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Welfare and Spending Effects of Consumption Stimulus Policies

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Using a heterogeneous agent model calibrated to match measured spending dynamics over four years following an income shock (Fagereng, Holm, and Natvik (2021)), we assess the effectiveness of three fiscal stimulus policies employed during recent recessions. Unemployment insurance (UI) extensions are the clear "bang for the buck" winner when effectiveness is measured in utility terms. Stimulus checks are second best and have two advantages (over UI): they arrive and are spent faster, and they are scalable to any desired size. A temporary (two-year) cut in the rate of wage taxation is considerably less effective than the other policies and has negligible effects in the version of our model without a multiplier.

html: https://llorracc.github.io/HAFiscal/
PDF: HAFiscal.pdf
GitHub: https://github.com/llorracc/HAFiscal

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1 Introduction

Fiscal policies that aim to boost consumer spending in recessions have been tried in many countries in recent decades. The nature of such policies has varied widely, perhaps because traditional macroeconomic models have not provided plausible guidance about which policies are likely to be most effective—either in reducing misery (a 'welfare metric') or in increasing output (a 'GDP metric').

But a new generation of macro models has shown that when microeconomic heterogeneity across consumer circumstances (wealth; income; education) is taken into account, the consequences of an income shock for consumer spending depend on a measurable object: the intertemporal marginal propensity to consume (IMPC) introduced in Auclert, Rognlie, and Straub (2018). The IMPC extends the notion of marginal propensity to consume (MPC) to account for the speed at which households spend. Fortuitously, new sources of microeconomic data, particularly from Scandinavian national registries, have recently allowed the first reasonably credible measurements of the IMPC (Fagereng, Holm, and Natvik (2021)).

Even in models that can match a given measured IMPC pattern, the relative merits of alternative policies depend profoundly on the both the metric (welfare or GDP) and on the quantitative structure of the rest of the model – for example, whether multipliers exist and how they work. Here, after constructing a microeconomically credible heterogeneous agent (HA) model, we examine its implications for how optimal stimulus policies depend on the existence, nature, and timing of any "multipliers," which, following Krueger, Mitman, and Perri (2016), we model in a clean and simple way. As a result, the interaction of the multiplier (if any) with the other elements of the model is reasonably easy to understand. In order to ease interpretation of our results, as well as to keep the model tractable, our primary analysis is based on an aggregation of individual consumption responses. This partial equilibrium analysis allows us to introduce elements such as the fact that our multiplier only acts during a recession. However, a general equilibrium approach may introduce transmission channels that we miss in our primary analysis. Accordingly, we also analyze a simple HANK model that embed our household's consumption responses in a general equilibrium framework.

By "microeconomically credible," we mean a model that can match three things that we take to be stylized facts: (1) the measured IMPCs from Fagereng, Holm, and Natvik (2021), (2) the cross-sectional distribution of liquid wealth (following Kaplan and Violante (2014)'s definition of liquid wealth) and (3) the spending induced by the unanticipated transitory shock is "front-loaded." What we mean by this is that a fairly standard HA model (specifically, the model in Carroll, Slacalek, Tokuoka, and White (2017)) can match both the initial distribution of liquid wealth, and the pattern of spending in periods after the shock arrives. But the prediction of that model for spending in the initial period is far below the actual spending measured. We call the extra spending that happens immediately in the period of receipt of the stimulus a "splurge." The evidence of front-loading from Fagereng, Holm, and Natvik (2021) is consistent with findings elsewhere in the literature.[1]

Our model's main innovation relative to the existing literature is designed specifically to match the evidence of front-loading. (If we were unable to reject the hypothesis that the required splurge was zero, we would not need to add the splurge). Specifically, our splurge assumption is that consumers spend a fixed fraction of their labor income each period. This spending occurs regardless of their current wealth and fits with the above-cited empirical evidence on front-loading as well as the evidence that even high-liquid-wealth households have high initial MPCs (see Crawley and Kuchler (2023), and the extensive literature cited therein). This 'splurge' model is also consistent with evidence, from Ganong and Noel (2019), that spending drops sharply following the large and predictable drop in income after the exhaustion of unemployment benefits (which a model without the splurge would not be able to match).[2] The resulting structural model could be used to evaluate a wide variety of consumption stimulus policies. We examine three that have been implemented in recent recessions in the United States (and elsewhere): an extension of unemployment insurance (UI) benefits, a means-tested stimulus check, and a payroll tax cut. (We assume all these policies are debt financed; see section 2 for details.)

Our first metric of policy effectiveness is "multiplication bang for the buck": For a dollar of spending on a particular policy, how much multiplication is induced? Timing matters because in our model (following the empirical literature), the size of any "consumption multiplier" depends on the economic conditions that prevail when the extra spending occurs. Our strategy to illuminate this point is twofold. First, we calculate the policy-induced spending dynamics in an economy with no multiplier (and, therefore, with no multiplication-bang-for-the-buck). We then follow Krueger, Mitman, and Perri (2016)'s approach to modeling the aggregate demand externality. In their approach, output depends mechanically on the level of consumption relative to steady state. But in contrast to Krueger, Mitman, and Perri (2016), the aggregate demand externality in our model is switched on only when the economy is experiencing a recession—there is no multiplication for spending that occurs after our simulated recession is over. A less stark assumption (for example, the degree of multiplication depends on the distance of the economy from its steady state, or the endogenous time-varying multiplication that arises in a New-Keynesian model) would perhaps be more realistic but also much harder to assess clearly.[3]

Because our model's outcomes reflect the behavior of utility-maximizing consumers,

[1]See Parker, Souleles, Johnson, and McClelland (2013); Olafsson and Pagel (2018); Ganong and Noel (2019).

[2]The logic of Akerlof and Yellen (1985) and Cochrane (1989) suggests tht the utility consequences of such a deviation from perfectly optimal behavior might not be too large. But such behavior might even be fully rational in a model in which measured consumption includes spending on 'small durables' that would generate splurge-like behavior – see Browning and Crossley (2009) for a start; see also Laibson, Maxted, and Moll (2022).

[3]The Econ-ARK toolkit with which the model was solved can construct the Jacobians necessary to connect a steady-state version of the model to the SSJ Toolkit, which would permit a full-fledged NK block; we have chosen not to pursue that option because it would not allow for a non-linear multiplier

we can calculate another, possibly more interesting, measure of the effectiveness of alternative policies: their effect on consumers' welfare. Even without multiplication, a utility-based metric can justify countercyclical policy because the larger idiosyncratic shocks to income that occur during a recession may justify a greater-than-normal degree of social insurance. We call this 'welfare bang for the buck.'

The principal difference between the two metrics is that what matters for the degree of spending multiplication is how much of the policy-induced extra spending occurs during the recession (when the multiplier matters), while effectiveness in the utility metric also depends on who is doing the extra spending (because different recipients have very different marginal utilities).

In the case of the policies compared here, an advantage of the stimulus checks (as we model them) is that they are distributed immediately upon commencement of the recession, when the multiplier is fully in force; our model implies that much of the induced extra spending occurs soon enough that it is multiplied. UI payments immediately increase spending by reducing the precautionary saving motive but, because "extended" UI payments may be made after the recession is over, a substantial proportion of UI-extension-induced spending will occur when there is no multiplier. However, the fact that UI recipients have a high MPC implies that the *utility* consequences of the UI policy for them will still be considerable, even if their post-recession spending does not get multiplied (section 4).

Because high-MPC consumers have high marginal utility, a standard aggregated welfare function would favor redistribution to such consumers even in the absence of a recession. We are interested in the degree of *extra* motivation for redistributive policies present in a recession, so we construct our social welfare metric specifically to measure only the *incremental* social welfare effect of alternative policies during recessions (beyond whatever redistributional logic might apply during expansions – see section 4.3).

Households do not prepare for our "MIT shock" recessions, which double the unemployment rate and the average length of unemployment spells. The end of the recession occurs as a Bernoulli process calibrated for an average recession length of six quarters, leading to a return of the unemployment rate to normal levels over time. When the multiplier is active, any reduction in aggregate consumption below its steady-state level directly reduces aggregate productivity and thus labor income. Hence, any policy stimulating consumption will also boost incomes through this aggregate demand multiplier channel.

Our results are intuitive. In the economy with no recession multiplier, the benefit of a sustained payroll tax cut is negligible.[4] When a multiplier exists, the tax cut has

and furthermore would bring in too many other confounding and confusing elements that would be likelier to obscure than to illuminate our points.

[4]One reason there is any (welfare) benefit at all, even for people who have not experienced an unemployment spell, is that the heightened risk of unemployment during a recession increases the marginal value of current income because it helps them build extra precautionary reserves to buffer against the extra risk. A second benefit is that, for someone who becomes unemployed some time into the recession, the temporary tax reduction will have allowed them to accumulate a larger buffer to sustain them during unemployment. Finally, in a recession, there are more people who will have experienced a spell of unemployment, and the larger population of beneficiaries means that the consequences of the prior mechanism will be greater. But, quantitatively, all of these effects are small.

more benefits, especially if the recession continues long enough that most of the spending induced by the tax cut happens while the economy is still in recession (and the multiplier still is in force). The typical recession, however, ends long before our "sustained" wage tax cut is reversed—and even longer before lower-MPC consumers have spent down most of their extra after-tax income. Accordingly, even in an economy with a multiplier that is powerful during recessions, much of the wage tax cut's effect on consumption occurs when any multiplier that might have existed in a recession is no longer operative.

Even leaving aside any multiplier effects, the stimulus checks have more value than the wage tax cut, because at least a portion of such checks go to unemployed people who have both high MPCs and high marginal utilities (while wage tax cuts, by definition, go only to persons who are employed and earning wages). The greatest "welfare bang for the buck" comes from the UI insurance extension, because almost *all* of the recipients are in circumstances in which they have a high MPC and a high marginal utility, whether or not the multiplier aggregate demand externality exists.

And, in contrast to the wage-tax cut, both the UI extension and the stimulus checks concentrate most of the marginal increment to consumption at times when the multiplier (if it exists) is still powerful. A disadvantage of the UI extension, in terms of "multiplied bang for the buck," is that (relative to the assumed-to-be-immediate-upon-recession checks), more of any extended UI payouts are likely to occur after the recession is over (when, by assumption, there is no multiplication). Countering this disadvantage is the fact that the MPC of UI recipients is higher than that of stimulus check recipients and furthermore the insurance nature of the UI payments reduces the precautionary saving motive; in the end, our model says that these two forces roughly balance each other, so that the "multiplied bang for the buck" of the two policies is similar. In this multiplier metric, the stimulus check is slightly more effective despite the fact it is not well targeted to high-MPC households. In the welfare metric, however, there is considerable marginal value to UI recipients who receive their benefits after the recession is over (and no multiplier exists), so in the welfare metric, the relative value of UI benefits is increased compared with the policy of sending stimulus checks.

We conclude that extended UI benefits should be the first weapon employed from this arsenal, as they have a greater welfare benefit than stimulus checks and a similar "multiplied bang for the buck." But a disadvantage is that the total amount of stimulus that can be accomplished with the UI extension is constrained by the fact that only a limited number of people become unemployed. If more stimulation is called for than can be accomplished via the UI extension, checks have the advantage that their effects scale almost linearly in the size of the stimulus—see Beraja and Zorzi (2023) for a more detailed exposition of the relation between MPC and stimulus size. The wage tax cut is also, in principle, scalable, but its effects are smaller than those of checks because recipients have lower MPCs and marginal utility than check and UI recipients. In the real world, a tax cut is also likely the least flexible of the three tools: UI benefits can be further extended, and multiple rounds of checks can be sent, but multiple rounds of changes in payroll tax rates would likely be administratively and politically more difficult.

One theme of our paper is that which policies are better or worse, and by how much, depends on both the quantitative details of the policies and the quantitative modeling of the economy.

But the tools we are using could be easily modified to evaluate a number of other policies. For example, in the COVID-19 recession in the US, not only was the duration of UI benefits extended, but those benefits were also supplemented by very substantial extra payments to every UI recipient. We did not calibrate the model to match this particular policy, but the framework could easily accommodate such an analysis.

1.1 Related literature

Several papers have looked at fiscal policies that have been implemented in the U.S. under the lens of a structural model. Coenen, Erceg, Freedman, Furceri, Kumhof, Lalonde, Laxton, Lindé, Mourougane, Muir, et al. (2012) analyses the effects of different fiscal policies using seven different models. The models are variants of two-agent heterogeneous agent models and make no attempt to match the full distribution of liquid wealth as we do in this paper. We also attempt to match the microdata on household consumption behavior, much of which has come more recently. More closely aligned to the methodology of our paper are McKay and Reis (2016), McKay and Reis (2021), and Phan (????) which look at the role of automatic stabilizers. By contrast, we consider discretionary policies that have been invoked after a recession has begun. Another related paper is Bayer, Born, Luetticke, and Müller (2023) who studies fiscal policies implemented during the pandemic. They find that targeted stimulus through an increase in unemployment benefits has a much larger multiplier than an untargeted policy. In contrast, we find that untargeted stimulus checks have slightly higher multiplier effects when compared with a targeted policy extending eligibility for unemployment insurance. Our results derive from the fact that—as in the data—even high liquid wealth consumers have relatively high MPCs in our model.

This paper is also closely related to the empirical literature that aims to estimate the effect of transitory income shocks and stimulus payments. We particularly focus on Fagereng, Holm, and Natvik (2021), who use Norwegian administrative panel data with sizable lottery wins to estimate the MPC out of transitory income in that year, as well as the pattern of expenditure in the following years. We build a model that is consistent with the patterns they identify. Examples of the literature that followed the Great Recession in 2008 are Parker, Souleles, Johnson, and McClelland (2013) and Broda and Parker (2014). These papers exploit the effectively random timing of the distribution of stimulus payments and identify a substantial consumption response. The results indicate an MPC that is difficult to reconcile with representative agent models.

Thus, the paper relates to the literature presenting HA models that aim to be consistent with the evidence from the micro-data. An example is Kaplan and Violante (2014), who build a model where agents save in both liquid and illiquid assets. The model yields a substantial consumption response to a stimulus payment, since MPCs are high both for constrained, low-wealth households and for households with substantial net worth that is mainly invested in the illiquid asset (the "wealthy hand-to-mouth"). Carroll, Crawley, Slacalek, and White (2020) present an HA model that is similar in many respects to the one we study. Their focus is on predicting the consumption response to the 2020 U.S. CARES Act that contains both an extension of unemployment benefits and a stimulus check. However, neither of these papers attempts to evaluate and rank the effectiveness of different stimulus policies, as we do.

Kaplan and Violante (2022) discuss different mechanisms used in HA models to obtain a high MPC and the tension between that and fitting the distribution of aggregate wealth. We use one of the mechanisms they consider, *ex-ante* heterogeneity in discount factors, and build a model that delivers both high average MPCs and a distribution of liquid wealth consistent with the data. The model allows for splurge consumption and thus also delivers substantial MPCs for high-liquid-wealth households. This helps the model match not only the initial MPC, but also the propensity to spend out of a windfall for several periods after it is obtained.

In our model, consumers do not adjust their labor supply in response to the stimulus policies. Our assumption is broadly consistent with the empirical findings in Ganong, Greig, Noel, Sullivan, and Vavra (2022) and Chodorow-Reich and Karabarbounis (2016). However, the literature is conflicted on this subject and Hagedorn, Manovskii, and Mitman (2017) and Hagedorn, Karahan, Manovskii, and Mitman (2019) find that extensions of unemployment insurance affec both search decisions and vacancy creation leading to a rise in unemployment. Kekre (2022), on the other hand, evaluates the effect of extending unemployment insurance in the period from 2008 to 2014. He finds that this extension raised aggregate demand and implied a lower unemployment rate than without the policy. However, he does not attempt to compare the stimulus effects of extending unemployment insurance with other policies.

One criterion to rank policies is the extent to which spending is "multiplied," and our paper therefore relates to the vast literature discussing the size and timing of any multiplier. Our focus is on policies implemented in the aftermath of the Great Recession, a period when monetary policy was essentially fixed at the zero lower bound (ZLB). We therefore do not consider monetary policy responses to the policies we evaluate, and our work thus relates to papers such as Christiano, Eichenbaum, and Rebelo (2011) and Eggertsson (2011), who argue that fiscal multipliers are higher in such circumstances. Hagedorn, Manovskii, and Mitman (2019) present an HA model with both incomplete markets and nominal rigidities to evaluate the size of the fiscal multiplier and also find that it is higher when monetary policy is constrained. Unlike us, they focus on government spending instead of transfers and are interested in different options for financing that spending. Broer, Krusell, and Öberg (2023) also focus on fiscal multipliers for government spending and show how they differ in representative agent and HA models with different sources of nominal rigidities. Ramey and Zubairy (2018) investigate empirically whether there is support for the model-based results that fiscal multipliers are higher in certain states. While they find evidence that multipliers are higher when there is slack in the economy or the ZLB binds, the multipliers they find are still below one in most specifications. In any case, we condition on policies being implemented in a recession—when, this literature argues, multipliers are higher—but it is not crucial for our purposes whether the multipliers are greater than one or not. We are concerned with relative multipliers, and the multiplier is only one of the two criteria we use to rank policies.

The second criterion to rank policies is our measure of welfare. Thus, the paper relates to the recent literature on welfare comparisons in HA models. Both Bhandari, Evans, Golosov, and Sargent (2021) and Dávila and Schaab (2022) introduce ways of decomposing welfare effects. In the former case, these are aggregate efficiency, redistribution and insurance, while the latter further decomposes the insurance part into intra- and intertemporal components. These papers are related to ours, but we do not decompose the welfare effects. Regardless of decomposition, we want to (1) use a welfare measure as an additional way of ranking policies and (2) introduce a measure that abstracts from any incentive for a planner to redistribute in the steady state (or "normal" times).

2 Model

Consumers differ by their level of education and, within education group, by subjective discount factors (calibrated to match the within-group distribution of liquid wealth). We first describe each kind of consumer's problem, given an income process with permanent and transitory shocks calibrated to their type, as well as type-specific shocks to employment. The next step describes the arrival of a recession and the policies we study as potential fiscal policy responses. The last section discusses an extension incorporating aggregate demand effects that induce feedback from aggregate consumption to income and (via the marginal propensity to consume) back to consumption, amplifying the effect of a recession when it occurs.

A consumer i has education $e(i)$ and a subjective discount factor β_i. The consumer faces a stochastic income stream, $\mathbf{y}_{i,t}$, and chooses to consume some of that income when it arrives (the 'splurge') and then to optimize consumption with what is left over. Therefore, consumption each period for consumer i can be written as

$$\mathbf{c}_{i,t} = \mathbf{c}_{sp,i,t} + \mathbf{c}_{opt,i,t}, \tag{1}$$

where $\mathbf{c}_{i,t}$ is total consumption, $\mathbf{c}_{sp,i,t}$ is the splurge consumption, and $\mathbf{c}_{opt,i,t}$ is the consumer's optimal choice of consumption after splurging. Splurge consumption is simply a fraction of income:

$$\mathbf{c}_{sp,i,t} = \varsigma \mathbf{y}_{i,t}, \tag{2}$$

while the optimized portion of consumption is chosen to maximize the perpetual-youth lifetime expected-utility-maximizing consumption, where D is the end-of-life probability:

$$\sum_{t=0}^{\infty} \beta_i^t (1-D)^t \mathbb{E}_0 u(\mathbf{c}_{opt,i,t}). \tag{3}$$

We use a standard CRRA (constant relative risk aversion) utility function, so $u(c) = c^{1-\gamma}/(1-\gamma)$ for $\gamma \neq 1$ and $u(c) = \log(c)$ for $\gamma = 1$, where γ is the coefficient of relative risk aversion. The optimization is subject to the budget constraint, given existing market resources $\mathbf{m}_{i,t}$ and income state, and a no-borrowing constraint:

$$\begin{aligned} \mathbf{a}_{i,t} &= \mathbf{m}_{i,t} - \mathbf{c}_{i,t}, \\ \mathbf{m}_{i,t+1} &= R\mathbf{a}_{i,t} + \mathbf{y}_{i,t+1}, \\ \mathbf{a}_{i,t} &\geq 0, \end{aligned} \tag{4}$$

where R is the gross interest factor for accumulated assets $\mathbf{a}_{i,t}$.

2.1 The income process

Consumers face a stochastic income process with permanent and transitory shocks to income, along with unemployment shocks. In normal times, consumers who become unemployed receive unemployment benefits for two quarters. Permanent income evolves according to:

$$\mathbf{p}_{i,t+1} = \psi_{i,t+1}\Gamma_{e(i)}\mathbf{p}_{i,t}, \tag{5}$$

where $\psi_{i,t+1}$ is the shock to permanent income and $\Gamma_{e(i)}$ is the average growth rate of income for the consumer's education group $e(i)$.[5] The realized growth rate of permanent income for consumer i is thus $\hat{\Gamma}_{i,t+1} = \psi_{i,t+1}\Gamma_{e(i)}$. The shock to permanent income is normally distributed with variance σ_ψ^2.

The actual income a consumer receives will be subject to the individual's employment status as well as transitory shocks, $\xi_{i,t}$:

$$\mathbf{y}_{i,t} = \begin{cases} \xi_{i,t}\mathbf{p}_{i,t}, & \text{if employed} \\ \rho_b\mathbf{p}_{i,t}, & \text{if unemployed with benefits} \\ \rho_{nb}\mathbf{p}_{i,t}, & \text{if unemployed without benefits} \end{cases} \tag{6}$$

where $\xi_{i,t}$ is normally distributed with variance σ_ξ^2, and ρ_b and ρ_{nb} are the replacement rates for an unemployed consumer who is or is not eligible for unemployment benefits, respectively.

A Markov transition matrix Π generates the unemployment dynamics where the number of states is given by 2 plus the number of periods that unemployment benefits last. An employed consumer can continue being employed or move to being unemployed with benefits.[6] The first row of Π is thus given by $[1-\pi_{eu}^{e(i)}, \pi_{eu}^{e(i)}, \mathbf{0}]$, where $\pi_{eu}^{e(i)}$ indicates the probability of becoming unemployed from an employed state and $\mathbf{0}$ is a vector of zeros of the appropriate length. Note that we allow this probability to depend on

[5] We model the rate of growth for permanent income for each education group and keep this rate unchanged during periods of unemployment. There is evidence, e.g. in Davis and Wachter (2011), that unemployment, especially in a recession, leads to permanent income loss. This finding could be added to the model—see Carroll, Crawley, Slacalek, and White (2020) for an example—but is not material to the evaluation of stimulus payments here so we have chosen to keep the model simple.

[6] That is, as long as we assume that there is at least one period of unemployment benefits.

the education group of consumer i and will calibrate this parameter to match the average unemployment rate for each education group. Upon becoming unemployed, all consumers face a probability π_{ue} of transitioning back into employment and a probability $1 - \pi_{ue}$ of remaining unemployed with one less period of remaining benefits. After transitioning into the unemployment state where the consumer is no longer eligible for benefits, the consumer will remain in this state until becoming employed again. The probability of becoming employed is thus the same for each of the unemployment states and education groups.

2.2 Recessions and policies

We model the arrival of a recession, and the government policy response to it, as an unpredictable event—an MIT shock. We have four types of shocks: one representing a recession and one for each of the three different policy responses we consider. The policy responses are usually modeled as in addition to the recession, but we also consider a counterfactual in which the policy response occurs without a recession in order to understand the welfare effects of the policy.

Recession. At the onset of a recession, several changes occur. First, the unemployment rate for each education group doubles: Those who would have been unemployed in the absence of a recession are still unemployed, and an additional number of consumers move from employment to unemployment. Second, conditional on the recession continuing, the employment transition matrix is adjusted so that unemployment remains at the new high level and the expected length of time for an unemployment spell increases. In our baseline calibration, discussed in detail in section 3.3.1, we set the expected length of an unemployment spell to one and a half quarters in normal times, and this length increases to four quarters in a recession. Third, the end of the recession occurs as a Bernoulli process calibrated for an average length of recession of six quarters. Finally, at the end of a recession, the employment transition matrix switches back to its original probabilities, and, as a result, the unemployment rate trends down over time, back to its steady-state level.

Stimulus check. In this policy response, the government sends money to every consumer that directly increases the individual's market resources. The checks are means-tested depending on permanent income. A check for $1,200 is sent to every consumer with permanent income less than $100,000, and this amount is then linearly reduced to zero for consumers with a permanent income greater than $150,000. Similar policies were implemented in the U.S. in 2001, 2008, and during the pandemic.

Extended unemployment benefits. In this policy response, unemployment benefits are extended from two quarters to four quarters. That is, those who become unemployed at the start of the recession, or who were already unemployed, will receive unemployment benefits for up to four quarters (including quarters leading up to the recession). Those who become unemployed one quarter into the recession will receive up to three quarters of unemployment benefits. These extended unemployment benefits will occur regardless of whether the recession ends, and no further extensions are granted if the recession continues. This policy reflects temporary changes made to unemployment benefits in the U.S. following the great recession.

Payroll tax cut. In this policy response, employee-side payroll taxes are reduced for a period of eight quarters.[7] During this period, which continues irrespective of whether the recession continues or ends, employed consumers' income is increased by 2 percent. The income of unemployed consumers is unchanged by this policy. Consumers also believe there is a 50-50 chance that the tax cut will be extended by another two years if the recession has not ended when the first tax cut expires.[8] A payroll tax cut was introduced in the U.S. in 2010.

Financing the policies. Some work in the HA macro literature has shown that if taxes are raised immediately to offset any fiscal stimulus, results can be very different than they would be if, as occurs in reality, recessionary policies are debt financed. Typical fiscal rules assume that any increase in debt gets financed over a long interval. Since much of our analysis effectively normalizes our policies' size so that the total cost of each policy (and therefore the associated debt) is the same, almost all of the effects of any particular fiscal rule should be very similar for each of our policies so long as the great majority of the debt is repaid after the short recessionary period that is our main focus.

To keep our analysis as simple as possible, we do not model the debt repayment. Any of a variety of fiscal rules could be imposed for the period following our short period of interest, but we did not want to choose any particular fiscal rule in order to avoid making a choice that has little consequence for our key question. Advocates of alternative fiscal rules likely already have intuitions about how such rules' economic consequences differ, but those consequences—under our partial equilibrium analysis—will be similar for all three policies we consider. Alternative choices of fiscal rules will therefore not affect the ranking of policies that is our principal concern.[9]

2.3 Aggregate demand effects

Our baseline model is a partial equilibrium model that does not include any feedback from aggregate consumption to income. In an extension to the model, we add aggregate demand effects during the recession. The motivation for this specification comes from the idea that spending in an economy with substantial slack and in which the central bank is unable to prevent a recession will result in higher utilization rates and greater output. By contrast, government spending in an economy running at potential with

[7]Although payroll taxes are paid by both the employer and the employee, the payroll tax cuts in the U.S. have been applied only the employee side.

[8]The belief that the payroll tax cut may be extended makes little difference to the results.

[9]In our general equilibrium analysis in section5, we apply a fiscal rule that assumes debt is slowly paid back over time.

an active monetary policy will not succeed in increasing output. The recent inflation experience of the U.S. provides some evidence that output responds highly non-linearly to aggregate demand. This idea is explored in a recent revival of research into non-linear Phillips curves, such as Benigno and Eggertsson (2023) and Blanco, Boar, Jones, and Midrigan (2024).

With this extension, any changes in consumption away from the steady-state consumption level feed back into labor income. Aggregate demand effects are evaluated as

$$AD(C_t) = \begin{cases} \left(\frac{C_t}{\tilde{C}}\right)^{\kappa}, & \text{if in a recession} \\ 1, & \text{otherwise,} \end{cases} \tag{7}$$

where $\tilde{C}$ is the level of consumption in the steady state. Idiosyncratic income in the aggregate demand extension is multiplied by $AD(C_t)$:

$$\mathbf{y}_{AD,i,t} = AD(C_t)\mathbf{y}_{i,t}. \tag{8}$$

The series $\mathbf{y}_{AD,i,t}$ is then used for each consumer's budget constraint.

3 Parameterizing the model

This section describes how we set the model's parameters. First, we estimate the extent to which consumers 'splurge' when receiving an income shock. We do so using Norwegian data to allow the model to match the best available evidence on the profile of the marginal propensity to spend over time and across different wealth levels, as provided by Fagereng, Holm, and Natvik (2021). We also show that a consumer model without the splurge is inferior in matching these profiles.

Second, we set up the full model on U.S. data, taking the splurge factor as given from the Norwegian estimation. In the full model, agents differ according to their level of education and their subjective discount factors. A subset of the parameters in the model are calibrated equally for all types, and some parameters are calibrated to be specific to each education group. Finally, a distribution of subjective discount factors is estimated separately for each education group to match features of each within-group liquid wealth distribution.

3.1 Estimation of the splurge factor

We define splurging as the act of spending our of current labor income without concern for intertemporal maximization of utility. (*The previous sentence needs to be discussed.*) The splurge allows us to capture the shorter- and longer-term response of consumption to income shocks, especially for consumers with significant liquid wealth, that a standard model cannot. Specifically, we show that our model can account well for the results of Fagereng, Holm, and Natvik (2021), who study the effect of lottery winnings in Norway

	MPC					
	1st WQ	2nd WQ	3rd WQ	4th WQ	Agg	K/Y
Splurge ≥ 0	0.27	0.48	0.60	0.66	0.50	6.58
Splurge $= 0$	0.13	0.51	0.62	0.68	0.49	6.59
Data	0.39	0.39	0.55	0.66	0.51	6.60

Table 1 Marginal propensities to consume across wealth quartiles and the total population as well as the wealth to income ratio, in the model with or without splurge an according to the data

on consumption using millions of records from the Norwegian population registry. We calibrate our model to reflect the Norwegian economy and, using their results, estimate the splurge factor, as well as the distribution of discount factors in the population, to match two empirical moments.

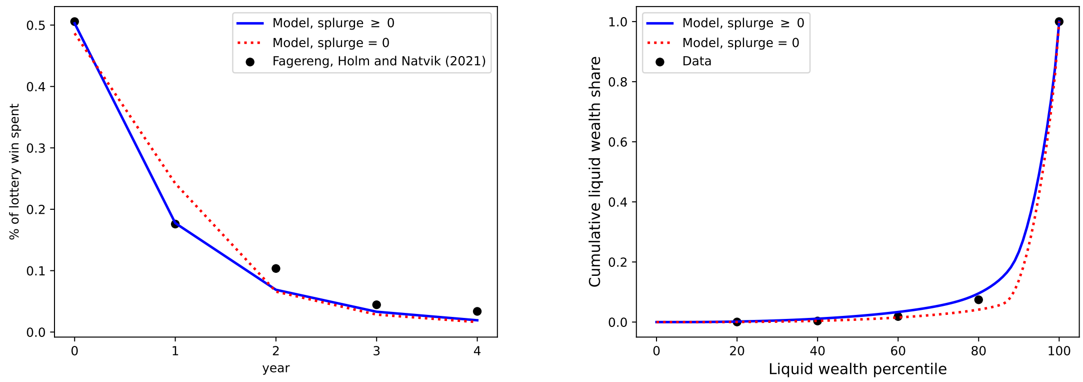
First, we take from Fagereng, Holm, and Natvik (2021) the marginal propensity to consume out of a one-period income shock. We target not only the initial (aggregate) response of consumption to the income shock, but also the subsequent effect on consumption in years one through four after the shock. We also target the initial consumption response in the cross-section, i.e. across the quartiles of the liquid wealth distribution, for which empirical estimates also exist.

The shares of lottery winnings expended at different time horizons, as found in Fagereng, Holm, and Natvik (2021), are plotted in figure 1a. Table 1 (last row) shows the initial consumption response across liquid wealth quartiles.

Second, we match the steady-state distribution of liquid wealth in the model to its empirical counterpart. Because of the lack of data on the liquid wealth distribution in Norway, we use the corresponding data from the United States, assuming that liquid wealth inequality is comparable across these countries.[10] Specifically, we impose as targets the cumulative liquid wealth shares for the entire population at the 20th, 40th, 60th, and 80th income percentiles, which, in data from the Survey of Consumer Finances (SCF) in 2004 (see section 3.2 for further details), equal 0.03 percent, 0.35 percent, 1.84 percent, and 7.42 percent, respectively. Hence, 92.6 percent of the total liquid wealth is held by the top income quintile. We also target the mean liquid wealth to income ratio of 6.60. The data are plotted in figure 1b.

For this estimation exercise, the remaining model parameters are calibrated to reflect the Norwegian economy. Specifically, we set the real interest rate to 2 percent annually and the unemployment rate to 4.4 percent, in line with Aursland, Frankovic, Kanik, and Saxegaard (2020). The quarterly probability to survive is calibrated to $1 - 1/160$, reflecting an expected working life of 40 years. Aggregate productivity growth is set to 1 percent annually, following Kravik and Mimir (2019). The unemployment net replacement rate is calibrated to 60 percent, following OECD (2020). Finally, we set

[10] Data from the Norwegian tax registry contains information on liquid assets, but not liquid debt. Only total debt is reported – which is mainly mortgage debt. Therefore, we cannot construct liquid wealth as Kaplan and Violante (2014) can for the U.S.



(a) Share of lottery win spent **(b)** Distribution of liquid wealth

Figure 1 Targets and model moments from the estimation

Note: Panel (a) shows the fit of the model to the dynamic consumption response estimated in Fagereng, Holm, and Natvik (2021); see their figure A5. Panel (b) shows the fit of the model to the distribution of liquid wealth (see Section 3.2 for the definition) from the 2004 SCF.

the real interest rate on liquid debt to 13.6 percent, following data from the Norwegian debt registry Gjeldsregistret (2022).[11]

Estimates of the standard deviations of the permanent and transitory shocks are taken from Crawley, Holm, and Tretvoll (2022), who estimate an income process on administrative data for Norwegian males from 1971 to 2014. The estimated annual variances for the permanent and transitory shocks are 0.004 and 0.033, respectively.[12] As in Carroll, Crawley, Slacalek, Tokuoka, and White (2020), these are converted to quarterly values by multiplying the permanent and transitory shock variances by 1/4 and 4, respectively. Thus, we obtain quarterly standard deviations of $\sigma_\psi = 0.0316$ and $\sigma_\xi = 0.363$.

Using the calibrated model, we simulated unexpected lottery winnings and calculate the share of the lottery spent in each year. Specifically, each simulated agent receives a lottery win in a random quarter of the first year of the simulation. The size of the lottery win is itself random and spans the range of lottery sizes found in Fagereng, Holm, and Natvik (2021). The estimation procedure minimizes the distance between the target and model moments by selecting the splurge factor and the distribution of discount factors in the population, where the latter are assumed to be uniformly distributed in the range

[11] Specifically, we determine the average volume-weighted interest rate on liquid debt, which consists of consumer loans, credit and payment card debt and all other unsecured debt. We use data from December 2019. Note that although these data let us pin down aggregate quantities, they do not solve the issue referred to in footnote 10, since we cannot link them to the tax registry at the individual level. We set the borrowing limit on liquid debt to zero.

[12] As shown in Crawley, Holm, and Tretvoll (2022), an income process of the form that we use here is more accurately estimated using moments in levels not differences. Hence, we take the numbers from column 3 of their table 4.

$[\beta - \nabla, \beta + \nabla]$. We approximate the uniform distribution of discount factors with a discrete approximation and let the population consist of eight different types.

The estimation yields a splurge factor of 0.249 and a distribution of discount factors described by $\beta = 0.968$ and $\nabla = 0.0578$. Given these estimated parameters and the remaining calibrated ones, the model is able to replicate the time path of consumption in response to a lottery win from Fagereng, Holm, and Natvik (2021) and the targeted distribution of liquid wealth very well (see the solid, blue line in figure 1).

The splurge is essential in matching the empirical evidence mentioned above. If we impose a zero splurge in our estimation, the model is not able to account for the exact empirical profiles. In order to generate a high initial marginal propensity to consume, the estimation yields a very wide distribution of discount factors ($\beta = 0.921$ and $\nabla = 0.116$). This ensures that sufficient agents are at the liquidity constraint and sensitive to transitory income shocks to generate a high initial MPC in absence of the splurge. However, the large differences in discount factor lead to a strongly unequal distribution of liquid wealth, exceeding that observed in data. The model without the splurge also misses the time profile of the marginal propensity to consume and the distribution of initial consumption responses across wealth quartiles. Specifically, the model cannot account for the high initial MPC among the wealthiest. To compensate for that, the estimation yields more liquidity-constrained agents, and thus a higher MPC among the least wealthy. This in turn leads also to a higher spending propensity in the first year after the shock as liquidity-constrained agents spend the additional income quicker. Overall, the model fit with the data deteriorates roughly by a factor of two measured by the Euclidean norm of the targeting error.[13]

The shortcomings of the model without a splurge are likely to affect the derived policy recommendations, for two reasons. First, if multipliers are larger during recessions and the recession length is stochastic, the exact timing of induced consumption matters for the policies' overall effectiveness. A recession-dependent multiplier will in particular magnify the already sizeable difference in predicted consumption responses in year 1 and 2 across the models with and without the splurge. Second, the welfare impacts of the policies will depend on how the policies affect consumption responses across the wealth distribution. The model without the splurge predicts - counterfactually - that consumption responses are concentrated among the poorest (that are most likely to be affected by recession-induced unemployment). The model with the splurge can instead accurately capture consumption responses across the wealth distribution.

3.2 Data on permanent income, liquid wealth, and education

Before we move on to the parameterization of the full model, we describe in detail the data that we use to get measures of permanent income, liquid wealth, and the division of households into educational groups in the United States. We use data on the distribution of liquid wealth from the 2004 wave of the SCF. We restrict our attention to households

[13]Specifically, the Euclidean norm of the targeting error increases from 0.04 to 0.08 for the time-profile of the marginal propensity to consume when the splurge is removed, from 0.16 to 0.29 for the marginal propensity to consume across wealth quartiles and from 0.027 to 0.032 for the Lorentz curve.

where the head is of working age, which we define to be in the range from 25 to 62. The SCF-variable "normal annual income" is our measure of the household's permanent income, and, to exclude outliers, we drop the observations that make up the bottom 5 percent of the distribution of this variable. The smallest value of permanent income for households in our sample is thus $16,708.

Liquid wealth is defined as in Kaplan and Violante (2014) and consists of cash, money market, checking, savings, and call accounts; directly held mutual funds; and stocks and bonds. We subtract off liquid debt, which is the revolving debt on credit card balances. Note that the SCF does not contain information on cash holdings, so these are imputed with the procedure described in Appendix B.1 of Kaplan and Violante (2014), which also describes the credit card balances that are considered part of liquid debt. We drop any households that have negative liquid wealth.

Households are classified into three educational groups. The first group, "Dropout," applies to households where the head of household has not obtained a high school diploma; the second group, "Highschool," includes heads of households who have a high school diploma and those who, in addition, have some years of college education without obtaining a bachelor's degree; and the third group, "College," consists of heads of households who have obtained a bachelor's degree or higher. With this classification of the education groups, the Dropout group makes up 9.3 percent of the population, the Highschool group 52.7 percent, and the College group 38.0 percent.

With our sample selection criteria, we are left with a sample representing about 61.3 million U.S. households.

3.3 Parameters in the full model

With households classified into the three education groups using the SCF data, we proceed to set the parameters of the model as follows. First, we calibrate a set of parameters that apply to all types of houesholds in the model. Second, we calibrate another set of parameters that are specific to each education group to capture broad differences across these groups. Finally, given the calibrated parameters we estimate discount factor distributions for each education group that allow us to match the distribution of liquid wealth in each group.

The model is a simplified model for households in that we do not take into account heterogeneity across household size or composition. The households are ex-ante heterogeneous in their subjective discount factors as well as their level of education. We classify the education level of the household based on the education of the head of the household, and we typically think of individual characteristics as applying to that person.

A period in the model is one quarter. This choice makes it realistic to consider stimulus policies that are implemented in the same period as a recession starts.

3.3.1 Calibrated parameters

Panel A of table 2, lists parameters that are calibrated equally across all types in the model. Panel B of table 2, lists parameters in the model that are education specific. For completeness, panel C of table 2 summarizes the parameters describing how we model a recession and the three policies we consider as potential responses to a recession.

Preferences, survival and interest rates. All households are assumed to have a coefficient of relative risk aversion equal to $\gamma = 2$. We also assume that all households have the same propensity to splurge out of transitory income gains and set $\varsigma = 0.306$, the value estimated in section 3.1. However, each education group is divided into types that differ in their subjective discount factors. The distributions of discount factors for each education group are estimated to fit the distribution of liquid wealth within that group, and this estimation is described in detail in section 3.3.2. Regardless of type, households face a constant survival probability each quarter. This probability is set to $1 - 1/160$, reflecting an expected working life of 40 years. The real interest rate on households' savings is set to 1 percent per quarter.

Labor market risk while employed. When consumers are born, they receive an initial level of permanent income. This initial value is drawn from a log-normal distribution that depends on the education level the household is born with. For each education group, the parameters of the distribution are determined by the mean and standard deviation of log-permanent income for households in that group where the head of the household is of age 25 in the SCF 2004. For the Dropout group, the mean initial value of quarterly permanent income is \$6,200; for the Highschool group, it is \$11,100; and for the College group, it is \$14,500. The standard deviations of the log-normal distributions for each group are, respectively, 0.32, 0.42, and 0.53.

While households remain employed, their income is subject to both permanent and transitory idiosyncratic shocks. These shocks are distributed equally for the three education groups. The standard deviations of these shocks are taken from Carroll, Crawley, Slacalek, Tokuoka, and White (2020), who set the standard deviations of the transitory and permanent shocks to $\sigma_\xi = 0.346$ and $\sigma_\psi = 0.0548$, respectively.

Permanent income also grows, on average, with a growth rate $\Gamma_{e(i)}$ that depends on the level of education. These average growth rates are based on numbers from Carroll, Crawley, Slacalek, and White (2020), who construct age-dependent expected permanent income growth factors using numbers from Cagetti (2003) and fit the age-dependent numbers to their life-cycle model. We construct the quarterly growth rates of permanent income in our perpetual-youth model by taking the average of the age-dependent growth rates during a household's working life. The average gross quarterly growth rates that we obtain for the three education groups are then $\Gamma_d = 1.0036$, $\Gamma_h = 1.0045$, and $\Gamma_c = 1.0049$.

Unemployment. Consumers also face the risk of becoming unemployed and will then have access to unemployment benefits for a certain period. The parameters describing the unemployment benefits in normal times are based on the work of Rothstein and Valletta (2017), who study the effects on household income of unemployment and of running out of eligibility for benefits. The unemployment benefits replacement rate is thus set to $\rho_b = 0.7$ for all households, and when benefits run out, the unemployment replacement rate without any benefits is set to $\rho_{nb} = 0.5$. These replacement rates are set as a share of the households' permanent income and are based on the initial drop

Panel (A) Parameters that apply to all types		
Parameter	Notation	Value
Risk aversion	γ	2.0
Splurge	ς	0.306
Survival probability, quarterly	$1 - D$	0.994
Risk free interest rate, quarterly (gross)	R	1.01
Standard deviation of transitory shock	σ_ξ	0.346
Standard deviation of permanent shock	σ_ψ	0.0548
Unemployment benefits replacement rate (share of PI)	ρ_b	0.7
Unemployment income w/o benefits (share of PI)	ρ_{nb}	0.5
Avg. duration of unemp. benefits in normal times (quarters)		2
Avg. duration of unemp. spell in normal times (quarters)		1.5
Probability of leaving unemployment	π_{ue}	0.667
Consumption elasticity of aggregate demand effect	κ	0.3

Panel (B) Parameters calibrated for each education group			
	Dropout	Highschool	College
Percent of population	9.3	52.7	38.0
Avg. quarterly PI of "newborn" agent ($1000)	6.2	11.1	14.5
Std. dev. of log(PI) of "newborn" agent	0.32	0.42	0.53
Avg. quarterly gross growth rate of PI (Γ_e)	1.0036	1.0045	1.0049
Unemployment rate in normal times (percent)	8.5	4.4	2.7
Probability of entering unemployment (π^e_{eu}, percent)	6.2	3.1	1.8

Note: The first three rows show numbers from the 2004 SCF. The fourth row are averages of growth rates from Carroll, Crawley, Slacalek, and White (2020). The fifth row are numbers for 2004 from statista.com, and the sixth row are calculated from these unemployment rates.

Panel (C) Parameters describing policy experiments	
Parameter	Value
Change in unemployment rates in a recession	$\times 2$
Expected unemployment spell in a recession	4 quarters
Average length of recession	6 quarters
Size of stimulus check	$1,200
PI threshold for reducing check size	$100,000
PI threshold for not receiving check	$150,000
Extended unemployment benefits	4 quarters
Length of payroll tax cut	8 quarters
Income increase from payroll tax cut	2 percent
Belief (probability) that tax cut is extended	50 percent

Table 2 Panel (A) shows parameters calibrated the same for all types. Panel (B) shows parameters calibrated for each education group. Panel (C) shows the numbers describing how we model a recession and the three policies we consider. "PI" refers to permanent income.

in income upon entering an unemployment spell, presented in figure 3 in Rothstein and Valletta (2017).[14]

The duration of unemployment benefits in normal times is set to two quarters, so that our Markov transition matrix Π has four states. This length of time corresponds to the mean duration of unemployment benefits across U.S. states from 2004 to mid-2008 of 26 weeks, reported by Rothstein and Valletta (2017).

The probability of transitioning out of unemployment is set to match the average duration of an unemployment spell in normal times. In data from the Bureau of Labor Statistics, this average duration was 19.6 weeks or 1.5 quarters in 2004. We do not have data on education-specific duration rates, however, so we set the average duration of unemployment to 1.5 quarters for all households. This implies that the transition probability from unemployment to employment is set to $\pi_{ue} = 2/3$.

The Bureau of Labor Statistics provide data on unemployment rates for different education groups, and we match the average rate in each group in 2004 by setting an education-specific probability of transitioning from employment into unemployment. Note that this calibration strategy is consistent with the results in Mincer (1991) who finds that the main difference between education groups is in the incidence of unemployment, and not its duration.[15] More recent work by Elsby and Hobijn (2010) includes data upto 2009 and echoes Mincer's results.

The average unemployment rate in 2004 was 8.5 percent for the Dropout group, 4.4 percent for the Highschool group, and 2.7 percent for the College group. These values imply that the probabilities of transitioning into unemployment in normal times are $\pi^d_{eu} = 6.2$ percent, $\pi^h_{eu} = 3.1$ percent, and $\pi^c_{eu} = 1.8$ percent, respectively.[16]

Finally, the strength of the aggregate demand effect in recessions is determined by the consumption elasticity of productivity. We follow Krueger, Mitman, and Perri (2016) and set this to $\kappa = 0.3$.

[14] See the lines for their UI exhaustee sample including and excluding UI income. Rothstein and Valletta (2017) also point out that "UI benefits replace about 40 percent of the lost earnings on average" (page 894). For a household with two income earners with equal income, these findings would mean that income drops to 70 percent when one earner becomes unemployed and to 50 percent when benefits run out. In this paper we ignore several of the channels studied by Rothstein and Valletta (2017) such as within household insurance and other social programs that can provide income even after UI benefits have run out.

[15] Mincer (1991) states that "the reduction of the incidence of unemployment [at higher education levels] is found to be far more important than the reduced duration of unemployment in creating the educational differentials in unemployment rates" (page 1).

[16] Also note that the probability of transitioning from employment to unemployment is the probability of a job separation times the conditional probability of unemployment given a job separation. Mincer (1991) reports that both of these are lower for higher education levels. For our calibration, this means that a higher job finding rate *within* the quarter of the job separation for more educated workers translates into a lower probability of transitioning from employment to unemployment during a quarter. In that sense, our calibration is consistent with short-term job-finding rates being higher for more educated workers.

3.3.2 Estimating the discount factor distributions

Discount factor distributions are estimated separately for each education group to match the distribution of liquid wealth for households in that group. To do so, we let each education group consist of types that differ in their subjective discount factor, β. The discount factors within each group $e \in \{d, h, c\}$ are assumed to be uniformly distributed in the range $[\beta_e - \nabla_e, \beta_e + \nabla_e]$. The parameters β_e and ∇_e are chosen for each group separately to match the median liquid-wealth-to-permanent-income ratio and the $20th$, $40th$, $60th$, and $80th$ percentile points of the Lorenz curve for liquid wealth for that group. We approximate the uniform distribution of discount factors with a discrete approximation and let each education group consist of seven different types.

Panel A of table 3 shows the estimated values of (β_e, ∇_e) for each education group. The panel also shows the minimum and maximum values of the discount factors we actually use in the model when we use a discrete approximation with seven values to approximate the uniform distribution of discount factors. Panel B of table 3 shows that with these estimated distributions, we can exactly match the median liquid-wealth-to-permanent-income ratios for each education group. Figure 2 shows that with the estimated distributions, the model quite closely matches the distribution of liquid wealth within each education group as well as for the population as a whole. Our model does not suffer from the "missing middle" problem, identified in Kaplan and Violante (2022), in which the middle of the wealth distribution has too little wealth. Our model avoids this problem for two reasons: (1) The splurge pushes up MPCs relative to wealth, and (2) we calibrate to liquid wealth rather than total wealth.

One point we should note concerns the estimated discount factor distribution for the Highschool group, however. Panel A of table 3 reports values of $\beta_h = 0.924$ and $\nabla_h = 0.137$. With these values, the largest discount factors in our discrete approximation of the uniform distribution in the range $[\beta_h - \nabla_h, \beta_h + \nabla_h]$ would be greater than 1. More importantly, the value would violate the Growth Impatience Condition (GIC), discussed in Carroll (2022). (The GIC is required to prevent the ratio of total wealth to total income of any group from approaching infinity. It does this by making sure that the growth of wealth of the group is less than or equal to the growth of income). We replace values violating the GIC with values close to the upper bound on β imposed by the GIC. In panel A of table 3 the largest value is marked by a $*$ to indicate that it has been replaced to avoid violating the GIC. We always impose that the GIC is satisfied in the estimation of the discount factor distributions, but for the baseline parameter values it is only binding for the Highschool group. Thus, the estimation can select a large value of ∇_h without violating the constraint.[17]

Also, note that several of the types in the Dropout group have very low discount factors and are very impatient. In this way, the model fits the feature of the data for the Dropout group that the bottom quintiles do not save at all and do not accumulate any

[17]The constraint is imposed by calculating a discount factor β^{GIC} where the GIC holds with equality. Then the estimation can pick how close to this value the largest discount factor is by estimating x and setting the largest discount factor to $\exp(x)/(1 + \exp(x))\beta^{\text{GIC}}$.

Panel (A) Estimated discount factor distributions

	Dropout	Highschool	College
(β_e, ∇_e)	(0.735, 0.298)	(0.924, 0.137)	(0.984,0.010)
(Min, max) in approximation	(0.480, 0.991)	(0.806, 0.989*)	(0.976, 0.992)

Panel (B) Estimation targets

	Dropout	Highschool	College
Median LW/ quarterly PI (data, percent)	4.64	30.2	112.8
Median LW/ quarterly PI (model, percent)	4.64	30.2	112.8

Panel (C) Non-targeted moments

	Dropout	Highschool	College	Population
Percent of total wealth (data)	0.8	17.9	81.2	100
Percent of total wealth (model)	1.1	21.9	77.0	100
Avg. annual MPC (model, incl. splurge)	0.87	0.71	0.48	0.64

Table 3 Estimated discount factor distributions, estimation targets, and non-targeted moments

Note: Panel (A) shows the estimated parameters of the discount distributions for each education group. It also shows the minimum and maximum values we use in our discrete approximation to the uniform distribution of discount factors for each group. The $*$ indicates that the highest value in the uniform distribution of discount factor values violates the growth impatience condition (GIC) and has been replaced. Panel (B) shows the weighted median ratio of liquid wealth to permanent income from the 2004 SCF and in the model. In the annual data from the SCF, the annual PI is divided by 4 to obtain a quarterly number. Panel (C) shows percent of total wealth held by each education group in the 2004 SCF and in the model. It also shows the average annual MPCs calculated for each individual from the splurge and the quarterly MPCs, and then averaged by education group.

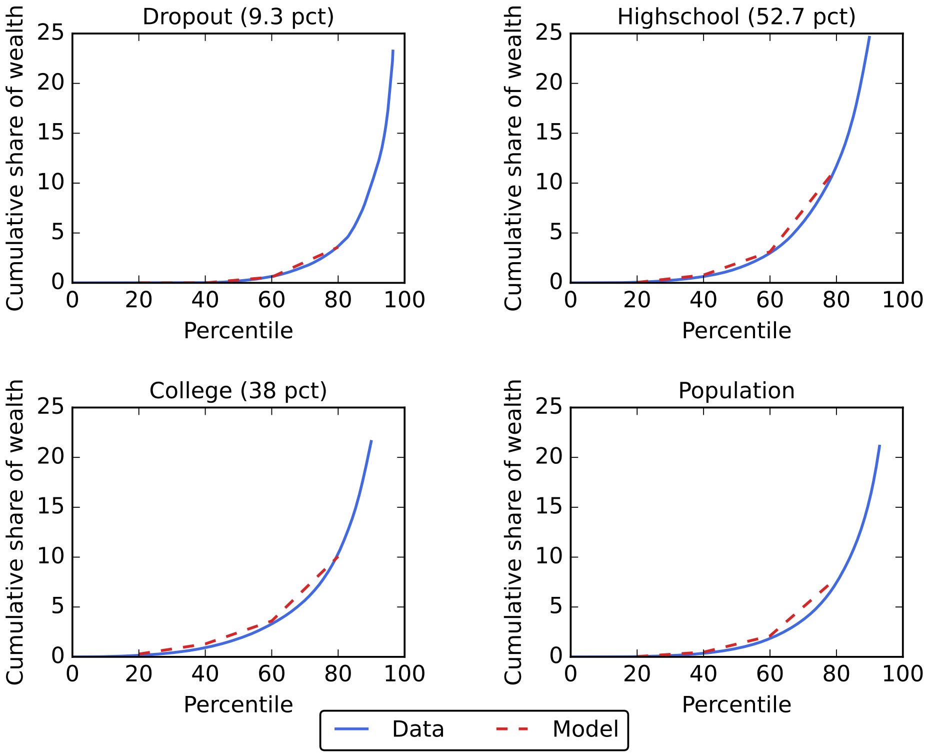


Figure 2 Distributions of liquid wealth within each educational group and for the whole population from the 2004 Survey of Consumer Finances and from the estimated model

liquid wealth. Very low estimates for discount factors are in line with those obtained in the literature on payday lending.[18]

Finally, panel C of table 3 shows the wealth distribution across the three education groups in the data and in the model. The model matches these shares quite closely, which may not be surprising given that we calibrate the size of each group and we manage to fit the wealth distribution within each group separately. The panel also reports the average marginal propensity to consume within a year after an income shock for each education group. This measure of the annual MPC takes into account the initial splurge factor when an income shock is first received, as well as the decisions to consume out of additional income over four quarters after the shock. The average annual MPC for

[18]See, for example, Skiba and Tobacman (2008), who estimate two-week discount rates of 21 percent, and Allcott, Kim, Taubinsky, and Zinman (2021), who estimate an initial period discount factor between 0.74 and 0.83 in a model where a period is eight weeks long. Both of these papers use quasi-hyperbolic preferences, so the estimates are not directly comparable with parameters in our model. Nevertheless, they support the point that very high discount rates are necessary to model the part of the population that takes out payday loans at very high interest rates.

the population as a whole is 0.64 in the model, which is slightly higher than the 0.63 estimated for Norway by Fagereng, Holm, and Natvik (2021).

4 Comparing fiscal stimulus policies

In this section, we present our results where we compare three policies to provide fiscal stimulus in our calibrated model. The policies we compare are a means-tested stimulus check, an extension of unemployment benefits, and a payroll tax cut. Each policy is implemented at the start of a recession, and we compare results both with and without aggregate demand effects being active during the recession. First, we present impulse responses of aggregate income and consumption after the implementation of each policy. Then we compare the policies in terms of their cumulative multipliers and in terms of their effect on a welfare measure that we introduce. Finally, based on these comparisons, we can rank the three policies.

4.1 Impulse responses

The impulse responses that we present for each stimulus policy are constructed as follows:

- A recession hits in quarter one.
- We compute the subsequent path for the economy without any policy introduced in response to the recession.
- We also compute the subsequent path for the economy with a given policy introduced at the onset of the recession in quarter one.
- The impulse responses we present are then the *difference* between these two paths for the economy and show the effect of a policy relative to a case where no policy was implemented.
- The solid lines show these impulse responses for an economy where the aggregate demand effects described in section 2.3 are not active, and the dashed lines show impulse responses for an economy where the aggregate demand effects are active during the recession.
- Red lines refer to aggregate labor and transfer income, and blue lines refer to consumption.

Note that all graphs show the average response of income and consumption for recessions of different length. Specifically, we simulate recessions lasting from only one quarter up to 20 quarters. We then take the sum of the results across all recession lengths weighted by the probability of this recession length occurring (given our assumption of an average recession length of six quarters).

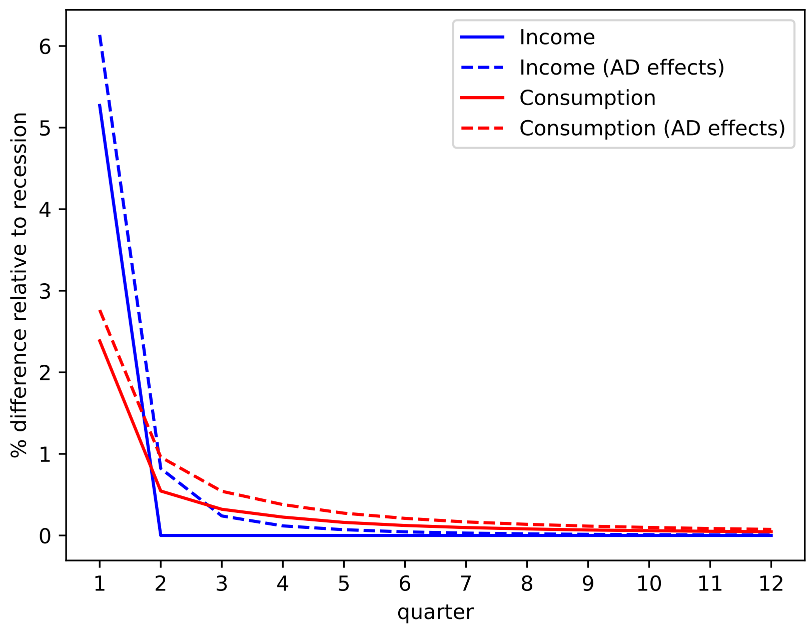


Figure 3 Impulse responses of aggregate income and consumption to a **stimulus check** during recessions with and without aggregate demand effects

4.1.1 Stimulus check

Figure 3 shows the impulse response of income and consumption when stimulus checks are issued in the first quarter of a recession. In the model without a multiplier, the stimulus checks account for 5.5 percent of the first quarter's income. In the following quarters, there are no further stimulus payments, and income remains the same as it would have been without the stimulus check policy. Consumption is about 3 percent higher in the first quarter, which includes the splurge response to the stimulus check. Consumption then drops to less than 1 percent above the counterfactual, and the remainder of the stimulus check money is then spent over the next few years. In the model with aggregate demand effects, income in the first quarter is 6.5 percent higher than the counterfactual, as the extra spending feeds into higher incomes. Consumption in this model jumps to a higher level than without aggregate demand effects and comes down more slowly as the feedback effects from consumption to income damp the speed with which income—and hence the splurge—return to zero. After a couple of years, when the recession is most likely over and aggregate demand effects are no longer in place, income is close to where it would be without the stimulus check policy, although consumption remains somewhat elevated.

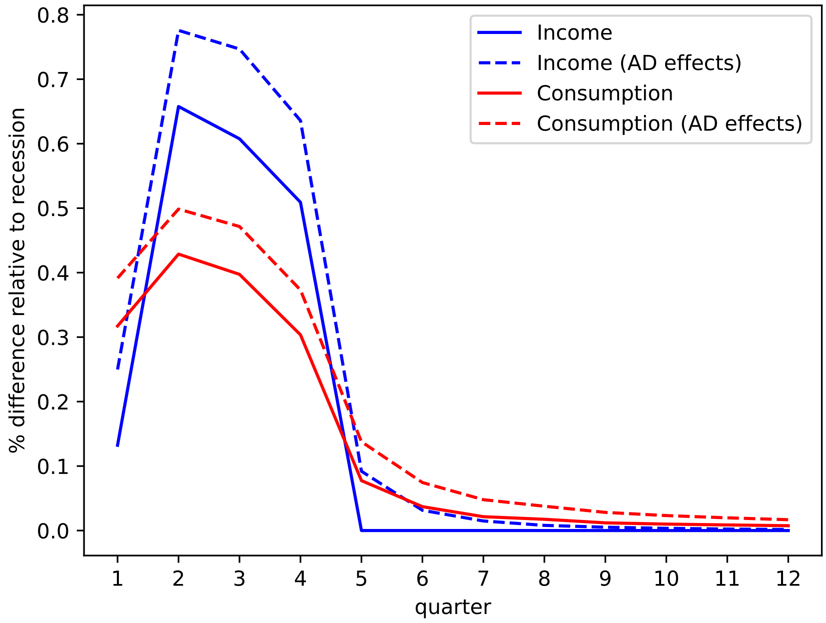


Figure 4 Impulse responses of aggregate income and consumption to a **UI extension** during recessions with and without aggregate demand effects

4.1.2 UI extension

The impulse responses in figure 4 show the response to a policy that extends unemployment benefits from 6 months to 12 months for a period of a year. In the model without aggregate demand effects, the path for income now depends on the number of consumers who receive the extended unemployment benefits. These consumers are those who have been unemployed for between 6 and 12 months. In the first quarter of the recession, the newly unemployed receive unemployment benefits regardless of whether they are extended or not. Therefore, it is in the second and third quarters, when the effects of the recession on long-term unemployment start to materialize, that the extended UI payments ramp up, amounting to an aggregate increase in quarterly income by 0.7 percent. By the fifth quarter, the policy is no longer in effect, and income from extended unemployment goes to zero. Consumption in the first quarter jumps by more than income (by 0.3 percent), prompted by both the increase in expected income and the reduced need for precautionary saving given the extended insurance. In the model without aggregate demand effects, consumption is only a little above the counterfactual by the time the policy is over. In the model with aggregate demand effects, there is an extra boost to income of about the same size in the first and second quarters. As this extra aggregate demand induced income goes to employed consumers, more of it is saved, and consumption remains elevated several quarters beyond the end of the policy.

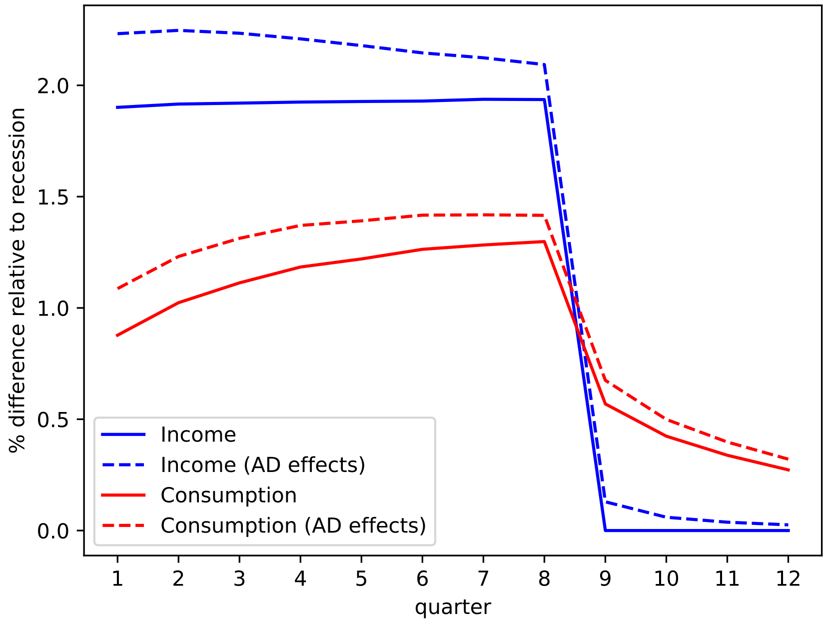


Figure 5 Impulse responses of aggregate income and consumption to a **payroll tax cut** lasting eight quarters during recessions with and without aggregate demand effects

4.1.3 Payroll tax cut

The final impulse response graph, figure 5, shows the impulse response for a payroll tax cut that persists for two years (eight quarters). In the model without aggregate demand effects, income rises by close to 2 percent as the take-home pay for employed consumers goes up. After the two-year period, income drops back to where it would have been without the payroll tax cut. Consumption jumps close to 1.3 percent in response to the tax cut. Over the period in which the tax cut is in effect, consumption rises somewhat as the stock of precautionary savings goes up, before declining in anticipation of the drop in income at the two-year mark. Following the drop in income, consumption drops sharply because of the splurge and then decreases over time as consumers spend out the savings they built up over the period the tax cut was in effect. In the model with aggregate demand effects, income rises by about 2.5 percent above the counterfactual and then declines steadily as the probability that the recession remains active—and hence the aggregate demand effects in place—goes down over time.[19] In response to the now declining expected path for income over the two years during which the tax cut remains in place, consumption also declines, albeit at a slightly slower pace. Following

[19]Again, consumption tends to first rise because of the build-up of precautionary savings, before falling again as the probability that the recession remains in place declines. This hump-shaped pattern feeds through to income, explaining the upward trend in income during the first two quarters.

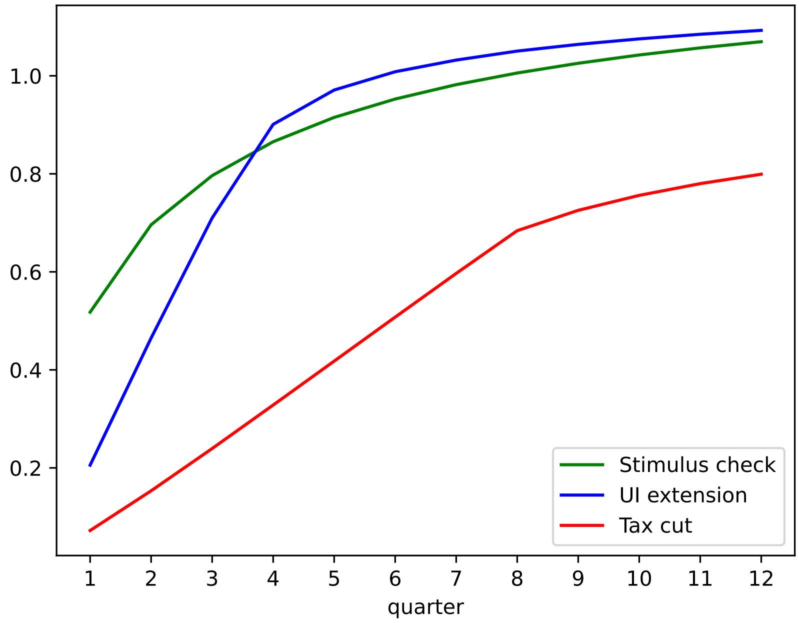


Figure 6 Cumulative multiplier as a function of the horizon for the three policies. Note: Policies are implemented during a recession with AD effect active.

the end of the policy, the savings stock in the model with aggregate demand effects is high, and consumption remains significantly elevated through the period shown.

4.2 Multipliers

In this section, we compare the fiscal multipliers across the three stimulus policies. Specifically, we employ the cumulative multiplier, which captures the ratio between the net present value (NPV) of stimulated consumption up to horizon t and the full-horizon NPV of the cost of the policy. We thus define the cumulative multiplier up to horizon t as

$$M(t) = \frac{NPV(t, \Delta C)}{NPV(\infty, \Delta G)},$$

where ΔC is the additional aggregate consumption spending up to time t in the policy scenario relative to the baseline and ΔG is the total government expenditure caused by the policy. The NPV of a variable X_t is given by $NPV(t, X) = \sum_{s=0}^{t} \left(\prod_{i=1}^{s} \frac{1}{R_i} \right) X_s$.

Figure 6 plots the cumulative multipliers at different horizons, and table 4 shows the 10y-horizon multiplier for each policy. The stimulus check, which is paid out in quarter one, exhibits the largest multiplier on impact. About 60 percent of the total policy expenditure is immediately spent by consumers. After one year, and because of the aggregate demand effects, consumption has increased cumulatively by more than the

	Stimulus check	UI extension	Tax cut
10y-horizon Multiplier (no AD effect)	0.854	0.893	0.826
10y-horizon Multiplier (AD effect)	1.199	1.175	0.952
10y-horizon (1st round AD effect only)	1.125	1.119	0.926
Share of policy expenditure during recession	100.0%	79.6%	57.8 %

Table 4 Multipliers as well as the share of the policy occurring during the recession

cost of the stimulus check. Over time, the policy reaches a total multiplier of 1.245. Without AD effects the policy only generates a multiplier of 0.872.

The multiplier is slightly lower for the UI extension policy than the stimulus check over most horizons. Since spending for the UI policy is spread out over four quarters (and peaks in quarters two to three), the multiplier in the first quarter is considerably lower than in the case of the stimulus check. The UI extension policy is targeted in the sense that it provides additional income to only those consumers, who, because of unemployment, have large MPCs. However, it is slow to roll out, and some of the spending occurs at later quarters, when the recession might have ended. Overall, around 80 percent of the policy expenditure occurs during the recession. In contrast, the stimulus check is paid out fully during the first quarter, when, by construction, the recession occurs with certainty. Therefore, the aggregate demand effects are particularly potent for the stimulus check policy despite being less targeted and providing stimulus also to agents with low MPCs relative to the extended UI policy.

The payroll tax cut has the lowest multiplier irrespective of the considered horizon. A multiplier of 1 is reached only after 10 years with AD effects. These relatively small numbers reflect that policy spending lasts for a long time and is thus more likely to occur after the recession has ended. Moreover, only employed consumers, often with relatively low MPCs, benefit directly from the payroll tax cut. Therefore, the policy is poorly targeted if the goal is to provide short-term stimulus.

Table 4 contains an additional (middle) row. To understand these values note that the policies initially increase the income of consumers directly, which leads to a boost in consumption. As a consequence, this boost triggers an aggregate demand effect which increases the income of everyone and in turn leads to an additional boost to consumption. We refer to the sum of this initial and the indirect boost to consumption as the first-round AD effect. However, the AD effect continues as the indirect boost to consumption triggers another round of income increases which further boost consumption and so on. One might argue that these higher-order rounds of the AD effect are not likely to be anticipated by consumers. Since higher-order consumption boosts only materialize if consumers anticipate them and act accordingly, the overall increase in consumption might turn out to be smaller than suggested by the full AD effect. The middle row of the table shows the multipliers that result in the special case where we only consider the first-round AD effect. As expected, the multipliers are smaller when excluding higher-order rounds. Nevertheless, the ranking of the policies remain unchanged.

4.3 Welfare

In this section, we look at the welfare implications of each stimulus policy. To do so, we need a way to aggregate welfare in our model with individual utility functions. Our approach to constructing a welfare measure is based on three principles:

1. The felicity of each consumer at any moment in time is valued equally by the social planner. However, the planner has a personal discount rate, which may not coincide with that of any consumer in the model.

2. There is no social benefit or cost to implementing any of the policies outside of a recession.

3. Utility is gained from splurge spending in the same way as other spending.

The first of these principles would suggest that a simple aggregation of consumers' utilities, discounted at the social planner's discount rate, is appropriate. However, this simple aggregation would give the social planner a large incentive to redistribute income from high- to low-consumption households, even during normal times, which runs against the second principle. Instead, we use the aggregated utility function as a building block. Let $\mathcal{W}(\text{policy}, Rec, AD)$ be the aggregated utility function:

$$\mathcal{W}(\text{policy}, Rec, AD) = \frac{1}{N}\sum_{i=1}^{N}\sum_{t=0}^{\infty}\beta_S^t u(\mathbf{c}_{it,\text{policy},Rec,AD}), \tag{9}$$

where policy $\in$ {None, Stimulus Check, UI extension, Payroll Tax Cut} is the stimulus policy followed, $Rec \in \{1,0\}$ is an indicator for whether the policy coincides with the start of a recession or is implemented in nonrecessionary times, and $AD \in \{1,0\}$ is an indicator for whether the aggregate demand effects are active during the recession. $\mathbf{c}_{it,\text{policy},Rec,AD}$ are the consumption paths (including the splurge) for each consumer i in each scenario. β_S is the social planner's discount factor that we will set equal to the inverse of the real interest rate R. N is the number of consumers simulated.

We use the steady-state baseline as a way to convert from welfare units to consumption units. Using this baseline, we define the marginal increase in welfare that occurs when every consumer increases consumption proportionally to baseline consumption as the following[20]

$$\mathcal{W}^c = \frac{1}{N}\sum_{i=1}^{N}\sum_{t=0}^{\infty}\beta_S^t \mathbf{c}_{it,\text{None},0,0}u'(\mathbf{c}_{it,\text{None},0,0}). \tag{10}$$

With this definition, we consider, in steady-state consumption units $\mathcal{W}^c$, the increase in welfare induced by a policy: $\frac{\mathcal{W}(\text{policy},Rec,AD)-\mathcal{W}(\text{None},Rec,AD)}{\mathcal{W}^c}$. However, this welfare increase

[20] Note that with log utility, $\mathcal{W}^c = \frac{1}{N}\sum_{i=1}^{N}\sum_{t=0}^{\infty}\beta_S^t = \frac{1}{1-\beta_S}$

ignores the cost of the policy to the government, $PV(\text{policy}, Rec)$.[21] We therefore subtract the fiscal cost of each policy in steady-state consumption units: $\frac{PV(\text{policy},Rec)}{P^c}$, where P^c, the marginal cost of increasing every consumer's steady-state consumption proportionally, is given by

$$\mathcal{P}^c = \frac{1}{N} \sum_{i=1}^{N} \sum_{t=0}^{\infty} R^{-t} \mathbf{c}_{it,\text{None},0,0}. \tag{11}$$

Finally, we normalize the welfare benefit by subtracting the welfare effect of the policy in non-recessionary times. This normalization can be thought to encompass both the preferences of society not to redistribute and the negative incentive effects of redistribution in normal times. Our final welfare measure, expressed in units of steady-state consumption, is

$$\begin{aligned}\mathcal{C}(\text{policy}, Rec, AD) = &\left(\frac{\mathcal{W}(\text{policy}, Rec, AD) - \mathcal{W}(\text{None}, Rec, AD)}{\mathcal{W}^c} - \frac{PV(\text{policy}, Rec)}{\mathcal{P}^c} \right) \\ &- \left(\frac{\mathcal{W}(\text{policy}, 0, 0) - \mathcal{W}(\text{None}, 0, 0)}{\mathcal{W}^c} - \frac{PV(\text{policy}, 0)}{\mathcal{P}^c} \right). \end{aligned} \tag{12}$$

Table 5 shows the welfare benefits of each policy as defined by equation (12). The stimulus check and payroll tax cut policies have been adjusted to be the same fiscal size (in the absence of a recession) as the UI extension.[22] The table shows consumption-equivalent welfare gains in basis points, which are to be interpreted as follows. A welfare gain of x implies that the social planner is indifferent between the stimulus policy being implemented in response to a recession and a permanent increase in the baseline consumption of the total population by x basis points (that is a one-hundredth of 1 percent of the baseline consumption). We will, however, first discuss the relative differences across the policies and then discuss the magnitude of the welfare effects.

Without aggregate demand effects (the first row of the table), the payroll tax cut has extremely limited welfare benefits compared with the other policies. The reason is that the payroll tax cut goes to consumers who remain employed, and therefore it does not directly affect the unemployed consumers who are the most hit by the recession. However, employed consumers do reduce their consumption at the onset of the recession because of the increased unemployment risk, so the tax cut helps them more than in nonrecessionary times. Similarly, the stimulus check has limited benefits relative to the UI policy, as it mostly goes to employed consumers, although it has the benefit

[21]For the stimulus check and extended UI, the payments made by the government are clearly defined and do not depend on aggregate demand effects. For the payroll tax cut, we define the payments as the difference between the take-home pay with and without the tax cut, but ignoring any aggregate demand effects. Aggregate demand effects would increase the value of the tax cut because incomes would rise, but, in fact, the effects increase rather than decrease the tax receipts of the government.

[22]Specifically, we reduce the size of the stimulus check from \$1200 to \$80 per person, while the payroll tax cut is reduced from a 2 pp to a 0.05 pp cut. We have verified that the multiplier for check stimulus and the tax cut is only marginally changed by the downscaling.

over the payroll tax cut of also reaching those made unemployed and those who remain unemployed because of the recession. The extended UI policy is the clear "bang for the buck" winner, as the extended UI payments are well targeted to the households who are particularly severely hit by the recession, giving rise to large welfare improvements relative to pursuing the policy in normal times.

The second row of the table shows the welfare benefits in the version of the model with aggregate demand effects during the recession. The payroll tax cut now has a noticeable benefit, as some of the tax cut gets spent during the recession, resulting in higher incomes for all consumers. However, the tax cut is received over a period of two years, and much of the relief may be after the recession—and hence the aggregate demand effect—is over. Furthermore, because the payroll tax cut goes only to employed consumers who have relatively lower MPCs, the spending out of this stimulus will be further delayed, possibly beyond the period of the recession. By contrast, the stimulus check is received in the first period of the recession and goes to both employed and unemployed consumers. The earlier arrival and higher MPCs of the stimulus check recipients mean more of the stimulus is spent during the recession, leading to greater aggregate demand effects, higher income, and higher welfare. The extended UI arrives, on average, slightly later than the stimulus check. However, the recipients, who have been unemployed for at least six months, spend the extra benefits relatively quickly, resulting in significant aggregate demand effects during the recession. In contrast to the payroll tax cut, extended UI has the benefit of automatically reducing if the recession ends early, making fewer consumers eligible for the benefit.

The welfare effects for the UI extension are largest compared with other stimulus policies when those policies are scaled down to match the total expenditure size of the UI extension policy. Nevertheless, the welfare effect of the UI extension is relatively modest, amounting to only 1.101 basis points of baseline consumption. However, while the UI extension policy cannot be easily scaled to a larger size, scaling is certainly possible for the stimulus check. If we consider a \$1,200 stimulus check rather than the \$80 check underlying the calculations in table 5, we obtain—using a simple back-of-the-envelope calculation—a welfare gain equivalent to $0.151 \times \frac{1200}{80} = 2.3$ basis points of baseline consumption. If we then assume that the average consumer experiences recessions five times during a lifetime, the welfare gain of this policy being implemented during recessions is $2.3 \times 5 = 11.5$ basis points, which is larger than the welfare cost estimated in Lucas (1987) for business cycle fluctuations.

	Stimulus check	UI extension	Tax cut
$\mathcal{C}(Rec, \text{policy})$	0.011	0.509	0.002
$\mathcal{C}(Rec, AD, \text{policy})$	0.151	1.101	0.056

Table 5 Consumption-equivalent welfare gains in basis points, calculated for policies implemented in a recession with and without aggregate demand effects

4.4 Comparing the policies

The results presented in sections 4.2 and 4.3 indicate that the extension of unemployment benefits is the clear "bang for the buck" winner. The extended UI payments are well targeted to consumers with high MPCs and high marginal utility, giving rise to large multipliers and welfare improvements. The stimulus checks come in slightly higher when measured by their multiplier effect but are a distant second when measured by their welfare effects. The stimulus checks have large multipliers because the money gets to consumers at the beginning of the recession and is therefore most likely to be spent during the recession when spending passes through to productivity. However, the checks are not well targeted to high-MPC consumers, so even though the funds arrive early in the recession, they are spent out more slowly than the extended unemployment benefits. Furthermore, the average recipient of a stimulus check has a much lower marginal utility than consumers receiving unemployment benefits, so the welfare benefits of this policy are substantially muted relative to UI extensions.

The payroll tax cut policy does poorly by both measures: It has a low overall multiplier and negligible welfare benefits. The reasons are that the funds are slow to arrive, so the subsequent spending often occurs after the end of the recession, and that the payments are particularly badly targeted—they go only to employed consumers.

While it is clear from the analysis that the extended unemployment benefits should be the first tool to use, a disadvantage of them is that they are limited in their size. If a larger fiscal stimulus is deemed appropriate, then stimulus checks provide an alternative option that will stimulate spending during the recession even if the welfare benefits are substantially lower than the UI extension.

4.5 Comparing the policies in model without the splurge

- Figure 7 shows the cumulative multipliers over time when AD effects are switched on for the model with and without the splurge. Table 6 shows the 10y-horizon multiplier across the two models.

- The absence of the splurge entails a calibration with more agents near the liquidity constraint. Nevertheless, the average MPC is lower in the model without the splurge. [Is this right Håkon?] Hence, the check and tax cut exhibit lower multipliers when there is no splurge.

- For the UI extension we observe the opposite pattern, as the multiplier is larger in the model without the splurge.
  - When agents receive the UI extension, they have already spent two quarters with diminished incomes. In the calibration without the splurge, this pushes more agents to the liqudity constraint as the number of agents close to the liquidity constraint is higher compared to the model with the splurge.
  - This can be seen in figure 8, which plots the evolution of income, consumption and share of agents at the borrowing limit among those that stay unemployed

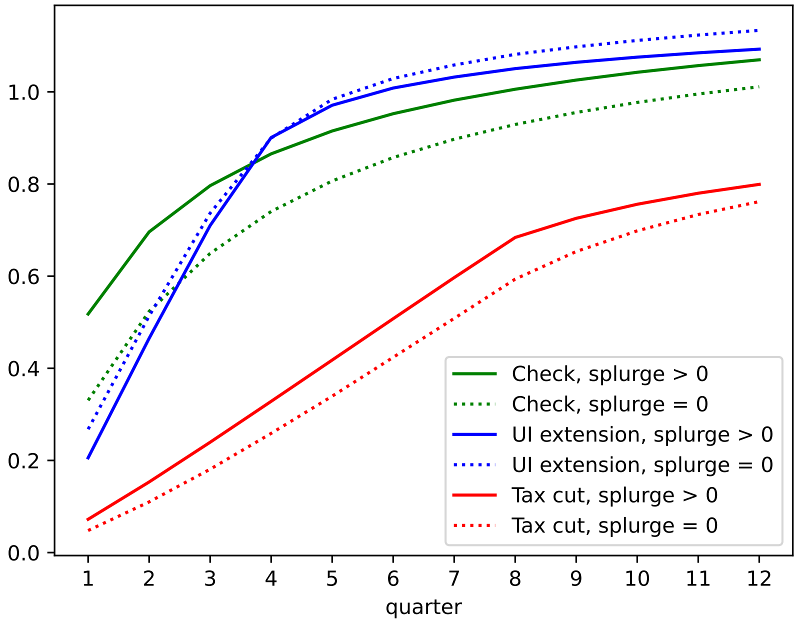


Figure 7 Cumulative multiplier as a function of the horizon for the three policies with and without the splurge. Note: Policies are implemented during a recession with AD effect active.

for at least five quarters. In this simulation, there is no recession and none of the fiscal policies are implemented. Agents becoming unemployed receive UI payments equal to 70% of their permanent income. In the third quarter, they lose UI eligibility. The number of agents hitting the borrowing constraint in that period disproportionally increases in the model without the splurge. The decline in consumption is, however, similar across the model.

  - Hence, in the model without the splurge the MPC among the UI extension beneficiaries will be high because there are many liquidity-constrained agents, while in the model with the splurge, the splurge itself will lead to high MPCs. Overall, the multipliers for the UI extension policy ends up slightly higher in the absence of the splurge.

- The policy ranking in terms of the multiplier changes: While viewed from the model with the splurge the check policy delivers multiplier effects much more rapidly than the UI extension and has similar implications at longer horizons, the UI extension appears superior to the check in the model without the splurge.

- Table 7 compares the welfare implications of the two models.

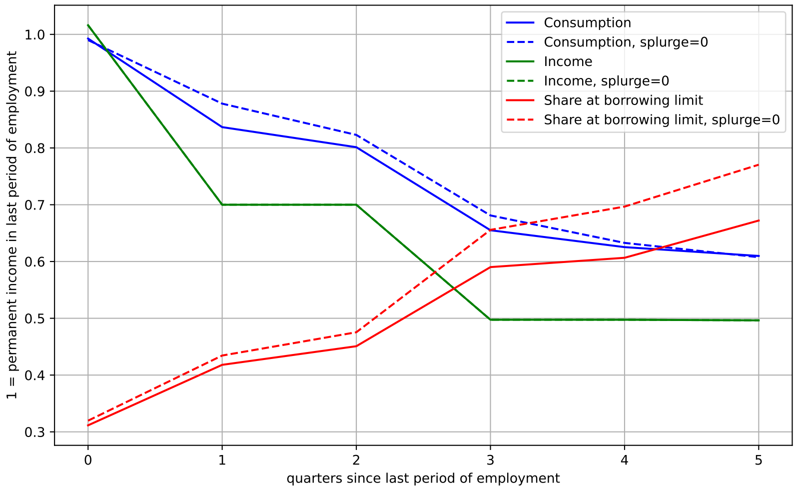


Figure 8 Consumption and income levels for agents staying unemployed for at least five quarters and the share of those agents at the borrowing limit, in the model with and without the splurge. Note: No policy nor the recession are active.

	Stimulus check	UI extension	Tax cut
10y-horizon Multiplier (no AD effect)	0.870(0.854)	0.910(0.893)	0.839(0.826)
10y-horizon Multiplier (AD effect)	1.143(1.199)	1.221(1.175)	0.947(0.952)

Table 6 Multipliers, calculated for policies implemented in a recession with and without aggregate demand effects. The values outside of the brackets capture the multipliers in the model without the splurge, while those inside the brackets are mulitiplier with the splurge.

	Stimulus check	UI extension	Tax cut
$\mathcal{W}(\text{policy}, Rec = 0, AD = 0)$	0.97(0.96)	0.84(0.85)	0.99(0.99)
$\mathcal{W}(\text{policy}, Rec = 1, AD = 0)$	1.00(0.99)	1.80(1.82)	0.97(0.98)
$\mathcal{W}(\text{policy}, Rec = 1, AD = 0)$	1.27(1.34)	2.12(2.11)	1.09(1.10)

Table 7 Welfare measure, calculated for policies implemented both out of and in a recession with and without aggregate demand effects. The values outside of the brackets capture the multipliers in the model without the splurge, while those inside the brackets are mulitiplier with the splurge.

5 Robustness in a General Equilibrium HANK Model

The main results of this paper are presented in a partial equilibrium setup with aggregate demand effects that do not arise from a general equilibrium setup. We think there are many advantages to studying the welfare and multiplier effects in this setting without embedding the model in general equilibrium. First, general equilibrium models often struggle to adequately capture the feedback mechanisms between consumption and income, particularly the asymmetric nature of these relationships during recessionary versus expansionary periods. Additionally, a complete general equilibrium treatment would necessitate the analysis of numerous complex channels including investment dynamics, firm ownership structures and dividend distribution policies, inventory management, and international trade flows—elements that, while important in their own right, would potentially obscure the core mechanisms we aim to investigate.

Despite the advantages of our partial equilibrium approach, here we complement our analysis with a general equilibrium HANK model, as standard as possible, but able to capture supply-side effects that are absent from the partial equilibrium setup. In particular, fiscal policies can generate labor market responses that our partial equilibrium analysis does not address. Employee tax cuts, for instance, may increase employment through changes in workers' incentives. These supply-side channels can affect both the welfare implications and the fiscal multipliers of different policy interventions.

We embed the consumption choices of our households—–with heterogeneity over education type and discount factors—–in a New Keynesian model with search and matching. Aside from the consumption block of the model, the framework closely follows Du (????), with complete details provided in appendix C.[23] The general equilibrium structure generates fiscal multipliers through a Keynesian cross mechanism, which becomes particularly pronounced when monetary policy is passive. Moreover, the search and matching framework allows for a supply-side response to policy interventions, allowing us to capture both demand and supply effects of fiscal policies.

Our approach in this section relies on linearizing the macro dynamics of the model and employs the Sequence Space Jacobian methods developed by Auclert, Bardóczy, Rognlie, and Straub (2021). This linearization imposes certain constraints on our analysis. Notably, we cannot evaluate the effects of different policies starting from a deep recessionary state, as we do in our main results. This limitation prevents us from conducting welfare comparisons between recessionary periods and the steady state. Additionally, the Keynesian cross mechanism embedded in the model exhibits uniform behavior regardless of the degree of economic slack—–a feature that stands in contrast to the state-dependent multipliers we apply in our partial equilibrium analysis****CHRIS - CAN YOU ADD TEXT ABOUT CENTRAL BANKS REACTING LATE, ETC*****.[24]

[23]Du (????) in turn builds off Gornemann, Kuester, and Nakajima (2021) and Auclert, Rognlie, and Straub (2020)

[24]We note two additional technical limitations of our general equilibrium implementation. First, stimulus payments in the model are specified as proportional to permanent income, rather than as means-tested fixed dollar amounts as implemented in practice. Second, we do not include the splurge in consumption.

The consumption response in this general equilibrium model to each of the three policies is shown in figure 9 For each of the three fiscal policies, we have shown the consumption response under three different monetary policy rules: 1) an active Taylor rule with a coefficient of 1.5 on inflation; 2) a fixed nominal rate (simulating a effective lower bound); and 3) a fixed real rate (closest in spirit to our partial equilibrium analysis).

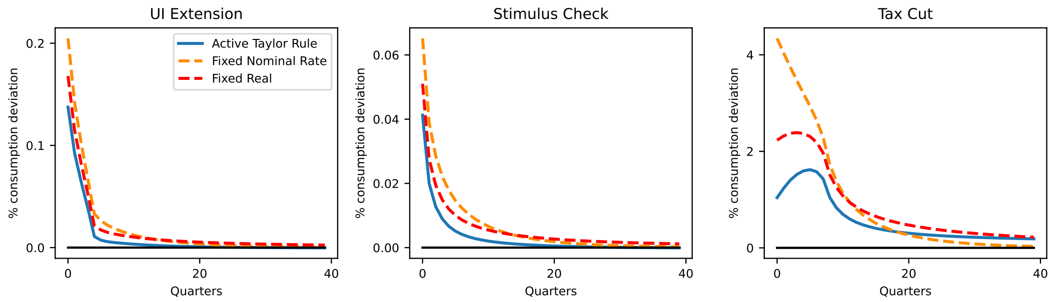


Figure 9 Consumption Impulse Responses to Each Policy in the HANK Model

Overall, the IRFs from this model are similar to those from the partial equilibrium analysis, especially under the fixed real-rate rule.[25] Furthermore, although we are unable to repeat our welfare analysis under a recession in this model, the distributional effects of the policies are similar. Most importantly, the mechanism leading to far greater welfare benefits for the UI extension, namely that the newly unemployed have high marginal utility, are robust to the supply-side effects of a general equilibrium HANK model.

Figure 10 shows the consumption multipliers over different horizons under a fixed real rate rule. This figure can be compared to figure 6 which shows a similar figure in our partial equilibrium analysis. In both versions of the model, the consumption multipliers over time horizons are similar, with the effect of the tax cut substantially smaller than the stimulus check or UI extension policies, despite the inclusion of supply-side effects in this HANK model.

6 Conclusion

For many years leading up to the Great Recession, a widely held view among macroeconomists was that countercyclical policy should be left to central banks, because fiscal policy responses were unpredictable in their timing, their content, and their effects. Nevertheless, even during this period, fiscal policy responses to recessions were repeatedly tried, perhaps because the macroeconomists' advice to policymakers, "don't just do something; stand there"—is not politically tenable.

This paper demonstrates that macroeconomic modeling has finally advanced to the point where we can make reasonably credible assessments of the effects of alternative

[25]Note that the dynamics of the UI extension IRF are somewhat faster acting. This is because, under the recession that we study in the partial equilibrium analysis, the large mass of newly-unemployed households do not start receiving extended UI for six months.

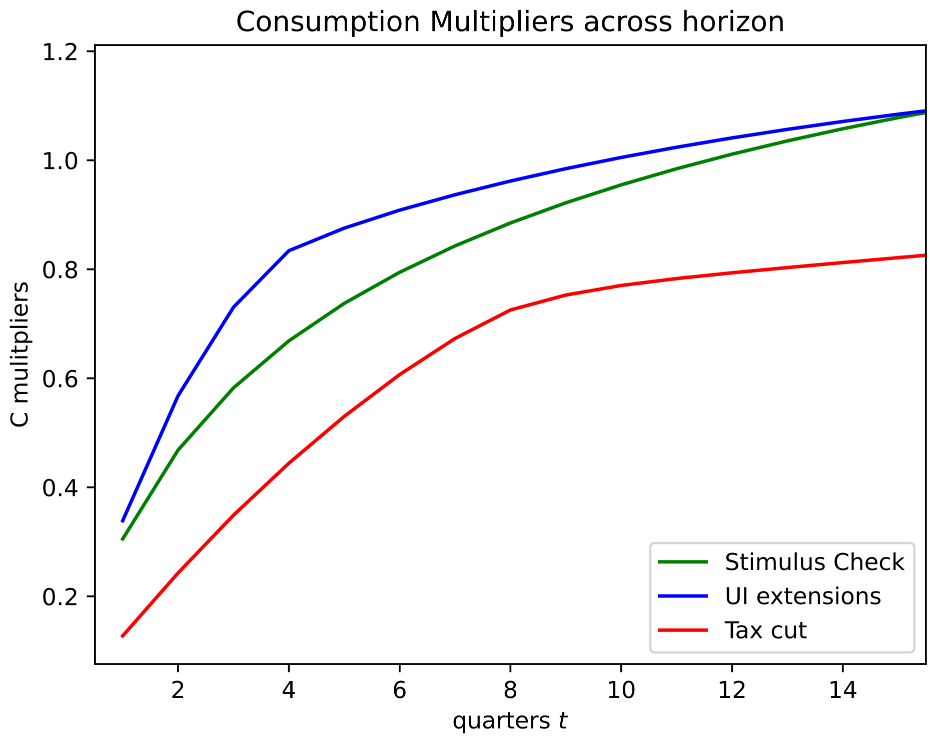


Figure 10 Consumption Multipliers over Different Horizons in the HANK Model

policies of the kinds that have been tried. The key developments have been both the advent of national registry datasets that can measure crucial microeconomic phenomena and the creation of tools of heterogeneous agent macroeconomic modeling that can match those micro facts and glean their macroeconomic implications.

We examine three fiscal policy experiments that have actually been implemented in the past: an extension of UI benefits, a stimulus check, and a tax cut on labor income. Our model suggests that the extension of UI benefits is a clear "bang for the buck" winner. While the stimulus check arrives faster, it is less well targeted to high-MPC households than an extension of UI benefits and therefore has only a mildly greater spending boost while the recession is ongoing (when multipliers are likely to be strongest). By contrast, the welfare gains of extended UI benefits are significantly greater than those of a stimulus check. The chief drawback of the UI extension is that its size is limited by the fact that a relatively small share of the population is affected by it. In contrast, stimulus checks are easily scalable while exhibiting only slightly less recession-period stimulus (in a typical recession). However, since some of the stimulus checks flow to well-off consumers, such checks do worse than UI extensions when we evaluate welfare consequences. Finally, the payroll tax cut is the least effective in terms of both the multiplier and welfare effect, since it targets only employed consumers and, for a typical recession, more of its payouts are likely to occur after the recessionary period (when multipliers may exist) has ended.

The tools we are using could be reasonably easily modified to evaluate a number of other policies. For example, in the COVID-driven recession, not only was the duration of UI benefits extended, but those benefits were also supplemented by substantial payments to all UI recipients. We did not calibrate the model to match this particular policy, but the framework could easily accommodate such an analysis.

Appendices

A Estimating discount factor distributions for different interest rates

Figure 11 shows the fit of the liquid wealth distribution for interest rates of 0.5 percent and 1.5 percent per quarter. In both cases, the estimation exactly matches the median liquid wealth to permanent income ratios for each education group listed in Panel B of Table 3.

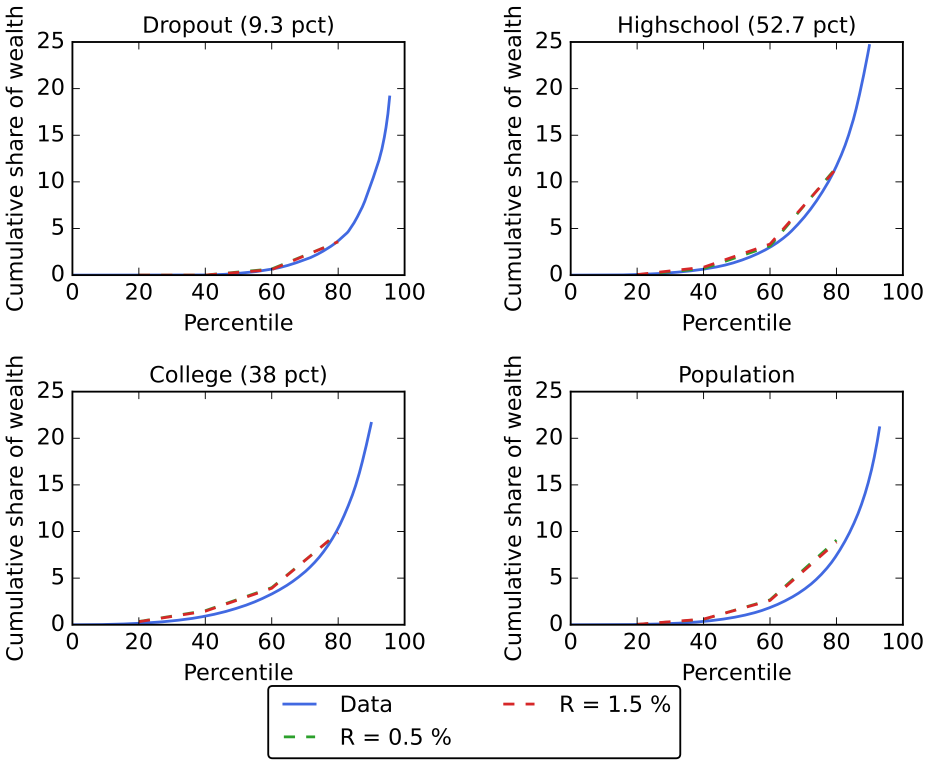


Figure 11 Distributions of liquid wealth within each educational group and for the whole population from the 2004 Survey of Consumer Finance and from the estimated model for different values of the interest rate, R.

B Robustness

In this section, we analyze how sensitive our results are to some of the parameters in the model. In particular, we focus on parameters that heavily influence consumers' incentives to save. These parameters are (1) the interest rate that affects the returns on

		Dropout		Highschool		College	
	Splurge	β	∇	β	∇	β	∇
$R = 1.005$	0.307	0.740	0.298	0.927	0.193*	0.989	0.0082
$R = 1.01$ (baseline)	0.307	0.735	0.298	0.924	0.137*	0.984	0.0096
$R = 1.015$	0.307	0.724	0.357*	0.919	0.138*	0.979	0.0105

Table 8 Estimates of the splurge and (β, ∇) for each education group for different values of the interest rate R. A $*$ denotes an estimate of ∇ that implies that the largest discount factor value in our discrete approximation would violate the GIC and is thus replaced with a value below the upper bound.

saving and (2) the degree of risk aversion and the replacement rates when unemployed with or without benefits that affect the strength of a precautionary saving motive. The aim is to alter these incentives while maintaining the requirement that the distributions of liquid wealth in each education group match the distributions in the data. Hence, in each case, we re-estimate the distributions of discount factors in each education group (and, if necessary, the degree of splurge spending in consumption). The aim is thus to compute new results for a model with different parameters that also fits data on the distribution of liquid wealth. At the end of the section, we also consider how changing the properties of the recession affects our main results.

B.1 Changing the interest rate

In our baseline calibration, the interest rate is set to 1 percent per quarter. Here, we consider the effect on our results of increasing or decreasing this value. Changes to the U.S. interest rate do not affect the estimation of the splurge parameter ς. However, before we can calculate updated results for a different interest rate, the distribution of discount factors within each education group must be re-estimated for the model to continue to match the liquid wealth distributions.

B.1.1 Discount factor distributions with different interest rates

Table 8 shows the values we obtain for the discount factor distributions when we change the quarterly interest rate by either decreasing it to 0.5 percent or increasing it to 1.5 percent. In both cases, the estimation can exactly match the median liquid-wealth-to-permanent-income ratios for each education group reported in panel B of table 3.

The first row of table 8 shows the estimated β_e and ∇_e for the lower interest rate of 0.5 percent per quarter. With a lower interest rate and an unchanged discount factor distribution, consumers would tend to substitute away from saving and toward current consumption. They would therefore accumulate less wealth, leading to a lower median liquid-wealth-to-permanent-income ratio. In all education groups, we therefore see that the estimated discount factor distributions are centered around higher values of β to

		Stimulus check	UI extension	Tax cut
no AD effects	$R = 1.005$	0.005	0.295	0.001
	$R = 1.01$ (baseline)	0.011	0.509	0.002
	$R = 1.015$	0.014	0.666	0.003
AD effects	$R = 1.005$	0.081	0.618	0.030
	$R = 1.01$ (baseline)	0.151	1.101	0.056
	$R = 1.015$	0.215	1.496	0.081

Table 9 Consumption-equivalent welfare gains in basis points, calculated for policies implemented in a recession with and without aggregate demand effects, for different values of the interest rate R

ensure that the model still matches the median liquid-wealth-to-permanent-income ratio in the data. An increase in patience cancels out the effect of the lower interest rate on median saving. Similarly, in the third row, we see the opposite effect when the interest rate is increased to 1.5 percent. Ceteris paribus saving would be more attractive with a higher interest rate, and this is offset by a reduction in β.

Figure 11 in Appendix A shows that the re-estimated model also matches the liquid wealth distributions for each of these values of the interest rate. From table 8, we see that the values of ∇_e for the three education groups do not need to change much for this to be the case.

B.1.2 Results with different interest rates

In this section, we repeat the welfare analysis conducted in section 4.3 for different values of the interest rate. As in that section, the stimulus check and payroll tax cut policy have been adjusted to be of the same fiscal size as the UI extension. All three policies are implemented during a recession. We determine welfare results for the policies implemented both with and without aggregate demand effects.

As can be seen in table 9, a higher interest rate increases the welfare benefits of all three policies. This result obtains despite only small changes in the multipliers for the different interest rates. Higher interest rates result in higher welfare benefits, as measured in lifetime consumption units, for all policies because the benefits of the policies (in the numerator) are front-loaded compared with a proportional increase in consumption through all periods (in the denominator). Thus, increasing the interest rate—which is also the social planner's discount rate—reduces the value of a proportional increase in consumption by more than the consumption increases associated with each policy. Nevertheless, the qualitative result that the extended UI benefits provide by far the highest welfare gains, followed by the stimulus checks, is strongly robust to changes in the interest rate.

	Splurge	Dropout		Highschool		College	
		β	∇	β	∇	β	∇
$\gamma = 1.0$	0.312	0.692	0.333	0.966	0.154^*	$1.05^\dagger$	0.015
$\gamma = 2.0$ (baseline)	0.306	0.735	0.298	0.924	0.137^*	0.984	0.0096
$\gamma = 3.0$	0.304	0.593	0.459^*	0.889	0.110	0.973	0.017

Table 10 Estimates of the splurge and (β, ∇) for each education group for different values of risk aversion, γ. A $*$ denotes an estimate of ∇ that implies that the largest discount factor value in our discrete approximation would violate the GIC and is thus replaced with a value below the upper bound. A $\dagger$ indicates an estimate of β that is so large that all values in the discrete approximation violate the GIC and replaced with a value below the upper bound.

B.2 Changing risk aversion

In our baseline calibration, consumers have a risk aversion of $\gamma = 2$, which is quite common in macroeconomic models. Here, we investigate how alternative values of γ would influence our results. Again, we re-estimate the distribution of discount factors within each education group, but in this case, we also re-estimate the degree of splurge spending in consumption.

B.2.1 Discount factor distributions with different risk aversion

Table 10 displays the values we obtain for the splurge and the discount factor distributions when we change γ to 1 and 3. The table shows that the splurge is not very sensitive to the degree of risk aversion. The splurge controls the degree of spending that consumers do before considering the trade off involved in optimally allocating spending over time and across different future states of the world. Risk aversion affects that trade off but does not have a big influence on a parameter that controls spending that is independent of that problem.

The second and third rows of table 10 show results when we increase risk aversion from $\gamma = 2.0$ to $\gamma = 3.0$. Increasing risk aversion for all types within an education group makes the precautionary saving motive stronger for all consumers in that group. Ceteris paribus, these consumers would then increase the amount of liquid wealth they accumulate, and the median liquid-wealth-to-permanent-income ratio for the education group would increase. For all the education groups, the discount factor distributions are therefore centered around lower values of β when risk aversion is increased to 3.0. As for the increase in the interest rate in section B.1.1, the decrease in patience counteracts the stronger incentive to save from the higher risk aversion. However, the reductions in β when increasing risk aversion from 2.0 to 3.0 are much larger than when increasing the interest rate from 1 to 1.5 percent.

The effects on ∇ and the concentration of the liquid wealth distribution may be less intuitive. However, if the only changes were to increase risk aversion and to decrease β while keeping ∇ fixed at the value for $\gamma = 2.0$, then the result would be a liquid wealth distribution that was much less concentrated than in the data. If all consumers in an education group are less patient, the reduction in saving is larger for the wealthier consumers. Thus, to maintain the concentrated wealth distribution, ∇ increases substantially for the Dropout and College groups. The results are distributions of discount factors within these groups that are centered around lower values, but that are much more dispersed. The effect is that the discount factor for the most patient type within each education group is not changed very much, but the lowest discount factor is much lower than when $\gamma = 2.0$, and the liquid wealth distributions remain as concentrated as they are in the data.

For the Highschool group the effect is a bit different. In the baseline case, ∇_h is so high that the discount factor for the most patient type violates the GIC. The discount factor for the most patient type is therefore not determined by ∇_h. When risk aversion is increased to $\gamma = 3.0$ and the discount factor distribution is centered around a lower value for β_h, the estimated value of ∇_h no longer implies that the GIC is violated by the most patient type. Thus the comparison of ∇_h with the value from the baseline is not so relevant.[26]

When we decrease risk aversion to $\gamma = 1.0$, however, we run into problems when estimating the discount factor distribution. Our model fails to jointly fit both the median liquid-wealth-to-permanent income ratios and the liquid wealth distributions for the Dropout and the College groups. Table 11 shows that for $\gamma = 1.0$, while the model can match the median liquid-wealth-to permanent-income ratios for the Highschool and College groups, it does not do so for the Dropout group. With such a low value of risk aversion, the estimation cannot yield a discount factor distribution where the median household has any significant savings. Instead, the resulting distribution concentrates most of the saving with the most patient types so that the distribution of liquid savings is matched fairly well. This is shown in the upper left panel of Figure 12.

For the College group we encounter a different problem. With a lower risk aversion and a weaker precautionary saving motive the intuition from the case where $\gamma = 3.0$ is reversed. When households are less risk averse, the model requires them to be more patient to match the same level of saving as in the baseline case. But the estimated values of β_c and ∇_c in Table 10 yield a discount factor distribution that violates the GIC for all the 7 types. Their discount factor is then set to a value close to the upper bound which is estimated to fit the overall level of saving. As row 1 of Table 11 shows, the model then fits the median liquid wealth to permanent income ratio. However, the lower left panel of Figure 12 shows that without dispersion of the discount factors for this education group, the model does not match the distribution of liquid wealth.

The strength of the precautionary saving motive is determined by more than just risk aversion. The risks that households face also drive the strength of this motive for

[26] Note that with risk aversion set to $\gamma = 3.0$, the discount factor for the most patient type in the Dropout group is also constrained by the GIC.

	Dropout	Highschool	College
Median LW/PI (data, percent)	4.64	30.2	112.8
Median LW/PI (model, $\gamma = 1.0$, percent)	0.00	30.1	112.8
Median LW/PI (model, $\gamma = 2.0$, percent)	4.64	30.2	112.8
Median LW/PI (model, $\gamma = 3.0$, percent)	4.64	30.2	112.8

Table 11 Median liquid-wealth-to-permanent-income ratios

Note: The table shows the weighted median ratio of liquid-wealth-to permanent-income from the 2004 SCF and in versions of the model with different risk aversion. In the annual data from the SCF, the annual PI is divided by 4 to obtain a quarterly number.

saving, and in our model, a key risk is unemployment risk. The replacement rates that households face when they are unemployed with or without benefits play an important role. In section B.3, we therefore consider an alternative calibration of these values.

B.2.2 Results with different risk aversion

In this section, we conduct the welfare analysis for the case with $\gamma = 3.0$. We do not repeat these calculations for $\gamma = 1.0$, since in that case the model cannot match the level and distribution of liquid wealth making the results for that case less interesting.

A higher risk aversion implies a greater welfare loss associated with the same drop in consumption, and thus, a greater welfare gain for policies that reduce the consumption drop. However, changing the risk-aversion parameter has a number of other ramifications for our welfare measure that are difficult to assess without simulation. A higher risk aversion (ceteris paribus) induces agents to hold a higher buffer stock of savings, making them less sensitive to adverse economic shocks in terms of their consumption response. As argued earlier, and since we target the empirical wealth-to-income ratios, we increase impatience to counteract this larger incentive to save. These changes then affect the consumption response of agents to the recession and to the policies implemented.

Table 12 shows the welfare results for the baseline case and for the higher value of risk aversion. For $\gamma = 3$ and AD effects switched on, we obtain slightly higher welfare effects than in the baseline. When AD effects are switched off, this only applies in the case of the UI extension. For both cases, with and without AD effects, the changes are quite small in magnitude.[27] Most importantly, the welfare ranking of the policies is robust to this alternative value for the risk-aversion parameter.

[27] Mirroring the welfare results, the 10y-horizon multipliers of the policies for the higher risk aversion value are very close to those for the baseline calibration.

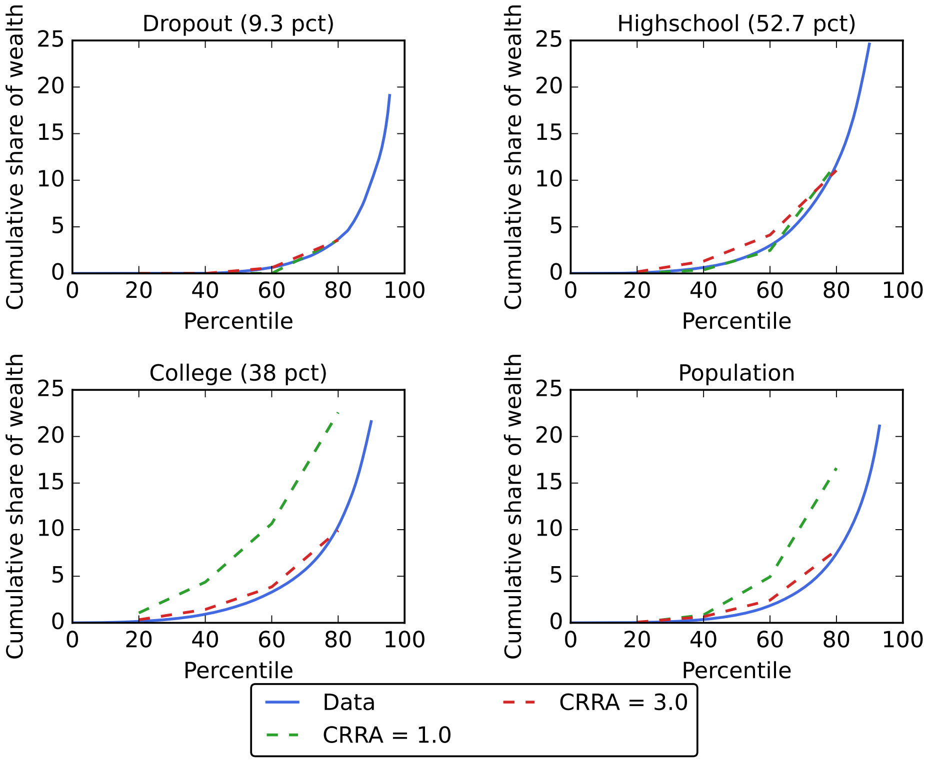


Figure 12 Distributions of liquid wealth within each educational group and for the whole population from the 2004 Survey of Consumer Finances and from the estimated model for different values of risk aversion, γ

B.3 Changing benefits

In our baseline calibration, we follow Rothstein and Valletta (2017) and calibrate the replacement rates to $\rho_b = 0.7$ with unemployment benefits and $\rho_{nb} = 0.5$ without benefits. Here, we consider replacement rates that are considerably less generous and more in line with values used in the previous macro literature with unemployment in models with heterogeneous agents. The alternative values we consider are a replacement rate of $\rho_b = 0.3$ when unemployed with benefits, as in Carroll, Crawley, Slacalek, and White (2020), and a replacement rate of $\rho_{nb} = 0.15$ when unemployed without benefits. This latter value is the same as the replacement rate used in Den Haan, Judd, and Juillard (2010).[28] With these replacement rates, being unemployed is more serious for consumers than in our baseline calibration, and the precautionary saving motive is stronger.

[28] In Den Haan, Judd, and Juillard (2010), there is only one unemployment state and, hence, no sense in which benefits expire after a while. Therefore, this replacement rate applies for long-term unemployed, as it does in our model, but in this paper there is also an intermediate state in which benefits are higher until they expire.

		Stimulus check	UI extension	Tax cut
no AD effects	$\gamma = 2.0$ (baseline)	0.011	0.509	0.002
	$\gamma = 3.0$	0.011	0.558	0.002
AD effects	$\gamma = 2.0$ (baseline)	0.151	1.101	0.056
	$\gamma = 3.0$	0.156	1.207	0.059

Table 12 Consumption-equivalent welfare gains in basis points, calculated for policies implemented in a recession with and without aggregate demand effects, for different values of risk aversion, γ

			Dropout		Highschool		College	
		Splurge	β	∇	β	∇	β	∇
Baseline	($\rho_b = 0.7$, $\rho_{nb} = 0.5$)	0.306	0.735	0.298	0.924	0.137*	0.984	0.010
Altern.	($\rho_b = 0.3$, $\rho_{nb} = 0.15$)	0.306	0.609	0.445*	0.890	0.116	0.978	0.016

Table 13 Estimates of the Splurge and (β, ∇) for each education group for the baseline replacement rates ρ_b and ρ_{nb} and an alternative calibration. A $*$ denotes an estimate of ∇ that implies that the largest discount factor value in our discrete approximation would violate the GIC and is thus replaced with a value below the upper bound.

B.3.1 Discount factor distributions with different benefits

Table 13 shows that when benefits are less generous and the precautionary motive is stronger, the estimated discount factor distributions are centered on lower values of β. The intuition is similar to the case when increasing risk aversion from $\gamma = 2.0$ to $\gamma = 3.0$, discussed in section B.2.1: A stronger precautionary motive for saving must be counteracted by a lower average discount factor to match the same average level of saving as before. The distributions must also be more dispersed to match the same concentration of liquid wealth.[29] In fact, the estimated discount factor distributions for the alternative calibration of the replacement rates are very similar to those reported for $\gamma = 3.0$ in row 3 of table 10.

B.3.2 Results with different benefits

In this section, we perform the welfare analysis for different benefit replacement rates. Table 14 shows that the alternative parameterization of the unemployment replacement

[29]Note that the estimated ∇_h values for the Highschool group are not directly comparable in terms of the degree of dispersion. One of these estimate is affected by hitting the GIC-imposed upper bound, but the other is not.

		Stimulus check	UI extension	Tax cut
no AD effects	Baseline ($\rho_b = 0.7,\ \rho_{nb} = 0.5$)	0.011	0.509	0.002
	Altern. ($\rho_b = 0.3,\ \rho_{nb} = 0.15$)	0.043	1.845	0.003
AD effects	Baseline ($\rho_b = 0.7,\ \rho_{nb} = 0.5$)	0.151	1.101	0.056
	Altern. ($\rho_b = 0.3,\ \rho_{nb} = 0.15$)	0.157	2.514	0.048

Table 14 Consumption equivalent welfare gains in basis points, calculated for policies implemented in a recession with and without aggregate demand effects, for different unemployment benefit rates

rates yields considerably higher welfare benefits for the UI extension policy. In particular, the lower the replacement rate under the no-benefit regime, the more harmful is the expiration of eligibility to the UI. The UI extension is thus particularly powerful if ρ_{nb} is small, which is mirrored by the 10y-horizon multiplier of the UI extension policy. It increases from 1.20 in the baseline calibration to 1.38 under the lower replacement rates. In contrast, multipliers and welfare effects of the other two policies do not change dramatically under the alternative calibration. Again, our ranking of the three policies remains the same.

B.4 Changing the properties of the recession

In this section, we alter two properties of the recession and study the effect of those changes (one at a time) on our main results. First, we lower the average length of a recession from six quarters in the baseline to four quarters. Second, we increase the consumption elasticity of the aggregate demand effect, κ, from 0.3 in the baseline to 0.5. In either case, the parameter changes do not require a re-estimation of the discount factor distribution, since the baseline saving behavior is unaffected by properties of the recession, which arrives as an MIT shock.

Table 15 presents the welfare results for different properties of the recession. In case of a shorter average recession length of four, instead of six, quarters, we observe lower welfare effects of the policies. As argued earlier, the reason is that the policies are particularly effective during recessions. With a shorter average recession length, the additional spending induced by the policies is now less likely to occur while the recession is ongoing. This outcome can also be seen by investigating the 10y-horizon multipliers of the policies, which fall slightly for all three policies considered: from 1.245 in the baseline to 1.224 in case of the shorter recession length for the stimulus check, from 1.200 to 1.180 for the UI extension, and from 0.999 to 0.967 for the tax cut.

A higher value for κ—and hence stronger aggregate demand effects—considerably increases the welfare effects of each policy. Of course, this is only the case in the version of the model where the aggregate demand effects are active. In their absence, there is no change in the welfare results relative to the baseline calibration. The larger κ implies a

		Stimulus check	UI extension	Tax cut
no AD effects	Baseline	0.011	0.509	0.002
	Shorter average recession, 4q	0.010	0.424	0.002
	Stronger AD effects, 0.5	0.011	0.509	0.002
AD effects	Baseline	0.151	1.101	0.056
	Shorter average recession, 4q	0.143	0.926	0.045
	Stronger AD effects, 0.5	0.297	1.695	0.110

Table 15 Consumption-equivalent welfare gains in basis points, calculated for policies implemented in a recession with and without aggregate demand effects, for different properties of the recession

larger boost to aggregate income in response to the demand effects of the policies. This larger boost translates to a larger increase in consumption and thus a stronger welfare effect. Under stronger AD effects, the policies also have considerably larger 10y-horizon multipliers. The stimulus check exhibits a multiplier of 1.636 (baseline: 1.245); the UI extension, a multiplier of 1.492 (1.200); and the tax cut, a multiplier of 1.152 (0.999).

B.5 Summary of robustness exercises

The robustness checks in this section show that our main results are robust to a wide range of alternative parameter choices. A key step in the robustness exercises that directly affect the strength of the precautionary savings motive—changing the interest rate, the risk aversion parameter, or the replacement rates in the unemployment system—is to reestimate the distribution of discount rates. Thus, we aim to match the distribution of liquid wealth in each case. This appears to more or less pin down the aggregate consumption properties for the model, regardless of the other parameters. Importantly, none of the robustness checks alter the ranking of policies in terms of their effectiveness and therefore the overall conclusions of this paper are unaffected.

Characteristics of the recession do, however, matter for our results. Shorter recessions or those with smaller aggregate demand effects reduce the effectiveness of policies. Conversely, more severe recessions will render the policies even more efficient than our baseline results suggest.

C Details of the HANK Model

C.1 Households

The household block follows closely to the main text with a few exceptions. To begin, the splurge factor is set to zero. Secondly, the level of permanent income of all newborns is equal to one. Finally, all households face the same employment to unemployment and unemployment to employment probabilities. The probabilities are calibrated to the transition probabilities of high school graduates from the main text.

C.2 Goods Market

There is a continuum of monopolistically competitive intermediate good producers indexed by $j \in [0,1]$ who produce intermediate goods Y_{jt} to be sold to a final good producer at price P_{jt}. I assume intermediate good producers consume all profits each period. Using intermediate goods Y_{jt} for $j \in [0,1]$, the final good producer produces a final good Y_t to be sold to households at price P_t.

C.2.1 Final Good Producer

A perfectly competitive final good producer purchases intermediate goods Y_{jt} from intermediate good producers at price P_{jt} and produces a final good Y_t according to a CES production function.

$$Y_t = \left(\int_0^1 Y_{jt}^{\frac{\epsilon_p - 1}{\epsilon_p}} \, dj \right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$$

where ϵ_p is the elasticity of substitution.

Given P_{jt} , the price of intermediate good j , the final good producer maximizes his profit by solving:

$$\max_{Y_{jt}} P_t \left(\int_0^1 Y_{jt}^{\frac{\epsilon_p - 1}{\epsilon_p}} \, dj \right)^{\frac{\epsilon_p}{\epsilon_p - 1}} - \int_0^1 P_{jt} Y_{jt}, \; dj$$

The first order condition leads to demand for good j

$$Y_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\epsilon_p} Y_t$$

and the price index

$$P_t = \left(\int_0^1 P_{jt}^{1-\epsilon_p} \, dj \right)^{\frac{1}{1-\epsilon_p}}$$

C.2.2 Intermediate Good Producer

Intermediate goods producers produce according to a production function linear in labor L_t.

$$Y_{jt} = Z L_{jt}$$

where Z is total factor productivity.

Each Intermediate goods producer hires labor L_t from a labor agency at cost h_t. Given the cost of labor, each Intermediate goods producer chooses P_{jt} to maximize its profit facing price stickiness a la **Rotemberg 1982**. I assume intermediate good producers hold all profits as HANK models with sticky prices produce countercyclical profits which combined with households with high MPCs can lead to countercyclical consumption responses out of dividends. I therefore abstract from consumption behavior in response to firm profits. Intermediate goods producers maximize profit by solving:

$$J_t\left(P_{jt}\right)=\max_{\{P_{jt}\}}\left\{\frac{P_{jt}Y_{jt}}{P_t}-h_tL_{jt}-\frac{\varphi}{2}\left(\frac{P_{jt}-P_{jt-1}}{P_{jt-1}}\right)^2Y_t+J_{t+1}\left(P_{jt+1}\right)\right\}$$

The problem can be rewritten as the standard New Keynesian maximization problem:

$$\max_{\{P_{jt}\}}\mathrm{E}_t\left[\sum_{s=0}^{\infty}M_{t,t+s}\left(\left(\frac{P_{jt+s}}{P_{t+s}}-MC_{t+s}\right)Y_{jt+s}-\frac{\varphi}{2}\left(\frac{P_{jt+s}}{P_{jt+s-1}}-1\right)^2Y_{t+s}\right)\right]$$

where $MC_t=\frac{h_t}{Z_t}$

Given all firms face the same adjustment costs, there exists a symmetric equilibrium where all firms choose the same price with $P_{jt}=P_t$ and $Y_{jt}=Y_t$.

The resulting Phillips Curve is

$$\epsilon_pMC_t=\epsilon_p-1+\varphi(\Pi_t-1)\Pi_t-M_{t,t+1}\varphi(\Pi_{t+1}-1)\Pi_{t+1}\frac{Y_{t+1}}{Y_t}$$

where $\Pi_t=\frac{P_t}{P_{t+1}}$.

C.3 Labor market

C.3.1 Labor agency

A risk neutral labor agency sells labor N_t to intermediate good producers at cost h_t by hiring households. To hire households, the labor agency posts vacancies v_t that are filled with probability ϕ_t. Households search is random. Following **Bardoczy 2020**, I assume the labor agency cannot observe the labor productivity of individual households. Instead, the labor agency can only observe the average productivity of all employed workers which is always equal to one.

$$J_t(N_{t-1})=\max_{N_t,v_t}\{(h_t-w_t)N_t-\kappa v_t+\mathrm{E_t}\left[\frac{J_{t+1}(N_t)}{1+r_t^a}\right]\}$$

s.t.

$$N_t=(1-\omega)N_{t-1}+\phi_tv_t$$

The resulting job creation curve is:

$$\frac{\kappa}{\phi_t} = (h_t - w_t) + (1-\omega)\mathrm{E}_t\left[\frac{\kappa}{(1+r_t^a)\phi_{t+1}}\right]$$

C.3.2 Matching

Household and labor agency matching follows a Cobb Douglas matching function:

$$m_t = \chi e_t^{\alpha} v_t^{1-\alpha}$$

where m_t is the mass of matches, e_t is the mass of job searchers, and χ a matching efficiency parameter.

The vacancy filling probability ϕ_t, job finding probabilities η_t evolve according to:

$$\eta_t = \chi \Theta_{it}^{1-\alpha}$$
$$\phi_t = \chi \Theta_t^{-\alpha}$$

where $\Theta_t = \frac{v_t}{e_t}$ is labor market tightness.

C.4 Wage Determination

Similar to **Gornemann et al. 2021** and **Blanchard and Gali 2010** , I assume the real wage follows the rule :

$$log\left(\frac{w_t}{w_{ss}}\right) = \phi_w log\left(\frac{w_{t-1}}{w_{ss}}\right) + (1-\phi_w) log\left(\frac{N_t}{N_{ss}}\right)$$

where ϕ_w dictates the extent real wages are rigid.

C.5 Fiscal Policy

The government issues long term bonds B_t at price q_t^b in period t that pays δ^s in period $t+s+1$ for $s = 0, 1, 2, ..$

The bond price satisfies the no arbitrage condition:

$$q_t^b = \frac{1 + \delta \mathrm{E}_t[q_{t+1}^b]}{1 + r_t^a}$$

The government finances its expenditures with debt and taxes.

$$(1 + \delta q_t^b) B_{t-1} + G_t + S_t = \tau_t w_t N_t + q_t^b B_t$$

where S_t are payments for unemployment insurance and other transfers.

Following **?**, the tax rate adjusts to stabilize the debt to GDP ratio:

$$\tau_t - \tau_{ss} = \phi_B q^b_{ss} \frac{B_{t-1} - B_{ss}}{Y_{ss}}$$

where ϕ_B governs the speed of adjustment.

C.6 Monetary Policy

The central bank follows the Taylor rule:

$$i_t = r^* + \phi_\pi \pi_t + \phi_Y (Y_t - Y_{ss})$$

where ϕ_π and ϕ_Y are the Taylor rule coefficient for inflation and output, respectively. r^* is the steady state interest rate, Y_{ss} is the steady state level of output.

C.7 Equilibrium

An equilibrium in this economy is a sequence of:

- Policy Functions $(c_{it}(m))_{t=0}^{\infty}$ normalized by permanent income

- Prices $\left(r_t, r^a_{t+1}, i_t, q^b_t, w_t, h_t, \pi_t, \tau_t\right)_{t=0}^{\infty}$

- Aggregates $(C_t, Y_t, N_t, \Theta_t, B_t, A_t)_{t=0}^{\infty}$

Such that:

$(c_{it}(m))_{t=0}^{\infty}$ solves the household's maximization problem given $(w_t, \eta_t, r^a_t, \tau_t)_{t=0}^{\infty}$.

The final goods producer and intermediate goods producers maximize their objective function.

The nominal interest rate is set according to the central bank's Taylor rule.

The tax rate is determined by the fiscal rule and the government budget constraint holds.

Table 16 Calibration

Description	Parameter	Value	Source/Target
Job Separation Rate	ω	0.1	JOLTS
Job Finding Probability	η_t	.67	EU probability
Elasticity of Substitution	ϵ_p	6	Standard
Price Adjustment Costs	φ	96.9	**Ravn and Sterk 2017**
Vacancy Filling Rate	ϕ	0.71	**Den Haan et al. 2000**
Matching Elasticity	α	0.65	**Ravn and Sterk 2017**
Real Wage Rigidity parameter	ϕ_w	0.837	**Gornemann et al. 2021**
Vacancy Cost	κ	0.056	$\frac{\kappa}{w\phi} = .071$
Government Spending	G	0.38	Gov. budget constraint
Decay rate of Government Coupons	δ	0.95	5 Year Maturity of Debt
Taylor Rule Inflation Coefficient	ϕ_π	1.5	Standard
Response of Tax Rate to Debt	ϕ_b	0.015	**Auclert et al. 2022**

The value of assets is equal to the value of government bonds.:

$$A_t = q_t^b B_t$$

The goods market clears[30]:

$$C_t = w_t N_t + G_t$$

where $C_t \equiv \int_0^1 \mathbf{p}_{it} c_{it}\, di$

The labor demand of intermediate good producers equals labor supply of labor agency:

$$L_t = N_t$$

[30]Note if profits were not held by firms then the goods market condition would be $C_t + G_t = Y_t - \kappa v_t - \frac{\varphi}{2}\left(\frac{P_t}{P_{t-1}} - 1\right)^2 Y_t$. In particular, since firm profits are $D_t = Y_t - w_t N_t - \kappa v_t - \frac{\varphi}{2}\left(\frac{P_t}{P_{t-1}} - 1\right)^2 Y_t$, then the goods market condition would become $C_t + G_t = w_t N_t + D_t = Y_t - \kappa v_t - \frac{\varphi}{2}\left(\frac{P_t}{P_{t-1}} - 1\right)^2 Y_t$.

D Calibration of Non-Household Blocks

The job separation rate is set to 0.1 in line with JOLTS. I set the job finding probability for the employed η_t is set to 0.67. The quarterly vacancy filling rate is 0.71 as in **Den Haan et al. 2020**. The matching elasticity is 0.65 following **Ravn and Sterk 2017** and the vacancy cost is set to 7% of the real wage as in **Christiano et al. 2016**[31]. The elasticity of substitution is set to 6. The price adjustment cost parameter is set to 96.9 as in **Ravn and Sterk 2017**. The tax rate is set to 0.3 and government spending is set to clear the government budget constraint. The speed of fiscal adjustment, ϕ_b, is set to 0.015, the lower bound of the estimates in **Auclert et al. 2022**.[32] Furthermore, the decay rate of government coupons is set to $\delta = 0.95$ to match a maturity of 5 years[33].

[31] The range of plausible values lie between 4% and 14% **Silva and Toledo 2009**

[32] The speed of adjustment parameter is set to the lower bound to ensure that the policies evaluated in the HANK and SAM model are almost entirely deficit financed.

[33] The duration of bonds in the model is $\frac{(1+r)^4}{(1+r)^4-\delta}$

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