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Distributional Considerations for Monetary Policy Strategy

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The analysis in this paper was presented to the Federal Open Market Committee as background for its discussion of the Federal Reserve's review of monetary policy strategy, tools, and communication practices. The Committee discussed issues related to the review at five consecutive meetings from July 2019 to January 2020. References to the FOMC's current framework for monetary policy refer to the framework articulated in the Statement on Longer-Run Goals and Monetary Policy Strategy first issued in January 2012 and reaffirmed each January, most recently in January 2019.

Abstract

We show that makeup strategies, such as average inflation targeting and price-level targeting, can be more effective than a flexible inflation-targeting strategy in overcoming the obstacles created by the effective lower bound in a heterogeneous agent New Keynesian (HANK) model. We also show that the macroeconomic stabilization benefits from such alternative strategies can be substantially larger in a HANK environment than in a representative agent New Keynesian model. We argue that gains in employment outcomes from switching to an alternative strategy would generate disproportionate improvements for historically disadvantaged households and thus have potentially long-lasting effects on the economic well-being of these groups.

JEL Classification: D31, E3, E52
Keywords: heterogeneous agent New Keynesian model, representative agent New Keynesian model, effective lower bound, inequality, hand to mouth, average inflation targeting, price-level targeting

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I. Introduction and Summary

High and rising income and wealth inequality poses challenges for monetary policymakers, particularly in the current environment of heightened risk that the policy rate becomes constrained by the effective lower bound (ELB) in a recession. Recessionary episodes are made even more severe by high levels of inequality in the economy if this environment implies a greater share of "hand to mouth" consumers in a downturn. Because these types of consumers spend all of their income and have little in the way of precautionary savings buffers, negative shocks tend to be amplified throughout the economy. Moreover, the burdens of recessions are not shared equally. Already disadvantaged groups—minorities, out-of-school youth, and the less educated—experience much greater-than-average increases in their unemployment rates during recessions. And the costs of unemployment spells can be long lasting. For instance, a job loss that induces an adverse credit event has negative and persistent implications for future access to both credit and employment. In addition, cohorts that enter the labor market during a recession find their job prospects negatively affected for decades. These considerations provide a further incentive for monetary policymakers to find strategies that reduce the frequency, duration, and severity of ELB episodes.

Arias and others (2020) and Hebden and others (2020) show that a class of makeup strategies in which policymakers aim to stabilize inflation over some longer time horizon may indeed be successful at reducing the frequency, duration, and severity of ELB episodes. In this paper, we suggest that the improvement in employment outcomes of moving to such makeup strategies may be even larger than shown in Arias and others (2020) and Hebden and others (2020) when we explicitly take into account that there is a significant share of hand-to-mouth consumers in the economy and that this share increases in recessions. In addition, moving to makeup strategies may have other long-term benefits—namely, through their effect on the distribution of income. Any gains in employment outcomes from switching to an alternative strategy would generate disproportionate improvements for historically disadvantaged households and thus have potentially long-lasting effects on the economic well-being of these groups. Nevertheless, as we discuss later in this paper, there will be short-term opposing effects

for some households—such as borrowers and savers—that may be particularly evident at times in which the makeup strategies require the Federal Open Market Committee (FOMC) to be more restrictive or accommodative than it would be under the current strategy. For example, keeping rates lower for longer in the case of past inflation shortfalls will effectively amount to a transfer from savers to borrowers.

In section II, we discuss interactions between inequality and the challenges posed by recessions that include a return to the ELB. The risk of returning to the ELB is greater in a low interest rate environment, and rising inequality is potentially one of many contributing factors that may be depressing the real natural rate of interest. In this section, we introduce heterogeneity in household income into a macroeconomic model and show that the presence of inequality can lead to more pronounced business cycle fluctuations, especially when the ELB constraint binds.

In section III, we discuss the highly unequal costs of business cycle downturns for different households and individuals. Alternative monetary policy strategies that reduce the frequency and severity of ELB recessions mitigate the adverse consequences of economic inequality, which then enhances the resilience of the economy to economic disturbances. We also provide an overview of the main redistributive effects of changes in the stance of monetary policy.

Finally, in section IV, we provide a quantitative evaluation of the benefits of some alternative strategies in the presence of borrowing constraints. Compared with Arias and others (2020) and Hebden and others (2020), we find larger improvements in macroeconomic outcomes from the adoption of an inflation makeup strategy in models that explicitly take into account distributional considerations. Furthermore, we reiterate that these average improvements mask disproportional benefits for the most disadvantaged groups in the population.

II. Rising Inequality and the Challenges for Monetary Policy

Over the past few decades, income, wealth, and consumption inequality has increased.[1] These increases have been largely driven by structural factors—such as

[1] There is evidence for rising inequality in income (Piketty, Saez, and Zucman, 2018), earnings (Katz and Murphy, 1992; Kopczuk, Saez, and Song, 2010), wealth (Saez and Zucman, 2016), lifetime earnings

technological disruption, trade integration, demographics, and institutional change—that are beyond the influence of monetary policy. The rise in inequality potentially matters for monetary policy, as it contributes to the challenges posed by recessions that lead to a return to the ELB. First, if those with higher incomes at a given age have a higher marginal propensity to save than those with lower incomes, greater income inequality increases the net supply of savings and lowers the real interest rate. The upward trend in income inequality may therefore have contributed to the secular decline in interest rates and thus to a higher probability of hitting the ELB.[2] Second, greater inequality may also make recessions more severe. The greater the fraction of households that live paycheck to paycheck, the more sensitive consumption expenditures are to changes in earnings. As a result, rising inequality can make aggregate demand more responsive to adverse economic shocks, and, without an appropriate monetary policy response, recessions become deeper.

Table 1: Properties of RANK and HANK Models under Inertial Taylor (1999) Rule

	E[π]	E[u]	STD[π]	STD[u]	SKW[π]	SKW[u]	FRQ[ELB]	DUR[ELB]
RANK (with ELB)	1.97	6.30	.58	3.25	-.38	2.24	27.50	13.75
RANK (no ELB)	2.00	6.00	.48	1.21	0	0	n.a.	n.a.
HANK (with ELB)	1.93	6.94	.69	6.10	-1.52	3.65	29.16	10.45
HANK (no ELB)	2.00	6.00	.48	1.41	0	0	n.a	n.a

Note: π and u are inflation rate and unemployment rate, respectively. E[·], STD[·], and SKW[.] stand for unconditional mean, standard deviation, skewness, and duration in quarters. FRQ [ELB] is the fraction of quarters spent at the effective lower bound (ELB). DUR[ELB] is the average duration of an ELB episode in quarters. RANK is representative agent New Keynesian. HANK is heterogeneous agent New Keynesian. The moments are computed with 160,000 quarters of simulation with identical random draws of demand, technology, and price markup shocks.

Source: Authors' calculations.

To illustrate how inequality can lead to more pronounced business cycle fluctuations when the ELB constraint binds, table 1 compares simulated macroeconomic outcomes from two versions of a New Keynesian model. The two models differ in the degree of inequality but are otherwise identical in structure and are subject to the same

(Guvenen and others, 2017), and consumption (Attanasio and Pistaferri, 2016). In addition, the share of income paid as labor compensation has fallen, and the share of profits has risen. Intergenerational mobility has remained roughly stable (Chetty and others, 2014).

[2] See Eggertsson, Mehrotra, and Robbins (2019); Rachel and Summers (2019); and Straub (2019).

macroeconomic shocks. They are each populated by households that face idiosyncratic unemployment risk. In the first model, a representative agent New Keynesian (RANK) model, all households can perfectly insure away all idiosyncratic income risk by borrowing and lending in perfectly functioning financial markets.[3] As a result, every household enjoys the same level of consumption at all times. In the second model, a heterogeneous agent New Keynesian (HANK) model, households can insure earnings risk only imperfectly because of frictions in financial markets, so that consumption levels vary with individual labor market histories. Because of bad luck, households are occasionally forced to cut back on consumption after exhausting all available access to credit.[4] Other policy models, such as FRB/US, incorporate similar hand-to-mouth consumption behavior but assume that the share of such households does not vary over the cycle. A key distinguishing feature of the HANK model is that the proportion of hand-to-mouth consumers rises in downturns. We parametrize the HANK model to generate realistic levels of income and wealth inequality. In both models, monetary policy follows an inertial version of the Taylor (1999) rule in determining the level of the policy rate, and policy does not use forward guidance or asset purchases.

In the RANK model, monetary policy operates primarily through the intertemporal substitution channel in consumption—that is, through changes in the incentives to spend and save in response to changes in interest rates. In the HANK model, this traditional interest rate channel is weaker in the aggregate, because many households' spending decisions are constrained by available income and therefore do not react to changes in interest rates. Consumption varies more with income, making aggregate demand more sensitive to shocks in the HANK model, but also making the stabilizing effects of monetary policy stronger. While a smaller fraction of consumer spending is directly reactive to interest rates, changes in spending by interest-rate-sensitive households are propagated more strongly into overall aggregate spending.[5] This

[3] Alternatively, households are perfectly insulated from unemployment risk by government unemployment insurance.

[4] For a discussion of the literature on HANK models, see the survey article by Kaplan and Violante (2019). The model used for the simulations in this paper is a simplified version of the models discussed in Cairo and Sim (2018) and Gornemann, Kuester, and Nakajima (2016).

[5] Monetary policy transmission also operates through redistributive effects across households with different marginal propensities to consume (see Auclert, 2019). Such redistribution channels are absent in most traditional models but are reflected in the HANK model.

relationship explains why, despite the differences in the transmission mechanisms, the inertial Taylor (1999) rule provides similar amounts of stabilization when there is no ELB constraint (see the second and fourth rows of table 1). However, economic outcomes are significantly worse in the HANK economy when the ELB binds, as monetary policy cannot effectively stabilize the economy, as shown by comparing the first and third rows of table 1. As a result, the unemployment rate is, on average, about 85 percent more volatile in the model with inequality, and while ELB spells are not necessarily longer or much more frequent, they give rise to lower average inflation and a higher average unemployment rate.[6]

III. Evaluating Distributional Implications of Different Monetary Policy Strategies

Inequality may worsen the effects of recessions in the face of the ELB, strengthening the case for considering alternative monetary policy strategies that alleviate the consequences of such recessions. When assessing the distributional implications of different strategies, the first and foremost consideration is the ability of these alternative strategies to better smooth cyclical fluctuations, which is especially beneficial for the most vulnerable households of the economy.

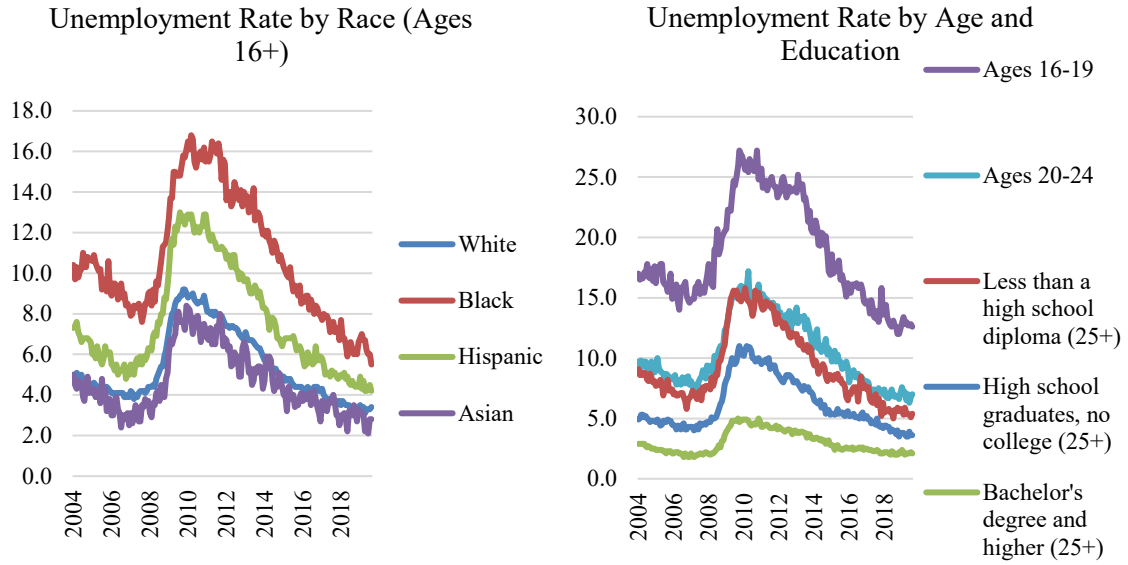
The Unequal Costs of Business Cycle Downturns

The costs of business cycle downturns are not borne equally by all households, and seemingly small differences in the aggregate unemployment rate can have substantial welfare implications for specific vulnerable groups. Figure 1 shows unemployment rates during the Great Recession for different subgroups of the population. Clearly, the levels of the unemployment rate across groups were quite different at the onset of the recession. Groups with higher average unemployment rates also experienced larger increases in their unemployment rates during the recession. For instance, the unemployment rates of minorities, the young, and those with less education all rose substantially more than the 5 percentage point increase for the population overall. Those groups experiencing larger increases in unemployment rates also suffered more severe earnings losses. These losses

[6] Both models have the same steady-state real interest rate of 0.50 percent, which is also the average real rate in both models without the ELB.

were only partially offset by increases in government transfer payments. Calculations by Krueger, Mitman, and Perri (2016) suggest a total cost-of-job loss in the recession equal to 2 percent of lifetime consumption for the wealthiest households but as high as 5 percent for low-wealth households.

Figure 1: Unemployment Rates by Race and by Age and Education, 2004–19



Note: All rates are seasonally adjusted.
Source: U.S. Bureau of Labor Statistics, Employment Situation, http://stats.bls.gov/news.release/pdf/empsit.pdf.

In general, earnings risk is countercyclical, and workers who enter a recession with high earnings experience smaller percentage earnings losses compared with those who enter with low earnings.[7] Individual earnings fluctuations do not necessarily average out over booms and busts, which tend to be asymmetric in duration and amplitude. Even if individual earnings losses and gains did average out perfectly over a business cycle, the costs would remain unequally distributed, as households differ in their ability to insure against earnings fluctuations. In addition, households that are less able to buffer cyclical labor market risks are also likely to be more vulnerable to variability in real purchasing power caused by price instability.

[7] See, for instance, Storesletten, Telmer, and Yaron (2004) and Guvenen, Ozkan, and Song (2014).

Considerable evidence shows that earnings losses in economic downturns are often highly persistent—that is, subject to "negative hysteresis."[8] For example, Rothstein (2019) identifies persistent negative effects on employment rates among cohorts graduating after the Great Recession, and Kahn (2010) documents similar effects for earlier recessions. Also, in weak labor markets, more workers are forced into early retirement (Coile and Levin, 2011), and the longer-term costs of job displacement are not limited to earnings losses but include higher mortality and more adverse health outcomes that have spillover effects on children and other family members.[9]

Motivated by Okun's (1973) notion of cyclical upgrading, some have also suggested that positive benefits during economic booms can be long lasting—that is, "positive hysteresis." This notion is buoyed by empirical evidence that disadvantaged groups experience greater contemporaneous benefits from exposure to particularly strong economic environments (see, for example, Aaronson and others, 2019). In addition, some evidence indicates that positive hysteresis exists but that the positive effect on labor market outcomes from exposure to a strong economy lasts only about three to four years (Fallick and Krolikowski, 2018; Hotchkiss, 2019).[10] That said, these disproportionate benefits are dominated by the disproportionate costs of weak economic conditions imposed on the same disadvantaged groups (Hotchkiss and Moore, 2018; Hotchkiss, 2019).

For these reasons, monetary policy strategies that reduce the frequency and severity of recessions are, all else being equal, likely to decrease economic inequality.[11] The asymmetric nature of the ELB constraint makes this prospect even more likely, because strategies that mitigate the consequences of the ELB may not only lower the variability of the unemployment rate, but also reduce its average level. This outcome is the case, for instance, in simulations that we will discuss in section IV.

[8] A key reason is that in recessions, more workers face occupation displacement—that is, find reemployment only in lower-paying occupations—and lose human capital (Huckfeldt, 2016).
[9] See, for instance, Mathers and Schofield (1998); Sullivan and von Wachter (2009); Golberstein, Gonzalas, and Meara (2019); and Gathmann and others (2018).
[10] Whether the unprecedented lengthy period of low unemployment in 2018 and 2019 would lead to more persistent positive outcomes for less-advantaged workers is unknown.
[11] See also Romer and Romer (1999).

Short-Term Distributive Effects of Monetary Policy

The FOMC's current monetary policy strategy is generally interpreted as a "bygones be bygones" approach.[12] To alleviate the consequences of the ELB constraint, Arias and others (2020) and Hebden and others (2020) consider a class of makeup strategies in which policymakers aim to stabilize inflation over some longer horizon. Adopting such a makeup strategy would require that the FOMC occasionally use its tools to deliberately target rates of inflation that deviate from the 2 percent objective on one side to offset past deviations on the other side. Namely the FOMC would sometimes need to be more restrictive or more accommodative than would be desirable in the absence of any previous commitment to a makeup strategy, for instance, by keeping rates lower for longer in the case of past inflation shortfalls. In practice, different types of households can experience different effects from adopting a relatively more accommodative or restrictive policy stance. In this section, we describe the main short-term distributional effects of such changes in the stance of monetary policy.

Differences in Income Sources

Different groups rely on different sources of income that are not equally sensitive to changes in monetary policy. The left panel in figure 2 shows that wage income makes up around 60 to 80 percent of total income for working-age households (with heads aged under 65) outside of the top 5 percent of the income distribution. For most households, the effect of changes in monetary policy on labor earnings is therefore a major source of distributional effects.[13] As in economic downturns more generally, the largest short-run cost of tighter monetary policy is that it harms the employment prospects of low-income individuals—that is, minorities, out-of-school youth, and the less skilled.[14]

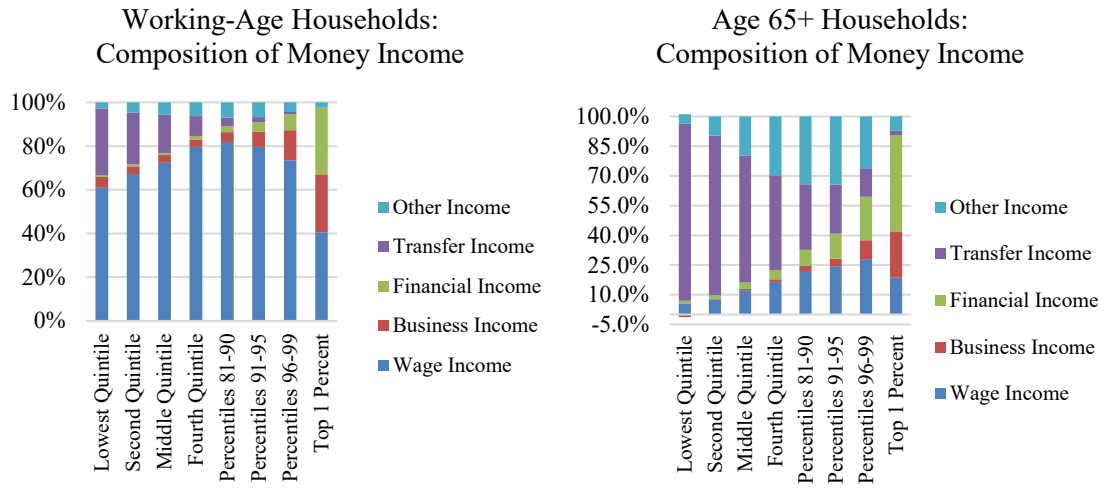
[12] According to the Statement on Longer-Run Goals and Monetary Policy Strategy reaffirmed in January 2019, the FOMC seeks to mitigate deviations of inflation from its longer-run goal and deviations of employment from the FOMC's assessments of its maximum level. A 2 percent symmetric inflation rate is viewed as most consistent with the dual mandate. The FOMC takes a balanced approach to addressing deviations in inflation from its objective and employment from the FOMC's assessment of its maximum level.

[13] See the evidence in Coibion and others (2017) and Lenza and Slalcek (2018).

[14] Carpenter and Rogers (2004) document evidence for disproportionate effects of a monetary tightening on the unemployment rate of these disadvantaged groups.

Households with heads aged 65 and older in the lower half of the income distribution rely mostly on Social Security transfers (see the right panel of figure 2). These transfer payments generally respond little to monetary policy and are adjusted automatically to keep pace with inflation. Richer, older households rely more heavily on business and financial income. Business and financial income are directly sensitive to changes in monetary policy but are more concentrated at the top of the distribution where the welfare effect of income fluctuations is smaller.

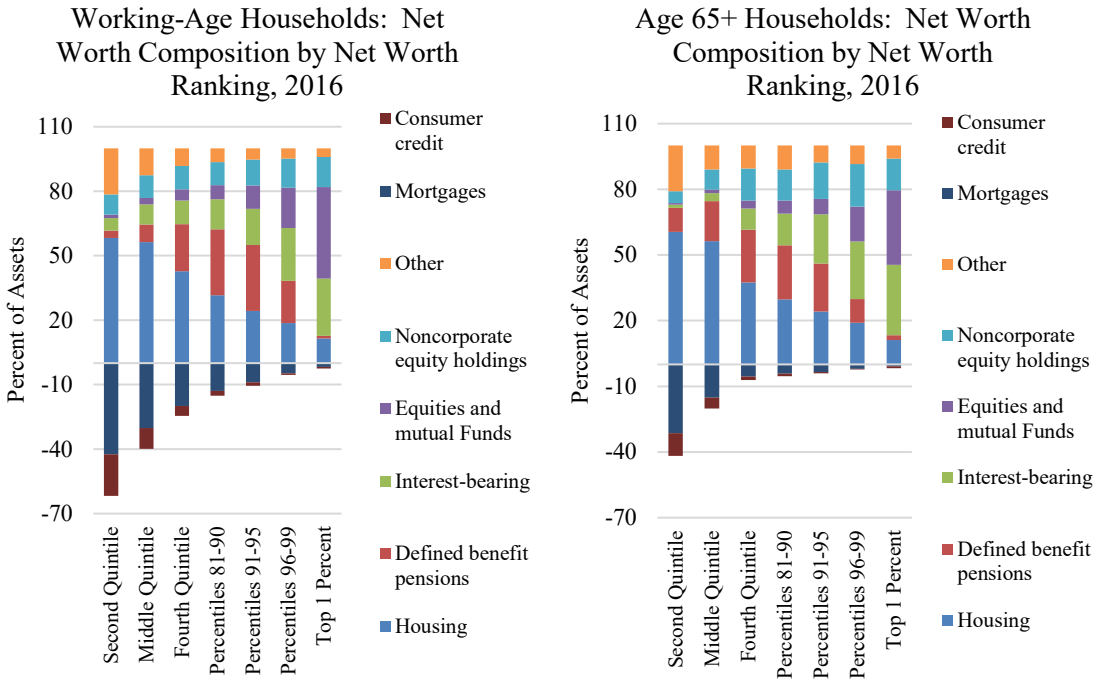
Figure 2: Composition of Money Income in 2016 by After-Tax and Transfer Income Percentiles



Note: Statistics are for 2016. All percentages are out of total money income (excludes noncash compensation and imputed income).

Source: Authors' calculations; Congressional Budget Office, *The Distribution of Household Income*, 2016, https://www.cbo.gov/publication/55413.

Figure 3: The Composition of Net Worth in 2016



Note: Statistics are for 2016. All percentages are out of total assets.
Source: Federal Reserve, Survey of Consumer Finances, http://www.federalreserve.gov/econresdata/scf/scfindex.htm. , 2016.

Differential Exposures to Real Interest Rates

The distribution of wealth across households is highly uneven, and the composition of assets and liabilities varies greatly. The top 10 percent of wealthiest households account for more than three-fourths of total wealth, while the bottom half of all families have net worth close to zero, as any assets (in housing and transaction accounts) are offset by mortgage debt and other consumer loans (namely, credit cards, auto loans, and student loans). For most families between those two groups, home equity and defined benefit pensions are the main sources of net worth (see the left panel of figure 3).[15] At the top, wealth is concentrated in direct equity holdings, mutual funds, and other financial wealth. The higher-income elderly also hold large shares in financial wealth (see the right panel in figure 3).

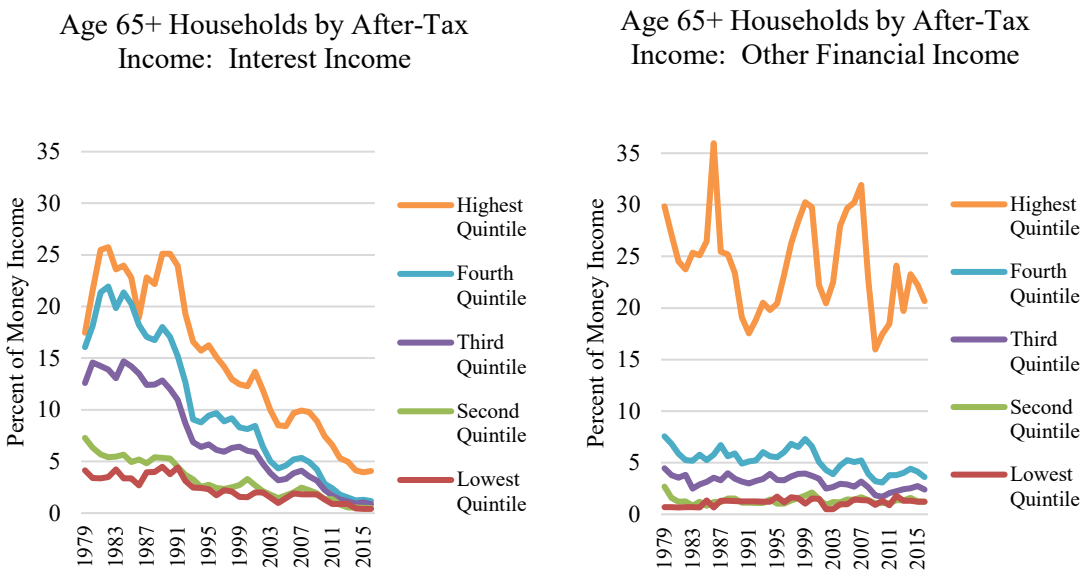
[15] Defined contribution pension wealth and individual retirement accounts are split among equities and mutual funds, interest-bearing assets, and "other."

Given the heterogeneity in the level and composition of household assets and liabilities, changes in interest rates inevitably have redistributive effects. Higher real interest rates induced by tighter monetary policy lower the values of stocks, long-term bonds, and real estate and therefore reduce the wealth of homeowners and households holding those assets. On the other hand, households with large balances in shorter-duration interest-bearing assets such as certificates of deposit, money market, or savings accounts—retirees, in particular—benefit from higher yields. This trend is exemplified by the gradual decline in interest income of elderly households in parallel with the secular decline of interest rates. The left panel in figure 4 shows how the share of interest in total retirement income fell from around 25 percent in the 1980s to less than 5 percent in 2016. The right panel shows there was no offsetting rise in other financial income to make up for the loss. For middle- and upper-middle-income retirees, interest rates that are 2 percentage points higher than current levels would boost their income an average of about $1,000 to $3,000 per year, or 2 to 3 percent of their annual income.

An increase in interest rates affects the purchasing power of those households that need loans for new purchases, especially young, middle-income households that hope to buy a new house or car. In addition, households relying on short-term credit (for example, credit card debt, consumer loans, or variable-rate mortgages) become more indebted when interest rates rise, while households with outstanding fixed-rate mortgage debt or other fixed-rate longer-term loans remain more insulated. On the flip side, indebted households—and, because of refinancing opportunities, even those with fixed-rate mortgages—benefit from lower rates.[16] Because of financial segmentation, lack of access to credit, and problems of financial literacy, however, not all households are able to take advantage of lower rates.

[16] Wong (2019) finds that homeowners that refinance increase consumption when monetary policy becomes more expansionary.

Figure 4: Financial Income of Households Aged 65 and Older, 1979–2016



Note: Other financial income consists of dividend income, realized capital gains, and rental income. All percentages are out of total money income (excludes noncash compensation and imputed income).

Source: Authors' calculations; Congressional Budget Office, *The Distribution of Household Income*, https://www.cbo.gov/publication/55413

Differential Nominal Balance Sheet Exposures

Temporarily lower inflation induced by tighter monetary policy increases the real value of nominal assets and liabilities. This growth benefits (generally richer and older) owners of long-term bonds and households holding mainly cash (generally younger) but increases the real debt burden of middle-class households with fixed-rate mortgages. Such redistributions of real wealth, however, are only quantitatively important for large inflation surprises.[17] With current low and stable inflation, the effects are small.

Differential Inflation Rates

Another source of distributive effects arises from differences in the composition of consumer spending and changes in relative prices. For example, on the one hand, low- and middle-income households spend a relatively higher share of their income on goods

[17] For instance, if inflation came in 5 percentage points higher than expected for an extended period (as in the 1970s), young, middle-income households would experience an increase in real wealth of 20 to 45 percent, while older households of all incomes could see their real wealth shrink up to 10 percent. See Doepke and Schneider (2006).

and services with more flexible prices, such as gasoline and food. Higher-income households, on the other hand, spend a higher share of income on items with more rigid prices, such as school tuition and child care. Items with more flexible prices tend to react more to changes in monetary policy in the short run, such that low- and middle-income consumers experience larger changes in their cost of living.[18] Just as with the nominal wealth exposure channel discussed earlier, the redistributive effects through this channel are small at the current low and stable rates of inflation.

Table 2: Main Redistributive Effects of Looser Monetary Policy

	Working-Age Households	Retirees
Low Income	(+) Less unemployment and higher labor earnings (+) Lower real interest on consumer loans and student debt (+) Higher inflation decreases the real value of outstanding nominal debt (-) Cost of living increases relative to those with higher incomes	(-) Cost of living increases relative to those with higher incomes
Middle Income	(+) Capital gains on housing assets and retirement savings due to lower real interest rates (+) Higher inflation decreases the real value of outstanding nominal debt (+) Lower real interest rates on mortgages and consumer loans	(-) Lower interest income
High Income	(+) Higher business income (-) Lower interest income (+) Capital gains on financial wealth due to lower real interest rates (-) Higher inflation decreases real asset values	

Source: Authors' calculations.

[18] Cravino, Lan, and Levchenko (2020) find that price increases following looser monetary policy are about one-third smaller for high-income households than for middle-income households.

Summary of Distributive Effects

Table 2 provides an overview of the main distributive effects of monetary policy for working-age and elderly households at different levels of income.[19] In cases of overshoots of inflation, under a symmetric makeup strategy, the FOMC would need to respond by adopting a more restrictive stance compared with a bygones-be-bygones approach. This position may be unpopular because of higher unemployment among lower-income families and the higher borrowing costs for younger and middle-income groups. The middle-income elderly, on the other hand, benefit from higher interest income in retirement. With regard to past shortfalls of inflation, the adoption of a lower-for-longer policy stance will, at that time, hurt middle-income retirees but help the working poor and borrowers.[20]

IV. A Quantitative Evaluation of Makeup Strategies in the Presence of Inequality

As mentioned earlier, the first and foremost consideration when assessing the distributional implications of alternative monetary policy strategies is the ability to better smooth cyclical fluctuations. More specifically, strategies that reduce the frequency of recessions and the severity of unemployment increases during recessions stand the best chance of reducing economic inequality in the longer term. Arias and others (2020) and Hebden and others (2020) illustrate—in simulations of a demand-driven recession in which the ELB binds—that various inflation makeup strategies succeed in reducing both the increase in the unemployment rate and the drop in inflation relative to the current

[19] There are, of course, many other ways to cut classify the population, such as on the basis of race, education, and so forth. Regional heterogeneity might also lead to substantial redistributive effects of monetary policy. For example, house prices in some areas might be more elastic to interest rates because of local differences in the elasticity of housing supply. Similarly, employment is more concentrated in interest rate or cyclically sensitive sectors in some regions than in others. The regional incidence depends on the degree of labor mobility—that is, on the ability or willingness of workers to move to places with lower housing costs or better jobs. While internal migration in the United States is high relative to most other developed economies, it has steadily declined since 1980 (see Molloy, Smith, and Wozniak, 2011). The decline in internal migration does not necessarily mean that labor mobility has decreased. According to Kaplan and Schulhofer-Wohl (2017), the decline reflects that local labor markets have become less specialized and that workers make more informed migration decisions.

[20] In principle, the costs to retirees are more avoidable by appropriate adjustments in the composition of retirement assets. It seems, however, many do not make these adjustments in practice.

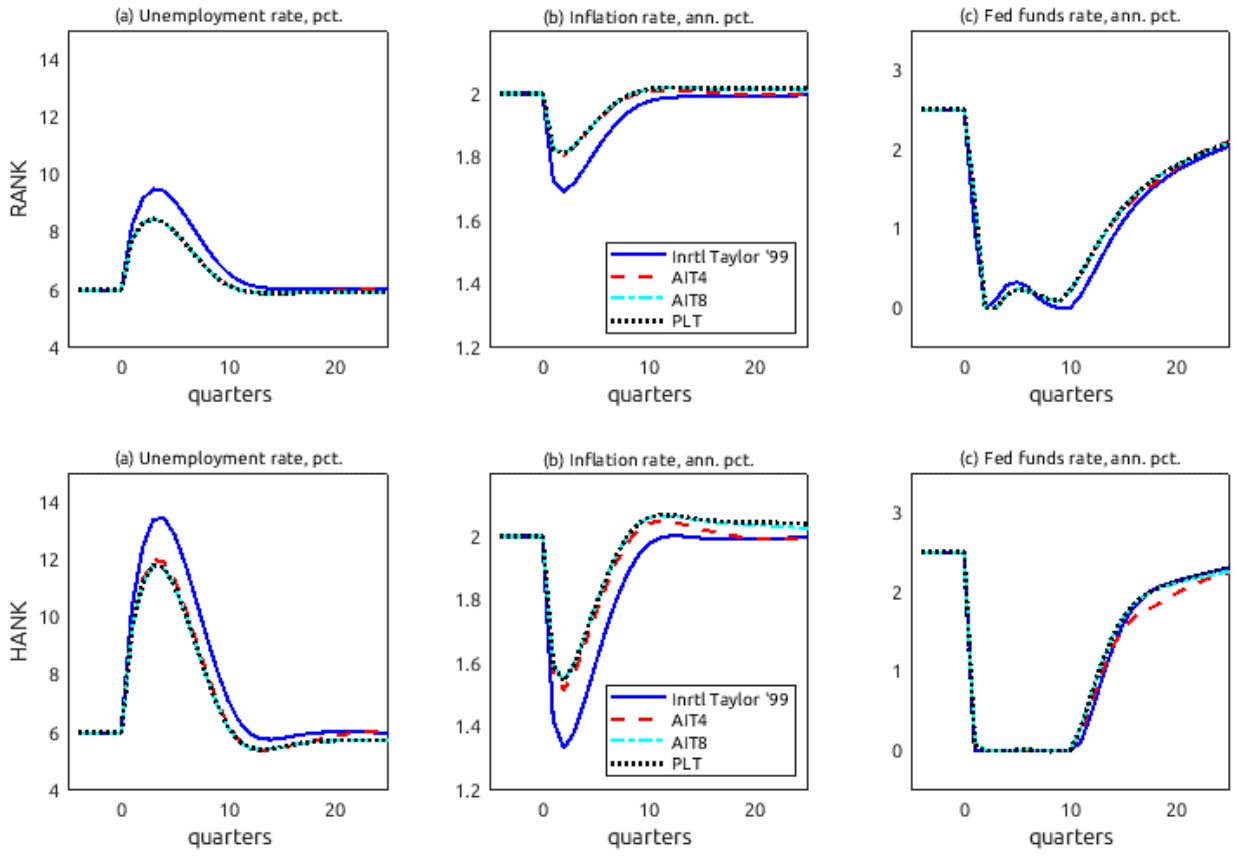
bygones-be-bygones approach. The simulations also showed that the improvements in macroeconomic outcomes are relatively modest on average.

This section evaluates quantitatively whether distributional considerations strengthen the case for the adoption of an alternative strategy.[21] Figure 5 shows simulation results for a severe recession scenario triggered by the same large adverse demand shocks in both the RANK and HANK models. Under the inertial version of the Taylor (1999) rule, the federal funds rate reaches the ELB in both model simulations and remains close to zero for several years. The RANK model is a smaller, simplified version of the DGS-FHP model used in Arias and others (2020) and, as such, performs similarly to that model.[22] For both the RANK and HANK models, figure 5 also shows alternative outcomes for cases in which monetary policy instead follows variants of an inflation makeup strategy: average inflation targeting with four- and eight-year windows (AIT-4 and AIT-8) and price-level targeting (PLT).

[21] For more discussion of the effects of forward guidance and makeup strategies in HANK models, see, for example, Archarya and Dogra (2018); Bilbiie (2019); McKay, Nakamura, and Steinsson (2016); and Hagedorn and others, (2019).

[22] The DGS model is a medium-scale New Keynesian dynamic stochastic general equilibrium model used for policy analysis by the Federal Reserve Bank of New York, developed by Del Negro, Giannoni, and Schorfheide (2015). DGS-FHP is a slightly modified version of this model used in Arias and others (2020).

Figure 5: Performance of Inflation Makeup Strategies at the ELB in a Severe Recession: RANK versus HANK



Note: The top row shows the response of the representative agent New Keynesian (RANK) model to a sequence of adverse demand shocks under different monetary policy rules. The bottom row shows the response of the heterogeneous agent New Keynesian (HANK) model to the same sequence of shocks under different policy rules. Inertial Taylor '99 shows the response under an inertial Taylor 1999 rule. AIT4/AIT8 shows the response under average inflation targeting with four- and eight-year windows. PLT shows the response under price-level targeting. ELB is effective lower bound.

Source: Authors' calculations.

As mentioned earlier, the negative shock that causes the ELB to bind results in more severe economic downturns in the HANK model because of stronger multiplier effects. Because of borrowing constraints, certain low-wealth households are unable to insulate consumption from the effect of job loss by dissaving or borrowing so the consumption of these agents depends on current available income. Spending by some households with substantial positive wealth is also more strongly dependent on current income. This is the case for households that keep most of their savings in illiquid assets that are costly to adjust in order to smooth consumption in the shorter run, such as home

equity and defined benefit pension plans.[23] The presence of these wealthier hand-to-mouth households further contributes to the stronger income multiplier effects and sharper economic downturn. Finally, in contrast to models that abstract from credit frictions, such as the RANK model, or that posit a fixed share of hand-to-mouth consumers, such as FRB/US, the fraction of credit-constrained consumers in the HANK model also rises endogenously during recessions. In the scenario depicted in figure 5, for example, this share rises from less than 2 percent to more than 9 percent of households for the case of the inertial Taylor rule.

Figure 5 shows that each of the alternative strategies succeeds in containing the rise in unemployment and the drop in inflation during the depth of the recession. The gains, however, are more significant in the HANK model.[24] In both models, the commitment under the makeup strategies to overshoot inflation in the future lowers real interest rates and stimulates additional spending at the ELB. In the HANK model, the additional spending by the more interest-rate-sensitive consumers raises the incomes of hand-to-mouth consumers and prevents sharper and self-reinforcing reductions in spending and employment through multiplier effects. Because the promises to keep rates lower for longer are relatively effective in mitigating the drop in output and inflation, the number of quarters when the federal funds rate remains at the ELB under the makeup strategies is not meaningfully longer than under the inertial Taylor rule.

[23] In principle, the use of home equity lines or 401(k) loans to some extent enables consumption out of illiquid forms of wealth. However, these tools for consumption smoothing may not be available when credit conditions tighten in a downturn. Kaplan, Violante, and Weidner (2014) provide evidence that the share of wealthy hand-to-mouth consumers is on the order of one-fourth to one-half of all households.
[24] The gains relative to those in the RANK model arise mainly when the ELB binds. Figure 6 in the appendix shows that the differences in outcomes between the inertial Taylor rule and the makeup strategies are much smaller in a milder recession scenario in which the ELB is never reached.

Table 3: Properties of HANK Model under Alternative Monetary Policy Strategies

	E[π]	E[u]	STD[π]	STD[u]	SKW[π]	SKW[u]	FRQ[ELB]	DUR[ELB]
HANK	1.93	6.94	.69	6.10	-1.52	3.65	29.16	10.45
HANK AIT4	1.97	6.48	.59	4.80	-.52	2.27	30.16	12.07
HANK AIT8	1.98	6.54	.55	4.03	-.40	2.96	34.09	10.97
HANK PLT	2.00	6.44	.55	3.90	-.41	3.24	24.55	10.09

Note: π and u are inflation rate and the unemployment rate, respectively. E[·], STD[·], and SKW[.] stand for unconditional mean, standard deviation, skewness, and duration in quarters. FRQ [ELB] is the fraction of quarters spent at the effective lower bound (ELB). DUR[ELB] is the average duration of an ELB episode in quarters. RANK is representative agent New Keynesian. HANK is heterogeneous agent New Keynesian. The moments are computed with 160,000 quarters of simulation with identical random draws of demand, technology and price markup shocks. AIT4/AIT8 shows the response under average inflation targeting with four- and eight-year windows. PLT shows the response under price-level targeting.

Source: Authors' calculations.

Table 3 shows simulated macroeconomic outcomes in the HANK model under the inertial Taylor rule and the various inflation makeup strategies. Compared with the inertial Taylor rule, all three alternative strategies manage to alleviate the consequences of the ELB constraint substantially. The alternative strategies do not reduce the frequency or average durations of ELB episodes very significantly. However, they make the ELB recessions less severe and, as a result, lead to a substantially lower average unemployment rate. Importantly, the reduction in average unemployment is larger in the HANK model than the reductions in Arias and others (2020). Specifically, table 3 shows that the average unemployment rate is reduced 0.2 to 0.3 percentage point when moving from the inertial version of the Taylor (1999) rule to the makeup strategies in the HANK model. In contrast, the improvements in the long-term unemployment rate from moving from the inertial Taylor (1999) rule to the makeup strategies in the FRB/US or DGS-FHP models (table 2 in Arias and others, 2020) were closer to only 0.1 percentage point.[25]

The simulations in figure 5 and table 3 illustrate that in models that take distributional considerations more seriously, the improvements in macroeconomic outcomes from adopting an inflation makeup strategy are potentially more significant.

[25] The mean unemployment rates are different in table 2 of Arias and others (2020) and table 3 of the current paper because of differences in calibration. Arias and others (2020) calibrate the natural rate as 4.4 percent. In this paper, we calibrate it as 6 percent without the ELB, which is closer to the historical postwar average. The higher natural rate generates a stronger precautionary savings motive because of higher unemployment risk.

An important caveat is that these improvements assume that the FOMC is able to commit credibly to future policy actions and that private agents understand, believe, and react to these commitments ex ante.[26]

We conclude by reiterating that the case for alternative strategies that succeed in reducing the frequency, severity, or both of ELB recessions is reinforced by the potential for longer-run beneficial effects on economic inequality. In the previous simulations as well as in Arias and others (2020) and Hebden and others (2020), inflation makeup strategies typically result in lower average unemployment rates. The improvements to the average unemployment rate mask even larger improvements for subgroups of the population. For instance, any reduction in the average unemployment rate will be roughly doubled for both Black men and men without a high school degree.[27] Seemingly small reductions in the aggregate unemployment rates are therefore, in fact, more meaningful reductions for specific and particularly vulnerable subgroups of the populations.

[26] For an in-depth discussion of these caveats, see Hebden and others (2020).
[27] See Aaronson and others (2019).

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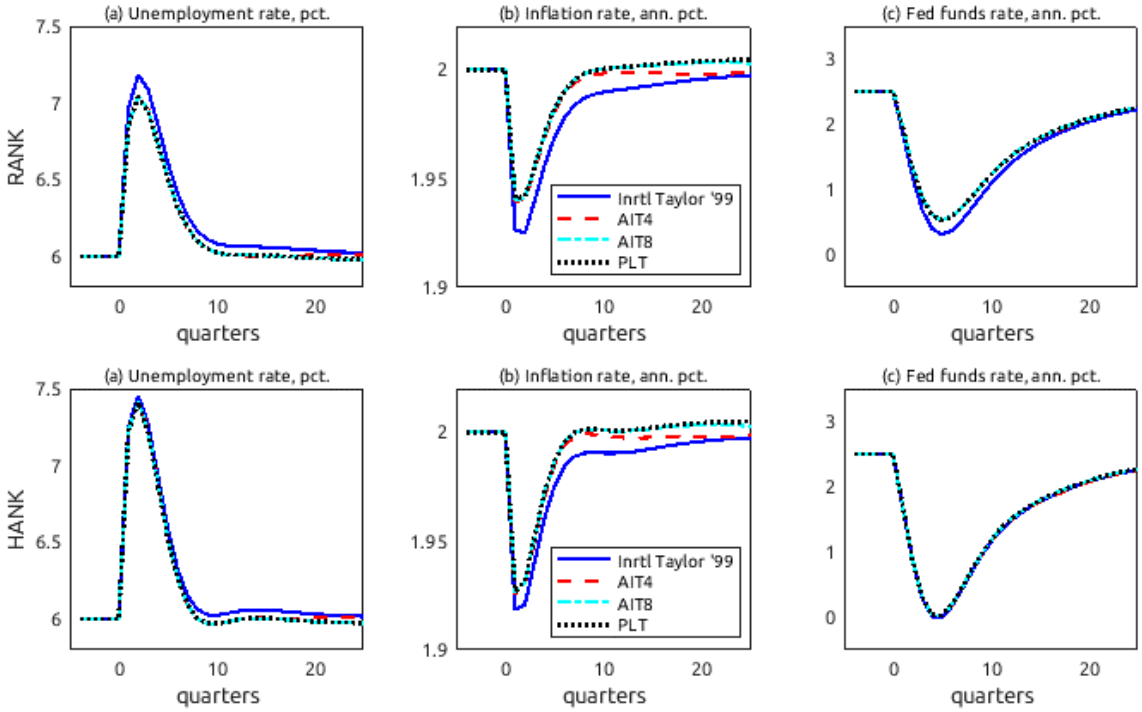
Appendix

Figure 6: Performance of Inflation Makeup Strategies Away from the ELB: RANK versus HANK



Note: The top row shows the response of the representative agent New Keynesian (RANK) model to an adverse demand shock under different monetary policy rules. The bottom row shows the response of the heterogeneous agent New Keynesian (HANK) model to the shock under different policy rules. Inrtl Taylor '99 shows the response under an inertial Taylor 1999 rule. AIT4/AIT8 shows the response under average inflation targeting with four- and eight-year windows. PLT shows the response under price-level targeting. ELB is effective lower bound.

Source: Authors' calculations.