

# STAFF MEMO

## Debt and household consumption responses

NO. 1 | 2016

ANDREAS FAGERENG  
AND ELIN HALVORSEN



NORGES BANK

Staff Memos present reports and documentation written by staff members and affiliates of Norges Bank, the central bank of Norway. Views and conclusions expressed in Staff Memos should not be taken to represent the views of Norges Bank.

© 2016 Norges Bank

The text may be quoted or referred to, provided that due acknowledgement is given to source.

Staff Memo inneholder utredninger og dokumentasjon skrevet av Norges Banks ansatte og andre forfattere tilknyttet Norges Bank. Synspunkter og konklusjoner i arbeidene er ikke nødvendigvis representative for Norges Banks.

© 2016 Norges Bank

Det kan siteres fra eller henvises til dette arbeid, gitt at forfatter og Norges Bank oppgis som kilde.

ISSN 1504-2596 (online only)

ISBN 978-82-7553-883-1 (online only)

# Debt and household consumption responses\*

Andreas Fagereng<sup>†</sup>

Elin Halvorsen<sup>‡</sup>

January 7, 2016

**Abstract:** Norwegian households' levels of housing wealth have since the banking crisis of the 90s become an ever more dominant part of households' portfolios. Low interest rates and easy access to mortgages have contributed to both increasing house prices and the corresponding increase in household debt. A potential concern for policy makers is how these high debt levels will affect household consumption were the economy to experience a sudden shock, in form of higher unemployment, rising interest rates, falling house prices or a combination of the three. This memo provides an overview of the theoretical implications and the empirical literature on the effects of such shocks on consumption, with an emphasis on heterogeneous responses. We use Norwegian register data on income and wealth to impute measures of consumption for the population and explore differences in consumption rates to gauge the potential impact of such shocks in Norway. We study the role of debt for consumption and find support for the hypothesis that consumption expenditure growth is lower among households with high debt. Much of the leveling off in consumption growth after the crisis reflects a regular response by highly indebted households. Still, a somewhat stronger relationship after the crisis shows that precautionary savings may have played a role.

---

\*This report documents consultancy work done for Norges Bank autumn 2015. Thanks to Kjersti-Gro Lindquist, Haakon Solheim, Kristine Høegh-Omdal, Kjersti Næss Torstensen and Bjørn Helge Vatne for useful comments and valuable feedback.

<sup>†</sup>Norges Bank, Statistics Norway, [andreas.fagereng@ssb.no](mailto:andreas.fagereng@ssb.no)

<sup>‡</sup>Norges Bank, Statistics Norway, [elin.halvorsen@ssb.no](mailto:elin.halvorsen@ssb.no)

## 1 Introduction

In economic models households manage the fundamental problem of choosing consumption and saving in the face of deterministic income as well as income shocks. What complicates the matter is that households differ with respect to preferences and ability, some are more patient than others, some are more risk averse, and some plan better for the future. In addition, capital markets are not perfect and the ability to smooth income shocks is largely dependent on the access to and the sophistication of asset markets. Finally, the current situation in Norway where most households have a large fraction of their wealth invested in illiquid housing wealth, and many have an additional mortgage many times their annual income, will certainly influence the ability to adjust and the magnitude of response to an unexpected income or wealth shock.

In the last decade, both theoretical and empirical economic research has acknowledged that there is substantial heterogeneity across households in their consumption responses to income shocks. However, most economic life-cycle models are still based on a single asset and a representative household. In this memo we first present a general life-cycle model that divides assets into liquid assets, mortgages and housing wealth in order to provide a theoretical framework that resembles more the situation at hand. We then proceed to deriving the theoretic predictions for consumption following a change in interest rates, a change in house prices and unemployment.

Next, we present some descriptive evidence on Norwegian households' consumption and saving behavior. In this memo we apply Norwegian registry data on wealth and income to gauge the potential impact of such shocks in Norway. Firstly we document substantial heterogeneity in households' balance sheets and their apparent preparedness for interest hikes, income shortfalls or house price drops. The data reveal large differences among the households, but also that many of the most indebted households are concentrated among the higher income deciles.

Finally, we study the evolution of household consumption growth around the most turbulent period we observe in our data, the 2008 financial crisis. Norway was not severely hit during the crisis in terms of unemployment, but the economy experienced (in addition to an uncertain economic environment) both increased interest rates for a time and also a temporary drop in housing prices. As other international studies have found, we also find that households with ex ante higher levels of leverage reduced their consumption growth substantially more than those with lower leverage from the years before crisis. However, we also show that part of this result may be explained by the fact that when grouping household by high

loan-to-income or loan-to-value in a particular year, a reduction in consumption in subsequent years follows naturally from the infrequent nature of durable spending.

## 2 Theory

Intertemporal household choice models that include housing in the utility function and a diversified asset portfolio tend to become very complicated to solve. Here we will present such a model not with the intention of solving it and using it for simulations, but as a framework that may help clarifying the economic mechanisms that we assume will be present following an income or wealth shock. For more complete model framework and numerical solutions we refer to Li and Yao (2007) and Yang (2009).

### 2.1 Utility

In this model the household gains instantaneous utility from non-durable consumption and housing services. While the former needs to be purchased anew in every period, the latter depend on the stock of housing that the household owns in the period of interest. Preferences are represented by a standard CRRA utility for the composite good and a Cobb-Douglas function to aggregate current consumption and housing services. The weight parameter  $\phi$  determines preferences toward consumption and housing services.

$$u(C_t, H_t) = \frac{(C_t^{1-\phi} H_t^\phi)^{1-\theta}}{1-\theta}$$

Usually with a CRRA utility function,  $\theta$  denotes relative risk aversion, and  $1/\theta$  the inter-temporal elasticity of substitution. Here, since the indivisible good housing is included in the function, the coefficient is no longer equal to the relative risk aversion, and we may rather call it a curvature parameter. The household discounts the future using a constant factor  $\beta \leq 1$ . The household enters the model at time  $t = 1$ , and leaves at the deterministic age  $T^1$ . The expected discounted lifetime utility becomes

$$U_0 = E \left[ \sum_{t=1}^T \beta^t u(C_t, H_t) \right]$$

---

<sup>1</sup>Alternatively one could have included age-specific conditional survival probabilities - this would have affected the inter-temporal discounting.

## 2.2 Labor income

The households receive an exogenous stream of labor income  $Y_t$  in each period, depending on a deterministic component,  $f(t, Z_t)$  and an idiosyncratic stochastic component,  $\varepsilon_t$ . The labor income process hence takes the following form:

$$Y_t = f(t, Z_t) \exp\{\varepsilon_t\}$$

The deterministic component  $f(t, Z_t)$  is a function of age and education; the stochastic component is the sum of an idiosyncratic temporary shock  $\xi_t \sim N(0, \sigma_\xi^2)$  and a persistent shock  $v_t$  that follows a random walk:

$$v_t = v_{t-1} + \vartheta_t$$

where  $\vartheta_t$  is distributed as  $N(0, \sigma_\vartheta^2)$ .

## 2.3 Housing

Housing plays a dual role in this model. It is both a durable consumption good and a vehicle for investment. The household receives housing services that is proportional to the size of the current housing stock. In each period a fraction  $\delta$  is lost due to depreciation. Moreover, housing is an investment good with uncertain capital value  $P_t^h$  which is a relative price that represents the price of one unit of housing in terms of the consumption good. The house price is assumed to follow an exponential trend with growth rate,  $g$ , and stochastic component,  $\eta_t$ .

$$P_t^h = \exp\{gt + \eta_t\}$$

Housing in this model refers to the households' primary residence and is thus traded as a single indivisible piece. Housing is severely illiquid. When adjusting the housing stock the household has to sell the old property, incurring a transaction cost that amounts to  $\lambda$  times the old house's current value. Denote the gross investment in the housing stock by  $P^h I^h$ . Hence the quantity of housing owned by the household is

$$H_t = \begin{cases} (1 - \delta) H_{t-1} & \text{for } I_t^h = 0 \\ (1 - \lambda)(1 - \delta) H_{t-1} + I_t^h & \text{for } I_t^h \neq 0 \end{cases}$$

## 2.4 Financial assets

There are two financial instruments in this model; bonds/savings accounts, and mortgages.<sup>2</sup> The household can invest non-negative amounts in the risk free liquid asset,  $A$ , that has a safe return  $R^a$  (remember that  $R = 1 + r$ ). The second instrument is a mortgage,  $D$ , that requires an interest payment  $R^d - 1$  in every period. The maximum mortgage a household can have is dependent on the value of the current housing stock. Real estate can thus be financed with a loan except for the down payment, the fraction  $\kappa$  of the purchase value that has to be paid up front (loan-to-value requirement).

$$D_t \leq (1 - \kappa_t) P_t^h H_t$$

The additional resources that the households receives by taking out a mortgage can be used for consumption, housing investments or financial investments.

## 2.5 Lifetime budget constraint

The household begins each period with a level of net assets  $NA$  that depends on last period's financial investments, and the debt taken out. We can rewrite the expression for net assets at the beginning of period  $t + 1$  as

$$NA_{t+1} = A_t R_{t+1}^a - D_t R_{t+1}^d$$

Furthermore we express cash-on-hand  $X$  as the sum of net assets and current labor income:

$$X_{t+1} = NA_{t+1} + Y_{t+1}$$

The household can use her resources which consists of cash-on-hand and the debt taken out to finance the purchase of the non-durable good, to invest in financial assets and to adjust her housing stock.

$$X_t + D_t = A_t + C_t + P_t^h I_t^h$$

Combining the equations above leads to the household's dynamic budget constraint

$$X_{t+1} = (X_t + D_t - C_t - P_t^h I_t^h) R_{t+1}^a - D_t R_{t+1}^d + Y_{t+1}$$

---

<sup>2</sup>A risky asset could also have been added.

## 2.6 The optimization problem

The household maximizes expected discounted lifetime utility subject to the dynamic budget constraint, the law of motion for the housing stock, the stochastic processes and the constraints on the financial instruments.

$$\max U_0 = E \left[ \sum_{t=1}^T \beta^t u(C_t, H_t) \right]$$

with respect to consumption ( $C_t$ ), debt ( $D_t$ ), and housing investment ( $I_t^h$ ). The problem has three state variables; cash-on-hand ( $X_t$ ), last period's housing stock ( $H_{t-1}$ ), and the current housing price ( $P_t^h$ ). Let  $V_t$  denote the household's period  $t$  expectation of life-time welfare, the maximization problem can then be restated recursively using Bellman's principle of optimality as

$$V_t(X_t, H_{t-1}, P_t^h) = \max_{C_t, D_t, I_t^h} \left\{ u(C_t, H_t) + \beta E V_{t+1}(X_{t+1}, H_t, P_{t+1}^h) \right\}$$

subject to laws of motion for the states:

$$X_{t+1} = (X_t + D_t - C_t - P_t^h I_t^h) R_{t+1}^a - D_t R_{t+1}^d + Y_{t+1}$$

$$H_t = \begin{cases} (1 - \delta) H_{t-1} & \text{for } I_t^h = 0 \\ (1 - \lambda)(1 - \delta) H_{t-1} + I_t^h & \text{for } I_t^h \neq 0 \end{cases}$$

the house price and income process

$$P_t^h = \exp \{gt + \eta_t\}$$

$$Y_t = f(t, Z_t) \exp \{\varepsilon_t\}$$

the credit constraint

$$D_t \leq (1 - \kappa_t) P_t^h H_t$$

and

$$A_t = X_t + D_t - C_t - P_t^h I_t^h \geq 0$$

## 2.7 An increase in the interest rate

The effect of a change in the interest rate on household consumption is both theoretically and empirically indeterminate. Here we will consider an increase in

the key policy rate that will drive up all the interest rates in the model, thus we simplify by considering the overall return  $R$ . Using the framework of the model above and disregarding for the moment the inclusion of housing in the utility function (or assuming  $\phi = 1$ )<sup>3</sup>, the standard Euler equation derived from a CRRA utility function is

$$\frac{u'(C_t)}{u'(C_{t+1})} = \frac{(1+r_t)}{(1+\rho)} = \beta(1+r_t)$$

$$\frac{C_{t+1}}{C_t} = (\beta R_t)^{\frac{1}{\theta}}$$

where  $\rho$  is the subjective time preference rate. When the interest rate is higher than the subjective time preference ( $\beta R_t > 1$ ), the household will prefer to have positive savings and consumption will grow over time, but the degree of intertemporal smoothing will depend on the inverse of the relative risk aversion, i.e. the intertemporal elasticity of substitution,  $1/\theta$ . Taking logs of consumption we get an approximate expression for the growth rate of consumption

$$\log\left(\frac{C_{t+1}}{C_t}\right) \approx \frac{1}{\theta}(r_t - \rho)$$

So, the substitution effect of a higher interest rate pulls clearly in the direction of lower consumption today, higher savings today and thus higher consumption tomorrow. However, it will depend on the individuals' preferences, i.e. their patience, and the degree of intertemporal smoothing.

All saving in this model is for life-cycle smoothing purposes, i.e. there is no bequest motive. The savings profile is hump-shaped, rising in the early part of the life cycle, then falling, and eventually becoming negative as wealth is run down in retirement. Saving may also be negative at the beginning of the life cycle. We define lifetime wealth in any period as the sum of asset wealth (accrued savings) and human wealth (the present value of future earnings). Since the present value of future earnings falls with a rise in the interest rate, the human wealth effect from a rise in the interest rate causes a decrease in current consumption. Note that the human wealth effect is likely to differ with age and the remaining horizon. The short run interest elasticity of savings should be higher for younger persons than for older ones because the human wealth effect is greater.

---

<sup>3</sup>When we include housing, we get the additional effect that a higher interest rate will increase the user cost of housing, and we would expect an intra-temporal substitution away from housing towards other consumption. However, this will depend on the preference parameter  $\phi$  and the substitution effect relative to the transaction cost  $\lambda$ . Therefore we disregard this intra-temporal substitution here.

If we consider the asset wealth effect, then the budget constraint shows how effects will depend on the person or households' net position in financial assets, whether they are net savers or net borrowers. To avoid confusing this with the traditional income effect in a two-period model, we call this the resource effect thus linking it more closely to the cash-on-hand concept. When the interest rate rises, the consumer's capital income is also altered. Whether income rises or falls depend on whether the consumer was a net borrower or a net lender prior to the rise in the interest rate. If the family was a net saver, then a rise in the interest rate will yield additional gains on accrued savings. Thus, the family can consume more, both now and in the future. The reverse is true for net borrowers. At a higher interest rate loans cost more than before. Consequently, the consumption possibilities for the net borrower will decline with an increase in the interest rate. In the model above, net wealth is never negative as the credit constraint

$$D_t \leq (1 - \kappa_t) P_t^h H_t$$

ensures that total wealth  $A - D + P^h H \geq 0$ , but net financial assets ( $A - D$ ) can be negative. This imposes also a liquidity constraint since cash-on-hand in its simplest version (all interest rates equal) is

$$X_t = Y_t + (A_{t-1} - D_{t-1}) R_t$$

and if income  $Y$  is given and the interest rate increases, the only way to maintain resources available for consumption is by borrowing more. However, if the consumer is already in the corner solution where  $D_t = (1 - \kappa_t) P_t^h H_t$ , then he cannot borrow more. Thus with liquidity constraints, fluctuations in income in the constrained part of the life cycle result in one-for-one changes in consumption. Later on in life, when incomes are higher and the balance between  $A$  and  $D$  less extreme, there is more room for adjustment and behavioral responses to changes in intertemporal prices.

Given that liquidity constraints may be binding for young households or heavily indebted households, it is likely that the negative resource effect of an increased interest rate will be dominant, while for less constrained households there will be a combination of the resource effect (the size and sign of which will depend on net financial assets  $A - D$ ) and the substitution effect. If  $A > D$  then the resource and substitution effect on consumption will pull in opposite directions and the total effect will be a priori indeterminate.

To sum up all the effects on consumption of an increase in the interest rate: For net savers ( $A > D$ ), there is a negative substitution effect and a positive resource

effect. In addition there may be a negative human wealth effect, but small if the net savers are relatively old. In total the theoretical effect on consumption is a priori indeterminate. For net borrowers ( $A < D$ ) there is both a negative substitution effect and a negative resource effect, and in addition the negative human wealth effect is potentially larger for net borrowers if they are relatively young. At the outset the total effect on consumption should then be clearly negative.

An interesting point raised by Sufi (2015), is that there may be asymmetrical responses to positive and negative changes in the interest rate also within the net borrowers group. Given a reduction in interest rates in order to boost consumption, households with already high debt burden may be either unwilling or unable to increase their consumption more. Unwilling because they would prefer to take advantage of the lower debt cost to pay down more on their mortgage, or unable because they are already at their credit limit. If this effect is important then a higher interest rate will lower consumption for net borrowers, but a lower interest rate will not yield a symmetrical increase in consumption.

Also in empirical studies it has proved difficult to find a clear effect of interest rates on saving and consumption. So far, results from empirical studies using aggregate time-series data have been inconclusive. Virtually no aggregate time-series studies suggest a large savings response by households to changes in the after-tax return. Estimating the savings elasticity is difficult with aggregate time-series data because of the problems of disentangling the impact of the interest rate from other factors that affect consumption and savings decisions. Business cycle variables such as real income growth, credit supply, house prices and other asset prices are jointly determined with the interest rate and also influence each other. This problem introduces substantial uncertainty into determining the empirical responsiveness of household savings to changes in the after-tax return.

Another empirical approach to estimating savings response are analyses of the relationship between the growth rate of consumption - rather than the level of consumption - and the after-tax rate of return. Using micro data, Blundell et al. (1994) and Attanasio and Browning (1995) obtain variation in interest rates by construction "synthetic cohort" data, in which interest rates is a weighted average of time-specific interest rates. These studies report estimates for the intertemporal elasticity of substitution that vary between 0.6 and 2.2, on average about 0.75.

There are two main problems with the identification of the interest rate effect on consumption growth/saving that comes purely from time series variation in the interest rate (also when instrumenting the rate with twice lagged interest rates). The first is mentioned above; the difficulty of identifying the impact from interest rates

because of the co-variation with other time series factors. Instrumenting with lagged interest does not solve this problem if factors are evolving. The second problem, pointed out by Carroll (2001), is that a higher interest rate will lead to higher wealth holdings, which reduces the variance of consumption, lowering the growth rate of consumption. This violates the assumption of most analyses of the log-linearized Euler equation, namely that the consumption variance term does correlate with the interest rate, and causes biased estimates of the elasticity of intertemporal substitution (downwards).

### 2.8 A drop in house prices

Rising house prices affect household spending by either loosening a household's lifetime budget constraint ("pure" lifetime wealth effect, see Skinner, 1994) or loosening the household's borrowing constraint so that consumption rises toward the level implied by the consumption Euler equation (borrowing collateral effect, see Iacoviello, 2004). In this model the wealth effect is assumed to be operating through the collateral channel, i.e. higher housing wealth opens up for re-mortgaging, while a drop in house prices,  $\eta_t$ , will tighten the credit constraint. Recalling that

$$P_t^h = \exp \{gt + \eta_t\}$$

and

$$D_t \leq \begin{cases} (1 - \kappa_t) P_t^h (1 - \delta) H_{t-1} & \text{for } I_t^h = 0 \\ (1 - \kappa_t) P_t^h [(1 - \lambda) (1 - \delta) H_{t-1} + I_t^h] & \text{for } I_t^h \neq 0 \end{cases}$$

For households already in the corner solution where the mortgage is at the maximum, a drop in house values may require increased savings as the mortgage has to be brought down to the new (lower) level implied by the credit constraint. In practice this constraint may not be as binding for existing borrowers as banks seldom require that households adjust their loan-to-value to fluctuating house prices. New housing investment will not be affected as long as we assume the agents are buying and selling in the same market. Entry into the housing market will be easier with low house prices, unless a fall in house prices is accompanied by an increase in the equity requirement,  $\kappa$ . This could happen in a market with adaptive expectations and where the creditors expect house values to continue to fall in the future, see Anundsen and Jansen (2013).

Unlike in the previous section where an interest rate shock would affect consumption and saving differently depending on the net asset position, and where it also

would potentially cause substitution effects, a wealth effect of housing is more clear cut. An increase in consumption would be mirrored by a similar reduction in saving.

Most empirical studies conclude that house price appreciation affects household spending through the borrowing collateral channel and not the pure wealth effect channel. Generally they find a small, but significant, effect of (unanticipated) housing capital gains on consumption behavior. The most recent analyses also consider heterogeneous responses, mainly the heterogeneity in responses between young and old homeowners and renters (Campbell and Cocco, 2007; Attanasio et al., 2009; Disney et al., 2010) under the argument that young and old households are “short” and “long” in their holdings of housing wealth and should therefore respond differently. Furthermore, the size of the wealth effect is based on perceptions of the change in wealth. Disney et al. (2010) find a much smaller response to a house price “shock” (an average marginal propensity to consume out of unanticipated gains of around 0.01) than Campbell and Cocco (2007) find for pure changes in the UK housing wealth (who finds a marginal propensity to consume out of housing wealth of close to 0.1). For the US, Cooper (2012) finds that the consumption of potentially borrowing constrained households increases between 0.06 and 0.18 per dollar increase in their housing equity, while the consumption of unconstrained households is little changed. Using Danish data for consumption similar to the data used in this memo, Browning et al. (2013) also find a positive and significant relationship between unanticipated house price innovations and consumption only for young households who are likely to be credit constrained (with an average MPC of 0.05). Only one study, Disney et al. (2010), considers asymmetrical effects of house price rises and falls, but finds no evidence of a significant asymmetry in the response to gains and losses.

### 2.9 A negative income shock (unemployment)

A negative shock to labor income,  $\varepsilon_t$ , (that may have been caused by an increase in the unemployment rate) will in isolation simply have a negative income effect:

$$Y_t = f(t, Z_t) \exp \{ \varepsilon_t \}$$

Remember that cash-on-hand  $X$  is the sum of net assets (at the start of the period), its return, and current labor income:

$$X_t = NA_t + Y_t = (A_{t-1} - D_{t-1}) R_t + Y_t$$

and that the household can use her resources which consists of cash-on-hand and the debt taken out to finance consumption, to invest in financial assets (savings) and to invest in housing.

$$X_t + D_t = A_t + C_t + P_t^h I_t^h$$

A negative income shock leads to less consumption and/or lower investment in housing as long as the household is credit constrained and is unable to borrow to smooth the shock (negative savings). As the equation above shows, if the household has enough financial assets, an alternative is to use some of these resources to smooth consumption (also negative savings).

By now, it is widely accepted in the literature that the individual income process is well described as in Section 2.2 of this memo; a deterministic part (life-cycle) plus an income process consisting of a permanent (random walk) and transitory (white noise) component. Thus, effects will depend on whether the income shock is perceived to be transitory or permanent. According to Friedman (1957)'s permanent income theory the consumer's response to a permanent income shock should be close to 1, while the response to a transitory income shock should be close to zero.

Basten et al. (2015) use the Norwegian register data to investigate saving patterns and portfolio rebalancing toward safer assets before unemployment. They find additional saving in the three years before the unemployment spell as well as in years 3 and 4 after job loss. Furthermore, they also find evidence of portfolio rebalancing in the years before unemployment. The latter two results suggest that the average household is indeed able to foresee the upcoming unemployment spell, and is then both able and willing to prepare for those rainy days.<sup>4</sup>

In reality, a macro economic shock often involves a change in all parameters in the model simultaneously; the interest rate  $R$ , the house price shock  $\eta$  and the income shock  $\varepsilon$ . Furthermore, high levels of debt, where interest expenditures are paid with current income, make households more vulnerable to economic changes such as higher interest rates, loss of income or a drop in house prices. Some of this vulnerability may be offset by flexibility in the credit market, but more often than not the credit market is pro-cyclical – tightening in when needed the most – or exhibiting so-called credit crunches. In the model this could be illustrated by an endogenous increase in  $\kappa$ , a lowering of the loan-to-value ratio.

---

<sup>4</sup>However the data set in their analysis is restricted to stable couples between 30 and 58 years old, who are less likely to be liquidity constrained.

### 3 Empirical evidence for Norway

Norway is an interesting case to study because it is a country with a long history of promoting homeownership, partly through making housing a very tax-favored savings vehicle. The economic incentives lead young households to enter the housing market early and with high leverage. Furthermore, since the Norwegian economy is generally good and the country has a very well developed social security system, access to mortgages has been easy for most households since the last banking crisis ended (in 1992). This has led to a high share of mortgage-financed homeownership in Norway. Finally, there is a prevalence of floating interest rate mortgages. Only a small fraction hold fixed interest rate loans. Although this fraction varies over time it has rarely been above 10 percent of the total amount of loans in the household sector. In other words, the majority of the Norwegian population is quite exposed to interest rate changes through their mortgages, and interest changes have an immediate effect on the households' budget.

#### 3.1 Data description

The data is derived from a combination of administrative registers covering all individuals in Norway, where the main data source used in the analysis is the register of tax returns that contains detailed information about all individuals' incomes and wealth. These data are of high quality because most information is third-part reported to the tax authorities, and very little is self-reported. The information from the tax returns is combined with family identifiers from the population register in order to aggregate all income and wealth information at the family level. Thus all variables in the analysis is measured at the family level.<sup>5</sup> In this analysis we focus on the period 2000-2011.

We combine information from Norwegian registry data on income, asset holdings, and asset returns to arrive at imputed consumption expenditure from the household budget constraint. The method is comparable to, and along the lines of the work done by Browning and Leth-Petersen (2003), Kreiner et al. (2014) and Koijen et al. (2014). Using the notation from the theory section, the household can use her resources which consists of cash-on-hand and the debt taken out to finance

---

<sup>5</sup>A family is defined as either one or two adults plus any number of children.

consumption, to invest in financial assets (savings) and to invest in housing

$$\begin{aligned}
X_t + D_t &= A_t + C_t + P_t^h I_t^h \\
C_t &= Y_t + (A_{t-1} - D_{t-1}) R_t + D_t - A_t - P_t^h I_t^h \\
C_t &= Y_t + (A_{t-1} - D_{t-1}) r_t - (A_t - A_{t-1} + D_{t-1} - D_t + P_t^h I_t^h)
\end{aligned}$$

which gives us a definition of consumption of household  $i$  in period  $t$  as income minus savings. However, for reasons that will be explained in Appendix A we exclude periods with housing investment ( $P_t^h I_t^h$ ) because of measurement errors. On the other hand we include lottery winnings, inter vivos gifts and inheritances ( $B_t$ ) that are not in the model but available in the data, i.e.

$$C_t = \underbrace{Y_t + (A_{t-1} - D_{t-1}) r_t + B_t}_{\text{disposable income}} - \underbrace{(A_t - A_{t-1} + D_{t-1} - D_t)}_{\text{active saving}} \quad (1)$$

In our data, the change in nominal financial assets from one year to the next consists of two parts; changes in the stock of asset and changes in the valuation of the asset. We do not want unrealized changes in the asset's price, i.e. unrealized capital gains and losses, to be part of our consumption imputation as they do not reflect the household's active consumption and savings behavior. Thus what we call "active savings" is the nominal change in financial assets minus capital gains and losses.<sup>6</sup> Equation (1) also provides the definition of disposable income used throughout this analysis as labor income + transfers + net capital income, all measured after tax, plus any lottery winnings, inter vivos gifts and inheritances.<sup>7</sup> See Appendix A for a more detailed description of the imputation method and sample restrictions.

### 3.2 Consumption tracks income - savings reflect life cycle behavior

Consumption tracks income closely over the life cycle. This property follows from the way consumption is imputed, i.e. as income minus active savings. We therefore focus on saving behavior over the life cycle. Figure 1 shows the effect of separating active and passive savings. Passive saving refers to the annual difference in net financial wealth, without adjusting for capital gains and losses. Passive saving follows mainly

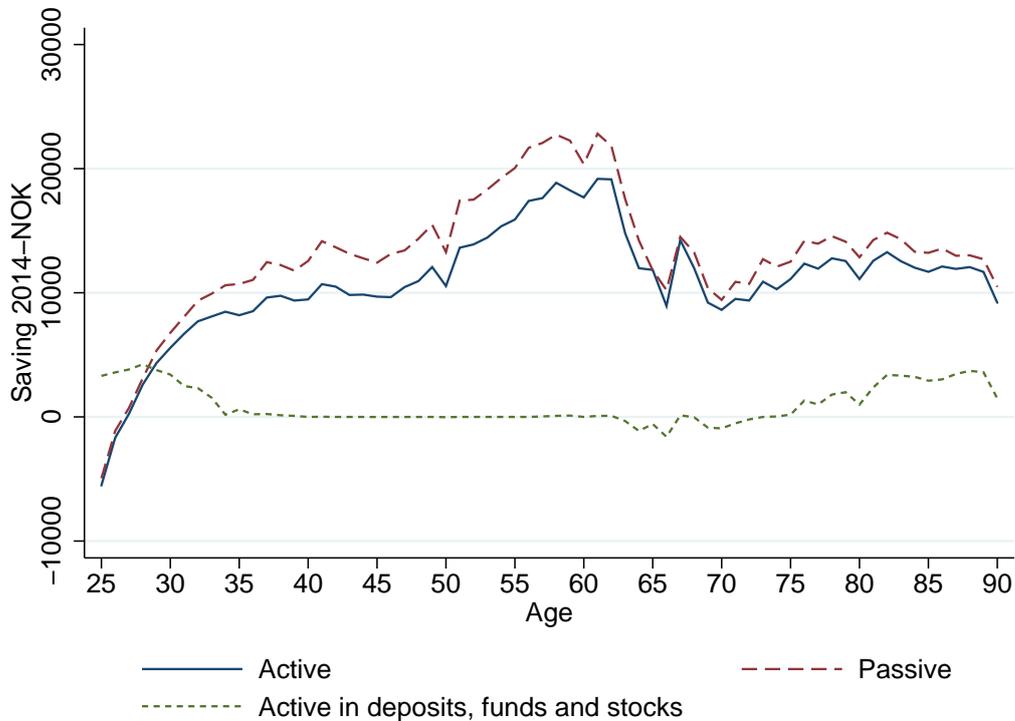
---

<sup>6</sup>For stocks we have used the Oslo Stock Exchange index (OSE) to calculate gains and losses, for mutual funds we have used a combination of the OSE and the MSCI World index and for bond we have used the Treasury bill rate.

<sup>7</sup> In Fagereng and Halvorsen (2015) we also present imputations of consumption that include imputed rent from owner-occupied housing, and a savings measure that include changes in real assets other than housing, essentially adding depreciation of cars, boats and other durables in the consumption definition.

the same pattern as active saving, and is in line with traditional life-cycle theory; negative savings in younger years, then a gradual increase in savings until it peaks at ages 55-60, thereafter saving drops markedly at retirement. The lowest line in Figure 1 shows active saving in all financial assets except changes in debt. It highlights how down payment on mortgages is the main savings vehicle for most households. Active saving other than accrual or down payment of debt is small at the median, except for young households saving up for house purchases and elderly households. The median values are low and are not representative of average saving, but useful as an illustration of the saving pattern over the life cycle.<sup>8</sup>

Figure 1: Median active vs passive saving by age. 2005-2011



*Note:* Active saving is the first difference in net financial wealth adjusted for unrealized capital gains and losses, while passive saving is the first difference in net financial wealth with no adjustment. Active saving in deposits, funds and stocks denotes active saving in all positive financial assets (i.e. not including changes in debt). Median of all years pooled together at each age.

### 3.3 Initial impacts – size and distribution

With comprehensive micro data for households it is straightforward to compute the size of an initial income/wealth effect and its distribution over the population. Ideally, we would like to use the imputed consumption measures to calculate the

<sup>8</sup>Statistical means of saving by age are dominated by extreme values and not fit for graphical representation.

marginal propensities to consume over the life cycle, and subsequently the aggregate consumption effect of an income change. However, since we have used current income in the construction of consumption, it would be tautological to estimate a regression where current income is included as an explanatory variable.<sup>9</sup> In Appendix B we present a short survey of the literature on the marginal propensity to consume (MPC) out of permanent and transitory income shocks.

In Figures 2 and 3 we show the first effect of a one percentage point increase in the interest rate, a one percent drop in labor income, and a one percent drop in house prices. The outcome is calculated on the distribution in 2011 and is therefore measured in 2011-kroner. For interest rates we present the after-tax income effect, for labor income we present the pre-tax income affect (as the tax varies individually), and for the drop in house prices we present the effect on the net housing value (defined as housing wealth less debt).<sup>10</sup> The latter differs from the two former effects by not directly affecting the households' cash-on-hand. One could argue that it is the effect on gross housing value that is relevant, especially when there is a drop in house prices and the household has a high loan-to-value. This will be more discussed in later sections.

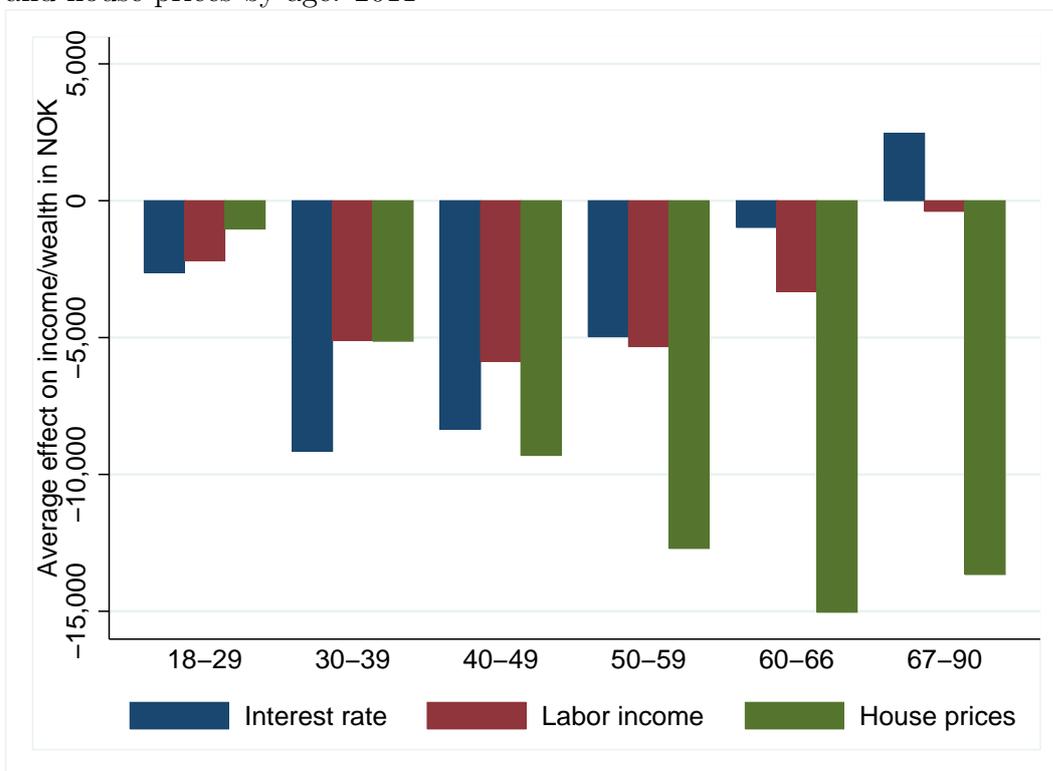
Due to the currently high degree of indebtedness in the population, an increase in the interest rate would be a negative income shock for most households, especially those in prime working ages. Only the oldest age groups have positive net interest bearing assets on average. In 2011 an increase in the interest rate of 1 percentage point would lead to an average drop in annual after-tax income of about NOK 9,000 after tax for households in their 30s, or an annual drop of NOK 27,000 if the increase was 3 percentage points. However, Figure 3 indicates that households on average are relatively robust as the main bulk of debt is concentrated in the upper income deciles. As shown in the theory section, the crucial variable is the net asset position. This will determine the immediate income effect from a change in the interest rate. If we consider the net position in interest bearing assets, those with high levels of debt will typically also have negative net assets, even though they may at the same time have a decent amount in savings accounts. The overall impact on the household's cash-on-hand will depend on both the income shock relative to current labor income and liquid buffer stock. As Figure 3 shows, high-income households bear the highest change in interest expenses, suggesting that they might have enough resources.

---

<sup>9</sup>An alternative would be to find an estimator and a way of instrumenting for income that deals with this endogeneity problem. One choice would be to apply the GMM estimator that uses previous lags of levels and/or differences or forward deviations in income as instruments. As discussed in Cappelen et al. (2016), such estimators may come close to the true estimates but will never completely resolve the endogeneity problem.

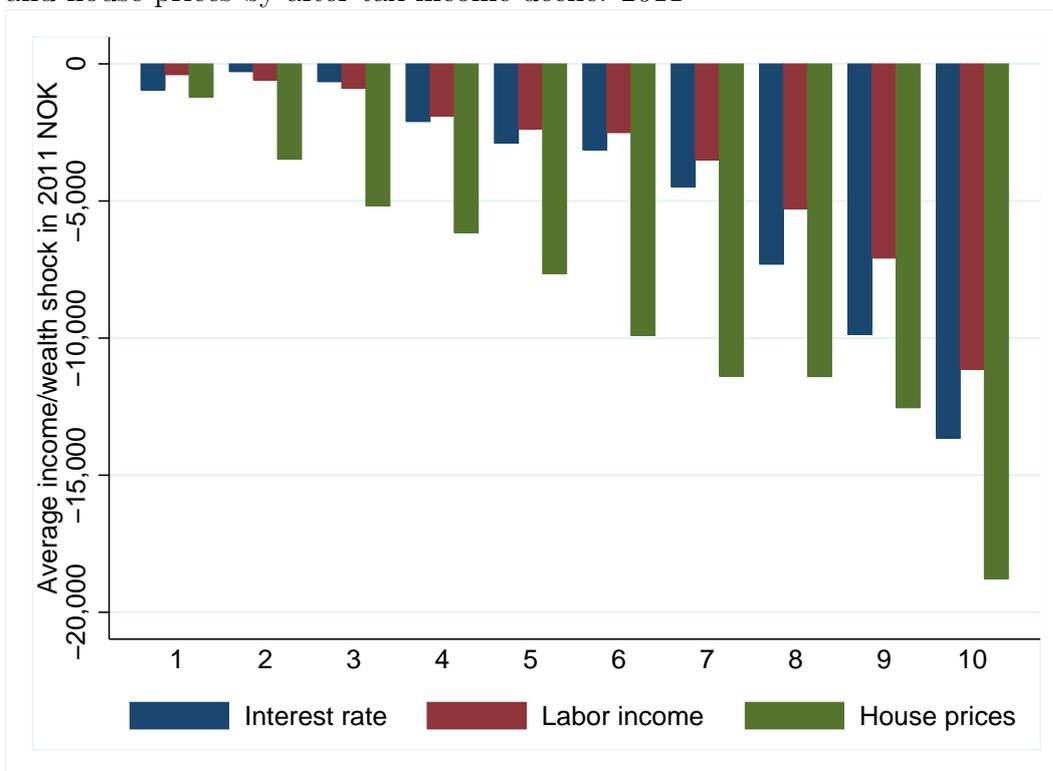
<sup>10</sup>Housing wealth is measured as the tax value multiplied with 4.

Figure 2: The effect on income and wealth of a shock to interest rates, labor income and house prices by age. 2011



Note: The after-tax income effect of a 1 percentage point increase in interest rates; the pre-tax income effect of a 1 percent drop in labor income; the net wealth effect of a 1 percent drop in house prices. Net wealth is measured as housing wealth less debt.

Figure 3: The effect on income and wealth of a shock to interest rates, labor income and house prices by after-tax income decile. 2011



Note: The after-tax income effect of a 1 percentage point increase in interest rates; the pre-tax income effect of a 1 percent drop in labor income; the net wealth effect of a 1 percent drop in house prices. Net wealth is measured as housing wealth less debt.

The decline in labor income affects only non-retired households, and the potential accompanying increase in uncertainty would affect young households more than more mature and settled households with a shorter remaining working life. Thus a labor income shock would affect young households relatively more than older households. However, there are two factors that mitigate the effect of a labor income shock. Firstly, taxes work as automatic stabilizers (not shown in the figures here), and secondly, there is public insurance against unemployment.

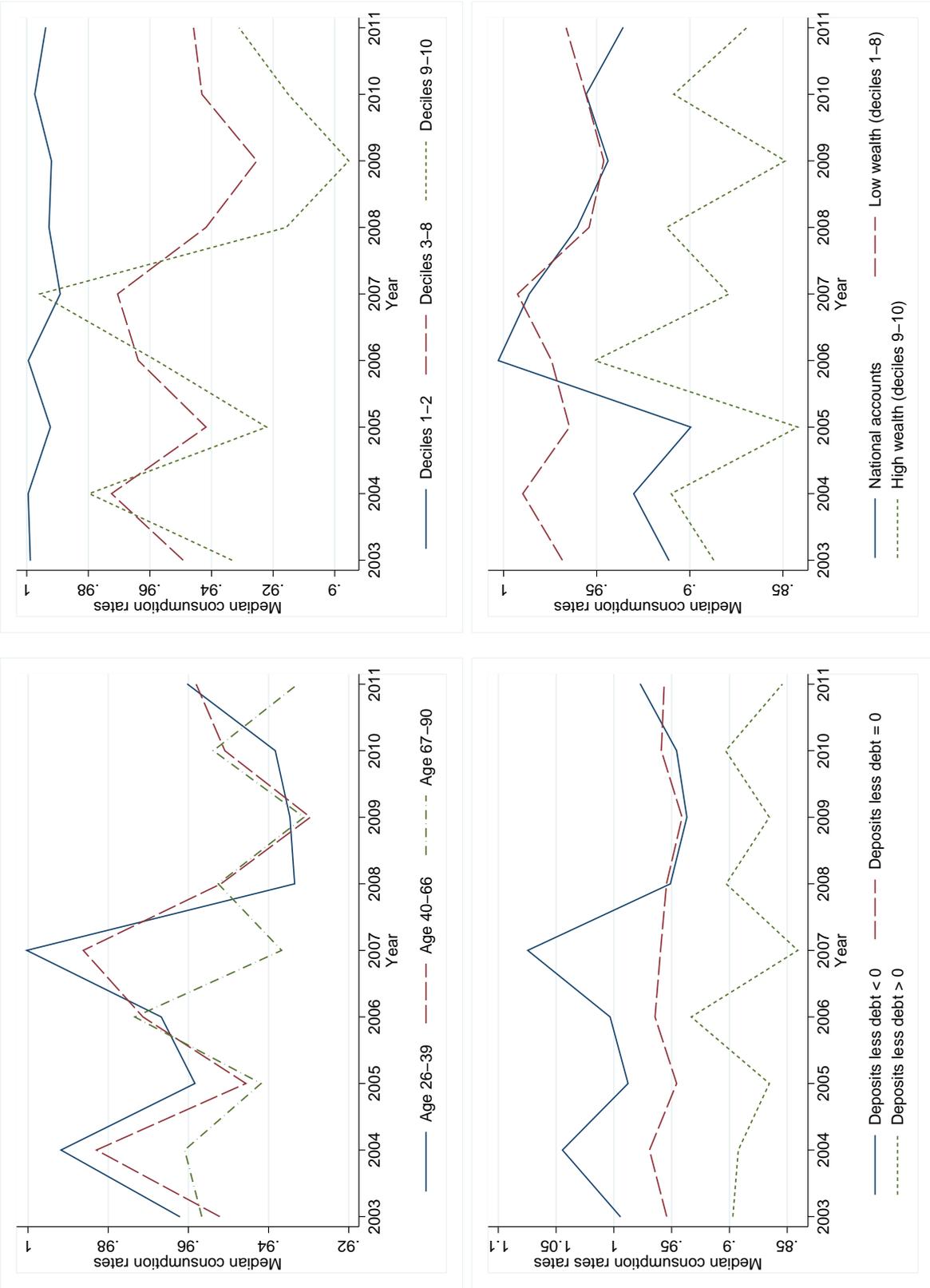
Since housing equity accounts for a large share of total net wealth in Norway, even small changes in house prices may generate a large impact. This is illustrated in the figure by the fact that a one percent drop in house prices generates the largest effect of all, even though a one percent drop in the house price is not very much. According to Figure 2, the housing net wealth effect will affect older age groups relatively more. Figure 3 shows that housing wealth is more evenly distributed over income than other types of assets, but a drop in house prices will affect the upper decile more.

### *3.4 Consumption rates over time*

There are three important dimensions that may determine both the impact of a shock and the consumption response to the shock; age, after-tax income and indebtedness, see the discussion in Appendix B. In policy discussions one seems to concentrate on several distinct household “types” that are not necessarily well identified simply across the dimensions age, income and debt. The most vulnerable households are usually low-income households, but may be found in all age groups. The indebted households are mainly in the age group 30-49 years old – but not necessarily – and as shown above they can be found over the entire income distribution. Their main characteristic is the huge imbalance between positive and negative interest income which makes them especially vulnerable for interest rate changes, and yet statistics show that there is a significant fraction of 30-49 year olds that actually have a substantial financial buffer. Finally, the very wealthy is a main driver of the macro measures, but their response to policy changes and macroeconomic shocks may deviate substantially from the response of an ordinary, indebted household since their portfolio is more diversified.

The four panels in Figure 4 show median consumption rates, defined as consumption over disposable income, for different groupings of the population over the years 2003-2011 (the consumption rates presented in the figure are also given in Appendix C). In the upper left panel we have divided into three age groups; the “young” (age 26-39), the “middle aged” (age 40-66) and the “elderly” (age 67-90).

Figure 4: Median consumption rates by age, disposable income decile, deposits less debt position, and net total financial wealth compared to the National Account consumption rate. 2003-2011



The figure shows that the young in general have higher consumption rates and their drop in consumption during the financial crisis is more pronounced than for the two other age groups, although there is a distinct drop in the consumption rate of middle aged households as well. Only in retired households do we not find the same pattern. The upper right panel shows a split into disposable income deciles. We have grouped the two lowest deciles and the two highest deciles separately, while deciles 3-8 is the third group. Here we see a clear difference between the lowest part of the income distribution and the rest. Low income household have quite consistently consumption rates close to unity, in other words they consume all their income or in the terminology used before, they are hand-to-mouth consumers. For the remaining part of the distribution, there is no apparent difference between the top incomes and the middle incomes apart from somewhat higher consumption rates in 2007 and a subsequently larger decline in consumption rates in 2008-2009 for the top incomes.

Next, we sort by bank deposits less debt having in mind that changes in interest rates will have opposite effects on those who are net savers and those who are net borrowers in banks. In the figure we let those with positive net interest bearing assets (bank deposits minus debt) be in the net savers group, and those with negative interest bearing assets be in the net borrowers group, those with neither is in the remaining group, called “deposits less debt = 0” in Figure 4.<sup>11</sup> In the latter group we find households with little or no assets, and these seem to have very stable consumption rates over time. Net borrowers exhibit the same pattern as young households in the figure above, but at a higher level. This indicates that not all young households are net borrowers. Likewise, the pattern of net savers resembles that of older households, and this is not surprising since there is substantial overlap between these two characteristics. Older households account for 17 percent of the population in 2011, while the group of net savers are about 14 percent. Correspondingly, net borrowers constitute about 42 percent of the population in 2011, and young households 38 percent.

The lower right panel sort households by the distribution of total net financial wealth. While one may worry about how vulnerable households will be affected by policy changes, their consumption and savings behavior will have little influence on the aggregate measures of consumption and savings. In Norway, the ten percent wealthiest own half of total net wealth, and the top three deciles of the income distribution receives almost half of total after-tax income (according to Statistics

---

<sup>11</sup>To be precise the “deposits less debt = 0” group is defined as having deposits less debt smaller than +/- annual gross income.

Norway's income and wealth statistics for 2013<sup>12</sup>). The behavior of the wealthy households may have a large impact on aggregate measures (forcefully demonstrated before the 2006 tax reform) but their behavior is not necessarily described by a general lifecycle model, see Carroll (2000). Thus, in this figure we have included the consumption rate from the National Accounts.<sup>13</sup>

The figure illustrates a main point; that most of the fluctuations in the National Accounts' consumption rate are driven by the wealthiest households.<sup>14</sup> Being wealthy is here defined as being in the top two deciles of the net financial wealth distribution. This is especially apparent for the years 2003-2006, but also the decline in consumption rates in 2011 seems to reflect more the wealthy households' behavior than the rest of the population. The conclusion is the same for the aggregate saving rate, since it will only mirror the consumption rate. As we saw above the top income households do not correlate as much with the National Accounts' as the top of the wealth distribution does. The wealth distribution is more unequally distributed than the income distribution, thus the top of the wealth distribution identifies more clearly the "rich" households than do the top of the income distribution.

Finally, we investigate the role of high debt ratios and liquid financial buffers (bonds/bank accounts plus mutual funds). We split the sample into the following three groups; consumers with no financial buffer, consumers who have high loan-to-income or high loan-to-value but also some financial buffer, and the rest of the population. We define "no buffer"-consumers as households with a financial buffer smaller than one month's gross income. Consumers with high debt ratios have either a loan-to-income of 3 or more, or they have a loan-to-value larger than 0.85, but we look separately at those who are not in the former group (thus they do have a financial buffer larger than one month's gross income). Since the imputed consumption automatically will be high when debt is incurred, we define high debt ratio households on the basis of the previous period (assuming at the same time that they are not in the "no buffer" group in the current period). The rest of the population is in neither group, i.e. they have moderate loan-to-income ratios and a liquid financial buffer larger than one month's gross income.

Figure 5 shows that the "no buffer"-group has consumption rates around one, indicating that they consume approximately all their income, acting as hand-to-mouth consumers. Rest of the population-group exhibits also quite stable consumption rates

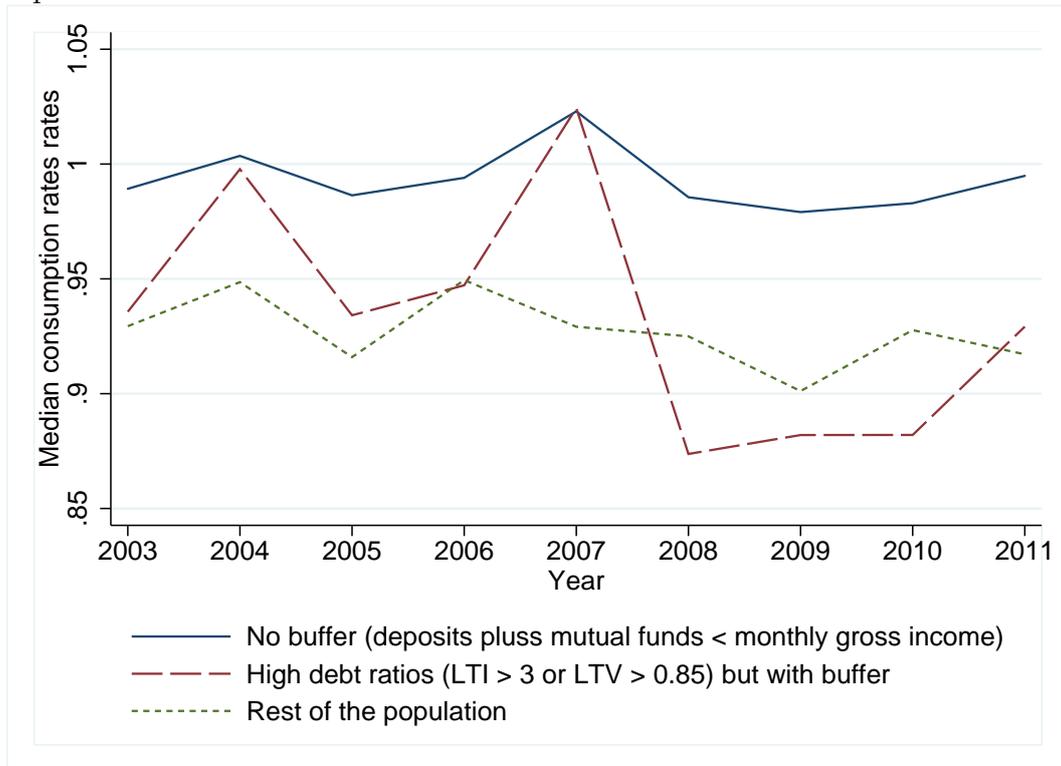
---

<sup>12</sup><https://www.ssb.no/inntekt-og-forbruk/statistikker/ifhus/aar/2014-12-17>

<sup>13</sup><https://www.ssb.no/nasjonalregnskap-og-konjunkturer/statistikker/nr>

<sup>14</sup>The conclusion holds even when we use mean or aggregate consumption rates or base the median statistic on the whole sample, i.e. without excluding owners of non-listed shares and business capital. However, consumption rates based on a non-restricted sample becomes very volatile and is therefore not shown.

Figure 5: Median consumption rates (consumption/disposable income) in three groups of households. 2003-2011



over time, but at a lower level implying lower propensities to consume. Furthermore, their consumption rate is relatively stable during the financial crisis. It is in the high debt ratio group that we find the largest response to the crisis. Although this group is smaller than the others (which may explain some of the volatility in the statistics), we still recall this drop in consumption rates in 2008 from the previous figures for young households, top income decile households and negative net financial asset households respectively. From Figure 5 it seems that the combination of high loan-to-income (or loan-to-value) and a reasonably large financial buffer identifies quite well the group of consumers that respond most strongly to income shocks or other changes on economic conditions.

Table 1 looks more closely at the characteristics of the three groups used for illustration in Figure 5. The "no buffer" group have by construction little financial assets but they also have a fair amount of debt and we note that their annual interest expenses exceed their financial buffer, indicating that they are vulnerable to increases in the interest rate. There is a slightly higher fraction of males in this group, and they account for about 30 percent of the population. This is quite a large fraction considering that it is a group that seems less able to smooth their consumption in the presence of income shocks. The relative size of this group is also

Table 1: Characteristics of the three groups in Figure 5. 2011

	No buffer	High debt ratio	Rest of the population
Disposable income	375,065	417,020	426,422
Earned income	452,985	558,975	416,535
Interest expenses	50,150	81,442	23,421
Debt	1,130,596	2,161,331	621,685
Net housing value	579,552	759,178	1,426,605
Financial buffer	20,181	320,343	518,514
Risky share	.06	.08	.06
No of children	.64	.81	.43
Male	.52	.51	.47
Loan-to-income (median)	1.44	3.25	.47
Loan-to-value (median)	.14	.72	.01
Age (median)	41	37	53
Fraction of population	.30	.12	.58

*Note:* Values in 2011 NOK, measured at the household level. Mean values based on unrestricted sample. All rates are measured as fraction of disposable income, and reported as median rates.

surprisingly close to the estimated fraction of hand-to-mouth consumers in Kaplan and Violante (2014), and to the fraction of rational non-planners in Reis (2006).

The main characteristics of the high debt ratio consumers is that they have both high earnings and high debt values (as illustrated in Figure 3), but also a considerable financial buffer. On average they seem to have room to maneuver and to be able to smooth income shocks. However, as Figure 5 illustrates, they still may have high propensities to consume and may react strongly to negative or positive income shocks. This group is also characterized by being somewhat younger and having more children, and as a fraction of the population they are increasing over time. Given the way it is defined above this group constitutes 12 percent of the population in 2011, as opposed to about 9 percent in 2005. However, it is important to note that given the way we have defined and sorted households (based on their current position or position in the previous period), there is a considerable amount of entry and exit between the different groups over time so we are not necessarily comparing the same households over time. In the next section we take on an alternative approach where the groups are defined on the basis of their debt position in an initial period and where the behavior of that group is followed over time.

Using Norwegian consumption data from Fagereng and Halvorsen (2015), Yao et al. (2015) investigate how housing and mortgage debt affects households' marginal

propensity to consume out of wealth. They find that after controlling for wealth, the households with high loan-to-value decrease their consumption more when their wealth decreases. They next develop a structural model to account for how households accumulate mortgage debt over the life cycle and how this affects consumption choice.

## 4 Consumption responses after the financial crisis

Many countries saw steeply rising debt levels prior to the financial crisis. At the same time house prices also rose rapidly, so that debt to asset ratios remained fairly stable. When the financial crisis hit, a dramatic drop in house prices in many countries left a number of households with very high loan-to-value ratios. In Norway, the decline in house prices was only moderate compared to countries such as Denmark and the US (in Norway nominal house prices fell by 1,4 percent in 2008<sup>15</sup>, while they fell by 16 percent in Denmark), thus the loan-to-value ratio has been of a lesser concern than indebtedness in general.

Dynan (2012) was among the first to analyze specifically the role of households' indebtedness in the downturn in consumer spending that followed the financial crisis. More precisely, she shows that US mortgagors with high loan-to-value (LTV) ratios prior to the crisis subsequently experienced larger declines in spending between 2007 and 2009. The analysis was followed up by similar work in the United Kingdom by Bunn and Rostom (2014), and in Denmark by Andersen et al. (2014). In the Danish paper the authors also find that high levels of household debt measured by the loan-to-value ratio are associated with deeper downturns in consumer spending. They extend their analysis by allowing for a non-linear correlation, finding a stronger correlation the higher the LTV ratio. Bunn and Rostom (2014) study the indebtedness of UK households by loan-to-income (LTI) ratios instead of LTVs, and find the same pattern. Another related paper is Mian et al. (2013) who found that retail sales declined more in counties where households were highly leveraged prior to the crisis. Further, Baker (2015) finds that households with higher debt levels are more sensitive to a given change in income, using firm shocks as instruments for household income changes.

In this section we follow up on work by Andersen et al. (2014) who study whether high household leverage in Denmark amplified the reduction in household spending over the course of the financial crisis of 2008. Since the analysis by Andersen et al. (2014) is based on consumption data derived in the same manner as our data, we will initially replicate their analysis by estimating the following econometric specification:

$$\Delta C_{i,07-s} = a + F(\beta, LTV_{i,07}) + \delta_1 \ln(Y_{i,07}) + \delta_2 NW_{i,07} + \delta_3 FW_{i,07} + \delta_4 \Delta Y_{i,07-s} \quad (2)$$

$$+ \delta_5 \Delta H_{i,07-s} + \delta_6 \Delta kids_{i,07-s} + \delta_7 \Delta C_{i,06-07} + \gamma X_{i,07} + \epsilon_{i,s}, \quad (3)$$

---

<sup>15</sup>According to Statistics Norway's annual house price index.

where the left hand side variable is the change in family  $i$ 's consumption from 2007 to year  $s$ . Similar to Andersen et al. (2014) the change in consumption is measured as a share of family  $i$ 's pre-tax income in 2007. The most important variable is the leverage, which we measure as loan-to-value (LTV) prior to the crisis. For the analysis to be valid we perform the regression for homeowners only. About two-third of Norwegian households are homeowners. Disposable income is defined as all income (labor, transfer and capital) minus tax and interest expenditure plus gifts and inheritances. Financial wealth is the sum of bank accounts, bonds, funds and listed stocks (remember that owners of non-listed stocks are removed from the imputation of the consumption variable). Housing wealth is measured as tax values converted to appropriate market values of owner occupied housing for the years 2010-2011, whereas for previous years the preliminary values calculated by Statistics Norway are used, see Appendix A. Net wealth is then financial wealth plus housing wealth minus debt. For more details on the data, see the data section. Other controls are change in number of adults, change in number of children, age of oldest family member, age of the youngest child, and county of residence.

Table 2: Consumption responses in and after the financial crisis, by loan-to-value  
Change in consumption from 2007 to year  $s$ , as a fraction of income in 2007

	$s = 2008$	$s = 2009$	$s = 2010$	$s = 2011$
Loan-to-value (LTV) ratio in 2007	-.088*** (.006)	-.137*** (.016)	.018** (.007)	-.046** (.008)
Log of disposable income <sub>2007</sub>	.171*** (.008)	.210*** (.022)	.214*** (.010)	.110*** (.010)
Financial wealth <sub>s</sub> /income <sub>2007</sub>	.098*** (.002)	.226*** (.006)	.045*** (.003)	.130*** (.003)
Net wealth <sub>s</sub> /income <sub>2007</sub>	-.002** (.000)	-.042*** (.001)	.041*** (.001)	-.008*** (.001)
$\Delta$ Disposable income <sub>2007-s</sub> /income <sub>2007</sub>	.430*** (.003)	1.22*** (.007)	1.35*** (.004)	.796*** (.002)
$\Delta$ Housing wealth <sub>2007-s</sub> /income <sub>2007</sub>	.038*** (.002)	-.009** (.001)	.072*** (.001)	-.026*** (.001)
Constant	-2.29*** (.214)	-2.53 (1.45)	-3.43** (.640)	-1.93** (.678)
R-squared	0.807	0.407	0.607	0.521
Observations	108,724	106,769	103,741	100,995

Notes: Income is pre-tax income. Other controls are change in number of adults, change in number of children, age of oldest family member, age of the youngest child and county of residence. Clustered standard errors in parenthesis. Coefficient significance: \*\*\* 1 percent; \*\* 5 percent; \* 10 percent.

Table 2 shows that we in general obtain similar correlations between consumption change and loan-to-value ratio as Andersen et al. (2014). A higher loan-to-value ratio in 2007 decreases consumption growth in succeeding years. Our analysis suffer from the use of preliminary imputations of housing wealth for the years 2007-2009, which makes our measure of the loan-to-value ratio imprecise prior to 2010. It also causes a break in the data when the new tax values are introduced in 2010, something that probably explains why the coefficient for the loan-to-value ratio changes from negative to positive in 2010.

An alternative is to replace the loan-to-value ratio with loan-to-income ratio as right-hand-side variable:

$$\begin{aligned} \Delta C_{i,07-s} = & a + F(\beta, LTI_{i,07}) + \delta_1 \ln(Y_{i,07}) + \delta_2 NW_{i,07} + \delta_3 FW_{i,07} + \delta_4 \Delta Y_{i,07-s} \\ & + \delta_5 \Delta H_{i,07-s} + \delta_6 \Delta kids_{i,07-s} + \delta_7 \Delta C_{i,06-07} + \gamma X_{i,07} + \epsilon_{i,s}, \end{aligned} \quad (4)$$

With the loan-to-income ratio we obtain coefficients that are similar to the Danish analysis inn all periods, see Table 3. We find a clear negative correlation between the change in household consumption from 2007 to the years 2008-2011 and household indebtedness in 2007. As in Andersen et al. (2014) we find that the effect is persistent also after the financial crisis, i.e. we find an effect in 2010-2011. Furthermore, we also find a stronger correlation between the decline in spending and the loan-to-income ratio for higher levels of the LTI, see Table 4 where we instead of using loan-to-income ratio linearly, use a piecewise linear specification, where each of the coefficients display the slope between categories of loan-to-income ratios.

Because of the endogeneity between change in income, wealth and consumption by construction, the coefficient for change in disposable income cannot be interpreted as a marginal effect. We note, however, that the estimated values are in the range 0.53-0.78, which is similar to the estimates in Cappelen et al. (2016) on the effect on consumption of changes in disposable income using other econometric specifications. The coefficients with respect to income are also more stable over the periods in the specification with loan-to-income on the right-hand-side compared to the specification with loan-to-value on the right-hand-side (except for the variables relating to house value that still suffers from measurement errors as discussed above).

The results from this analysis should be interpreted with care. The combination of variables on the right-hand side may cause multicollinearity problems, and the results are sensitive to the choice of the right-hand-side variables. To evaluate the robustness of the conclusion that the decline in consumption growth during and

Table 3: Consumption responses in and after the financial crisis, by loan-to-income  
Change in consumption from 2007 to year  $s$ , as a fraction of income in 2007

	$s = 2008$	$s = 2009$	$s = 2010$	$s = 2011$
Loan-to-income (LTI) ratio in 2007	-.131*** (.002)	-.121*** (.002)	-.138*** (.002)	-.108*** (.002)
Log of disposable income <sub>2007</sub>	.047*** (.006)	.050*** (.006)	.052*** (.007)	.034*** (.006)
Financial wealth <sub><math>s</math></sub> /income <sub>2007</sub>	.098*** (.002)	-0.46*** (.002)	.076*** (.002)	-.007** (.002)
Net wealth <sub><math>s</math></sub> /income <sub>2007</sub>	.001* (.000)	-.018*** (.001)	.010*** (.001)	.016*** (.001)
$\Delta$ Disposable income <sub>2007-<math>s</math></sub> /income <sub>2007</sub>	.660*** (.004)	.527*** (.003)	.778*** (.004)	.712*** (.004)
$\Delta$ Housing wealth <sub>2007-<math>s</math></sub> /income <sub>2007</sub>	.003* (.002)	.016*** (.001)	-.005*** (.001)	.006*** (.001)
Constant	-.217 (.385)	-.567 (.411)	-.462 (.434)	-.521 (12.1)
R-squared	.454	.382	.353	.4357
Observations	127,246	124,605	120,778	117,260

Notes: Income is pre-tax income. Other controls are change in number of adults, change in number of children, age of oldest family member, age of the youngest child and county of residence. Clustered standard errors in parenthesis. Coefficient significance: \*\*\* 1 percent; \*\* 5 percent; \* 10 percent.

Table 4: Consumption response, using LTI - piecewise linear specification  
Change in consumption from 2007 to year  $s$ , as a fraction of income in 2007

	$s = 2008$	$s = 2009$	$s = 2010$	$s = 2011$
LTI in 2007 < 1	-.066*** (.009)	-.089*** (.009)	-.040*** (.010)	-.023 (.009)
LTI in 2007 < 3 & $\geq$ 1	-.121*** (.006)	-.084*** (.007)	-.103*** (.007)	-.094*** (.006)
LTI in 2007 < 5 & $\geq$ 3	-.183*** (.012)	-.196*** (.013)	-.248*** (.014)	-.045*** (.012)
LTI in 2007 < 7 & $\geq$ 5	-.070*** (.023)	-.018 (.025)	-.347*** (.026)	-.310*** (.023)
LTI in 2007 $\geq$ 7	-.262*** (.013)	-.277*** (.013)	-.088*** (.015)	-.268*** (.012)
Constant	-.113 (.385)	.351 (.411)	.488 (.433)	.254 (.120)
R-squared	.457	.383	.356	.441
Observations	127,246	124,605	120,778	117,260

Notes: Income is pre-tax income. Other controls as in Table 3. Clustered standard errors in parenthesis. Coefficient significance: \*\*\* 1 percent; \*\* 5 percent; \* 10 percent.

Table 5: Consumption responses after the year 2004, by loan-to-income (LTI)  
Change in consumption from 2004 to year  $s$ , as a fraction of income in 2004

	$s = 2005$	$s = 2006$	$s = 2007$	$s = 2008$
Loan-to-income (LTI) ratio in 2004	-.120*** (.003)	-.069*** (.002)	-.103*** (.002)	-.109*** (.003)
Log of disposable income <sub>2004</sub>	-.004 (.007)	.063*** (.005)	-.019** (.005)	-.034** (.007)
Financial wealth <sub>s</sub> /income <sub>2004</sub>	-.078*** (.002)	.047*** (.001)	.001 (.002)	.018*** (.002)
Net wealth <sub>s</sub> /income <sub>2004</sub>	.001 (.001)	.009*** (.000)	-.004*** (.000)	.022*** (.000)
$\Delta$ Disposable income <sub>2004-s</sub> /income <sub>2004</sub>	.639*** (.003)	.769*** (.002)	.705*** (.003)	.424*** (.003)
$\Delta$ Housing wealth <sub>2004-s</sub> /income <sub>2004</sub>	-.253*** (.011)	-.015*** (.001)	.003*** (.000)	.003** (.001)
Constant	.020 (.230)	-.380 (.207)	.381 (.315)	.203 (.313)
R-squared	.611	.685	.410	.240
Observations	189,789	181,628	179,247	176,865

Notes: Income is pre-tax income. Other controls are change in number of adults, change in number of children, age of oldest family member, age of the youngest child and county of residence. Clustered standard errors in parenthesis. Coefficient significance: \*\*\* 1 percent; \*\* 5 percent; \* 10 percent.

Table 6: Consumption responses after the year 2005, by loan-to-income (LTI)  
Change in consumption from 2005 to year  $s$ , as a fraction of income in 2005

	$s = 2006$	$s = 2007$	$s = 2008$	$s = 2009$
Loan-to-income (LTI) ratio in 2005	-.085*** (.002)	-.055*** (.002)	-.079*** (.003)	-.072*** (.003)
Log of disposable income <sub>2005</sub>	.255*** (.005)	.158*** (.005)	.355** (.008)	-.236** (.007)
Financial wealth <sub>s</sub> /income <sub>2005</sub>	.112*** (.002)	.140*** (.001)	.194*** (.002)	.139*** (.002)
Net wealth <sub>s</sub> /income <sub>2005</sub>	.047*** (.000)	.027*** (.000)	.027*** (.000)	-.040*** (.000)
$\Delta$ Disposable income <sub>2005-s</sub> /income <sub>2005</sub>	.654*** (.003)	.665*** (.002)	.950*** (.004)	.162*** (.002)
$\Delta$ Housing wealth <sub>2005-s</sub> /income <sub>2005</sub>	.051*** (.001)	.005*** (.000)	.176*** (.000)	-.113*** (.000)
Constant	-3.42 (.191)	-2.64 (.270)	-4.67 (.276)	2.91 (.337)
R-squared	.641	.744	.702	.594
Observations	166,681	164,914	162,177	158,715

Notes: Income is pre-tax income. Other controls are change in number of adults, change in number of children, age of oldest family member, age of the youngest child and county of residence. Clustered standard errors in parenthesis. Coefficient significance: \*\*\* 1 percent; \*\* 5 percent; \* 10 percent.

after the financial crisis was very much due to the high loan-to-value or loan-to-income among households at the outburst of the crisis, we rerun the regression on alternative sample periods. Our hypothesis is that highly indebted households will have a lower consumption growth compared to other households independent of the macroeconomic environment.

Table 5 and Table 6 presents the regression of equation 4 using other time periods, i.e. the change in household consumption from 2004 to the years 2005-2008, and 2005 to the years 2006-2009, respectively. The results show approximately the same negative correlation between consumption change and initial debt to income in these periods. These results support the hypothesis that the negative impact of a high income-to-loan ration on consumption growth is a regular property.

Compared with the results in Table 5 and 6, the results in Table 3 do show a larger negative impact on consumption growth over the crisis and post-crisis years of high loan-to-income levels. We assume, as Andersen et al. (2014), that an important factor is increased uncertainty in the financial crisis and to some degree also a revision of expectations about future incomes, in particular for households that because of a strong belief in their future income prospects had already acquired a high level of debt.

The regularity stems from the fact that consumption is defined as total expenditure, including expenditures on durables. In the imputation method purchases of durable goods financed with advances on mortgages or unsecured lending will give a sharp rise in consumption in the year of purchase. Since investment in durables is infrequent, consumption after episodes of lumpy durable investments will always be lower relative to the period of investment. Andersen et al. (2014) also suggest that highly leveraged households exhibited unsustainably high consumption level prior to the crisis and that the decline in spending for these households has more or less brought them back to more “normal” consumption levels.

Although there is some regularity in that households have lower consumption following periods of high debt-financed consumption, there may still have been an additional drop in consumption during the financial crisis. This can be illustrated by looking at the consumption growth rates for different consumption categories in the National Accounts, see Appendix D. Contrasting the categories with the least change during the crisis with the categories with the largest change in growth rates, we find that the largest drop in consumer demand in 2008 was for durables (furniture and cars) or luxury consumption (entertainment and holidays). There is very little trace of the financial crisis in the demand for basics such as food, health and housing. In fact, there are several papers that emphasize that the timing of

durables is an effective way for households to smooth other consumption across periods of fluctuating income.<sup>16</sup>

## 5 Summary

Understanding the role of debt and leverage for households' consumption and savings behavior is important from a policy perspective. A highly leveraged household sector can amplify an economic downturn or financial crisis. In this memo we have looked at the role of debt from both a theoretical perspective and from an empirical perspective. According to the theoretical model, debt does not play a role in itself expect as determining the size of the resource effect from a change in interest rates. However, debt can play a role if the household is in a corner solution and behave as if it is credit constrained and thus not able to optimally smooth consumption over time.

Descriptively we have shown that among leveraged households, a large fraction have little financial assets available as a buffer against potential income shocks. Low buffer households are expected to cut consumption much in the event of a negative income shock, and our analysis support this expectation. These households are likely to exhibit a one-to-one reduction in consumption to any change in current income.

At the same time, there is a fraction of highly leveraged households with sufficient buffers against income shocks but who still responded strongly to the changing economic conditions during the financial crisis. Hence, we have analyzed further the role of households' indebtedness for the downturn in consumer spending that followed the financial crisis. We find similar results as previous studies on Danish and British data, but also that some of the effect of indebtedness on consumption growth is due to a regularity that follows from conditioning on indebtedness in the initial period. Households' consumption will usually be relatively lower in periods after debt-financed durables investment, as these investments are infrequent and far apart. However, we still find a larger negative impact on consumption growth in and after the financial crisis. We assume that this is due to increased precautionary saving and that expenditures on durable goods were postponed.

---

<sup>16</sup>See for example Browning and Crossley (2009), Parker et al. (2011), Aaronson et al. (2012) and Cerletti and Pijoan-Mas (2012).

## References

- Aaronson, D., S. Agarwal, and E. French (2012). The spending and debt response to minimum wage hikes. *American Economic Review* 102(7), 3111–39.
- Andersen, A. L., C. Duus, and T. L. Jensen (2014). Household debt and consumption during the financial crisis: Evidence from Danish micro data. *Danmarks Nationalbank Working Papers*.
- Anundsen, A. and E. Jansen (2013). Self-reinforcing effects between housing prices and credit. *Journal of Housing Economics* 22(3), 192–212.
- Attanasio, O. P., L. Blow, R. Hamilton, and A. Leicester (2009). Booms and busts: Consumption, house prices and expectations. *Economica* 76(301), 20–50.
- Attanasio, O. P. and M. Browning (1995). Consumption over the Life Cycle and over the Business Cycle. *American Economic Review* 85(5), 1118–37.
- Baker, S. R. (2015). Debt and the consumption response to household income shocks. *Available at SSRN*.
- Basten, C., A. Fagereng, and K. Telle (2015). Saving and portfolio allocation before and after job loss. *forthcoming Journal of Money, Credit and Banking*.
- Blundell, R., M. Browning, and C. Meghir (1994). Consumer demand and the life-cycle allocation of household expenditures. *Review of Economic Studies* 61(1), 57–80.
- Browning, M. and T. F. Crossley (2009). Shocks, stocks, and socks: Smoothing consumption over a temporary income loss. *Journal of the European Economic Association* 7(6), 1169–1192.
- Browning, M., M. Gørtz, and S. Leth-Petersen (2013). Housing wealth and consumption: A micro panel study. *The Economic Journal* 123(568), 401–428.
- Browning, M. and S. Leth-Petersen (2003). Imputing consumption from income and wealth information. *The Economic Journal* 113(488), F282–F301.
- Bunn, P. and M. Rostom (2014). Household debt and spending. *Bank of England Quarterly Bulletin*, 304–15.
- Campbell, J. Y. and J. F. Cocco (2007). How do house prices affect consumption? Evidence from micro data. *Journal of Monetary Economics* 54(3), 591–621.

- Campbell, J. Y. and N. G. Mankiw (1989). Consumption, income and interest rates: Reinterpreting the time series evidence. *NBER Macroeconomics Annual* 4, 185–216.
- Campbell, J. Y. and N. G. Mankiw (1990). Permanent income, current income and consumption. *Journal of Business and Economic Statistics* 8(3), 265–279.
- Cappelen, Å., A. Fagereng, and E. Halvorsen (2016). Income taxes as automatic stabilization after the Norwegian 2006 tax reform. *forthcoming Statistics Norway Discussion Paper*.
- Carroll, C. (2000). Why do the rich save so much? In J. Slemrod (Ed.), *Does Atlas Shrug? The Economic Consequences of Taxing the Rich*, pp. 465–483. Cambridge: Harvard University Press.
- Carroll, C., T. Crossley, and J. Sabelhaus (2014). *Improving the Measurement of Consumer Expenditures*. University of Chicago Press.
- Carroll, C. D. (2001). Death to the Log-Linearized Consumption Euler Equation! (And Very Poor Health to the Second-Order Approximation). *The B.E. Journal of Macroeconomics* 1(1), 1–38.
- Carroll, C. D. (2009). Precautionary saving and the marginal propensity to consume out of permanent income. *Journal of Monetary Economics* 56(6), 780–790.
- Carroll, C. D., J. Slacalek, K. Tokunaka, and M. N. White (2015). The distribution of wealth and the marginal propensity to consume. Working paper available at <http://www.econ2.jhu.edu/people/ccarroll/papers/cstwmipc/>.
- Cerletti, E. and J. Pijoan-Mas (2012). *Durable Goods, Borrowing Constraints and Consumption Insurance*. Centre for Economic Policy Research.
- Chetty, R. and A. Szeidl (2007). Consumption Commitments and Risk Preferences. *The Quarterly Journal of Economics* 122(2), 831–877.
- Cooper, D. (2012, October). House price fluctuations: The role of housing wealth as borrowing collateral. *Review of Economics and Statistics* 95(4), 1183–1197.
- Deaton, A. (1991). Saving and liquidity constraints. *Econometrica* 59(5), 1221–1248.
- Disney, R., J. Gathergood, and A. Henley (2010). House price shocks, negative equity, and household consumption in the United Kingdom. *Journal of the European Economic Association* 8(6), 1179–1207.

- Dynan, K. (2012). Is a household debt overhang holding back consumption? *Brookings Papers on Economic Activity*, 299–362.
- Fagereng, A., C. Gottlieb, and L. Guiso (2015). Asset market participation and portfolio choice over the life-cycle. *SAFE Working paper 115*.
- Fagereng, A. and E. Halvorsen (2015). Imputing consumption from Norwegian income and wealth information. *Statistics Norway Discussion Papers no 831*.
- Friedman, M. (1957). *A Theory of the Consumption Function*. Princeton University Press.
- Gudmundsson, J. and G. Natvik (2012). That uncertain feeling - how consumption responds to economic uncertainty in Norway. *Staff Memo no.23, Norges Bank*.
- Heathcote, J., K. Storesletten, and G. L. Violante (2009). Quantitative Macroeconomics with Heterogeneous Households. *Annual Review of Economics* 1(1), 319–354.
- Hsieh, C.-T. (2003). Do consumers react to anticipated income shocks? Evidence from the alaska permanent fund. *The American Economic Review* 93(1), pp. 397–405.
- Iacoviello, M. (2004). Consumption, house prices, and collateral constraints: A structural econometric analysis. *Journal of Housing Economics* 13(4), 304–320.
- Jappelli, T. and L. Pistaferri (2010). The consumption response to income changes. *Annual Review of Economics* 2, 479–506.
- Kaplan, G. and G. L. Violante (2014). A model of the consumption response to fiscal stimulus payments. *Econometrica* 82(4), 1199–1239.
- Koijen, R., S. Van Nieuwerburgh, and R. Vestman (2014). Judging the quality of survey data by comparison with “truth” as measured by administrative records: evidence from Sweden. In C. Carroll, T. Crossley, and J. Sabelhaus (Eds.), *Improving the Measurement of Consumer Expenditures*. University of Chicago Press.
- Kreiner, C. T., D. D. Lassen, and S. Leth-Petersen (2014). Measuring the accuracy of survey responses using administrative register data: Evidence from Denmark. In C. Carroll, T. Crossley, and J. Sabelhaus (Eds.), *Improving the Measurement of Consumer Expenditures*. University of Chicago Press.

- Li, W. and R. Yao (2007). The life-cycle effects of house price changes. *Journal of Money, Credit and Banking* 39(6), 1375–1409.
- Mian, A., K. Rao, A. Sufi, et al. (2013). Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics* 128(4), 1687–1726.
- Parker, J. A., N. S. Souleles, D. S. Johnson, and R. McClelland (2011). Consumer spending and the economic stimulus payments of 2008. *American Economic Review* 103(6), 2530–2553.
- Reis, R. (2006). Inattentive consumers. *Journal of Monetary Economics* 53(8), 1761–1800.
- Skinner, J. S. (1994). *Housing and Saving in the United States*, pp. 191–214. University of Chicago Press.
- Slemrod, J. (2000). *Does Atlas Shrug?: The Economic Consequences of Taxing the Rich*. Cambridge: Harvard University Press.
- Sufi, A. (2015). Out of many, one? Household debt, redistribution and monetary policy during the economic slump. *Andrew Crockett Memorial Lecture*.
- Thomassen, A. and I. Melby (2009). Beregning av boligformue. *Statistics Norway Notater* 53.
- Yang, F. (2009). Consumption over the life cycle: How different is housing? *Review of Economic Dynamics* 12(3), 423 – 443.
- Yao, J., A. Fagereng, and G. Natvik (2015). Housing, debt and the marginal propensity to consume. *Job Market Paper, Johns Hopkins University*.

## **Appendix A Detailed description of the imputation method and sample selections**

We start out with a 20% random sample of the population. We keep all types of households but limit the age of the household head downward to 25 and upward to 90. The consumption and savings measure derived from first differences in taxable wealth suffers from an important measurement error. While all debt secured by housing wealth is measured in full, its counterpart, the housing value, is not. The housing values used are calculated as 4 times the tax values in 2010 and 2011, and for previous years we use the values imputed by Statistics Norway prior to the inclusion of the new imputed values in the tax return from 2010, documented by Thomassen and Melby (2009) and successive annual reports.<sup>17</sup> Even though imputed measures of housing values were implemented in the tax return from 2010, these values are also imprecise with respect to the actual market value of each individual dwelling. This asymmetry is most problematic for remortgaging in connection with house transactions, but also when there are transactions of summer homes or when there is financial reshuffling after divorces. As a consequence we have imposed a restriction that ensures that we only consider stable periods, thus excluding single years of housing transactions, holiday home transactions, or periods in which couples move together or split up. The tax returns have no direct information about such events, but some may be deduced from changes in address, transitions of existence/non-existence of tax values, and changes in number of adults in the household. Obviously, such information is not very precise and even when applying exclusions based on this information we are still left with a sizeable measurement error problem.

In addition, there are two other measurement error problems: large movements in unlisted stock wealth among the wealthy, and very low after-tax income. The latter is a measurement problem if it represents unreported incomes or timing issues that causes a misrepresentation of annual income. Large movements in unlisted stock wealth among the wealthy are more a source of noise in the data, but in years before and after the tax reform of 2006 it is also a systematic problem as the wealthy were adjusting income and wealth to avoid the introduction of a tax on dividends. It is hard to justify such behavior as a true measure of consumption and saving.

As a consequence, all consumption and savings measures reported in Table 7 and elsewhere in this memo are based on the exclusions made in Fagereng and Halvorsen (2015), which are mainly the exclusion of year observations of address

---

<sup>17</sup>The Norwegian Tax Authorities stipulates that the tax value of real estate should be about 25 percent of the market value (Fagereng et al., 2015). However, the tax values were not always updated regularly (especially prior to 2009).

Table 7: Selected sample statistics. 2007-2011

	2007	2008	2009	2010	2011
Consumption	393,868	385,292	397,977	416,918	440,813
Disposable income	344,522	352,508	372,335	388,914	408,288
Bank deposits	255,637	272,966	280,292	293,111	315,102
Debt	757,973	801,139	840,787	884,264	948,874
Consumption rate	.986	.958	.941	.957	.960
Saving rate	-.001	.036	.037	.024	.028
Debt rate	1.12	1.09	1.13	1.15	1.20

*Note:* Mean values in 2011 NOK, measured at the household level. All rates are measured as fractions of disposable income, and reported as median rates.

change (assuming that relocation coincides with buying/selling of homes), excluding owners of non-listed stocks, year observations of annual household income lower than 1 G, and households headed by persons older than 90 and younger than 25. All other statistics use the full sample when possible. Thus any group definition is based on the full sample, although the group's consumption and saving rates are based on the restricted sample within each group (in other words, we assume that the restricted sample represents the "normal" behavior of the entire group).

As mentioned above, the measurement problem with respect to debt increases measured in full pertains even after the exclusions since information about transactions is imprecise. Therefore there is still a highly left-skewed distribution of saving, and aggregate rates of active savings are still predominantly negative, as illustrated in Table 7. An alternative is to present median rates as these will be more representative of behavior in the middle or the central part of the population. Median rates are more robust to the amount of extreme values and the skewness of the distribution.

## Appendix B Marginal propensity to consume (MPC)

According to economic theory, any expected change in the budget constraint would be incorporated in the optimal consumption path over the life cycle, whereas unexpected permanent shocks to income would manifest fully in changed consumption and unexpected transitory shocks would change savings most and consumption less. Examples of permanent income shocks are promotions or wage increases, an unexpected permanent income shock would be an accident causing disability, while a spell of unemployment or a one-off bonus would be examples of transitory income shocks. Standard life-cycle models with one risk free asset, and especially macro models (Heathcote et al., 2009), imply a small and negligible MPC out of transitory income. In such models the only households that would react to transitory income would be credit constrained households. Although the definition of a credit constrained household has been discussed, the standard interpretation in macro models has been a household with close to zero net worth. This fraction is usually too small to make a difference in the aggregate, in particular considering that they usually have both low levels of income and consumption as well.

In the literature the marginal propensity to consume out of a permanent shock is often assumed to be equal to one. One theoretical underpinning for this is Deaton (1991)'s life-cycle model with liquidity constraints. In his model the only source of income uncertainty is permanent shocks (i.e. income is assumed to follow an AR1 process). The combination of autoregressive income and liquidity constraints yields a situation where a consumer with no assets will never save (will always consume all income) and have a propensity to consume out of a permanent shock equal to one. Another is Carroll (2009), who solves numerically a buffer-stock model and finds a marginal propensity to consume out of a permanent shock in the range of 0.75-0.92. The reason that his estimates are less than unity is that an increase in permanent income reduces the ratio of assets to permanent income, thus increasing the amount of precautionary saving.

Jappelli and Pistaferri (2010) review the literature and Carroll et al. (2015) summarize the microeconomic evidence on the marginal propensity to consume out of a transitory shock. The estimates range between 0 and 0.75, but most estimates lie in the range 0.3-0.6 for total consumer expenditure. Carroll et al. (2015) then proceed to simulate a buffer-stock model with heterogeneous time preference, or impatience. The combination of an income process with permanent and transitory income shocks and heterogeneity in time preference is able to match the observed degree of inequality in the wealth distribution, and provides a range of marginal

propensities to consume out of transitory shocks between 0.2 and 0.4 where the highest propensities apply to households with low income or low target wealth (wealth to permanent income).

In later years there have been other nuanced approaches to the topic of the marginal propensity to consume that agrees more with observations in real life. Chetty and Szeidl (2007) emphasize that many households have “consumption commitments” that are costly to adjust when income shocks occur. Kaplan and Violante (2014) return to the distinction made by Campbell and Mankiw (1989, 1990) between current-income-consumers and life-cycle planners, but sophisticating the distinction by asset ownership and providing a structural model as an underpinning. They argue that there are two types of current-income-consumers, or what they call “hand-to-mouth” consumers; the usual poor hand-to-mouth consumers with close to zero net worth, and a group of wealthy hand-to-mouth consumers who have substantial net worth but all of it tied up in illiquid wealth and are on their credit limit. The latter group will act as current-income-consumers (and thus appear as credit constrained) because they are better off bearing the welfare loss of fluctuating consumption rather than incurring the transaction cost of tapping into their illiquid wealth. Either they can only obtain credit at very expensive interest rates, or by keeping liquid assets they would forego the high return on their illiquid asset.. Kaplan and Violante found that between 17.5% and 35% of US households were “hand-to-mouth” consumers, and between 40 and 80 percent of these were relatively wealthy.

Although we are mostly concerned with the response to an unexpected income shock, in reality it is not always so easy to distinguish between types of shocks. In the consumption-income literature, shocks to labor income is defined as the residual from a model determining life-cycle income, where the residual is subsequently econometrically decomposed into a permanent shock and a transitory shock as in Section 2.2. However, this method hinges on a lot of assumptions such as knowing the correct lifetime income model, and ultimately it is not observable whether a shock is permanent or transitory. The individual itself may be uncertain about the duration or type of shock. Furthermore, it is not obvious whether an interest income or wealth shock is perceived to be permanent or transitory. When it comes to income shocks due to interest rate changes this differs from individual income shocks by being common to all, but whether it is a positive shock or a negative shock will depend on the net asset position. Also, there is likely to be a size-asymmetry in the consumption response to small and large income changes (Hsieh, 2003).

Furthermore, expectations about duration may depend on whether the change is

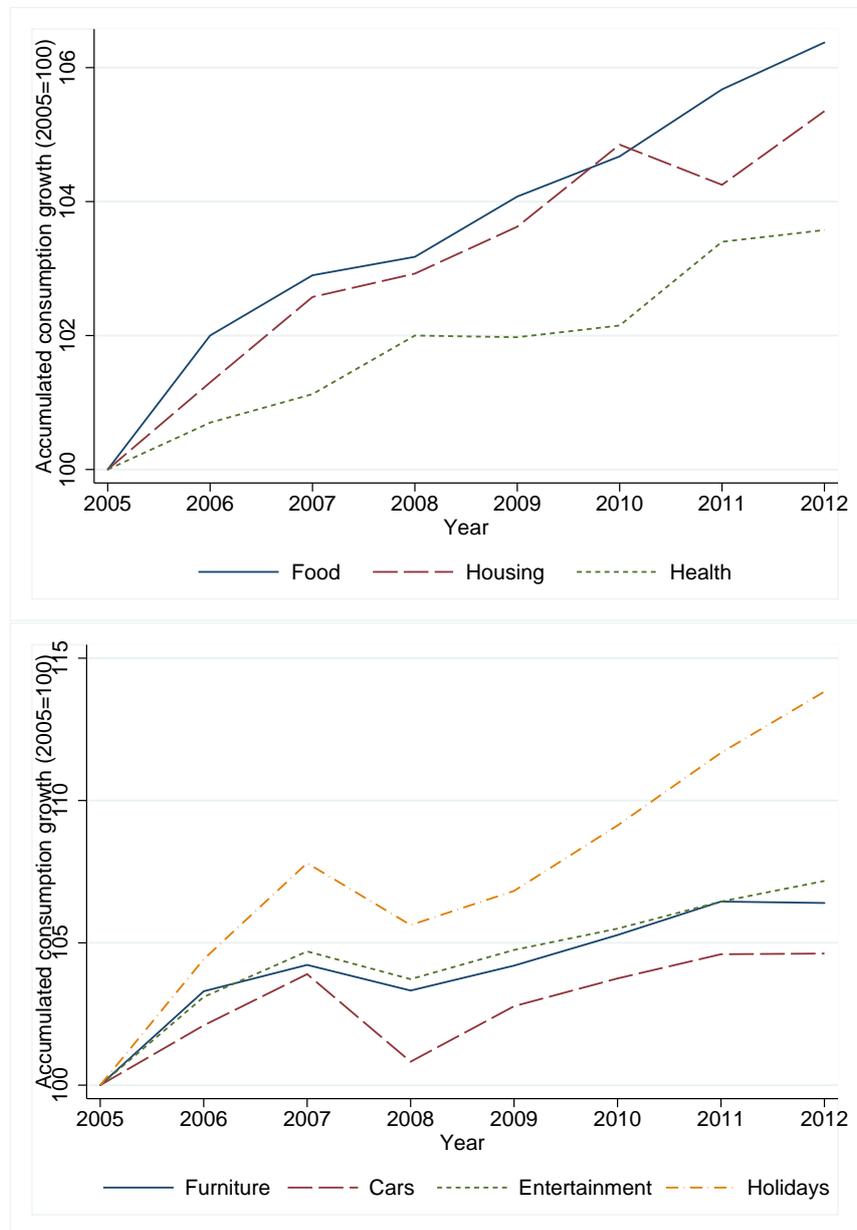
moving away from or towards the long term equilibrium, and whether the shock is national (internal) or international (external). In some of the studies analyzing the effect of housing wealth on consumption, house price “shocks” are defined as the residual from an autoregressive estimation of regional house prices, thus assuming that house price expectations are essentially adaptive and not related to any long term equilibrium. Also, as discussed in the theoretical section, there could be asymmetrical responses to positive and negative shocks. Finally, uncertainty in itself may play a role. Negative shocks may increase the overall uncertainty about future incomes and may cause higher precautionary saving (Gudmundsson and Natvik, 2012).

**Appendix C Median consumption rates by population group. 2003-2011**

	By age group			By after-tax income		
	Age 26-39	Age 40-66	Age 67-80	Decile 1-2	Decile 3-8	Decile 9-10
2003	0.96	0.95	0.96	1.00	0.95	0.93
2004	0.99	0.98	0.96	1.00	0.97	0.98
2005	0.96	0.95	0.94	0.99	0.94	0.92
2006	0.97	0.97	0.97	1.00	0.96	0.96
2007	1.00	0.99	0.94	0.99	0.97	1.00
2008	0.93	0.95	0.95	0.99	0.94	0.92
2009	0.93	0.93	0.93	0.99	0.93	0.90
2010	0.94	0.95	0.95	1.00	0.94	0.92
2011	0.96	0.93	0.93	0.99	0.95	0.93
All years	.96	.96	.95	.99	.96	.88

	By net financial assets			By wealth distribution		National Accounts
	Negative	Zero	Positive	Bottom 80	Top 20	
2003	0.99	0.95	0.90	0.97	0.89	0.91
2004	1.04	0.97	0.89	0.99	0.91	0.93
2005	0.99	0.99	0.87	0.96	0.84	0.90
2006	1.00	0.96	0.93	0.97	0.95	1.00
2007	1.07	0.96	0.84	0.99	0.88	0.99
2008	0.95	0.95	0.90	0.95	0.91	0.96
2009	0.94	0.94	0.87	0.95	0.85	0.94
2010	0.95	0.96	0.90	0.96	0.91	0.96
2011	0.98	0.98	0.85	0.97	0.87	0.94
All years	.99	.95	.94	.97	.89	

Appendix D Accumulated consumption growth by consumption category.  
2005=100



Source: National Accounts, Statistics Norway

Note: Housing is current expenditures on housing, not imputed rent.