Durable Goods and Consumer Behavior with Liquidity Constraints: Evidence from Norway

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Abstract

This paper jointly analyzes consumer demand and consumption for Norwegian consumers for 1979-2018 with allowance for durable goods and liquidity constraints. An indirect utility function is specified with the user cost of durable goods, and demand functions for nondurable and durable goods and a consumption Euler **equation** are estimated by incorporating liquidity constraints. Traditional demand analyses ignoring durable goods leads to a significant bias in the elasticities of nondurable goods. Norwegian consumers are found impatient with low risk aversion. There is weak evidence for liquidity constraints in consumption. No strong evidence exists for intertemporal substitution in consumption. A considerable effect of uncertainty is found on consumption, especially for durable goods.

Keywords: Indirect utility function, User cost of durable goods, Euler equation, Risk aversion, Intertemporal substitution.

JEL Classification: E21, D15, D12

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1. Introduction

The literature on consumer demand bounds with empirical studies undertaken to estimate price and income elasticities of goods and services, which are important summary measures characterizing consumer behavior (see Clemens et al., 2019, for a recent study covering 37 OECD countries). In these studies, durable goods are either ignored (Deaton and Muellbauer, 1980b), tacitly assuming that nondurable goods are separable from durable goods, or treated like nondurable goods without recognizing the inherent differences between the two classes of goods (see Clemens et al., 2019). Either approach is not satisfactory. Durable goods are essential in consumer behavior and play a pivotal role in the economy, and ignoring them may not provide an adequate portrayal of consumer behavior. Moreover, durable goods, unlike nondurable goods, have distinct features. The consumer does not derive utility directly from spending on durable goods in the current period, but rather from the flow of services they provide over time that is assumed to be propo given but is endogenously determined on problem. This implies that the intratemporal (within period) and intertemporal (across period) allocation decisions cannot be separated; hence a proper understanding of consumer behavior entails an integration of consumer demand and consumption studies in a unifying framework.

To that end, we present and estimate an integrated model of consumer demand and consumption for Norwegian consumers by utilizing the idea of intertemporal two-stage budgeting with durable goods and liquidity constraints. There are studies on durable goods in consumption with liquidity constraints, but they fail to account for the intratemporal allocation problem of consumption (Chah et al., 1995; Alessie et al., 1997). There are also studies employing intertemporal two-stage budgeting, but they assume that capital markets are perfect and do not allow for durable goods (Blundell et al., 1997). Kim et al. (2021) generalize intertemporal two-stage budgeting but do not utilize the user cost of durable goods, and thus the demand for durable goods is not explicitly analyzed. Moreover, there are studies on consumer behavior for Norway that estimate demand functions as well as consumption functions; see the detailed literature review presented in the Appendix. However, virtually none of these studies incorporates durable goods, and they fail to allow for the interplay between intratemporal and intertemporal allocation decisions. Thus they are limited in scope and analysis to address broad issues in consumer behavior in a unifying framework.

To represent consumer preferences in our analysis, we specify an indirect utility function as a function of total consumption on nondurable and durable goods and prices of these goods, with durable goods expressed in a stock form and their price represented by the user cost, and derive the demand functions for nondurable and durable goods. Then, from intertemporal optimization with the indirect utility function, we obtain the Euler equation for consumption with allowance for liquidity constraints. We generalize the traditional measure of risk aversion based on power or CRRA utility by utilizing the indirect utility function. Then by taking a lognormal approximation of the Euler equation, we derive a log-linearized consumption growth equation that depends on the interest rate, growth rates of nondurables prices and user cost, conditional variance capturing uncertainty with precautionary saving, and liquidity constraints.

We conduct an empirical analysis of the integrated model of consumer behavior, using annual Norwegian data for 1979-2018 on eight disaggregate nondurable goods and an aggregate durable good. We employ a flexible specification of the indirect utility function that places

goods and services and an aggregate durable good. Eight nondurable goods and services include (1) food and non-alcoholic beverages, (2) alcoholic beverages, tobacco and narcotics, (3) clothing and footwear, (4) housing services, (5) water and fuels, (6) health services, (7) transport services, (8) other nondurables and services. Durable goods include items such as furnishings, household equipment, appliances and equipment, vehicles, telephone and telefax equipment, and audio-visual, photographic and information processing equipment.

The aggregate price indexes for each category of nondurable goods and services and for an aggregate durable good are constructed as weighted averages of the component price indexes, with expenditure shares for each component good serving as weights. Then the quantity indexes for nondurable and durable goods are obtained by dividing their respective current expenditure by the associated price index, which equals real expenditure for nondurable and durable goods.

As argued in the Introduction, the relevant price of durable goods is the user cost r_t^k, not purchase price, of these goods. It is defined at time *t* as (see Deaton and Muellbauer, 1980a, Chapter 13)

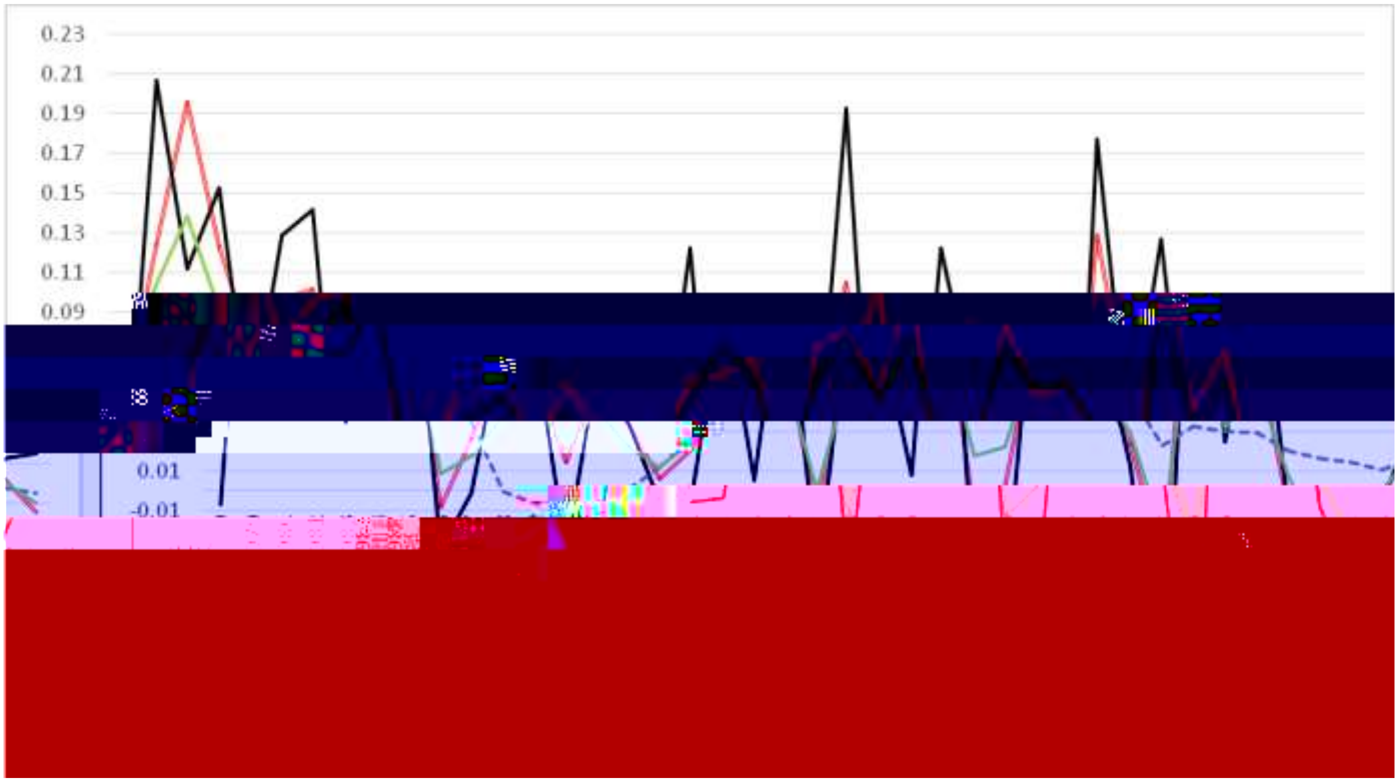
$$r_t^k = p_t^k - \frac{(1-\delta)}{(1+r_{t+1})} p_{t+1}^k. \tag{1}$$

where p_t^k is the aggregate price of durable goods, δ is the depreciation rate assumed constant, and r_{t+1} is the interest rate at time *t*+1. Given a resale or second-hand market with no transaction cost, the user cost equals the net expense of buying a unit of durable goods in one period, using it in the same period and selling it at the discounted depreciated price in the next period. Assuming that p_t^k grows by $\Delta \ln p_{t+1}^k$ and approximating (1), the user cost of durable goods is considered its rental equivalent price, i.e., $r_t^k = p_t^k(r_{t+1} + \delta - \Delta \ln p_{t+1}^k)$, where $\Delta \ln p_{t+1}^k$ is the expected rate of inflation of durable goods. For the interest rate, a three-month interest rate on short-term government bonds is used. For the depreciation rate, we used δ = 0.20 (20% per year) (see Mankiew, 1985).

We assume that the consumer derives utility from the service flow of durable goods that is proportional to the stock of these goods. To construct durables stock, we utilize t

the sample period. It is interesting to note that the user cost of durable goods shows an almost same pattern of the price index of durable goods, although with quite less fluctuations. The interest rate shows a slight decreasing trend over the years. It was above 10% during 1979-1992, but it has been falling since then from the value of 7.265% in 1993 to 2.236% in 2012. It remained below 2% since then until the end of the sample period.

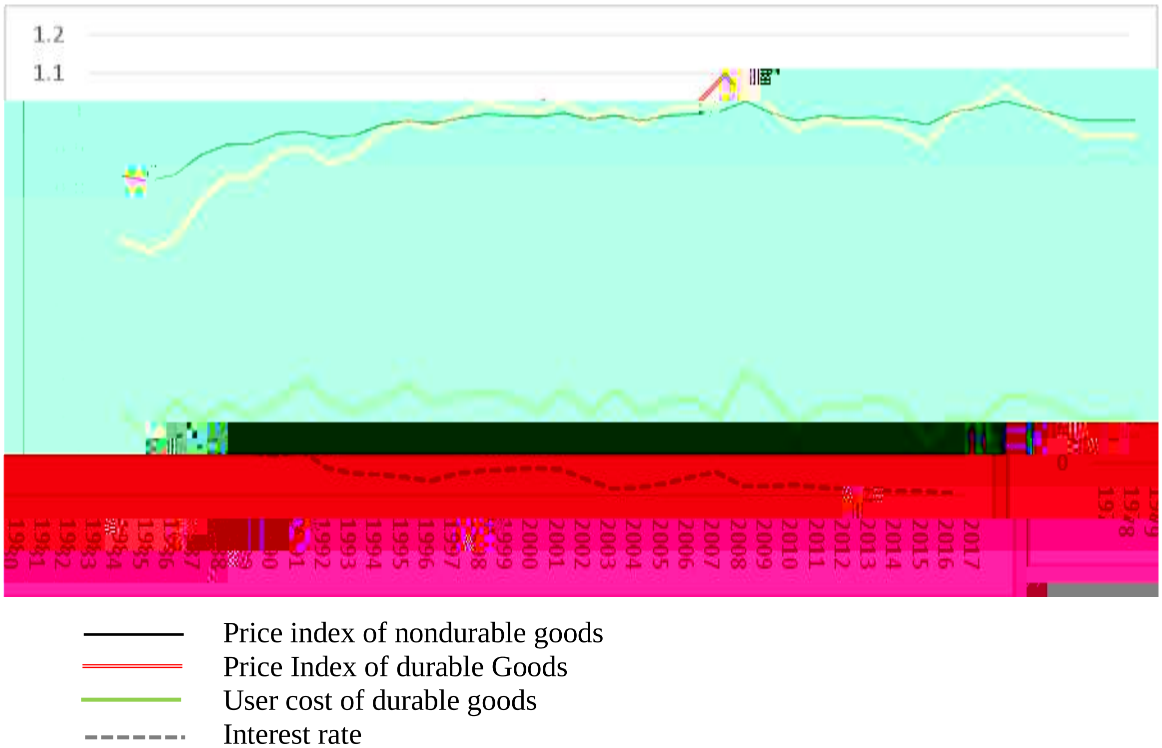
Figure 1: Annual Growth Rates of Consumption and Durables Stock



Nominal growth rate of M_t (total consumption)
Nominal growth rate of C_t (nondurable consumption)
Real growth rate of C_t (nondurable consumption)
Growth rate of k_t (durables stock)

For intertemporal analysis of consumption, we examine growth rates of nondurable consumption and durables stock as well as growth rates of associated prices and the interest rate (see Section 3.4 for a detailed discussion). Also important in this analysis is the role of uncertainty. While standard deviation or variance tells us about the variability of a variable, conditional variance is a relevant measure of uncertainty about the future (Ballie and Bollerslev, 1992). Conditional variances for total consumption, nondurable consumption, and durables

Figure 2: Movements of Price Indexes, User Cost, and Interest Rate over Time



stock growth are approximated by $^{2}_{M_{t\ 1}}$ E_t $\ln M_{t\ 1}$ ^{2} , $^{2}_{C_{t\ 1}}$ E_t $\ln C_{t\ 1}$ ^{2} , and $^{2}_{k_{t\ 1}}$ = E_t $\ln k_{t\ 1}$ ^{2} , where is the expectation operator conditional on information available at period *t*. They are also obtained by a second-order Taylor series expansion of an Euler equation with CRRA utility for M_t , , and (see Ludvigson and Paxson, 2001; Dynan, 1993) but are not directly observable. What we observe, instead, is the realized values $(\ln M_{t\ 1})^2$, $(\ln C_{t\ 1})^2$, and $(\ln k_{t\ 1})^2$. Under rational expectations, we can take the realized values by instrumenting them with lagged values. Gudmundsson and Natvik (2012) recognized the importance of uncertainty in consumption in Norway. They looked at three components of household consumption: nondurables, durables, and services to examine the effect of uncertainty on them. For durables consumption, its expenditure is used without considering the user costs. In contrast to our measures of uncertainty, they utilized two alternative measures of uncertainty volatility indexes from financial markets and the frequency with which economic uncertainty is mentioned in the Norwegian press.

Table 1. Summary Statistics

Variable	Mean (%)	Std Dev	Minimum	Maximum
$\Delta \ln M$	4.61	7.82	-12.14	20.71
$\Delta \ln C$	4.74	5.13	-4.26	19.61
$\Delta \ln k$	4.17	2.73	-0.63	9.15
$\Delta \ln p_1$	2.56	5.19	-4.20	22.05
$\Delta \ln p_2$	4.65	6.46	-5.28	31.33
$\Delta \ln p_3$	-0.27	6.28	-17.65	17.56
$\Delta \ln p_4$	3.21	5.22	-6.39	17.60
$\Delta \ln p_5$	4.55	8.63	-11.07	22.50
$\Delta \ln p_6$	4.30	4.91	-4.25	16.12
$\Delta \ln p_7$	4.10	6.42	-10.21	23.39
$\Delta \ln p_8$	2.09	6.82	-9.53	19.83
$\Delta \ln r^k$	-0.05	22.79	-53.35	47.31
r	7.13	4.66	0.89	15.37
$\Delta \ln Y^d$	5.69	11.25	-22.11	35.97
σ_M^2	0.81	1.07	0.00	4.29
σ_c^2	0.48	[illegible]	0.00	3.85
σ_k^2	0.25	[illegible].23	0.00	0.84

Notes: M = total expendi[illegible]e, C = n[illegible]durable consumption, k = durables stock, p_1 = price of food and [illegible]alcoholic beverages, p_2 = price of alcoholic beverages, tobacco [illegible] narcotics, p_3 = price of clothing and footwear, p_4 = price of h[illegible]ing services, p

growth rates during the sample period are alcoholic beverages, tobacco and narcotics with 4.65%, followed by water and fuels (4.55%) and health services (4.33%). Clothing and footwear exhibit a negative growth rate of prices (-0.27%).

3.1.1. Indirect Utility Function and Demands for Nondurable and Durable Goods

Let be an n quantity vector at period t of nondurable and durable goods, which consists of eight nondurable goods and an aggregate durable good by taking $q_{nt} \quad k_t$. Given a direct utility function, $u(\mathbf{q}_t)$, which is continuous, increasing, and quasi-concave in ,

second stage optimization problem is summarized by the indirect utility function, $(M_t, \mathbf{p}_t)$, defined as

$$(M_t, \mathbf{p}_t) \quad \max_{\mathbf{q}_t}\{u(\mathbf{q}_t) \,|\, \mathbf{p}_t \quad \mathbf{q}_t \quad M_t\}, \tag{3}$$

where is consumption expenditure to be allocated among nondurable and durable goods at period t, i.e., $M_t \quad C_t \quad r_t^k k_t$, and $\mathbf{p}_t$ is an n price vector at period t of nondurable and durable goods with $p_{nt} \quad r_t^k$. The above indirect utility function is well defined as a description of the

-period preferences under the following regularity conditions: it is continuous, increasing in decreasing in $\mathbf{p}_t$,homogeneous of degree zero in and $\mathbf{p}_t$, and quasi-convex in $\mathbf{p}_t$ (see Deaton and Muellbauer, 1980a).

Application entity to the indirect utility function (3) yields the system of nondurable and durable demand functions:

$$q_{it} \quad g_i(M_t, \mathbf{p}_t) \quad \frac{(M_t, \mathbf{p}_t)/ \quad p_{it}}{(M_t, \mathbf{p}_t)/ \quad M_t}, \; i \quad 1, \ldots, n, \tag{4}$$

which consists of eight ordinary or Marshallian demand functions for nondurable goods and an aggregate ordinary demand function for durable goods. It should be noted that these demand functions for nondurable and durable goods are different from the traditional demand functions incorporating durable goods that are treated like nondurable goods (Clemens et al., 2019). In traditional demand analysis, the demand for durable goods is specified in a flow form, i.e., the quantity q_t^k of these goods, with the purchase price p_t^k. In our analysis, it is specified in a stock form, i.e., durables stock with the user cost r_t^k. Further, in traditional demand analysis, durables expenditure is given by $p_t^k q_t^k$, and total expenditure is defined as $M_t \quad C_t \quad p_t^k q_t^k$. In our analysis, durables expenditure is given by $r_t^k k_t$, and total expenditure is defined as $M_t \quad C_t \quad r_t^k k_t$. These results suggest that traditional demand analysis with durable goods likely leads to a bias in demand elasticities for nondurable and durable goods.

3.1.2. Intertemporal Optimization and the Consumption Euler Equation

The above second stage optimization problem is derived under the assumption that the consumer takes, as given, consumption expenditure . The first stage problem of intertemporal two-stage budgeting allows us to determine it optimization decision. In particular, the consumer faces an intertemporal finance or budget constraint:

$$A_s \quad (1 \quad r_{s\ 1})A_{s\ 1} \quad Y_s \quad M_s \text{ for all } s \quad t, \tag{5}$$

where is the value of financial assets at the end of period *s* to be carried into the next period, $r_{s\ 1}$ is the nominal interest rate on assets that can be both bought and sold between periods *s*-1 and *s*,[2] is labor income at period *s*.[3] If the consumer faces a borrowing or liquidity constraint, debt cannot exceed the total current value of assets. The liquidity constraint is specified by

$$A_s \quad L_s \text{ for all } s \quad t, \tag{6}$$

where L_s is the limit on net indebtedness at period *s* with $L_s \quad 0$, for all $s \quad t$.[4] If $L_s \quad 0$, the consumer cannot borrow or incur debt at all, but he can save and earn interest from his asse

Cox form for $v(M_t, \mathbf{p}_t)$:

$$U_t \quad \frac{v(M_t, \mathbf{p}_t)^{1} \quad 1}{1}, \tag{7}$$

where is a Box-Cox parameter, with the marginal utility of given by

$$U_M(M_t, \mathbf{p}_t) \quad \frac{U_t}{M_t} \quad (M_t, \mathbf{p}_t) \quad v_M(M_t, \mathbf{p}_t), \tag{8}$$

where $v_M(M_t, \mathbf{p}_t) \quad (M_t, \mathbf{p}_t) / \quad M_t$. The Box-Cox transformation with the parameter allows the indirect utility function (3) to be cardinal under intertemporal separability of preferences. It also allows for an additional degree of flexibility in measuring the intertemporal properties of this function.While the indirect utility function (3) as a representation of within-period preferences is well defined with its regularity conditions discussed above, we assume that U_t in (7) is continuous, increasing, and, more importantly, strictly concave in for given $\mathbf{p}_t$. The concavity condition ensures the existence of a solution to the intertemporal optimization problem, and implies that the necessary conditions are indeed sufficient.

Now, with the transformation of the indirect utility function, optimization problem is to choose for so as to maximize

$$E_t \sum_{s \quad t} (1 \quad)^{(s \quad t)} \quad \frac{v(M_t, \mathbf{p}_t)^{1} \quad 1}{1} \quad , \tag{9}$$

where is the constant subject to the intertemporal budget constraint (5), the liquidity constraint (6), and the appropriate transversality condition for assets. The expectation operator E_t is taken over future variables, using information available at the beginning of period *t*. We assume that the consumer replans continuously when solving the above stochastic dynamic control problem. This means that the calendar time solution for should be the successive time *t* solution of this optimization problem as evolves through time, with the present always being time *t*. This idea satisfies dynamic consistency, in the sense that, provided expectations are realized, the optimal solution for derived at time *t* will coincide with the time *t* solution derived beginning at time *s*. For estimation and data analysis then, only the first-order conditions necessary for the intertemporal optimization problem (6) at the initial point in time ( ) are relevant. They are given by

$$M_t : \; (M_t, \mathbf{p}_t) \quad v_M(M_t, \mathbf{p}_t) \qquad {}_t \tag{10}$$

and

$$A_t : \quad {}_t \qquad {}_t \quad E_t \quad \frac{1 \quad r_t}{1} \qquad {}_{t\;1} \;, \tag{11}$$

where $\;_t$ is the Lagrange multiplier associated with the asset accumulation constraint (5) known at time *t*, and $\;_t$ is the Lagrange multiplier associated with the liquidity constraint (4) known at period *t*. $\;_t$ will be positive when the liquidity constraint is binding and zero when it is not. Equation (10) indicates that the marginal utility of wealth is equated to the marginal utility of consumption at the optimum. This is a property implied by intertemporal separability of preferences that underlies intertemporal two-stage budgeting. Equation (11) is thestandard Euler equation for consumption adjusted for the presence of a liquidity constraint. For empirical analysis, it is convenient to work with this equation in a ratio form represented by

$$E_t \quad \frac{1 \quad r_t}{1} \quad \frac{{}_{t\;1}}{{}_t} \qquad 1 \qquad {}_t \;, \tag{12}$$

where $\;_t \quad\; _t \,/\, \;_t$.

3.1.3. Risk Aversion

The degree of relative risk aversion (*RRA*) is typically measured with the well-known power or CRRA utility function, $u(c_t) \quad \frac{c_t^{1} \qquad 1}{1}$, with c_t real nondurable consumption, which gives *RRA* =

(see Hansen and Singleton, 1983; Mehra and Prescott, 1985). This measure of RRA hinges on restrictive preferences with real consumption under homothetic preferences, and its value is constant. To generalize the risk aversion measure based on power utility, we can employ the indirect utility function (3). However, while the demand functions are determined by an ordinary utility function, a risk aversion function is determined by a cardinal utility function. To allow for this, we take a Box-Cox transformation of the indirect utility function given in (7) with the marginal utility of consumption given in (8). The coefficient of relative risk aversion is then defined as

$$RRA(M_t, \mathbf{p}_t) \quad \frac{M_t U_{MM}(M_t, \mathbf{p}_t)}{U_M(M_t, \mathbf{p}_t)} \quad \frac{\ln U_M(M_t, \mathbf{p}_t)}{\ln M_t}, \tag{13}$$

where

$$U_{MM}(M_t, \mathbf{p}_t) \quad \frac{U_M(M_t, \mathbf{p}_t)}{M_t} \quad \frac{{}_{MM}(M_t, \mathbf{p}_t)}{(M_t, \mathbf{p}_t)} \quad \frac{{}_{M}(M_t, \mathbf{p}_t)^{\quad 2}}{(M_t, \mathbf{p}_t)^{(\quad 1)}}.$$

The concavity of the intertemporal utility function with respect to M_t implies that $U_{MM}(M_t, \mathbf{p}_t) \quad 0$ and hence $RRA(M_t, \mathbf{p}_t) \quad 0$.

3.1.4. Intertemporal Allocation of Consumption: Consumption Growth Equation

In the above discussion, consumption expenditure is treated as exogenous, but it is endogenously . It is not, however, feasible to obtain a structural or closed form of this function from the intertemporal optimization problem, even for simple utility functions when the environment is stochastic. To circumvent this problem, it is instead a common practice to work with the Euler equation in studies on consumption and saving (see, e.g., Hall, 1978; Hansen and Singleton, 1983; Ludvigson and Paxson, 2001), which is adopted here. To do so, we use the Euler equation for consumption (12) and exploit a lognormal property. Assuming that the quantity $(\quad _{t\ 1} / \quad _t)$ has a lognormal distribution and takinglogs on both sides of (12), we have

where

of

$$\ln \quad _{t \; 1} \quad b_{Mt} \quad \ln M_{t \; 1} \quad {}^{n}_{j \; 1} b_{jt} \quad \ln p_{jt \; 1}, \qquad (15)$$

where $b_{Mt} \quad \frac{\ln \quad _t}{\ln M_t} \quad \frac{\ln \quad (M_t, \mathbf{p}_t)}{\ln M_t} \quad \frac{\ln \quad _M (M_t, \mathbf{p}_t)}{\ln M_t}$ and $b_{jt} \quad \frac{\ln \quad _t}{\ln p_{jt}} \quad \frac{\ln \quad (M_t, \mathbf{p}_t)}{\ln p_{jt}}$

$\frac{\ln \quad _M (M_t, \mathbf{p}_t)}{\ln p_{jt}}$, $j = 1$ to n. S between permanent and temporary changes in the interest rate because consumers react differently to these changes. When a change in the interest rate is *temporary*, i.e., a change in the *current* rather than taking them immediately (see Gudmundsson and Natvik, 2012).

From the above discussions, it is clear that any change in the time preference rate, the interest rate, liquidity constraints, and uncertainty will have an effect on current consumption M_t and indirectly on the demands for nondurable and durable goods in (4). Commodity prices, which determine commodity demands, also influence consumption. This implies that

intratemporal and intertemporal allocations of consumption are inexplicably linked together. Hence, consumer demands and intertemporal consumption cannot be analyzed in isolation of each other, as is done in previous studies. Rather, a proper understanding of consumer behavior entails an integration of consumer demands and consumption with allowance for durable goods.

3.2. Empirical Specification

For empirical analysis, the specification of an appropriate functional form for the indirect utility function (3) is essential to obtain reasonable results. To properly characterize consumer behavior, however, the chosen functional form should be flexible while satisfying the requisite regularity conditions for within-period as well as intertemporal preferences. The PIGLOG (Price Independent Generalized Logarithmic) form, popularized by Deaton and Muellb

Almost Ideal Demand System (AIDS) is widely used in demand analysis. Blundell et al. (1994), despite some drawbacks with this system, utilized it to analyze consumer behavior in the context of intertemporal two-stage budgeting with no durable goods. When there are substantial changes in real income or consumption, the implied budget share equations for AIDS violate the required monotonicity and curvature conditions. In this study, we have adapted Cooper and McLaren (1992) M(modified) PIGLOG form as a functional representation of the indirect utility function (3). This extended MPIGLOG form is a composite indirect utility function of rank 3 (McLaren and Wong, 2009) and thus is more flexible than PIGLOG and MPIGLOG forms based on rank 2. The MPIGLOG specification allows easier imposition of regularity conditions in the form of effective global regularity (Cooper and McLaren, 1996; McLaren and Wong, 2009).

With the extended MPIGLOG specification, the indirect utility function (3) is given by

$$(M_t\,, \quad _t) \quad \frac{\frac{M_t}{P_A \quad _t} \quad 1}{} \quad \frac{\frac{M_t}{P_B \quad _t}}{1 \quad \frac{P_C \quad _t}{M_t}}, \qquad (17)$$

where

positive, increasing, and concave in . We assume that the price indexes take the forms:

$$\mathrm{P}_A \;\mathbf{p}_t \quad {}_{j\;1}^{\;n} \;{}_j\, p_{jt}^{\;A} \;{}^{1/\;A}, \mathrm{P}_B \;\mathbf{p}_t \quad {}_{j\;1}^{\;n}\, p_j^{\;j}, \quad {}_{j\;1}^{\;n} \;{}_j \quad \text{, and } \mathrm{P}_C \;\mathbf{p}_t \quad {}_{j\;1}^{\;n} \;{}_j\, p_j. \tag{18}$$

Given (17) and (18), we can see the direct connections between the extended MPIGLOG - MPIGLOG forms and MPIGLOG - PIGLOG forms. If we set to be zero, equation (17) reduces to the MPIGLOG form (Cooper and McLaren, 1992). In addition, setting to be zero, the MPIGLOG form reduces 980b) PIGLOG form.

Given (17) together with associated price indexes in (18), we obtain the following derivatives:

$$\frac{(M_t\,,\,\mathbf{p}_t\,)}{M_t} \quad \frac{\frac{M_t}{P_B\;\mathbf{p}_t}}{M_t \quad P_C\;\mathbf{p}_t} \quad 1 \qquad RP_{C_s} \quad R_t \quad , \tag{19}$$

$$\frac{}{} \quad \frac{\frac{1}{}}{} \quad \frac{1}{} \quad \frac{}{} \tag{20}$$

and

$$\tag{21}$$

where $R_t \quad \dfrac{\frac{M_t}{P_A\;\mathbf{p}_t} \quad 1}{}$, $RP_{C_t} \quad \dfrac{P_C(\mathbf{p}_t)}{M_t \quad P_C(\mathbf{p}_t)}$, and $E_{Ait} \quad \dfrac{\ln \;P_A}{\ln \;p_{it}} \quad \dfrac{{}_i\, p_{it}^{\;A}}{{}_j \quad {}_j\, p_{jt}^{\;A}}$.

Expressions (19) and (20) could be used identity (4). In a budget or expenditure share form, we have

$$S_{it} \quad \frac{(M_t\,,\,\mathbf{p}_t\,)/\;\;p_{it}}{(M_t\,,\,\mathbf{p}_t\,)/\;\;M_t} \; \frac{p_{it}}{M_t} \quad \frac{1 \quad R_t \;\;E_{Ait} \qquad {}_i R_t \quad \frac{{}_i\, p_{it} R_t}{M_t \quad P_C(\mathbf{p}_t)}}{1 \qquad\qquad RP_{C_t} \quad R_t}, \; i \quad 1,\ldots,n, \tag{22}$$

where ${}_{it} \quad {}_{it}\;{}_{it}/\;\;{}_t$ is the share of the ith $(i \quad 1,\ldots,n)$ good in total expenditure, with . The coefficient of relative risk aversion (13) is derived where

$$\frac{\ln \quad (M_t\,,\,\mathbf{p}_t)}{\ln M_t} \quad \frac{1}{R_t} \qquad\qquad RP_{C_t}$$

and

$$\frac{\ln \quad {}_M(M_t\,,\,\mathbf{p}_t)_t}{\ln M_t} \quad \frac{RP_{C_t} \quad 1 \quad R_t \quad RP_{C_t} \quad 1 \quad RP_{C_t} \quad R_t}{1 \qquad\qquad RP_{C_t} \quad R_t} \qquad 1 \quad RP_{C_t} \;.$$

The Euler equation in (12) could be written as

$$\frac{1 \quad r_t}{1} \frac{{}_{t\ 1}}{{}_t} \quad \frac{{}_t}{{}_t} \quad 1 \quad {}_{t\ 1}\,, \tag{24}$$

where ${}_{t\ s}$ $\dfrac{(M_{t\ s}, \mathbf{p}_{t\ s})}{1 \quad {}^{s}} \dfrac{(M_{t\ s}, \mathbf{p}_{t\ s})}{M_{t\ s}}$, for s = 0 and 1, and ${}_t$ is an expectation error, with

$(M_{t\ s}, \mathbf{p}_{t\ s})$ and $\dfrac{(M_{t\ s}, \mathbf{p}_{t\ s})}{M_{t\ s}}$ given by (17) and (19). Estimation of the Euler equation (24) requires the solution for the Lagrange multiplier or shadow price for liquidity constraints ${}_t$. This variable is a non-differentiable function of many variables, which is difficult to derive analytically. As a result, previous studies often employ some indicators such as wealth to identify whether households are liquidity constrained (see Zeldes, 1989; Wakabayashi and Horioka, 2005). In this paper, we use a different approach to identify the presence or absence of liquidity constraints. When the consumer faces a liquidity constraint, his ability to adjust current consumption is limited in response to a future increase in income; hence his optimal consumption is constrained by current income. If the consumer is liquidity-constrained and his disposable income increases in the current period, the constraint wi1 498.4hLF1 12 Tf1 0 0 1 540.1 394.75 Tm0

$$_{t} \quad _{0} \quad _{1}\ln Y_t^d \quad _{2}\ln k_t\,, \tag{25}$$

where Y_t^d is disposable income at period *t*, and $_1$ and $_2$ are parameters with the restriction that $_1 < 0$ and $_2 < 0$ if the consumer is liquidity constrained.

Further properties of the extended MPIGLOG budget share system (22) can be derived. The expenditure elasticities satisfy

$$\frac{\ln g_i(M_t\,,\,\mathbf{p}_t)}{\ln M_t} \quad 1 \quad \frac{1}{Z_{it}} \quad E_{Ait} \quad _i \quad \frac{_i\,p_{it}}{M_t \quad P_C \quad \mathbf{p}_t} \quad \frac{M_t}{P_A \quad \mathbf{p}_t} \quad \frac{_i\,p_{it} R_t (1 \quad RP_{C_t})}{M_t \quad P_C \quad \mathbf{p}_t}$$

$$\frac{1}{_{M_t}} \quad RP_{C_t} \quad \frac{M_t}{_{A} \quad _{t}} \quad RP_{C_t} \;\; 1 \quad _{C_t} \quad _{t}\,, \tag{26}$$

and the own/cross price elasticity equations satisfy

$$\frac{\ln g_t(M_t\,,\,\mathbf{p}_t)}{\ln p_{jt}} \quad _{ij} \quad \frac{1}{Z_{it}} \begin{matrix} 1 \quad R_t \quad E_{Aijt} \quad E_{Ajt} \quad E_{Ait} \quad _{it} \quad \dfrac{_i\,p_{it}}{M_t \quad P_C} \quad _{it}R_t \\ \dfrac{_i\,p_{it}R_t}{M_t \quad P_C} \quad _{ij} \quad \dfrac{_i\,p_{jt}}{M_t \quad P_C} \end{matrix} \tag{27}$$

where and Z_{M_t} are the expressions in the top and bottom of equation (22), and $_{ij}$ is the Kronecker delta.

4. Estimation and Results

Empirical investigation was carried out using annual consumption expenditure data for Norway discussed in Section on eight nondurable goods and an aggregate durable good spanning the period 1979 to 2018. In this section, we discuss estimation procedures of the empirical model and present estimation results.

4.1. Estimation methods

To obtain the values of parameters in the extended MPIGLOG indirect utility function (17) together with the Box-Cox parameter and the time preference rate appearing in the intertemporal optimization problem (9), we jointly estimate the budget share equations for eight nondurable goods and an aggregate durable good in (22) and the Euler equation for total consumption in (24). Although the Euler equation contains all information to identify the parameters, its use only is not efficient because it neglects the information given in the budget share equations. In estimation, it should be noted that total consumption is not exogenous

is correlated

with the error terms. Also, current prices $\mathbf{p}_t$ and the interest rate may not be strictly exogenous. Moreover, there are variables dated t

variables may not be strictly exogenous. Hence, we pursue an instrumental variables method, using as instruments one-period lags of all regressors. For conditional variance of total consumption, we can take the realized values by instrumenting them with lagged values under rational expectations (see the discussion in Section 2.2). We also assume that other explanatory variables such as the interest rate and growth variables may not be strictly exogenous and thus instrument them with lagged values.

4.2. Parameter Estimates

Table 2 reports estimation results for the empirical model based on joint estimation of the nine budget share along with the Euler equation for consumption. The following comments are in order. The model is highly nonlinear with many parameters, and we experienced a convergence problem. Thus to ensure that the requisite within-period and intertemporal regularity conditions are satisfied, we imposed a parameter restriction in estimation by setting $_3 = 0$ in the extended MPIGLOG indirect utility function (17). With this restriction, all of the regularity conditions are satisfied at every sample period. The ^{2} based J-test shows that the overidentifying restrictions are not decisively rejected at the conventional significance levels, providing evidence for the validity of the chosen instruments in our estimation. Moreover, the general fit of the budget share system as indicated by the R^2 values is quite good.[6] Autocorrelation diagnostics revealed in the Durbin-Watson and Box- ^{2} statistics suggest that serial correlation in the error terms is no longer severely pathological.

While these results lend some validity of our estimated model, there are some estimated parameters that are of particular interest in our analysis. The estimated (0.030) is significantly different from zero, substantiating the relevance of the Box-Cox transformation of the indirect utility function (17). The liquidity constraint parameters $_1$ (-0.015) and $_2$ (-0.011) have expected negative signs and are significant at conventional significance levels. Thus disposable income and durables stock affect the liquidity constraint, but their effects are rather small. The value of $_0$ is also small but significant. Using (25), the degree of liquidity constraint is evaluated at the sample means of disposable income and durables stock, which gives the estimated $_t$ value of 0.0062 with the *t* ratio of 2.6209. This clearly suggests

Table 2: Joint Estimation

q_5 = water and fuels, q_6 = health services, q_7 = transport services, q_8 = other non-durables and services, and *k* = durables stock.

Finally, the estimated time preference rate of 0.074 means that consumers discount the utility of future consumption at an annual rate of 7.4%. To see this in proper perspective, we compare the time preference rate with the interest rate. During the sample period, the average annual interest rate was 7.13%. However, this average rate is misleading to represent the behavior of the interest rate during the sample period (see Table 1). The interest rate was above 10% during 1979-1992, but it has been falling since then -- from the value of 7.265% in 1993 to 2.236% in 2012. It remained below 2% for 2013 2018. Thus the time preference rate was greater than the interest rate for most of the sample period. This implies that Norwegian consumers, to a large extent, appear to be impatient, in the sense that they have a high time preference for present consumption relative to the risk-free interest rate.

4.3. Estimated Demand Elasticities and Relative Risk Aversion

Table 3 displays mean budget shares for commodities and estimated expenditure and price elasticities for nondurable and durable goods using (26) and (27) along with estimates of relative risk aversion (RRA) using (23) evaluated at the sample means of the variables. Two sets of estimates with and without durable goods are presented to see the bias resulting from ignoring durable goods, using nondurable goods only. Looking at the mean budget shares without durable goods, a substantial portion of expenditure on nondurable goods and services except for other goods is spent for housing services (20.4%), followed by food and non-alcoholic beverages (18.9%) and transport services (11.7%). When durable goods are included, it is important to note that durables expenditure is

Table 3: Estimation Results: Expenditure and Price Elasticities and Relative Risk Aversion (t ratios in parentheses)

Commodities	Mean Budget Shares		Expenditure Elasticities		Own Price Elasticities	
	With Durables	Without Durables	With Durables	Without Durables	With Durables	Without Durables
q_1	0.150 (6.193)	0.189	0.675	0.566	-0.407	-0.514

Estimated price elasticities also reveal a marked difference with and without durable goods. When durable goods are considered, all nondurable goods are price-inelastic. Durable goods are also found to be price-inelastic. There are studies estimating income and price elasticities of demand for Norwegian consumers (see the Appendix for literature review). However, they do not consider durable goods and use different groupings of nondurable goods, and thus they are not comparable to our results.

There has been a dramatic rise in the share of income spent on health expenditures in many countries, including Norway, and it is believed that this is a consequence of rising income or living standards (Hall and Jones, 2007). This would be the case if health care is a luxury. Acemoglu et al. (2013) investigated this issue by estimating the income elasticity of health care for the United States, and found that the estimate is much less than unity. This led them to conclude that rising income is unlikely to be a major driver of the rising health expenditure share of GDP. It has been often suggested, without evidence, that the invention of new and expensive medical technologies causes health spending to rise over time (see Hall and Jones, 2007).

The question that remains is, what is behind the notable trend in the rising health share of income? Our analysis provides some answer to this question for Norway. In particular, the estimated expenditure elasticity of health services when durable goods are included is 0.261, which is less than all other goods, meaning that health services are more necessary than other goods. Thus, the evidence is clear to reject that health care is a luxury; it can be rather considered a necessity. More importantly, we have an expenditure share equation for health care estimated in conjunction with other commodities [see (22)], with an average of 1.4% of total consumption spent on health care. From this equation, we can estimate the health share elasticities of income and prices, which are directly related to the income and price elasticities of health services in Table 3. From the estimated expenditure elasticity of health services, we get a health share elasticity of income of -0.739 with the *t* value of -2.696. This means that rising income has a negative effect on the health share of income, in direct contradiction to the conventional view (see Hall and Jones, 2007). The estimated price elasticity of health services is -0.253, yielding a health share elasticity of the health services price of 0.747 with the *t* value of 2.449. We then can conclude that the rise in the health expenditure share of GDP in Norway has been driven by rising health care prices or costs rather than by rising income. To by

4.4.

Table 4:

consumption measured by its realized value

Further, housing is excluded in durable goods in Eurostat on which our data are based. These results suggest that the EIS in total consumption is close to zero.

Importantly, however, the EIS measures the response of consumption growth to a *temporary* change in the interest rate. The negligible value of this elasticity is largely attributed to a lack of sufficientq0.00000912 0 612 792 reW* nBT/F4 12 Tf1 0 0 1 490.06 667.42 Tm6lack of

Gudmundsson and Natvik (2012) employed a structural VAR framework with two different measures of uncertainty

These results are informative to understand Norwegian consumer behavior relative to previous studies. However, to draw firm conclusions about consumer demand and consumption, more empirical work may be in order with a possibly refined empirical model and better use of the data.

interest is that the expenditure elasticities of fish and cheese implied by the static LAIDS are negative and insignificant, while the own-price elasticity of egg is positive and insignificant.

In Rickertsen (1996), five types of meat and fish consumption from 1960-1992 were

capture the structural change in private consumption. The author also acknowledged that commodity prices in the models are endogenous, leading him to use the three-stage least square technique rather than the conventional method to estimate the models. Overall, results show a graduate change in the demand for meat and fish during the 1980s and there have been statistically significant shifts towards fish and chicken and away from beef.

Further studies on Norwegian macro-consumption function were based on the approaches developed by Brodin and Nymoen (1992) and Magnussen and Moum (1992), and their major findings are summarized in Landsem (2016, page 28). For example, Ekeli (1992) modified luding stocks and bonds) definition to measure wealth variable, while this modification does not change the parameter estimates of the

model by including a dummy variable to capture the effect of deregulation of the credit market. Interestingly, he found that the estimated wealth elasticity is less the structural change since 2008. Two interesting results emerged from Landsem's study. Firstly, the impact of income distribution (measured by Gini ratio and wage sh

Theory and Evidence. Journal of Political Economy 86 (6), 971-987.

Hall, R.E., 1988. Intertemporal Substitution in Consumption.

of Economics and Statistics 83 (2), 242 256.

Magnussen, K., Moum, K., 1992. Is Eilev Jansen wrong all the same? Sosialokonomen 46,12-18.

Mankiw, N.G., 1985. Consumer Durables and the Real Interest Rate. Review of Economics and Statistics 67 (3), 353 62.

McLaren, K.R., Wong, K.K.G., 2009.

Rosenberg, E., Lind, A., Espegren, K.A., 2013. The Impact of Future Energy Demand on renewable Energy Production-Case of Norway. Energy 61, 419-431.

Snella, J.J., 1978. An analysis of Consumer Demand in Norway, 1947-1974. The Scandinavian Journal of Economics 80, 283-298.

Smith, A.L., 2020.