CONSUMPTION PATTERNS OF THE ELDERLY

THREE ESSAYS ON THE CONSUMPTION PATTERNS OF THE ELDERLY

By STEPHEN P. BONNAR, B.MATH (HONS., CO-OP), M.A.

A Thesis Submitted to the School of Graduate Studies
in Partial Fulfilment of the Requirements for the Degree
Doctor of Philosophy

McMaster University

McMaster University DOCTOR OF PHILOSOPHY (2016) Hamilton, Ontario (Economics)

TITLE: Three Essays on the Consumption Patterns of the Elderly

AUTHOR: Stephen P. Bonnar, B.Math (University of Waterloo), M.A. (McMaster University)

SUPERVISOR: Professor Michael Veall

NUMBER OF PAGES: xiii, 138

Abstract

Overall this thesis explores the age pattern of consumption of the Canadian elderly. Theoretical applications of the Life Cycle Hypothesis suggest that these consumption patterns should be constant in real terms as individuals age. However, most empirical work observes a declining pattern of consumption with age and health status. This thesis attempts to resolve this difference.

The first chapter uses data from the Canadian National Population Health Survey. Using a comprehensive measure of health status, it finds that poor health explains the reduction in consumption (and its marginal utility), with most of the effect occurring among individuals whose income is above the median.

The second chapter uses data from the Canadian Survey of Household Spending to explore the effect on non-healthcare consumption of falling into ill health. It finds that the effect on non-healthcare consumption varies by

the level of a household's saving or dissaving. Non-healthcare consumption decreases by roughly 2.25% of after-tax income for those households that dissave 10% of their current year after-tax income or less. As households dissave larger and larger amount, however, the effect first becomes less negative, and then more positive.

The third chapter develops a theoretical approach to calculating a life annuity value that produces optimal levels of annual consumption that reflect changes in utility based on health status and age. Relative to an annuity that produces a constant real stream of income for a healthy 65 year old male, the optimal stream of income starts roughly 2% higher and drops by 2% to 3% by age 80 and by a further 2% or so by age 95. This pattern of consumption is roughly equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation.

Acknowledgements

I would like to acknowledge the calm guidance, sage advice, and helpful criticism that I received from my supervisor, Professor Michael Veall. He, together with my other committee members, Professors Byron Spencer and Michel Grignon, aided me immeasurably by pushing me to develop well rounded answers to the research questions that I was addressing.

I am grateful for the financial support provided to me by both McMaster University and the Social Sciences and Humanities Research Council (SSHRC). The analysis presented in this thesis was conducted at the Research Data Centre at McMaster University, which is part of the Canadian Research Data Centre Network (CRDCN). The services and activities provided by the Research Data Centre at McMaster University are made possible by the financial or in-kind support of the SSHRC, the CIHR, the CFI, and Statistics Canada. The opinions expressed herein do not necessarily represent the views of the supporting organizations.

I also want to thank my classmates for making me feel part of the class, in spite of the fact that they were roughly the age of my children.

On a more personal note, I am very thankful to family and friends who offered kind words of encouragement. These words came in spite of what I am sure was bemusement that I would choose to complete a Ph.D. as my "retirement" activity.

Finally, I want to thank my wife for the chore of putting up with a "student" after 30+ years of marriage. I also enjoyed our discussions of the difference in approach to answering research questions between economics and sociology. I am not sure either of us convinced the other.

Contents

List of Tables

List of Figures

Introduction

This thesis focusses on the consumption patterns of the Canadian elderly. Broadly speaking, the existing theoretical literature expects the elderly to consume at a constant real pace. The existing empirical literature, however, generally finds that the elderly in a variety of countries reduce their consumption as they age and fall into ill health. The following chapters attempt to link the theoretical expectations with the empirical results with respect to the Canadian elderly.

The seminal paper on the Life Cycle Savings Hypothesis, Modigliani & Brumberg (1954), provides a general analytical framework using marginal utility analysis to establish motives for savings. The particular motive that they explore is the desire to save or dissave at different times in order to create an optimal age pattern of consumption. Optimization occurs when the marginal utility of consumption is held constant. With some simplifying assumptions this leads to constant real consumption. This thesis argues that these simplifying assumptions need to be relaxed to reflect real-world behaviour. Specifically, there needs to be some reflection of Health State (and perhaps age) in the determination of the marginal utility of consumption.

In order to address this question, a "perfect" data file would be longitudinal and would contain detailed information on individuals' (or households') health status and consumption. In Canada, this type of data does not yet exist. However, the Canadian Longitudinal Survey on Aging (CLSA) will go some way to addressing this shortfall once further waves of the survey are compiled.

In the absence of such a data file, this thesis examines two separate data files:

- the Canadian National Population Health Survey (NPHS), which is a longitudinal survey that has an abundance of information on health status, but no information on consumption; and
- the Canadian Survey of Household Spending (SHS), which is a survey with repeated cross-sections that has an abundance of information on consumption, but little information on health status.

Chapter 1 uses the NPHS, exploring the impact of several different health measures: the Health Utility Index[1], HUI3; number of chronic diseases; re-

[1]This index was developed at the Centre for Health Economics and Policy Analysis at McMaster University, and provides a summary description of an individual's overall

duced activities of daily living; and self-rated health.

As mentioned above, the NPHS has no information on consumption. However, under certain conditions, it is possible to make inferences about changes in the marginal utility of consumption from changes in the marginal utility of permanent income. This relationship was originally documented in a working paper version of Finkelstein et al. (2013), and is used in Chapter 1. Using this relationship, Chapter 1 makes inferences about the effect of health status on the marginal utility of consumption.

Using ordered logit regressions, the results of Chapter 1 show that the estimated marginal utility of consumption when sick is *larger* than when healthy, if sickness is defined as the number of chronic diseases. On the other hand, when using the more comprehensive measure of sickness, HUI3, the estimated marginal utility of consumption when sick is *smaller* than when healthy.

In analyzing the several sickness measures together, the HUI3 measure has the largest effect. The implication of the analysis using the HUI3 measure is that, relative to constant real consumption during retirement, a greater

health. Details of the calculation methodology are contained in Furlong *et al.* (1998). A fully healthy individual would have a score of 1.000; someone who is dead would have a score of 0.000. The minimum potential value is -0.330. Negative numbers correspond to a health status that is though to be worse than death.

amount should be consumed while in a healthy state and a lesser amount while sick. Additionally, there seems to be some evidence that the effect of sickness on the estimated marginal utility varies with income level. Virtually all of the change in the estimated marginal utility of consumption when sick occurs in the upper half of the income distribution.

Chapter 2 uses the SHS to examine the impact of health status on the observed consumption levels of elderly Canadians. Its major contribution to the literature is that it analyzes this impact at varying levels of savings/dissavings.

One of the key challenges in this analysis is to create some indicator of Health State from a data set that largely contains only information on consumption expenditures. The baseline measure in this Chapter is determined from household healthcare spending[2] for supplies, pharmaceuticals, healthcare practitioners, hospitals[3], and other medical services. Households are defined as “Sick” if their healthcare spending as a proportion of after-tax income is at or above the upper quartile break, where the quartile breaks are set separately for each income quartile.

[2]In Canada, a large proportion of healthcare costs are provided through the Provincial governments. Physician services and most hospital services are provided in this way.

[3]Largely this is comprised of the excess of the cost of semi-private or private accommodation over ward accommodation, the cost of which is provided through the Provincial governments.

The baseline results show that the non-healthcare consumption share of income *increases* when the household is "Sick" by 6.70% overall, but it *reduces* by 1.95% for those households whose current year consumption expenditure is less than their current year after-tax income. Exploring this relationship at a more granular level, the results show that non-healthcare consumption share of income reduces by roughly 2.25% for those households that dissave 10% of their current year after-tax income or less. As households dissave larger and larger amounts, however, the relationship becomes first less negative, and then more positive.

Chapter 3 develops a theoretical approach to determining a life annuity that produces a stream of income that will finance optimal consumption expenditures reflecting state-dependent utility. It proves that in the absence of state dependence, the optimal annuity value simplifies to a traditional annuity value.

The chapter then proceeds to calculate optimal annuity values based on data in the NPHS. It does not find a significant *economic* impact of Health State alone on the optimal pattern of consumption in retirement for the Canadian elderly. This result is obtained in spite of finding that the estimated marginal utility of consumption varies in a statistically significant (at the 0.1% level) way dependent on Health State. For example, a healthy Canadian male age 65 would optimally consume 100.20%, 100.03%, and 99.64%

when in good health, middling health, and poor health, respectively, relative to an optimal consumption pattern that ignores Health State (i.e., is constant in real terms).

However, when both age and Health State are reflected in the optimal pattern of consumption, the effect is both statistically significant (at the 1% level) and economically significant. Relative to a stream of income that is constant in real terms for a healthy 65 year old male, a stream of income reflecting both age and Health State will start roughly 2% higher and will drop by 2% to 3% by age 80 and by a further 2% or so by age 95. This pattern of consumption reflecting age and Health State is roughly equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation and does not reflect the effects of age and Health State.

Bibliography

[1] Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo. "What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption." *Journal of the European Economic Association* 11.s1 (2013): 221 – 258.

[2] Furlong William et al. *Multiplicative Multi-Attribute Utility Function for the Health Utilities Index Mark 3 (HUI3) System: A Technical Report.* No. 1998-11. Centre for Health Economics and Policy Analysis (CHEPA), McMaster University, Hamilton, Canada, 1998.

[3] Modigliani, Franco. "The Collected Papers of Franco Modigliani, Volume 6." *MIT Press Books* 6 (2005).

Chapter 1

The Effect of State Dependent Utility on the Optimal Consumption Pattern for Canadian Elderly

1.1 Introduction

The seminal paper on the Life Cycle Savings Hypothesis, Modigliani & Brumberg (1954), provides a general analytical framework using marginal utility analysis to establish motives for savings. The particular motive that they explore is the desire to save or dissave at different times in order to create an optimal age pattern of consumption.

In their paper, they make only two fundamental assumptions – that households receive no inherited assets, and that the utility function is such that the optimal proportion of resources devoted to consumption in any year is determined only by tastes, and not by the total amount of resources. They then introduce two additional assumptions made solely for convenience of exposition – that the interest rate for determining the present value of both consumption and income is zero, and that individuals plan to consume at a constant rate over the balance of their life. They also make an implicit assumption that capital markets are perfect and complete.

It is the second additional assumption that is the focus of this paper. In particular, this paper will address the question of whether health status has an effect on the marginal utility, and if so, in what direction.

Several authors (for example, Clarida (1991), Danziger *et al.* (1982), and Landsberger (1970)) take this assumption as fundamental to their analyses. However, other authors observe facts that are inconsistent with this assumption.

- "It has frequently been observed that the elderly either continue to save in retirement or decumulate much more slowly than would be predicted ..." [Davies (1981)]

- "...the savings rates of the elderly remain positive from some years" [Demery & Duck (2006)]
- "The elderly do not seem to dissave with age." [Hurd (1992)]
- "The total assets of continuing two-person households increase substantially well into old age." [Poterba, Venti & Wise (2010)]

Rather, the fundamental assumption for the Life Cycle Savings Hypothesis is that individuals optimally plan to hold constant their *marginal utility of consumption* over their lifetime. With a typical concave utility function[1] the result is a plan for constant consumption, as long as there is no state-dependency in the utility function.

Very little attention has been paid to the issue of state-dependency outside of the investment finance area. A theoretical outline of state dependent utility (SDU) is provided in Rustichini & Dreze (1994). Applications of SDU that relate to health and health issues are described in relatively few papers.

- Arrow (1974) applies SDU with regard to optimal levels of health insurance. However, this paper does not directly analyze the change in the marginal utility of consumption as the state of health changes.
- Viscusi & Evans (1990) capture state-dependence in an imaginative way, using interviews of workers to assess their reservation wages for

[1] $u^{'}(c) > 0$ and $u^{''}(c) < 0$.

different levels of job risk. They find that the marginal utility of consumption is lower in the event of a job injury.

- Evans & Viscusi (1991) analyze the effect of minor temporary illness on SDU. They find no effect on the marginal utility of consumption.

- Sloan *et al.* (1998) look at the impact of Multiple Sclerosis on the utility function, finding that the marginal utility of consumption is lower for those who have the disease.

- Palumbo (1999) looks at the impact of sickness on retired elderly individuals in the US. He uses the amount of healthcare expenditures as his indicator of sickness, and finds that the marginal utility of consumption reduces in the event of sickness (and also age).

- De Nardi, French & Jones (2006) also look at the impact on retired elderly individuals in the US. They use information on the health status of actual survey participants to find that the consumption and its marginal utility reduces as individuals fall into poor health (and also as they age).

- Domeij & Johannesson (2006) use Swedish data for all ages, not just seniors. They calibrate a structural model that shows a declining pattern of consumption with sickness (and also age).

- Finklestein *et al.* (2013) analyze SDU as it applies to retired elderly individuals in the US. Specifically, their data includes those age 50 and older, out of the workforce, and with health insurance coverage. Using the number of chronic diseases[2] as their indicator of sickness, they find that the marginal utility of consumption reduces in the event of sickness.

There is one paper that finds the opposite result – that the marginal utility of consumption *increases* when individuals fall into ill heatlh. Lillard & Weiss (1997) examine seniors in the US to come to this finding. It is unclear exactly why they come to a different finding. However, they do use a quadratic form of utility function, so the third derivative ("prudence") is zero. The other papers that find a decrease in the marginal utility function all use some form of Constant Relative Risk Aversion (CRRA) utility function, where the third derivative is not zero. This may explain the difference in results from the other papers.

In addition, there are two papers that find similar results without explicitly using SDU. Börsch-Supan & Stahl (1991) apply a constraint on the physical consumption opportunities of the elderly. Yogo (2009) uses a life-cycle model in which households (with household heads over age 65) face stochastic health depreciation and choose consumption, healthcare expenditure and portfolio allocation. Both of these papers achieve results that are consistent with a reduction in the marginal utility of consumption in the

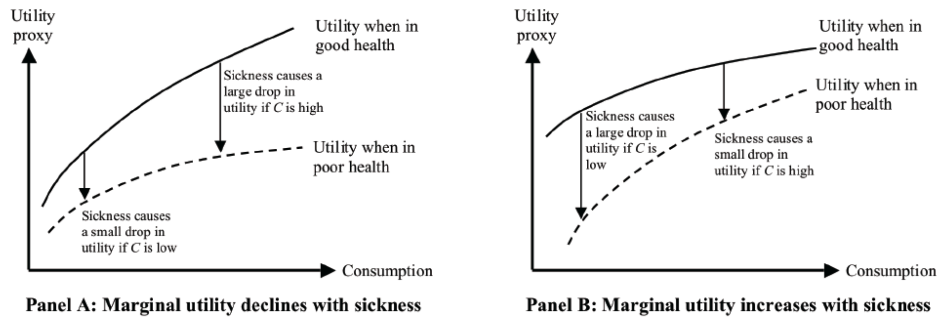
[2]They consider the following seven diseases that are asked about consistently over time in their data: hypertension, diabetes, cancer, heart disease, chronic lung disease, stroke, and arthritis.

event of sickness.

This paper initially tries to replicate the methodology and results in Finkelstein *et al.* (2013), applying it to the Canadian elderly who are out of the workforce. However, unlike the estimates of Finkelstein *et al.* (2013) for the United States, the estimates from the Canadian data that use the number of chronic diseases as a measure of sickness find that the marginal utility of consumption *increases* in the event of sickness. HUI3 is a more comprehensive measure of health/sickness. Using this measure, the marginal utility of consumption does decrease significantly in the event of sickness. Most of this effect, however, is among those individuals whose income is above median.

The rest of this paper proceeds as follows:

- Section 2 provides additional background;
- A description of the data and methodology is contained in Section 3;
- Results are reported in Section 4; and
- Section 5 concludes.



Source: Finkelstein *et al* (2013)

Figure 1.1: State Dependent Utility Functions

1.2 Background

While there can be little argument that the *absolute* level of utility is lower in a state of poor health relative to a state of good health *ceteris paribus*, what is interesting to explore is whether *marginal* utility increases or declines with poor health status. These two results are illustrated in Figure 1.1, which is reproduced from Finkelstein *et al.* (2013).

In Panel A of Figure 1.1, the marginal utility of consumption reduces when in poor health. Thus, maximizing lifetime utility would lead an individual to reduce consumption when in poor health relative to consumption while in good health. The reverse is illustrated in Panel B of Figure 1.1.

As in a working paper version of Finkelstein *et al.* (2013), this paper will express utility as a function of consumption and “sickness” as follows:

$$U(C, S) = \gamma_0 S + (1 + \gamma_1 S)u(C), \tag{1.1}$$

where C denotes consumption, S denotes sickness or a state of poor health, and u is a standard CRRA sub-utility function.

As noted above, we expect utility to be lower in a state of poor health. So, we expect that γ_0 will be negative. The parameter of interest is γ_1. If one thinks of S as a measure that increases in the event of sickness, then a positive value of γ_1 suggests that the marginal utility of consumption increases when in poor health, which in turn suggests that the optimal level of consumption should also increase in order to achieve a constant level of marginal utility of consumption. A negative value suggests that the optimal level of consumption should decrease while in poor health.

The empirical approach in this paper will also follow the approach of Finkelstein *et al.* (2013) and will estimate the following equation:

$$UtilityProxy_{it} = g(\beta_1 S_{it} \bar{Y}_i^{\beta_2},\ \beta_3 S_{it},\ X_{it}\Psi_1,\ \theta_i), \tag{1.2}$$

where i indexes individuals, t indexes time, S is a measure of sickness, $\bar{Y}$ is a measure of permanent income[3], X is a set of (potentially time-varying)

[3]Permanent income is the term used in Finkelstein *et al.* (2013). That use of this term

demographic covariates, and θ absorbs the individual fixed effects. In this formula, β_3 is analogous to γ_0 in formula (1), and β_1 is analogous to γ_1. Using β_2 as a power provides for some curvature in the utility function.

It should be noted that permanent income, $\bar{Y}$, is used in this specification and not consumption. There are two difficulties with using consumption – first, it typically is not readily available in the same dataset as health and utility indicators and secondly, it is difficult to measure, particularly in relation to the consumption of consumer durable goods. Drawing from a working paper version of Finkelstein *et al.* (2013), the Appendix contains a model of optimizing consumption behaviour that allows inferences about how the marginal utility of consumption changes with changes in health status from estimates of how marginal utility of permanent income varies with health status. The key requirement is that health shocks (as opposed to the general level of health status) do not lead to changes in periodic consumption.

Being mindful of the limitation of using permanent income rather than consumption in the identifying specification, the objective of the analysis is to determine whether the parameter β_1 is significant, and if so, what is its sign.

is continued in this paper, even though it is actually determined as average income in retirement.

1.3 Data and Methodology

The baseline specification that will be used for the analysis is the following regression model:

$$HAPPY_{it} = \beta_1 S_{it} log(\bar{Y}_i) + \beta_3 S_{it} + \Psi_1 X_{it} + \theta_i + \epsilon_{it} \tag{1.3}$$

The parameter of interest[4] is β_1, which represents the change in the marginal utility of consumption while in ill health.

The data used for the analysis is from the National Population Health Survey (NPHS), Household Component, Cycles 1 to 9. The NPHS collects information related to the health of the Canadian population. The Household component started in 1994/1995 and has been conducted every two years. The sample includes 17,276 persons from all ages in 1994/1995. Each cycle, a common set of health questions is asked of the respondents. Unfortunately, this sample has a fairly high rate of attrition[5]. People exit the survey for four potential reasons.

- They die.

[4] β_1 in this formula reflects the combined effects of β_1 and β_2 from formula 1.2 due to the taking of logarithms.

[5] Of the 1,855 individuals that satisfied the selection criteria for this study in the first cycle of the survey, only 18.5% continued to participate throughout all 9 cycles of the survey. By comparing total attrition to expected mortality from the "Life Tables, Canada, Provinces and Territories, 2009 to 2011", we can say that roughly 75% to 90% of the attrition is caused by mortality.

- They become institutionalized.
- They cannot be found to be interviewed.
- They refuse to respond to the interview.

The measure of consumption that is being analyzed in this paper is largely non-healthcare consumption[6]. Those that become institutionalized by entering into long-term care facilities have very little in the way of consumption expenditures beyond the costs of the facility. If their exclusion from further analysis has any effect on the results, it would be expected that it would have an upward bias[7] on the estimate of β_1. For those that cannot be found or refuse to be interviewed, the implicit assumption in the analysis is that their consumption patterns, their "happiness", and their likelihood of becoming "sick" is similar to the people who remain in the survey.

So that health state does not affect non-healthcare consumption, the observations utilized in this paper are restricted to individuals age 65 or older at the time of their observation (and thus qualify for comprehensive provincial healthcare coverage including some coverage for prescription drugs[8]) living in

[6]Provincial healthcare provides for most healthcare consumption, though out-of-pocket healthcare expenses are included as consumption.

[7]These individuals have clearly fallen into poorer health. Their non-healthcare consumption reduces from whatever it was in their pre-institutionalized state to virtually nil, since the cost of the long-term care facility is considered a healthcare expenditure. Thus, even though their absolute utility has fallen (γ_0 is negative in equation 1.1), the extreme fall in their non-healthcare consumption would be expected to produce a significantly negative value for γ_1.

[8]Prescription drug coverage for seniors varies across the provinces. Nova Scotia, New

households in which the primary source of income is not from employment. In addition, some observations were dropped where data concerning the key variables $HAPPY$ and S were missing. 927 individuals were dropped due to a missing value for $HAPPY$, and a further 580 individuals were dropped due to a missing value for S. In total, there were 2,931 individuals that were included in the study, totalling 13,165 observations. On average individuals were observed in 4.5 cycles of the survey. Table 1.1 provides a summary of the reasons for dropping individuals from the study. Specific variables used in the analysis are the following:

- $HAPPY_{it}$ is the utility proxy[9] and it is derived from the answers to the question: "How satisfied are you with your life in general?" The distribution of responses to this question is provided in Table 1.2.

- Permanent income, $\bar{Y}$, is derived from household income[10] averaged across cycles of the study. There are many observations where household income is missing or not stated. In these cases, a value was imputed that is equal to the value for the closest cycle with a valid amount

Brunswick and Quebec require explicit premiums, ranging up to as much as $2,000. Some provinces provide quite comprehensive coverage, typically with some deductible and/or co-payment. Newfoundland and Manitoba provide only coverage for catastrophic drug expenses.

[9]Since the data employed is longitudinal, the present analysis avoids the pitfall of attempting inter-household comparisons of utility. Rather, a much weaker assumption is made that individuals are consistent in the assessment of their "happiness" or utility over time and over health states.

[10]On average, there were 1.6 individuals in each household, and over 93% of the households had either 1 or 2 individuals. Results adjusting permanent income for the size of the household were almost identical to the results without adjustment for household size. Reported results in this paper do not adjust permanent income for household size.

for income and where the individual is age 65 or older (information from earlier cycles is preferred in cases of ties). The average is then taken over all cycles in which the individual participated and was age 65 or older at the time, without any adjustment for inflation. The distribution of average income is provided in Table 1.3. As a test of robustness, some of the analysis is repeated using only individuals where income did not need to be imputed.

- A number of measures are used for "sickness". The most comprehensive and least subjective measure of sickness is HUI3, which is the *a priori* preferred measure.
  - Number of chronic diseases is the sickness measure used in Finkelstein *et al.* (2013). The distribution of the number of chronic diseases is shown in Table 1.4. Since observations for which the number of chronic diseases is "not stated" should not be included in regressions where this measure is used, they are excluded from those regressions. For comparability purposes, these observations are also excluded from some of the regressions that use other sickness measures.
  - A continuous measure of sickness is the Health Utility Index (HUI3)[11][12].

[11]Even though this measure is described as "utility", there should not be any problem in including this as an explanatory variable in the same regression as an actual measure of utility is the dependent variable. This is because in this measure, "utility" is being used only as a weighting measure to determine overall health – to determine, for example, whether diabetes is "better" or "worse" than leukemia, and by how much.

[12]Furlong, *et al.* (1998) provide the following description: "The HUI3 classification

This index was developed at the Centre for Health Economics and Policy Analysis at McMaster University, and provides a summary description of an individual's overall health. Details of the calculation methodology is contained in Furlong *et al.* (1998). A fully healthy individual would have a score of 1.000; someone who is dead would have a score of 0.000. The minimum potential value is -0.330. Negative numbers correspond to a health status that is thought to be worse than death. The distribution of this health measure is provided in Table 1.5.

– Number of reduced activities of daily living can be thought of as a proxy for a measure of sickness. The distribution of the number of reduced activities of daily living is shown in Table 1.6

– Self-rated health is a subjective measure of sickness/health. Allowed responses to the survey question are "Excellent", "Very Good", "Good", "Fair", and "Poor". In order to align reasonably with the proportion of respondents who report that they have either 0 or 1 chronic diseases, those who report their health as "Excellent" or "Very Good" are deemed to be "healthy". In the data, 39.2% of the observations are reported as "healthy". The distribution of self-rated health is shown in Table 1.7.

system includes eight attributes: vision, hearing, speach, ambulation, dexterity, emotion, cognition, and pain and discomfort. Each attribute has 5 or 6 defined functional levels, and a comprehensive HUI3 health state is defined by a vector consisting of one level from each of the eight attributes. ... [HUI3] provide[s] estimates of the preferences for health states from a community perspective."

- Finally, the only time-varying demographic covariates, X, are age, marital status, and, for the regressions attempting to replicate the results in Finkelstein *et al.* (2013), number of people in the household. Other demographic covariates, such as gender, education, and language, will be absorbed into the fixed effects parameter, θ.

1.4 Results

1.4.1 *Replication of Results from Finkelstein* et al. *(2013)*

Finkelstein *et al.* (2013) use a binary measure for happiness, where 87% of their observations are deemed to be happy. To match this with the data used in this paper, those that answer that they are "happy and interested in life" (76% of the observations) are deemed to be happy.

A linear probability model was run with controls for age, the square of age, marital status, number of people in the household, and a fixed effect for each cycle of the NPHS. Standard errors are calculated by bootstrapping. The results of this regression are shown in Table 1.8.

While the absolute change in utility is negative and significant, as expected, the change in the marginal utility of consumption is positive and significant. That is, the marginal utility of consumption is estimated to be greater while in poor health. This situation is represented by the image in Panel B of Figure 1.1. This is the opposite of the result found in Finkelstein *et al.* (2013).

The regression was rerun using dummy variables for each number of chronic diseases (results not shown). The results of this revised specification are consistent. That is, absolute utility declines when sick, but the marginal utility of consumption increases.

The reasons for the inconsistency of results with Finkelstein *et al.* (2013) are not clear. The data utilized in this paper are similar to theirs, including elderly individuals out of the workforce and with comprehensive healthcare insurance. One reason may be that the data in this paper includes only those age 65 and older, while Finkelstein *et al.* (2013) include those age 50 and older. Also, while each province provides some degree of prescription drug coverage for those age 65 and older, some coverage is only for catastrophic expenses. Finally, the definition of chronic diseases is different between the two data sets.

The regression was rerun including observations for those age 50 and older, and out of the workforce (24,817 total observations). The results (not shown) are qualitatively similar – absolute utility declines when sick, but the marginal utility of consumption increases. The remaining difference between this analysis and that in Finkelstein *et al.* (2013) is the differing definitions of chronic diseases. Finkelstein *et al.* (2013) analyze seven different types of chronic diseases. All of these are included in the data for the present analysis. However, many other types of chronic diseases are also included in the NPHS, for example, allergies, asthma, epilepsy, dementia, and glaucoma. The reason for the difference in results between the two studies is likely due to the difference in the definition of chronic disease. Since the comparison to Finkelstein *et al.* (2013) is solely as a starting point for the present analysis, no further reconciliation of results is attempted.

1.4.2 *Varying Definitions of "Sickness"*

As mentioned in the Section 1.3, the data include four alternative measures of "sickness", with the measure HUI3 being the preferred measure on an *a priori* basis. The specification used is the following:

$$HAPPY_{it} = \beta_1 S_{it} log(\bar{Y}_i) + \beta_3 S_{it} + \Psi_1 X_{it} + \theta_i + \epsilon_{it} \quad (1.4)$$

where the matrix of control variables X includes age and marital status. It is also worth noting in detail how the sickness measures are treated.

- Number of chronic diseases is used directly.

- The HUI3 measure is used directly. However, since larger values of HUI3 represent healthier lives, the sign of the coefficient β_3 is expected to be positive, rather than negative.
- Number of reduced activities of daily living (RADL) is used directly.
- Self-rated health is represented by a dummy variable equal to one if the rating is either poor, fair or good (i.e., "sick").

Table 1.9 provides a summary, using ordered logistic regressions, of the effect of using each of these four measures. For all of the sickness measures, the estimated absolute level of utility moves in the expected direction – up for HUI3 and down for the other three measures. The estimated marginal utility of consumption increases when sick when the sickness measure is either the number of chronic diseases or self-rated health. It decreases when sick when the sickness measure is either HUI3 or reduced activities of daily living, although the coefficient for reduced activities of daily living is not measured precisely. Qualitatively consistent results were obtained when the regressions for the number of chronic diseases and reduced activities of daily living were rerun using dummy variables[13]. The Pseudo R^2 shown in the Tables 1.9 to 1.13 is McFadden's measure[14].

[13] A dummy variable was created for each number of chronic diseases and each number of reduced activities of daily living.

[14] $R^2 = 1 - \frac{ln\hat{L}(M_{Full})}{ln\hat{L}(M_{Intercept})}$, where $\hat{L}$ is the estimated likelihood, M_{Full} is the full model with all the predictors, and $M_{Intercept}$ is the model without predictors.

There is some potential for multicollinearity since age is one of the variables in the vector X and it might be expected to be correlated with any sickness measure. In fact, the correlations between age and the various sickness measures are fairly low: .29 for the number of chronic diseases; $-.36$ for HUI3; .35 for reduced activities of daily living; and .11 for self-rated health. In any event, multicollinearity would not bias the estimates of β_1 and β_3. It would merely make the standard errors larger. Since we observe significant results on most of the measures in any event, multicollinearity does not seem to be an issue.

To explore which measure of sickness has the greatest effect, all were included in a single regression. The results of that regression are shown in Table 1.10. The only estimate that remains significant at the 1% level is the one for HUI3. This provides evidence supporting the *a priori* belief that HUI3 is the preferred measure of sickness. Of note in this regression, the marginal utility of consumption reduces when in ill health for three of the sickness measures (all but self-rated health). This larger regression provides a sign on the estimated coefficient for number of chronic diseases that is consistent with the results of Finkelstein *et al.*, though it is not measured precisely.

1.4.3 *Robustness Checks*

Several sets of robustness checks were run.

- The results were stratified by income level using HUI3 as the sickness measure.
- The results were run dropping the individuals that had missing income measures, again using HUI3 as the sickness measure.
- The results were run using self-reported health as the sickness measure, but redefining "healthy" as "Excellent", "Very Good", or "Good".

Stratifying the analysis by income level becomes problematic at some point as the number of observations gets smaller and the estimates become less precise. However, to provide some idea of sensitivity to the level of income Table 1.11 provides a summary of the results for incomes below and above the median using HUI3 as the sickness measure. The signs of the estimated coefficients remain positive. However, the estimated coefficient that represents the estimated marginal utility of consumption for those with earnings below the median is no longer significant. Most of the effect of state dependent utility seems to occur at the higher income levels. This makes some intuitive sense as those at higher income levels would have more discretionary consumption expenditures that could be reduced in the event of falling into ill health.

The regression using HUI3 as the sickness measure was rerun to assess the sensitivity to the effect of changing the measure of household income, rather than just dropping the observations with missing income. Table 1.12 summarizes the results where the individuals with missing income information were dropped. The results are qualitatively equivalent to the primary specification. The estimated coefficients β_1 and β_3 are both positive and significant.

Using self-rated health as the sickness measure, the definition of “healthy” was revised to add the rating of “Good” as being “healthy”. Table 1.13 summarizes the results with a comparison to the results of the original definition of “healthy”. In this case, while the sign of the change in the estimated marginal utility of consumption is still positive, it is no longer significant.

1.5 Conclusion

When analyzing the effect of a sickness measure on the marginal utility of consumption it seems to matter which sickness measure is used. When defining sickness as the number of chronic diseases, the estimated marginal utility of consumption when sick is *larger* than when healthy. On the other hand, when using the more comprehensive measure of sickness, HUI3, the estimated marginal utility of consumption when sick is *smaller* than when healthy.

In analyzing several sickness measures together, the HUI3 measure seemed to have the most effect. The implication of the analysis using the HUI3 measure is that relative to constant real consumption during retirement, a greater amount should be consumed while in a healthy state and a lesser amount while sick. For someone whose health moves from the 75th percentile of the HUI3 measure to the 25th percentile, the estimated marginal utility of consumption declines by 4.26%. Moving down to the 10th percentile reduces the estimated marginal utility of consumption by a further 5.19%.

Additionally, there seems to be some evidence that the effect of sickness on marginal utility varies with income level. Using the HUI3 as the measure of sickness, there is a significant decrease in the estimated marginal utility of consumption when sick for those whose income is above median levels. No significant result was found for those whose income is below median.

Finally, this paper has only focussed on the sign and significance of the estimated coefficients that represent the marginal utility of consumption by health status. Chapter 3 addresses *inter alia* the absolute amount of the change in the marginal utility of consumption at different levels of HUI3, with a view to deriving the optimal pattern of consumption in retirement.

1.6 Appendix

The following derivations were developed in a working paper version of Finkelstein *et al.* (2013). In their paper, optimizing individuals are assumed to allocate lifetime income over consumption in two periods. In the first period, all individuals are healthy ($S = 0$). In the second period, these individuals have probability p of falling ill ($S = 1$). As a result, lifetime utility is given by the following formula:

$$\begin{aligned} U(C_1, C_2, S) &= u_1(C_1) + \frac{1}{1+\delta} u_2(C_2, S) & (1.5) \\ &= \frac{1}{1-\alpha} C_1^{1-\alpha} + \frac{1}{1+\delta}\left(\gamma_0 S + (1+\gamma_1 S)\frac{1}{1-\alpha}C_2^{1-\alpha}\right), & (1.6) \end{aligned}$$

where C_1 and C_2 denote first- and second-period consumption respectively, δ denotes the discount rate, and α is the coefficient of relative risk aversion. The objective is to recover an unbiased estimate of γ_1.

The budget constraint is the following:

$$Y = C_1 + \frac{1}{1+r} C_2. \quad (1.7)$$

From the perspective of period 1, health in period 2 is a random variable, and the individual maximizes expected lifetime utility in period 1. Using the budget constraint to eliminate C_1, we find expected utility as a function of

C_2:

$$E[U] = \frac{1}{1-\alpha}\left(Y - \frac{C_2}{1+r}\right)^{1-\alpha} + \frac{1}{1+\delta}\left(p\gamma_0 + \frac{1}{1-\alpha}(1+p\gamma_1)C_2^{1-\alpha}\right) \tag{1.8}$$

Taking the derivative of $E[U]$ with respect to C_2 and setting it equal to zero yields the following first order condition:

$$C_2^* = \frac{\frac{(1+p\gamma_1)^{1/\alpha}}{(1+\delta)^{1/\alpha}}}{\left(\frac{1}{(1+r)^{1/\alpha}} + \frac{(1+p\gamma_1)^{1/\alpha}}{(1+\delta)^{1/\alpha}(1+r)}\right)} Y \equiv cY, \tag{1.9}$$

where c is a parameter that expresses the optimal second-period consumption as a fraction[15] of permanent income (Y). Note that second-period consumption is increasing in permanent income and does not depend on the realization of the health shock.

[15] This expression is different from the expression in the working paper version of Finkeltein *et al.* (2013), which I cannot replicate. However, it yields the same conclusion that second-period consumption is increasing in permanent income and does not depend on the realization of the health shock.

Bibliography

[1] Arrow, Kenneth J. "Optimal Insurance and Generalized Deductibles." *Scandinavian Actuarial Journal* 1974.1 (1974): 1–42.

[2] Börsch-Supan, Axel, and Konrad Stahl. "Life Cycle Savings and Consumption Constraints." *Journal of Population Economics* 4.3 (1991): 233–255.

[3] Clarida, Richard H. "Aggregate Stochastic Implications of the Life Cycle Hypothesis." *The Quarterly Journal of Economics* (1991): 851–867.

[4] Danziger, Sheldon, et al. "The Life-Cycle Hypothesis and the Consumption Behavior of the Elderly." *Journal of Post Keynesian Economics* 5.2 (1982): 208–227.

[5] Davies, James B. "Uncertain Lifetime, Consumption, and Dissaving in Retirement." *Journal of Political Economy* (1981): 561–577.

[6] De Nardi, Mariacristina, Eric French, & John Bailey Jones. *Differential Mortality, Uncertain Medical Expenses, and the Savings of Elderly Singles.* No. w12554. National Bureau of Economic Research, 2006.

[7] Demery, David and Nigel W. Duck. "Savings-Age Profiles in the UK". *Journal of Population Economics* 19.3 (2006): 521–541.

[8] Domeij, David and Magnus Johannesson. " Consumption and Health." *Contributions to Macroeconomics.* 6.1 (2006): 1–30.

[9] Evans, William N., and W. Kip Viscusi. "Estimation of State-Dependent Utility Functions using Survey Data." *The Review of Economics and Statistics* (1991): 94–104.

[10] Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo. "What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption." *Journal of the European Economic Association* 11.s1 (2013): 221 – 258.

[11] Furlong William et al. *Multiplicative Multi-Attribute Utility Function for the Health Utilities Index Mark 3 (HUI3) System: A Technical Report.* No. 1998-11. Centre for Health Economics and Policy Analysis (CHEPA), McMaster University, Hamilton, Canada, 1998.

[12] Hurd, Michael D. "Wealth Depletion and Life-Cycle Consumption." *Topics in the Economics of Aging.* University of Chicago Press, 1992. 135–162.

[13] Landsberger, Michael. "The Life-Cycle Hypothesis: A Reinterpretation and Empirical Test". *American Economic Review* 60.1 (1970): 175–183.

[14] Lillard, Lee A. and Yoram Weiss. "Uncertain Health and Survival: Effects on End-of-Life Consumption." *Journal of Business & Economic Statistics* 15.2 (1997): 254–268.

[15] Modigliani, Franco. "The Collected Papers of Franco Modigliani, Volume 6." *MIT Press Books* 6 (2005).

[16] Palumbo, Michael G. "Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle." *The Review of Economic Studies* 66.2 (1999): 395 – 421.

[17] Poterba, James M., Steven F. Venti and David A. Wise. *Family Status Transitions, Latent Health, and the Post-Retirement Evolution of Assets.* No. w15789. National Bureau of Economic Research, 2010.

[18] Rustichini, Aaldo, and JacquesÂ H. Dreze. *State Dependent Utility.* No. 1994043. Université Catholique de Louvain, Center for Operations Research and Econometrics (CORE), 1994.

[19] Sloan, Frank A., et al. "Alternative Approaches to Valuing Intangible Health Losses: The Evidence for Multiple Sclerosis." *Journal of Health Economics* 17.4 (1998): 475–497.

[20] Statistics Canada. *Life Tables, Canada, Provinces and Territories, 2009 to 2011.* Catalogue no. 84-537-X – No. 005. Ottawa: Statistics Canada, 2013.

[21] Viscusi, W. Kip and William N. Evans. "Utility Functions that Depend on Health Status: Estimates and Economic Implications." *The American Economic Review* (1990): 353–374.

[22] Yogo, Motohiro. *Portfolio Choice in Retirement: Health Risk and the Demand for Annuities, Housing, and Risky Assets.* No. w15307. National Bureau of Economic Research, 2009.

Table 1.1: Summary of Records Dropped

Total number of individuals in survey	17,276
Under age 65 or in the workforce	-12,487
"Happiness" indicator missing	-927
HUI3 missing	-580
Earnings miscoded	-351
Total individuals included in study	2,931

Table 1.2: Distribution of Happiness Indicator

So unhappy that life is not worthwhile	44
Unhappy with little interest in life	145
Somewhat unhappy	277
Somewhat happy	2,585
Happy and interested in life	9,908

Table 1.3: Distribution of Permanent Income

Percentile	Income
10	12,457
25	16,815
50	25,084
75	42,617
90	90,219

Table 1.4: Distribution of Number of Chronic Diseases

0	1,530
1	2,661
2	2,689
3	2,110
4	1,475
5	934
6	517
7	261
8	130
9	42
10+	32
Not stated	779

Table 1.5: Distribution of HUI3

Percentile	HUI3
10	.281
25	.661
50	.905
75	.973
90	.973

Table 1.6: Distribution of Reduced Activities of Daily Living

0	7,528
1	2,762
2	1,271
3	571
4	469
5	295
6	269

Table 1.7: Distribution of Self-Reported Health

Poor	831
Fair	2,549
Good	4,627
Very Good	3,850
Excellent	1,304

Table 1.8: Replication of Finkelstein Analysis
Number of Chronic Diseases

Variable	*Coefficient*
$S \times log\bar{Y}$	.0038**
	(2.57)
S	-.0656***
	(-4.31)
Age	.0221***
	(33.53)
Age^2	-.0001***
	(-19.78)
$Married$	.0508***
	(5.15)
$HHSize$	-.0067
	(-0.96)
R^2	.7811
N	12,386

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 1.9: Summary of Alternative Sickness Measures

Variable	*Chronic Disease*	*HUI3*	*RADL*	*Self-Rated Health*
$S \times log\bar{Y}$	.0258***	.1366***	-.0123	.0912***
	(3.65)	(3.98)	(-0.88)	(3.27)
S	-.4054***	2.3131***	-.2422	-2.0362***
	(-5.58)	(6.37)	(-1.71)	(-7.07)
Age	-.0053	.0342***	.0179***	-.0042
	(-1.65)	(9.66)	(5.21)	(-1.28)
$Married$	.2827***	.3322***	.3363***	.3067***
	(6.08)	(6.64)	(7.21)	(6.54)
Pseudo R^2	.0173	.1278	.0428	.0401
N	12,386	12,386	12,386	12,386

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 1.10: Comparison of Alternative Sickness Measures

Variable	*Chronic Disease*	*HUI3*	*RADL*	*Self-Rated Health*
$S \times log\bar{Y}$	-.0168	.1694***	-.0423*	.0472
	(-1.25)	(3.34)	(-2.10)	(0.09)
S	.2250	2.0085***	.4941*	-.9920
	(1.64)	(3.79)	(2.41)	(-1.85)
Age		.0295***		
		(8.07)		
Married		.3683***		
		(7.30)		

Regression has a Pseudo R^2 of .1344,
and is run with 12,386 observations.
t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: The results shown here are comprised of a single regression.

Table 1.11: Stratification by Income Measure
Sickness measure is HUI3

	Median and Below	Above Median
Variable	*Coefficient*	*Coefficient*
$S \times log\bar{Y}$	.0416	.1592*
	(0.68)	(2.29)
S	3.2180***	2.3342**
	(5.34)	(3.10)
Age	.0342***	.0263***
	(7.94)	(5.11)
Married	.1025	.4909***
	(1.48)	(7.09)
Pseudo R^2	.1447	.1645
N	6,347	6,818

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 1.12: Missing Earnings Dropped
Sickness measure is HUI3

Variable	*Coefficient*
$S \times log\bar{Y}$	.1913***
	(3.37)
S	1.6480**
	(2.75)
Age	.0310***
	(5.35)
Married	.3300***
	(4.21)
Pseudo R^2	.1298
N	4,771

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 1.13: Different Definitions of "Healthy"

Variable	Excellent, Very Good & Good *Coefficient*	Excellent & Very Good *Coefficient*
$S \times log\bar{Y}$	.0279	.0912***
	(0.72)	(3.27)
S	-1.4829***	-2.0362***
	(-3.81)	(-7.07)
Age	-.0033	-.0042
	(-1.01)	(-1.28)
Married	.3337***	.3067***
	(7.19)	(6.54)
Pseudo R^2	.0453	.0401
N	12,386	12,386

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Chapter 2

Elderly Consumption Patterns: A Study of Revealed Preferences

2.1 Introduction

Over sixty years ago, Modigliani & Brumberg (1954) proposed the Life-Cycle Savings Hypothesis (LCH). Under the LCH, individuals save and dissave over time in order to maximize their lifetime utility. Under certain assumptions, such as when the utility function is constant over time and strictly concave, the LCH results in a situation where individuals will optimally consume at a constant rate.

Over the last sixty years, virtually all of the theoretical research in this area assumes that optimal consumption is constant over time, where consumption is financed by current income and, as needed, running down savings. Examples include Clarida (1991), Danziger *et al.* (1982), and Landsberger (1970). However, almost all of the empirical research in this area shows declining consumption or lack of savings drawdown for the elderly. Some examples are as follows:

- "It has frequently been observed that the elderly either continue to save in retirement or decumulate much more slowly than would be predicted ..." [Davies (1981)]
- "The elderly do not seem to dissave with age." [Hurd (1992)]
- "... the savings rates of the elderly remain positive from some years" [Demery & Duck (2006)]
- "The total assets of continuing two-person households increase substantially well into old age." [Poterba, Venti & Wise (2010)]

Relatively little research investigating the importance of health status has been conducted to try to reconcile the theory with empirical observations of the consumption patterns of the elderly. This paper will contribute to that literature by examining the impact of health status on the observed consumption levels of elderly Canadians using data from the Survey of Household Spending (SHS).

What follows is a review of the literature in this area[1]. Most of the papers find that consumption (or the marginal utility of consumption) decreases with age and sickness.

- Davies (1981) is a largely theoretical paper that examines the effect of uncertain mortality rates on the level of consumption. The paper utilizes a constant relative risk aversion (CRRA) period utility function and does not include a bequest motive. The finding is that consumption declines with age, but only when mortality is uncertain.

- Börsch-Supan & Stahl (1991) set up a theoretical model that proposes that there is an upper constraint on consumption that varies with age and health status. The paper then uses actual consumption patterns in West Germany using a general form of utility function, with no bequest motive, in order to fit the theoretical model, including solving for the consumption constraints. The data used is from the West German Income and Expenditure Survey. It finds that at older ages there is a binding consumption constraint, and this helps to explain the observed decrease in consumption with both age and sickness.

- Palumbo (1999) uses the US Panel Study in Income Dynamics (PSID) and the National Medical Care Expenditure Survey (NMCES) to ex-

[1] Many of the papers in the literature review of this chapter are also covered in Chapter 1. The purpose behind having two separate reviews is to focus more closely on the specific research question being addressed.

amine the total consumption of seniors over time. He uses expenditure on health care as a proxy for health state. The utility function is a multiplicative form , $v(h_t, c_t) = \delta(h_t)u(c_t)$, to reflect health status, and a CRRA form for $u(c_t)$. The findings show that total consumption reduces with both age and sickness, implying that the marginal utility of consumption is also reducing.

- De Nardi, French & Jones (2006) utilize US data from the Assets and Health Dynamics of the Oldest Old (AHEAD) dataset to look at the consumption pattern of seniors over time. Unlike Palumbo (1999), this dataset includes information on the health status of the actual survey participants. However, similar to Palumbo (1999), this paper uses a multiplicative utility function where health status is modelled as $\delta(h_t) = 1 + \delta h_t$, and $u(c_t)$ is a CRRA utility function. Also like Palumbo (1999) it does not reflect any bequest motive. The findings show that total consumption reduces with age.

- Domeij & Johannesson (2006) use Swedish data (where they say that individuals face virtually no out-of-pocket medical expenses) to calibrate a structural model. It has a period utility function similar to both Palumbo (1999) and De Nardi, French & Jones (2006). Unlike these papers, it also reflects a bequest motive in lifetime utility. The theoretical model shows a pattern of consumption that declines with age and sickness. However, the rate of decline is not as great as in the actual data.

- Finkelstein *et al.* (2013) analyze state-dependent utility as it applies to retired elderly individuals in the US. Their theoretical model maximizes lifetime utility by using a two period utility function of the following form:

$$U = \left(\frac{1}{1-\gamma}\right)\left(C_1^{1-\theta} + \frac{1}{1+\delta}((1-\gamma)E_1[U_2]^{(1-\theta)/(1-\gamma)}\right)^{(1-\gamma)/(1-\theta)}, \tag{2.1}$$

where C_1 is first period non-health consumption, γ represents the coefficient of relative risk aversion, $1/\theta$ represents the elasticity of intertemporal substitution, δ is the discount rate, and $E_1[U_2]$ is the expectation of second period utility from the perspective of period 1. Second period utility is given by the following expression:

$$U_2 = (1+\varphi_1 S)\frac{1}{1-\gamma}C_2^{1-\gamma} + S\Psi(H), \tag{2.2}$$

where C_2 is second period non-health consumption, H is consumption of health services, and S is an indicator of sickness.

They use panel data on those retired elderly and near-elderly individuals in the US who have health insurance, where such data is taken from the Household Retirement Survey (HRS). The findings show that consumption and the marginal utility of consumption[2] decrease as individuals fall into ill health.

- The results from Chapter 1 are derived from Canadian data from the National Population Health Survey (NPHS). Utility is inferred from answers to a question about each individual's happiness. The results vary based on the measure of health status. However, for the preferred measure of health status, the marginal utility of consumption is lower when in ill health. This effect holds most strongly for those in the upper half of the income distribution.

On the other hand, Lillard & Weiss (1997) find results that are different, in that the marginal utility of consumption *increases* when households fall into ill health. They examine the pattern of seniors' total consumption over time using US data from the Household Retirement Survey (HRS). They reflect health status in a quadratic utility function of the following form[3]: $u(h_{it}, c_{it}) = \alpha(h_{it})c_{it} - \frac{\beta(h_{it})}{2}c_{it}^2$. The paper also includes a bequest motive with a similar quadratic form. As mentioned above, the findings show that the marginal utility of consumption increases when households fall into ill health. As a result, households tranfer consumption from the healthy state to the sick state. However, because of the quadratic form of the utility func-

[2]The marginal utility of consumption in the second period is represented by the expression $(1 + \varphi_1 S)u'(c_2)$.

[3]$u(\cdot,\cdot)$ is the period utility function, h_{it} is the health status of individual i at time t, c_{it} is the total consumption of individual i at time t, and $\alpha(\cdot)$ and $\beta(\cdot)$ are functions of health status.

tion, $u_{ccc} = 0$, so there is no role for "prudence"[4] in individuals' consumption decisions. Most of the other papers referenced here use a CRRA utility function where $u_{ccc} > 0$, so there is a role for "prudence". This may explain the difference in results from other papers.

There is also a somewhat related literature that examines the effect on household asset allocation as individuals age and fall into ill health[5]. However, that literature does not explicitly look at consumption patterns.

The present study contributes to the literature by isolating the impact of health on the consumption of non-healthcare goods and services. It focusses on Canadian elderly individuals who are out of the workforce. It also contributes to the literature by analyzing this effect at varying levels of saving/dissaving.

This paper uses data from the Canadian Survey of Household Spending (SHS). The baseline specification shows that non-healthcare consumption of the Canadian elderly *increases* by an estimated 6.70% when "Sick", which is significant at the 0.1% level. This result varies somewhat by income level, but the estimated coefficient remains positive and significant at least at the 1% level across the first three income quartiles. It fails to be significant in

[4] An individual is defined as "prudent" when $u_{ccc} > 0$. "Prudence" creates a motive for precautionary savings.

[5] See, for example, Edwards (2008) and Yogo (2009).

the fourth income quartile. The results are robust to several alternative specifications.

However, the effect on non-healthcare consumption varies by the level of the household's saving or dissaving. Non-healthcare consumption is estimated to *decrease* by roughly 2.25% for those households that dissave 10% of their current year net income or less. As households dissave larger and larger amounts, however, the estimated effect first becomes less negative, and then more positive. The literature to date appears not to have documented this effect.

It may be that the households that are dissaving significantly have an increased propensity to consume for all purposes. When they become "Sick", this propensity causes both healthcare and non-healthcare consumption to increase, perhaps as a result of the potential shortening of the household members' remaining lifetime due to falling into ill health.

The rest of this paper proceeds as follows:

- Section 2 provides the theoretical basis for the analysis;
- Section 3 describes the data and methodology employed;
- Section 4 contains the results; and
- Section 5 concludes.

2.2 Theoretical Basis

As mentioned above, under the LCH individuals save and dissave over time in order to maximize their lifetime utility. More formally, and abstracting from a bequest motive, individuals choose a consumption path to maximize

$$\sum_{t=1}^{\omega} \beta^t u(c_t), \tag{2.3}$$

subject to a budget constraint. While the analysis in this paper does not explicitly reflect a bequest motive, the conclusions will apply as long as the bequest motive is unchanged when individuals in households fall into ill health. Given that this paper is analyzing the effect on retired elderly households , this condition is equivalent to assuming that households set aside the present value of their intended bequest at the time of their retirement. Then, it is the balance of their wealth and all of their income that is analyzed.

Assuming that $u(c_t)$ has typical characteristics, such as $u'(c_t) > 0$, $u''(c_t) < 0$ and the utility function does not change over time and has no arguments other than c_t, lifetime utility is maximized by consuming at a constant rate over time (i.e., $c_t = c, \forall t$)[6]. However, if the utility function also contains an argument for "sickness", individuals will need to maximize a somewhat more

[6] Some may argue that needs change when children "leave the nest" or at the point of retirement. Since this paper focusses on seniors who have already retired, these objections are not applicable in this instance. Also, it allows for the analysis to concentrate on the question of changing needs or tastes in the event of sickness.

complicated function (also subject to a budget constraint) that might look like the following[7]:

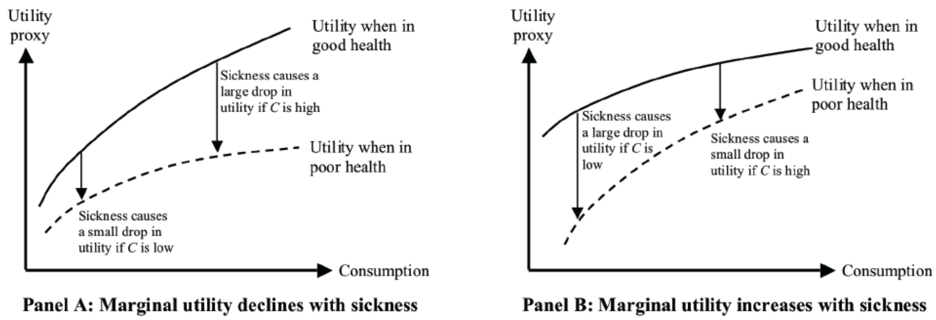
$$\sum_{t=1}^{\omega} \beta^t U(c_t, S_t) = \sum_{t=1}^{\omega} \beta^t \left(\gamma_0 S_t + (1 + \gamma_1 S_t)\, u(c_t)\right), \tag{2.4}$$

where S_t is an indicator of "sickness" that increases as individuals fall into progressively poorer health. The effect of this additional argument in the utility function is shown conceptually in Figure 2.1 that is reproduced from Finkelstein *et al.* (2013), where γ_0 represents the vertical displacement of the utility curve in the event of "sickness" and γ_1 represents the change in the slope of the utility curve (marginal utility of consumption) in the event of "sickness".

Lifetime utility is maximized by holding the marginal utility of consumption constant over time. Given this functional form, this means that $(1 + \gamma_1 S_t)u'(c_t)$ needs to be held constant over time, which requires consumption to vary based on the degree of "sickness" and the sign of γ_1. In particular, if γ_1 is negative, then lifetime utility will be maximized by progressively reducing consumption as individuals fall into progressively poorer health (assuming that the period utility function is strictly concave).

The objective of this paper is to examine the impact of health status on

[7]This functional form was proposed in a working paper version of Finkelstein *et al.* (2013).



Source: Finkelstein *et al.* (2013)

Figure 2.1: State Dependent Utility Functions

observed consumption levels of retired elderly Canadian households. In the theoretical model with perfect foresight, a 20 year old would optimize for the rest of their life, and could leave their plan in place without adjustment. In practice, there are many uncertainties, the occurence of any of which would lead to a re-optimization. By retirement, these uncertainties are largely limited to mortality and health. With respect to health, a finding that γ_1 is negative would be consistent with the empirical observations made at the beginning of the literature review in the preceding section.

The data used for the empirical analysis is based on households. The theory outlined here is largely based on individuals. However, if we assume that households make joint decisions while attempting to maximize individual utility functions, and the relative bargaining power within the household does not change during retirement (even though it may have changed upon the incidence of retirement) then the empirical results will be consistent with the theory.

2.3 Data and Methodology

The baseline specification that will be used for the analysis is the following regression model:

$$
\begin{aligned}
NHCS_i = & \beta_0 + \beta_1 INCOME_i + \beta_2 SICK_i + \beta_3 f(AGE_i) + \\
& \beta_4 g(YOB_i) + \beta_5 \mathbf{X}_i + \epsilon_i
\end{aligned}
\tag{2.5}
$$

where

- $NHCS_i$ is the share of after-tax household income taken up by non-healthcare consumption[8];
- $INCOME_i$ is the logarithm of total adjusted household income after taxes[9], and includes income from pensions, investments, and government transfers. After-tax income is used because that is the amount available to the household to use for current consumption (both non-

[8]Healthcare expenditures are excluded. Those that are non-zero at the 90th percentile are expenditures for pharmaceuticals, healthcare supplies, healthcare practitioners, eye-care goods and services, dental services, and health insurance premiums. Also, expenditures on durable goods are based on purchases, not the flow of services from such goods.

[9]Household income is adjusted for the number of people in the household by dividing by the square root of the number of household members.

healthcare and healthcare) and savings;

- $SICK_i$ is a measure of sickness. The baseline measure is determined from household healthcare spending[10] for supplies, pharmaceuticals, healthcare practitioners, hospitals[11], and other medical services. Notably, it excludes expenditures for vision care, dental, and healthcare premiums, which would not be expected to change materially based on an individual's health status. It is set equal to 1 for those households whose healthcare spending as a proportion of after-tax income is at or above the upper quartile break, where the quartile breaks are set separately for each income quartile[12]. Robustness of the results to alternative definitions is also shown;

- $f(AGE_i)$ is a function that picks up age effects. For the baseline regressions $f(AGE_i) = AGE_i$.

- $g(YOB_i)$ is a function of year of birth that will pick up cohort effects. For the baseline regressions $g(YOB_i) = YOB_i$.

- $\mathbf{X}_i$ is a vector of control variables:

    - province/territory dummy variables,

[10]In Canada, a large proportion of healthcare costs are provided through the Provincial governments. Physician services and most hospital services are provided in this way.

[11]Largely this is comprised of the excess of the cost of semi-private or private accomodation over ward accommodation.

[12]It would be useful to have a control to indicate whether the household has any form of private insurance coverage. Unfortunately, the data do not capture insurance coverage that is fully paid for by an employer or ex-employer. As a result, for a subgroup of the sample, there will be some difference between healthcare utilization and healthcare spending.

  - city size dummy variables,
  - sex of the reference person,
  - household size, and
  - a dummy variable for "higher education", where "higher education" is defined as a Bachelors degree or higher attained by either spouse.

The parameter of interest is β_2, which represents the difference in the non-healthcare consumption share of household after-tax income as a result of the household being "Sick", rather than "Healthy".

Data is taken from the Survey of Household Spending (SHS). This survey, which has repeated cross-sections, has been conducted annually since 1997[13]. This paper uses all 16 of the SHS surveys from 1997 to 2012. The SHS collects detailed information about expenditures for consumer goods and services, changes in assets, mortgages and other loans, and annual income.

The SHS is carried out in private households in Canada's provinces and, for some surveys, the territories. The following groups are excluded from the survey:

- those living on Indian reserves and crown lands (with the exception of the territories);

[13]The Family Expenditures Survey (FAMEX) was integrated into SHS in 1997.

- official representatives of foreign countries living in Canada and their families;
- members of religious and other communal colonies;
- members of the Canadian Forces living in military camps; and
- people living full-time in institutions: for example, inmates of penal institutions and chronic care patients living in hospitals and nursing homes[14].

The SHS covers roughly 98% of the population in the 10 Provinces, with somewhat lower coverage in the Territories. Spending data is collected for every household member at the time of the interview, including those who joined the household in the survey year, regardless of whether the previous household existed or the person was living alone. Data are not collected for those who leave the household in the survey year. Persons temporarily living away from their families (for example, students at university) are included in the household to avoid double counting.

The SHS is a sample survey with a cross-sectional design. From 1997 to 2012, the total sample comprises 247,803 households. Over the years, the response rate has varied from a low of 63.4% to a high of 76.4%. Each year's

[14]The exclusion of individuals living in hospitals and nursing homes is expected to cause some bias in the results. These individuals are spending significant amounts on healthcare consumption and very small amounts on non-healthcare consumption. As a result, if they were able to be included in the analysis, we would expect a larger drop (or a smaller increase) in non-healthcare consumption while sick.

sample is a stratified, multi-stage sample selected from the Labour Force Survey (LFS) sampling frame. The regressions are based on weighted observations. Since the total weights are not consistent across each year, they have been converted to percentages of the total number of households in each year. In general, the regression results are qualitatively similar comparing the weighted and unweighted results. The data summaries in Tables 2.1 to 2.8 are based on the unweighted data.

In order to identify β_2 as due solely to the effect of being in ill health, the effects of sickness on labour force participation and the budget constraint need to be eliminated. In order to do this, those households where the main source of household income is from employment or where the reference person or the spouse, if present, is under the age of 65 are excluded from the analysis. This exclusion reduces the sample size to 38,061 households.

There is a possibility that those households whose expenditures on consumption in the current year exceed after-tax income for the current year experience a "tightening" of the budget constraint when they fall into ill health and have larger healthcare expenditures. This has the potential to create a bias in the parameter β_2. Because of this potential for bias, the results are also shown by excluding these additional households. This causes a further reduction in sample size to 24,373 households.

A summary of the variables used is provided below.

- Non-healthcare consumption share of after-tax income has a median of 74%, with quartile breaks at 62% and 84%.
- Total household pre-tax and after-tax income, expressed in 2012 dollars[15], are summarized in Tables 2.1 and 2.2, respectively. The values in Tables 2.1 and 2.2 are not adjusted for the size of the household. However, for purposes of the regressions, household income is adjusted by dividing by the square root of the number of people in the household.
- Total healthcare expenditures, expressed in 2012 dollars, is summarized in Table 2.3. Table 2.3 summarizes healthcare expenditures from all sources[16]. As noted above, not all healthcare expenditures are utilized to determine whether a household is "Sick".
- The mean and median age of the reference person in the sample is 76, and 42% of the sample respondents are male.
- The breakdown of the households by province/territory is shown in Table 2.4. While households in the provinces are surveyed each year, those in the territories have been surveyed only every other year since 1999. For purposes of the regressions, Ontario is the reference group.

[15] All inflation adjustments are made using average CPI (Canada - All Items) for the appropriate calendar year.

[16] The types of expenditures that are non-zero at the 90th percentile are pharmaceuticals, healthcare supplies, healthcare practitioners, eye-care goods and services, dental services, and health insurance premiums.

- The breakdown of the households by city size is shown in Table 2.5. For purposes of the regressions, cities with a population in excess of one million is the reference group.

- The overwhelming majority (96%) of the households have either one or two people in the household. Table 2.6 contains a more detailed breakdown by household size[17].

- A variable describing the highest level of educational attainment has been included in the survey only since 2005. For those years, the breakdown of households by the educational attainment of the reference person and the spouse, if any, is shown in Tables 2.7 and 2.8, respectively.

2.4 Results

2.4.1 *Baseline Regressions – Sickness Defined by Healthcare Spending*

Recall that, in the baseline specification, "Sick" is defined as those households with certain components of healthcare consumption expenses as a share of after-tax income in the fourth quartile, separately for each income quartile[18]. For those households whose after-tax income is very small or negative,

[17]Marital status correlates very closely with household size (correlation well over 0.80). As a result, both covariates cannot be used in the regression. Because household size has slightly more information than marital status, it is used as the covariate.

[18]Included components of healthcare expenditure as a percentage of after-tax income amount to 5.7%, 4.7%, 4.6%, and 3.5% at the fourth quartile level for each quartile of

the share can become distorted. For the regressions, those households with after-tax income less than $10,000 are excluded. This removes 516 households from the regression with all households, and 87 households from the regression with those households whose current year after-tax income exceeds current year consumption expenditures.

In the baseline regression[19] that includes all households, the estimated effect of being "Sick" *increases* non-healthcare consumption by 6.70% of after-tax income, which is significant at the 0.1% level. When the regression is limited to those households whose current year consumption expenditures are less than their current year income, the estimated effect of being "Sick" *reduces* non-healthcare consumption by 1.95% of after-tax income (also significant at the 0.1% level). These inconsistent results are examined further in Subsection 2.4.3.

A summary of the regressions is included as Table 2.9. From the table, the following can be observed:

- Non-healthcare consumption share of after-tax income (NHCS) is estimated to reduce by 1.73% for each year of age (.84% for those house-

after-tax income from the lowest to the highest, respectively.

[19]In all of the regressions, standard errors have been determined using a heteroskedasticity consistent covariance matrix (HCCM) of the following form: $(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}' diag\left[\frac{e_i^2}{(1-h_{ii})^2}\right]\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}$, where the e_i are the regression residuals and $h_{ii} = x_i(\mathbf{X}'\mathbf{X})^{-1}x_i'$.

holds whose current year consumption expenditures are less than their current year income). These results are consistent with much of the other literature that finds that consumption falls with both age and sickness. They are also consistent with the intuition that, with each year of age, the expected age at death increases. As a result, the optimal consumption path should be redetermined and consumption reduced in order to avoid outliving one's assets;

- NHCS is estimated to reduce by a further 0.55% for each year that the reference person belongs to a younger cohort (0.43% for those households whose current year consumption expenditures are less than their current year income);

- NHCS is estimated to reduce by 26.93% for each additional unit of log (after-tax income) (15.26% for those households whose current year consumption expenditures are less than their current year income). As the level of after-tax income moves from the lower quartile break to the upper quartile, NHCS is estimated to reduce by roughly 19.9% (11.7%). For example, NHCS would be about 20 percentage points lower for a household whose current year after-tax income is $38,659, than for a household whose current year after-tax income is $18,452. The direction of this relationship makes intuitive sense in that it would be expected that lower income households would consume a larger proportion of their income, and that higher income households would have more capacity to add to (or draw down less from) precautionary savings;

- If the reference person is male, NHCS is estimated to increase by 3.65% (for those households whose current year consumption expenditures are less than their current year income, the sex of the reference person has no significant impact on consumption);

- NHCS is estimated to reduce by 2.59% for each additional household member (.89% for those households whose current year consumption expenditures are less than their current year income). The intuition here is that it is less expensive per person to live as a couple rather than a single;

- NHCS is estimated to be higher by 5.01% if the reference person or their spouse has a Bachelor Degree (or higher) (1.37%, but not significant, for those households whose current year consumption expenditures are less than their current year income). The potential intuition for this is that the better educated have a better handle on their financial needs and require less precautionary savings, *ceteris paribus*;

- Relative to Ontario (the reference group), NHCS is estimated to be generally lower in other provinces, with many of these results significant at least at the 1% level; and

- Relative to large cities (over 1 million population), NHCS is estimated to be significantly lower in cities of 30,000 or less and in rural areas.

The results do vary somewhat by income quartile, as shown in Table 2.10 for all households. In the first three quartiles, the estimated coefficient on “Sick” is significant at least at the 1% level. In the fourth quartile, the estimated coefficient is not significant. The estimated coefficient is positive in all quartiles, ranging from 11.73% in the second quartile to 2.32% in the fourth quartile.

The results for those households whose current year consumption expenditures are less than their current year income are shown in Table 2.11. As in the regression for all households, the estimated coefficient on “Sick” is significant at least at the 5% level for the first three quartiles. In the fourth quartile, the estimated coefficient is not significant. Unlike the results for all households, the estimted coefficient is negative in the first three quartiles, ranging from -4.64% in the first quartile to .27% in the fourth quartile.

It is unclear why there should be any income gradient. It may be that consumption changes when “Sick” by roughly a fixed amount, rather than as a percentage of net income – an increase of roughly $1,500 (with a “blip” upward in the second quartile) when all households are considered and a decrease of roughly $600 (with a “blip” downward in the fourth quartile) for those households whose current year consumption expenditures are less than their current year income.

2.4.2 *Baseline Regressions – Sickness Defined by Disability and Reduced Activities of Daily Living*

Starting in 2005, the SHS has asked questions about disability and limitation of activities of daily living. Possible answers to these questions are "Yes, sometimes", "Yes, often", and "No". Since 2005, 32% of the households in the sample have identified either the reference person or their spouse, if any, as being disabled "often", and 29% of the households have identified either the reference person or their spouse, if any, as having some form of activity limitation "often". The regressions were rerun changing the definition of "Sick" to be disabled "often" and limitation of activity "often". The results of these regressions are summarized in Tables 2.12 and 2.13.

The effect of changing the definition of "Sick" is that the estimated coefficients are no longer significant. However, they are all negative, and the relationship between the estimated coefficients with all households and the estimated coefficients with households whose current year consumption expenditures are less than their current year income is the expected one. The estimated coefficients of the former group are larger in absolute value than the estimated coefficients of the latter group. This relationship likely reflects the tightening of the budget constraint due to healthcare expenditures when someone in the household becomes disabled or has restrictions in their activities of daily living.

It may be that the lack of significance is because of the reduction in the number of observations. However, even in the smallest regression, there are still over 12,000 observations. So, the likely explanation is that there is no significant relationship between disability or activity limitation and NHCS. All further analysis is conducted using a definition of "Sick" based on healthcare spending.

2.4.3 *Sensitivity to Different Levels of Savings or Dissavings*

It is clear that the relationships are materially different for those households who save in the current year compared to those households who dissave. In order to get a better sense of the relationships at different levels of saving/dissaving, the results of additional regressions with increasing levels of dissavings and savings are summarized in Tables 2.14 and 2.15, respectively. The trend of the value of the coefficient on variable "Sick" is illustrated in Figure 2.2. The estimated coefficient is not significant when the household saves at least 50% of their current year net income. However, at this point the number of observations is very low, less than 5% of the original sample. Allowing for the lack of precision in the measurement of this estimate, the estimated coefficients can be described as being roughly level around -2.25% for those households that dissave 10% of their current year net income or less.

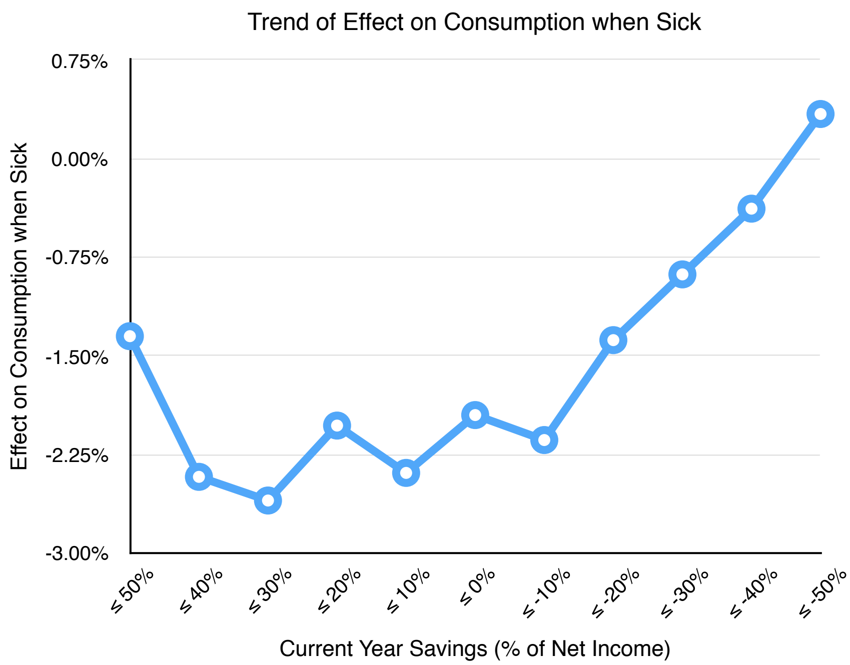


Figure 2.2: Trend of Effect on Consumption when Sick

As households dissave larger and larger amounts, however, the estimated coefficient becomes first less negative, and then more positive.

There is no clear reason for this gradient. The literature to date appears not to have documented it. It may be that the households that are dissaving significantly have an increased propensity to consume for all purposes. When they become “Sick”, this propensity causes both healthcare and non-healthcare consumption to increase. This may be caused by the potential shortening of the household members' remaining lifetime as a result of falling into ill health. This effect may also be because healthcare expenditure is a weak indicator of sickness for some households.

Alternatively, it may be that those households that are saving from current year income are motivated by a bequest motive the present value of which had not been satisfied by the time of retirement. When they fall into ill health, their healthcare expenditures increase. They then reduce their non-healthcare expenditures to maintain the amount of assets that they want to bequeath. This explanation assumes implicitly that the life expectancy of these households is not reduced sufficiently in the event of ill health to allow them to maintain the amount of assets that they want to bequeath. Unfortunately, the data do not contain sufficient information on life expectancy to assess this implicit assumption.

Examining the estimated coefficients on the other variables for those dissaving, no gradient is observed based on level of dissaving (or the estimate is not statistically significant). On the other hand, for those households that are saving from current year income, we observe a gradient by level of saving for all of the statistically significant estimates – the estimated coefficients on "Age", "Year of Birth", and "Log (After-Tax Income)". It makes inuitive sense that "Log (After-Tax Income)" has less and less effect as households save larger and larger amounts of current year income. Similarly, the gradient on "Age" makes intuitive sense as the re-optimization that takes place each year is unlikely to result in much of a change in consumption when the resource constraint is so slack. Finally, it is not obvious why there should be a cohort effect at all, let alone a reason for the gradient by level of savings.

2.4.4 *Function of Age*

The baseline regressions use "*Age*" as an explanatory variable. In order to test the potential for age to enter the regression in a nonlinear fashion, the regressions were rerun using both "*Age*" and "Age^2" as explanatory variables. The results of these regressions are summarized in Table 2.16.

In these regressions, there is no material impact on any estimates other than "*Age*" and "Age^2". In the regression including all households, there appears to be a bit of curvature in the way that "*Age*" is estimated to enter the regression, having a smaller (negative) impact at older ages than younger ages. However, the curvature is not large and there is no material effect on the other estimates. In the regression that includes only households whose current year consumption expenditures is less than current year net income, there is no observable curvature in the way that "*Age*" is estimated to enter the regression. For practical purposes, having "*Age*" enter the regression in a linear fashion represents the data reasonably well.

2.4.5 *Function of Year of Birth*

The baseline regressions use "Year of Birth" as an explanatory variable. In order to test the potential for cohort effects to enter the regression in a non-linear fashion, the regressions were rerun using both "Year of Birth" and its square as explanatory variables. The results of these regressions are summarized in Table 2.17.

In these regressions, there is no material impact on any estimates other than "Year of Birth" and its square. However, the estimated coefficients on "Year of Birth" and its square have opposite signs. In the regression including all households, the estimated coefficients are both significant at the 1% level. However, the estimated coefficient on the square of "Year of Birth" is .0001, which shows that any curvature is not large. Similarly, in the regression that includes only households whose current year consumption expenditure is less than current year net income, the estimated coefficient on the square of "Year of Birth" is zero to four decimal places. For practical purposes, having "Year of Birth" enter the regression in a linear fasion represents the data reasonably well.

Of note, the estimated coefficient on "Year of Birth" in both regressions is an order of magnitude larger than in the regressions that do not include its square. The effect of this is offset by a material increase in the size of the estimated intercept term.

2.4.6 *Impact of Higher Education Separately for Each Spouse*

The baseline regressions use a variable that combines the effect of either the reference person or the spouse having a Bachelor Degree (or higher). In order to separate the effect of education for each spouse, the regressions were re-run using separate dummy variables that reflect the education of each spouse. The results of these regressions are summarized in Table 2.18.

In these regressions, the estimated coefficients on the variables other than education are virtually unchanged relative to the baseline regression. When the education of both spouses are combined, the effect of having at least one spouse with a Bachelor Degree (or higher) is that non-healthcare consumption is estimated to be higher by 5.01% of after-tax income relative to households that do not have a spouse with higher education (1.37% for those households whose current year consumption expenditure is less than current year after-tax income). This result is significant at the 5% level for all households. When the effect of each spouse is examined separately, the estimated effect of the reference person having higher education is roughly the same, an increase in non-healthcare consumption of 5.87% of after-tax income (1.06% for those households whose current year consumption expenditure is less than current year after-tax income). The estimated *additional* effect of the spouse having higher education is a negligible increase in non-healthcare consumption of 0.19% of after-tax income (1.13% for those households whose current year consumption expenditure is less than current year after-tax income). As can be seen, the effect of educational achievement seems to be largely determined by the educational achievement of the reference person. However, for those households whose current year consumption expenditure is less than current year after-tax income, there is some additional effect if the spouse is educated, though the effect is not statistically significant.

2.4.7 *Separate Results by Sex*

In order to see if the effects on non-healthcare consumption are different by the sex of the respondent[20], separate regressions were examined. The results of those regressions are summarized in Table 2.19.

In general, the estimated coefficients on the variables are comparable between the regressions for males and females. The major difference is that the estimated effect of being "Sick" for male respondents is roughly 1% higher than the effect for female respondents. Also, the estimated effect of higher education is almost completely attributable to those households where females are the respondents. The cause of this phenomenon is unclear, but there is some literature that suggests that household decisions are based on a bargaining model[21]. It may be that women's bargaining position is strengthened

[20] Typically, the respondent is the individual in the household most responsible for making consumption decisions.
[21] See, for example, Elder & Rudolph (2003).

by being educated, which is causing this phenomenon.

2.4.8 *Separate Results by Household Size*

As mentioned previously, over 95% of all households have either one or two persons. Separate regressions by household size were run in order to examine the degree of influence of this factor. The results of these regressions are summarized in Table 2.20.

There are some minor differences between these regressions and the baseline regression. However, the results are qualitatively similar both between one- and two-person households and to the baseline regressions.

2.4.9 *Reflecting Healthcare Expenses at and above the 90th Percentile*

In order to get a sense of the gradient of healthcare expenses on non-healthcare consumption, two additional regressions were run to separate the effect of healthcare expenses above the 90th percentile from healthcare expenses from the 75th to the 89th percentile. The results of those regressions are summarized in Table 2.21. In the baseline regression, those that are “Sick” are estimated to consume 6.70% more of their after-tax income than those that are “Healthy” (1.95% less for those households whose current year consumption expenditure is less than their current year after-tax income). In the new regressions, those with healthcare expenditures as a share of after-tax income between the 75th and the 89th percentiles are estimated to consume 4.40% more of their after-tax income (1.00% less for those households whose current year consumption expenditure is less than their current year after-tax income), while those whose healthcare expenditure share is above the 90th percentile are estimated to consume 10.41% more (3.91% less for those households whose current year consumption expenditure is less than their current year after-tax income). In the regression that includes only a variable for healthcare expenditure share above the 90th percentile, those who are “Sick” are estimated to consume 9.64% more (3.75% less for those households whose current year consumption expenditure is less than their current year after-tax income). All of these estimated coefficients are significant, generally at the 0.1% level. The estimated coefficients on the other variables are virtually unchanged relative to the baseline regression.

These results show that the change in non-healthcare consumption as a share of after-tax income becomes progressively larger as healthcare spending increases.

2.5 Summary and Conclusions

Using data from the Survey of Household Spending, the baseline regressions estimate that the non-healthcare consumption share of income *increases* when the household is “Sick”, by 6.70% overall (*reduces* by 1.95% for those households whose current year consumption expenditure is less than their current year after-tax income), which is significant at the 0.1% level. Across the income quartiles, non-healthcare consumption share of income when the household is “Sick” is estimated to increase by somewhere in the range of 11.73% to 2.32% (reduce by 4.64% to 1.99% in the first three income quartiles and increases by 0.27% in the fourth quartile for those households whose current year consumption expenditure is less than their current year after-tax income). The amounts in the first three income quartiles are all significant. The amount in the fourth income quartile is imprecisely measured.

On the other hand, changing the definition of “Sick” to be disabled or having a limitation of an activity of daily living produces different results. In this case, there is no significant effect on non-healthcare consumption share of income when someone in the household becomes “Sick”.

The major contribution of this paper is the analysis of the effect of becoming “Sick” for those households with different levels of current year savings. The estimated coefficient can be described as being roughly level around -2.25% for those households that dissave 10% or less of their current year net income. As households dissave larger and larger amounts, however, the estimated coefficient becomes first less negative, and then more positive.

The results are robust to many alternative specifications – different functions of age and year of birth, different specifications for higher education, and separate results by the sex of the reference person and household size.

Finally, the analysis shows that the estimated change in non-healthcare consumption share of income is larger when “Sick” is defined as healthcare expenditures at and above the 90th percentile relative to when “Sick” is defined as healthcare expenditures at and above the 75th percentile.

Bibliography

[1] Börsch-Supan, Axel, and Konrad Stahl. "Life Cycle Savings and Consumption Constraints." *Journal of Population Economics* 4.3 (1991): 233–255.

[2] Clarida, Richard H. "Aggregate Stochastic Implications of the Life Cycle Hypothesis." *The Quarterly Journal of Economics* (1991): 851–867.

[3] Danziger, Sheldon, et al. "The Life-Cycle Hypothesis and the Consumption Behavior of the Elderly." *Journal of Post Keynesian Economics* 5.2 (1982): 208–227.

[4] Davies, James B. "Uncertain Lifetime, Consumption, and Dissaving in Retirement." *Journal of Political Economy* (1981): 561–577.

[5] Demery, David and Nigel W. Duck. "Savings-Age Profiles in the UK". *Journal of Population Economics* 19.3 (2006): 521–541.

[6] De Nardi, Mariacristina, Eric French, & John Bailey Jones. *Differential Mortality, Uncertain Medical Expenses, and the Savings of Elderly Singles.* No. w12554. National Bureau of Economic Research, 2006.

[7] Domeij, David and Magnus Johannesson. " Consumption and Health." *Contributions to Macroeconomics.* 6.1 (2006): 1–30.

[8] Edwards, Ryan D. "Health Risk and Portfolio Choice." *Journal of Business & Economic Statistics* 26.4 (2008): 472–485.

[9] Elder, Harold W., and Patricia M. Rudolph. "Who makes the financial decisions in the households of older Americans?." *Financial Services Review* 12.4 (2003): 293.

[10] Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo. "What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption." *Journal of the European Economic Association* 11.s1 (2013): 221 – 258.

[11] Hurd, Michael D. "Wealth Depletion and Life-Cycle Consumption." *Topics in the Economics of Aging.* University of Chicago Press, 1992. 135–162.

[12] Landsberger, Michael. "The Life-Cycle Hypothesis: A Reinterpretation and Empirical Test". *American Economic Review* 60.1 (1970): 175–183.

[13] Lillard, Lee A. and Yoram Weiss. "Uncertain Health and Survival: Effects on End-of-Life Consumption." *Journal of Business & Economic Statistics* 15.2 (1997): 254–268.

[14] Modigliani, Franco. "The Collected Papers of Franco Modigliani, Volume 6." *MIT Press Books* 6 (2005).

[15] Palumbo, Michael G. "Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle." *The Review of Economic Studies* 66.2 (1999): 395 – 421.

[16] Poterba, James M., Steven F. Venti and David A. Wise. *Family Status Transitions, Latent Health, and the Post-Retirement Evolution of Assets.* No. w15789. National Bureau of Economic Research, 2010.

[17] Yogo, Motohiro. *Portfolio Choice in Retirement: Health Risk and the Demand for Annuities, Housing, and Risky Assets.* No. w15307. National Bureau of Economic Research, 2009.

Table 2.1: Distribution of Pre-Tax Household Income – 2012 Dollars

	Consumption Less than Income	All Households
Percentile	*Income*	*Income*
10	15,996	15,112
25	19,765	19,013
50	30,003	28,455
75	46,614	43,372
90	70,369	65,471

Table 2.2: Distribution of After-Tax Household Income – 2012 Dollars

	Consumption Less than Income	All Households
Percentile	*Income*	*Income*
10	15,849	15,215
25	19,279	18,452
50	28,396	26,708
75	41,562	38,659
90	59,390	55,284

Table 2.3: Distribution of Healthcare Expenditures – 2012 Dollars

	Consumption Less than Income	All Households
Percentile	*Expenditure*	*Expenditure*
10	191	213
25	559	607
50	1,244	1,333
75	2,382	2,519
90	4,016	4,251

Table 2.4: Geographical Distribution of Sample

Province/ Territory	Consumption Less than Income *Number*	Consumption Less than Income *Percentage*	All Households *Number*	All Households *Percentage*
Nfld.	2,430	9.97	3,377	8.87
PEI	1,122	4.60	1,737	4.56
NS	2,544	10.44	3,866	10.16
NB	2,317	9.51	3,528	9.27
PQ	2,835	11.63	4,871	12.80
Ont.	2,917	11.95	4,683	12.30
Man.	2,713	11.13	4,072	10.70
Sask.	2,814	11.55	4,239	11.14
Alta.	1,834	7.52	2,990	7.86
BC	2,633	10.80	4,305	11.31
YK	99	0.41	183	0.48
NWT	83	0.34	140	0.37
Nunavut	37	0.15	70	0.18
Total	24,373		38,061	

Table 2.5: Distribution by City Population

	Consumption Less than Income		All Households	
City Size	*Number*	*Percentage*	*Number*	*Percentage*
Over 1 million	3,537	14.51	5,964	15.67
Over 500,000 to 1 million	2,945	12.08	4,737	12.45
Over 250,000 to 500,000	1,484	6.09	2,338	6.14
Over 100,000 to 250,000	3,249	13.33	5,084	13.36
Over 30,000 to 100,000	2,347	9.63	3,738	9.82
Over 1,000 to 30,000	4,538	18.62	6,829	17.94
Rural	6,273	25.74	9,372	24.62
Total	24,373		38,061	

Table 2.6: Distribution by Household Size

	Consumption Less than Income		All Households	
Household Size	*Number*	*Percentage*	*Number*	*Percentage*
1	12,440	51.04	20,182	53.03
2	10,888	44.67	16,314	42.86
3	817	3.35	1,210	3.18
4	154	0.63	232	0.61
5	47	0.19	74	0.19
6+	27	0.11	49	0.13
Total	24,373		38,061	

Table 2.7: Highest Educational Attainment of Reference Person

	Consumption Less than Income		All Households	
Educational Attainment	*Number*	*Percentage*	*Number*	*Percentage*
Less than HS	4,635	38.36	6,869	37.28
HS or equivalent	2,063	17.07	3,256	17.67
Trade/vocational cert.	1,094	9.05	1,746	9.48
Apprenticeship cert.	101	0.84	159	0.86
Community College diploma	1,035	8.57	1,693	9.19
University cert. below Bachelor's	437	3.62	673	3.65
Bachelor's degree	721	5.97	1,073	5.82
University degree above Bachelor's	556	4.60	790	4.29
Other	1,441	11.93	2,168	11.77
Total	12,083		18,427	

Table 2.8: Highest Educational Attainment of Spouse

	Consumption Less than Income		All Households	
Educational Attainment	*Number*	*Percentage*	*Number*	*Percentage*
Less than HS	1,951	35.48	2,762	35.05
HS or equivalent	968	17.59	1,422	18.04
Trade/vocational cert.	503	9.14	765	9.71
Apprenticeship cert.	49	0.89	68	0.86
Community College diploma	541	9.83	770	9.77
University cert. below Bachelor's	188	3.42	270	3.43
Bachelor's degree	304	5.53	447	5.67
University degree above Bachelor's	194	3.53	274	3.48
Other	804	14.61	1,103	14.00
Total	5,502		7,881	

Table 2.9: Baseline Results

	Consumption Less than Income		All Households	
Variable	*Coefficient*	*t-value*	*Coefficient*	*t-value*
Sick	-.0195***	-4.77	.0670***	6.64
Age	-.0084***	-16.68	-.0173***	-13.91
Year of Birth	-.0043***	-9.83	-.0055***	-5.12
Log (After-Tax Income)	-.1526***	-30.79	-.2693***	-19.47
Sex = Male	-.0021	-0.56	.0365***	4.28
Household Size	-.0089**	-3.00	-.0259***	-3.96
BA or higher	.0137	1.60	.0501*	2.42
Province (reference group is Ontario)				
Nfld	-.0176**	-2.98	-.1060***	-9.29
PEI	-.0092	-1.11	-.0645***	-4.15
NS	-.0120*	-2.33	-.0434**	-3.24
NB	-.0187***	-3.37	-.0486***	-4.10
PQ	-.0048	-0.89	-.0629***	-5.30
Man.	-.0375***	-6.06	-.0736***	-5.24
Sask.	-.0417***	-7.33	-.0786***	-6.21
Alta.	-.0216**	-3.10	-.0104	-0.59
BC	-.0242***	-4.42	-.0238	-1.90
YK	.0350*	2.37	.0452	1.48
NWT	.0419*	2.26	-.0314	-0.97
Nun.	.0669	1.94	-.0331	-0.89
City Size (reference group is over 1 million)				
Over 500,000 to 1 million	.0006	0.09	-.0090	-0.57
Over 250,000 to 500,000	-.0040	-0.55	-.0181	-0.91
Over 100,000 to 250,000	-.0115	-1.83	-.0291*	-2.07
Over 30,000 to 100,000	-.0118	-1.77	-.0106	-0.67
Over 1,000 to 30,000	-.0158**	-2.79	-.0615***	-4.88
Rural	-.0349***	-5.77	-.0639***	-5.02
Intercept	11.2026***	12.94	15.6989***	7.34
R^2	.2112		.0732	
N	24,286		37,545	

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 2.10: Results by Income Quartile (All Households)

	Q1	Q2	Q3	Q4
Variable		*Coefficient*		
Sick	.0845***	.1173***	.0460**	.0232
	(4.37)	(4.38)	(2.79)	(1.61)
Age	-.0054**	-.0107***	-.0219***	-.0281***
	(-2.58)	(-4.83)	(-8.71)	(-10.94)
Year of Birth	.0054**	-.0003	-.0092***	-.0152***
	(2.76)	(-.13)	(-4.54)	(-7.18)
Log (After-Tax Income)	-.6140***	-.4611***	-.1364	-.1636***
	(-5.32)	(-6.72)	(-1.80)	(-5.97)
Sex = Male	.0269	.0134	.0427**	.0451*
	(.97)	(.71)	(3.10)	(2.54)
Household Size	.1863	-.0608*	-.0435	-.0058
	(1.88)	(-2.52)	(-1.84)	(-.53)
BA or higher	.4166	.1726	.0448	-.0040
	(1.19)	(1.85)	(1.52)	(-.17)
Intercept	-3.3540	7.0153	21.8783***	34.0078***
	(-.84)	(1.65)	(5.67)	(8.06)
R^2	.1067	.0529	.0442	.0584
N	9,000	9,514	9,515	9,516

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.11: Results by Income Quartile (Consumption less than Income)

	Q1	Q2	Q3	Q4
Variable		*Coefficient*		
Sick	-.0464***	-.0199***	-.0215*	.0027
	(-6.46)	(-2.83)	(-2.68)	(.30)
Age	-.0063***	-.0071***	-.0090***	-.0112***
	(-7.51)	(-7.89)	(-10.00)	(-9.15)
Year of Birth	.0034***	-.0049***	-.0039***	-.0050***
	(-4.77)	(-5.86)	(-4.97)	(-5.09)
Log (After-Tax Income)	-.0962***	-.1475***	-.1391***	-.1526***
	(-5.27)	(-5.36)	(-5.54)	(-12.84)
Sex = Male	-.0066	-.0019	.0016	.0082
	(-.98)	(-.23)	(.25)	(1.06)
Household Size	-.0038	-.0318**	-.0084	.0012
	(-.78)	(-3.04)	(-.91)	(.22)
BA or higher	.0006	.0201	.0333	.0124
	(.04)	(.70)	(1.77)	(1.12)
Intercept	8.8894***	12.2239***	10.3984***	12.6920***
	(6.09)	(7.89)	(6.50)	(6.56)
R^2	.1152	.0563	.1172	.1598
N	6,005	6,096	6,092	6,094

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.12: Alternative Definitions of "Sick" (All Households)

Variable	Disabled	Activity Limitation
	Coefficient	
Sick	-.0162	-.0159
	(-1.37)	(-1.34)
Age	-.0048*	-.0045*
	(-2.11)	(-1.98)
Year of Birth	-.0056**	-.0059**
	(2.59)	(2.72)
Log (After-Tax Income)	-.3524***	-.3523***
	(-19.07)	(-19.04)
Sex = Male	.0238*	.0236*
	(2.03)	(2.02)
Household Size	-.0265**	-.0265**
	(-2.77)	(-2.77)
BA or higher	.0846***	.0841***
	(3.69)	(3.67)
Intercept	-5.9528	-6.5338
	(-1.38)	(-1.51)
R^2	.1041	.1040
N	18,191	18,196

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.13: Alternative Definitions of "Sick" (Consumption less than Income)

Variable	Disabled *Coefficient*	Activity Limitation
Sick	-.0020	-.0023
	(-.35)	(-.40)
Age	-.0086***	-.0086***
	(-6.83)	(-6.77)
Year of Birth	-.0045***	-.0045***
	(-3.95)	(-3.92)
Log (After-Tax Income)	-.1552***	-.1552***
	(-21.69)	(-21.74)
Sex = Male	-.0059	-.0060
	(-1.04)	(-1.05)
Household Size	-.0107*	-.0106*
	(-2.44)	(-2.45)
BA or higher	.0160	.0159
	(1.75)	(1.74)
Intercept	11.6552***	11.5945***
	(5.10)	(5.07)
R^2	.1888	.1888
N	12,054	12,056

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.14: Results by Level of Dissaving

Variable	*Coefficient by Level of Dissaving (% of Current Year's After-Tax Income)* ≤ 10%	≤ 20%	≤ 30%	≤ 40%	≤ 50%
Sick	-.0214***	-.0138***	-.0088*	-.0038	.0034
	(-5.41)	(-3.33)	(-2.04)	(-.80)	(0.69)
Age	-.0097***	-.0103***	-.0106***	-.0107***	-.0113***
	(-18.80)	(-18.93)	(-18.52)	(-17.81)	(-18.47)
Year of Birth	-.0052***	-.0054***	-.0052***	-.0048***	-.0051***
	(-11.94)	(-11.01)	(-10.18)	(-8.70)	(-8.97)
Log (After-Tax Income)	-.1604***	-.1635***	-.1674***	-.1721***	-.1749***
	(-33.37)	(-32.26)	(-32.47)	(-29.84)	(-29.98)
Sex = Male	-.0001	-.0016	-.0001	.0026	.0059
	(-.02)	(-.38)	(-.04)	(.56)	(1.23)
Household Size	-.0114***	-.0105*	-.0127**	-.0115*	-.0127**
	(-3.98)	(-2.35)	(-2.92)	(-2.38)	(-2.63)
BA or higher	.0155	.0152	.0154	.0143	.0126
	(1.83)	(1.62)	(1.60)	(1.46)	(1.26)
Intercept	13.2551***	13.6096***	13.4166***	12.7648***	13.4076***
	(15.20)	(14.05)	(13.16)	(11.60)	(11.85)
R^2	.2035	.1823	.1674	.1546	.1466
N	28,566	31,191	32,836	33,907	34,702

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.15: Results by Level of Saving

Variable	*Coefficient by Level of Saving (% of Current Year's After-Tax Income)* > 10%	> 20%	> 30%	> 40%	> 50%
Sick	-.0239***	-.0203***	-.0260***	-.0242***	-.0135
	(-6.00)	(-4.42)	(-4.51)	(-4.12)	(-1.44)
Age	-.0071***	-.0055***	-.0036***	-.0014	.0012
	(-13.23)	(-9.17)	(-5.04)	(-1.33)	(.55)
Year of Birth	-.0035***	-.0027***	-.0013**	-.0005	.0005
	(-7.61)	(-5.38)	(-2.62)	(-.72)	(0.53)
Log (After-Tax Income)	-.1321***	-.1081***	-.0841***	-.0624***	-.0217
	(-23.35)	(-15.46)	(-9.19)	(-4.62)	(-.86)
Sex = Male	-.0020	-.0024	-.0073	-.0079	-.0109
	(-0.49)	(-0.51)	(-1.17)	(-.87)	(-.79)
Household Size	-.0049	.0043	.0036	-.0005	.0144*
	(-1.53)	(1.16)	(.75)	(-0.12)	(2.48)
BA or higher	.0060	.0077	.0039	-.0001	.0052
	(.67)	(.79)	(.42)	(-.01)	(.40)
Intercept	9.3962***	7.3390***	4.2647***	2.1370	-.5846
	(10.19)	(7.33)	(4.13)	(1.56)	(-.26)
R^2	.1904	.1508	.1083	.0630	.0163
N	18,021	11,859	7,109	3,879	1,848

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.16: Results Including Age^2

	Consumption Less than Income		All Households	
Variable	*Coefficient*	*t-value*	*Coefficient*	*t-value*
Sick	-.0195***	-4.78	.0669***	6.65
Age	-.0135**	-2.71	-.0656***	-6.13
Age Squared	.0000	1.03	.0003***	4.66
Year of Birth	-.0004***	-9.85	-.0057***	-5.26
Log (After-Tax Income)	-.1527***	-30.78	-.2681***	-19.46
Sex = Male	-.0019	-0.50	.0385***	4.51
Household Size	-.0088**	-2.97	-.0252***	-3.86
BA or higher	.0135	1.58	.0484*	2.33
Province (reference group is Ontario)				
Nfld	-.0175**	-2.97	-.1056***	-9.27
PEI	-.0093	-1.12	-.0650***	-4.18
NS	-.0120*	-2.34	-.0437**	-3.27
NB	-.0187***	-3.38	-.0489***	-4.13
PQ	-.0048	-0.90	-.0632***	-5.34
Man.	-.0376***	-6.07	-.0736***	-5.24
Sask.	-.0418***	-7.35	-.0795***	-6.28
Alta.	-.0216**	-3.11	-.0100	-0.57
BC	-.0241***	-4.40	-.0242	-1.93
YK	.0348*	2.36	.0431	1.41
NWT	.0417*	2.26	-.0323	-1.00
Nun.	.0666	1.94	-.0354	-0.95
City Size (reference group is over 1 million)				
Over 500,000 to 1 million	.0005	0.08	-.0097	-0.61
Over 250,000 to 500,000	-.0041	-0.57	-.0186	-0.94
Over 100,000 to 250,000	-.0117	-1.85	-.0302*	-2.14
Over 30,000 to 100,000	-.0119	-1.77	-.0101	-0.63
Over 1,000 to 30,000	-.0159**	-2.81	-.0614***	-4.89
Rural	-.0350***	-5.78	-.0641***	-5.03
Intercept	11.4200***	12.90	17.8200***	8.09
R^2	.2114		.0742	
N	24,286		37,545	

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 2.17: Results Including $YearofBirth^2$

	Consumption Less than Income		All Households	
Variable	*Coefficient*	*t-value*	*Coefficient*	*t-value*
Sick	-.0195***	-4.78	.0672***	6.66
Age	-.0085**	-16.44	-.0178***	-14.42
Year of Birth	-.0682	-.82	-.0553**	-2.97
Year of Birth Squared	.0000	.77	.0001**	2.93
Log (After-Tax Income)	-.1526***	-30.79	-.2685***	-19.48
Sex = Male	-.0020	-0.53	.0376***	4.40
Household Size	-.0088**	-2.99	-.0256***	-3.93
BA or higher	.0134	1.56	.0475*	2.28
Province (reference group is Ontario)				
Nfld	-.0176**	-2.98	-.1060***	-9.29
PEI	-.0093	-1.12	-.0654***	-4.21
NS	-.0120*	-2.34	-.0439**	-3.28
NB	-.0187***	-3.38	-.0490***	-4.13
PQ	-.0048	-0.90	-.0632***	-5.33
Man.	-.0377***	-6.07	-.0747***	-5.31
Sask.	-.0418***	-7.36	-.0796***	-6.28
Alta.	-.0217**	-3.12	-.0106	-0.61
BC	-.0241***	-4.40	-.0241	-1.92
YK	.0352*	2.38	.0449	1.48
NWT	.0419*	2.27	-.0310	-0.96
Nun.	.0668	1.94	-.0342	-0.92
City Size (reference group is over 1 million)				
Over 500,000 to 1 million	.0006	0.09	-.0087	-0.55
Over 250,000 to 500,000	-.0041	-0.57	-.0187	-0.94
Over 100,000 to 250,000	-.0116	-1.85	-.0297*	-2.10
Over 30,000 to 100,000	-.0119	-1.78	-.0105	-0.66
Over 1,000 to 30,000	-.0159**	-2.80	-.0615***	-4.88
Rural	-.0350***	-5.79	-.0639***	-5.02
Intercept	72.8100	0.91	543.7000**	3.03
R^2	.2113		.0737	
N	24,286		37,545	

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 2.18: Impact of Including Higher Education Separately for Each Spouse

	Consumption Less than Income		All Households	
Variable	*Coefficient*	*t-value*	*Coefficient*	*t-value*
Sick	-.0194***	-4.75	.0673***	6.67
Age	-.0084***	-16.65	-.0173***	-13.95
Year of Birth	-.0043***	-9.77	-.0055***	-5.12
Log (After-Tax Income)	-.1526***	-30.90	-.2694***	-19.57
Sex = Male	-.0022	-0.56	.0359***	4.19
Household Size	-.0090**	-3.03	-.0252***	-3.82
BA or higher:				
Reference Person	.0106	1.11	.0587*	2.52
Spouse	.0113	0.75	.0019	-0.08
Province (reference group is Ontario)				
Nfld	-.0175**	-2.97	-.1062***	-9.29
PEI	-.0091	-1.10	-.0648***	-4.17
NS	-.0119*	-2.33	-.0437**	-3.26
NB	-.0186***	-3.36	-.0488***	-4.11
PQ	-.0047	-0.88	-.0632***	-5.33
Man.	-.0376***	-6.08	-.0739***	-5.26
Sask.	-.0417***	-7.33	-.0788***	-6.22
Alta.	-.0216**	-3.10	-.0107	-0.61
BC	-.0241***	-4.38	-.0238	-1.89
YK	.0351*	2.38	.0454	1.49
NWT	.0419*	2.26	-.0319	-0.98
Nun.	.0672	1.95	-.0348	-0.94
City Size (reference group is over 1 million)				
Over 500,000 to 1 million	.0005	0.08	-.0087	-0.55
Over 250,000 to 500,000	-.0040	-0.55	-.0182	-0.92
Over 100,000 to 250,000	-.0115	-1.83	-.0292*	-2.07
Over 30,000 to 100,000	-.0119	-1.78	-.0102	-0.64
Over 1,000 to 30,000	-.0159**	-2.80	-.0614***	-4.87
Rural	-.0349***	-5.77	-.0637***	-5.00
Intercept	11.1726***	12.88	15.6805***	7.36
R^2	.2113		.0733	
N	24,286		37,545	

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 2.19: Results Separately for Each Sex

	Consumption Less than Income		All Households	
	Male	**Female**	**Male**	**Female**
Variable	*Coefficient*		*Coefficient*	
Sick	-.0137*	-.0245***	.0724***	.0620***
	(-2.15)	(-4.05)	(4.52)	(4.76)
Age	-.0091***	-.0079***	-.0213***	-.0143***
	(-11.56)	(-11.95)	(-10.42)	(-9.32)
Year of Birth	-.0045***	-.0040***	-.0084***	-.0032*
	(-6.65)	(-7.20)	(-4.81)	(-2.37)
Log (After-Tax Income)	-.1458***	-.1575***	-.2505***	-.2850***
	(-17.65)	(-27.41)	(-11.08)	(-16.22)
Household Size	-.0033	-.0124**	-.0242*	-.0274**
	(-.67)	(-3.17)	(-2.49)	(-3.01)
BA or higher	-.0023	.0317**	.0287	.0761*
	(-.17)	(3.20)	(1.00)	(2.42)
Intercept	11.6472***	10.7626***	21.4094***	11.1700***
	(8.64)	(9.62)	(6.14)	(4.17)
R^2	.1923	.2235	.0686	.0812
N	10,107	14,180	15,474	22,071

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.20: Regressions Separately for One- and Two-Person Households

	Consumption Less than Income		All Households	
	One Person Households	**Two Person Households**	**One Person Households**	**Two Person Households**
Variable	*Coefficient*		*Coefficient*	
Sick	-.0195***	-.0174***	.0834***	.0641***
	(-3.61)	(-2.75)	(6.17)	(4.07)
Age	-.0075***	-.0099***	-.0121***	-.0255***
	(-11.05)	(-11.69)	(-7.86)	(-11.62)
Year of Birth	-.0036***	-.0049***	-.0017	-.0107***
	(-5.98)	(-7.37)	(-1.17)	(-6.29)
Log (After-Tax Income)	-.1592***	-.1397***	-.2457***	-.2761***
	(-25.59)	(-16.07)	(-17.32)	(-10.78)
Sex = Male	-.0102	.0135*	.0301*	.0539***
	(-1.79)	(2.19)	(2.49)	(4.06)
BA or higher	.0081	.0140	.0589	.0577
	(.62)	(1.16)	(1.78)	(1.88)
Intercept	9.6632***	12.3639***	7.6018**	26.4006***
	(8.20)	(9.39)	(2.69)	(7.74)
R^2	.2346	.1653	.0760	.0707
N	12,359	10,883	19,743	16,244

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Table 2.21: Results that Distinguish Levels of Healthcare Expenditure

Variable	Consumption Less than Income *Coefficient*		All Households *Coefficient*	
Sick between 75th and 89th Percentile	-.0100*	–	.0440***	–
	(-2.00)	–	(3.96)	–
Sick at and above 90th Percentile	-.0391***	-.0375***	.1041***	.0964***
	(-6.86)	(-6.64)	(6.12)	(16.88)
Age	-.0084***	-.0084***	-.0174***	-.0171***
	(-16.62)	(-16.73)	(-13.98)	(-33.96)
Year of Birth	-.0043***	-.0043***	-.0056***	-.0054***
	(-9.84)	(-9.96)	(-5.18)	(-12.39)
Log (After-Tax Income)	-.1523***	-.1519***	-.2690***	-.2708***
	(-30.77)	(-30.81)	(-19.48)	(-54.74)
Sex = Male	-.0023	-.0022	.0368***	.0369***
	(-0.60)	(-0.59)	(4.31)	(9.67)
Household Size	-.0088**	-.0092**	-.0260***	-.0246***
	(-2.99)	(-3.12)	(-3.97)	(-8.36)
BA or higher	.0137	.0137	.0499*	.0500***
	(1.60)	(1.61)	(2.41)	(5.86)
Intercept	11.1976***	11.2857***	15.8258***	15.4259***
	(12.95)	(13.08)	(7.40)	(17.85)
R^2	.2124	.2121	.0739	.0731
N	24,287	24,287	37,545	37,545

*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Note: Controls for Province/Territory and City Size are included in the regressions, but not shown due to space limitations.

Chapter 3

A Quantification of the Optimal Consumption Pattern for the Canadian Elderly

3.1 Introduction

The Life Cycle Savings Hypothesis (LCH), first outlined in Modigliani & Brumberg (1954), says that people choose to save or dissave over time in order to maximize lifetime utility. As shown in Chapter 1, utility is state-dependent (based on health status) at least for retired Canadians over the age of 65 with income above the median.

With the members of the baby boom generation either approaching retirement or recently retired, a key question is how should they optimally spend their accumulated retirement savings over the rest of their lives[1]. This paper explores that question in the context of state-dependent utility (SDU). Specifically, it develops a theoretical approach to determining a life annuity that produces a stream of income that will finance optimal consumption expenditures reflecting state-dependent utility. The chapter then determines optimal annuity values based on data from the NPHS.

As Chapter 1 describes, little work has been conducted with respect to SDU as it applies to health status. The literature includes these eight papers: Arrow (1974), Viscusi & Evans (1990), Evans & Viscusi (1991), Sloan *et al.* (1998), Palumbo (1999), De Nardi, French & Jones (2006), Domeij & Johannesson (2006), and Finkelstein *et al.* (2013). Of these papers, Finkelstein *et al.* (2013) comes closest to trying to quantify its impact on retirees. It explores, in a stylized fashion, the impact of SDU on the optimal level of Health Insurance benefits and the optimal percentage of pre-retirement income to save for retirement. It finds that recognizing SDU leads to a significant difference in these items, relative to ignoring SDU.

This paper does not find a significant *economic* impact of Health State

[1]Of note, this paper does not attempt to address the question of the appropriate level of income in retirement as, for example, in Skinner (2007). It also does not attempt to address the question what influences the age at retirement as, for example, in Schirle (2010).

alone on the optimal pattern of consumption in retirement for the Canadian elderly. This result is obtained in spite of finding that the marginal utility of consumption varies in a statistically significant (at the 0.1% level) way dependent on Health State. For example, a healthy Canadian male age 65 would optimally consume 100.20%, 100.03%, and 99.64% when in good health, middling health and poor health, respectively, relative to an optimal consumption pattern that ignores Health State (i.e., is constant in real terms).

However, when both age and Health State are reflected in the optimal pattern of consumption, the effect is both statistically significant (at the 1% level) and economically significant. Relative to a stream of income that is constant in real terms for a healthy 65 year old male, a stream of income reflecting both age and Health State will start roughly 2% higher and will drop by 2% to 3% by age 80 and by a further 2% or so by age 95. This pattern of consumption reflecting age and Health State is roughly equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation and does not reflect the effects of age or Health State.

The rest of this paper proceeds as follows. Section 2 describes the theoretical background. Section 3 sets out the data employed and the empirical methodology. Section 4 contains the results, and Section 5 concludes.

3.2 Theoretical Background

As mentioned in the preceding section, the LCH suggests that people save and dissave in order to optimize lifetime consumption. If we consider a simple two-period model, lifetime utility is represented by the following formula:

$$U(C_1, C_2) = u_1(C_1) + \frac{1}{1+\delta} u_2(C_2) \tag{3.1}$$

where C_1 and C_2 represent consumption in the first and second period, respectively, and δ is the discount rate.

An optimal consumption pattern would maximixe $U(C_1, C_2)$, subject to the budget constraint:

$$Y = C_1 + \frac{1}{1+r} C_2 \tag{3.2}$$

where Y represents income, which is assumed to be earned in the first period only, and r denotes the real interest rate.

If we use the budget constraint to eliminate C_1, we get a restated utility function as follows:

$$U\left(Y - \frac{1}{1+r} C_2, C_2\right) = u_1\left(Y - \frac{1}{1+r} C_2\right) + \frac{1}{1+\delta} u_2\left(C_2\right) \tag{3.3}$$

We can now take the derivative of U with respect to C_2 to obtain the following expression:

$$\frac{\partial U}{\partial C_2} = u_1^{'}(C_1)\left(\frac{-1}{1+r}\right) + \frac{1}{1+\delta}u_2^{'}(C_2) \tag{3.4}$$

Simplifying this by assuming that $r = \delta$ and setting it equal to 0 yields the familiar result[2]

$$u_1^{'}(C_1) = u_2^{'}(C_2) \tag{3.5}$$

It is relatively straightforward to extend this argument to multiple periods, yielding the result that:

$$u_1^{'}(C_1) = u_2^{'}(C_2) = \ldots = u_n^{'}(C_n) \tag{3.6}$$

If all of the period utility functions are the same, then we get the typical expectation from the LCH that constant real consumption maximizes lifetime utility[3].

However, consider a utility function of the following form that was sug-

[2] Assuming that the first derivatives of the period utility functions are positive and that the second derivatives of the period utility functions are negative.

[3] Given the assumptions made in the previous footnote.

gested in a working paper version of Finkelstein *et al.* (2013):

$$U_t(C_t, S_t) = \gamma_0 S_t + (1 + \gamma_1 S_t)\, u_t(C_t), \quad \forall t \tag{3.7}$$

where S_t denotes sickness or state of health at time t. Then, in a two-period model, we will want to obtain the following result in order to maximize lifetime utility:

$$(1 + \gamma_1 S_1)u_1^{'}(C_1) = (1 + \gamma_1 S_2)u_2^{'}(C_2) \tag{3.8}$$

For purposes of exposition, let us set $u_t(C_t) = log(C_t),\ \forall t.$ then we get the result that:

$$\frac{1 + \gamma_1 S_1}{C_1} = \frac{1 + \gamma_1 S_2}{C_2} \tag{3.9}$$

Rearranging yields the following relationship:

$$\frac{C_2}{C_1} = \frac{1 + \gamma_1 S_2}{1 + \gamma_1 S_1} \tag{3.10}$$

Somewhat different relationships exist for different specifications of the period utility function. Using a CRRA utility function, we get the result that:

$$C_2 = C_1 \times R(S_1, S_2) \tag{3.11}$$

where R is a function of only sickness status in the two periods of interest.

One strand of the literature in this area has attempted to explain the observed drop in consumption with *both* increasing age and sickness. See, for example, Börsch-Supan & Stahl (1991), Palumbo (1999), De Nardi, French & Jones (2006), and Domeij & Johannesson (2006). We can extend the utility function of equation 3.7 to include the effect of age on utility as follows:

$$\begin{aligned} U_t(C_t, S_t, t) =& \gamma_0 S_t + \delta_0 t + \alpha_0 S_t t + \\ & (1 + \gamma_1 S_t + \delta_1 t + \alpha_1 S_t t) u_t(C_t), \quad \forall t \end{aligned} \tag{3.12}$$

It is then a simple matter to obtain a relationship comparable to equation 3.10 as follows:

$$\frac{C_2}{C_1} = \frac{1 + \gamma_1 S_2 + (\delta_1 \times 2) + (\alpha_1 S_2 \times 2)}{1 + \gamma_1 S_1 + (\delta_1 \times 1) + (\alpha_1 S_1 \times 1)} \tag{3.13}$$

How can these approaches be used to determine the optimal pattern of consumption? In order to focus on the impact of SDU, the following assumptions will be made for sake of exposition:

- all retirement savings are accumulated by the date of retirement (i.e., no additional allocation of income to savings in retirement);
- all income in retirement will come from accumulated retirement savings; and

- either the individual has no bequest motive, or assets attributable to the bequest motive are separated at retirement from the assets to be used for retirement income.

A typical annuity factor, the present value of $1 at the end of each year, to a person age x for the rest of her lifetime is of the following form:

$$\begin{aligned} a_x &= vp_x + v^2 p_x p_{x+1} + v^3 p_x p_{x+1} p_{x+2} + \dots \\ &= \sum_{t=1}^{\omega - x} v^t {}_t p_x \end{aligned} \tag{3.14}$$

where ω is the oldest potential age, $v = \frac{1}{1+r}$ and r is a one-year real rate of return, p_x is the probability of surviving for one year for an individual currently age x, and ${}_t p_x$ is the probability of surviving for t years for an individual currently age x.

First, consider an environment with three states of health, but no SDU. Denote the states of health by the superscripts h, m, and s for good health, middling health and poor health, respectively. Then a_x^h is determined as follows:

$$a_x^h = vp_x^h + v^2 p_x^h \left(t_{x,h}^h p_{x+1}^h + t_{x,m}^h p_{x+1}^m + t_{x,s}^h p_{x+1}^s \right) + \dots \tag{3.15}$$

where t represents the transition probability between live states, the superscript denotes the current state, and the subscript denotes the future state.

As such, the expression in brackets represents the weighted average probability of surviving from age $x+1$ to age $x+2$, where the weights are dependent on the health status at age x. If we let p_x^* represent this weighted average, then the overall expression can be simplified as follows:

$$\begin{aligned} a_x^h &= vp_x^h + v^2 p_x^h p_{x+1}^* + v^3 p_x^* p_{x+1}^* p_{x+2}^* + \dots \\ &= vp_x^h \left(1 + vp_{x+1}^* + v^2 p_{x+1}^* p_{x+2}^* + \dots\right) \\ &= vp_x^h \left(1 + \sum_{t=1}^{\omega-x-1} v_t^t p_{x+1}^*\right) \\ &= vp_x^h \left(1 + a_{x+1}^*\right) \end{aligned} \tag{3.16}$$

If we change perspective from considering an individual to considering a population, we can develop the following expression:

$$\begin{aligned} a_x^* &= vp_x^* + vp_x^* a_{x+1}^* \\ &= \sum_{t=1}^{\omega-x} v_t^t p_x^* \end{aligned} \tag{3.17}$$

If the ${}_tp_x^*$ are determined based on population average weights for health state at age x, then

$$ {}_tp^*_x = {}_tp_x \tag{3.18} $$

$$ a^*_x = a_x \tag{3.19} $$

Now, let us consider SDU based on Health State only. First, we will normalize $R(S_t, S_u) = 1$ when $S_t = S_u$ and $t \neq u$. Then, the annuity expression becomes the following:

$$
\begin{aligned}
a^h_x &= vp^h_x + v^2p^h_x \left(t^h_{x,h}p^h_{x+1} + R(h,m)t^h_{x,m}p^m_{x+1} + R(h,s)t^h_{x,s}p^s_{x+1}\right) + \ldots \\
&= vp^h_x \left(1 + vt^h_{x,h}p^h_{x+1} + v^2t^h_{x,h}p^h_{x+1}\left(t^h_{x+1,h}p^h_{x+2} + t^m_{x+1,h}p^h_{x+2} + t^s_{x+1,h}p^h_{x+2}\right) + \ldots\right) \\
&+ R(h,m)\left(vt^h_{x,m}p^m_{x+1} + v^2t^h_{x,m}p^m_{x+1}\left(t^h_{x+1,m}p^m_{x+2} + t^m_{x+1,m}p^m_{x+2} + t^s_{x+1,m}p^m_{x+2}\right) + \ldots\right) \\
&+ R(h,s)\left(vt^h_{x,s}p^s_{x+1} + v^2t^h_{x,s}p^s_{x+1}\left(t^h_{x+1,s}p^s_{x+2} + t^m_{x+1,s}p^s_{x+2} + t^s_{x+1,s}p^s_{x+2}\right) + \ldots\right) \\
&= vp^h_x\left(1 + a^h_{x+1} + R(h,m)a^m_{x+1} + R(h,s)a^s_{x+1}\right) \qquad (3.20)
\end{aligned}
$$

Similar expressions can be developed for a^m_x and a^s_x. Of course, the expressions for $R(\cdot,\cdot)$ need to be modified if relative consumption depends on both age and Health State.

Of importance as to whether SDU matters in an economic sense is the relationship between a^h_x with and without SDU, and similarly for a^m_x and a^s_x. To make this assessment, it is necessary to estimate the following:

- a full transition matrix between health states,

- $R_x(S_t, S_u)$ evaluated at all necessary combinations of age and health states,
- mortality rates (or alternatively survival probabilities) appropriate for the different health states, and
- a real rate of return to be used for discounting future payments.

These are the issues to which we turn our attention in the next section.

3.3 Data and Methodology

The data utilized for this paper is the same as the data used for Chapter 1. A full description of the data is provided in Section 3 of that chapter. Some highlights of the data are as follows.

- The data come from the Canadian National Population Health Survey (NPHS), Household Component, cycles 1 through 9. This is a longitudinal survey conducted every two years starting in 1994/1995.
- Individuals are included in the analysis if they are age 65 or older at the time of the survey and if their primary source of income is not from employment income.
- In total, 2,391 individuals are included in the analysis, totalling 13,165 observations. On average, individuals are observed in 4.5 cycles of the survey.

3.3.1 *Transition Matrices*

The sample is split into three roughly equal segments based on the Health Utility Index[4] (HUI3).

- "Good" health is assigned to individuals whose HUI3 values range from .95 to 1.00.
- "Middling" health is assigned to individuals whose HUI3 values range from .75 to less than .95.
- "Poor" health is assigned to individuals whose HUI3 values are less than .75.

To arrive at sufficient observations to create reasonable transition matrices quinquennial age groupings from age 65 to age 90 are used. All observations age 90 and above are grouped into one matrix. The transition matrices are calculated directly from the raw data without adjustment and are shown in Tables 3.1 to 3.6.

[4]This index was developed at the Centre for Health Economics and Policy Analysis at McMaster University, and provides a summary description of an individual's overall health. Details of the calculation methodology are contained in Furlong *et al.* (1998). A fully healthy individual would have a score of 1.000; someone who is dead would have a score of 0.000. The minimum potential value is -0.330. Negative numbers represent someone whose health status is worse than death.

3.3.2 *Relative Consumption – Health State Dependent Only*

As set out in the previous section, we need to determine γ_1 from equation (3.7) in order to estimate relative consumption based on Health State alone. To do this, the following regression is fit to the data:

$$HAPPY_{it} = \beta_1 S_{it} log(\bar{Y}_i) + \beta_2 S_{it} + \Psi_1 \mathbf{X_{it}} + \theta_i + \epsilon_{it} \qquad (3.21)$$

The parameter of interest is β_1, which corresponds to γ_1 in formula (3.7).

- $HAPPY_{it}$ is a utility proxy, and is derived from the question: "How satisfied are you with your life in general?" For this regression, $HAPPY_{it}$ is set equal to 1 if the answer to this question is "Happy and interested in life", and 0 otherwise. Under this definition, 76.5% of the observations have $HAPPY_{it}$ set equal to 1.

- Permanent income, $\bar{Y}_i$, is derived from household income[5] averaged[6] across the cycles of the NPHS. As demonstrated in Chapter 1, inferences about consumption can be made from inferences about permanent income in certain circumstances. The data do not include information on consumption, which is why permanent income is used

[5]On average, there are 1.6 individuals in each household, and over 93% of the households had either 1 or 2 individuals. In Chapter 1, results adjusting permanent income for the size of the household were almost identical to the results without adjustment for household size. Reported results in this paper do not adjust permanent income for household size.

[6]Details of how the averaging process addresses missing values are provided in Chapter 1.

instead.

- HUI3 is used as the indicator of Health State. Within the three Health States described above, average levels of HUI3 are .973, .905, and .660 for the healthy, middling health and sick states, respectively.

- The only time varying covariates, $\mathbf{X_{it}}$, are age and marital status. Other demographic covariates, such as permanent income, gender, education, and language are absorbed into the fixed effects parameter, θ_i.

The regression is run as OLS. As such, it is a linear probability model. A summary of the regression is contained in Table 3.7. The parameter β_1 has a point estimate of 1.85%, which is significant at the 0.1% level. Normalizing consumption in the good health state to 1, this yields optimal relative consumption in the middling health and poor health states of 99.9% and 99.4%, respectively[7]. Foreshadowing one of the conclusions of this paper, these values indicate why the effect of SDU on optimal consumption patterns in this case is not economically significant even though the estimated parameter β_1 is statistically significant at the 0.1% level.

[7]In Finkelstein *et al.* (2013) auxiliary regression are run in order to determine the magnitude of the effect of health status on the marginal utility of consumption. In the present case, only the *relative* effect across different health states is required. As a result, no auxiliary regressions are needed.

3.3.3 *Relative Consumption – Age and Health State Dependent*

If relative consumption is dependent on both age and health state, we need to determine γ_1, δ_1, and α_1 from equation 3.12. In this case, the following regression is fit to the data:

$$\begin{aligned} HAPPY_{it} =& \beta_1 S_{it} log(\bar{Y_i}) + \beta_2 S_{it} + \beta_3 Age_{it} log(\bar{Y_i}) + \\ & \beta_4 S_{it} Age_{it} log(\bar{Y_i}) + \Psi_1 \mathbf{X_{it}} + \theta_i + \epsilon_{it} \end{aligned} \tag{3.22}$$

Here, the parameters of interest are β_1, β_3, and β_4. A summary of this regression is contained in Table 3.8. The estimates of β_1 and β_3 are both significant (at the 5% and 1% levels, respectively) and the estimates of β_1, β_3, and β_4 are jointly significant at the 1% level.

Let us normalize relative consumption for a healthy 65 year old to 1. Then, these results yield optimal relative consumption at age 80 of 98.2%, 97.9% and 96.9% for someone in good, middling, and poor health, respectively. At age 95, optimal relative consumption is 96.4%, 96.2%, and 95.5%, respectively[8].

A question might arise as to why there should be any effect of age, independent of health state. In the present analysis, there is no aggregate

[8]See previous footnote.

uncertainty with respect to mortality. However, any one individual does face mortality uncertainty. Using a 65 year old as an example and initially ignoring any precautionary savings motive, she would spread her accumulated retirement savings (net of bequest motive) over the period to her expected age at death[9]. If this individual lives for, say, 5 years, then her remaining retirement savings at age 70 would not be sufficient to maintain her current level of expenditure because her expected age at death at age 70 is now older than it was at age 65. She would re-optimize her income to spread it over the period to the updated expected age at death. Expanding the example to include precautionary savings would not eliminate this age effect unless the target for precautionary savings reduces in order to offset exactly the increase in expected age at death. This is unlikely to be the case.

3.3.4 *Mortality Rates*

Statistics Canada has published "Life Tables, Canada, Provinces and Territories, 2009 to 2011". The base mortality rates used in this paper are the sex distinct complete life tables for Canada, 2009 to 2011 from that paper. Mortality rates at selected ages are shown in Table 3.9. Annual rates of future mortality improvement are developed by taking the geometric average rate of improvement in the rates from the comparable table published for 1996.

[9]In practice, an individual would spread their accumulated savings based on a life annuity factor, which is not equal to an annuity certain over the period to expected age at death due to Jensen's inequality. However, this description is a reasonable approximation to describe the age effect and is intuitively appealing.

Annual rates of improvement at selected ages are shown in Table 3.10.

These base rates need to be adjusted to reflect health status. As a starting point, the rates of withdrawal from the NPHS are examined. Participants withdraw from the survey for four potential reasons:

- they die;
- they become institutionalized;
- they cannot be found to be interviewed; or
- they refuse to respond to the interview.

These various reasons are not captured separately in the survey. As a result, a simplifying assumption needs to be made, which is that total withdrawal rates from all sources are proportional to withdrawal rates due to death alone.

Using this working assumption, total withdrawal rates by five-year age groups up to age 85, and another group capturing those age 85 and older are determined. These rates are then “normalized” so that the weighted average rates are equal to the overall average mortality rates for the appropriate age group. These relative mortality factors are set out in Table 3.11.

3.3.5 *Real Rate of Return*

The most appropriate market-based rate of return is the yield to maturity available on Government of Canada Real Return Bonds (RRBs). These bonds are as risk-free as possible in the Canadian market. Both the coupon payments and the outstanding principal are adjusted to reflect changes in the Consumer Price Index, Canada, All Items. Finally, they have roughly the same payment period as a life annuity at age 65. However, they are not a perfect match to the expected payment stream.

As of December 16, 2015, the Government of Canada Real Return benchmark bond yield, long term[10] was .7375%. For purposes of the results in the next section, annuity values are shown using real rates of return of 0.50%, 0.75%, 1.00%, and at an extreme 3.00%.

3.4 Results

3.4.1 *Health State Dependent Only*

Based on the theory outlined in Section 3.2 and the methodology described in Section 3.3, several annuity factors are calculated for a healthy male age 65. These factors are determined both reflecting Health State dependence and not reflecting it. Panel I of Table 3.12 contains those annuity factors

[10]Source from CANSIM table number 176-0048.

using several discount rates.

Panel II of Table 3.12 shows the amount of annual income recognizing Health State dependence when a capital amount is annuitized, relative to the annual income ignoring such dependence. As pointed out previously, while the estimated effect of Health State dependence on the marginal utility of consumption is statistically significant, it does not appear to have *economic* significance in this application. Using several different discount rates, optimal consumption (for a 65 year old healthy male) recognizing Health State dependence is never more than 1% different from optimal consumption ignoring Health State dependence.

Table 3.13 summarizes annuity values with and without recognition of Health State dependence for 65 year old males and females in different initial health states. Across all combinations, little difference is seen between the optimal levels of consumption recognizing and ignoring SDU.

As a test of the robustness of these results, the calculation for a 65 year old healthy male is repeated by setting γ_1 equal to its estimated value, plus two standard errors. This yields a value for γ_1 of 2.85% (compared to 1.85% in the baseline results). These results are virtually identical to the results reported in Table 3.12.

3.4.2 *Age and Health State Dependent*

Based on the theory outlined in Section 3.2 and the methodology described in Section 3.3, several annuity factors are calculated for a healthy male age 65. These factors are determined in two ways – reflecting both age and Health State dependence on the one hand and not reflecting either on the other hand. Panel I of Table 3.14 contains those annuity factors using several discount rates.

Panel II of Table 3.14 shows the amount of annual income recognizing age and Health State dependence when a capital amount is annuitized, relative to the annual income ignoring such dependence. Unlike the results in the previous subsection, there does appear to be some economic effect of reflecting age and Health State in setting up an optimal annuity stream, though the effect is not large. Initial income for a healthy 65 year old male is between 1.5% and 2.0% larger, depending on the discount rate. Income at age 80 is about 2% lower than at age 65 for those in good health and over 3% lower for those in poor health. The effect at age 95 is a further drop of roughly 2%. In very rough terms, the optimal adjustment to reflect age and Health State is equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation and that does not reflect the effects of age and Health State.

Table 3.15 summarizes annuity values with and without recognition of age and Health State for 65 year old males and females in different initial health states. Across all combinations, the differences between the optimal initial levels of consumption recognizing age and Health State and ignoring them range from 1.8% to 2.3% depending on gender, discount rate, and initial Health State.

3.5 Conclusion

While the effect of Health State alone on the marginal utility of consumption is statistically significant at the 0.1% level, its economic effect is not material, never affecting the optimal annual consumption by more than 1%. On the other hand, the combined effect of age and Health State on the marginal utility of consumption is both statistically signficant (at the 1% level) and economically significant. Relative to a stream of income that is constant in real terms, a stream of income optimized by reflecting both age and Health State will start roughly 2% higher and will drop by 2% - 3% by age 80 and by a further 2% or so by age 95. This optimal pattern of consumption reflecting age and Health State is roughly equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation and does not reflect the effects of age and Health State.

These results may call into question the typical pension policy approach of assuming that the appropriate retirement income target is a stream of income that is fully indexed to price inflation. Instead, it may be a stream of income that is larger at the start, but does not fully reflect price inflation over time, all at an equivalent discounted present value.

Bibliography

[1] Arrow, Kenneth J. "Optimal Insurance and Generalized Deductibles." *Scandinavian Actuarial Journal* 1974.1 (1974): 1–42.

[2] Börsch-Supan, Axel, and Konrad Stahl. "Life Cycle Savings and Consumption Constraints." *Journal of Population Economics* 4.3 (1991): 233–255.

[3] De Nardi, Mariacristina, Eric French, & John Bailey Jones. *Differential Mortality, Uncertain Medical Expenses, and the Savings of Elderly Singles.* No. w12554. National Bureau of Economic Research, 2006.

[4] Domeij, David and Magnus Johannesson. " Consumption and Health." *Contributions to Macroeconomics.* 6.1 (2006): 1–30.

[5] Evans, William N., and W. Kip Viscusi. "Estimation of State-Dependent Utility Functions using Survey Data." *The Review of Economics and Statistics* (1991): 94–104.

[6] Finkelstein, Amy, Erzo F.P. Luttmer, and Matthew J. Notowidigdo. “What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption.” *Journal of the European Economic Association* 11.s1 (2013): 221 – 258.

[7] Furlong William et al. *Multiplicative Multi-Attribute Utility Function for the Health Utilities Index Mark 3 (HUI3) System: A Technical Report.* No. 1998-11. Centre for Health Economics and Policy Analysis (CHEPA), McMaster University, Hamilton, Canada, 1998.

[8] Modigliani, Franco. ”The Collected Papers of Franco Modigliani, Volume 6.” *MIT Press Books* 6 (2005).

[9] Palumbo, Michael G. “Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle.” *The Review of Economic Studies* 66.2 (1999): 395 – 421.

[10] Schirle, Tammy. ”Health, pensions, and the retirement decision: Evidence from Canada.” *Canadian Journal on Aging/La Revue canadienne du vieillissement* 29.04 (2010): 519-527.

[11] Skinner, Jonathan. *Are you sure you’re saving enough for retirement?.* No. w12981. National Bureau of Economic Research, 2007.

[12] Sloan, Frank A., et al. “Alternative Approaches to Valuing Intangible Health Losses: The Evidence for Multiple Sclerosis.” *Journal of Health Economics* 17.4 (1998): 475–497.

[13] Statistics Canada. *Life Tables, Canada, Provinces and Territories, 2009 to 2011.* Catalogue no. 84-537-X – No. 005. Ottawa: Statistics Canada, 2013.

[14] Viscusi, W. Kip and William N. Evans. “Utility Functions that Depend on Health Status: Estimates and Economic Implications.” *The American Economic Review* (1990): 353–374.

Table 3.1: Annual Transition Rates Ages 65 to 69

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.84	0.13	0.03
Middling	0.15	0.66	0.19
Sick	0.08	0.16	0.76

Table 3.2: Annual Transition Rates Ages 70 to 74

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.80	0.16	0.05
Middling	0.17	0.64	0.19
Sick	0.05	0.13	0.82

Table 3.3: Annual Transition Rates Ages 75 to 79

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.76	0.18	0.07
Middling	0.13	0.65	0.22
Sick	0.07	0.12	0.82

Table 3.4: Annual Transition Rates Ages 80 to 84

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.70	0.19	0.11
Middling	0.11	0.66	0.23
Sick	0.02	0.08	0.90

Table 3.5: Annual Transition Rates Ages 85 to 89

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.58	0.20	0.23
Middling	0.09	0.63	0.28
Sick	0.03	0.06	0.91

Table 3.6: Annual Transition Rates Ages 90 and Older

Future State	*Healthy*	*Middling*	*Sick*
Current State			
Healthy	0.64	0.14	0.22
Middling	0.01	0.66	0.32
Sick	0.01	0.02	0.96

Table 3.7: Regression to Estimate γ_1

Variable	*Coefficient*
$S \times log\bar{Y}$	.0185***
(γ_1)	(3.65)
S	.4644***
	(8.65)
Age	.0033***
	(23.51)
Married	.0391***
	(5.50)
R^2	.8023
N	13,165

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 3.8: Regression to Estimate γ_1, δ_1, and α_1

Variable	*Coefficient*
$S \times log\bar{Y}$	.1141*
(γ_1)	(1.96)
$Age \times log\bar{Y}$	-.0004**
(δ_1)	(-2.64)
$Age \times S \times log\bar{Y}$	-.0009
(α_1)	(-1.08)
S	-.5619
	(-.94)
Age	.0068***
	(5.05)
$Married$	.0428***
	(5.87)
R^2	.8025
N	13,165

t-values are in parentheses.
*** significant at 0.1% level
** significant at 1% level
* significant at 5% level

Table 3.9: Mortality Rates (selected ages)

Age	Males	Females
65	0.01260	0.00782
70	0.02040	0.01284
75	0.03310	0.02146
80	0.05383	0.03654
85	0.08776	0.06338
90	0.14341	0.11196
95	0.21839	0.18849
100	0.30802	0.28671
105	0.40149	0.39395
110	1.00000	1.00000

Table 3.10: Annual Rates of Mortality Improvement (selected ages)

Age	Male	Female
65	0.97479	0.98257
70	0.97462	0.98450
75	0.97578	0.98498
80	0.97633	0.98375
85	0.97801	0.98326
90	0.98291	0.98569
95	0.98363	0.98971
100	0.98403	0.99201
105	0.98245	0.99208
110	1.00000	1.00000

Table 3.11: Mortality Factors Relative to Overall Average Mortality

Age Range	*Healthy*	*Middling*	*Sick*
65 - 69	0.9	0.7	1.8
70 - 74	0.6	0.9	1.7
75 - 79	0.7	0.8	1.5
80 - 84	0.7	0.7	1.5
85+	0.8	0.8	1.1

Table 3.12: Annuity Factors for a Healthy Male, Age 65

Discount Rate	0.50%	0.75%	1.00%	3.00%
Panel I – Annuity Values				
Without SDU	18.35721	17.80681	17.27995	13.83459
Health State Dependent Only	18.31935	17.76952	17.24515	13.80919
Panel II – Income Reflecting Health State Relative to Income Ignoring Health State				
Healthy	1.00207	1.00204	1.00202	1.00184
Middling	1.00083	1.00081	1.00079	1.00084
Sick	0.99639	0.99636	0.99634	0.99583

Table 3.13: Annuity Factors at Age 65

Discount Rate	0.50%		0.75%		1.00%	
	No SDU	With SDU	No SDU	With SDU	No SDU	With SDU
Panel I – Males						
Healthy	18.35721	18.31935	17.80681	17.76952	17.27995	17.24515
Middling	18.22796	18.18147	17.67888	17.63406	17.15530	17.11205
Sick	18.13660	18.07903	17.58883	17.53300	17.06651	17.01233
Panel II – Females						
Healthy	20.41804	20.67220	19.76830	19.72444	19.14967	19.10768
Middling	20.33000	20.27515	19.68192	19.62915	19.06490	19.01410
Sick	20.26916	20.20288	19.62198	19.55787	19.00584	18.94379

Note: In this table, State Dependent Utility refers to Health State, only.

Table 3.14: Annuity Factors for a Healthy Male, Age 65

Discount Rate	0.50%	0.75%	1.00%	3.00%
Panel I – Annuity Values				
Without SDU	18.35721	17.80681	17.27995	13.83459
Age and Health State Dependent	18.02437	17.48745	16.97527	13.61601
Panel II – Income Reflecting Age and Health State Relative to Income Ignoring Age and Health State				
65 Healthy	1.01847	1.01826	1.01795	1.01605
80 Healthy	1.00009	0.99989	0.99958	0.99772
80 Middling	0.99730	0.99710	0.99680	0.99494
80 Sick	0.98728	0.98708	0.98678	0.98494
95 Healthy	0.98171	0.98151	0.98121	0.97938
95 Middling	0.97985	0.97965	0.97935	0.97752
95 Sick	0.97312	0.97293	0.97263	0.97082

Table 3.15: Annuity Factors at Age 65

Discount Rate	0.50%		0.75%		1.00%	
	No SDU	With SDU	No SDU	With SDU	No SDU	With SDU
Panel I – Males						
Healthy	18.35721	18.02437	17.80681	17.48745	17.27995	16.97527
Middling	18.22796	17.87216	17.67888	17.33780	17.15530	16.82812
Sick	18.13660	17.74965	17.58883	17.21680	17.06651	16.70858
Panel II – Females						
Healthy	20.41804	20.02310	19.76830	19.39116	19.14967	18.78931
Middling	20.33000	19.91082	19.68192	19.28078	19.06490	18.68079
Sick	20.26916	19.81776	19.62198	19.18884	19.00584	18.58995

Note: In this table, State Dependent Utility refers to both Age and Health State.

Conclusion

This thesis analyzes the consumption patterns of the Canadian elderly. It attempts to link the theoretical expectations of constant real consumption with the empirical observations of reduced consumption as individuals age and fall into ill health.

Chapter 1 uses data from the Canadian National Population Health Survey (NPHS) to analyze the effect of sickness on the marginal utility of consumption for the Canadian elderly. The major contribution of this chapter is that it analyzes the effect of several different sickness measures. When defining sickness as the number of chronic diseases, the marginal utility of consumption when sick is *larger* than when healthy. On the other hand, when using a more comprehensive measure of sickness, HUI3, the marginal utility of consumption when sick is *smaller* than when healthy.

In analyzing several sickness measures together, the HUI3 measure has the largest effect. The implication of the results using the HUI3 measure is that, relative to constant real consumption during retirement, a greater amount should be consumed while in a healthy state and a lesser amount while sick. For someone whose health moves from the 75th percentile of the HUI3 measure to the 25th percentile, the estimated marginal utility of consumption declines by 4.26%. Moving down to the 10th percentile reduces the estimated marginal utility of consumption by a further 5.19%.

Additionally, there is some evidence that the effect of sickness on marginal utility varies with income level. Using HUI3 as the measure of sickness, there is a significant decrease in the estimated marginal utility of consumption when sick for those whose income is above median levels. No significant result is found for those whose income is below median.

Chapter 2 uses data from the Canadian Survey of Household Spending (SHS) to analyze the effect of sickness on the consumption levels of the Canadian elderly. It constructs a measure of sickness that is defined as household healthcare spending on certain items that is at or above the upper quartile break, where the quartile breaks are set separately for each income quartile.

The baseline results show that the non-healthcare consumption share of after-tax income *increases* when the household is "Sick" by an estimated 6.70%. However, it *reduces* by an estimated 1.95% when the analysis is restricted only to those households whose current year consumption expenditure is less than their current year after-tax income. Both of these results are significant at the 0.1% level. Across the income quartiles, non-healthcare consumption share of after-tax income when the household is "Sick" is estimated to increase by somewhere in the range of 11.73% to 2.32% (reduce by 4.64% to 1.99% in the first three income quartiles and increases by 0.27% in the fourth quartile for those households whose current year consumption expenditure is less than their current year after-tax income). The amounts in the first three income quartiles are all significant. The amounts in the fourth income quartile are imprecisely measured.

Changing the definition of "Sick" to be disabled or having a limitation of an activity of daily living produces different results. In this case, the estimated effect on non-healthcare consumption share of after-tax income when someone in the household becomes "Sick" is not significant.

The major contribution of this chapter is the analysis of the effect of becoming "Sick" for those households with different levels of current year savings. The estimated effect is a reduction in non-healthcare consumption share of after-tax income that is roughly level around 2.25% for those households that dissave 10% of their current year after-tax income or less. As households dissave larger and larger amounts, however, the reduction first becomes smaller, and then becomes an increase.

The results of this chapter are robust to many alternative specifications – different functions of age and year of birth, different specifications for higher education, and separate results by the sex of the reference person and by household size.

The final portion of the analysis in this chapter shows that the estimated change in non-healthcare consumption share of after-tax income is larger when "Sick" is defined as healthcare expenditures at and above the 90th percentile relative to when "Sick" is defined as healthcare expenditures at and above the 75th percentile.

Chapter 3 uses the same data as Chapter 1 to estimate optimal consumption patterns based on level of Health State and age. Its main contribution is that it develops a theoretical approach to determining a life annuity that produces a stream of income that will finance optimal consumption expenditures reflecting state-dependent utility. It proves that in the absence of state dependence, the optimal annuity value simplifies to a traditional annuity value.

The chapter then determines optimal annuity values based on data from the NPHS. When state dependence is based on Health State alone, it does not find a significant *economic* impact on the optimal pattern of consumption in retirement for the Canadian elderly. This result is obtained in spite of finding that the estimated marginal utility of consumption varies in a statistically significant (at the 0.1% level) way dependent on Health State. To illustrate, a healthy Canadian male age 65 would optimally consume 100.20%, 100.03%, and 99.64% when in good health, middling health, and poor health, respectively, relative to a consumption pattern that is constant in real terms.

However, when both age and Health State are reflected in the optimal pattern of consumption, the effect is both statistically significant (at the 1% level) and economically significant. Relative to a stream of income that is constant in real terms for a healthy 65 year old male, a stream of income reflecting both age and Health State will start roughly 2% higher and will drop by 2% to 3% by age 80 and by a further 2% or so by age 95. This pattern of consumption reflecting age and Health State is roughly equivalent to ignoring 15 to 20 basis points of annual inflation relative to an annuity that is fully indexed to inflation and does not reflect the effects of age and Health State.

The results of this chapter may call into question the typical pension policy approach of assuming that the appropriate retirement income target is a stream of income that is fully indexed to price inflation. Instead, it may be a stream of income that is larger at the start, but does not fully reflect price inflation over time, all at an equivalent discounted present value.