HAFiscal project paper outline

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1 Introduction

Add Intro here.

2 Model

2.1 The Household Problem

A household i faces a stochastic income stream, $y_{i,t}$, 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 household i can be written:

$$c_{i,t} = c_{sp,i,t} + c_{opt,i,t}, \tag{1}$$

where $c_{i,t}$ is total consumption, $c_{sp,i,t}$ is the splurge consumption and $c_{opt,i,t}$ is the household's optimal remaining consumption. Splurge consumption is simply a fraction of income:

$$c_{sp,i,t} = \varsigma y_{i,t}, \tag{2}$$

while the optimized portion of consumption is chosen to maximize lifetime expected consumption:

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

subject to a no-borrowing constraint and the budget constraint given existing market resources $m_{i,t}$ and income state.

The Income Process Households face a stochastic income process with permanent and transitory shocks to income, along with unemployment shocks. In normal times, households receive unemployment benefits for two quarters before they run out. Permanent income in the model is described by the following equation:

$$p_{i,t} = \psi_{i,t} \Gamma_{e(i)} p_{i,t-1}, \tag{4}$$

where $\psi_{i,t}$ is the shock to permanent income and $\Gamma_{e(i)}$ is the growth rate of income for education group $e(i)$ of the household. The shock to permanent income is normally distributed with variance σ_ψ.

The actual income a household receives will be subject their employment status as well as transitory shocks, $\xi_{i,t}$:

$$y_{i,t} = \begin{cases} \xi_{i,t} p_{i,t}, & \text{if employed} \\ 0.3 p_{i,t}, & \text{if unemployed with benefits} \\ 0.05 p_{i,t}, & \text{if unemployed without benefits} \end{cases} \tag{5}$$

where $\xi_{i,t}$ is normally distributed with variance σ_ξ. A Markov transition matrix with four states generates the unemployment dynamics. An employed household can continue being employed, or move to being unemployed with benefits (with one remaining period of benefits). This household can then either become employed or move to being unemployed with benefits (but no remaining periods of benefits). A household in this state can then either become employed or unemployed without benefits, where they will remain until they become employed again. The probability of becoming employed is the same for each unemployed state and the probabilities of transitioning from employment to unemployment and vice-versa are chosen to match the unemployment rate for each education group (in steady state) and an average duration of unemployment of 1.5 quarters.

2.2 MIT Shocks

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 shock representing a recession and 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 remain so, and an additional number of households move from employment to unemployment. Second, conditional on the recession continuing, the emplyment transtion matrix is adjusted so that unemployment remains at the new high level, and the expected length of time for an unemployment spell increases from two to four quarters. Third, the end of the recession occurs as a Poisson 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 tends down over time back to its steady-state level.

Stimulus Check In this policy response, the government sends money to every household that directly increases their market resources. The checks are means-tested depending on permanent income. A fixed check amount is sent to every household with permanent income less than a threshold and this amount is then linearly reduced to zero for households about a higher permanent income threshold.

Extended Unemployment Benefits In this policy response, unemployment benefits are extended from 2 quarters to 4 quarters. That is, those who become unemployed at the start of the pandemic, 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.

Payroll Tax Cut In this policy response, employee-side payroll taxes are reduced for a period of 8 quarters. During this period, which continues irrespective or whether the recession continues or ends, employed households' income is increased by the amount of the tax cut. The income of unemployed households is unchanged by this policy.

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. 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:

$$AD(C_t) = \begin{cases} \left(\frac{C_t}{\tilde{C}}\right)^{\kappa}, & \text{if in a recession} \\ 1, & \text{otherwise} \end{cases} \tag{6}$$

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

$$y_{AD,i,t} = AD(C_t)y_{i,t} \tag{7}$$

The series $y_{AD,i,t}$ is then used for each household's budget constraint.

3 Estimation and calibration

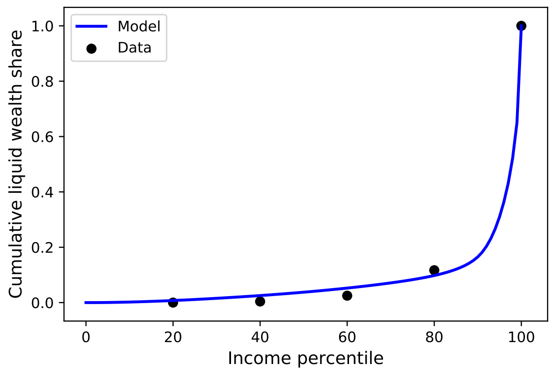
3.1 Estimation of the "splurge" factor

We define splurging as the free spending of available income without concern for intertemporal maximization of utility. As we will show in this section, a model allowing for splurging performs well at capturing the shorter and longer term response of consumption to income shocks. Specifically, we show that our model can account well for the results of Fagereng, Holm, and Natvik (2021), who study the impact of lottery winnings in Norway on consumption using millions of datapoints from the Norwegian population registry. To do so we calibrate our model to reflect the Norwegian economy and estimate the splurge factor, as well as the distribution of discount factors in the population to match two empirical moments.

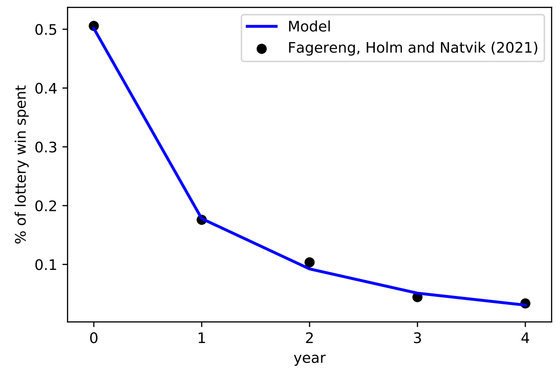
First, we match the steady-state distribution of liquid wealth in the model to its empirical counterpart. Due to the lack of data on the liquid wealth distribution in Norway, we resort to the corresponding data from the US - assuming that liquid wealth inequality is comparable across these countries. Specifically, we impose as targets the cummulative liquid wealth share at the 20th, 40th, 60th and 80th income percentile, which equal 0%, 0.4%, 2.5% and 11.7%.[1] Hence, 87.3% of the total liquid wealth is held by the top income quintile. The data is plotted in figure 1a. Second, we take from Fagereng, Holm, and Natvik (2021) the marginal propensity to consume out of a one-period income shock. We not only target the contemporaneous respone of consumption to the income shock, but also the subsequent impact on consumption in years one to four after the income shock. The share of lottery winnings expended at different time horizions, as found in Fagereng, Holm, and Natvik (2021), are plotted in figure 1b.

The remaining model parameters are calibrated to reflect the Norwegian economy. Specifically, we set the real interest rate to 2% annually and the unemployment rate to 4.4%, in line with Aursland, Frankovic, Kanik, and Saxegaard (2020). The quartarly probability to survive is calibrated to

[1] @Edmund, where is this data from?



(a) Distribution of liquid wealth



(b) Share of lottery win spent

Figure 1: Targets and model moments from the estimation

$1 - 1/160$, reflecting an expected working life of 40 years. Aggregate productivity growth is set to 1% annually following Kravik and Mimir (2019). The unemployment net replacement rate is calibrated to 60% following OECD (2020). Finally, we set the real interest rate on liquid debt to 13.6% and the borrowing constraint on 80% of permanent income following data from the Norwegian debt registry Gjeldsregistret (2022).[2] The standard deviation of the permanent and transitory shock are 0.07 and 0.346, respectively. [@Hakon, could you add a few sentences on the data on which the std was estimated?]

Using the calibrated model, unexpected lottery winnings are simulated and the share of the lottery spent in each year is calculated. 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 targets 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 $[\beta - \nabla, \beta + \nabla]$. We approximate the uniform distribution of discount factors with a discrete approximation and let the population consist of 7 different discount types.

The estimation yields a splurge factor of 0.32 and a distribution of discount factors described by $\beta = 0.986$ and a $\nabla = 0.0174$. 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 figure 1.

3.2 Parametrization of the US model

4 Results

We consider the following fiscal policy experiments

[2]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. To determine the borrowing limit on liquid debt we determine the ratio between total credit card limit divided by total wage income in Norway. We use data from December 2019.

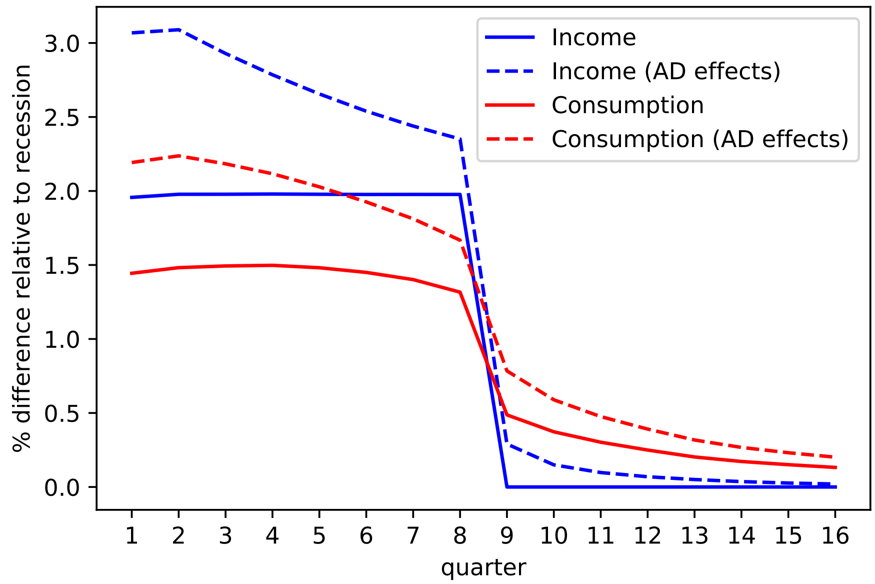


Figure 2: Impulse responses of aggregate income and consumption to a pay roll tax cut during a recesssion lasting eight quarters with and without aggregate demand effects

- Payroll tax cut: Employed individuals benefit from a 2 percentage points lower payroll tax cut. The tax cut is unanticipated and usually lasts for 8 quarters. However, there is a 50% chance, that the policy is extended by another 8 quarters if the recession is still ongoing in the 8th quarter of the payroll tax cut.
- Unemployment insurance extension: The duration of the unemployment insurance is doubled from 2 to 4 quarters. Agents, that are unemployed when the policy is implemented thus receive up to 4 quarters of unemployment insurance. The policy is unanticipated and active only for one quarter.
- Stimulus check: Each individual, independent of employment status, receives an unanticipated payment of \$1200 in one quarter. However, the check is only paid out fully to individuals with a permanent yearly income smaller than 100,000 and not at all to those with a income greater than 150,000. Those within the two thressholds receive a share of the full stimulus check amount proportionate to their position within threshholds.[3]

4.1 Impulse responses

[3] For this income group, the check amount is given by $\$1200(1-\frac{Income-100{,}000}{50{,}000})$. For example, an individual with a permanent yearly income of 110,000 receives 80% of the stimulus, i.e. \$960.

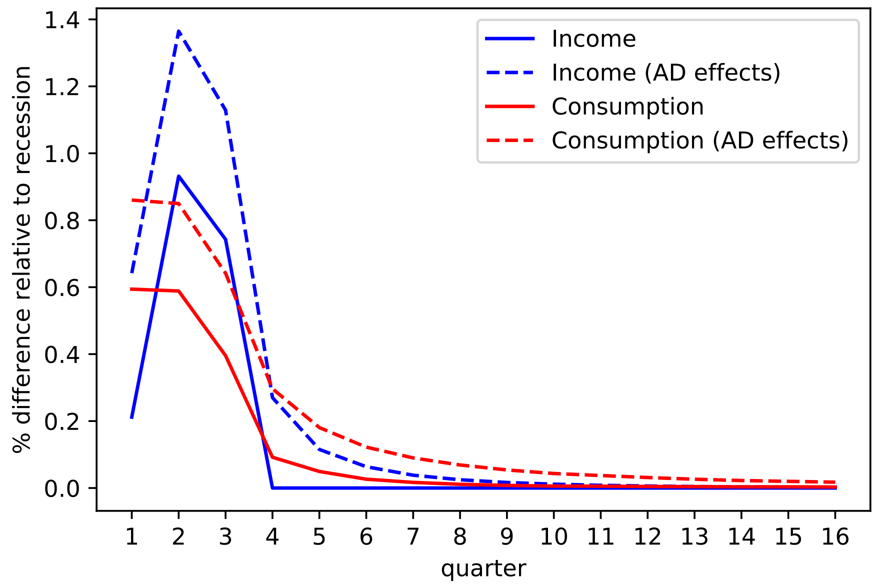


Figure 3: Impulse responses of aggregate income and consumption to a UI extension during a recesssion with and without aggregate demand effects

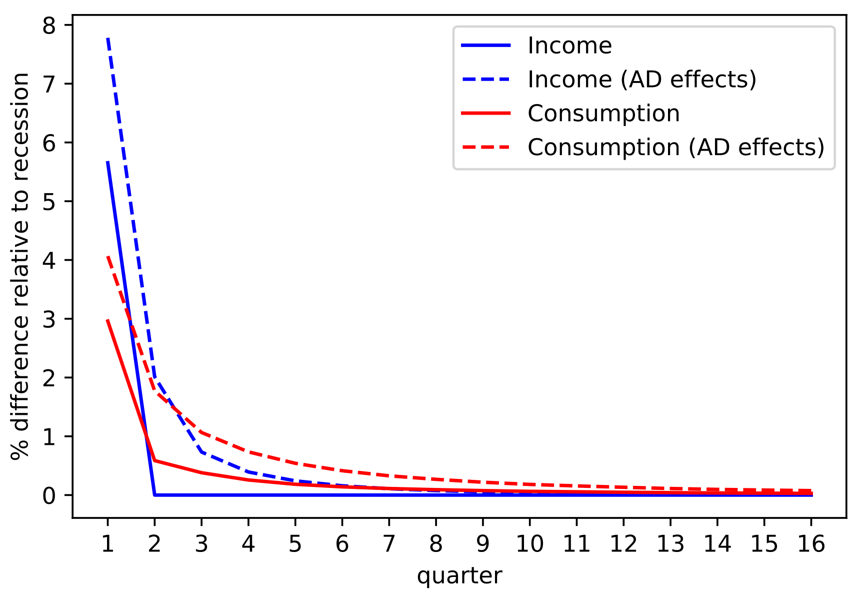


Figure 4: Impulse responses of aggregate income and consumption to a stimulus check during a recesssion with and without aggregate demand effects

4.2 Multipliers

Definitions:

- The *net present value (NPV)* of a variable X at horizon t is given by

$$NPV(t, X) = \sum_{s=0}^{t} \left(\prod_{i=1}^{s} \frac{1}{R_i} \right) X_s \tag{8}$$

- The *cummulative multiplier (CM)* of a policy is given by

$$CM(t) = \frac{NPV(t, \Delta C)}{NPV(T_{max}, \Delta G)} \tag{9}$$

  where ΔC is the additional aggregate consumption spending in the policy scenario relative to the baseline and ΔG is the government expenditures caused by the policy.

5 Welfare analysis

We want to convert welfare units to consumption units. A proportional increase in every agents' consumption in the baseline by fraction x, in welfare, is equal to:

$$x \frac{1}{N} \sum_{i=1}^{N} \sum_{t=0}^{\infty} D^t c_{it,\text{base}} u'(c_{it,\text{base}}) \tag{10}$$

where c_{it} is consumption (including the splurge) of agent i at time t and D is the social planner's discount rate. N is the number of agents.

The cost of such an increase is

$$x \frac{1}{N} \sum_{i=1}^{N} \sum_{t=0}^{\infty} R^{-t} c_{it,\text{base}} \tag{11}$$

Define

$$\mathcal{W}^c = \frac{1}{N} \sum_{i=1}^{N} \sum_{t=0}^{\infty} D^t c_{it,\text{base}} u'(c_{it,\text{base}}) \tag{12}$$

$$\mathcal{P}^c = \frac{1}{N} \sum_{i=1}^{N} \sum_{t=0}^{\infty} R^{-t} c_{it,\text{base}} \tag{13}$$

	Tax Cut	UI extension	Stimulus check
Multiplier (with AD effects)	1.285	1.795	1.850
Multiplier (with only 1st round AD effects)	1.146	1.480	1.481
Share of policy expenditure during recession	46.4%	71.4%	66.0 %

Table 1: Multipliers as well as the share of the policy ocurring during the recession for the three policies considered

	Tax Cut	UI extension	Stimulus check
Recession lasts 2q	1.096	1.648	1.689
Recession lasts 4q	1.224	1.718	1.842
Recession lasts 8q	1.471	1.864	1.999

Table 2: Multipliers (with AD effects) for different recesssion lengths for the three policies considered

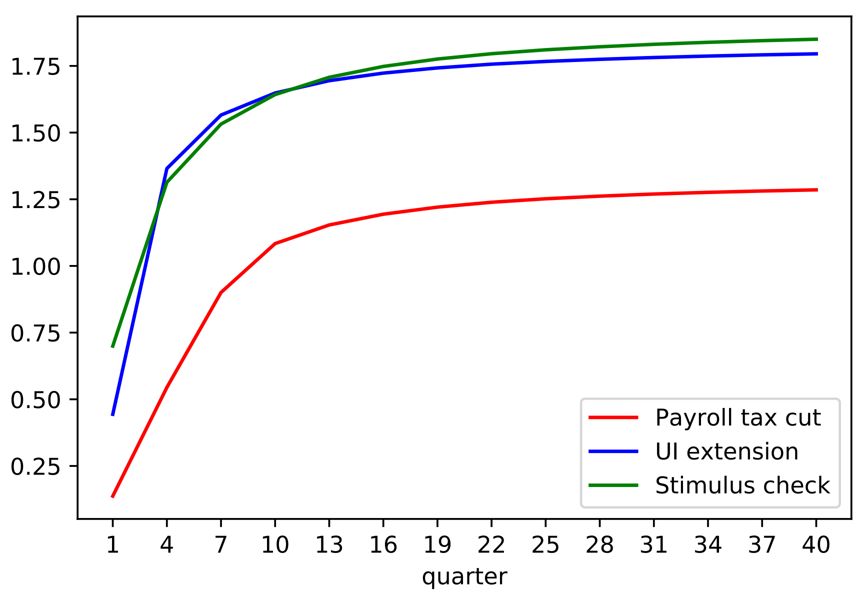


Figure 5: Cummulative Multiplier as a function of the horizon in quarters for the three policies considered. Policies are implemented during a recession with AD effects active

	Check	UI	Tax Cut
$\mathcal{C}(Rec, \text{policy})$	0.090	3.395	0.004
$\mathcal{C}(Rec, AD, \text{policy})$	0.426	5.005	0.133

Table 3: Consumption Equivalent Welfare Gains in Basis Points

Aside - with log utility, $\mathcal{W}^c = \frac{1}{N}\sum_{i=1}^{N}\sum_{t=0}^{\infty} D^t = \frac{1}{1-D}$

We will assume that a government expenditure of size F with welfare benefit $\mathcal{W}$ will be funded by a proportional consumption tax of size $\frac{F}{\mathcal{P}^c}$ resulting in a welfare loss of $\frac{F}{\mathcal{P}^c}\mathcal{W}^c$. The overall welfare benefit will be equivalent to consumption units:

$$\mathcal{C} = \frac{\mathcal{W}}{\mathcal{W}^c} - \frac{F}{\mathcal{P}^c} \tag{14}$$

There is also an 'unseen' cost to the government policy exactly equal to implementing the policy in normal times.

Define welfare of a policy as:

$$\mathcal{W}(\text{policy}, AD, Rec) = \frac{1}{N}\sum_{i=1}^{N}\sum_{t=0}^{\infty} D^t u(c_{it,\text{policy},AD,Rec}) \tag{15}$$

So the consumption equivalent of a policy implemented in recession is:

$$\begin{aligned} \mathcal{C}(\text{policy}, AD, Rec) = &\left(\frac{\mathcal{W}(\text{policy}, AD, Rec) - \mathcal{W}(AD, Rec)}{\mathcal{W}^c} - \frac{PV(\text{policy}, Rec)}{\mathcal{P}^c}\right) \\ &- \left(\frac{\mathcal{W}(\text{policy}) - \mathcal{W}(\text{base})}{\mathcal{W}^c} - \frac{PV(\text{policy})}{\mathcal{P}^c}\right) \end{aligned} \tag{16}$$

Table 3 shows results for this method. Note that the policy expenditures of each policy have been equalized.

6 Conclusion

Add conclusion here...

References

Aursland, T. A., I. Frankovic, B. Kanik, and M. Saxegaard (2020): "State-dependent fiscal multipliers in NORA - A DSGE model for fiscal policy analysis in Norway," *Economic Modelling*, 93, 321–353.

Fagereng, A., M. B. Holm, and G. J. Natvik (2021): "MPC Heterogeneity and Household Balance Sheets," *American Economic Journal: Macroeconomics*, 13(4), 1–54.

Gjeldsregistret (2022): "Nøkkeltall fra Gjeldsregisteret," *Gjeldsregistret nettside*, Url: https://www.gjeldsregisteret.com/pages/nokkeltall.

Kravik, E. M., and Y. Mimir (2019): "Navigating with NEMO," *Norges Bank Staff Memo*, 5.

OECD (2020): "Net replacement rate in unemployment," *OECD statistics "Social Protection and Well-being"*, Url: https://stats.oecd.org/Index.aspx?DataSetCode=NRR.

Size of stimulus check	\$75	\$1200	\$5000
Add. cons. as share of baseline cons. (recession, AD)	0.019	0.308	1.294
Multiplier (recession, AD)	1.849	1.850	1.866

Table 4: Multipliers for different sizes of the stimulus check

A Linearity of the check multiplier

Table 4 shows the amount of additional consumption stimulated (as % of baseline consumption) caused by stimulus checks of different sizes as well as their multiplier (i.e. the ratio between stimulated consumption and the cost of the policy, in net present value). The table shows that the impact of the check stimulus experiment scales roughly linearly with the size of the stimulus check, leaving the multiplier largely unaffected by the size of check.