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Are the Demand and Supply Channels of Inflation Persistent?

Evidence from a Novel Decomposition of PCE Inflation

Viacheslav Sheremirov

Using highly disaggregated personal consumption expenditures data, I analyze whether the recent inflation run-up is explained by supply shocks more than by demand shocks, and whether these demand and supply shocks are likely persistent or transitory. I develop a new decomposition method that enables me to classify inflation in disaggregated consumption categories as being driven predominantly by persistent supply shocks, transitory supply shocks, transitory demand shocks, or persistent demand shocks. Similar to other recent analyses, this brief finds that both demand and supply shocks are responsible for the recent inflation run-up, and that quantitatively, supply shocks have played a larger role than demand shocks. However, while supply shocks are classified as mostly transitory, for much of the recent period the demand shocks had a relatively large persistent component. In light of these results, I briefly discuss how the sources of inflation and their persistence can affect the monetary policy response to inflation and the likelihood of achieving a soft landing.

Viacheslav Sheremirov is a senior economist in the Research Department at the Federal Reserve Bank of Boston. His email address is Viacheslav.Sheremirov@bos.frb.org.

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After a long period of relatively stable prices, inflation has come to the forefront of economic debate once again. Based on year-over-year changes in the personal consumption expenditures (PCE) price index, a measure preferred by the Federal Reserve, the rate of inflation increased from 1.8 percent in the first quarter of 2021 to 6.5 percent in the second quarter of 2022, the highest quarterly inflation rate since 1982. What are the sources of the inflation run-up and how persistent are they? Economists have long differentiated between macroeconomic fluctuations that are driven by persistent supply and demand shocks and those driven by transitory supply and demand shocks.[1] Understanding the sources of inflation plays an important role in the optimal design of stabilization policies. For example, countercyclical policies tend to be more effective in offsetting fluctuations caused by demand shocks versus those caused by supply shocks, because a response to supply shocks has to take into account a costly tradeoff between price and output stability. As stabilization policies tend to have a long operational lag, the optimal response to either a demand or supply shock differs in practice depending on whether the shock is persistent or transitory. Persistent demand shocks may require substantially more leaning against the wind than transitory demand shocks would call for. Persistent supply shocks, in turn, may result in a higher *sacrifice ratio* (output or employment that needs to be sacrificed in order to reduce inflation) than in the case of transitory supply shocks.

In this brief, I analyze whether supply shocks are more responsible than demand shocks for the recent run-up in inflation, and whether these shocks are likely persistent or transitory. Using PCE price and quantity indexes for 191 consumption categories, I decompose consumer price inflation into four components: persistent supply, transitory supply, transitory demand, and persistent demand. Similar to Sheremirov (2021) and Shapiro (2022), I differentiate between demand and supply shocks by examining the comovement of prices and quantities for each sector.[2] Demand shocks lead to a positive comovement, whereas prices and quantities comove negatively in response to supply shocks. This is a key definition used to decompose inflation into demand and supply components. I then differentiate between persistent and transitory shocks based on the stability of the corresponding demand/supply classification for each category during the preceding 12-month period. The main idea is that persistent shocks result in a demand/supply classification that is relatively stable over a short period. That is, a sector is nearly always classified as driven by demand or by supply. In contrast, transitory shocks lead to classifications that frequently alternate between demand and supply.

[1] Studies of persistent/transitory shocks and demand/supply shocks are related and have a long tradition in macroeconomics. See Beveridge and Nelson (1981) and Blanchard and Quah (1989) for early examples and Guerrieri et al. (2022) for a recent one.

[2] To account for secular trends in sectoral inflation and consumption growth, I subtract sectoral averages over the 2001–2019 period. I do not include 2020 and 2021 because of large deviations from the trends caused by the COVID-19 recession and the subsequent recovery.

I find that, of the four components, transitory supply shocks contributed the most to the 2021–2022 inflation run-up. This component accounted for almost 5 percentage points of headline PCE inflation and about 3 percentage points of core PCE inflation in June 2022. Supply shocks had particulary large effects on motor fuel and food prices. I find that persistent demand shocks also played an important role during the inflation run-up period. While its contribution has started to decline, at its peak persistent demand contributed just under 2 percentage points to headline inflation. Travel, including air transportation, and some in-person services experienced particularly sizeable and persistent demand shocks.

This decomposition also sheds light on other episodes of inflation dynamics. For example, negative demand shocks tend to exert downward pressure on inflation during recessions. These shocks were particularly large in magnitude during the Great Recession. Large transitory supply shocks often correspond to rapid oil price increases (for example, during the 2005–2008 period). Overall, supply shocks, both transitory and persistent, were often the reason for sharp swings in inflation. In contrast, prior to the latest episode, persistent demand shocks were rarely important, in part because they were promptly offset by countercyclical policies. This time, however, could be different due to the unprecedented pent-up demand caused by the COVID-19 pandemic and amplified by several rounds of a large fiscal stimulus and an expansionary monetary environment, among other factors.

It is worth noting that this classification of shocks' persistence is dynamic. Shocks are classified as transitory until enough evidence builds up to deem them persistent. Hence, in some cases large transitory shocks disappear quickly, whereas in other cases they are reclassified later as persistent. For instance, the deflationary supply shocks of 2015 and the contractionary demand shocks of 2020 were eventually classified as persistent, whereas the 2005–2006 inflationary supply shocks were not. Thus, it may be too early to tell whether the latest supply shocks, which are still labeled transitory according to this method, will be classified as persistent when further evidence accumulates. Whether it happens depends largely on factors that are currently hard to forecast: a further decline in COVID-19 transmissions, especially in developing countries; the easing of supply chain constraints; the duration of the war in Ukraine as well as the overall geopolitical situation; and many other factors.

Another important consideration is the link between the sectoral variation employed in this study and aggregate variation, which is more relevant for macroeconomic policy debates. While there is sufficient evidence that contractionary aggregate supply shocks have played a role on the aggregate level, the labor market remains surprisingly strong, with an unemployment rate of 3.5 percent as of July 2022. While understanding this puzzle requires serious work and is outside the scope of this brief, it is worth noting that aggregate output and consumption growth data have been rather weak lately. For instance, over the first two quarters of 2022, real GDP declined, and the

growth rate of aggregate real consumption was below its prepandemic average. Hence, the labor market puzzle notwithstanding, high aggregate inflation, falling aggregate output, and tepid real consumption growth combined are consistent with the prevalence of supply shocks. While this conclusion may in part depend on whether the trends have changed substantially, it seems highly unlikely that trend GDP growth has slowed enough to generate a large positive output gap.

Overall, my analysis suggests that the latest inflation episode stems from both demand and supply shocks, and that supply shocks have played a larger role than demand shocks in recent inflation dynamics. However, for much of the inflation run-up period, demand shocks had a relatively large persistent component, whereas most of the supply shocks were transitory. These results have two important implications for our understanding of the current economic environment. First, if transitory supply shocks dissipate quickly, it will be easier to achieve a soft landing compared with the scenario wherein supply shocks become persistent. Second, to stabilize prices, persistent demand shocks warrant a stronger policy response than transitory demand shocks. While it is too early to tell whether the persistence of demand shocks has started to decline, the June PCE release provides some hopeful signs.

This work is closely related to other recent attempts to identify inflation sources. Sheremirov (2021) uses a similar approach but focuses on the early COVID-19 period. Shapiro (2022) also uses similar methods of differentiating between demand and supply but considers deviations from time-varying trends. In this brief, I add another layer to those approaches by focusing on the persistence of demand and supply shocks. Thus, I remove time-invariant averages, because large persistent shocks may be inadvertently attributed to a time-varying trend, thereby tilting the classification away from finding persistent shocks. In the robustness section, I compare different methods of trend removal. I show that while the persistent/transitory classification indeed depends on the method used, the demand/supply classification is less sensitive to the underlying assumptions. This work is also related to the work of Lansing (2022), who studies aggregate inflation persistence during the recent inflation run-up. In comparison, this brief considers persistence of demand and supply separately.

This brief proceeds as follows. Section 1 discusses the data and, in particular, the level of disaggregation used to study consumption categories. Section 2 describes the method used to decompose PCE inflation into persistent and transitory demand and supply components. Section 3 shows the resulting decomposition and discusses its implications. Section 4 examines the effects of alternative methodological choices on the baseline decomposition. Section 5 concludes.

1. Consumption Categories

I use disaggregated price and real consumption indexes from the July release of the Bureau of Economic Analysis's (BEA) Personal Income and Outlays tables, which cover the period through June 2022 at a monthly frequency. I focus on 191 consumption categories that cover 99.6 percent of personal consumption expenditures in June.[3] A typical category is small, with a median weight of 0.2 percent. But the distribution of weights is skewed to the right, with the largest category (owner-occupied stationary homes) making up 10.7 percent of total personal consumption expenditures in June. Across the top 10 largest categories, the weight varies from 1.9 to 5.0 percent. The average weight is 0.5 percent.

As an alternative, I consider data at a higher level of aggregation, splitting personal consumption expenditures into 51 relatively large categories. In this case, the median category makes up 1.0 percent of PCE, and the average weight is 2.0 percent. The skewness of the distribution, at 3.0, is substantially lower than in the more disaggregated case (5.9). While the skewness of the weight distribution is lower at this level of disaggregation, the measurement error is likely greater because large categories are prone to experience simultaneously large demand and supply shocks.

2. Classification Method

Similar to Sheremirov (2021) and Shapiro (2022), I classify shocks as either demand or supply based on the comovement between inflation and consumption growth. If inflation and real consumption are both above or both below their trends, I classify the corresponding category as a demand category. If the trend deviations of inflation and consumption growth have opposite signs, I label the category as a supply category. It is important to consider trend deviations because for many disaggregated categories consumption and prices have changed drastically due to structural factors. For example, over a long period, quality-adjusted prices of electronic devices have declined, while their consumption shares have increased as a result of steady technological progress.

While there are many competing methods for estimating trends, I remove the average sectoral inflation and consumption growth during the sample period as a baseline. To avoid the disproportionate effects of inflation and consumption dynamics during the COVID-19 recession and subsequent recovery period, I compute averages over the 2001–2019 period. This approach is based on the assumption that, without shocks, sectoral prices and consumption would follow a log-linear path with constant, sector-specific growth rates. I prefer this approach because during the COVID-19 period, inflation and consumption growth deviated persistently from their prepan-

[3] I do not include expenditures abroad by U.S. residents and foreign travel expenditures by U.S. residents, as they are partially offset by the corresponding expenditures of nonresidents in the United States and are not informative about domestic prices. The PCE weights of these categories are typically small.

demic levels. Time-varying detrending methods could erroneously attribute these deviations to an evolving trend. To understand high inflation, it is more useful to err on the side of explaining some of the trend change rather than on the side of leaving some variation out of the classification. In the robustness section, I analyze decompositions obtained with alternative detrending methods, including time-varying trends.

To classify a shock as persistent or transitory, I examine how often a consumption category changes its classification during the 12-month period preceding a given month. If a category is classified as demand (or supply) for at least 11 months during this period, I classify it as a persistent demand (supply) category. If it is classified differently at least twice during this period, I consider the shock transitory. While a persistence threshold of 11 months is heuristic, I chose it so that transitory shocks are rarely misclassified as persistent. However, some shocks could be classified as transitory due to persistent forces still in their early stages. Thus, this approach is dynamic, based on the accumulation of evidence in the data. While there is a clear mechanical relationship between the persistence threshold and the share of persistent shocks, it appears to be not particularly important in practice. I discuss the quantitative effects of alternative thresholds in more detail in Section 4 and show additional results in the appendix.

The classification algorithm can be summarized as follows:

1. For each month t and consumption category i, compute year-over-year inflation and real consumption growth,

$$\pi_{i,t} = \frac{P_{i,t}}{P_{i,t-12}} - 1, \tag{1}$$

$$C_{i,t} = \frac{\text{RPCE}_{i,t}}{\text{RPCE}_{i,t-12}} - 1, \tag{2}$$

   where $P_{i,t}$ is the PCE price index, and $\text{RPCE}_{i,t}$ is the real personal consumption expenditures, respectively.

2. Compute the average year-over-year inflation ($\bar{\pi}_i$) and consumption growth ($\bar{C}_i$) during the 2001–2019 period.

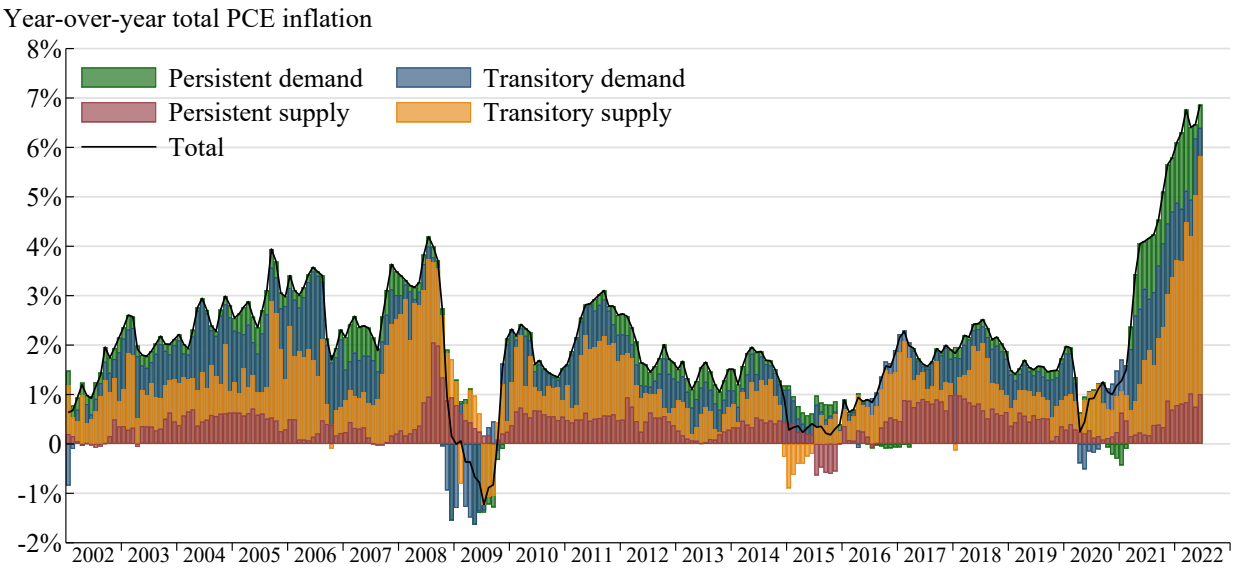
3. Classify a sectoral shock as a demand shock ($\mathbb{I}^{\text{D}}_{i,t} = 1$) if the following condition holds:

$$(\pi_{i,t} - \bar{\pi}_i) \times \left(C_{i,t} - \bar{C}_i\right) > 0. \tag{3}$$

   Otherwise, classify it as a supply shock ($\mathbb{I}^{\text{D}}_{i,t} = 0$).[4]

[4] In the data, this product never equals zero exactly. Shapiro (2022) classifies a sectoral shock as ambiguous if the corresponding metric is close to zero. The shocks classified as ambiguous therein are likely classified as transitory

Figure 1: Inflation Decomposition into Persistent and Transitory Demand and Supply Components



Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.

4. Count the months during the preceding 12-month period that the shock is classified as a demand shock,

$$\Sigma^{\mathrm{D}}_{i,t} = \sum_{s=0}^{11} \mathbb{I}^{\mathrm{D}}_{i,t-s}. \tag{4}$$

5. Classify the shock as (i) a persistent demand shock if $\mathbb{I}^{\mathrm{D}}_{i,t} = 1$ and $\Sigma^{\mathrm{D}}_{i,t} \geq 11$, and (ii) as a persistent supply shock if $\mathbb{I}^{\mathrm{D}}_{i,t} = 0$ and $\Sigma^{\mathrm{D}}_{i,t} \leq 1$.

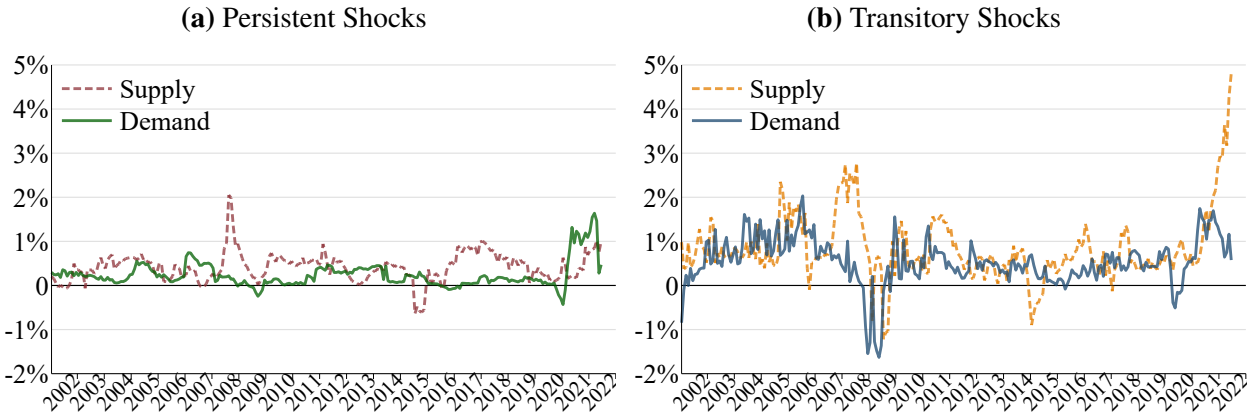
6. If neither condition (i) nor (ii) holds, classify the shock as a transitory demand (supply) shock if $\mathbb{I}^{\mathrm{D}}_{i,t} = 1$ ($\mathbb{I}^{\mathrm{D}}_{i,t} = 0$).

3. Baseline Decomposition

Figure 1 shows year-over-year changes in the total PCE price index (black line), along with its decomposition into four components: persistent demand (green stack, typically on the top), transitory demand (blue stack, second from the top), transitory supply (orange stack, second from the bottom), persistent supply (red stack, bottom). During the 2002–2022 period, the transitory component accounts for much of the inflation variation. The share of persistent demand shocks is on average low, which is likely the case because countercyclical policies offset demand shocks before

in this study. However, transitory shocks are not necessarily ambiguous. If the product in Equation (3) is large but changes signs often, the shock is transitory but not ambiguous. Because I focus on persistent shocks, which are less likely to be ambiguous, I do not consider this category separately.

Figure 2: Inflation Contribution by Component



Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.
Note: This figure shows the contributions to year-over-year total PCE inflation of the components shown in Figure 1. Panel (a) compares the contributions of persistent demand and supply components, while Panel (b) compares transitory demand and supply components.

they become persistent. Notice that supply shocks tend to have a particularly volatile transitory component.

We can also see that large persistent supply shocks tend to follow large transitory supply shocks. This can be explained by the reclassification of a shock as enough evidence builds up to label the shock persistent. This property exemplifies the dynamic nature of this classification method. For instance, crude oil prices rose sharply in 2007 and early 2008, reaching a peak in 2008:Q2. This peak corresponds to a spike in the red stack following the persistent increase in the orange stack. As another example, oil prices fell over the 2014–2015 period, reaching their trough in 2016:Q1. We can again clearly see this episode, reflected by a negative contribution of supply shocks during this period. Similarly, the decomposition highlights the negative contributions of demand shocks during the Great Recession and the early COVID-19 period. While the inflation contribution of persistent demand shocks is on average low, we can clearly see an increase in the share of this component in 2021 and 2022.

Figure 2 quantifies the inflation contributions of each component. Panel (a) compares persistent demand and supply shocks. While the contribution of persistent demand shocks is usually less than 0.5 percentage point, it was more than 1 percentage point in 2021 and early 2022. Persistent demand has started to decline recently, but this trajectory still needs to be confirmed with future data. The contribution of persistent supply shocks increased during the recent inflation run-up but mostly remained lower than the contribution of persistent demand. Despite inflation being much higher than during any other episode over the last 40 years, the size of persistent supply shocks during this period is comparable to what was observed before the inflation run-up.

Panel (b) focuses on the contribution of shocks classified as transitory. The contribution of

Table 1: Top-Five Categories with Persistent Demand and Supply Shocks: June 2021 through June 2022

	(1) Inflation contribution, ppts	(2) Price change, %	(3) Consumption change, %
Persistent supply			
New light trucks	0.23	11.3	−10.3
Furniture	0.15	13.1	−6.8
Fuel oil	0.14	98.5	−29.0
Motor vehicle leasing	0.08	18.8	−20.0
Tobacco	0.05	7.9	−10.1
Persistent demand			
Air transportation	0.17	29.8	25.0
Motor vehicle maintenance and repair	0.10	7.9	2.3
Hotels and motels	0.06	10.7	30.9
Alcohol in purchased meals	0.05	5.6	6.3
Hairdressing salons	0.02	6.3	9.4

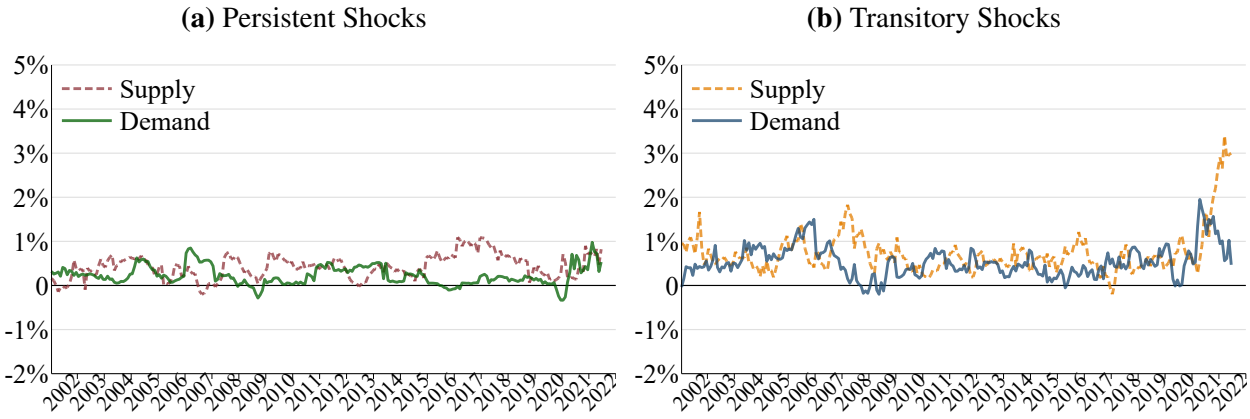
Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.

transitory supply shocks has been rising and is now close to 5 percentage points, whereas the contribution of transitory demand shocks has been falling. It is worth noting that transitory supply shocks are particularly difficult to interpret. As the chart shows, a run-up in supply shocks can portend a spike in the persistent supply component as transitory shocks are dynamically reclassified. This happened in 2008 and in 2015. However, during some other episodes, transitory supply shocks disappeared relatively quickly. For example, in 2005 and 2006 supply shocks were large but brief. And the large supply shocks in 2011 did not lead to persistent inflation. Whether supply shocks will dissipate soon or become persistent depends on many factors that at the moment are highly uncertain. These factors include the COVID-19 pandemic, the war in Ukraine, and the global supply chains. The decomposition, however, can be useful in separating inflation into a component that can be offset by stability policies at a relatively low cost (demand shocks) and a component associated with a potentially high sacrifice ratio (persistent supply).

To provide more detail on the baseline decomposition, Table 1 focuses on five consumption categories classified as persistent demand and five persistent supply categories that made the largest contributions to inflation in June 2022. Along with inflation contributions (column 1), the table shows inflation (column 2) and consumption growth (column 3). The categories affected by supply issues include motor vehicles, furniture, and energy. The categories that experienced persistent demand shocks include travel and some in-person services. These categories are characterized by a strong pent-up demand accumulated during the early COVID-19 period.

It is worth noting that some of these categories likely experienced both a large demand shock and a large supply shock. For example, while demand for air transportation increased sharply in

Figure 3: Contributions to Core Inflation



Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.
Note: This figure shows the contributions to year-over-year *core* PCE inflation of the persistent (Panel a) and transitory (Panel b) demand and supply components.

2021 and 2022, the industry was also affected by significant supply shocks, as the cost of jet fuel jumped while labor shortages hindered operations. Air transportation is classified as a demand sector because both prices and real consumption increased sharply. This example highlights the challenging nature of shock classification. While I attempt to minimize measurement error by focusing on highly disaggregated categories, even at the lowest available level of disaggregation some consumption categories in the PCE data are quite large.[5]

Core Inflation

Next, I decompose core PCE inflation into the four components. Much of the recent inflation run-up comes from rising energy and food prices. As these prices tend to be volatile, supply shocks associated with them are often deemed transitory. Hence, by decomposing core inflation into persistent demand and supply components, we can gauge the pass-through from energy and food prices into core prices.

Figure 3 shows the results. The volatility and the average contribution of transitory shocks, both demand and supply, become smaller as large and volatile energy shocks are removed from the measure. But the absolute contribution of persistent shocks also declines, which is especially clear in the case of demand shocks. The qualitative assessment of the four types of shocks, however, is similar to the case of headline inflation. Persistent demand shocks have played a role in the recent inflation run-up, with their contribution to core inflation peaking at 1 percentage point. The contributions of persistent and transitory demand shocks have recently declined, whereas the contribution of persistent supply shocks has risen. Thus, qualitatively the conclusions based on

[5]Housing is another notable example.

core inflation remain similar to the baseline.

4. Alternative Classifications

In this section, I examine the sensitivity of the method to the underlying assumptions. To save space, I briefly mention each robustness exercise and relegate the results to the appendix.

First, I consider alternative persistence thresholds (Figure A.1). In the baseline, I call a shock persistent if it is classified as demand (supply) for at least 11 months during the previous 12-month period. When instead I consider thresholds of 9, 10, or 12 months, the contribution of transitory supply shocks varies from approximately 4 percentage points to 5 percentage points. The peak contribution of persistent demand shocks varies from 1.5 to 2 percentage points. Thus, the classification is not particularly sensitive to the choice of the persistence threshold.

Second, I study alternative detrending methods (Figure A.2). I consider deviations from aggregate (rather than sectoral) averages (Panel a) and from the trends based on the fitted bilateral vector autoregression (VAR) process. The VAR includes 12 monthly lags of the logarithms of year-over-year inflation and real consumption growth rates. I consider a VAR estimated over the baseline sample (Panel b) and using 10-year moving windows (Panel c).[6] The classifications based on these alternative approaches give rise to less balanced decompositions. For example, focusing on deviations from the aggregate trend results in a disproportionately large share of shocks that are classified as supply shocks. This happens because categories with falling prices and rising consumption due to technological progress are classified as supply-shock categories, even though these changes are secular rather than cyclical. When I focus on bilateral VAR residuals, very few shocks are classified as persistent demand or persistent supply shocks, because the time-varying trends absorb persistent shocks. Even when I reduce the persistence threshold to nine months (Panel d), the share of shocks that are classified as persistent demand shocks remains disproportionately small during the sample period.

Finally, I consider a different level of aggregation (Figure A.3). Instead of 191 highly disaggregated categories, here I use 51 larger consumption categories. While the resulting decomposition is overall similar to the baseline, there are some quantitative differences. For example, during the 2021–2022 inflation run-up, the contribution of persistent demand shocks, peaking at 2 percent, is slightly larger than in the baseline, whereas the contribution of persistent supply shocks (0.5 percentage point, on average) is slightly smaller. This suggests that some sectors experienced simultaneously significant persistent demand shocks and persistent supply shocks.

[6]The baseline sample starts in 2000 to allow for both 12 lags and 12 classification months needed to determine persistence. For the moving-windows exercise, I add data from the 1990s: The first sample covers the 1991–2001 period, and the last sample covers the 2002–2012 period. That is, each window includes an extra year of data to control for 12 lags.

5. Takeaways

In this brief, I propose a novel decomposition of inflation into four components: persistent supply, transitory supply, transitory demand, and persistent demand. I find that, of these components, transitory supply shocks have made the largest contribution to the recent inflation run-up. While demand shocks had contributed less than supply shocks to inflation as of June 2022, for much of the run-up period demand shocks accounted for a relatively large share of the persistent component compared with supply shocks. If demand shocks remain persistent and supply shocks continue to be transitory, demand shocks may start playing a dominant role in inflation dynamics in the medium term. In this case, countercyclical policies may need to lean against the wind more than in the case of transitory demand shocks. Moreover, the potentially costly tradeoff between price stability and full employment may become less relevant if demand shocks become dominant. If instead supply shocks continue to drive inflation dynamics for a long period, it may become increasingly difficult to stabilize prices and achieve a soft landing simultaneously.

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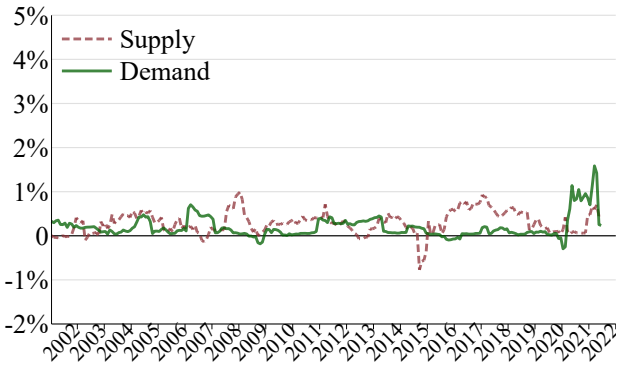
Appendix: Additional Results

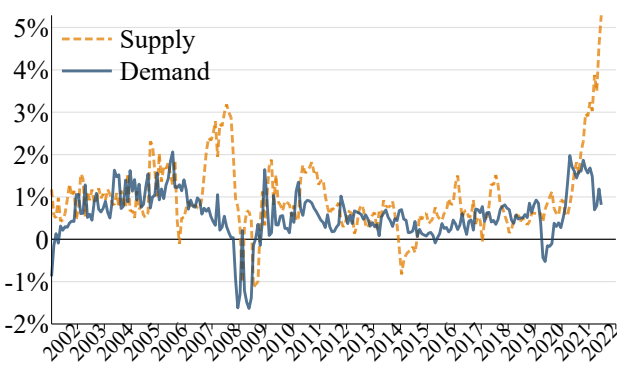
Figure A.1: Decomposition Sensitivity to Persistence Threshold

Persistence Threshold: 12 months

(a) Persistent Shocks

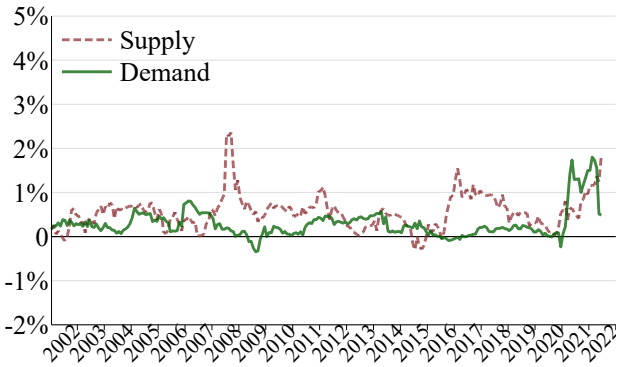


(b) Transitory Shocks

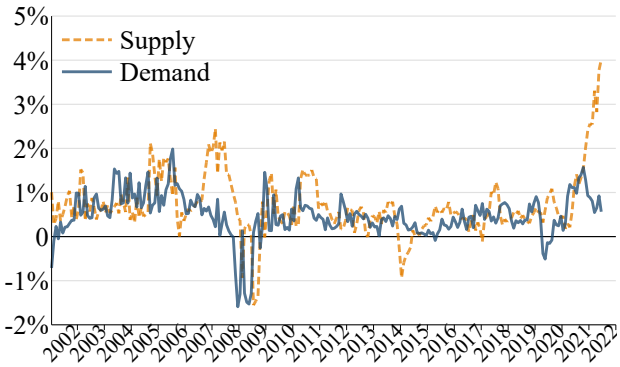


Persistence Threshold: 10 months

(c) Persistent Shocks

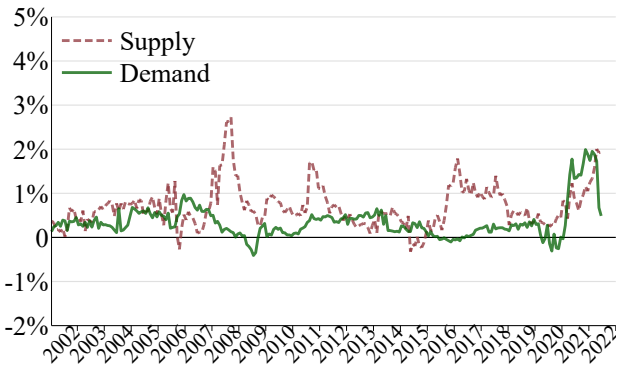


(d) Transitory Shocks

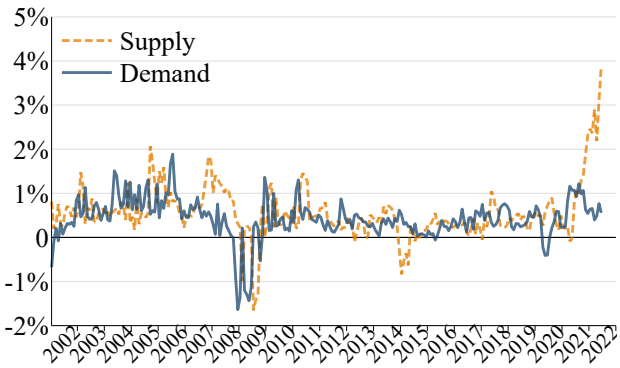


Persistence Threshold: 9 months

(e) Persistent Shocks



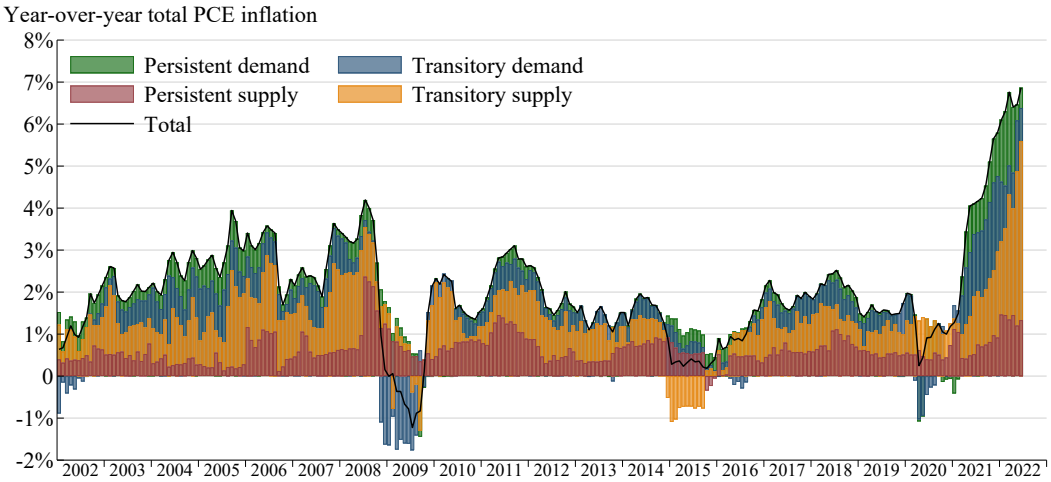
(f) Transitory Shocks



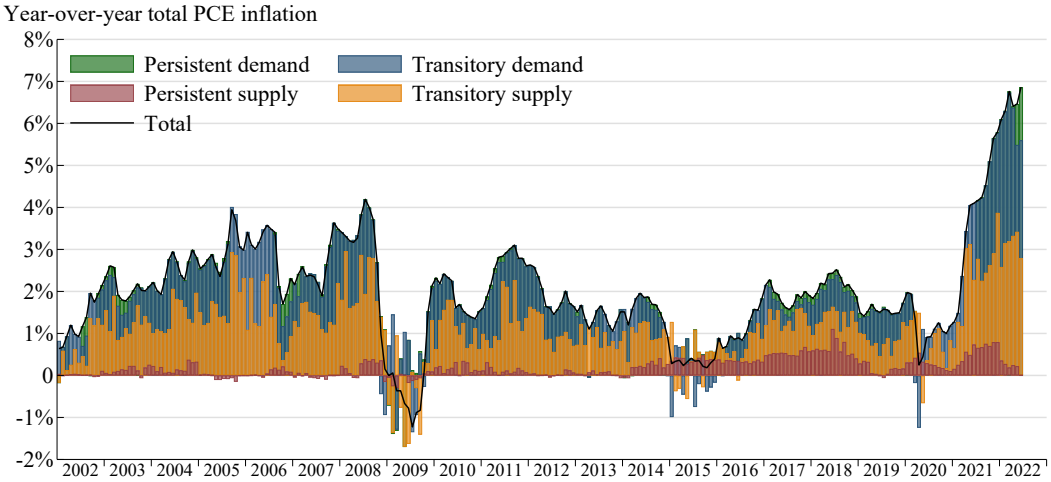
Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.

Figure A.2: Alternative Detrending Methods

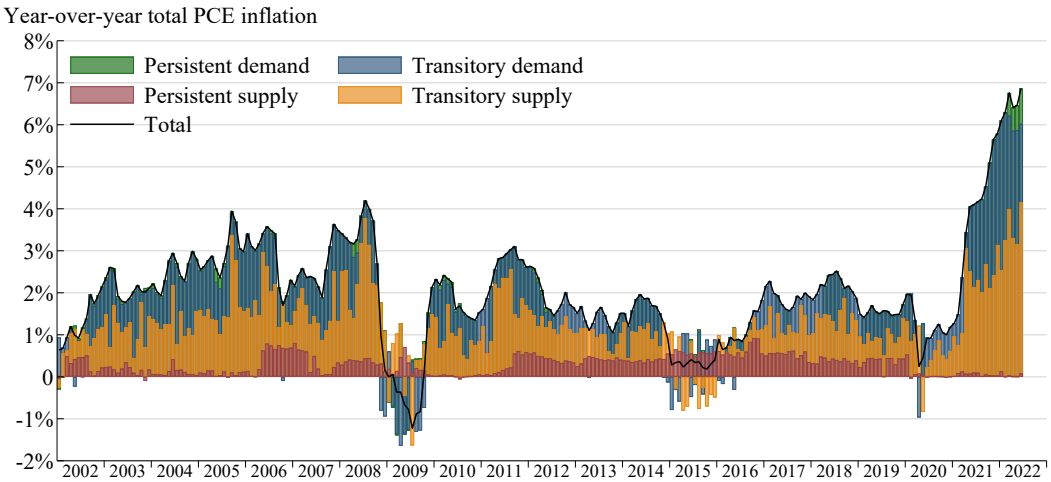
(a) Deviations from Aggregate Averages



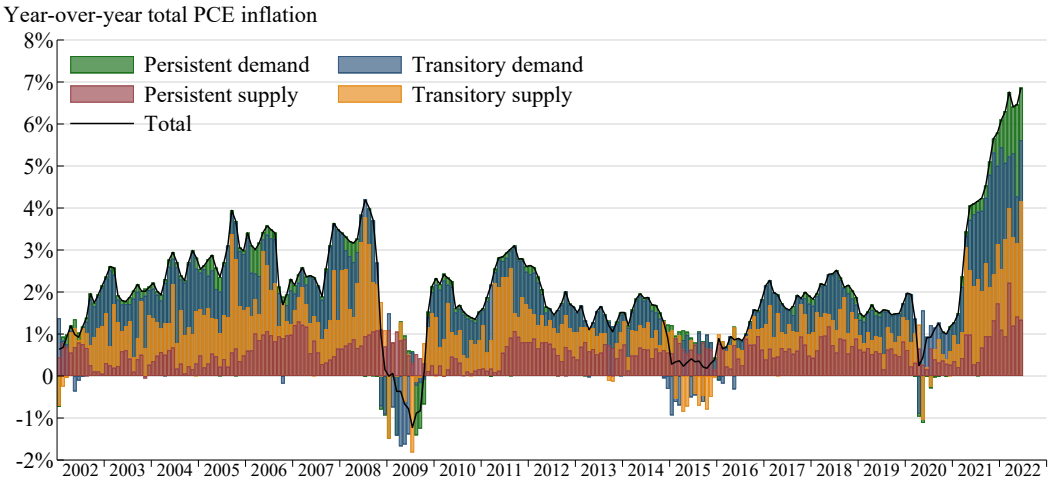
(b) Full-Sample VAR Residuals



(c) Ten-Year Moving Window VAR Residuals



(d) Ten-Year Moving Window VAR Residuals with a Lower Persistence Threshold

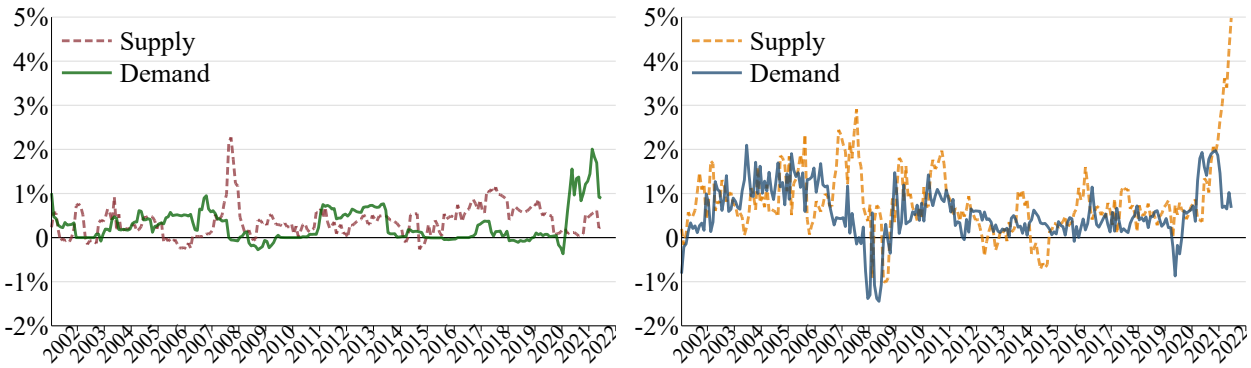


Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.

Figure A.3: Alternative Aggregation: 51 categories

(a) Persistent Shocks

(b) Transitory Shocks



Source: Author's calculations based on U.S. Bureau of Economic Analysis data through June 2022.