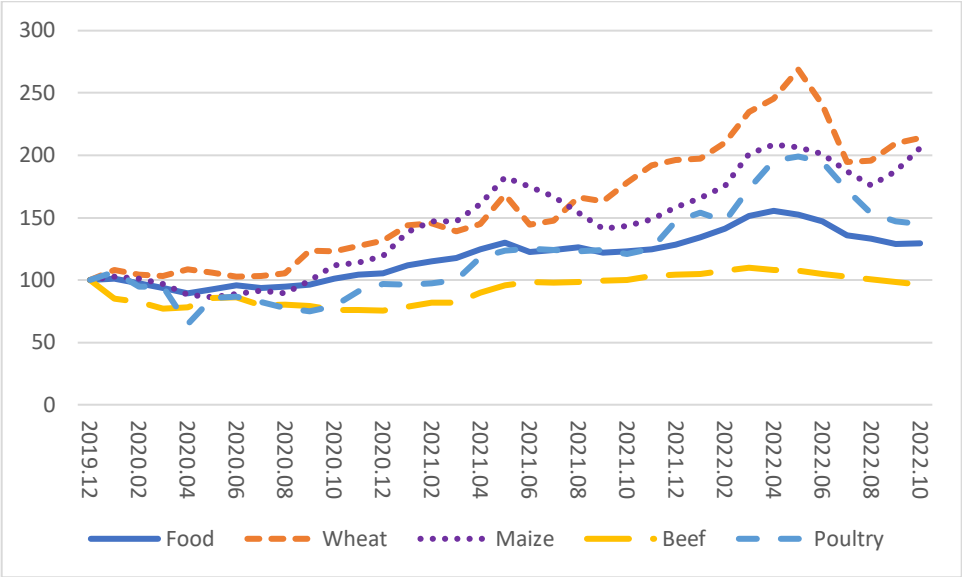
[33] In Cline (2017, p. 9) I estimated that an increase in the interest rate by 100 basis points reduces investment by $343 billion. Adjusting for price increases from 2017 to 2022 (20.6 percent; BLS, 2023a), the amount would be $414 billion. From December 2021 to December 2022 the Federal Reserve raised the federal funds rate from 0.08 percent to 4.33 percent, an increase of 325 basis points. Applying the investment impact coefficient, the expected reduction in investment would amount to $1,346 trillion, considerably larger than the increase in demand contributed by the 2023 installment of delayed household expenditure from the pandemic relief stimulus ($945 billion; table 4).

[34] The price indexes in figure 9 are based on dollar prices.

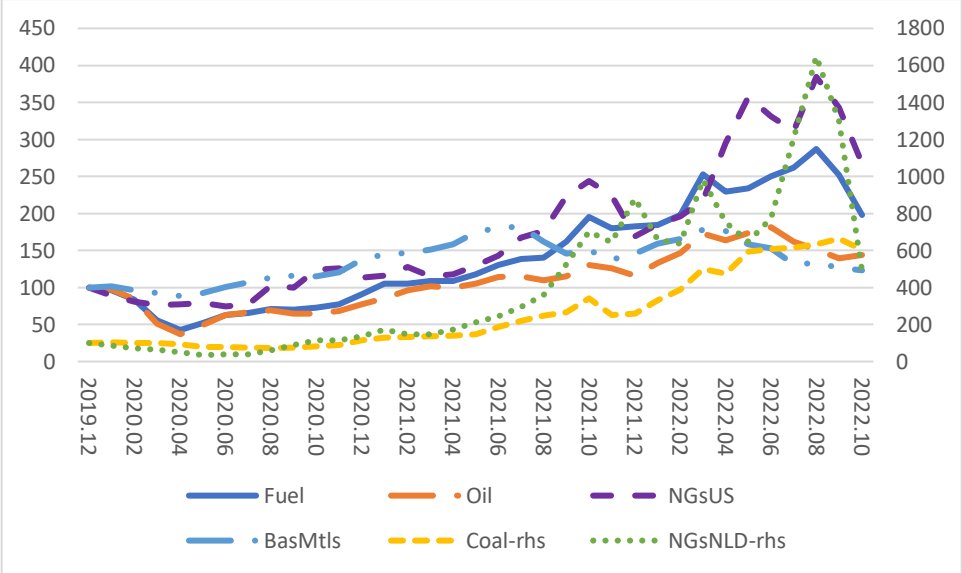
Figure 9

Commodity Prices (Dec. 2019 = 100)

A. Food



B. Energy and Base Metals[a]



a. Includes Aluminum, Cobalt, Copper, Iron Ore, Lead, Molybdenum, Nickel, Tin, Uranium, and Zinc

Source: IMF (2022e)`

Price increases were more extreme for some of the energy commodities, shown in panel B of the figure. Reflecting the cutoff in imports from Russia, natural gas prices in Europe (Netherlands) soared from an index of 100 in December 2019 to 1650 by August 2022 before

falling to 490 in October (right-hand scale). In the United States natural gas reached an index of 660 in September (left-hand scale), easing to 600 in October. The full category of fuel (energy) rose to a peak of about 290 in August 2022 before falling to about 200 in October. Oil peaked at an index of about 180 in June 2022 before falling to about 140 by October. Panel B also shows base metals, whose prices peaked in mid-2021 at about 180, and by late 2022 had fallen to about 125.

Easing Supply-Chain Constraints

As discussed above, estimates by Shapiro (2022) on the negative versus positive correlation between price and quantity movements in detailed price index categories suggest that about one-half of the US inflation surge has been driven by supply constraints. A major example has been the limited supply of new cars as a consequence of semiconductor shortages.[35]

Researchers at the Federal Reserve Bank of New York have developed a "Global Supply Chain Pressure Index" (Benigno, Giovanni, Groen, and Noble, 2022). Its first set of components tracks shipping costs (Baltic Dry Index for shipping raw materials such as coal and steel; Harpex index for container shipping rates). A second set of components uses Institute of Supply Management surveys of manufacturing (Purchase Manager Index, PMI) for China, Japan, Korea, Taiwan, the UK, and the US. Three PMI subcomponents are considered: delivery time, backlogs, and inventory accumulation. Their summary index begins in 1997, and their measure of "pressure" is the number of standard deviations above the average for the 25-year series. This GSCPI has reached far higher levels in the pandemic than in the two previous decades.[36] Figure 10 also reports an index of the global cost of shipping a 40-foot container (Statista, 2022).

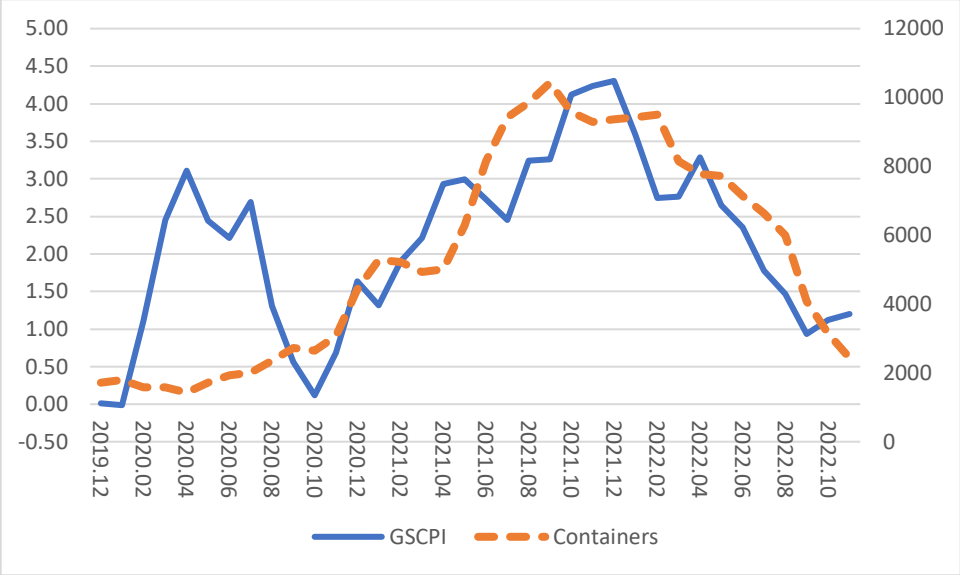
Only the GSCPI index shows a surge at the outset of the pandemic, which its authors attribute to imposition of lockdown measures in China. From relatively low levels by the third quarter of 2020, both the GSCPI and the container shipping cost index track a steep rise ("with COVID resurgent") to a peak in the second half of 2021 (Benigno et al, 2022), followed by a relatively steady and large decline through 2022. The indicators provide a degree of comfort that improving supply conditions should help extend the deceleration in inflation shown in figures 1 and 2.

[35] Early in the pandemic auto manufacturers canceled semiconductor orders. Manufacturers of semiconductors have given priority to smartphones and other consumer electronics, and carmakers comprise only a small fraction of semiconductor sales. Alex Bernstein, "Latest New Car Chip Shortage Updates," carsdirect.com, October 31, 2022; Jack Ewing and Neal E. Boudette, "A Tiny Part's Big Ripple: Global Chip shortage Hobbles the Auto Industry," *New York Times*, October 14, 2021.

[36] The previous peak was at about 1.6 times the standard deviation, in late 2011. In contrast, during 2021 and the first half of 2022, the index ranged between two and four times the standard deviation.

Figure 10

Indicators of Global Supply Chain Constraints
(Number of standard deviations from 25-year index average, left;
$US per 40-foot container, right)



GSCPI: Global Supply Chain Pressure Index
Source: FRBNY (2022b), Benigno et al (2022); Statista (2022)

Anchors Away?

A crucial issue in the effort to stem the inflationary outbreak is whether the expectational anchor to inflation has been dislodged by the sharp increase in prices. Appendix B sets forth the Phillips Curve framework for inflation. In this framework, wage increases are driven by expected price increases combined with the tightness of the labor market, measured by the difference between the unemployment rate and the "natural rate of unemployment" (or "non-accelerating inflation rate of unemployment"). For its part, the expected price increase is a weighted average of the "anchor rate" and the recent actual rate of inflation (e.g. the previous year's rate). Realized inflation is then determined by the increase in wages minus the rise in real labor productivity. In this framework, if the weight of the inflation anchor in expectations falls sharply, and the weight on recent inflation rises sharply, the system moves toward an accelerationist mode, in which inflation begins to feed on itself by prompting higher demands for wage increases.

A simple regression for the past 62 years finds that annual inflation, measured by the PCE excluding food and energy, equals 1.66 percent plus 0.55 times the increase in labor cost minus the increase in labor productivity).[37] The constant of about 2 percent suggests support

[37] The labor cost measure is percent increase in private sector employee compensation per hour; the productivity measure is percent increase in nonfarm business sector real output per hour for all employed persons. The

for the notion that such a level is a long-term anchor of expectations, while allowing for falling weight attached to that anchor by labor in wage demands during periods of high inflation, especially the late 60s through the early 1980s.

In its October 2022 World Economic Outlook, the International Monetary Fund reported an optimistic research finding suggesting that the de-anchoring of inflationary expectations in advanced economies after the pandemic was unlikely. It reported that:

> Historical episodes in advanced economies exhibiting wage, price, and labor market dynamics similar to those of the current circumstances – in particular, economies in which real wages … have been flat or falling … did not tend to show a subsequent wage-price spiral. … Given that inflationary shocks are originating outside the labor market, falling real wages are helping to slow inflation, and monetary policy is tightening more aggressively, the chances of persistent wage-price spirals emerging appear limited. (IMF, 2022c, p. 51).

However, in the report's online statistical appendix (IMF, 2022c, Annex 2.1, p. 9), it becomes clear that of the 22 episodes used in its test, inflation had reached high levels in just a few. Thus, if 7 percent CPI inflation is applied as a threshold that can shock expectations out their anchor, only 3 episodes meet the test.[38] In contrast, in the 2021-22 inflation outbreak, 12-month CPI inflation reached peaks exceeding 7 percent in all of the G-7 economies except Japan (figures 1A and 2A above).

Bianchi and Melosi (2022) add an important reason for concern about the anchor of inflation expectations. They contend that:

> The recent fiscal interventions in response to the COVID pandemic have altered the private sector's beliefs about the fiscal framework accelerating the recovery, but also determining an increase in fiscal inflation. This increase could not have been averted by simply tightening monetary policy. The conquest of post-pandemic inflation requires mutually consistent monetary and fiscal policies to avoid fiscal stagflation (p. 1)

regression explains about two-thirds of variation in inflation, with a high degree of significance (t-statistics of about 8 for the constant and 11 for the wage growth-productivity growth difference). (Appendix B.)

[38] Australia in 1980 (10.1 percent); Slovenia in 2000 (8.9 percent); and the United States in 1980 (13.5 percent). For the other 19 episodes, the median inflation was only 2.8 percent. (Calculated from IMF, 2022d).

In their model, the authors distinguish between a region of Active Monetary/ Passive Fiscal policy and a region of Active Fiscal/ Passive Monetary policy.[39] In the first, the Taylor principle is followed by monetary authorities to keep inflation under control while also addressing cyclical downturns, and the fiscal authority moves taxes to keep the ratio of debt to GDP from rising except when a recessionary shock occurs.[40] In the second, "the monetary authority … passively accommodates the behavior of the fiscal authority, … allowing inflation to move in order to stabilize the process for debt [ratio of debt to GDP]." (p. 11). By implication, inflation is allowed to rise as needed to shrink the real value of debt in the Active Fiscal regime. The expectational inflation anchor in the Phillips Curve and in labor negotiations would accordingly disappear in the Active Fiscal regime.

Beveridge Curve and Labor Force Participation Rate

The Rise in the Vacancy-to-Unemployment Ratio

Even if the expectational inflation anchor has not been blown away by the inflationary outbreak of 2021-22, there is another complication to inflation dynamics that poses problems for curbing inflation. For the United States, the so-called Beveridge Curve has shifted upward. In this curve, the unemployment rate is shown on the horizontal axis, and the vacancy rate is shown on the vertical axis. The vacancy rate is the ratio of job openings to the size of the labor force. Not surprisingly, the curve (or straight line) slopes from the upper left to the lower right, because there will tend to be more jobs available and less unemployment when the economy has relatively high job openings (vacancies).

In mid-2022, Blanchard, Domash, and Summers (2022a, p. 13) concluded that:

> The low unemployment rate and the very high vacancy-to-unemployment ratio suggest that not only is the labor market overheating but also the natural rate of unemployment has substantially increased, reflecting worse matching and higher reallocation. And the hope that a decrease in the vacancy-to-unemployment ratio can be achieved without much of an increase in unemployment flies in the face of theoretical and empirical evidence.

The authors judged that the shift in the Beveridge Curve implied that the US natural rate of unemployment (or non-accelerating inflation rate of unemployment, NAIRU) had increased

[39] The model is a dynamic-stochastic general equilibrium model (DSGEM), with an infinite horizon and with calibrated (as opposed to econometrically estimated) parameters.

[40] The Taylor rule has typically been interpreted as seeking target inflation of 2 percent, while placing the policy Federal Funds interest rate at 2 percent real and hence 4 percent nominal, under conditions of full employment and when inflation is at target. If inflation diverges from target, or if the level of activity diverges from the potential (full-employment) level, the policy rate is changed based on half weight placed on the inflation divergence and half on the output divergence. (Taylor, 1993; Cline, 2005, pp. 143-44.)

by about 1.3 percentage point from its pre-pandemic level (p. 2). By implication, the Phillips Curve would also have shifted up.[41]

Gagnon and Collins (2019, figure 6, p. 14) estimate a Phillips Curve for the United States that, in periods of high inflation, finds an increase of one percentage point in the unemployment rate reduces the inflation rate by 0.66 percentage point. (This parameter is not far from the corresponding 0.55 identified in Appendix B for the period 1960-2022). In December 2019 the US unemployment rate was 3.6 percent (BLS, 2023c). If one takes this point of departure as representing NAIRU prior to the pandemic, then the increase of 1.3 percentage point diagnosed by Blanchard, Domash, and Summers would place the natural rate of unemployment post-pandemic at 4.9 percent.

If the rise in the ratio of vacancies to unemployed has mainly been driven by temporary withdrawal of workers from the labor force because of Covid-19 and its aftermath, the implication would be that the Beveridge curve could shift back down as labor market conditions normalize. In that case a rise in the natural rate of unemployment, as diagnosed by Blanchard, Domash, and Summers, could be expected to be temporary, or at least to moderate as workers re-enter the labor force. The actual path of the vacancy rate does show at least some recent normalization with no cost in increased unemployment, as the US vacancy rate fell from 7.1 percent in the first quarter of 2022 to 6.2 percent in the fourth quarter, but unemployment fell rather than rising over this period (from 3.8 percent to 3.6 percent).[42]

Labor Force Participation Rate and Demographics

Labor force participation rates as measured by the Bureau of Labor Statistics do show a sharp initial decline in the second quarter of 2020 with the outbreak of the pandemic, and a subsequent recovery that has not been complete (figure 11). Thus, the number of employed and unemployed workers, as a percent of the population age 16 and older, fell from 63.3 percent in the fourth quarter of 2019 to 60.8 percent in the second quarter of 2020 in the acute initial phase of the pandemic. By the fourth quarter of 2021 the rate had only returned to 61.8 percent, and by the fourth quarter of 2022, to 62.2 percent. At least through late 2021, BLS authors cited "people choosing not to return to work because of health risks, early retirements, and family care duties" (as factors contributing to the incomplete recovery in labor force participation.[43]

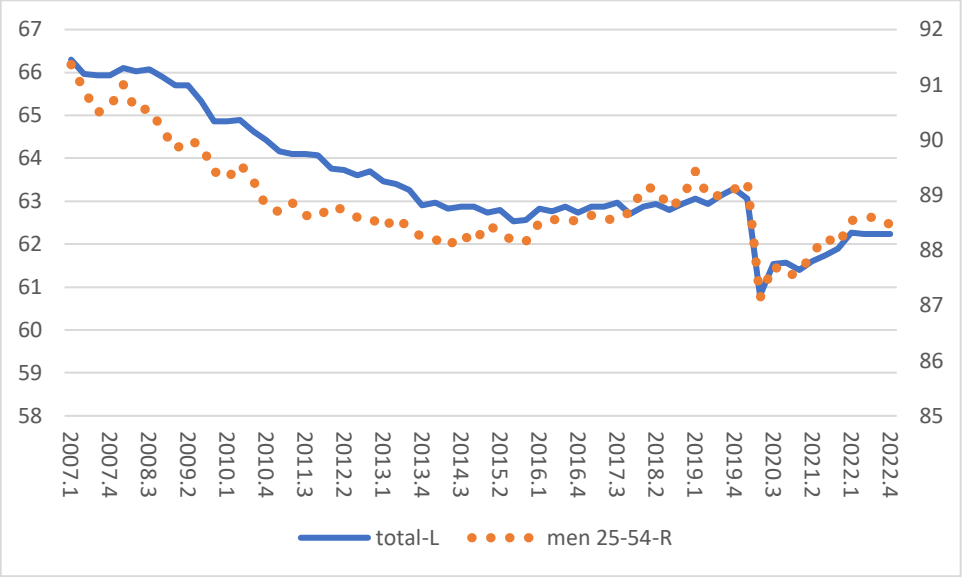
[41] Figura and Waller (2022) critique Blanchard, Domash, and Summers (2022a) for failing to use "standard" parameters for the curvature of the Beveridge Curve and hence not recognizing that with unemployment so low, a large reduction in the vacancies rate (and hence labor market pressure) would be possible with just a modest increase in unemployment. The three authors issued a blistering reply emphasizing that in actual practice the Beveridge Curve has been close to a series of straight lines rather than sharply convex (Blanchard, Domash, and Summers, 2022b).

[42] FRED (2023), series JTUJOR, UNRATE.

[43] Edwards, Essien, and Levinstein, 2022.

Figure 11

US Labor Force Participation Rate, 2007-2022 (percent)



Source: FRED (2023)[44]

Demographics also seem likely to have contributed to incomplete return of the participation rate.[45] In figure 11, it is evident that there has been a somewhat greater rebound for men of prime working age (25 to 54). More generally, the practice of using the entire population of ages 16 and above as the denominator for the participation rate implies either that workers never retire or that the demographic composition of the population remains unchanged; neither is the case. If one instead uses the "working age population" calculated as ages 15 through 64, and compares the labor force (civilian employed plus unemployed) to that base, from December of 2019 to December of 2020 the participation rate fell from 79.8 percent to 78.1 percent, and by December 2022 it was back up to 79.5 percent.[46] If this alternative measure is used, there would seem to be little scope remaining for a rebound in the participation rate as a mechanism for reducing the vacancy rate.[47]

From 2007 to 2014, the US population age 65 and older rose from 15.6 percent of the population 15 and older to 18.0 percent; by 2020, this older-population share had reached 20.9 percent.[48] The rising share of older population in the first period reflects the

[44] Series CIVPART and LRAC25MAUSM156S.
[45] For an earlier examination of the relative role of demographics versus worker discouragement in the declining participation rate after the Great Recession of 2007-09, see Cline (2014).
[46] The 15-64 years working age population is reported in FRED (2023), series LFWA64TTUSM647S.
[47] In contrast, using the BLS metric, restoring the labor force participation rate from 62.2 percent to the pre-pandemic 63.3 percent would increase the labor force by 1.77 percentage points. (That is: 63.30/62.23 = 1.00177.)
[48] Calculated from Census (2009, 2017, 2020).

timing of the post-war baby boom, and helps explain the persistent decline in the participation rate from 2007 through 2014 shown in figure 11.

Re-estimating the Phillips Curve Directly Using the Vacancy Ratio

Ball, Leigh, and Mishra (2022) argue that "the many economists on Krugman's (2021) 'Team Transitory,' including the authors …" had underestimated prospective inflation not only because of unanticipated shocks to headline inflation, especially supply chain disruptions and the energy price shock from the Ukraine war, but also because of "flaws in our pre-pandemic understanding …" (p. 18).[49] They cite three. First, the usual measurement of labor market tightness by the deviation of unemployment from its natural rate did not anticipate "the dramatic increase in the job vacancies-to-unemployed ratio …" that occurred by late 2021. Second, even considerations of a tightening labor market typically treated the inflationary effect as linear and modest. Third, the typical assumption was that "deviations of headline inflation from core would not feed into core …", making it possible to ignore the already large shocks in headline inflation by mid-2021.

The authors directly incorporate the ratio of vacancies to unemployment in estimating a Phillips Curve explaining core inflation as measured by the median consumer price index estimated by the Cleveland Federal Reserve Bank. In their main estimate, using quarterly data from 1985 to 2022, inflation equals a constant plus third-degree polynomial functions of the vacancies/unemployment ratio and of a headline inflation shock measure. The authors estimate that of the 7.2 percentage point rise in inflation from 1.3 percent at end-2020 to 8.5 percent in July 2022, headline inflation shocks account for 5.5 percentage points; the rise in labor market tightness (vacancies/unemployment), 1.0 percentage point; and a rise in expected inflation, 0.5 percentage point (p. 2). Applying their model, the authors conclude that "The forecasts of the Fed policymakers – inflation will return to target while unemployment barely rises above four percent – are reasonable only under quite optimistic assumptions about both the Beveridge curve and expectations" (p. 29). However, the strong nonlinearity of their headline inflation shock suggests the possibility of favorable surprise.

Pandemic as Temporary Aberration?

An important question is whether it is possible to use historical data to estimate a Phillips Curve relevant to the current situation even with special tailoring to capture the recent unusually high vacancy/unemployment ratios. One can imagine a time-series statistical model of inflation estimated 10 years in the future using then-historical data, showing an evident bulge in inflation in 2021-22 and seeking to explain it. As a first approximation, such an estimate could simply apply a "Covid-19 dummy variable" that would be likely to have a

[49] The authors noted that their analysis "overlapped" with that of Furman (2022a). Writing in early August, Furman placed underlying US inflation at 4 percent or more. Citing a "sacrifice ratio" of 5, he judged that reducing inflation to 3 percent would require "at least five point-years more of unemployment" (p. 2.)

statistically significant positive coefficient.[50] Ideally such a model would sort out inflationary pressure from standard sources, by including such variables as a measure of excess demand associated with large fiscal recovery transfers.

Because there has been no comparable pandemic for more than a century, the data set available for modeling inflation does not include a basis for estimating the likely inflation impact of this one. The aberration perspective helps explain the initial attraction of the "team transitory" viewpoint, and potentially retains relevance despite the much longer and stronger inflation surge than expected by that team. The strength of the "pandemic aberration" influences how aggressively it is advisable to pursue demand control and accept substantially higher unemployment as the means to curb the outbreak of relatively high inflation that has occurred.

Forecast Conflict between Model and Looking Out the Window?

With the average six-month annualized rate of inflation for the four principal measures of US inflation (CPI and PCE, each with and without food and energy) at 3.5 percent in December 2022 (figure 1), and despite its return to 4.6 percent in January, there has been substantial progress in curbing the inflationary outbreak of 2021-2022. Yet application of the Phillips Curve adjusted for the Beveridge Curve tends to suggest considerably higher inflation in 2023 and 2024 unless there is a sizable rise in unemployment and decline in the vacancy-to-unemployment ratio. For example, Jason Furman (2022) applies the Ball-Leigh-Mishra model using his own most reasonable parameter assumptions, and finds that with unemployment levels projected by the Federal Reserve's Open Market Committee, median CPI inflation would be 7 percent in 2023:1, 5.5 percent in 2023:4, and still 3.7 percent by 2024:4.[51] The prediction of high inflation in 2023 is driven by the high ratio of vacancies to unemployment.[52]

The influence of tightness in the labor market on wage increases, and the influence of wage increases of inflation, are at the center of the Phillips Curve/ Beveridge Curve models. So it is useful to consider the recent path of increases in labor cost growth as additional information on whether inflation has slowed meaningfully. Figure 12 shows US labor cost inflation as measured by the Employment Cost Index of the Bureau of Labor Statistics (BLS, 2023d).

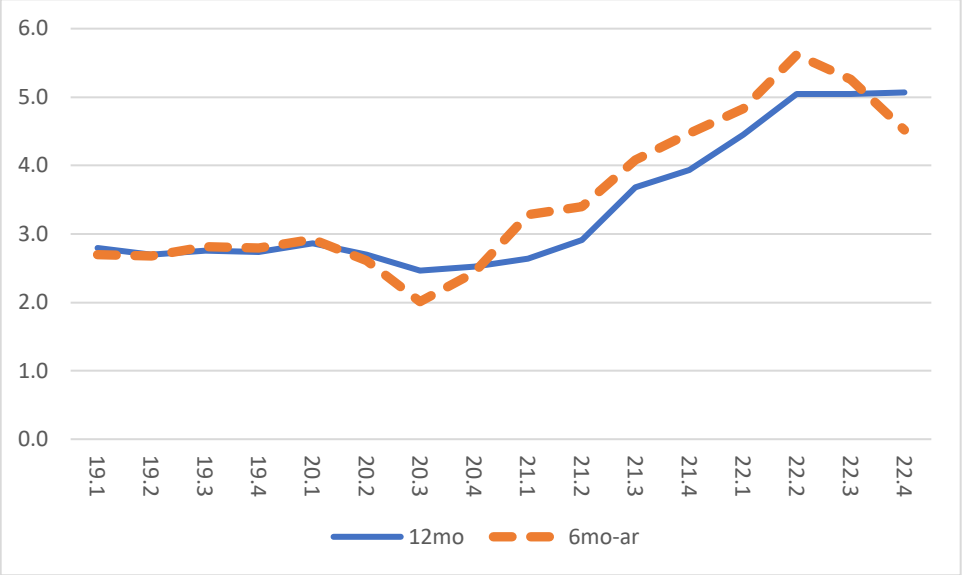
[50] The dummy variable takes a value of 1 during the period of the disturbance and 0 in all other periods. Its estimated coefficient then tells the size of the aberrational influence (e.g. a pandemic). An example of a strong dummy variable is the upward shift in the price-earnings ratio in equity valuations during the late 1990s run-up to year 2000 (Cline, 2022, p. 128).

[51] Furman assumes that the Beveridge Curve shifts two-thirds of the way back to where it was before the pandemic; inflation expectations remain as well anchored as they were in the decade before the pandemic and also shift halfway down to where they were in that period; and that there is a favorable downward shift in headline inflation by one percentage point from September to December 2022, in part reflecting lower gasoline prices. See minutes 17:25 – 20.56 in his comment on the Ball-Leigh-Mishra paper.

[52] Laurence Ball, by communication.

Figure 12

Increase in the US Employment Cost Index:
12 month and 6-month annualized rates (percent)



Source: FRED (2023)[53]

As shown in figure 12, whereas labor cost growth appears to have stalled in the second half of 2022 at a high rate of about 5 percent using the 12-month measure, the more sensitive 6-month annualized rate shows that it has fallen significantly from a trend pace of 5.6 percent in the second quarter of 2022 to 4.5 percent in the fourth.[54] The latter rate would be consistent with PCE inflation at 3.7 percent.[55]

A further consideration regarding the degree of divergence between model expectations and the deceleration of the 6-month annualized rate of US inflation by December is that most models likely show less inflation for 2023 than does the Ball-Leigh-Mishra model, which gives large, non-linear emphasis to headline inflation over the preceding year. Thus, the November 2022 survey of professional forecasters by the Philadelphia Federal Reserve (FRBPhil, 2022b) found that their median forecasts for inflation from fourth quarter 2022 to fourth quarter 2023 were 3.4 percent for the CPI, 3.5 percent for core (excluding food and energy) CPI, 2.9 percent for the PCE, and 3.0 percent for core PCE – or 3.2 percent for a simple

[53] Series ECIALLCIV.

[54] The ECI is quarterly. The six-month rate annualized is calculated as 100 x $[(1+c_q/c_{q-2})^2-1]$, where c is the ECI and q is the quarter.

[55] Gagnon and Rose (2022, p. 2) find that over the past two decades, PCE inflation has averaged 0.8 percentage point below ECI inflation. In November 2022 Furman and Powell (2022) argued that with recent wage growth at 5-1/2 percent, core PCE inflation of 4-1/2 percent would be expected. With the six-month annualized rate of labor cost growth down to 4-1/2 percent by December (figure 12), the corresponding outlook would be for 3-1/2 percent PCE inflation.

average of the four measures. The corresponding simple average (of the medians) for the year ending 2024:4 was 2.45 percent.

Nonetheless, the 6-month trend inflation outcome by December 2022 likely understated prospective inflation because of at least two considerations. First, prices were dragged down by the reversal of previous sharp increases associated with the pandemic in certain sectors beyond food and energy. Thus, from December 2021 to June 2022 the price index for used cars had risen 37.8 percent; this index then fell by 9.2 percent from June to December. For the same periods, airline fares rose by 52.4 percent and then fell by 17.6 percent (FRED, 2023).[56] Second, prices in major service sectors are likely to continue to be feeding in adjustments that take much longer than price swings in goods markets. In particular, rents continued to accelerate from the first half of 2022 to the second half, rising 3.6 percent from December to June and then by 4.6 percent from June to December (FRED 2023)[57]. And indeed, the 6-month annualized rate for the CPI did rebound in January 2023 (figure 1).[58]

Overall, these considerations suggest that *inflation in 2023 could well be in a range of 3½ to 4 percent.*

Adding Another Instrument: an Inflation-contingent Income Tax Surcharge

The pandemic breakout of high inflation in 2021-22 warrants renewed attention to the scope for incorporating fiscal restraint to cooperate with monetary restraint in the effort to curb inflation. There is a historical precedent for doing so: the US income tax surcharge enacted in 1968.

The combination of Vietnam War expenses and expansion of welfare programs under Lyndon B. Johnson's "Great Society" brought an acceleration of inflation from 1.6 percent in 1965 to 4.3 percent by 1968 and 5.8 percent by 1970 (FRED, 2023)[59] – numbers that sound familiar once again.[60] The Revenue and Expenditure Control Act of June 1968, the final year of Johnson's administration, imposed a one-year 10 percent surcharge on income taxes for individuals and corporations. The act also reduced expenditures in all budget categories except Vietnam operations, veterans' benefits, and social security, by an amount representing about 0.85 percent of GNP. The tax surcharge yielded revenue of about 1.5 percent of GNP (CEA, 1969, pp. 38-39; 227).

The fiscal balance, which had fallen from a surplus of 0.6 percent of GDP in 1965 to deficits of 0.2 percent of GNP in 1966 and 1.6 percent in 1967, swung to a surplus of 0.86

[56] Series CUSR0000SETA02, CUSR0000SETG01.
[57] Series CUSR0000SEHA.
[58] The seasonally adjusted 6-month annualized rate rose from 2.9 percent in December to 4.1 percent for the CPI, and from 5.1 percent to 5.3 percent for the CPIxFE (BLS, 2023b,c).
[59] Series FPCPITOTLZGUSA.
[60] The acceleration of inflation in the late 1960s predated further acceleration from the oil price shocks of 1973-74, associated with the Yom Kipur War, and 1979-80, associated with the Iranian revolution. Graefe (2013).

percent of GNP in 1968 and 1.6 percent in 1969 (CEA, 1970, pp. 32, 177). In his 1971 analysis of the effectiveness of the surcharge, Okun (1971) applied four leading econometric models. Their average measure of the actual against expected impact was 75 percent (p. 196). Demand for automobiles proved to be the main area in which the outcome failed to confirm the expectation.[61] Although inflation had continued to rise until after the 1970 recession, Okun argued that "the patient was more feverish than the doctors recognized … But don't blame the medicine; it did most of what it should reasonably have been expected to do" (p. 200).[62]

Ideally, an Inflation-contingent Income Tax Surcharge (ICITS) would be contingent on the state of inflation rather than limited to a single year. For example, the surcharge could be specified to remain in place until the most recent 12-month inflation rate (or 6-month annualized rate) fell below, say, 3.5 percent. At such point, further reduction of inflation would be expected to revert to management solely through monetary policy.

The distributional consequences of the ICITS would tend to be favorable, because the inflation tax hits poor households disproportionately, whereas income taxes are progressive.[63] The average federal tax rate for the lowest quintile of households in 2019 was 0.5 percent; for the middle three quintiles, 13.9 percent; for the 81st to the 99th percentile, 22.1 percent; and for the top 1 percent, 30 percent (CBO, 2022f, p. 26).

Dynan (2022) argues that the use of fiscal policy to fight inflation stemming from the pandemic shock would be ill-advised. She judges that:

> … raising taxes on middle- and lower-income households could exacerbate the hardship felt by those whose spending power is being eroded by inflation. Raising taxes on higher-income households might have little effect on aggregate demand because of the traditionally low spending propensity of this group (particularly given the additional savings accumulated during the pandemic). Fiscal policy is also not particularly nimble, an important consideration given the uncertain future path of inflation. Fiscal policymakers would have to guess at how long to impose fiscal austerity, and if inflation were to retreat unexpectedly quickly, altering policy in a

[61] A plausible reason for that outcome (not mentioned by Okun) is that households were reacting to the persistent increase in inflation by purchasing real assets, notably housing and automobiles.

[62] Inflation averaged 5.6 percent in 1969-70 before falling to 4.3 percent in 1971 and 3.3 percent in 1972. FRED (2023, series FPCPITOTLZGUSA). Note further that although Springer (1975) produced an econometric model that found "the 1968 surcharge did *not* lead to a significant reduction in consumption expenditures" (p. 645), Okun (1977) replied "Springer's article is unique in economic literature in purporting to resolve an empirical dispute among alternative equations without recourse to empirical evidence on their comparative performance." He also observed that "Most theorists support the permanent income (or long-horizon or life cycle) hypothesis …" [Springer's key premise limiting consumption response to tax changes] [but] most econometricians continue to rely on formulations with fairly short lags because they find them to work better empirically, particularly in capturing the cyclical swings in consumption" (p. 167).

[63] Inflation reduces real income by raising the price of consumption. The share of income going to consumption is higher for the poor than for the rich (concave consumption function).

short time frame could be difficult. The Federal Reserve has effective tools for managing inflation and should be primarily responsible for doing so.

However, the tax rates by quintile show that the burden of a tax surcharge would not fall on low-income households. The surge in demand that occurred from pandemic tax credits that included middle- and even relatively high-income households (implied by figure 7) suggests that there could be more response of consumption to the income tax surcharge than might be thought under the assumption of low marginal propensities to consume. The reduction in deficits from their alternative path would provide room for the Federal Reserve to raise interest rates less than otherwise, reducing distortions introduced by sole reliance on high interest rates (appreciation of the dollar with adverse implications for exports and manufacturing, concentration of impact on housing and on technology sectors where the importance of long-term growth magnifies interest rate effects). Formulation of the surcharge as contingent on high inflation would make it much more "nimble" than fiscal cuts on (for example) highway projects. Lags from monetary policy would not necessarily be much shorter than lags from the ICITS, especially if it were calibrated based on six-month annualized rather than 12-month inflation.

More fundamentally, a basic principle should be that curbing inflation will usually require a combination of both fiscal and monetary restraint in order to be accomplished in the least costly way. It is unclear why the pandemic inflation should be an exception.[64]

How Much Inflation Relief?

In fiscal 2022, US revenue from individual income taxes amounted to 10.5 percent of GDP; revenue from corporate income taxes was 1.7 percent of GDP (CBO, 2022e, p. 3). A 10 percent surcharge on personal and corporate income taxes would thus raise revenue amounting to 1.22 percent of GDP. If the effective translation of the increased revenue to reduced consumption and investment were one-half, the reduction in demand would amount to 0.6 percent of GDP. Within a framework of a Fiscal Quantity Theory of inflation under constrained supply (FQT), perhaps 60 basis points would be cut from the price increase during the year that would occur otherwise (for example, from 4.5 percent to 3.9 percent).

Perhaps more important than the direct effect, however, could be an indirect signaling effect. Adoption of an anti-inflation income tax surcharge would be a strong signal that politically a return to the high inflation of the late 1960s and the 1970s would be unacceptable. As such, it could help ensure that the pandemic shock will not translate to a de-anchoring of inflation expectations.

[64] For a recent call to integrate fiscal policy to support monetary policy in dealing with the pandemic inflationary outbreak, see Adrian and Gaspar (2022).

What Target for Inflation?

Over a decade, inflation at 7 percent cuts the real value of money by one half.[65] The fraction of real value lost at 6 percent inflation is 44 percent; at 5 percent inflation, 39 percent; at 4 percent inflation, 32 percent; at 3 percent inflation, 26 percent; and at 2 percent inflation, 18 percent real loss. The Federal Reserve has long placed its inflation target at 2 percent, and continues to do so.[66]

Three considerations raise the question of whether this target is too low. The first is that it may not leave enough room for cutting interest rates to stimulate the economy in a recession. This is the "zero bound" problem whereby (at least for the United States) a negative interest rate has not been an option. Quantitative Easing, large-scale purchases of Treasury bonds and mortgage backed securities by the Federal Reserve in 2008 and after, revived forcefully in 2020 in the face of the pandemic recession, has been the instrument designed to address this constraint.[67]

The second consideration has been that the Phillips Curve may be extremely flat at low inflation rates, making the trade-off between additional inflation reduction and the additional unemployment required disproportionate. As noted, Gagnon and Collins (2019, p. 14) find that when inflation is high, each percentage point increase in unemployment provides a reduction in inflation by 0.66 percentage point. However, they estimate that when inflation is below 3 percent, this trade-off falls to only 0.1 percentage point of further reduction in inflation per percentage point increase in unemployment.[68]

A third consideration in identifying the right inflation target is the level of inflation at which the risk of de-anchoring begins to be pronounced. Korenok, Munro, and Chen (2022) apply Twitter and Google mentions of "inflation" in 37 countries to estimate thresholds at which mentions of inflation begin to rise with further increases of inflation. For the United States, they find this threshold is about 3.3 percent (their table 3).[69]

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[65] By the rule 70, whereby a variable (in this case the price level) doubles over the number of years equal to 70 divided by its annual percent growth rate. More generally, over *t* years, annual inflation at numerical rate *r* (e.g. 0.02 for 2 percent) cuts the real value of money by the fraction: $1-[1/(1+r)^t]$

[66] Michael S. Derby, "Powell Says Fed Will Not Change 2% Inflation Goal," *Reuters*, December 14, 2022.

[67] Luck and Zimmerman (2019) observed that although the efficacy of Quantitative Easing remained controversial, their evidence from county-level exposure to mortgage-backed securities showed that "Like an interest rate cut … QE can lead to additional bank lending, which in turn translates into additional economic activity" (p. 5).

[68] They state: "An important argument for a nonlinear Phillips curve is that downward nominal wage and price rigidity reduces the slope of the Phillips curve when unemployment exceeds the NAIRU and inflation is very low" (p.5), and note that the author of the Phillips curve had made this point in his 1958 paper (Phillips, 1958).

[69] Also see Olivier Blanchard, "It is Time to Revisit the 2% Inflation Target," *Financial Times*, November 30, 2022. He cites "salience" as grounds for considering that "… the right target for advanced economies such as the US might be closer to 3 percent than our original 4 per cent proposal," referring to his 2010 proposal with Giovanni Dell'Aricia and Paolo Mauro.

Overall, these considerations suggest that a reasonable target for US inflation might be closer to 3 percent rather than the 2 percent target of the Federal Reserve.

Conclusion

This review of the inflationary outbreak finds that in the United States, fiscal relief of about $5 trillion was not well focused and hence excessive in a context of reduced supply. Only about one-fourth of output was in sectors severely affected by the pandemic in 2020, and only about 40 percent of spending in the major fiscal initiatives went to functional categories that were plausibly focused on affected populations (primarily unemployment compensation and health care). Placing the excess of cumulative actual inflation during 2020-2022 over the pre-pandemic baseline expected by the CBO at 7.7 percentage points, alternative estimates using a Fiscal Quantity Theory approach attribute one-third to two-thirds of this inflation shock to excess demand from pandemic fiscal stimulus.

Significant excess demand that remains in the pipeline for 2023 is likely to be offset by the monetary tightening of 2022. If US inflation nonetheless resumes at a pace substantially higher than the near-3 percent rate reached at least temporarily by 6-month annualized inflation in December 2022, consideration should be given to an income-tax surcharge like that enacted in 1968 (but on a more permanent and inflation-contingent basis) to supplement monetary tightening. Consideration should also be given to an inflation target closer to 3 percent rather than 2 percent in light of an increasingly costly tradeoff between unemployment and inflation at the lower level.

The United States has achieved major progress in reducing inflation from its high 6-month annualized trend pace of 7.4 percent in June 2022 to 3.5 percent in December (albeit with a return to 4.6 percent in January). The Federal Reserve should persist with its current expected strategy of aiming for an average Federal Funds rate of 5 to 5½ percent in 2023 (FOMC, 2022b) to help ensure that inflation falls below 3 percent by late 2023 and beyond. If higher inflation persists, policy-makers should consider enacting an Inflation Contingent Income Tax Surcharge (ICITS) to help curb demand. Consolidating confidence that inflation is under control is crucial and would warrant maintenance of such measures even at the cost of some increase in unemployment. The CBO's current estimate for the NAIRU (non-accelerating inflation rate of unemployment) in 2023 is 4.23 percent, and at least some move toward this rate from its recent 50-year low of 3.4 percent may be necessary to consolidate confidence in a return to sustainably low inflation commensurate with achievement of potential growth.[70]

[70] FRED (2023),series NROU and UNRATE.

References

Adrian, Tobias, and Vitor Gaspar. 2022. “How Fiscal Restraint Can Help Fight Inflation.” *IMF Blog*. Washington: International Monetary Fund (November)

Aladangady, Aditya, David Cho, Laura Feiveson, and Eugenio Pinto. 2022. “Excess Savings during the COVID-19 Pandemic, *FEDS Notes.* Washington: Federal Reserve (October)

Autor, David, David Cho, Leland D. Crane, Mita Goldar, Byron Lutz, Joshua K. Montes, William B. Peterman, David D. Ratner, Daniel Villlar Vallenas, and Ahu Yildirmaz. 2022. *The $800 Billion Paycheck Protection Program: Where Did the Money Go and Why Did It Go There?* Cambridge, MA: National Bureau of Economic Research, Working Paper 29669 (January).

Ball, Laurence, Daniel Leigh, and Prachi Mishra. 2022. “Understanding U.S. Inflation During the COVID Era,” *Brookings Papers on Economic Activity*, conference draft. Washington (September)

Barnichon, Regis, Luiz E. Oliveira, and Adam H. Shapiro. 2021. “Is the American Rescue Plan Taking Us Back to the ‘60s?” 2021. *FRBSF Economic Letter 2021-27*. Federal Reserve Bank of San Francisco (October)

BEA (Bureau of Economic Analysis). 2022a. *Table 2.6. Personal Income and Its Disposition, Monthly.* Washington (October)

BEA . 2022b. *U. Gross Output by Industry. Detail Level.* Washington (December)

BEA. 2023. *Table 1.1.3. Real Gross Domestic Product, Quantity Indexes.* Washington (January)

Benigno, Gianluca, Julian di Giovanni, Jan J.J. Groen, and Adam I. Noble. 2022. “A New Barometer of Global Supply Chain Pressures,” *Liberty Street Economics.* New York: Federal Reserve Bank of New York (January)

Bianchi, Francesco, and Leonardo Melosi. 2022. “Inflation as a Fiscal Limit.” Baltimore: Johns Hopkins University.

Binder, Carola, and Rupal Kamdar. 2022. “Expected and Realized Inflation in Historical Perspective,” *Journal of Economic Perspectives,* vol. 36, no. 3, Summer, pp. 131-156.

BIS (Bank for International Settlements). 2022. *Annual Economic Report* (Basel: June).

BIS (Bank for International Settlements). 2023. *Consumer Price Index: Table K1*. Basel (January)

Blanchard, Olivier. 2022. "Why I Worry about Inflation, Interest Rates, and Unemployment." RealTime Economic Issues Watch. Washington, D.C.: Peterson Institute for International Economics (March 14)

Blanchard, Olivier, Alex Domash, and Lawrence Summers. 2022a. *Bad News for the Fed from the Beveridge Space*. Washington, D.C.: Peterson Institute for International Economics, Policy Brief 22-7 (July)

Blanchard, Olivier, Alex Domash, and Lawrence Summers. 2022b. "The Fed is Wrong: Lower Inflation is Unlikely without Raising Unemployment," *RealTime Economics*. Peterson Institute for International Economics. Washington (August)

BLS. 2023a. *Unemployment Rate.* Washington (January)

BLS (Bureau of Labor Statistics). 2023b. *CPI for All Urban Consumers (CPI-U)*. *All items. Seasonally Adjusted.* (Series CUSR0000A0). Washington (February)

BLS. 2023c. *CPI for All Urban Consumers (CPI-U)*. *All items less food and energy. Seasonally Adjusted.* (Series CUSR0000SA0L1E). Washington (February)

Caldwell, Preston. 2022. "Why We Expect Inflation to Fall in 2023." Chicago: Morningstar (November)

CBO (Congressional Budget Office). 2020a. "January 2020 Baseline Forecast." *10-Year Economic Projections*. Washington (January). Available at: https://cbo.gov/data/budget-economicdata#4

CBO. 2020b. "Summary of Estimated Budgetary Effects of H.R. 748, the Coronavirus Aid, Relief, and Economic Security (CARES) Act, Public Law 116-136." Washington (April). Available at: https://www.cbo.gov/system/files/2020-04/hr748.pdf

CBO. 2020c. "CBO Estimate for H.R. 266, the Paycheck Protection Program and Health Care Enhancement Act. Washington (April). Available at: https://www.cbo.gov/system/files/2020-04/hr266.pdf

CBO. 2021a. *Summary Estimate for Divisions M Through FF, H.R. 133, Consolidated Appropriations Act, 2021, Public Law 116-260 Enacted on December 27, 2020*. Washington (January). Available at: https://www.cbo.gov/system/files/2021-01/PL_116-260_Summary.pdf

CBO. 2021b. "Estimated Budgetary Effects of H.R. 1319, American Rescue Plan Act of 2021." Washington (March). Available at: https://cbo.gov/publication/57056

CBO. 2021c. *The Distribution of Major Tax Expenditures in 2019.* Washington (October). (Publication 58585.)

CBO. 2022a. “Estimated Budgetary Effects of H.R. 4346.” (CHIPS and Science Act.) Washington (July). Available at: https://cbo.gov/publication/58319

CBO. 2022b. “Estimated Budgetary Effects of H.R. 3967, Honoring our PACT Act of 2021.” Washington (June). Available at: https://cbo.gov/publication/58177

CBO. 2022c. “Estimated Budgetary Effects of HR. 5376, the Inflation Reduction Act.” Washington (August). Available at: https://cbo.gov/publication/58366

CBO. 2022d. *Costs of Suspending Student Loan Payments and Cancelling Debt.* Washington (September). https://cbo.gov/publication/58484

CBO. 2022e. *Monthly Budget Review: Summary for Fiscal Year 2022*. Washington (November)

CBO. 2022f. *The Distribution of Household Income, 2019.* Washington (November)

CEA (Council of Economic Advisers). 1969. *Economic Report of the President, 1969.* Washington.

CEA. 1970. *Economic Report of the President, 1970.* Washington.

Census (U.S. Census Bureau). 2009. “Population by Age and Sex: 2007,” *Current Population Survey, Annual Social and Economic Supplement, 2007.* Washington (May)

Census. 2017. “Population by Age and Sex: 2014,” *Current Population Survey, Annual Social and Economic Supplement, 2014.* Washington (August)

Census. 2020. “Total U.S. Resident Population by Age, Sex, and Series,” *2020 Demographic Analyses.* Population Division. (Washington: December)

Choi, Jason, Taeyoung Doh, Andrew Foerster, and Zinnia Martinez. 2022. “Monetary Policy Stance is Tighter than Federal Funds Rate,” *FRBSF Economic Letter 2022-30.* San Francisco: Federal Reserve Bank of San Francisco (November)

Cline, William R. 2005. *The United States as a Debtor Nation.* Washington: Institute for International Economics and Center for Global Development.

Cline, William R. 2014. *Demographic versus Cyclical Influences on US Labor Force Participation*, Working Paper 14-4. Washington: Peterson Institute for International Economics (July)

Cline, William R. 2017. *Trade and Fiscal Deficits, Tax Reform, and the Dollar: General Equilibrium Impact Estimates,* Working Paper 17-9. Washington: Peterson Institute for International Economics (August)

Cline, William R. 2021. "U.S. Debt Sustainability under Low Interest Rates and after the Covid-19 Shock," *The Cato Journal,* vol. 41, no. 3, pp. 451-485.

Cline, William R. 2022. *Median Incomes, China Shock, Climate Metrics, and Debt Sustainability: Collected Papers, 2018-2021.* Washington: Economics International Inc. (May).

Congressional Research Service. 2020. *COVID-19 and Direct Payments to Individuals: Summary of the 2020 Recovery Rebates/ Economic Impact Payments in the CARES Act (P.L. 116-136)*. Washington (April)

De Soyres, François, Ana Maria Santacreu, and Henry Young. 2022. "Fiscal Policy and Excess Inflation During Covid-19: A Cross-country View," *FEDS Notes*, July 15. Washington: Federal Reserve.

Di Giovanni, Julian, Şebnem Kalemli-Özcan, Alvaro Silva, and Muhammed A. Yildirim. 2022. "Global Supply Chain Pressures, International Trade, and Inflation," *Staff Reports* No. 1024. New York: Federal Reserve Bank of New York (July)

Edwards, Roxanna, Lawrence S. Essien, and Michael Daniel Levinstein. 2022. "U.S. Labor Market Shows Improvement in 2021, but the COVID-19 Pandemic Continues to Weigh on the Economy," *Monthly Labor Review*, U.S. Bureau of Labor Statistics. Washington (June).

EIA (US Energy Information Administration). 2023a. "Cushing, OK WTI Spot Price FOB." Washington (January)

EIA. 2023b. "Gasoline and Diesel Fuel Update." Washington (January)

Figura, Andrew, and Chris Waller. "What Does the Beveridge Curve Tell Us about the Likelihood of a Soft Landing?" *FEDS Notes*. Washington: Federal Reserve Board (July)

FOMC (Federal Open Market Committee). 2022a. *Summary of Economic Projections*. Washington: Federal Reserve Board (June)

FOMC. 2022b. *Summary of Economic Projections*. Washington: Federal Reserve Board (December)

FRBNY (Federal Reserve Bank of New York). 2022a. *Survey of Consumer Expectations*. New York (September).

FRBNY. 2022b. *Global Supply Chain Pressure Index (GSCPI).* New York (December).

FRBPhil (Federal Reserve Bank of Philadelphia). 2022a. *The Livingston Survey*. Philadelphia (June)

FRBPhil. 2022b. *Survey of Professional Forecasters.* Philadelphia (November)

FOMC. 2022. *Summary of Economic Projections.* Washington: Federal Reserve Board (June) Available at: https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20220615.pdf

FRED (Federal Reserve Bank of St. Louis, Economic Data). 2022. St. Louis (December)

FRED. 2023. St Louis (February)

Furman, Jason. 2022a. "America's Wage-Price Persistence Must Be Stopped." *Project Syndicate*, August 2, 2022.

Furman, Jason. 2022b. "Comment on 'Understanding U.S. Inflation During the COVID Era." Brookings Papers on Economic Activity. Washington: Brookings Institution (September). https://brookings.edu/events/bpea-fall-2022-conference/

Furman, Jason, and Wilson Powell III. 2022c. "US Job Growth is Slowing, but the Labor Market Remains Very Hot," *Realtime Economics.* Washington: Peterson Institute for International Economics (November)

Gagnon, Joseph E., and Christopher G. Collins. 2019. *Low Inflation Bends the Phillips Curve.* Working Paper 19-6. Washington, D.C.: Peterson Institute for International Economics (April)

Gagnon, Joseph E., 2022a. "Why US Inflation Surged in 2021 and What the Fed Should Do to Control It." RealTime Economic Issues Watch. Washington, D.C.: Peterson Institute for International Economics (March 11)

Gagnon, Joseph E. 2022b. *25 Years of Excess Unemployment in Advanced Economies: Lessons for Monetary Policy.* Working Paper 22-17. Washington: Peterson Institute for International Economics (October)

Graefe, Laurel. 2013. "Oil Shock of 1978-79." Federal Reserve History. Washington: Federal Reserve (November)

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Ivan Werning. 2022. "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?" *American Economic Review*, vol. 112, no. 5, pp. 1437-1474.

Ha, Jongrim, M. Ayhan Kose, and Franziska Ohnsorge. 2022. *From Low to High Inflation: Implications for Emerging Market and Developing Countries.* CEPR Policy Insight No. 115. London: Centre for Economic Policy Research (March)

Hakkio, Craig S. 2008. "PCE and CPI Inflation Differentials: Converting Inflation Forecasts," *Economic Review – First Quarter 2008,* pp. 51-67. Kansas City: Federal Reserve Bank of Kansas City.

Holston, Kathryn, Thomas Laubach, and John C. Williams. 2016. *Measuring the Natural Rate of Interest: International Trends and Determinants.* Working Paper 2016-11, Federal Reserve Bank of San Francisco. San Francisco (December)

IMF (International Monetary Fund). 2022a. *Fiscal Monitor: Fiscal Policy from Pandemic to War*. Washington (April)

IMF (International Monetary Fund). 2022b. "Wage Dynamics Post-Covid-19 and Wage-Price Spiral Risks," *World Economic Outlook October 2022*, pp. 51-70.

IMF (International Monetary Fund). 2022c. *World Economic Outlook, October 2022: Countering the Cost-of-Living Crisis*. Washington (October)

IMF (International Monetary Fund). 2022d. *World Economic Outlook Database, October 2022.* Washington (October)

Jordà, Óscar, Celeste Liu, Fernanda Nechio, and Fabiàn Rivera-Reyes. 2022. "Why is U.S. Inflation Higher than in Other Countries?" *FRBSF Economic Letter 2022-07*. San Francisco: Federal Reserve Bank of San Francisco (March)

Konish, Lorie. 2022. "How effective were those stimulus checks? Some argue the money may have fueled inflation." CNBC, June 11.

Korenok, Oleg, David Munro, and Jiayi Chen. 2022. *Inflation and Attention Thresholds.* (September). Available at: https://ssrn.com/abstract=4230600.

Krugman, Paul. "Wonking Out: I'm Still on Team Transitory." *New York Times*, September 10, 2021.

Luck, Stephan, and Thomas Zimmermann. 2019. "The Years Later – Did QE Work?" *Liberty Street Economics.* New York: Federal Reserve Bank of New York (May)

OECD (Organisation for Economic Co-operation and Development). 2022a. *Consumer price indices: Contribution to annual inflation by COICOP by country.* Paris (November)

OECD (Organisation for Economic Co-operation and Development). 2022b. *Consumer price indices: CPIs and Weights by COICOP by country.* Paris (November)

Okun, Arthur M. 1971. "The Personal Tax Surcharge and Consumer Demand, 1968-70," *Brookings Papers on Economic Activity, 1:1971*, pp. 167-200. Washington: Brookings Institution.

Okun, Arthur M. 1977. "Did the 1968 Surcharge Really Work? Comment," *American Economic Review*, vol. 67, no. 2, March, pp. 166-169.

Phillips, Alban William. 1958. "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957. *Economica* 25: pp. 283-299.

PRAC (Pandemic Response Accountability Committee). 2022. *Pandemic Oversight: Funding Overview*. Washington (December). Available at: https://www.pandemicoversight.gov/data-interactive-tools/funding-overview

Reifschneider, David, and David Wilcox. 2022. *The Case for a Cautiously Optimistic Outlook for US Inflation.* Washington, D.C.: Peterson Institute for International Economics, Policy Brief 22-3 (March)

Romer, Christina D., and David H. Romer. 2022. "A Social Insurance Perspective on Pandemic Fiscal Policy: Implications for Unemployment Insurance and Hazard Pay," *Journal of Economic Perspectives,* vol. 36, no. 2, Spring, pp. 3-28.

Shapiro, Adam Hale. 2022. "How Much Do Supply and Demand Drive Inflation?" FRBSF Economic Letter 2022-15. San Francisco: Federal Reserve Bank of San Francisco (June)

Springer, William L. 1975. "Did the 1968 Surcharge Really Work?" *American Economic Review*, vol. 65, no. 4, September, pp. 644-659.

Statista. 2022. "Global Container Freight rate Index from January 2019 to November 2022." Available at: https://statista.com/statistics/1250636/global-container-freight-index/

Taylor, John B. 1993. *Discretion versus Policy Rules in Practice.* Carnegie Rochester Conference Series on Public Policy 39, pp. 195-214.

Weber, Michael, Francesco D'Acunto, Yuriy Gorodnichenko, and Olivier Coibion. 2022. "The Subjective Inflation Expectations of Households and Firms: Measurement, Determinants, and Implications," *Journal of Economic Perspectives,* vol. 36, no. 3, Summer, pp. 157-184.

Worldometer. 2023. *Total Coronavirus Deaths in the United States.* Available at: https://www.worldometers.info/coronavirus/country/us/. (January)

York, Erica. 2022. 'Summary of the Latest Federal Income Tax Data." Washington: Tax Foundation (January 20)

Zandi, Mark, and Bernard Yaros. 2021. *Macroeconomic Consequences of the Infrastructure Investment and Jobs Act & Build Back Better Framework.* Moody's Analytics. New York (November)

Appendix A

US Fiscal Stimulus by Functional Category

Table A.1

Functional Detail of Major US Fiscal Spending Initiatives[a], 2020-2022
($ billions)

	CARES	PPP&HCE	CRRSA	AARP	Other	Total
Oversight	69.2	4.9	4.2	12.4	1.3	92.1
Global Assistance	0.6	0.0	4.0	10.5	1.0	16.1
Public Services	45.9	9.3	2.6	29.7	3.7	91.2
State & Local Gov.	212.9	0.0	23.1	436.9	1.5	674.3
Health Care	101.0	87.8	61.3	100.2	1.0	351.4
Individuals	317.4	0.0	239.3	569.9	19.8	1146.5
Unemployment	634.7	0.0	197.9	202.2	1.0	1035.7
Veterans	17.4	0.0	0.0	17.0	0.1	34.4
Broadband Tech.	2.3	0.0	6.9	9.8	0.0	19.1
Education	31.0	0.0	81.9	170.6	0.0	283.5
Farming Industry	9.5	0.0	12.0	10.7	0.0	32.2
Financial Inst., Fed. Rsrv	21.2	60.0	0.0	0.0	0.0	81.2
PPP	219.5	261.3	289.9	7.3	0.0	778.0
Small Businesses	10.0	60.0	35.0	79.0	0.0	184.0
Transportation	68.1	0.0	33.0	58.2	0.0	159.2
Private Sector Pensions	0.0	0.0	0.0	86.0	0.0	86.0
Total	1760.7	483.4	991.3	1800.2	29.3	5064.9

a. Coronavirus Aid, Relief, and Economic Security Act ; Paycheck Protection Program and Health Care Enhancement Act; Coronavirus Response & Relief Consolidated Appropriation Act, American Rescue Plan Act. Other: Coronavirus Preparedness and Response Supplemental Appropriations Act; Families First Coronavirus Response Act

Source: PRAC (2022)

Appendix B

Phillips Curve, Expectational Anchor, and Acceleration

In the mainstream macroeconomic model of inflation, the Phillips curve, wage increases depend on expected inflation and on the state of tightness in the labor market as represented by the difference between actual unemployment and the "natural" rate of unemployment at which the economy produces at full potential without boosting the inflation rate.[71] Thus:

$$B1)\dot{w}_t = \dot{p_t^e} - \beta(u_t - u^*)$$

where *w* is the wage rate; p^e is the expected price level; the overdot represents percent change; *u* is the unemployment rate; subscript *t* is the year; and *u** is the natural rate of unemployment.[72]

There is an "anchor" rate of expected inflation "α", such as the US Federal Reserve's long-proclaimed target of two percent. The expected rate of inflation is simply this anchor rate, if firms and workers have complete confidence policymakers will achieve this target. However, if external shocks (such as the pandemic) or policy shocks (such as a loss of confidence in long-term fiscal sustainability) cause expectations to de-anchor, there is an increased role for inflation expectations to rise. Thus:

$$B2)\dot{p_t^e} = (1-\lambda)\alpha + \lambda\dot{p}_{t-1}$$

If the anchoring of expectations is complete, $\lambda = 0$; if the anchor has been completely lost, $\lambda = 1$, and expected inflation becomes simply an extrapolation of recent inflation. In this case, inflation becomes "accelerationist," as an unexpected surge in inflation to a high rate in the previous year becomes perpetuated the base for wage demands in the current year.

Finally, if firms do not change their mark-up practices, the rate of inflation realized for the year in question will equal the percent increase in wages; minus an allowance for trend increase in worker productivity ($\hat{q}$); but plus whatever magnitude stems from an exogenous shock in the year in question (x_t).

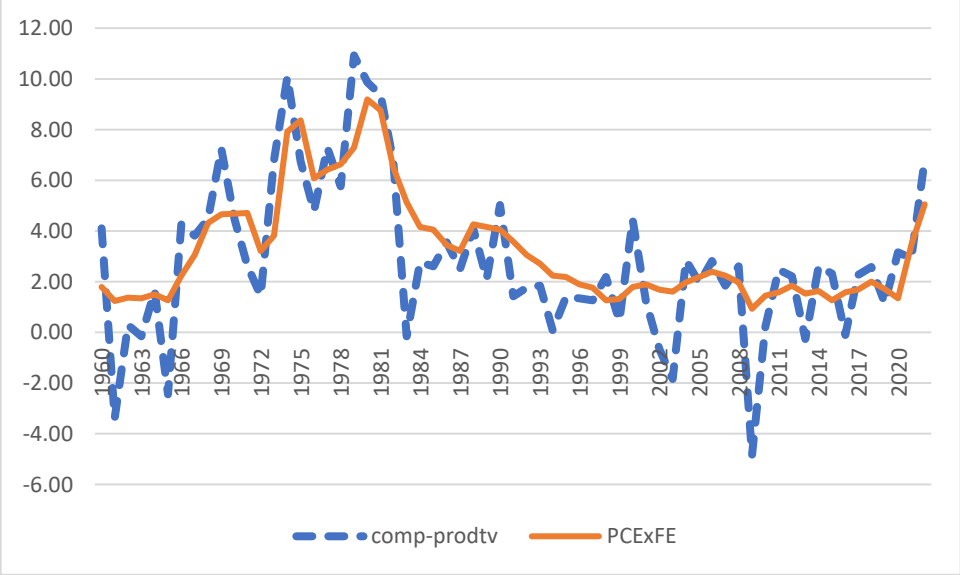
$$B3)\dot{p}_t = \dot{w}_t - \hat{q} + x_t$$

[71] Also known as NAIRU, or non-accelerating inflation rate of unemployment.
[72] For a statement of this framework, see Blanchard (2022a).

Figure B.1 shows annual data from 1960 through 2022 reporting the percent increase in the PCE excluding food and energy, as the measure of US inflation, and the percent increase in private sector employee compensation per hour minus the percent increase in real output per worker (productivity).[73] These measures reflect the left-hand side and the first two elements in the right-hand side of equation B3 (except that the productivity measure is annual rather than trend).[74] A simple regression for the full period finds a highly significant relationship between inflation and wage growth minus productivity growth.[75]

Figure B.1

Inflation[a] and Wage Growth[b] minus Productivity Growth[c], 1960-2022
(percent)



a. PCE excluding food and energy
b. Non-farm business sector, hourly compensation for all employed persons
c. Nonfarm Business Sector: output per hour for all employed persons
Source: FRED (2023, series PCEEPiLFE, PRS85006092, and PRS85006101.

[73] For inflation, 2022 is estimated the ratio of the average price index in January through November to that in the same period of 2021. For compensation and productivity, annual estimates for 2022 assume that increases from the year before in the fourth quarter equal those in the third quarter.

[74] Note that the productivity growth for 2022 is unusual in being negative, at –5.9 percent over a year before in the first quarter, -4.1 percent in the second, and +0.8 percent in the third. The estimate assumes the rate continued at +0.8 percent in the fourth quarter, placing the annual average at -2.1 percent.

[75] The regression yields: inflation = 1.66 percent (7.6) +0.550 × [wage growth minus productivity growth] (10.6); adjusted R^2 = .64 (t-statistics in parentheses).