Inflation and Real GDP Growth in the U.S.

– Demand or Supply?

Jui-Chuan Della Chang
Professor of Banking and Finance, National Chiayi University,
580 Sinmin Rd., Chiayi City 60054, Taiwan
Phone: +886-5-2732864; Fax: +886-5-2732889
E-mail: jccdella@mail.ncyu.edu.tw

Dennis W. Jansen
Director of the Private Enterprise Research Center and the Jeff Montgomery Professor of Economics, Texas A&M University, College Station, TX 77843-4228
Phone: 979-8457351; Fax: 979-8478757
E-mail: dennisjansen@tamu.edu

Carolina Pagliacci[+]
Associate Professor, IESA School of Management
Av. IESA, urb. San Bernardino, Caracas 1010, Venezuela
Phone: +58-412-2559217
E-mail: carolina.pagliacci@iesa.edu.ve

This version: April 28th, 2023

[+] Corresponding author.

Introduction

Decompositions of real GDP growth and inflation into aggregate demand and aggregate supply components have been a feature of macroeconomic analysis since at least the paper by Blanchard and Quah (1989). Fackler and McMillin (1998) use historical decompositions from structural shocks to analyze the impact of aggregate demand on the economy. These papers both relied on long run restrictions to identify underlying structural shocks. Later sign restrictions have been used as a method of identifying structural shocks, as summarized in Uhlig (2017). These methods can be used to decompose in real GDP growth and inflation in terms of shocks to demand or shocks to supply via sign restrictions. Recently Pagliacci (2019) used sign restrictions to identify demand and supply shocks and calculate historical decompositions in order to gauge the importance of supply shocks for short run variations in output. Here we look at the recent experience of the United States via the lens of sign restrictions to identify shocks to aggregate demand and aggregate supply. We use historical decompositions to create the components of real GDP growth, and inflation, that are due to the cumulation of the shocks to aggregate demand or aggregate supply. We find strong evidence that the experience of the U.S. during the Covid Recession and during the subsequent recovery as driven by both aggregate demand and aggregate supply. In particular, both aggregate demand and aggregate supply shocks are responsible for the large increase in the U.S. inflation rate. Real GDP growth was largely driven by aggregate demand shocks, with aggregate supply shocks exerting a drag on output growth.

Methods

Supply and demand inflation are a subproduct of identifying structural supply and demand shocks in the aggregate goods market. As in Blanchard & Quah (1989), aggregate supply and demand shocks represent a summary of all the specific shocks that affect the goods market during a particular time interval, and therefore can be labelled as *umbrella* shocks. One advantage of only identifying these two shocks is that output growth and inflation can be completely described by them, in the same way aggregate supply and demand curves' shifts explain output growth and inflation fluctuations in basic macro models. Moreover, variables can be separated into components that explicitly describe the dynamic impacts of each structural shock. For computing supply and demand inflation, we start identifying structural supply and demand shocks using sign restrictions.[1]

Start with Z, a vector of two endogenous variables $\mathrm{Z} = [y, \pi]'$, where *y* represents the country GDP growth and π the inflation rate traced by the GDP deflator. The reduced VAR is given by:

$$Z_t = A_1 Z_{t-1} + \cdots + A_l Z_{t-l} + e_t \qquad (1)$$

where $e = [e^y,\ e^\pi]'$ is the vector of the reduced-form residuals with covariance matrix Σ. The associated structural model is:

$$\Psi^{-1} Z_t = \Gamma_1 Z_{t-1} + \cdots + \Gamma_l Z_{t-l} + \varepsilon_t \qquad (2)$$

[1] Our approach is to look at aggregate real GDP and aggregate inflation. Others have looked at disentangling supply and demand from or with a large number of variables and building up to an analysis of overall demand and supply factors. Two somewhat different papers using this type of approach include Eickmeier and Hofmann (2022) and Shapiro (2022).

where ε is the vector of structural supply and demand shocks $\varepsilon = [\varepsilon^S, \varepsilon^D]'$ and Ψ^{-1} contains the contemporaneous structural relationship among the endogenous variables and residuals, so that $e_t = \Psi\, \varepsilon_t$.

Sign restriction identification implies estimating Ψ matrices that deliver variables' responses to structural shocks that are sign-consistent with theoretical prescriptions. In this case, output growth and inflation are expected to be positively correlated after a demand shock and negatively correlated after a supply shock. Candidates for Ψ come from $\Psi = PQ$, where *P* is a decomposition of Σ that satisfies $\Sigma = P\ P\ '$, and *Q* is a rotation matrix that satisfies $Q\ Q\ ' = Q\ '\ Q = I$.[2] Structural shocks can be recovered from $e_t = PQ\ \varepsilon_t$. Since there are as many structural residuals as valid *Q* matrices satisfying sign restrictions, the system is overidentified.

Variables' components are labeled: supply growth (y_t^S), demand growth (y_t^D), supply inflation (π_t^S), and demand inflation (π_t^D), which correspond to the historical impacts of structural supply or demand shocks on output growth and inflation, respectively. These historical decompositions are function of the median structural shocks (recovered across valid *Q* matrices) and are evaluated for a window of *H* periods -the time span for which shocks' impacts are relevant. The expressions to compute historical decompositions are:

$$[y_t^S, \pi_t^S]' = \sum_{h=0}^{H-1} A^j P\ q^S\ \varepsilon_{t-h}^S$$

[2] *P* can be obtained either from a Cholesky or a spectral decomposition. We use the Cholesky one. Rotation matrices are obtained by applying the QR decomposition to a unitary random matrix, following Rubio-Ramirez, Waggoner, & Zha, (2010). Simulations are run in MATLAB with our own code.

(3)

$$[y_t^D, \pi_t^D]' = \sum_{h=0}^{H-1} A^j P \; q^D \; \varepsilon_{t-h}^D$$

where *A* represents the companion form matrix of the *A*s matrices in equation (1). Vectors q^S and q^D denote the first and second column of matrix *Q**, i.e., the rotation matrix that delivers structural residuals closer to their median value, as suggested in Fry & Pagan (2011). Notice that vectors $P \; q^S$ and $P \; q^D$ transform the units of structural shocks into units of output growth and GDP inflation.

Results

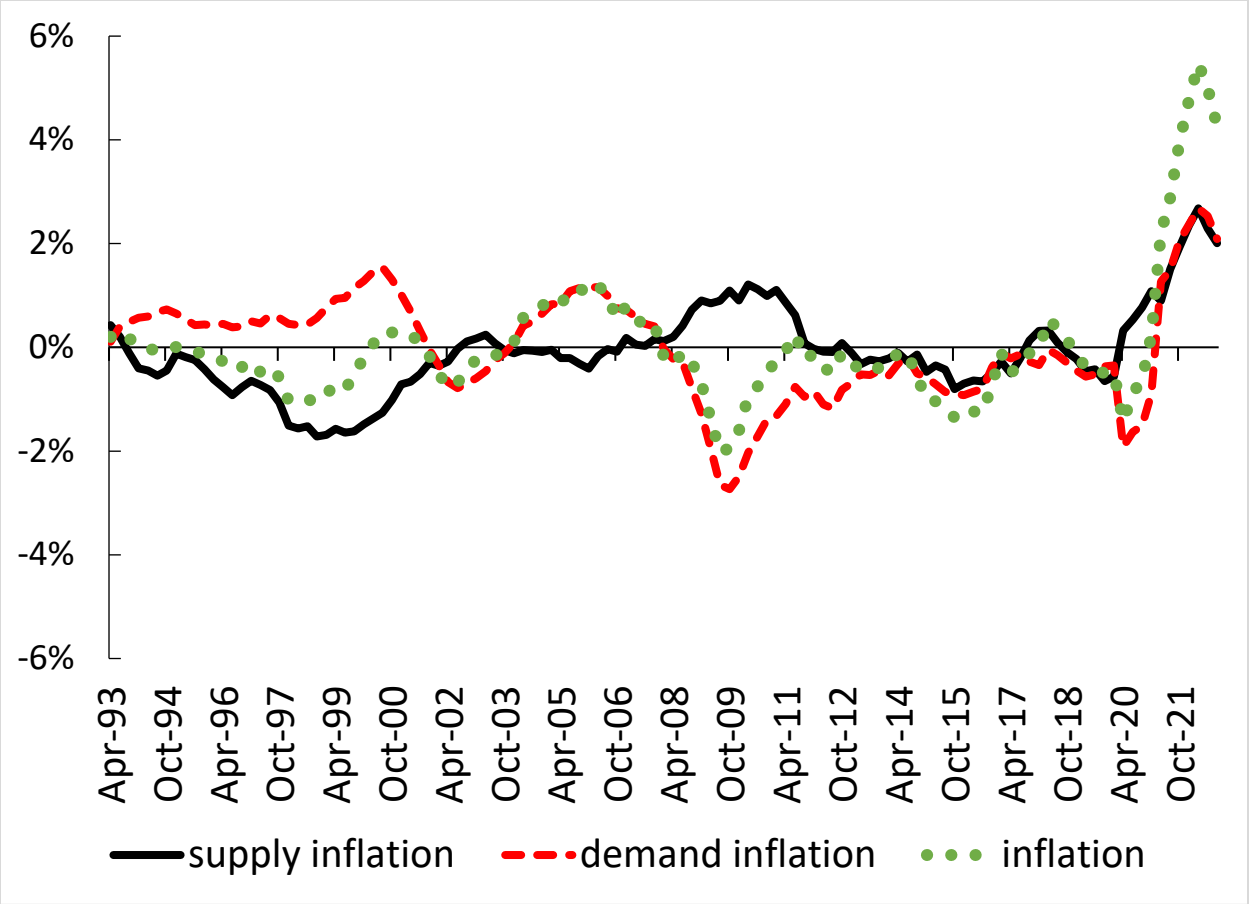
Figure 1 provides graphs of realized inflation, along with the historical decomposition of the inflation series into that part driven by aggregate supply shocks (labeled 'supply inflation') and that part driven by aggregate demand shocks (labeled 'demand inflation'). Note that the realized inflation rate is detrended for comparison to the historical decompositions. The trend inflation rate over our sample is 2.15%.

Historically it is often the case that supply inflation and demand inflation moved countercyclically with each other, so that the realized inflation rate was between the two. During the 1990s we had a period of positive demand inflation (or more correctly, above-trend inflation), but a period of negative (or again, more correctly, below-trend) supply inflation. We might venture an explanation as this being the result of globalization, especially greatly increasing trade with China. Demand inflation turned negative after the dot-com burst and the recession of early 2000, but supply inflation moved upward, hovering near trend for the early and middle period of the 2000s. Demand inflation turned positive again in the middle 2000s,

and we might venture an explanation as due to low monetary policy interest rates during this period. Indeed, some blame the low Federal Funds Rate experienced during this period for the rapid increases in housing prices and the subsequent Global Financial Crisis and Great Recession. In any case, demand inflation turned sharply negative during and after the Great Recession, while supply inflation was positive for a time.

As the economy recovered from the Great Recession and moved into the years 2012-2019, both demand inflation and supply inflation were below trend, and thus the realized inflation rate was below trend. The Federal Reserve reported difficulty in keeping the inflation rate at its 2% target during this period.

Figure 1. Realized Inflation with Supply Inflation and Demand Inflation Decompositions.



The COVID pandemic and recession hit the economy hard in March-April 2020, and in the graph there is a sharp decline in demand inflation and a sharp increase in supply inflation. This can be attributed to the immediate impact of the pandemic and accompanying shutdowns on demand, as well as the supply chain problems and workforce issues hitting supply. But aggregate demand quickly reversed itself as the government engaged in massive borrowing and spending to support economic activity, and by 2021 both supply inflation and demand inflation are sharply higher and well above trend levels, leading to the large spike in realized inflation rates. This period of demand and supply inflation moving in tandem is unusual over the period in the graph. Further, the magnitude of the supply and demand inflation is some of the largest

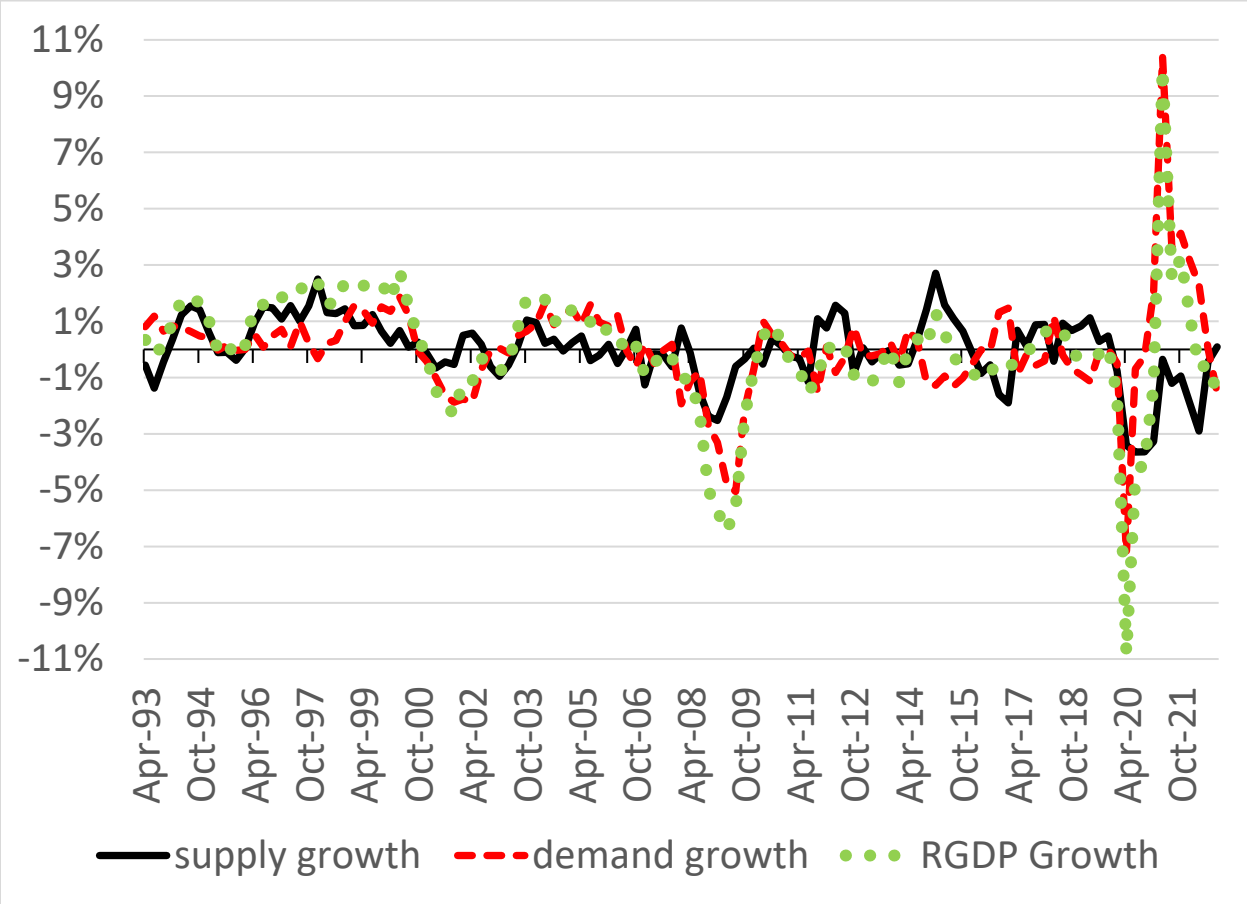
seen during this period, especially on the positive side. Both of these features are responsible for the occurrence of such high realized inflation rates at the end of the sample.

On the output side, there is less of a pattern of negatively correlated movements of supply growth and demand growth components of realized real GDP growth. In Figure 2 we graph the demand and supply components of growth, which are detrended, along with detrended realized real GDP growth. The trend in realized real GDP growth over our sample period is 2.5% annually.

In Figure 2, realized real GDP growth turns negative during recessions, indicating below-trend realization. Relatively large negative realization of (detrended) real GDP growth occur in the recession periods of 2000-2001, 2007-2009, and 2020. In the first period, supply growth was near zero for part of the period, but the decline in demand growth dominated and led to a recession. Again, this was a recession associated with the end of the dot.com bubble. The much larger Great Recession was a combination of negative supply growth and negative demand growth, leading to a very large and fairly long period of negative realized real GDP growth. Finally, the COVID Recession was a combination of a sharp but short-lived decline in demand growth at the outset of the recession, along with a decline in supply growth that persisted for a longer period. The sharp decline in demand growth was quickly followed by an equally sharp but much more persistent increase in demand growth, likely associated with the multiple large fiscal stimulus actions undertaken during this period, and resulting in a quick reversal of the realized real GDP growth pattern to strong positive values. By the end of our

sample the demand growth had fallen to values below trend, while supply growth had largely returned to trend, resulting in realized real GDP growth basically at or slightly below trend.

Figure 2. Realized RGDP Growth with Supply Growth and Demand Growth Decompositions.



The Federal Reserve System has blamed the inflation experienced during 2021 -2023 as springing in large part from supply chain issues, and at least initially labeled this inflation as temporary. Figure 2 provides some support for the idea that supply issues provided a drag on real GDP growth, and Figure 1 shows how supply issues led to higher inflation rates over this period. However, the Federal Reserve System has resisted somewhat in accepting criticism of a

too-easy policy stance over this same period, especially in light of the very strong stimulus packages enacted by Congress. Figures 1 and 2 suggest that demand influences after the COVID Recession were very strongly influencing real GDP growth, and had equally strong impact as the supply influences in the increase in inflation.

Conclusion.

References

Ascari, G., Bonomolo, P., Hoeberichts, M., and Trezzi, R. (2023). The Euro area great inflation surge. DeNederlandscheBank working paper.

Blanchard, O., & Quah, D. (1989). The dynamic effects of aggregate demand and aggregate supply. *The American Economic Review, 79*(4), 655-673.

Eickmeier, S., and Hofmann, B. (2022). What drives inflation? Disentangling demand and supply factors. Bank for International Settlements working paper 1047.

Fackler, J. S., and McMillan, W.D. (1998). Historical decomposition of aggregate demand and supply shocks in a small macro model. *The Southern Economic Journal* (64(3), 648-664.

Fry, R., & Pagan, A. (2011). Sign restrictions in structural vector autoregressions: A critical review. *Journal of Economic Literature, 49*(4), 938-960.

Pagliacci, C. (2019). Are we ignoring supply shocks? A proposal for monitoring cyclical fluctuations. *Empirical Economics*, 56, 445-467.

Rubio-Ramirez, Waggoner, & Zha, (2010). Structural Vector Autoregressions: Theory of Identification and Algorithms for Inference. *The Review of Economics Studies* 77(2), 65-696.

Shapiro, A. H. (2022). Decomposing supply and demand driven inflation. Federal Reserve Bank of San Francisco working paper 2022-18.

Uhlig, H. (2017) Shocks, sign restrictions, and identification. In *Advances in Economics and Econometrics*, Eleventh World Congress, Cambrige University Press, 95-127.