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Redistribution and the monetary-fiscal policy mix

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We show that the effectiveness of redistribution policy is tied to how much inflation it generates, and thereby to monetary-fiscal adjustments that ultimately finance the transfers. In the monetary regime, taxes increase to finance transfers while in the fiscal regime, inflation rises, imposing inflation taxes on public debt holders. We show analytically that the fiscal regime generates larger and more persistent inflation than the monetary regime. In a two-sector model, we quantify the effects of the CARES Act in a COVID recession. We find that transfer multipliers are larger, and that moreover, redistribution is Pareto improving, under the fiscal regime.

Keywords. Household heterogeneity, redistribution, monetary-fiscal policy mix, transfer multiplier, welfare evaluation, COVID-19, CARES Act.

JEL classification. E53, E62, E63.

1. Introduction

Recently, the U.S. experienced the two largest contractions after World War II—the Great Recession and the COVID-19 recession. The government responded to them with unprecedented fiscal measures, namely the American Recovery and Reinvestment Act of 2009 and the Coronavirus Aid, Relief, and Economic Security (CARES) Act of 2020. These fiscal responses included significant transfer components, and they have renewed interest in the effectiveness of transfer policies in rebooting the economy and improving household welfare. They have raised several research questions. What are the macroeconomic effects of redistribution policies that transfer resources from one set of agents in the economy to another? Are such policies inflationary, and if so, how long-lasting is

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the ensuing inflation? What are the determinants of the transfer multiplier? When is the transfer multiplier large? What are the welfare implications of such policies?

In a dynamic general equilibrium model, one would have to take numerous factors into account to answer the above questions. In this paper, we focus on the source of financing and show how government finances transfers has a first-order importance for their effectiveness. Our focus is motivated by the ongoing rapid increase in public debt caused by the large-scale transfer programs. This eventually requires fiscal and/or monetary adjustments, which would *ultimately* finance current transfers.

We compare two distinct ways to finance transfers in a two-agent New Keynesian (TANK) model. In the model, a set of households are unable to borrow and lend to smooth consumption over time. A transfer policy redistributes resources toward such "hand-to-mouth" (HTM) households and away from "Ricardian" households that own government bonds.[1] In the first policy regime, the government raises taxes. Inflation is then stabilized in the usual way by the central bank. We call this case the "monetary regime." In the second regime, the government commits itself to no adjustments in taxes, and the central bank allows inflation to rise to stabilize the real value of debt, thereby imposing "inflation taxes" on households that hold nominal government debt. In this "fiscal regime," the fiscal theory of the price level operates.

We find that the effectiveness of transfer policy is directly tied to how much inflation it generates. A transfer policy is inflationary irrespective of the policy regimes in the model. It is, however, more inflationary in the fiscal regime than in the monetary regime. Therefore, inflation-financed transfers can be used to fight deflationary pressures during recessions, thereby preventing the output and consumption of both types of households from dropping significantly. As a result, the welfare of both household types is higher when transfers are inflation-financed than when they are tax-financed.

Furthermore, somewhat surprisingly, inflation-financed transfers can produce a Pareto improvement relative to the no-transfer case. Notice that, since the model features a staggered Calvo-type price setting, inflation is not a free lunch: it generates, *ceteris paribus*, significant resource misallocation, which leads to a decrease in labor productivity and in welfare. These negative effects of inflation are, however, outweighed by the positive effects of inflation in the low-inflation environment considered in this paper. In fact, without an inflationary intervention, the economy would experience deflation, so there is little cost of inflation.

Our paper starts with a simple flexible-price model that permits analytical results, which allows us to illuminate the fiscal theory mechanism in a heterogeneous-household framework. This model also serves as a useful reference point, as the two policy regimes produce exactly the same multipliers for output and consumption and an identical level of household welfare, even if inflation dynamics are different. This is due to two features. First, both conventional taxes, which are assumed to be a lump

[1]As we describe in further detail later, in our application, we think of these HTM households as working in the service sector that is affected by a large negative sectoral shock.

sum, and inflation taxes are nondistortionary. Second, price flexibility shuts down any feedback effects from inflation on real variables.[2]

For inflation, the fiscal regime gives rise to higher and more persistent inflation than the monetary regime. In particular, transfers affect inflation through two channels in this regime. First, an increase in transfers leads directly to an increase in public debt, which accumulates over time. Consequently, inflation rises to stabilize the real value of debt. Second, an increase in transfers may indirectly raise future public debt through an interest rate channel. Redistribution changes Ricardian household consumption, which in turn affects real interest rates, and thus outstanding public debt in the following periods. That is, redistribution generates a new valuation effect through real interest rate changes, an effect that is absent in the standard one-agent model often used to analyze the fiscal regime. This interest rate channel may lead to a further increase in inflation. Showing these two effects explicitly in a nonlinear two-agent model is a contribution of our paper.

We then build on the analytical results and proceed to a quantitative analysis employing a two-sector TANK model. Relative to the simplified version, the quantitative model includes several realistic features that break the uniformity of the two regimes in terms of the multipliers. The two most important are nominal rigidities and the "COVID shocks." Sticky prices are important, as transfers now can increase output through the usual New Keynesian channel by generating inflation—on top of the classical labor supply channel. Introducing shocks is also consequential as the multipliers are generally state-dependent. In particular, the COVID shocks cause the economy to fall into what we refer to as a "COVID recession" as well as a liquidity trap, in which the effects of redistribution can be different quantitatively.[3]

Specifically, we suppose that the COVID shocks consist of adverse aggregate and sector-specific demand shocks and sector-specific labor supply shocks. The sector-specific shocks intend to capture the observation that "locked out of work" and "fear of unsafe consumption" features are more pronounced in certain sectors of the economy.[4] Situating the model economy in a COVID-recession-like environment, we calibrate the size of transfers to match the transfer amount in the CARES Act and study how the economy responds to redistribution policy.

We find that the transfer multipliers are significantly larger under the fiscal regime than under the monetary regime, primarily because of the difference in inflation dynamics. For instance, the 4-year cumulative multiplier for aggregate output is 1.732 in the monetary regime while it is 5.552 in the fiscal regime. This multiplier is greater than unity even under the monetary regime, thanks to nominal rigidities and the binding zero

[2]The transfer multiplier for output is small yet still positive due to the classical labor supply channel. Redistribution causes Ricardian household consumption to fall, creating a negative "wealth effect" on labor supply.

[3]Another difference from the analytical model is that the government raises (gradually) labor taxes, rather than lump-sum taxes, in the monetary regime, which through distortionary effects, influences the transfer multipliers.

[4]We decompose the U.S. economy into two sectors: (1) transportation, recreation, and food service sector and (2) the rest of the economy, and let the HTM households work in the former sector and the Ricardian households work in the other sectors that are less affected by the COVID pandemic.

lower bound (ZLB). Just as strikingly different are the 4-year cumulative consumption multipliers. For the Ricardian households, it is negative −0.002 in the monetary regime and 3.078 in the fiscal regime, while for the HTM households, it is 7.409 in the monetary regime and 13.652 in the fiscal regime.[5]

We isolate the role played by various model elements in driving our quantitative results using counterfactual exercises. The unusually large multipliers reported above, especially under the fiscal regime, result from the economy being situated in the historically severe COVID recession with large deflationary pressures. For example, shutting down the COVID shocks, the 4-year cumulative multiplier for aggregate output is 1.490 in the monetary regime, while it is 2.696 in the fiscal regime. This result underscores the state-dependency of policy effects. Importantly, the difference in the multipliers for output and consumption between the two regimes gets larger in the presence of COVID shocks, which implies that while both labor-tax-financed transfers and inflation-financed transfers are more effective in the COVID recession than in a normal environment; the latter is even more so. In addition, we also find that relying on labor taxes rather than lump-sum taxes in the monetary regime plays a role.

Overall, as a consequence, the contraction in output and consumption is much more muted when transfers are financed by inflation taxes. Specifically, transfers, when inflation-financed, would reduce the output loss caused by the COVID shocks by roughly 4.1 percentage points at the trough compared to a no-intervention case. We also find that the expansionary effects of inflation-financed transfers are so large that such redistribution policy generates a Pareto improvement: It increases the welfare of both the recipients and sources of transfers, even taking into account the resources taken away from the Ricardian household and the fact that the Ricardian household's leisure decreases as a result of output increases and distortions generated by high and persistent inflation.

Our results shed light on possible determinants of persistently high U.S. inflation following the CARES Act and the COVID recession. First, we show that regardless of the monetary-fiscal policy mix, transfer policies are inflationary, which suggests at least a partial role for fiscal policy in explaining inflation dynamics. Second, if the prevailing policy regime is fiscal, we show that high inflation lasts for a long time. For instance, our quantitative results show that if transfers had been financed by conventional labor taxes, as opposed to inflation taxes, the annualized inflation rate would be lower, on average, by 3.1 percentage points over the 1-year horizon and by 1.8 percentage points over the 2-year horizon. This suggests the plausibility of the fiscal regime, and with it a role for government debt dynamics, as an explanation for the persistent inflation (and economic expansion) that has been a defining feature of the post-COVID U.S. economy.[6]

Our paper builds on several strands of the literature. It is related to the fiscal-monetary interactions literature as originally developed in Leeper (1991), Sims (1994),

[5]The positive Ricardian household consumption multiplier is unique, even qualitatively, in the fiscal regime.

[6]To explain fully the recent rise of U.S. inflation, it is important to account for other drivers of inflation—in particular, supply shocks due to production network disruptions and commodity price movements. We show that our key results are robust to modeling such effects in a simple way through direct shocks to firms' optimal prices.

Woodford (1994), Cochrane (2001), Schmitt-Grohé and Uribe (2000), and Bassetto (2002).[7] Sims (2011) introduced long-term debt under this regime in a sticky-price model, which Cochrane (2018) used to analyze inflation dynamics following the Great Recession. Analytical characterization of the fiscal regime in a linearized sticky-price model is in Bhattarai, Lee, and Park (2014). Our additional analytical contribution here is to derive the fully nonlinear results of this fiscal regime in a tractable two-agent model. Motivated by the COVID crisis and the CARES Act, we then assess the quantitative effects of redistribution policy as well as its welfare implications in a two-sector, two-agent, nonlinear model.

We build on two-agent models as originally developed in Campbell and Mankiw (1989), Galí, López-Salido, and Vallés (2007), and Bilbiie (2018). Moreover, Bilbiie, Monacelli, and Perotti (2013), closely related to this paper, show that different financing schemes affect the size of the output transfer multiplier in a TANK model. However, they only consider the monetary regime. Our main contribution is to assess the effects of redistribution policy in such an environment and show how it depends on the monetary-fiscal policy mix.[8]

Recently, there have been several contributions to an analysis of macroeconomic effects of the COVID crisis. Our quantitative two-sector, two-agent model is closest to the important work of Guerrieri, Lorenzoni, Straub, and Werning (2022). In assessing the quantitative effects of fiscal policy during the pandemic using a model with household heterogeneity, we are also related to Faria-e-Castro (2021) and Bayer, Born, Luetticke, and Müller (2020). Our relative contribution is in showing how the effects of redistribution depend on the monetary-fiscal policy regime and then assessing both quantitative effects and welfare implications by matching some important aggregate and sectoral aspects of the U.S. data.

Our paper is also related to recent papers that analyze monetary-fiscal policy interactions in TANK models—in particular, Bhattarai, Lee, Park, and Yang (2022), Bianchi, Faccini, and Melosi (2021), and Motyovszki (2020). Bhattarai et al. (2022) study the effects of a one-time permanent capital tax rate change in a model that features capital-skill complementarity. Bianchi, Faccini, and Melosi (2021) and Motyovszki (2020) are motivated by the COVID crisis and are closely related to our analysis.[9] Our relative contribution analytically is a nonlinear solution of a TANK model under the two regimes. On the quantitative side, while these studies focus on the positive implications of increases in transfers, we additionally provide welfare implications for different types of households. We also emphasize that the positive and normative implications of redistribution

[7] Canzoneri, Cumby, and Diba (2010) and Leeper and Leith (2016) are recent surveys of this literature.

[8] Motivated by the ARRA Act, Oh and Reis (2012) assess the effects of transfers in a model with incomplete consumption insurance, also considering only the monetary regime.

[9] Bianchi, Faccini, and Melosi (2021) show that inflating away a targeted fraction of debt will increase the effectiveness of the fiscal stimulus in a medium-scale model while Motyovszki (2020) considers a small-open economy environment. Bianchi and Melosi (2019) shows that the fiscal regime improves representative household's welfare. We show that the fiscal regime leads to a Pareto improvement in a two-agent model where the redistribution policy is aimed at combating asymmetric effects of a pandemic, and where the policy trade-off is on using distortionary labor taxes versus inflation taxes to finance such redistribution. We find that a key driver of our welfare results is the state-dependent effects of the redistribution policy, including those that come from nonlinearity.

are state-dependent and that inflation-financed transfers are disproportionately more effective than tax-financed transfers in a COVID-recession-like environment driven by both sector-specific and aggregate shocks. That is, it is important that our analysis traces the recovery of the economy once the economy falls in a COVID-like recession. Relatedly, the nonlinear solution method we use allows for a quantitatively accurate computation given large shocks and the binding ZLB that are a feature of our simulation.

Finally, our paper is also related to the government spending multiplier literature, as the effects of transfer policy in two-agent models share some common elements with the effects of government spending policy in representative agent models. Thus, in connecting the effects to the nature of monetary policy, the binding ZLB, and the monetary-fiscal policy regime, our work builds on important contributions in the government spending multiplier literature by Woodford (2011), Christiano, Eichenbaum, and Rebelo (2011), Eggertsson (2011), Leeper, Traum, and Walker (2017), and Jacobson, Leeper, and Preston (2019). Beck-Friis and Willems (2017), in particular, show analytically that the government spending multiplier is greater under the fiscal regime than under the monetary regime in the linearized sticky-price model.

The rest of the paper is organized as follows. Section 2 develops a simple model with two types of households and presents analytical results on how the effects of redistribution policy depend on the monetary-fiscal policy mix. Section 3 presents a quantitative model with an application focused on the COVID crisis and the CARES Act, and analyzes how the macroeconomic effects and welfare implications of transfer policy depend on the monetary-fiscal policy regimes. Section 4 concludes. An Appendix in the Online Supplementary Material (Bhattarai, Lee, and Yang (2023)) and a full replication code suite are available online.

2. Simple model and redistribution policy

We present a simple model that yields analytical results on the effects of redistribution policy.

2.1 *Model*

There are two types of households: Ricardian and HTM. The Ricardian household makes optimal labor supply and consumption/savings decisions, while the HTM household simply consumes government transfers every period. In this setup, we analytically show the effects on inflation of transferring resources away from the Ricardian households and toward the HTM households and point out that these effects depend critically on how the transfer policy is financed.

2.1.1 *Households*

Ricardian households The Ricardian households, of measure $1-\lambda$, take prices as given and choose $\{C_t^R, L_t^R, B_t^R\}$ to maximize

$$\sum_{t=0}^{\infty} \beta^t \left[\log C_t^R - \chi \frac{\left(L_t^R\right)^{1+\varphi}}{1+\varphi} \right]$$

subject to a standard No-Ponzi-game constraint and a sequence of flow budget constraints

$$C_t^R + B_t^R/P_t = (1+i_{t-1})B_{t-1}^R/P_t + w_t L_t^R + \Psi_t^R - \tau_t^R,$$

where C_t^R is consumption, L_t^R is hours, B_t^R is nominal government debt, Ψ_t^R is real profits, τ_t^R is lump-sum taxes, P_t is the price level, w_t is the real wage, and i_t is the nominal interest rate. The discount factor and the inverse of the Frisch elasticity are denoted by $\beta \in (0, 1)$ and $\varphi \geq 0$, respectively. The superscript, R, represents "Ricardian." The flow budget constraints can be written as

$$C_t^R + b_t^R = (1+i_{t-1})b_{t-1}^R/\Pi_t + w_t L_t^R + \Psi_t^R - \tau_t^R,$$

where $b_t^R = \frac{B_t^R}{P_t}$ is the real value of debt and $\Pi_t = \frac{P_t}{P_{t-1}}$ is the gross rate of inflation.

Optimality conditions are given by the Euler equation, the intratemporal labor supply condition, and the transversality condition (TVC):

$$\frac{C_{t+1}^R}{C_t^R} = \beta \frac{1+i_t}{\Pi_{t+1}}, \tag{2.1}$$

$$\chi (L_t^R)^{\varphi} C_t^R = w_t, \tag{2.2}$$

$$\lim_{t\to\infty} \left[\beta^t \frac{1}{C_t^R} \left(\frac{B_t^R}{P_t} \right) \right] = 0. \tag{2.3}$$

Hand-to-mouth households The HTM households, of measure λ, simply consume government transfers, s_t^H, every period ($C_t^H = s_t^H$). The superscript, H, represents "HTM."

2.1.2 *Firm* A representative firm in the competitive product market chooses hours, L_t, in each period to maximize profits:

$$\Psi_t = Y_t - w_t L_t,$$

subject to the production function

$$Y_t = L_t. \tag{2.4}$$

Zero profit condition implies

$$w_t = 1. \tag{2.5}$$

2.1.3 *Government* The government issues one-period nominal debt, B_t. Its budget constraint (GBC) is

$$B_t/P_t = (1+i_{t-1})B_{t-1}/P_t - \tau_t + s_t,$$

where s_t is transfers and τ_t is taxes. It can be rewritten as

$$b_t = (1+i_{t-1})b_{t-1}/\Pi_t - \tau_t + s_t, \tag{2.6}$$

where $b_t = \frac{B_t}{P_t}$ is the real value of debt. Transfer, s_t, is exogenous and deterministic.

Monetary and tax policy rules are

$$\frac{1+i_t}{1+\bar{i}} = \left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi}, \tag{2.7}$$

$$\tau_t - \bar{\tau} = \psi(b_{t-1} - \bar{b}), \tag{2.8}$$

where ϕ and ψ determine the responsiveness of the policy instruments to inflation and government indebtedness, respectively. The steady-state values of inflation, debt, and transfers, $\{\bar{\Pi}, \bar{b}, \bar{s}\}$, are set by policymakers and given exogenously.[10]

2.1.4 *Aggregation and the resource constraint* Aggregating the variables over the households yield $s_t = \lambda s_t^H$, $\tau_t = (1-\lambda)\tau_t^R$, $b_t = (1-\lambda)b_t^R$, $L_t = (1-\lambda)L_t^R$, and $\Psi_t = (1-\lambda)\Psi_t^R$. Combining household and government budget constraints gives the resource constraint, $(1-\lambda)C_t^R + \lambda C_t^H = Y_t$. The resource constraint, together with the HTM household budget constraint, implies that output is simply divided between the two types of households as

$$C_t^H = \frac{1}{\lambda}s_t, \qquad C_t^R = \frac{1}{1-\lambda}Y_t - \frac{1}{1-\lambda}s_t. \tag{2.9}$$

2.2 *Effects of redistribution policy*

We now show the effects of transferring resources away from the Ricardian households and toward the HTM households. The government can finance such a transfer program in two distinct ways. In the first policy regime, the government raises taxes sufficiently. Inflation is then stabilized in the usual way by the central bank. In the second regime, the government does not raise taxes, and the central bank allows inflation to rise to stabilize the real value of debt, thereby imposing "inflation taxes" on the Ricardian households that hold nominal government debt. The fiscal theory of the price level operates in this case.

We solve for the equilibrium time path of $\{Y_t, C_t^R, C_t^H, \Pi_t, i_t, b_t, \tau_t\}$ given exogenous $\{s_t\}$. Output and consumption of the two households, and thus their welfare, are independent of whether the government relies on conventional or inflation taxes. We first consider those policy-invariant variables in Section 2.2.1. The alternative financing schemes, however, generate quite different inflation dynamics, which is the main focus of this simple model. The determination of the rate of inflation is detailed in Section 2.2.2.

2.2.1 *Output and consumption* We start with output. Equation (2.2) can be written as

$$Y_t = \chi^{-1}(1-\lambda)^{1+\varphi}Y_t^{-\varphi} + s_t \tag{2.10}$$

using equations (2.4), (2.5), (2.9), and $L_t = (1-\lambda)L_t^R$. Equation (2.10) implicitly defines output as a function of transfers: $Y_t = Y(s_t)$. One can obtain the "transfer multiplier"

[10]We abstract from government spending here, but present an extension with it in Online Appendix A.6.2.

as

$$\frac{dY(s_t)}{ds_t} = \frac{1}{1 + (1-\lambda)^{1+\varphi}\chi^{-1}\varphi Y_t^{-(1+\varphi)}}.$$

Notice that $0 \leq \frac{dY_t}{ds_t} \leq 1$.

An increase in transfers raises output, but not from the Keynesian demand-side reason. The channel here instead is purely classical and supply-side: An increase in s_t causes Ricardian household consumption to fall, creating a negative "wealth effect" on labor supply. The households supply more hours for a given wage rate, which in turn raises output.[11] The multiplier is maximized ($dY_t/ds_t = 1$) when labor supply is perfectly elastic ($\varphi = 0$) while it is minimized ($dY_t/ds_t = 0$) when the Ricardian household does not value leisure ($\chi = 0$), which shuts down the wealth effect.

The Ricardian household consumption is obtained from equation (2.9) as

$$C_t^R = C^R(s_t) \equiv \frac{1}{1-\lambda}\big[Y(s_t) - s_t\big]. \tag{2.11}$$

The derivative is

$$\frac{dC^R(s_t)}{ds_t} = \frac{1}{1-\lambda}\left[\frac{dY(s_t)}{ds_t} - 1\right] \leq 0.$$

As will be clear below, how Ricardian household consumption depends on transfers matter for inflation dynamics as it affects the real interest rate. That is, there is a valuation effect on government debt due to changes in the real interest rate. This interest rate channel of transfers is absent in the model with a representative household, where transfers have no redistributive role, or with a perfectly elastic labor supply.

Notice that both tax types are nondistorting in this model. Consequently, for given $\{s_t\}$, the alternative ways to finance transfers (i.e., the policy regimes) have no effect on output and consumption, as seen above.

2.2.2 *Inflation* We now turn to the rest of the variables, $\{\Pi_t, i_t, b_t, \tau_t\}_{t=0}^{\infty}$, with a focus on inflation determination, given a path of $\{s_t\}_{t=0}^{\infty}$. The equilibrium time path of $\{\Pi_t, i_t, b_t, \tau_t\}$ satisfies the system of difference equations (2.1), (2.6), (2.7), and (2.8), the terminal condition given by TVC (2.3), and the initial conditions, b_{-1} and i_{-1}.

The system can be simplified as

$$\frac{\Pi_{t+1}}{\bar{\Pi}} = \frac{C_t^R}{C_{t+1}^R}\left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi}, \tag{2.12}$$

$$b_t - \bar{b} = \left[\beta^{-1}\frac{C_t^R}{C_{t-1}^R} - \psi\right](b_{t-1} - \bar{b}) + (s_t - \bar{s}) + \bar{b}\left[\beta^{-1}\frac{C_t^R}{C_{t-1}^R} - \beta^{-1}\right] \quad \forall t \geq 1, \tag{2.13}$$

$$b_0 - \bar{b} = \beta^{-1}\left(\frac{\bar{\Pi}}{\Pi_0} - 1\right)\bar{b} + (s_0 - \bar{s}) \quad \text{at } t = 0, \tag{2.14}$$

[11] The channel is the same as the effect of government spending in a one-agent model. In fact, an increase in government spending has exactly the same effect on output and inflation as an increase in transfers of the same amount in this simple model. This result is shown in Online Appendix A.6.2.

which determines $\{\Pi_t, b_t\}$ given $\{s_t\}$ and $\{C_t^R\}$, where note that from equation (2.11), the latter is a simple function of transfers; $\bar{s}$ and $\bar{b}$ are the steady-state values of (exogenous) transfers and debt.[12] Equation (2.12), obtained by combining the Euler equation and the monetary policy rule, shows how future inflation (Π_{t+1}) depends on current inflation (Π_t) and the real rate captured by C_{t+1}^R/C_t^R. Equation (2.13) is the GBC for $t \geq 1$ after we substitute out the nominal interest rate $(1+i_{t-1})$ and taxes (τ_t) using the Euler equation and the fiscal policy rule. Equation (2.14) is the GBC at $t=0$. This looks different from equation (2.13) because i_{-1} is exogenous, and thus cannot be replaced by the Euler equation.

Equation (2.13) describes how the deviation of the real value of debt from the steady state, $(b_t - \bar{b})$, evolves over time. An increase in transfers over its steady-state value $(s > \bar{s})$ affects debt dynamics directly and indirectly. First, *ceteris paribus*, such an increase causes b_t, debt carried over to the next period, to rise above $\bar{b}$. This direct effect is captured by the second term, $(s_t - \bar{s})$, on the right-hand side of equation (2.13). Second, a change in transfers affects Ricardian household consumption as shown in equation (2.11), and hence the real interest rate, which in turn influences debt dynamics. This indirect effect is reflected by $r_{t-1} \equiv \beta^{-1} C_t^R / C_{t-1}^R$ in equation (2.13), and operates even when the current period debt stays at the steady state (i.e., $b_{t-1} = \bar{b}$). The reason is a change in interest payments for a given amount of debt—as shown in the last term, $\bar{b}(\beta^{-1} C_t^R / C_{t-1}^R - \beta^{-1})$.

In solving the system, we consider a redistribution program in which $\{s_t\}_{t=0}^{\infty}$ can have arbitrary values greater than $\bar{s}$ until a time period T, and then $s_t = \bar{s}$ for $t \geq T+1$. In this case, regardless of the history until time $T+1$, starting $T+2$, equation (2.13) becomes

$$b_t - \bar{b} = \left(\beta^{-1} - \psi\right)(b_{t-1} - \bar{b}).$$

How the TVC is satisfied *depends* on the fiscal policy parameter ψ. When $\psi > 0$, debt dynamics satisfies the TVC regardless of the value of b_{T+1}.[13] When $\psi \leq 0$, however, the TVC requires $b_{T+1} = \bar{b}$, which can be achieved when monetary policy allows inflation to adjust by the required amount. Below, we discuss each case in turn.

Inflation under the monetary regime When $\psi > 0$, inflation is solely determined by equation (2.12), which becomes

$$\frac{\Pi_{t+1}}{\bar{\Pi}} = \left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi} \quad \text{for } t \geq T+1,$$

as C_t^R, Ricardian household consumption, is constant. In this case, if we were to consider $\phi < 1$, the system of equations (2.12)–(2.14) does not pin down initial inflation Π_0, and the model permits multiple nonexplosive solutions.

We therefore, instead consider the standard case, $\phi > 1$, which we call the *monetary regime*. This regime produces multiple equilibria in which inflation is unbounded and

[12] Online Appendix A provides detail.

[13] In addition, ψ should not be too big. We do not explicitly consider such empirically irrelevant cases.

a unique bounded equilibrium.[14] Here, we focus on the bounded equilibrium. In this case, it is necessary that $\frac{\Pi_{T+1}}{\bar{\Pi}} = 1$. Given this "stability" condition on inflation, one can pin down Π_t from $t = 0$ to T along the saddle path. In particular, inflation before $T + 1$ can be solved backward using equation (2.12). The initial inflation is given by

$$\frac{\Pi_0}{\bar{\Pi}} = C^R(\bar{s})^{\frac{1}{\phi^{T+1}}} \left[\frac{1}{C^R(s_T)C^R(s_{T-1})\cdots C^R(s_0)}\right]^{\frac{1}{\phi}} = \prod_{t=0}^{T} \left[\frac{C^R(\bar{s})}{C^R(s_t)}\right]^{\frac{1}{\phi}}. \tag{2.15}$$

Inflation in the following periods is then determined by equation (2.12).

Equation (2.15) shows that an increase in transfers is inflationary as the Ricardian household consumption declines below the pretransfer level. The magnitude of the effect depends on the response of monetary policy (measured by ϕ), the size of transfer increases, and the duration of the redistribution program. Most importantly, the effect is transitory: When the redistribution program ends, inflation returns immediately to the steady-state value.

Inflation under the fiscal regime We now consider the fiscal regime where $\psi \leq 0$ and $\phi < 1$. Solving for inflation involves a similar procedure as in the monetary regime. We first identify a terminal condition and then follow the saddle path to pin down initial inflation.

As mentioned above, when $\psi \leq 0$, the TVC requires $b_{T+1} = \bar{b}$. Given this terminal condition, debt in preceding periods can be solved backward using equation (2.13). Finally, given the solved b_0, the time-0 GBC equation (2.14) determines initial inflation Π_0, after which equation (2.12) produces a nonexplosive time path of inflation.

To develop intuition, let us first consider a simple case in which transfers increase only for one period: $s_0 > \bar{s}$ and $s_t = \bar{s}$ afterwards. In this case, it is necessary that $b_1 = \bar{b}$; otherwise, the TVC would be violated. The GBC at $t = 1$ is then given as

$$\underbrace{b_1 - \bar{b}}_{=0} = \left[\beta^{-1} \underbrace{\frac{C^R(\bar{s})}{C^R(s_0)}}_{>1} - \psi\right](b_0 - \bar{b}) + \underbrace{(s_1 - \bar{s})}_{=0} + \bar{b}\left[\beta^{-1} \underbrace{\frac{C^R(\bar{s})}{C^R(s_0)}}_{>1} - \beta^{-1}\right], \tag{2.16}$$

from which we can obtain the initial debt level b_0 ensuring that b_1 equals $\bar{b}$:

$$b_0 = \bar{b} - \bar{b}\left[\beta^{-1}\frac{C^R(\bar{s})}{C^R(s_0)} - \psi\right]^{-1}\left[\beta^{-1}\frac{C^R(\bar{s})}{C^R(s_0)} - \beta^{-1}\right].$$

The terminal condition ($b_1 = \bar{b}$) requires b_0 to decline below $\bar{b}$. For this to happen, Π_0 adjusts according to equation (2.14):

$$\frac{\Pi_0}{\bar{\Pi}} = \frac{1}{1 - \frac{\beta}{\bar{b}}(s_0 - \bar{s}) - \beta\left[\beta^{-1}\frac{C^R(\bar{s})}{C^R(s_0)} - \psi\right]^{-1}\left[\beta^{-1}\frac{C^R(\bar{s})}{C^R(s_0)} - \beta^{-1}\right]}. \tag{2.17}$$

[14] We rule out the case in which the price level approaches zero by the TVC.

The redistribution policy is more inflationary under the fiscal regime than under the monetary regime. Inflation rises by more on impact: Π_0 in equation (2.17) is greater than Π_0 in equation (2.15) even under the most dovish monetary regime (i.e., when $\phi \to 1$).[15] More importantly, the one-time transitory increase in transfers has persistent effects on inflation here, while the effect lasts only for one period under the monetary regime.[16]

The result above holds without the interest rate channel. The presence of the third term in the denominator, $-\beta[r_0 - \psi]^{-1}[r_0 - \bar{r}]$, however, does cause Π_0 to increase by more than it would in an analogous model with a representative household where transfer changes have no effect on the real interest rate.[17] This term results from increased interest payments that exert upward pressure on b_1 (see equation (2.16)). The upward pressure is offset by a further decrease in b_0, which is generated by a greater increase in Π_0.

The solution under a multiperiod redistribution program can be similarly obtained. Suppose $s_t = s_0 > \bar{s}$ for $0 \leq t \leq T$.[18] To obtain initial inflation, we use the property that the real interest rate is constant throughout except for the last period of a program, that is, $r_t = \bar{r}$ for $0 \leq t \leq T-1$ and $r_t > \bar{r}$. Equation (2.17) then generalizes to

$$\frac{\Pi_0}{\bar{\Pi}} = \frac{1}{1 - \frac{\beta}{\bar{b}}(s_0 - \bar{s}) \sum_{k=0}^{T} \left(\beta^{-1} - \psi\right)^{-k} - \beta(r_T - \psi)^{-1}(r_T - \bar{r})\left(\beta^{-1} - \psi\right)^{-T}},$$

which, like equation (2.17), reveals both direct and indirect (valuation) channels.

2.3 *Summary and an extension to nominal rigidities*

To summarize, transferring resources from Ricardian to HTM households is inflationary regardless of the financing schemes considered. The fiscal regime, however, generates greater and more persistent inflation than the monetary regime. The next section explores quantitative implications in a more general environment with sticky prices where such differential inflation dynamics result in distinct allocations and welfare levels—unlike in the simple model.[19]

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[15] An analytical proof under a mild sufficient condition is provided in Online Appendix A.5. In addition, we numerically verify this result in the simple and the quantitative model for a broad set of parameter values. Moreover, in Online Appendix A.6.1, we show that our results broadly hold even in the presence of a temporary (could be persistent) shock that drives the real rate negative. For extensive analyses of the fiscal theory in a low-interest environment, we refer the reader to Bassetto and Cui (2018), Brunnermeier, Merkel, and Sannikov (2020), and Miao and Su (2021).

[16] Under the fiscal regime, ϕ governs the size and persistence of inflation response in the ensuing periods via the Fisher relationship. When $\phi = 0$, inflation responds for two periods in this simple setup.

[17] In that model, the term would drop because $C_1^R / C_0^R = 1$.

[18] Online Appendix A.5 provides the discussion of a general multiperiod redistribution program in which $\{s_t\}_{t=0}^{T}$ is an arbitrary sequence.

[19] Online Appendix A also contains a simple model with sticky prices. Quantitatively, a priori, it is unclear if higher and more persistent inflation under the fiscal regime improves Ricardian household welfare in a sticky-price model because while their consumption would not decrease as much, they would have to work more not only to produce more output but in addition, high and persistent inflation in the fiscal regime

3. Quantitative model and COVID application

We now present a quantitative version of the model with an application focused on the economic crisis induced by COVID, modeled by introducing demand and supply shocks, and subsequent transfer policy, as embedded in the CARES Act. Compared to the simple model, the main extension is a development of a two-sector production structure with sticky prices, as well as the introduction of distortionary taxes such that the trade-off between different sources of financing government debt is meaningful. We describe the model succinctly below, with details in Online Appendix B.

3.1 *Model*

There are two distinct—Ricardian and HTM—sectors. Ricardian households work in the former, and HTM households work in the latter. Each sector produces a distinct good, which is in turn produced in differentiated varieties. Prices of differentiated varieties are sticky. Firms in both sectors are owned by Ricardian households. Government finances transfer to the HTM households by levying distortionary labor taxes on the Ricardian households. In the fiscal regime, partial financing also happens by inflating away nominal debt.

3.1.1 *Ricardian sector*

Households Ricardian (R) households, of measure $1-\lambda$, solve the problem

$$\max_{\{C_t^R, L_t^R, b_t^R\}} \sum_{t=0}^{\infty} \beta^t \exp(\eta_t^{\xi}) \left[\frac{(C_t^R)^{1-\sigma}}{1-\sigma} - \chi \frac{(L_t^R)^{1+\varphi}}{1+\varphi} \right]$$

subject to a standard No-Ponzi-game constraint and a sequence of flow budget constraints

$$C_t^R + b_t^R = (1+i_{t-1}) b_{t-1}^R / \Pi_t^R + (1-\tau_{L,t}^R) w_t^R L_t^R + \Psi_t^R,$$

where η_t^{ξ} is a preference shock.[20] Labor tax, $\tau_{L,t}^R w_t^R L_t^R$, constitutes one way in which the government finances transfer to the HTM household.

Consumption good C_t^R is a CES aggregator ($\varepsilon > 0$) of the two sectoral goods

$$C_t^R = \left[(\alpha)^{\frac{1}{\varepsilon}} (C_{R,t}^R)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\alpha)^{\frac{1}{\varepsilon}} (\exp(\zeta_{H,t}) C_{H,t}^R)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $C_{R,t}^R$ and $C_{H,t}^R$ are R-household's demand for R-sector and for HTM-sector goods, respectively. α is R-households' consumption weight on R-sector goods and $\zeta_{H,t}$ is a demand shock that is specific for HTM goods. Let us define for future use, one of the relative prices, $X_{R,t} \equiv P_{R,t}^R / P_t^R$, where $P_{R,t}^R$ is the R-sector's good price while P_t^R is the CPI price index of the R-household. Within each sector, differentiated varieties are produced under monopolistic competition. Thus, $C_{R,t}^R$ and $C_{H,t}^R$ are Dixit–Stiglitz aggregates of a continuum of varieties with an elasticity of substitution, $\theta > 1$.

produces resource misallocations, which increase labor hours required to produce the same amount of final output.

[20] The other notation are the same as before.

Firms Firms produce differentiated varieties using the linear production function, $Y_{R,t}(i) = L_{R,t}(i)$, and set prices according to the Calvo friction, where ω^R is the probability of not getting a chance to adjust prices. There is no price discrimination across sectors for varieties and we impose the law of one price.

3.1.2 *Hand-to-mouth sector*

Households HTM households, of measure λ, solve the problem

$$\max_{\{C_t^H, L_t^H\}} \frac{(C_t^H)^{1-\sigma}}{1-\sigma} - \chi^H \frac{((1+\eta_t^\xi)L_t^H)^{1+\varphi}}{1+\varphi}$$

subject to the flow budget constraint

$$C_t^H = w_t^H L_t^H + Q_t s_t^H,$$

where η_t^ξ is a shock to disutility from labor, w_t^H is the real wage, and L_t^H is labor supply. Note that relative price, $Q_t \equiv P_t^R / P_t^H$, appears in transfers as for fiscal variables we use the CPI for the Ricardian household as the deflator.

C_t^H is a CES aggregator of the consumption goods produced in the two sectors

$$C_t^H = \left[(1-\alpha)^{\frac{1}{\varepsilon}} \left(\exp(\zeta_{H,t}) C_{H,t}^H\right)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha)^{\frac{1}{\varepsilon}} \left(C_{R,t}^H\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $1-\alpha$ is *HTM*-households' consumption weight on the *HTM*-sector goods and $\zeta_{H,t}$ is a demand shock specific for *HTM*-sector goods.[21] Let us define for future use one of the relative prices, $X_{H,t} \equiv P_{H,t}^H / P_t^H$, where $P_{H,t}^H$ is the *HTM*-sector's good price while P_t^H is the CPI price index of the *HTM*-household. $C_{HH,t}$ and $C_{HR,t}$ are Dixit–Stiglitz aggregates of a continuum of varieties with an elasticity of substitution, $\theta > 1$.

Firms Firms produce differentiated varieties using the linear production function, $Y_{H,t}(i) = L_{H,t}(i)$, and set prices according to the Calvo friction, where ω^H is the probability of not getting a chance to adjust prices.

3.1.3 *Government* The government flow budget constraint is given by $B_t + T_t^L = (1 + i_{t-1})B_{t-1} + P_t^R s_t$, where tax revenues $T_t^L = (1-\lambda)\tau_{L,t}^R P_t^R w_t^R L_t^R$. Transfer (deflated by CPI of the Ricardian household), s_t, is exogenous and deterministic. Note that, $s_t = \lambda s_t^H$ and $b_t = (1-\lambda) b_t^R$.

Monetary and tax policy rules are of the feedback types with "smoothing," given by

$$\frac{1+i_t}{1+\bar{i}} = \max\left\{\frac{1}{1+\bar{i}}, \left(\frac{1+i_{t-1}}{1+\bar{i}}\right)^{\rho_1} \left(\frac{1+i_{t-2}}{1+\bar{i}}\right)^{\rho_2} \left[\left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi} \left(\frac{Y_t}{\bar{Y}}\right)^{\phi_x} \left(\frac{Y_t}{Y_{t-1}}\right)^{\phi_{\Delta y}}\right]^{1-\rho_1-\rho_2}\right\},$$

$$\tau_{L,t}^R - \bar{\tau}_L^R = \rho_L\left(\tau_{L,t-1}^R - \bar{\tau}_L^R\right) + (1-\rho_L)\psi_L(b_{t-1}/\bar{b} - 1),$$

where $\Pi_t = (1-\lambda)\Pi_t^R + \lambda \Pi_t^H$ is the average inflation, Y_t is aggregate output which is defined later, and the zero lower bound on the nominal rate applies.[22] As in the simple

[21] We impose the same consumption basket across households motivated by the data, implying $Q_t = 1$.

[22] Whether we define the price index in the monetary policy rule as population-weighted as above, or as consumption basket share weighted (using α as the weight for Π_t^R), does not matter quantitatively.

model, the monetary regime will feature large enough monetary and tax rule response coefficients, ϕ and ψ_L, such that government debt sustainability does not need to be ensured via inflation. In contrast, in the fiscal regime, a low enough tax rule coefficient, ψ_L, implies that monetary policy has to be accommodative via a low enough ϕ, such that debt is (at least partly) financed via inflation. The policy rules feature smoothing, as given by ρ_1, ρ_2, and ρ_L, and the monetary policy rule features feedback to output (given by ϕ_x) and output growth (given by $\phi_{\Delta y}$).[23]

3.1.4 *Market clearing, aggregation, resource constraints* Given wages and prices, labor and good markets clear in equilibrium. Define economy-wide consumption as $C_t = (1-\lambda)C_t^R + \lambda Q_t C_t^H$. Then an aggregate resource constraint is given by $Y_t = C_t = X_{R,t}Y_{R,t} + X_{H,t}Q_t Y_{H,t}$. Lastly, by aggregating firms' production functions, we can derive aggregate sectoral outputs, $(1-\lambda)L_t^R = Y_{R,t}\Xi_{R,t}$ and $\lambda L_t^H = Y_{H,t}\Xi_{H,t}$, where $\Xi_{j,t}$ for $j \in \{R, H\}$ is the price dispersion term arising from sticky prices.[24]

3.2 *Data and calibration*

We pick parameter values based on long-run averages or from the literature while calibrating the shocks to match employment and inflation dynamics during the COVID crisis. Table 1 presents our calibration. The data are described in detail in the Appendix.

The model is calibrated at a 2-month frequency with a time discount factor of $\beta = 0.9932$. We set the inverse of the Frisch elasticity (φ) to be 0.3 and the inverse of the elasticity of intertemporal substitution (σ) to be 1.0, following Gertler and Karadi (2011). We set the elasticity of substitution across firms to be four ($\theta = 4$), which corresponds to a recent estimate of average markup of 33% (Hall (2018)). We assume that the Ricardian and HTM goods are substitutes by setting the elasticity (ϵ) as 2.0, to ensure that our results are not being driven by the assumption of complementarity in the consumption of sectoral goods. We pick the Calvo parameters for the Ricardian sector as $\omega^R = 0.75$ and for the HTM sector as $\omega^H = 0.80$, which are consistent with estimates in Carvalho, Lee, and Park (2021).[25] Finally, the steady-state gross inflation is 1.

We set the fraction of HTM households (λ) to be 0.23, based on the employment share of retail trade, transportation and warehousing, and leisure and hospitality sectors in the U.S. Bureau of Labor Statistics (BLS).[26] We use the 2019 Consumer Expenditure Surveys (CEX) data to calibrate α, the share parameters in the consumption baskets.

[23] The monetary policy rule specification follows Coibion and Gorodnichenko (2011). As we do not have productivity shocks in the model, we do not include an output "gap" term in the rule.

[24] All model details and equilibrium condition derivations are in Online Appendix B.

[25] The HTM sector includes Transportation, Recreational, and Food Services, and the Ricardian sector is the rest of the economy. We take sectoral averages for the price infrequency estimates based on Carvalho, Lee, and Park (2021), which imply an 8-month and 10-month duration of price changes for the Ricardian and HTM sectors, respectively.

[26] Using the Panel Study of Income Dynamics data, Aguiar, Bils, and Boar (2020) estimate 23% of HTM households whose net worth is less than 2 months their labor earnings.

Table 1. Calibration.

	Value	Description	Sources
Panel A. Households			
β	0.9932	Time preference	2-month frequency
σ	1.0	Inverse of EIS	Gertler and Karadi (2011)
φ	0.3	Inverse of Frisch elasticity	Gertler and Karadi (2011)
χ	3.08	Ricardian labor supply disutility	$\bar{L}^R = 0.3$ (BLS Data)
χ^H	3.53	HTM labor supply disutility parameter	$\bar{L}^H = 0.25$ (BLS Data)
α	0.72	Consumption weight on Ricardian goods	Consumer Expenditure Surveys data
λ	0.23	Fraction of HTM households	Employment share of retail, transportation, leisure/hospitality
Panel B. Firms			
θ	4.0	Elasticity of substitution across firms	Steady-state markup: 33% (Hall (2018))
ε	2.0	Elasticity of substitution between Ricardian and HTM goods	Assigned
ω^R	0.75	Calvo parameter for Ricardian sector	Carvalho, Lee, and Park (2021)
ω^H	0.80	Calvo parameter for HTM sector	Carvalho, Lee, and Park (2021)
Panel C. Government			
$\frac{\bar{b}}{6\bar{Y}}$	0.509	Steady-state debt to GDP	Data (1990Q1–2020Q1)
$\frac{\bar{T}^L}{\bar{Y}}$	0.122	Steady-state labor tax revenue to GDP	Data (1990Q1–2020Q1)
$\frac{\bar{s}}{\bar{Y}}$	0.127	Steady-state transfers to GDP	Data (1990Q1–2020Q1)
Panel D. Monetary and Fiscal Policy Rules (Monetary Regime, Fiscal Regime)			
ρ_1	(1.12, 0.0)	Interest rate smoothing lag 1	Coibion and Gorodnichenko (2011)
ρ_2	(−0.18, 0.0)	Interest rate smoothing lag 2	Coibion and Gorodnichenko (2011)
ϕ_π	(1.58, 0.0)	Interest rate response to inflation	Coibion and Gorodnichenko (2011)
ϕ_x	(0.11, 0.0)	Interest rate response to output	Coibion and Gorodnichenko (2011)
$\phi_{\Delta y}$	(2.21, 0.0)	Interest rate response to output growth	Coibion and Gorodnichenko (2011)
ρ_L	(0.84, 0.0)	Labor tax smoothing	Bhattarai, Lee, and Park (2016)
ψ_L	(0.1, 0.0)	Labor tax rate response to debt	Bhattarai, Lee, and Park (2016)
Panel E. Shocks			
η_t^H	(−9%, 17%, 17%)	Size of HTM labor disutility shock	Total hours for retail, transportation, leisure/hospitality
η_t^ξ	(−7%, −22%, −21%)	Size of Ricardian preference shock	Total hours excluding retail, transportation, leisure/hospitality
$\zeta_{H,t}$	(−4%, −0.9%, 3%)	Size of HTM sector demand shock	PCE Inflation for recreation, transportation, food services
s_t	26.8%	Size of transfer distribution	2020 CARES Act

Note: This table shows model parameter values used for our baseline simulation. See Section 3.2 for details.

We assume households in the top 80 percentile of the income distribution as Ricardian households and set $1 - \alpha$ as 0.28 to match their consumption share for transportation and food away from home.[27]

[27]This value of α is the same if we assume households in the bottom 20 percentile of the income distribution as HTM households and target their consumption shares, which is why we modeled the same consumption basket for the two households.

For the steady state of fiscal variables, we use federal debt, federal receipts, and current government transfer payments data from 1990:Q1 through 2020:Q1. We use post-Volcker estimates in Coibion and Gorodnichenko (2011) to set the Taylor rule parameters under the monetary regime. We also use the tax rule estimates in Bhattarai, Lee, and Park (2016) for the tax rule parameters under the monetary regime.

To examine the dynamic effects of transfer policy, we calibrate the size of transfer distribution using the transfer amounts specified in the CARES Act, which came into operation in mid-April. In particular, we target the sum of three key components of the Act: \$293 billion to provide one-time tax rebates to individuals; (ii) \$268 billion to expand unemployment benefits; and (iii) \$150 billion in transfers to state and local governments. These three components of the CARES Act consist of around 3.4% of the GDP. Given our calibration of steady-state government transfers, this in turn amounts to an increase in transfers of 26.8%.[28] In our baseline exercise of transfer policy, we assume that the total amount of transfer is equally distributed over 6 months, that is, three periods.

A key component of our calibration is how we choose the shock sizes. The size of the three shocks (η_t^H, η_t^ξ, $\xi_{H,t}$) are estimated to match the dynamics, under the monetary regime with transfer policy, of total hours for both the HTM and Ricardian sectors and inflation for the HTM sector, as given in Appendix Figure 1. In our baseline calibration, we assume that the three shocks in the model are over after three periods.

In particular, we set the size of HTM sector labor disutility shocks to match BLS total hours changes from April through August in HTM sectors (retail trade, transportation and warehousing, and leisure and hospitality sectors). We then calibrate the size of the Ricardian preference shocks to match BLS total hours changes for sectors excluding HTM sectors, also from April through August. Finally, we set the size of HTM sector-specific demand shocks to match the PCE inflation for recreation, transportation, and food services sectors from the U.S. Bureau of Economic Analysis.[29] The three shocks series can perfectly match the dynamics of total hours and inflation from April through August, as reported in detail in Panel A of Table C.1 in the Online Appendix.

Moreover, Panel B of Table C.1 in the Online Appendix shows that our calibration is not completely off regarding the match with several nontargeted moments. For example, aggregate consumption and output dynamics in the model are close to that in the data. In terms of sectoral consumption, the model dynamics are close to the real PCE sectoral data initially.[30]

3.3 *Quantitative results*

We now present quantitative results on the implications of redistribution policy during a crisis.

[28] In a sensitivity analysis in Section 3.4.2, we drop the tax rebate component of the CARES Act while calibrating the transfer increase.

[29] While this intuitively describes our estimation procedure, we match jointly the data with all shocks.

[30] In terms of a nontargeted moment that we do not match as well, our calibration implies a bigger drop in inflation in the Ricardian sector than the data. A change in model parameters and/or calibration strategy to match this moment will, however, adversely affect the currently good nontargeted fit with respect to aggregate consumption, as well as potentially make the ZLB not binding in the monetary regime, which would be counterfactual.

3.3.1 *Dynamic effects of transfer policy* We show how key variables evolve over time in response to the COVID shocks—a combination of aggregate and sector-specific demand and supply shocks as discussed above. We then illustrate the effects of an increase in transfers for the two regimes. These results are in Figure 1, which presents four different scenarios: the monetary regime with and without transfers to the HTM households and the fiscal regime with and without transfers. Throughout, the duration of the redistribution policy is three periods (6 months), which coincides with the duration of the shocks.[31]

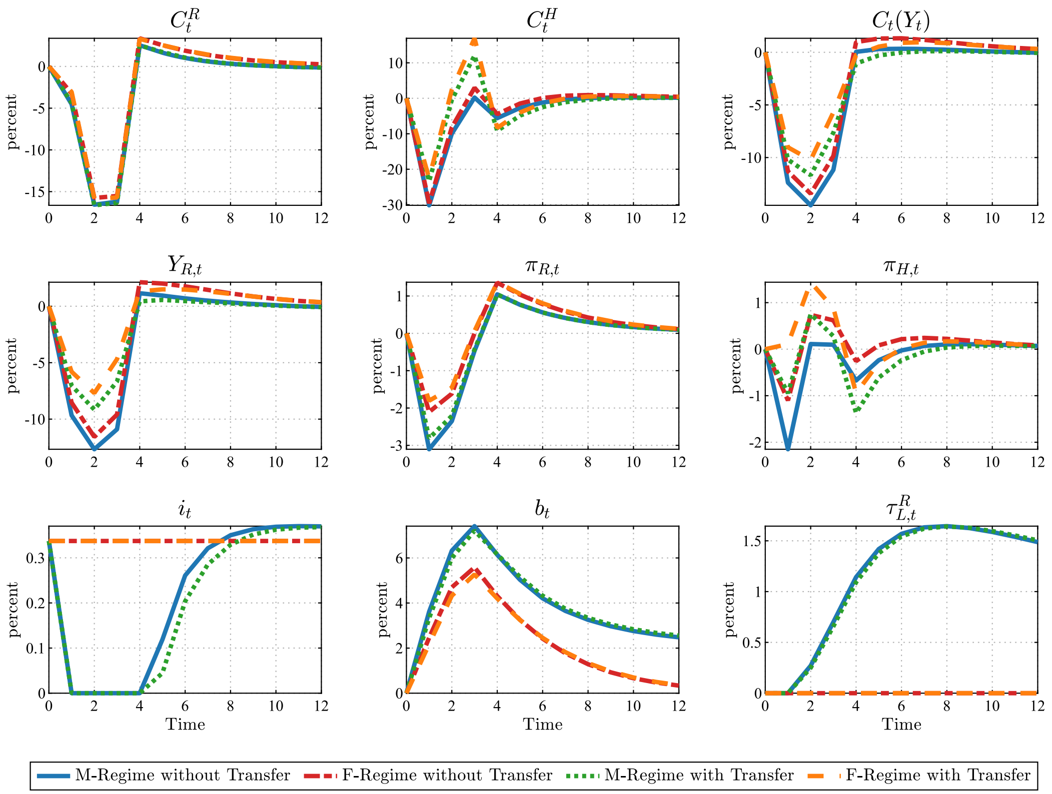


FIGURE 1. Redistribution Policy with Different Policy Regimes. *Note*: This figure shows dynamics of key variables in response to the COVID shocks under different regimes. Blue solid lines represent the monetary regime without transfers. Red dashed-dotted lines, green dotted lines, and orange dashed lines represent respectively the fiscal regime without transfers, the monetary regime with transfers, and the fiscal regime with transfers. The unit is the percent deviation from the steady-state level of each variable, except for the bottom left panel, where we show the level of the net interest rate.

[31]We solve the model nonlinearly under perfect foresight, and nonlinearity is important for the quantitative results due to large shocks and binding ZLB in the monetary regime. A linear solution method leads to higher inflation, as shown in Figure C.1 in the Online Appendix. All the model variables converge back to the steady state in the long run. Initial debt is also at a steady state so that we can focus on debt dynamics due to COVID shocks. In Section 3.4.4, we consider a case where initial debt is above the steady state.

Let us first look at the benchmark case, where the policymakers just stick to the usual macro policy (i.e., monetary regime) without redistribution. In this benchmark, the COVID shocks generate significant short-run contractions in aggregate output and household consumption of both types, as shown by the solid blue lines in the first row of the figure. The contraction leads to a decline in inflation (as shown in the second row) and in labor tax revenues, both of which in turn increase the real value of government debt. The government responds by increasing the tax rate to stabilize debt under this standard monetary regime. Meanwhile, the central bank decreases the nominal interest rate in response to the decline in inflation. These policy responses are shown in the bottom row of the figure. Notice that the ZLB endogenously binds in our model during the pandemic, without us calibrating it as a target.

Now, let us introduce the redistribution program to the monetary regime, the results of which are shown by the dotted green lines in Figure 1.[32] Overall, the effects of the redistribution program are largely in line with what we have shown using the simple model in Section 2. One major difference from the simple model is that the redistribution program is more expansionary here because both the classical labor supply channel and the Keynesian channel operate thanks to nominal rigidities, as we discussed in Section 2.3.

Transfers (directly) increase HTM household consumption and decrease Ricardian household consumption (due to both the resulting increase in the tax rate and the mechanism outlined in the simple model) relative to the benchmark. These are the direct effects of the redistribution. As discussed in Section 2, however, the redistribution program is inflationary, as shown by the difference between the solid blue lines and the dotted green lines in the second row. This indirectly has a positive effect on household consumption of both types through general equilibrium. In particular, Ricardian household consumption does not appear to drop compared to the benchmark case as the indirect positive effect of the redistribution on Ricardian household consumption countervails the direct negative effect.

Let us now turn to the fiscal regime where neither the tax rate nor the nominal interest rate changes. The effect of the redistribution program under this regime is shown by the dashed orange lines in Figure 1. Redistribution is more expansionary under this regime than under the monetary regime. Consequently, aggregate and Ricardian sector output and consumption of both types do not drop as much as in the monetary regime—as shown by the dashed orange lines that are located above the dotted green lines in the first four panels of Figure 1.

As in the simple model, the fifth and sixth panels of Figure 1 reveal that the fiscal regime generates greater and more persistent inflation than the monetary regime, as that stabilizes the real value of government debt without relying on labor taxes.[33] Due to nominal rigidities, this in turn has larger and longer-lasting positive effects on output and consumption. Furthermore, the ZLB binds in the monetary regime as we discussed above, which prevents the central bank from decreasing the policy rate according to the

[32] As we discussed before, transfers increase by 26.8% in total and are evenly distributed over 3 periods.

[33] With transfers, the aggregate (annualized) inflation rate in the monetary regime, compared to the fiscal regime, is lower, on average, by 3.1 percentage points over the 1-year horizon and by 1.8 percentage points over the 2-year horizon.

monetary policy rule, and leads to a bigger drop in the monetary regime. This mechanism is not relevant for the fiscal regime.

3.3.2 *Transfer multipliers* As a way to summarize these dynamic responses with and without redistribution policy, we now present results in terms of transfer multipliers for output and consumption. The transfer multiplier for output, for instance, under regime $i \in \{M, F\}$ is defined as

$$\mathcal{M}_t^i(Y) = \sum_{h=0}^{t} \beta^h (\tilde{Y}_h^i - Y_h^M) \Big/ \sum_{h=0}^{t} \beta^h s_h, \tag{3.1}$$

where $\tilde{Y}_h^i$ is output at horizon h under i-regime with transfers, Y_h^M is output at horizon h under the monetary regime without transfers (i.e., the benchmark), and s_h is transfers at horizon h. The multipliers for Ricardian sector output and the two consumption under i-regime—denoted respectively by $\mathcal{M}_t^i(Y^R)$, $\mathcal{M}_t^i(C^R)$, and $\mathcal{M}_t^i(C^H)$—are similarly defined. Following the government spending multiplier literature, we consider impact multiplier ($t = 0$) as well as 4-year ($t = 24$) cumulative multipliers, which allows for a consideration of dynamic effects in the model. These dynamic effects are important for our analysis as the model features several sources of endogenous persistence, including policy rules.

Note that in calculating these multipliers, our benchmark case, as in Section 3.3.1, is always the monetary regime without transfers.[34] This is the most relevant case to study, as we want to answer the question: Given a transfer policy we want to implement, what are the differences between using labor taxes or inflation taxes to finance the increase in debt?

Table 2 shows that aggregate output and Ricardian sector output multipliers are both above 1 in the monetary regime. Similarly, the C^H multiplier is above the simple model benchmark of $(1/\lambda)$, which would be 4.35 according to our calibration. The binding ZLB, sticky prices, and the COVID shocks contribute to the greater multipliers in this quantitative model—as detailed below in Section 3.4.1.

Table 2 also shows that those multipliers are even higher in the fiscal regime. In fact, uniquely, even the C^R multiplier is now positive in the fiscal regime for all horizons.

Table 2. Transfer multipliers.

	Monetary Regime				Fiscal Regime			
	$\mathcal{M}_t^M(Y)$	$\mathcal{M}_t^M(Y_R)$	$\mathcal{M}_t^M(C^R)$	$\mathcal{M}_t^M(C^H)$	$\mathcal{M}_t^F(Y)$	$\mathcal{M}_t^F(Y_R)$	$\mathcal{M}_t^F(C^R)$	$\mathcal{M}_t^F(C^H)$
Impact multipliers	1.923	1.863	0.119	7.828	2.949	2.726	1.166	8.788
4-year cumulative multiplier	1.732	2.023	−0.002	7.409	5.552	5.429	3.078	13.652

Note: This table shows the transfer multipliers under the monetary and fiscal regimes. $\mathcal{M}_t^i(X)$ represent the cumulative transfer multiplier of variable X at t-horizon under i regime. We report impact multipliers ($t = 0$) as well as 4-year ($t = 24$) cumulative multipliers when the government distributes transfers evenly over 6 months.

[34] Although in calibrating the model, we use the monetary regime with transfer policy to match the data.

The fact that the 4-year cumulative multiplier for C^R is positive in the fiscal regime distinguishes it from the monetary regime where it is negative.[35] The persistent inflation dynamics in this regime lead to persistent real effects due to sticky prices, which contributes to these higher multipliers. Later, in Section 3.4.1, we delve more deeply into the mechanisms that produce such large differences in the multipliers between the two regimes.

3.3.3 *Welfare effects of transfer policy* We finally show the effects on household welfare of the redistribution program. We consider both short- and long-run welfare effects. To this end, we implicitly define our measure of welfare gain for a household of type $i \in \{R, H\}$, $\mu^i_{t,k}$, as

$$\sum_{j=0}^{t} \beta^j U\big(C^i_j, L^i_j\big) = \sum_{j=0}^{t} \beta^j U\big(\big(1+\mu^i_{t,k}\big)\bar{C}^i, \bar{L}^i\big), \tag{3.2}$$

where $\{\bar{C}^i, \bar{L}^i\}$ is the steady-state level of type-i household's consumption and hours, and $\{C^i_j, L^i_j\}$ are the time path of type-i household's consumption and hours under the different transfer duration policies (indexed by k). In this way, $\mu^i_{t,k}$ measures welfare gains from period 0 till (arbitrary) period t in units of a percentage of the steady-state (or pre-COVID) level of consumption—when the redistribution program lasts for k periods.[36] The lifetime (total) welfare gain is then measured by $\mu^i_{\infty,k} \equiv \lim_{t\to\infty} \mu^i_{t,k}$, often the focus of the business cycle literature. Recall that, unless otherwise noted, we report the case in which $k = 3$, that is, the duration of the redistribution coincides with the duration of the shocks.

We find that whether the government introduces the redistribution program and how it is financed make a very small difference for the lifetime welfare for both types of households. This result is presented in Table 3. For example, the redistribution program financed by inflation taxes, that is the fiscal regime, increases the HTM households' lifetime welfare by 0.118 percentage point and increases the Ricardian households' lifetime welfare by 0.011 percentage point, compared to the benchmark. This result is expected

TABLE 3. Welfare gains.

	Monetary Regime		Fiscal Regime	
	Long-Run	Short-Run	Long-Run	Short-Run
Ricardian household	−0.014	−1.465	0.011	−1.214
HTM household	0.076	6.277	0.118	7.774

Note: This table shows long- and short-run ($t = 4$) welfare gains resulting from the redistribution, compared to the monetary regime without transfer distribution. The values are the difference in the welfare measure ($\mu^i_{t,k}$) between the transfer cases (under the two regimes) and the monetary regime without transfers.

[35] In the simple model where inflation is neutral, we showed analytically that this multiplier is negative.

[36] It measures welfare gains at the point when the agents are $2 \times t$ months old since the initial COVID shocks.

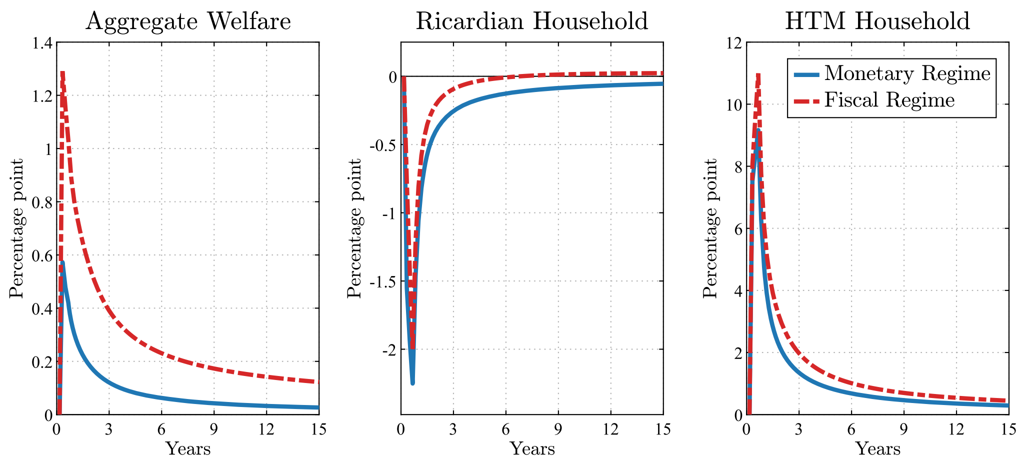


Figure 2. Short-Run Welfare Gains Comparison. *Note*: This figure presents the short-run welfare gains resulting from the redistribution, compared to the economy without transfer redistribution. The values are the difference in the welfare measures ($\mu^i_{t,k}$) between the transfer cases (under monetary and fiscal regimes) and the without-transfer case under the monetary regime as a function of time. Blue solid lines represent the short-run welfare gains under monetary regime and red dashed-dotted lines represent those under fiscal regime.

because the COVID shocks under consideration are short-lived, which implies the recession is only a small bump in the lifetime.[37] Despite this caveat on the quantitative magnitudes, our key qualitative finding is that of a Pareto improvement (only) under the fiscal regime, compared to the benchmark case of no transfer policy in the monetary regime.

Transfers and how they are financed matter much more in the short run. Figure 2 presents the aggregate and both households' welfare gains over time. The redistribution program, regardless of the policy regimes, increases the welfare of the HTM households significantly in the short run. The gains, however, are even bigger when the program is inflation-financed. For example, the HTM households' welfare gains over the first 8 months (at $t = 4$) from such redistribution amount to 7.774 percentage points of the steady-state consumption under the fiscal regime and 6.277 percentage points under the monetary regime, as reported in Table 3. The Ricardian households would suffer welfare losses with redistribution in the short run, but the losses are relatively milder under the fiscal regime: at $t = 4$, the losses are 1.214 percentage points under the fiscal regime and 1.465 percentage points under the monetary regime.

3.4 *Extensions and sensitivity analysis*

We now consider some important extensions and sensitivity analysis.

[37] We shut down all shocks other than the three-period COVID shocks over the lifetime. Therefore, this exercise is different from the usual ones in the business cycle literature.

TABLE 4. Transfer multipliers decomposition.

	Monetary Regime				Fiscal Regime			
	$\mathcal{M}_t^M(Y)$	$\mathcal{M}_t^M(Y_R)$	$\mathcal{M}_t^M(C^R)$	$\mathcal{M}_t^M(C^H)$	$\mathcal{M}_t^F(Y)$	$\mathcal{M}_t^F(Y_R)$	$\mathcal{M}_t^F(C^R)$	$\mathcal{M}_t^F(C^H)$
Panel A: Impact Multipliers								
Total effect	1.923	1.863	0.119	7.828	2.949	2.726	1.166	8.788
Covid effect with transfer	−11.628	−7.422	−2.567	−41.289	−12.571	−8.178	−2.403	−45.856
Transfer effect without Covid	2.670	2.464	−0.911	14.394	4.640	4.083	−0.028	19.920
Covid effect without transfer	−10.881	−6.821	−3.597	−34.723	−10.881	−6.821	−3.597	−34.723
Panel B: 4-Year Cumulative Multipliers								
Total effect	1.732	2.023	−0.002	7.409	5.552	5.429	3.078	13.652
Covid effect with transfer	−10.954	−7.083	−7.786	−21.321	−8.340	−4.779	−5.558	−17.447
Transfer effect without Covid	1.490	1.703	−1.107	9.991	2.696	2.805	−0.256	12.359
Covid effect without transfer	−11.196	−7.403	−8.891	−18.739	−11.196	−7.403	−8.891	−18.739

Note: This table shows the decomposition of the transfer multipliers for aggregate output, Ricardian sector output, Ricardian consumption, and HTM consumption, as given in equation (3.3). $\mathcal{M}_t^i(X)$ represent the cumulative transfer multiplier of variable X at t-horizon under i regime. We report impact multipliers ($t = 0$) as well as 4-year ($t = 24$) cumulative multipliers.

3.4.1 *Inspecting the mechanisms of transfer multipliers* As our main extension, we do several exercises to inspect the mechanisms that drive transfer multipliers across the two regimes. First, we decompose the transfer multiplier into three different components in Table 4, where in this decomposition, the output multiplier, for instance, under regime $i \in \{M, F\}$ is

$$\mathcal{M}_t^i(Y) = \underbrace{\frac{\sum_{h=0}^{t} \beta^h (\tilde{Y}_h^i - \tilde{Y}_{\text{no shock},h}^i)}{\sum_{h=0}^{t} \beta^h s_h}}_{\text{COVID effect with transfer}} + \underbrace{\frac{\sum_{h=0}^{t} \beta^h (\tilde{Y}_{\text{no shock},h}^i - \bar{Y})}{\sum_{h=0}^{t} \beta^h s_h}}_{\text{Transfer effect without COVID shocks}} - \underbrace{\frac{\sum_{h=0}^{t} \beta^h (Y_h^M - \bar{Y})}{\sum_{h=0}^{t} \beta^h s_h}}_{\text{COVID effect without transfer}}, \tag{3.3}$$

where $\tilde{Y}_h^i$ is output at horizon h under i-regime with both transfers and COVID shocks, $\tilde{Y}_{\text{no shock},h}^i$ is output at horizon h under i-regime with transfers, but without COVID shocks, Y_h^M is output under the monetary regime with COVID shocks, but without transfers, $\bar{Y}$ is output at steady state, and s_h is transfers at horizon h. Note that the third effect is the same across regimes, while the first two are different as they compute the effect for a given regime.

As Table 4 shows, even without the COVID shocks, the transfer multipliers are higher in the fiscal regime. This result is captured by the second component in equation (3.3). For example, this component of the 4-year cumulative multiplier for output is 2.696 under the fiscal regime, while it is only 1.49 under the monetary regime. The main reason for these results is the high and persistent effects on inflation in the fiscal regime.

We now consider the state dependence of the transfer multipliers, first within and then across the regimes. First, in each of the two regimes, the 4-year cumulative transfer multipliers for output and Ricardian consumption conditional on no COVID shocks (i.e., the second component) are less than the total multipliers. In the absence of the COVID shocks—that is, if the economy were in a steady state—transfer-induced inflation, while boosting the economy, would also generate inefficient price dispersion, which in turn would lead to resource misallocations and decrease labor productivity. However, if the economy were already in a COVID recession, inflationary pressures resulting from redistribution would actually counteract deflation, thereby decreasing, rather than increasing, the extent of such price dispersion. In addition, in the case of the monetary regime, the ZLB is irrelevant with no COVID shocks, which means that transfer-induced inflationary pressures do not lead to as strong a boost in Ricardian consumption as the real interest rate does not decrease strongly.

Second, comparing the two regimes, the transfer multipliers are more state-dependent in the fiscal regime than in the monetary regime. That is, transfers are disproportionately more effective in the fiscal regime than in the monetary regime when the economy falls into a COVID recession. The reason is that the aforementioned "counteracting" force is much stronger in the fiscal regime that produces higher and more persistent inflation.[38] Table 4 shows that the large difference in the 4-year cumulative multipliers between the two regimes is driven quantitatively by the first component, which captures how the effectiveness of transfers depends on the presence of COVID shocks. This is a measure of state dependence.

Besides the state dependence, our quantitative model includes two additional features that break the uniformity—obtained in the simple, analytical model—of the two regimes in terms of the multipliers. They are nominal rigidities and distortionary labor taxes. In order to isolate the role of these two features, we delve more into the second component of the transfer multipliers in equation (3.3) through counterfactual exercises.

For reference, Panel A of Table 5 first rereports the second component in the presence of the two features.[39] We then remove nominal rigidities (in Panel B) and further remove distortionary labor taxes (in Panel C). The last version is quite close to our analytical model. This exercise thus progressively allows an analysis of which elements are responsible for differences between the simple and the quantitative model results—besides the COVID shocks.

Panel B of Table 5 shows that the multipliers decrease substantially with flexible prices, as is often also found in the government spending multiplier literature. In fact, now the impact multipliers are the same across the regimes, as was the case in our simple, analytical model, as different inflation dynamics do not affect real allocations. Moreover, output multipliers are now below 1, the Ricardian consumption multiplier is negative, and the HTM consumption multiplier is closer to 4.35, the analytical model solution.[40] The cumulative multipliers are different from the impact multiplier in the mone-

[38]We can see this in the fifth panel of Figure 1. Without the transfer, as shown by the solid blue line, the COVID shocks generate significant deflation, which can be undone by inflation-financed transfers (shown by the dashed orange line).

[39]The values in the panel are thus the same as those in the third row of each panel of Table 4.

[40]The simple model would predict a Ricardian sector output multiplier of 0.644 and a Ricardian consumption multiplier of −0.464. Note that the simple model imposes log utility and is also a one-sector environment.

Table 5. Transfer multipliers without COVID shocks.

	Monetary Regime				Fiscal Regime			
	$\mathcal{M}_t^M(Y)$	$\mathcal{M}_t^M(Y_R)$	$\mathcal{M}_t^M(C^R)$	$\mathcal{M}_t^M(C^H)$	$\mathcal{M}_t^F(Y)$	$\mathcal{M}_t^F(Y_R)$	$\mathcal{M}_t^F(C^R)$	$\mathcal{M}_t^F(C^H)$
Panel A: Without COVID Shocks Under Sticky Price								
Impact multipliers	2.670	2.464	−0.911	14.394	4.640	4.083	−0.028	19.920
4-year cumulative multiplier	1.490	1.703	−1.107	9.991	2.696	2.805	−0.256	12.359
Panel B: Without COVID Shocks Under Flexible Price								
Impact multipliers	0.184	0.931	−0.747	3.230	0.184	0.931	−0.747	3.230
4-year cumulative multiplier	−0.115	0.63	−1.095	3.094	0.184	0.931	−0.747	3.230
Panel C: Without COVID Shocks Under Flexible Price and Lump-Sum Tax Adjustment								
Impact multipliers	0.184	0.931	−0.747	3.230	0.184	0.931	−0.747	3.230
4-year cumulative multiplier	0.184	0.931	−0.747	3.230	0.184	0.931	−0.747	3.230

Note: This table shows the transfer multipliers without COVID shocks. Panel A reports multipliers under sticky prices and distortionary labor taxes. Panel B reports multipliers under flexible prices and distortionary labor taxes. Panel C reports multipliers under flexible prices and nondistortionary lump-sum taxes.

tary regime—unlike the simple, analytical model—due to the dynamics of distortionary labor taxes. To make this clear, Panel C of Table 5 shows the case where the increase in transfers is financed by lump-sum taxes on the Ricardian household. Then all the multipliers are the same across the regimes and over horizons, as in the simple, analytical model.

Finally, to further explore the mechanisms that underlie the multipliers, and in particular, to emphasize the role of heterogeneity, we now analyze an alternative model economy with a representative Ricardian household. For this exercise, for a clear comparison, we start the economy from a steady state and without the COVID shocks.

First, our simple model suggests that under the fiscal regime, inflation should be less volatile in the representative agent (RA) economy than in the baseline economy due to the lack of the interest rate channel. That is indeed what we find in Table 6, comparing Panel A with Panel B or Panel C. Note that transfers are inflationary under the fiscal regime as an increase in transfer leads directly to an increase in government debt with insufficient (conventional) tax adjustments. This direct channel operates both in the RA economy and in our baseline TANK economy. However, in the latter economy, the interest rate channel additionally operates: the fall in Ricardian consumption due to the transfer increase causes the interest rate on government debt to rise, leading to a further increase in debt and inflation.

Turning to the monetary regime, inflation volatility is also lower in the RA economy than in the TANK economy. What is the mechanism? Under the monetary regime in the RA economy, the only reason that inflation even responds at all to a transfer shock is due to distortionary labor taxes that lead to a failure of Ricardian equivalence. This generates a positive, but very small, response of inflation. As Panel C shows, once we remove dis-

Table 6. Transfer multipliers and inflation volatility without COVID shocks.

	Monetary Regime			Fiscal Regime		
	$\mathcal{M}_t^M(Y)$	$\mathcal{M}_t^M(C^R)$	$\text{Var}^M(\Pi_t)$	$\mathcal{M}_t^F(Y)$	$\mathcal{M}_t^F(C^R)$	$\text{Var}^F(\Pi_t)$
Panel A: Baseline Model						
Impact multipliers	2.670	−0.911	1	4.640	−0.028	1.975
4-year cumulative multiplier	1.490	−1.107		2.696	−0.256	
Panel B: Representative Agent Model						
Impact multipliers	0.043	0.043	0.042	0.575	0.575	0.598
4-year cumulative multiplier	−0.303	−0.303		0.683	0.683	
Panel C: Representative Agent Model With Lump-Sum Tax						
Impact multipliers	0	0	0	0.575	0.575	0.598
4-year cumulative multiplier	0	0		0.683	0.683	

Note: This table shows the transfer multipliers and inflation volatility due to the transfer distribution under the monetary and fiscal regimes without COVID shocks. $\text{Var}^i(\Pi_t)$ represents (normalized) volatility of inflation due to transfer distribution under the i-regime, which is normalized to 1 for the volatility under the monetary regime of the baseline model. Panels A, B, and C show the results under the baseline model, under the representative model with distortionary labor taxes, and under the representative model with lump-sum tax adjustment, respectively.

tortionary labor taxes, there is no effect on inflation (or output and consumption) in the monetary regime as Ricardian equivalence holds.[41]

Next, given lower inflation responses in the RA economy, with sticky prices, we expect lower output multipliers for both regimes, which is also what we find comparing Panel A with Panel B.[42] Moreover, in the RA economy, a change in transfers does not generate the wealth effect on the Ricardian labor supply, which affects output even independently of inflation dynamics. The lack of the wealth effect also contributes to the difference in the multipliers between the RA and TANK economies. The upshot is that the TANK economy has higher inflation volatility and output multipliers than the RA economy for both policy regimes.

3.4.2 *Alternative calibrations with different transfer policies* We consider three alternative calibration strategies for the transfer policy.[43] Tables C.2 and C.3 in the Online Appendix present the results from these alternative calibration exercises.

Alternative calibration with transfer excluding one-time tax rebate First, we calibrate the size of the transfer increase in the model by excluding the one-time $600 individ-

[41] In contrast, under the fiscal regime, inflation would generally respond, even with lump-sum taxes, in a RA economy as inflation gets determined through government debt dynamics. In Table 6, there is no difference between Panel B and Panel C under the fiscal regime as labor taxes are constant in our baseline calibration. An alternate intuition for why the transfer increase is more inflationary in the TANK economy under the monetary regime is that a transfer increase in the TANK economy is similar to a government spending increase in a RA economy. Then we are essentially comparing the effects of government spending versus transfers in a RA economy, where it is well understood that government spending is inflationary and that there is a wealth effect on the labor supply channel of government spending that boosts output even under flexible prices.

[42] Notice that Ricardian consumption and output multipliers are identical in the RA economy.

[43] When we make changes here, we recalibrate the model to match the same targets as before.

ual tax rebates in the CARES Act. The main motivation is the survey finding in Coibion, Gorodnichenko, and Weber (2020) that on average, only about 40% of tax rebates appear to have been spent by households. The size of the transfer change decreases from 26.8% to 15.7% when we exclude the individual tax rebates. Panel A of Table C.2 in the Online Appendix shows that the multipliers are essentially the same as before under the monetary regime. For the fiscal regime, however, the multipliers are even bigger. Panel A of Table C.3 in the Online Appendix shows that welfare results are robust to this alternative calibration of transfer policy, with a Pareto improvement only in the fiscal regime.

Alternative calibration with transfer excluding unemployment benefit Second, we calibrate the size of the transfer increase in the model by excluding the unemployment insurance benefits extended in the CARES Act. The main motivation is the fact that our model does not feature classical unemployment due to search and matching frictions. The size of the transfer change decreases from 26.8% to 16.7% when we exclude unemployment benefits. Panel B of Table C.2 in the Online Appendix shows that the multipliers are essentially the same as before under the monetary regime while for the fiscal regime, the multipliers are even bigger. Panel B of Table C.3 in the Online Appendix shows that welfare results are robust to this alternative calibration of transfer policy, with a Pareto improvement only in the fiscal regime.

Alternative calibration with one-time tax rebate to both Ricardian and HTM Third, we consider the case where the one-time tax rebate components are distributed equally to both the HTM and Ricardian households. The main motivation is the fact that in the data, these tax rebates might not have been as targeted to the HTM households as assumed in our model. For this analysis, we continue to assume that the unemployment insurance benefits and transfers to state and local governments continue to be only distributed to HTM. As expected, Panel C of Table C.2 in the Online Appendix shows that the multipliers are overall lower than before for both regimes. Importantly, the fiscal regime continues to feature higher multipliers than the monetary regime. Moreover, Panel C of Table C.3 in the Online Appendix shows that even in this case, welfare results are robust, with a Pareto improvement only in the fiscal regime.[44]

3.4.3 *Model extensions* We now present results based on some model extensions. The details of the extended models are in Online Appendix B.3.

Adding government spending As one model extension, we consider government spending on goods in the model, which does not enter the utility function. First, we introduce steady-state government spending, where we set the steady-state government spending to output ratio ($\bar{G}/\bar{Y}$) to be 0.15, in line with the U.S. data average from 1990Q1 through 2020Q1. We report the transfer multiplier results in Panel A of Table C.4 in the Online Appendix and the welfare results in Panel A of Table C.5 in the Online Appendix.

[44] Finally, given the possible mismatch between model frequency and timing of transfer receipts in the real world, in Panel D of Table C.2 in the Online Appendix, we consider the case where the transfer in the first period is only half of the transfer increase in the next two periods while imposing that the total amount of transfer increase is still 26.8% of the steady-state level of transfer. Our results are robust to this alternate path of transfer increase.

Overall, the results are overall very similar to the case without steady-state government spending. Our key results that transfer multipliers are larger, and that there is a Pareto improvement, in the fiscal regime continue to hold in this extension.

Next, we allow government spending to increase from steady state following the COVID shocks, exactly analogous to our main experiment of a transfer increase. This allows us to compute government spending multipliers and welfare effects of increases in government spending, which we report in Panel B of Tables C.4 and C.5 in the Online Appendix, respectively. The results are overall very similar to transfer multipliers, and in particular, government spending multipliers are larger and there is a Pareto improvement in the fiscal regime. This reinforces the point we made earlier in the analytical model that transfer shocks and government spending shocks have similar propagation and implications in our model.

Finally, for the monetary regime, we redo the transfer increase with the COVID shocks experiment allowing government spending to decrease, as opposed to labor taxes increasing.[45] Thus, government spending follows

$$\hat{G}_t = \rho_G \hat{G}_{t-1} + (1-\rho_G)\psi_G \hat{b}_{t-1} + \varepsilon_{G,t},$$

where $\hat{G}_t = G_t/\bar{G} - 1$ and $\hat{b}_{t-1} = b_{t-1}/\bar{b} - 1$. We set the parameters of this rule to the same values as for our baseline labor tax rate rule. Table C.6 in the Online Appendix presents the transfer multipliers and welfare results, which are very similar to those in Tables C.4 and C.5 in the Online Appendix for the labor tax rate adjustment.[46]

Money-in-the-utility function Our quantitative model is cashless. As an extension, we now introduce (noninterest bearing) cash into the economy, where we follow Chari, Kehoe, and McGrattan (2002) by introducing a money-in-the-utility function for Ricardian households. The motivation is that this allows us to consider a classical channel through which inflation can affect model dynamics and welfare via real balances.

In this model extension, Ricardian households solve the problem

$$\max_{\{C_t^R, L_t^R, b_t^R, \frac{M_t}{P_t^R}\}} \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(\nu (C_t^R)^{\frac{\eta-1}{\eta}} + (1-\nu)(M_t/P_t^R)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta(1-\sigma)}{\eta-1}}}{1-\sigma} - \chi \frac{(L_t^R)^{1+\varphi}}{1+\varphi} \right]$$

subject to a standard No-Ponzi-game constraint and a sequence of flow budget constraints

$$C_t^R + b_t^R + M_t/P_t^R = (1+i_{t-1}) b_{t-1}^R / \Pi_t^R + M_{t-1}/P_t^R + (1-\tau_{L,t}^R) w_t^R L_t^R + \Psi_t^R.$$

The optimality condition over real balances, $m_t^R = M_t^R/P_t$, gives rise to a money-demand equation shown in the Online Appendix B.3.2. Due to nonseparability in the utility function, real balances now will affect model dynamics in the monetary regime. In the fiscal

[45] This government spending adjustment is relevant only for the monetary regime as under the fiscal regime, the thought experiment is that of no standard fiscal adjustment at all.

[46] For completeness, Table C.7 in the Online Appendix presents results on government spending multipliers with such a rule and show that they are qualitatively similar to those here.

regime, however, as our baseline parameterization is that of a constant nominal rate, this extension does not affect model dynamics.

Consistent with Chari, Kehoe, and McGrattan (2002), we set $\nu = 0.94$ and $\eta = 0.40$ and for concreteness, solve the model without COVID shocks. Table C.8 in the Online Appendix reports that the multipliers continue to be higher in the fiscal regime. As we explained above, for the fiscal regime, the results here are identical to those in Table 4 for the case of no COVID shocks, while they are similar but slightly smaller than those in Table 4 for the monetary regime.

Inflationary cost-push shocks An important caveat to our quantitative results so far is the assumption that other than COVID shocks, there are no other shocks in the economy. To address this shortcoming partially, and to make our analysis more relevant for current events, we now introduce an inflationary shock (ξ_t^π) directly into the firm's optimal prices. Further details of this extension are in Online Appendix B.3.3. This is akin to cost-push shocks in standard sticky-price models in the literature. We assume $\xi_t^\pi = \rho_\pi \xi_{t-1} + \varepsilon_{\pi,t}$ and set $\rho_\pi = 0.5$, such that these shocks persistently impinge on the model even after the COVID shocks are over, and consider two cases for the shock size, a 10%-shock, and a 20%-shock.[47] We then recalibrate the model to match the same data as in our baseline analysis.

Table C.9 in the Online Appendix reports the transfer multiplier results. Compared to our baseline results in Table 2, the multipliers are slightly higher in the monetary regime and slightly lower in the fiscal regime. The main reason is that as we explained before, in a deflationary environment, higher inflation is beneficial in the monetary regime where the interest rate is stuck at the ZLB. This allows the real rate to decline and as a result, we see that qualitatively a new result appears with the 4-year Ricardian consumption multiplier turning slightly positive. Our main result that transfer multipliers are higher in the fiscal regime continues to hold with this extension that incorporates inflationary shocks.[48] For this extension, Table C.10 in the Online Appendix reports the welfare results. As in our baseline results in Table 3, transfer policy is Pareto improving only in the fiscal regime. These results overall imply that our main message is robust to having temporarily high inflation in the model after the COVID recession is over.[49]

3.4.4 *Sensitivity analysis*

Alternative calibration with above steady-state initial debt Our baseline calibration is with initial government debt at the steady state. This is our preferred specification as it allows us to focus on debt dynamics following the COVID crisis induced by shocks.

[47] Bhattarai, Lee, and Park (2016) estimate mark-up shocks following an AR(1) process in a model with monetary–fiscal policy interactions. Their estimate of the AR(1) coefficient is 0.370 for the pre-Volcker era and 0.122 for the post-Volcker era at the quarterly frequency. Our calibration is at a 2-month frequency and we use slightly higher persistence than these estimates. Our quantitative results are robust to changing ρ_π around the baseline value of 0.5.

[48] The impulse responses for this model extension are in Figure C.2 in the Online Appendix.

[49] As we noted before, using a linear solution method also leads to higher inflation than the nonlinear solution method. A possible implication is then that our main message might continue to go through even with a linear solution method, and thus that our results might be robust to the computation strategy as well.

Moreover, the fiscal regime is inflationary with any positive outstanding debt, even without shocks, which further introduces a new component to model dynamics and can make interpretation harder.[50]

Nevertheless, to assess the robustness of our results, we now recalibrate the model with initial government debt above its steady-state level. In particular, we set debt at time 0—one period before the first wave of COVID shocks hit the model economy—to be 10% higher than the steady state. Panel A of Table C.11 in the Online Appendix shows the transfer multipliers under this new calibration while Panel A of Table C.12 in the Online Appendix shows the corresponding welfare results. The results are the same as those from our baseline calibration.

Notice that, in our baseline calibration, we use the average U.S. debt-to-GDP ratio from 1990Q1 through 2020Q1 to calibrate the steady-state debt-to-GDP ratio (50.9%). As an alternative sensitivity analysis, we set this variable to match the average U.S. debt-to-GDP ratio from 2010Q1 through 2020Q1 (71.3%) and calibrate the COVID shocks allowing time-0 debt to be 10% higher than its steady-state value. In this case, the debt-to-GDP ratio at time 0 in the model exactly matches the 2019Q4 debt-to-GDP ratio in the data. As shown in Panel B of Tables C.11 and C.12 in the Online Appendix, the results for multipliers and welfare gains from this alternate calibration are the same as those from our baseline calibration.[51]

Different duration of binding ZLB In our main analysis, the duration of binding ZLB under the monetary regime is four periods and essentially coincides with the duration of shocks, which is three periods. We now do a sensitivity check on how our multiplier results get affected if we increase the persistence of the Ricardian household's discount factor shock by modeling it as an AR(1) process, which in turn increases the duration of binding ZLB. The results are reported in Table C.14 in the Online Appendix, where we progressively increase the duration of binding ZLB from four to eight periods. The results show that multipliers do not change much in the monetary regime with an increased duration of binding ZLB, but they do increase further in the fiscal regime. This is another example of the higher degree of state dependence in the fiscal regime: As a longer ZLB is more deflationary and recessionary, the effectiveness of increasing transfers in the fiscal regime is higher.

Size and sign dependence of transfer multipliers We now explore further the state dependence of transfer multipliers in our model in terms of the size and sign of transfer change, a feature that does not appear in the linearized version of the model. That is, we compute transfer multipliers for transfer increases and decreases of varying magnitudes. To clarify the new nature of this state-dependence, we do so by computing the model for the case without COVID shocks, as our focus so far has been on state-dependence generated by COVID shocks.[52] Figure C.3 in the Online Appendix presents the impact and

[50]This is shown analytically in the linearized sticky-price model in Bhattarai, Lee, and Park (2014).

[51]That our simulation features shocks make a difference to some aspect of our results, as shown in Table C.13 in the Online Appendix. If we start the economy with high initial debt and do not consider shocks to replicate the COVID recession, then multipliers are lower than the baseline calibration (without shocks).

[52]In addition, an analysis of a decrease in transfers during a COVID-recession might not be very compelling.

4-year cumulative multipliers for different sign/sizes of transfer shocks. It shows that within a regime, transfer increases and decreases do not have an exactly symmetric effect and that for the same regime and sign, the multipliers also depend on the size. For transfer increases, output multipliers increase with the size of the transfers thanks to the relatively larger increase in HTM consumption in comparison to the moderate decline in Ricardian consumption, In addition, transfer increases lead to higher multipliers than transfer decreases in the fiscal regime. This result suggests that the targeted transfer program considered in this paper is likely to be more effective in a situation that requires a large-scale redistribution such as the COVID recession, in particular, under the fiscal regime.

Only discount factor shocks We calibrated our model with three types of shocks, Ricardian household discount factor shocks, HTM labor disutility shocks, and HTM sector-specific demand shocks, and jointly matched the dynamics of three variables in the data. As a sensitivity check, we now compute multipliers in our model while feeding in only the Ricardian household discount factor shock, which is a canonical demand shock in sticky-price models.[53] Table C.15 in the Online Appendix shows these results. Focusing on 4-year multipliers, they are quite similar to our baseline results, with higher effects in the fiscal regime. Table C.16 in the Online Appendix shows the welfare results, where we continue to find Pareto improvement in the fiscal regime.

4. Conclusion

Our paper makes clear that how transfers are ultimately financed is a first-order issue for their effectiveness. It arguably matters more than other factors identified in the literature, which typically reports moderate transfer multipliers. We find that inflation-financed transfers (fiscal regime) are significantly more effective than tax-financed transfers (monetary regime) in both boosting the economy and improving welfare.

We first consider a simple two-agent model that permits analytical results and illuminates the mechanisms through which redistribution generates inflation in both policy regimes. We then proceed to a quantitative analysis and show that inflation-financed transfers fight deflationary pressures in a COVID-recession-like environment, thereby preventing output and consumption from dropping significantly. Such inflation-induced expansionary effects are so large that redistribution can in fact produce a Pareto improvement.

The result that inflating away public debt can be a win-win solution for both the recipients and the sources of the transfers in a deep recession is encouraging, yet it is not without caveats. Most importantly, we have assumed that there will be no further shocks in the post-COVID crisis period. High inflation is, however, generally costly for social welfare and the fiscal regime might not necessarily be desired in normal situations. Therefore, our results should not be taken literally as a suggestion of a permanent interest rate peg by the Fed and no fiscal adjustment ever by the Treasury as such a policy recommendation might not hold in a richer stochastic model with various recurring

[53] In this exercise, we do not recalibrate the model with only this shock.

shocks. Generally, our perfect foresight nonlinear solution method misses the role future uncertainty can have on current private sector behavior, which is shown to be important for the effects of the CARES Act in Bayer et al. (2020). We also note that if, unlike in the model, it were not possible to perfectly target transfers to the HTM agents, then the effectiveness of such a policy would be lower.

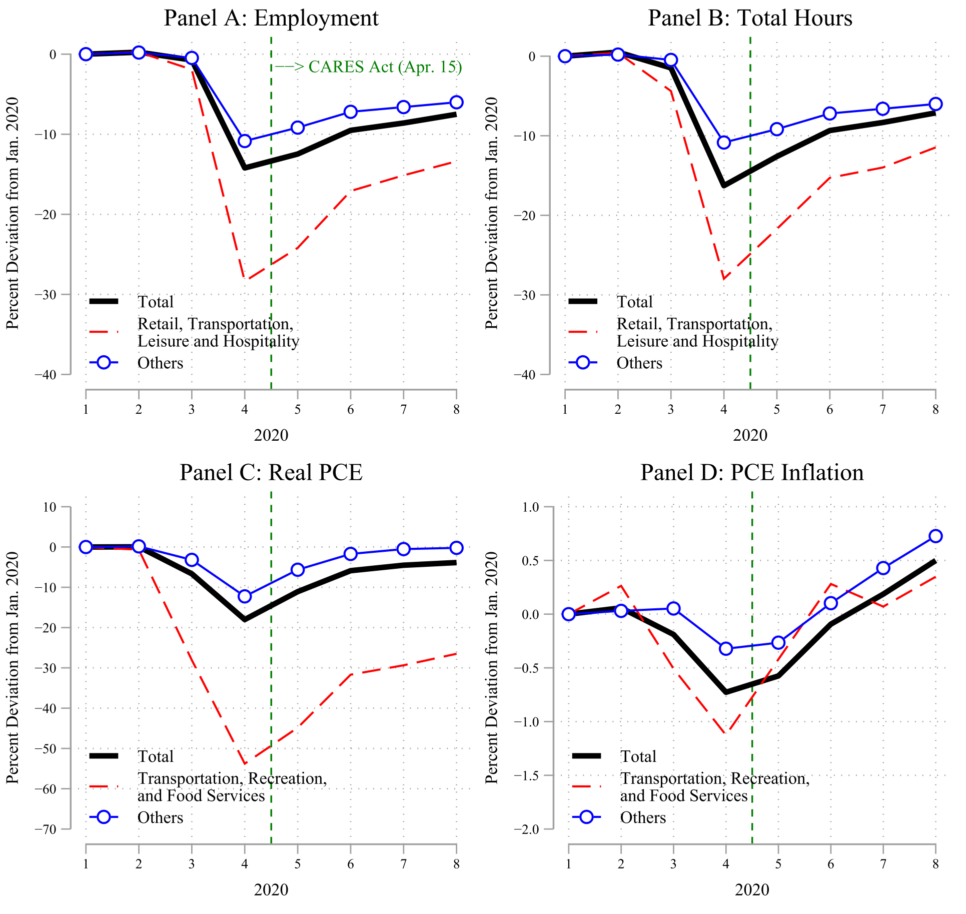
In future work, we can empirically explore whether fiscal policy significantly affects inflationary expectations, along the lines found recently in a randomized control trial by Coibion, Gorodnichenko, and Weber (2021). In addition, a comparative analysis of the future of the COVID recession and the Great Recession is potentially interesting as inflation dynamics were quite different between the two: inflation remained relatively subdued post-Great Recession, compared to the present time. Our results suggest that state dependency must have played a role as the size of fiscal expansions as well as the persistence and the size of the contractionary shocks differed significantly in these two episodes. Finally, fiscal regime-based policy implementation would not be as straightforward in an environment where economic agents take into account the possibility of regime switching by policymakers when the recession is over. We leave a more comprehensive analysis of such interesting issues for future research.

Appendix: Data description

Employment and total hours We use total employment and total hours data from the U.S. Bureau of Labor Statistics. We define the HTM sector as the sum of the following three sectors: Retail Trade (NAICS 44–45), Transportation and Warehousing (NAICS 48–49), and Leisure and Hospitality (NAICS 71–72).

Consumption and inflation We use real Personal Consumption Expenditure (PCE) data and PCE inflation from the U.S. Bureau of Economic Analysis. We define the HTM sector as the sum of the following three sectors: Transportation services, Recreation Services, and Food services and accommodations. We also use 2019 Consumer Expenditure Surveys (CEX) data to calibrate both Ricardian and HTM households' share parameters in the consumption baskets. We assume households in the top 80 percentile income distribution as Ricardian households and match their consumption share for transportation, entertainment, and food away from home. Similarly, we assume households in the bottom 20 percentile income distribution as HTM households and match their consumption share for these three sectors.

Fiscal variables We use government current transfer payments (A084RC1Q027SBEA in FRED) to calibrate steady-state transfers to the GDP ratio. We also use federal debt held by the public data (FYGFDPUN in FRED) to calibrate the debt-to-GDP ratio. Finally, we use compensation of employees, paid: wages and salaries (A4102C1Q027SBEA in FRED), proprietors' income (PROPINC in FRED), and federal government current receipts: contributions for government social insurance (W780RC1Q027SBEA in FRED) data to calibrate steady-state labor tax revenue to the GDP ratio. The sample period for these variables is from 1990Q1 through 2020Q1.



Appendix Figure 1. Aggregate and Sectoral Effects of COVID-19 Recession. *Note*: This figure shows the dynamics of key variables from January 2020. Panels A and B show employment and total hours dynamics in the U.S. Bureau of Labor Statistics, respectively. Black solid lines are dynamics of the total variable and red dashed lines represent the retail, transportation, leisure, and hospitality sector, and blue solid lines with circles represent all other sectors. Panels C and D present real personal consumption expenditure and PCE inflation in the U.S. Bureau of Economic Analysis, respectively. Black solid lines are dynamics of the total variable and red dashed lines represent the transportation, recreation, and food services sector, and blue solid lines with circles represent all other sectors. *Sources*: U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics.

Transfer distribution from the CARES Act We calibrate the size of the transfer distribution using the transfer amounts specified in the CARES Act, which came into operation in mid-April 2020. In particular, we target the sum of three key components of the Act: \$293 billion to provide one-time tax rebates to individuals; (ii) \$268 billion to expand unemployment benefits; (iii) \$150 billion in transfers to state and local governments. These three components of the CARES Act consist of around 3.4% of the GDP. In a sensitivity analysis, we count only components (ii) and (iii) above.

Employment, inflation, and consumption dynamics in 2020 Appendix Figure 1 presents dynamics of employment, hours, inflation, and consumption based on such a two-sector decomposition of the U.S. economy. We show the vertical dashed line when transfer payments from the CARES Act started to get mailed. As is clear, there was a sharp adverse effect on employment/hours in the HTM sector following the COVID crisis. Moreover, inflation in this sector also fell. Finally, while the HTM sector was disproportionately affected, there was also an aggregate, economy-wide contraction and fall in inflation as well. We calibrate the COVID shocks to perfectly reproduce the dynamics of hours in the two sectors and that of inflation in the HTM sector, thereby situating the model economy in a COVID-recession-like environment. We then calibrate the size of transfers to match the transfer amount in the CARES Act and study how the economy responds to the redistribution policy under several alternative scenarios.

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