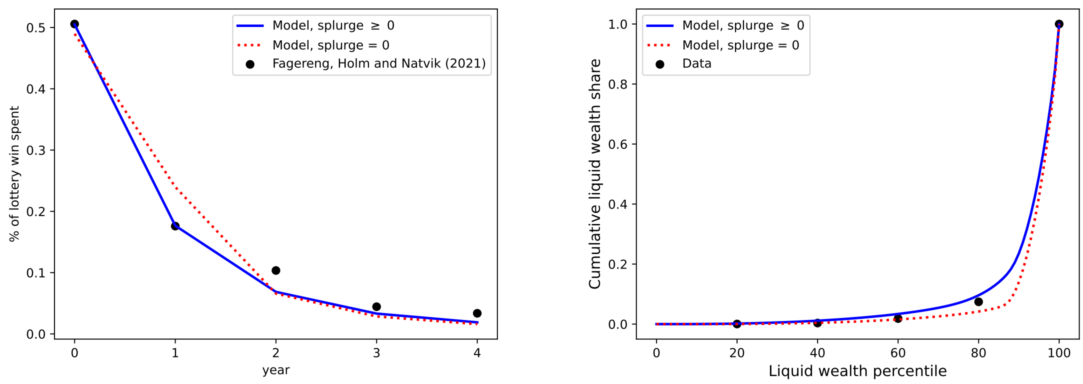
Appendices

1 Results in a model without the splurge

In this appendix, we consider the implications for our results of removing splurge consumption from the model. First, we discuss that model's ability to match the empirical targets that we used to estimate the splurge in section **??**. Second, we repeat the estimation of discount factor distributions in the US model in section **??**, and discuss the implications for both targeted and untargeted moments. Finally, we use the reestimated model to asses the relevance of the splurge for the effectiveness of the three policies.

1.1 Matching the IMPCs without the splurge

For the purpose of evaluating the results in the model without the splurge we do not require the reestimation of our Norwegian model, as the purpose of the latter is the estimation of the splurge. Nevertheless, we test how well the model can match the dynamics of spending after a temporary income shock as reported by **?** when the splurge is zero. Figure **??** illustrates the fit without the splurge and compares it to our baseline estimation.



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

Figure 1 Marginal propensity to consume over time and the liquid wealth distribution in the model with and without the splurge as well as in the data

Note: Panel (a) shows the fit of the model to the dynamic consumption response estimated in **?**; see their figure A5. Panel (b) shows the fit of the model to the distribution of liquid wealth (see Section **??** for the definition) from the 2004 SCF.

While the splurge helps in matching the empirical evidence on the IMPC, the model without the splurge also performs relatively well. This is because the model without

	MPC					
	1st WQ	2nd WQ	3rd WQ	4th WQ	Agg	K/Y
Splurge ≥ 0	0.27	0.49	0.60	0.66	0.50	6.59
Splurge $= 0$	0.13	0.52	0.62	0.68	0.49	6.58
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 and without the splurge and according to the data

the splurge is able to generate a high initial marginal propensity to consume through a wider distribution of discount factors ($\beta = 0.921$ and $\nabla = 0.116$) relative to the model with a splurge ($\beta = 0.968$ and $\nabla = 0.0578$). This ensures that sufficiently many agents are at the borrowing constraint and thus sensitive to transitory income shocks.

However, the model is not quite able to match the difference in spending between the initial year of the lottery win and the year after. The model without the splurge exhibits a higher spending propensity in the year after the shock occurs as borrowing-constrained agents spend the additional income quicker. The model without the splurge also provides a worse fit of the distribution of liquid wealth. Relative to the baseline model, and to the data, the model without a splurge generates a more unequal wealth distribution.

The reason for these two effects, becomes apparent when considering the cross-sectional implications of the models with and without the splurge across different wealth quartiles. While the model with the splurge can account for the empirically-observed initial MPCs among the wealthiest, the model without the splurge exhibits much lower MPCs among that group, see Table **??**. The wealthiest group will thus be very patient and have low MPCs, which can explain why the wealth distribution becomes more unequal and doesnq̂uite fit the targeted distribution in the data in the version of the model without the splurge.

Overall, the model fit with the data deteriorates roughly by a factor of two measured by the Euclidean norm of the targeting error.[1]

1.2 Estimating discount factor distributions without the splurge

Figure **??** shows that the model without splurge consumption can also match the wealth distributions in the three education groups very well. We therefore turn to the implications of this version of the model for the untargeted moments discussed in section **??**.

[1]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.

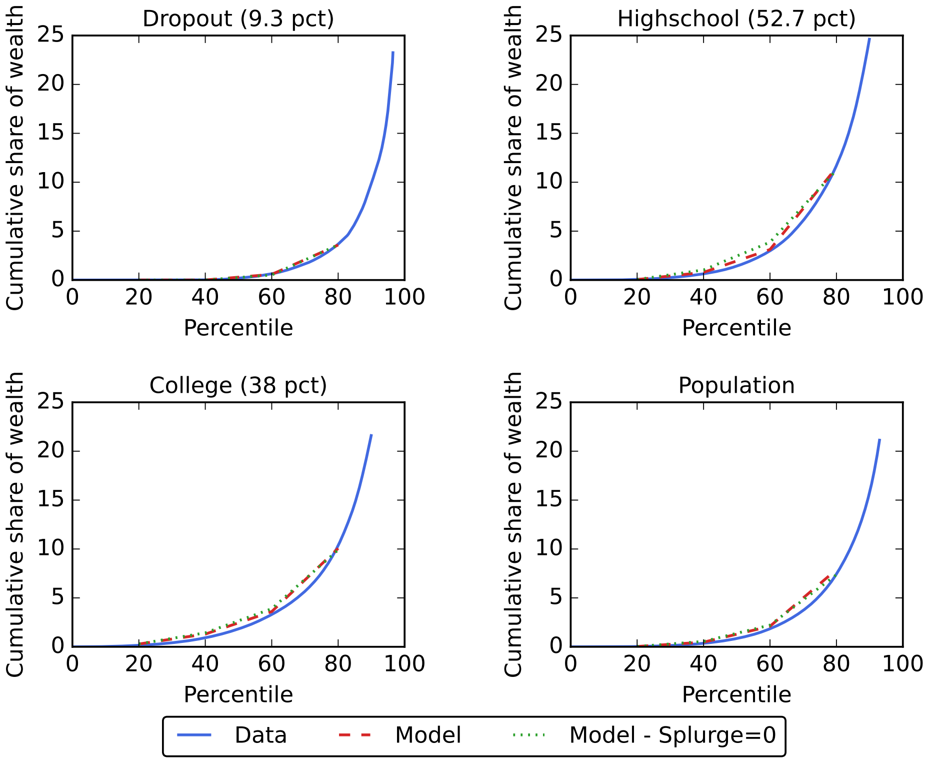


Figure 2 Distributions of liquid wealth within each educational group and for the whole population from the 2004 Survey of Consumer Finances and from the model estimated with and without splurge consumption

The main difference between the models with and without splurge consumption is that without splurge consumption the MPCs drop for each education group and wealth quartile. The difference is largest for the College group and for the highest wealth quartile (obviously with substantial overlap between these two groups). This is shown in the two panels in Table **??**. The rest of the table shows that the distribution of wealth is not substantially different in the model estimated without splurge consumption.

Finally, we again consider the implications of our model for the dynamics of spending over time and for the dynamics of spending for households that remain unemployed long enough for unemployment benefits to expire. Figure **??** repeats Figure **??** with results from the model without splurge consumption added. The implication is that the model without a splurge leads to a slightly too low MPC in the year of a lottery win and a slightly higher MPC in the year after.

The drop in spending when unemployment benefits expire is virtually the same in the model without splurge consumption (17 percent versus 18 percent in the baseline). While the consumption dynamics across the models with and without a splurge are fairly similar, the underlying drivers of the consumption drop upon expiry of unemployment benefits are different. In the model with the splurge, the drop in income translates

Panel (A) Non-targeted moments by education group

	Dropout	Highschool	College	Population
Percent of liquid wealth (data)	0.8	17.9	81.2	100
Percent of liquid wealth (model, baseline)	1.2	20.1	78.7	100
Percent of liquid wealth (model, Splurge=0)	1.6	18.7	79.7	100
Avg. lottery-win-year MPC (model, incl. splurge)	0.78	0.63	0.44	0.54
Avg. lottery-win-year MPC (model, splurge=0)	0.70	0.53	0.23	0.43

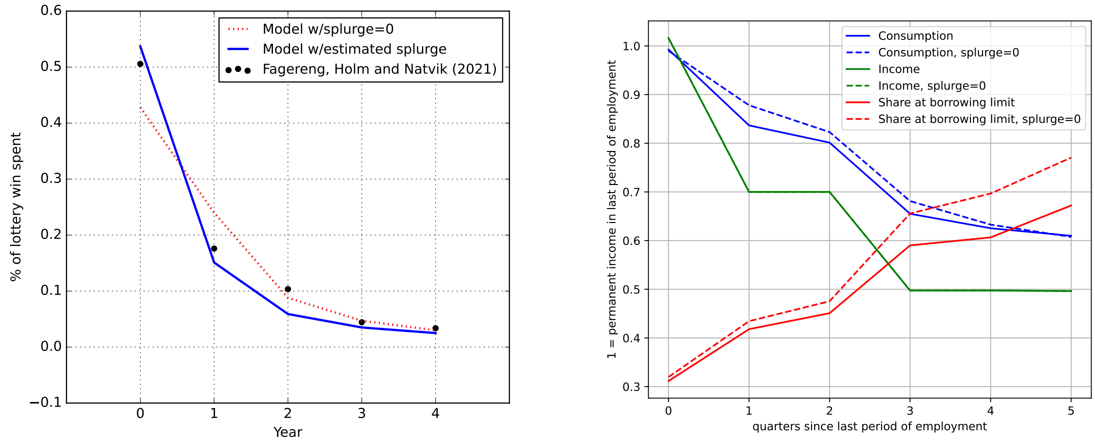
Panel (B) Non-targeted moments by wealth quartile

	WQ 4	WQ 3	WQ 2	WQ 1
Percent of liquid wealth (data)	0.14	1.60	8.51	89.76
Percent of liquid wealth (model, baseline)	0.09	0.96	4.55	94.40
Percent of liquid wealth (model, Splurge=0)	0.10	1.07	4.24	94.60
Avg. lottery-win-year MPC (model, incl. splurge)	0.78	0.63	0.44	0.31
Avg. lottery-win-year MPC (model, splurge=0)	0.69	0.53	0.36	0.14

Table 2 Implications for non-targeted moments

Note: Panel (A) shows percent of liquid wealth held by each education group in the 2004 SCF and in the model. It also shows the average MPCs after a lottery win for each education group. The MPCs are calculated for each individual for the year of a lottery win, taking into account that the win takes place in a random quarter of the year that differs across individuals. The MPCs are averaged across individuals within each education group. Panel (B) shows the same numbers for the population sorted into different quartiles of the liquid wealth distribution.

directly into lower consumption via the splurge itself. In the model without the splurge it is the sharp rise in agents hitting the borrowing constraint which accounts for the consumption drop after UI benefits expire. This is shown in the solid and dashed red lines in Figure **??**, and is due to the wider distribution of discount factors that is needed to match the wealth distributions in the model without the splurge. This leads to a greater number of agents being close the borrowing constraint.



(a) Share of lottery win spent **(b)** Spending upon expiry of UI benefits

Figure 3 Marginal propensity to consume over time and the spending upon expiry of UI benefits in the model

Note: Panel (a) compares the dynamic consumption response in the model to the estimates in **?**; see their Figure A5. Panel (b) shows the evolution of income and spending for households who remain unemployed long enough for UI benefits to expire; see Figure 2 in **?**.

1.3 Multipliers in the absence of the splurge

In this section we simulate the three fiscal policies from the main text in the estimated model without the splurge. The shape of the impulse response functions only marginally change relative to the model with the splurge. Hence, we focus on the quantitative changes as summarized by the cumulative multipliers in Figure **??**. The figure shows the multipliers when AD effects are switched on for the model with and without the splurge. Table **??** shows the 10y-horizon multiplier across the two models.

The absence of the splurge entails a calibration with a lower average MPC in the population. 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. This due to the consumption dynamics around the expiry of UI benefits described in the previous section. In the model without the splurge more agents hit the borrowing constraint upon the expiry of benefits. Providing those agents with an extension of UI benefits thus turns out to be slightly more powerful.

The policy ranking in terms of the multiplier shifts slighlty. In the model with the splurge, the check policy delivers multiplier effects much more rapidly than the UI extension. In the model without splurge consumption, the UI extension appears superior to the check, both at shorter and longer horizons. Both models agree on the tax cut being the least effective policy.

Figure 4 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.

	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 3 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 the corresponding mulitipliers with the splurge.

2 Details of the HANK and SAM Model

2.1 Households

The household block follows closely to the main text with a few exceptions. First, the splurge only occurs out of equilibrium—that is, the steady state of the model is calculated without the splurge behavior. Second, the level of permanent income of all newborns is equal to one. Furthermore, 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. Lastly, following the notation of **?**, r_t^a will denote the economy wide ex-ante real interest rate.

2.2 Goods Market

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

2.2.1 Final Goods Producer

A perfectly competitive final goods producer purchases intermediate goods Y_{jt} for $j \in [0, 1]$, from intermediate goods producers at price P_{jt} and produces a final good Y_t according to a CES production function given by

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

where ϵ_p is the elasticity of substitution.

Given P_{jt}, the price of intermediate good j, the final goods producer maximizes profits 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 given by

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

and the price index

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

2.2.2 Intermediate Goods Producers

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 profits facing price stickiness a la **?**. HANK models with sticky prices produce countercyclical profits which combined with households with high MPCs can lead to countercyclical consumption responses out of dividends. Therefore, we simply assume that intermediate goods producers consume all profits rather than distributing them to households. We therefore abstract from consumption behavior in response to firm profits. Intermediate goods producers maximize profits by solving:

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

where φ determines the cost of adjusting the price and, hence, the degree of price stickiness.

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

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

where $MC_t = \frac{h_t}{Z}$.

Given that 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

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

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

2.3 Labor market

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

Labor agency. The labor agency determines how many vacancies to post and how much labor to sell by solving the following problem:

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

subject to

$$N_t = (1 - \omega)N_{t-1} + \phi_t v_t.$$

The parameters κ and ω are, respectively, the cost of posting a vacancy, and the job separation rate.

The resulting job creation curve is:

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

Matching. Matching between households and the labor agency 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, α is the matching function elasticity, and χ is a matching efficiency parameter.

The vacancy filling probability ϕ_t and the 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.

Wage Determination. Similar to **?** and **?**, we 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 of real wage rigidity.

2.4 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 $s \in \{0, 1, 2, \ldots\}$.

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 and faces a budget constraint given by:

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

where S_t are payments for unemployment insurance and other transfers.

For all stimulus policies excluding the tax cuts, we follow **?** and let the tax rate adjusts to stabilize the debt to GDP ratio:

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

where ϕ_B governs the speed of adjustment.

For the tax cuts, we assume:

$$G_t - G_{ss} = \phi_G q_{ss}^b \frac{B_{t-1} - B_{ss}}{Y_{ss}}$$

where ϕ_G governs the speed of adjustment of government spending in response to debt.

2.5 Monetary Policy

The central bank follows a simple Taylor rule where it only responds to inflation:

$$i_t = r^* + \phi_\pi \pi_t,$$

where ϕ_π is the coefficient on inflation. Inflation is given by $\pi_t = P_t / P_{t-1} - 1$, and r^* is the steady state interest rate.

2.6 Equilibrium

An equilibrium in this economy is a sequence of:

- Policy Functions $(c_{it}(m))_{t=0}^{\infty}$ normalized by permanent income.
- Prices $\left(r_{t+1}^a, i_t, q_t^b, w_t, h_t, \pi_t, \tau_t\right)_{t=0}^{\infty}$.

– 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 $(w_t, \eta_t, r_t^a, \tau_t)_{t=0}^{\infty}$.

– The final goods producer and intermediate goods producers maximize their objective functions.

– 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.

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

$$A_t = q_t^b B_t.$$

– The goods market clears[2]:

$$C_t = w_t N_t + G_t,$$

where $C_t \equiv \int_0^1 \mathbf{c}_{it}\, di$.

– The labor demand of intermediate goods producers equals labor supply of labor agency:

$$L_t = N_t.$$

3 Calibration of Non-Household Blocks

The elasticity of substitution is set to 6, and the price adjustment cost parameter is set to 96.9 as in **?**. The vacancy cost is set to 7% of the real wage as in **?**.[3] The matching elasticity is 0.65 following **?**. The job separation rate is set to 0.092. As in section **??**, we set the job finding probability in the steady state for the unemployed η_{ss} to 0.67. Along with the job separation rate, this gives a probability of transitioning from employment to unemployment within a quarter of 3.1 percent which is the value we use for the Highschool group in section **??**. The quarterly vacancy filling rate is 0.71 as in **?** (and together with our other choices, this pins down the matching efficiency χ). The degree of wage rigidity ϕ_w is set to 0.837 following **?**. The tax rate is set to 0.3 and government spending is set to clear the government budget constraint. The parameters that dictate the speed of fiscal adjustment, ϕ_B and ϕ_G, are set to 0.015, the lower bound

[2]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 $C_t + G_t = w_t N_t + D_t = Y_t - \kappa v_t - \frac{\varphi}{2}\left(\frac{P_t}{P_{t-1}} - 1\right)^2 Y_t$.

[3]The range of plausible values lie between 4% and 14% **?**

Table 4 Calibration

{table:Calibration}

Description	Parameter	Value	Source/Target
Elasticity of Substitution	ϵ_p	6	Standard
Price Adjustment Costs	φ	96.9	**?**
Vacancy Cost	κ	0.056	$\frac{\kappa}{w\phi} = 0.071$
Job Separation Rate	ω	0.092	Match $\pi(eu)$ for Highschool group
Matching Elasticity	α	0.65	**?**
Job Finding Probability	η_{ss}	0.67	$\pi(ue)$ in section **??**
Vacancy Filling Rate	ϕ_{ss}	0.71	den Haan et al. (**?**)
Real Wage Rigidity parameter	ϕ_w	0.837	Gornemann et al. (**?**)
Government Spending	G	0.38	Gov. budget constraint
Decay rate of Gov. Coupons	δ	0.95	5 Year Maturity of Debt
Response of Tax Rate to Debt	ϕ_B	0.015	Auclert et al. (**?**)
Taylor Rule Inflation Coefficient	ϕ_π	1.5	Standard

of the estimates in **?**.[4] Furthermore, the decay rate of government coupons is set to $\delta = 0.95$ to match a maturity of 5 years.[5] Finally, the Taylor rule coefficient on inflation is set to the standard value of $\phi_\pi = 1.5$.

[4]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.

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