Quantifying the Inflationary Impact of Fiscal Stimulus Under Supply Constraints*

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Abstract

This paper builds on Baqaee and Farhi (2022) and di Giovanni et al. (2022) to quantify the contribution of fiscal policy on U.S. inflation over the Dec-2019 to June-2022 period. Model calibrations show that aggregate demand shocks explain roughly two-thirds of total model-based inflation, and that the fiscal stimulus contributed half or more of the total aggregate demand effect.

Keywords: Inflation, fiscal policy, supply constraints
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1 Introduction

U.S. headline inflation has hit levels not seen for several decades, reaching 9 percent per annum at its peak in June 2022, before declining to approximately 7 percent per annum by the end of 2022. In contrast, inflation was below 2 percent before the 2020 COVID-19 pandemic.

A priority that has been at the top of the minds of both policymakers and academics alike has been to quantify the relative importance of the key factors in driving the observed inflation, particularly the relative importance of supply bottlenecks vs. consumer demand, as the U.S. and world economies struggled with supply-demand imbalances arising from the COVID-19 health shock combined with stimulative policies.

The literature thus far has found differing results, ranging from one-third to two-thirds contributions from supply factors (with the remaining being demand). Shapiro (2022b,a) takes an econometric approach while di Giovanni et al. (2022) and Ferrante et al. (2022) use quantiative models.

Though these papers provide important early evidence on the different channels that drove the surge in inflation, none of them take a stand on the inflationary impact of specific policy actions. In particular, the 2021 Biden fiscal package totaled 15% of GDP and has been blamed by some for today's high inflation (Blanchard et al., 2022).

In this paper, we explicitly measure the impact of the fiscal stimulus on inflation over the Dec-2019 to June-2022 period. We follow our previous work and use the framework developed in Baqaee and Farhi (2022) in order to quantify the impact of different shocks on inflation. Importantly, unlike in our previous quantification exercises, we feed aggregate demand shocks into the model that vary depending on whether the fiscal impulse is included or not. Doing so allows us to (1) quantify the impact of aggregate demand in driving inflation, and (2) run a counterfactual scenario that omits observed government spending as part of the aggregate demand shock. This second scenario allows us to gauge the importance of the fiscal package's impact on inflation.

Our baseline results show that over the Dec19-Jun22 period, aggregate demand shocks explained roughly two-thirds of total model-based inflation in the US, and that the fiscal stimulus contributed half or more of the total aggregate demand effect. The range for the impact of fiscal stimulus vary depending on how we detrend the data in constructing the

empirical shock series. Since the fiscal packages came in a discrete fashion as bursts of government spending, such sensitivity is expected.

Section 2 presents a brief description of the model. Section 3 describes the data and methodology we use to construct the shocks that we feed into the model. Section 4 presents the main results.

2 Model

We build on previous work (di Giovanni et al., 2022) to quantify the sources of inflation using a multisector macro-network model in the spirit of Baqaee and Farhi (2022).

Inter-temporal Allocation. There are two periods: the first period corresponds to the pandemic and the second one represents the post-pandemic (i.e., the future). We denote the future quantities with an asterix ($*$) in the subscript. There are two types of consumers. Ricardian consumers optimize their budget across two periods to smooth out their consumption such that their intertemporal consumption decisions optimize:

$$C^{\beta} C_{*}^{1-\beta},$$

where C is the consumption and β captures the Ricardian consumers' time preferences. We assume that we are at the zero lower bound for the interest rate. Hence, household spending and income (I) are related to each other:

$$I + I_{*} = pC + p_{*}C_{*}.$$

Hand-to-mouth consumers, on the other hand, cannot borrow against their future income (I_{*}) and spend only their current income. The share of Ricardian consumers is denoted by ϕ.

Within-Period Consumption. We assume that there are N sectors. Within each period, the consumers allocate their budgets across the sectors with a Cobb-Douglas utility:

$$\ln C = \sum_{i=1}^{N} \alpha_i \, \delta_i \ln c_i, \tag{1}$$

where c_i is the consumption in sector i, α_i is the consumption share during the non-Covid period such that $\sum_{i=1}^{N} \alpha_i = 1$, and δ_i is the shift in sectoral consumption during the pandemic

such that $\sum_{i=1}^{N} \alpha_i \, \delta_i = 1$.

Production. Each sector i uses the intermediate inputs from other sectors (input from sector j to sector i is denoted by x_{ij}), sector specific labor (L_i) and sector specific capital K_i. The output of sector i (y_i) is given by:

$$y_i = \left[\left(\omega_{iL} L_i^{\frac{\gamma-1}{\gamma}} + \omega_{iK} K_i^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}\frac{\theta-1}{\theta}} + \left(\sum_{j=1}^{N} \omega_{ij} x_{ij}^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{2}$$

where ω_{iL} (ω_{iK}) determines the labor (capital) share, and ω_{ij} captures the intermediate input shares. ε dictates the inter-industry substitution between inputs, γ controls the substitution between labor and capital and θ determines the substitution between the factors and input bundle.

Equilibrium. For normalization purposes, we take $p_* = 1$ and $C_* = 1$. The equilibrium is achieved through adjustment of prices, wages and rental rents of capital such that good markets clear ($y_i = c_i + \sum_{j=1}^{n} x_{ji}$), capital markets clear ($K_i = K_{i*}$), producers maximize their profits and consumers optimize their consumption.

For labor, during pandemic, some workers are unable to work due to COVID-related reasons. Let's denote the pre- (post-) pandemic level of labor in industry i with L_{i*}. During pandemic, number of available workers in industry i shrinks to $\bar{L}_i \leq L_{i*}$. Moreover, the workers will not accept a wage below their pre-pandemic levels. Denoting the wage of workers in industry i with w_i, the wage levels satisfy $w_i \geq w_{i*}$, i.e., wages do not go below their equilibrium levels absent the pandemic.

3 Data

3.1 Detrending methods

We implement two detrending procedures to estimate the shocks the model requires. The model needs sectoral demand and supply shocks and an aggregate demand shock. In the first procedure, for sectoral shocks at monthly frequency, we compute the average annual growth

rate between 2015-2019 for sectoral total hours worked and sectoral consumption expenditure for each of the 66 sectors separately. For quarterly nominal GDP, we do the same for the period 2010-2019. Then for each sector for consumption and labor, and for aggregate nominal GDP, we take the deviations from these constant average growth rates during our analysis period to get at our shocks.

The second procedure estimates the following linear regression for each time series Y_t, at the sector or at the aggregate level:

$$\ln Y_t = \beta_0 + \beta_1 t + \varepsilon_t,$$

where β_0 and β_1 are estimated parameters, t is a linear-trend, and ε_t is an error term. We then compute the trend variable as

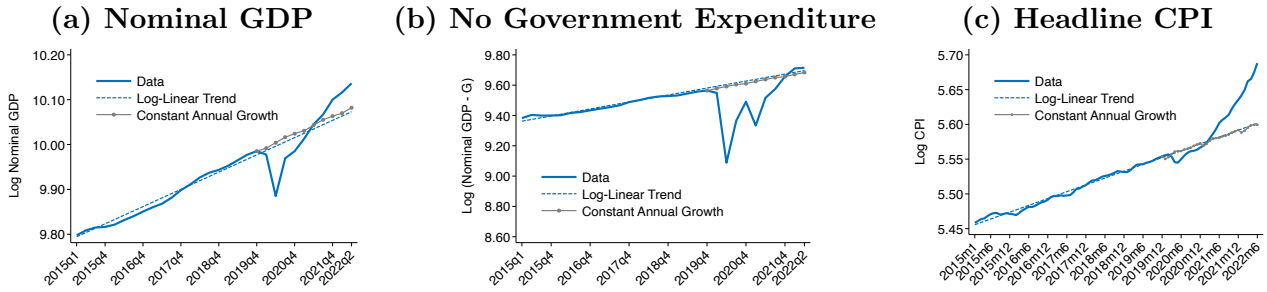
$$\widehat{Y}_t = \widehat{\beta}_0 + \widehat{\beta}_1 t.$$

The shocks we feed in are then the residuals:

$$\text{shock}_t = \ln Y_t - \ln \widehat{Y}_t.$$

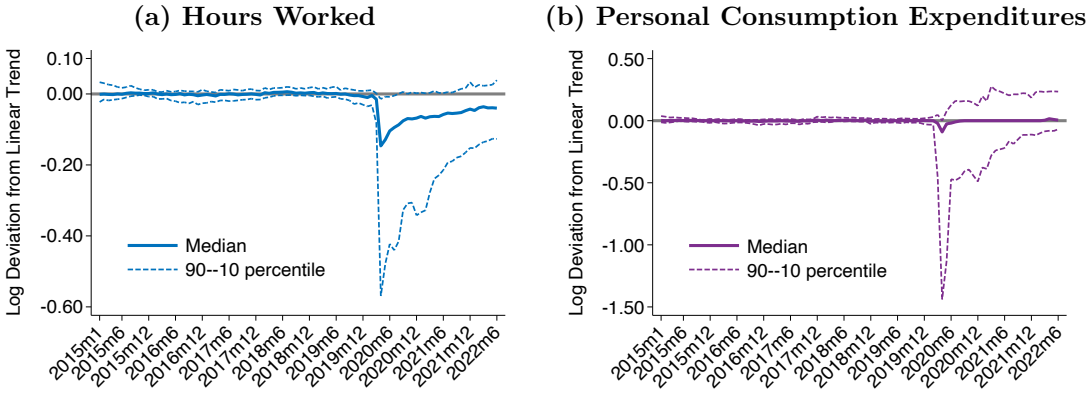
To get a sense of how these detrending procedures look like in practice, Figure 1 plots these trends for three aggregate time series together with actual data. Panels (a) and (b) plot the aggregate demand shock, nominal GDP and nominal GDP without government expenditure, respectively, while panel (c) plots headline inflation. The solid blue lines denote the raw data, the gray dotted lines denote the constant annual growth trend, and the blue dashed lines denote the log-linear trend. As can be seen, both methods deliver similar patterns for the three aggregate time series. For the detrending of the sector-level data, Figure 2 presents cross-sector differences. Panel (a) plots total hours worked (used for the sectoral supply shocks), while panel (b) plots personal consumption expenditures (used for the sectoral demand shocks). The figure shows the cross-sectional median (solid line) and the 90-10 percentiles (dashed lines) across 66 sectors at each point in time.

Figure 1.— Aggregate data time series



Notes: This figure shows the (log) levels of each series (solid lines) together with the annual constant growth rate series (gray dotted line) and a (log) linear trend (dashed lines).

Figure 2.— Sectoral data time series



Notes: This figure shows the cross-sectional median (solid line) and the 90-10 percentiles (dashed lines) across 66 sectors at each point in time. Panel (a) plots total hours worked, while Panel (b) plots personal consumption expenditures.

4 Results

Figure 3 presents the main results. Since we feed into the model shocks as deviations from trends, the model-predicted inflation is also deviation from trend and hence should be compared to June 2022 CPI's deviation from trend in the data.

Panel I presents results based on the constant-growth detrending method, while panel II presents results based on shocks derived from log-linear detrending. The percentage change in the price level given by CPI from December 2019 and June 2022 was 14.35 percent. The model

predicts something close to this number: 13.17 percent under constant-growth detrending, and 14.18 percent under log-linear detrending[1]. Sub-figures (a) and (c) use nominal GDP as an aggregate demand shock measure, while in sub-figures (b) and (d), we subtract total government expenditure from nominal GDP. Sectoral demand and supply shocks are as described above.

As expected, the model delivers higher inflation when feeding in nominal GDP as an aggregate demand shock relative to the exercises that excludes government expenditure. The aggregate demand shocks (orange bars) generate by themselves roughly two-thirds of the total model-based inflation (blue bars) in figures (a) and (c). Removing government expenditures in figures (b) and (d) drops the contribution of aggregate demand shocks considerably. Regardless of the detrending method, aggregate demand explains two-thirds of the model-based inflation when we include government stimulus. When we exclude government expenditure from nominal GDP, aggregate demand explains at most half of the model-based inflation, while sectoral supply shocks and sectoral demand shocks explain the rest (purple and yellow bars, respectively). These latter shocks contribute non-trivially to aggregate inflation; importantly, their absolute magnitude is not affected when government expenditure is dropped from the aggregate shock.

These results assume all households are Ricardian, that is $\phi = 1$. Figure 4 presents results when we allow thirty percent ($\phi = 0.7$) of the population to be hand-to-mouth consumers. Results are similar to the Ricardian model, except now predicted inflation is lower. Why is this? Remember that the model allows for the possibility of unemployment. When consumers are Ricardian and become temporarily unemployed, their consumption is unaffected as they can substitute future consumption for current consumption. In contrast, when hand-to-mouth consumers become temporarily unemployed, they reduce their demand for goods in the economy, as they have no income and no possibility of borrowing. As a result, any shock that causes unemployment now has a lower effect on prices as hand-to-mouth consumers lose their income, pushing demand down and, given supply, also prices. This mechanism is precisely what Figure 4 shows: both sectoral demand and sectoral supply shocks have lower inflationary effects in the hand-to-mouth scenario relative to the Ricardian scenario. Aggregate demand,

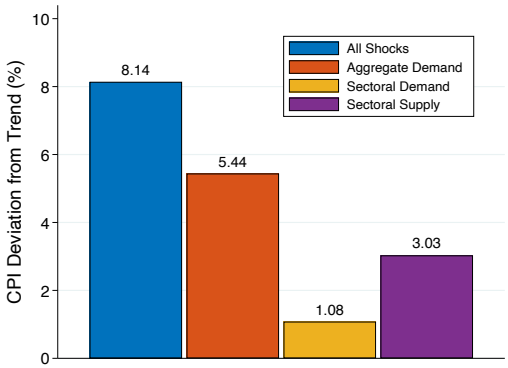
[1]Our model gives results as deviations from trend. To compare these results to actual inflation, we add the trend under each detrending method to the model's results, the numbers in the blue bar of panel (a) and (c) in Figure 3, respectively. The trend was 4.65 percent with constant-growth detrending and 4.86 under log-linear detrending.

in contrast, exhibits the same magnitudes as before. Recall that in the model, an aggregate demand shock works through intertemporal substitution: consumers substitute away from future consumption towards current consumption for given prices and income. Since all good and factor prices are flexible upwards, an increase in aggregate demand maps one-to-one to increases in good prices, ultimately resulting in inflation. However, the sectoral demand and supply shocks will impact inflation via the hand-to-mouth consumer constraint as these shocks will create some unemployment. This can seen by the different impact of these shocks in the right two bars of Figure 4 compared to their impact in the Ricardian model of Figure 3.

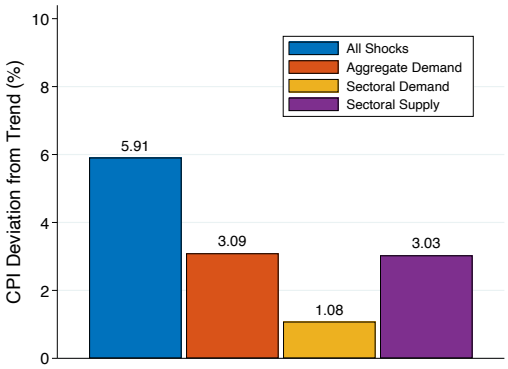
Figure 3.— CPI Deviation from Trend in June 2022 without Hand-to-Mouth Consumers

Panel I: Constant Annual Growth Rate

(a) Nominal GDP

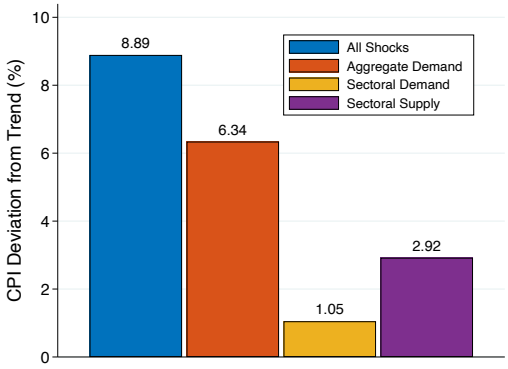


(b) No Government Expenditure

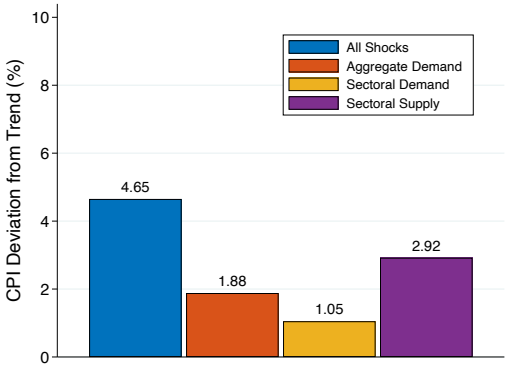


Panel II: Log-linear shocks

(c) Nominal GDP



(d) No Government Expenditure

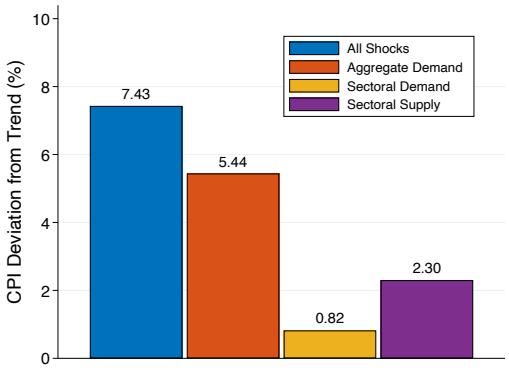


Notes: All figures compute shocks as deviation from trend in June 2022. Panel I uses a constant annual average growth rate starting in 2020Q1 to construct trend series. Panel II uses a log-linear trend. We compute shocks to each series as log-deviations from these trends respectively. Figures (a) and (c) feed in nominal GDP as an aggregate demand shock, while figures (b) and (d) feed in nominal GDP minus total government expenditure as the aggregate demand shock. The observed Headline CPI inflation between December 2019 – June 2022 was 14.35.

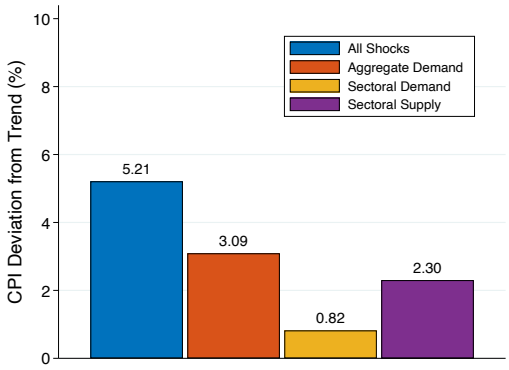
Figure 4.— CPI Deviation from Trend in June 2022 with Hand-to-mouth consumers.

Panel I: Constant Annual Growth Rate

(a) Nominal GDP

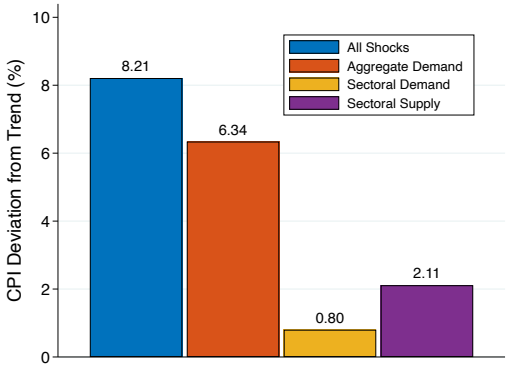


(b) No Government Expenditure

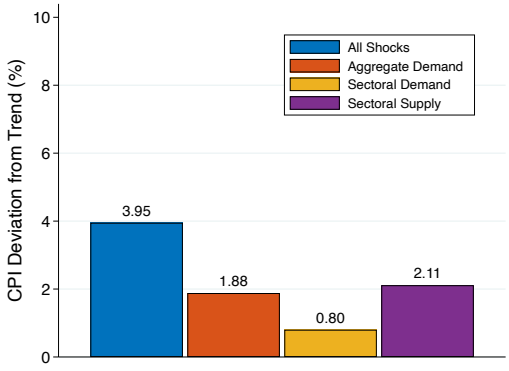


Panel II: Log-linear shocks

(c) Nominal GDP



(d) No Government Expenditure



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