# Three Essays on Family Labour Supply and Health over the Life Cycle

by

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# Abstract

The three essays in this thesis explore how intrahousehold decision making interacts with evolving health, disability shocks and aging to determine life cycle patterns of labour supply and retirement among Canadian and U.S. households. One of the main roles of marriage and cohabitation is to provide individuals with insurance against idiosyncratic risk such as health and disability shocks. The extent and effects of this insurance depend on how household members interact and delegate tasks— for instance, whether they can specialize and easily transition between home-based or market-based work— and the extent to which household members commit to and cooperate with each other. The first two chapters of the thesis document and provide a structural explanation for the fact that, in general, marriage is associated not only with better health outcomes but also with better economic outcomes conditional on health status. The final chapter suggests that these better outcomes, and the role of public policy in facilitating them, may be contingent on how cooperative household members are with each other when making career and retirement decisions. In general, the results suggest that household-level interactions have important implications for aggregate labour supply and human capital; for the role and appropriate use of public policy; and for the welfare of individuals confronted with uncertainty over the length and productivity of their working life.

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# Dedication

For my parents.

# Statement of Co-Authorship

Chapters 2 and 3 of this thesis are co-authored with, Dr. Giovanni Gallipoli, Assistant Professor of Economics at the University of British Columbia, as part of a project funded by the Canadian Labour Market and Skills Research Network. Both authors contributed to formulating and refining the research questions and to interpreting the results presented in Chapter 3. Outside of his (excellent) supervisory role, Dr. Gallipoli contributed to revising some drafts of Chapter 3. However, I am the primary author of each chapter of this thesis. Specifically, I am responsible the econometric strategy and results presented in Chapters 2 and 3, and for the analytical results and numerical simulations (including coding of the model) presented in Chapter 3. I am the sole author of Chapter 4.

# Chapter 1

# Introduction

The three essays in this thesis explore how intrahousehold decision making interacts with evolving health, disability shocks and aging to determine life cycle patterns of labour supply and retirement among Canadian and U.S. households. Chapters 2 and 3 deal with the experience of and long term effects of disability onset among Canadian households. Chapter 4 examines the incentives of the U.S. Social Security system for different degrees of cooperation among older U.S. households.

Chapter 2 provides an examination of the incidence, chronicity and economic effects of disability onset at the individual and household level using the 1999 and 2002 waves of the Survey of Labour and Income Dynamics. Reporting of some sort of physical or economically limiting disability is very widespread, and conditions that impose economic costs outside of work (for example, in the home or in leisure activities) affect a large part of the disabled population that may be missed in other income datasets. In general, having a long-term disability reduces the likelihood that individuals (specifically men) work, and appears to lower their earnings potential and income over time. These effects are more severe for younger than for older men; for lower educated than for higher educated men; and for more chronically rather than less chronically disabled men. Marital status also appears to be strong predictor of outcomes following disability. In particular, at any duration of a disability, single men are much more likely to have stopped working than married men with similar observable characteristics, and have much lower wages controlling for selection into the labour force. As in similar U.S.-based studies, there is no evidence of an "added worker effect" among the female spouses of the disabled.

In Chapter 3, I develop a structural model of single and married households that attempts to reconcile some of these observed patterns. Male members of households are subject to a process for disability in the context of evolving life cycle health. I argue that many of the features of responses to disability laid out in Chapter 2—particularly the much lower post-onset labour supplies of single men, small added worker effects, and long-run wage drops—are consistent with a model in which disability imposes time losses on individuals; labour supplies at home and in the formal market are endogenous; and main earners (typically husbands) face a loss of human capital if they reduce their market work effort in response to disability onset. In this case, wives support the labour supply of husbands by increasing their share of work effort in the home in order to ease the direct utility loss to the husband of continued market work.

In Chapter 4, I change focus from disability to life cycle health and retirement patterns among U.S. couples. I design, estimate and simulate a model of the household in which couples behave cooperatively over most aspects of married life but non-cooperatively when making decisions relating to retirement and to application for benefits under the Social Security system. The results of the chapter show that, under reasonable parameterizations, this semi-cooperative model rationalizes many patterns observed in U.S. data that cannot be explained by either a standard cooperative household model or a model in which couples benefit from complementaries in leisure during retirement. These patterns include the peak in retirement at age 62, the joint distributions of retirement for husbands and wives, the use of "bridge jobs" as transitions into retirement, and the use of the Social Security Disability Insurance program.

Taken as a whole, the findings of this thesis suggest that intrafamily insurance interacts with health and disability shocks in ways that are more complex and interesting than what can be captured by a standard stochastic life cycle model of the household. In this regard, they provide a solid foundation for future research. Developing models that can explain intrahousehold responses to evolving health and disability shocks, and pin down mechanisms by which individuals insure themselves and each other against these and other types of shocks, is essential if we want to understand the implications of idiosyncratic risk for individuals and households; to identify groups who are the most vulnerable to the effects of shocks; and to develop effective public policy prescriptions to protect these groups without distorting or accentuating the imperfections in insurance available through the family.

# Chapter 2

# Disability in Canada: A Longitudinal Household Analysis

## 2.1 Introduction

Disability report rates and benefit claiming in the United States have been on the rise for the past quarter-century, attracting increasing attention from economists. A series of recent reports, including [72], [25], [59], [24], [26], [28] and [70] have examined the incidence of disability and the responses of the individuals affected, as well the consequences for affected individuals and their families. Additional studies have examined the incentives associated with disability reporting ([15], [21]) and benefit claiming ([45], [19]) among U.S. and Canadian households. Understanding the patterns of response and consequences of disability is important both from a policy perspective and from the point of view of theorists wishing to gain insight into how individuals and households cope with health risk, the realizations of which typically take the form of highly correlated shocks affecting multiple facets of economic life. This chapter contributes further to the descriptive literature on disability by examining the economic effects of disability among Canadian households using the 1999-2007 waves of the Survey of Labour and Income Dynamics (SLID). The SLID provides both cross-sectional and longitudinal data on Canadian individuals and households. Importantly for our purposes, it also provides information from a fairly sophisticated disability questionnaire by the standards of income-based, as opposed to health-based, surveys. We believe this is the first study that utilizes the SLID to analyze the economic effects of disability in detail.

The chapter proceeds in five parts. In section 2.2, we describe our data source and discuss the relative benefits of the SLID compared to U.S. life course surveys for examining the effects of disability, as well as the limitations imposed by its relatively short panel dimension. Ideally, we want to examine the long-run responses and consequences of disability over a twelve-to-fifteen-year horizon around time of onset—as previous authors such as Stephens and Meyer & Mok have done with individuals in the Panel Study of Income Dynamics (PSID). The relatively rich disability module of the SLID allows us to track the evolution and duration of a disabling condition in individuals who are not present in the SLID at time of onset. However, the fact that we do not observe the same individual both before and at long durations after onset raises two problems for the analysis: first we are faced with the possibility of negative selection of individauls at longer durations. This type of selection is, in fact, a near-certainty since only those who experience a recurrence of a chronic condition *while in the SLID panel* will be identified as disabled at long durations. To correct for this problem, we reweight observations to replicate an average post-onset recurrence rate (the rate of active limitation at a given year post-onset) based on data from the first six waves of the National Health and Population Survey (NPHS), which has traced the same set of individuals biannually for twelve years.

Second, since we have relatively few observations of individuals three or more years prior to onset (what normally serves as the "control group" in descriptive studies examining dynamic effects of disability), we wish to augment our sample by drawing individuals from the population who are never observed with a disability using a nearest-neighbor propensity score match. We are able to show that, after our we-weighting and sample augmentations, our pool of individuals does not differ significantly over different years from onset in terms of observable characteristics, such as education, location, or likelihood of reporting blue collar employment. Our implicit assumption is that eliminating evidence of selection on observables also eliminates selection based on unobservables, or at least reduces it sufficiently to allow us to provide some useful insight into the *typical* experience of an individual experiencing the onset of a disability.

In section 2.3 we provide descriptive statistics on the incidence and chronicity of disability in Canada across time, across types of disability and across some major demographic groups. In section 2.4 we turn to examining the labour supply responses of prime-age Canadian men and their families, following the onset of disability, and also the consequences in terms of wages and personal and household-level income, both before and after government transfers are received. To conduct the analysis, and in line with the discussion above, we create two subsamples of the disabled Canadian male population, a "mean" disabled subsample—called our "NPHS-All" sample—and a "chronic" disabled subsample. As the labels suggest, the first group approximates the entire post-onset population in Canada, using weights derived from information on recurrence of disability from the first six waves of the NPHS. The second group represents the very chronically disabled population, those who report, on average, an active limitation in two thirds of the post-onset periods that we can observe them. For both groups, we disaggregate the responses by marital/cohabitation status (i.e. whether living with a partner or not), education (the degree equivalent of thirteen years of education vs. high school or less) and age (older than 45 vs. 45 and younger.)

Our results confirm several findings from previous economic studies of disability, while providing some novel information on the differential effects of disability across different subsets of the Canadian population. We find, first, that the incidence of reported disability is very high among the Canadian adult population, in particular relative to disability report rates in the PSID. Approximately 30% of adults between 45 and 70 report some kind of limitation in a given year (compared to around 22% in the PSID), and this share appears to be increasing over time. The SLID allows us to characterize disability by the type of economic limitation (if any) it imposes. We find that approximately 55% of reported limitations do not directly limit people at work, the main criterion for self-assessed disability classification in many income-based surveys, including the PSID. Overall, however, males experiencing recurring disabilities do appear to face serious economic consequences. These consequences are typically greater for younger, less educated, and unmarried men. The difference-in-difference between pre- and post-disability onset outcomes is especially striking when we disaggregate by marital status, and can not be readily explained by differences in standard observable characteristics (educational attainment, age, household size, or factors related to region or ethnicity) across these groups.[1] The relatively small observed differences in labour supply and wages for post-disability-onset married men are accompanied by very small household-level differences in average income and, confirming two studies using U.S. data, by small to non-existent "added worker effects" among wives of the disabled, even among the chronically disabled group. Section 2.5 summarizes our findings.

[1]In additional regressions, we also test the robustness of the differences-in-differences across marital status to including as additional controls self-assessed health, and blue-collar job status for the subsample of disabled men who report occupational status. The differences between married and single men in terms of particpation, hours worked and income are basically robust to both of these inclusions.

## 2.2 Understanding disability using the SLID

Data for our analysis comes from the 2002-2007 longitudinal and cross-sectional files of the Survey of Labour and Income Dynamics (SLID). The SLID is an annual longitudinal survey following individuals in rotating six-year panels, with a new panel beginning every three years. Each individual in the panel is assigned an annual weight, which varies based on demographic change and attrition rates, so that the panel is representative of the Canadian population (excluding the Northwest Territories, Yukon and Nanavut, plus Indian reserves) in the initial year of the panel. In addition to the six-year panels, SLID also collects representative cross-sectional samples for each year. These cross-section files combine individuals from the two active panels in a given year, plus individuals who join core panel households during the course of the panel, such as new spouses or adult relatives who move into the household. A cross-sectional weight is provided to make each cross-section representative of the Canadian population in a given sample year. There are between 17,000 and 21,000 individuals who provide partial or complete information in each panel, and more than twice that in each annual cross-sectional file, giving us a large sample size suitable for disaggregation.

SLID interviewing is conducted in January of the year following the reference year (e.g. the 2006 wave of the 2002 panel is collected in January of 2007) by telephone, with follow-up interviews in May. Typically, one household member provides proxy response for other members of the household, though this is disallowed if the proxy member lacks sufficient information on other family members. Importantly, participants may grant Statistics Canada access to tax return data rather than report their own income data from memory. According to Statistics Canada, more than 80% of respondents chose this option as of 2008.

The SLID differs from other life-course income studies (such as the Panel Study of Income Dynamics) in that it asks a series of detailed questions regarding the specific effect of disability on physical and economic life. Since 1999, the series of questions in the SLID disability module has been constant, reflecting the set of questions developed for the 2000 Canadian census. In this chapter, our conception of disability is based on four main variables constructed from four sets of questions on the effects of disability on daily life. We label these variables Q1-Q4. For Q1, individuals are asked whether they face physical impairments in completing any of several physical activities such as climbing stairs or lifting heavy objects: in the data file available to researchers, responses are condensed into a single variable coded “yes” if the individual reports an impairment in at least one of these physical activities. For Q2, individuals are asked whether their disability limits them in labour market activities, i.e. those "at work, at a job, at a job or business or at school"[2] and, separately, whether their disability "completely" prevented them from working in the reference year. For Q3, individuals are asked if they face limitations in activities "at home"; and in Q4, whether they face limitations in "other" activities, specifically including transportation or leisure. Individuals also provide information on the severity of their Q2-Q4 limitations, specifically whether the limitation occurs "sometimes" or "often".

From Q1-Q4, we construct the following definitions of disability: disability is "latent" if it limits the individual physically but not economically (that is, positive answer to Q1 and negative answers to Q2-Q4). Disability is "limiting" in work, home or leisure/other activities if the individual reports positive responses to Q2, Q3 or Q4 respectively. We refer to these individuals as $n$-limited / $h$-limited / $l$-limited, following standard notation for labour/ home production/ leisure from the economics literature. Our approach to disability broadly follows the framework developed by in the 1960s by Saad Nagi, described recently in [64] and [18]. In this conception, "disability" is the third stage of a three-stage process, beginning with a physical *pathology* such as blindness, chronic fatigue or bipolar disorder. Depending on the extent of the pathology and the individual's ability to combat and cope with it, the pathology that can lead to one or multiple *impairments* or *functional limitations*[3] such as those listed in Q1. Again, depending on (a) the nature of the impairment, (b) the attributes and tastes of the individual experiencing it, and (c) the social conditions and economic situation this individual, this purely physical limitation can eventually result in full-fledged *disability*, which can be thought of as a contraction in the individual's possibility frontier in social and economic life—reduced ability to work, accumulate human capital, or enjoy consumption and leisure.

[2] A question about limitations "at work" is asked of respondents or about subjects under 70 who worked in the reference year. The question about disability limitations "at a job or business or at school" is asked of respondents under 70 who did not work in the previous year. In the longitudinal file, the responses to these questions are combined into a single variable reported for the entire sample population under 70.

[3] In [63]'s framework, impairments and functional limitations are treated as separate stages, with the former relating to the region of the pathology (e.g. chronic fatigue may lead to impairments in cognitive function) and the latter relating to physical impairments or limitations experienced by the individual as a holistic organism (e.g. the reduction in cognitive function of the chronically fatigued individual may make it difficult for him to drive).

Our definitions "latent" and "limiting" refer to the second and third stages of this framework. The terminology reflects the fact that we consider disability as imposing limitations on *economic* life. A disability is latent if it creates physical limitations that do not encroach on economic life by preventing some activities that would otherwise lie in the current set of optimal behaviour, i.e. do not shrink the individual's current possibility frontier. In the SLID, as in most life-course income studies, we do not have information on the nature of the physical pathologies that undergird latent or limiting disabilities.

Finally, the SLID provides supplemental information on the third stage of disability that further informs our analysis. First, the SLID collects information on the duration of the condition—how many years the individual has had the condition, and whether the condition dates from birth. The former information is vital to the longitudinal analysis presented in Section 2.4 because it allows us to assess the *duration* (time from onset) of the the condition we are observing in the data. The SLID also collects some more specific information on the effect of the condition on working life, for instance whether the condition makes it difficult for the individual to change jobs or to work his or her desired number of hours.

## 2.3 Incidence and chronicity of disability among Canadian households

Descriptive statistics in this section are computed using SLID cross sectional files for the years 1999-2007. We consider the entire population between 20 and 69. For our demographic analysis, we define individuals as "low educated" if they have less than a postsecondary degree (i.e. some university or technical training but no diploma or degree beyond high school) and "high educated" if they report some form of degree or certificate beyond a high school diploma. This division splits the sample roughly in half. We take educational attainment as the highest attainment recorded in any year of the panel, and replace education with this value in any year it is not recorded. We categorize the marital status of individuals as currently married (we include common law married because we are primarily interested in the effects of living arrangements); never married; previously married but currently divorced or separated; and widowed, using the marital status variable provided by the SLID.[4] We keep all individuals for which information

[4]For our longitudinal results, we recategorize individuals based on reported living arrangements to divide them between the married and unmarried groups. Some individuals

on age, education, marital status, and a response to at least one of the four main disability indicators (Q1-Q4) are available.

### 2.3.1 Incidence of disability over time

We begin by examining the incidence of different types of disability among the adult Canadian population over the nine-year period between 1999 and 2007. Table 2.1 reports the incidence (the share of adults reporting the particular disability) of disability for odd-numbered years between 1999 and 2007. The first column reports the yearly incidence of any type of disability; column two reports the yearly incidence of latent disability; columns 3-5 report yearly incidences of each type of limiting disability when that type is the *only* type of limitation reported; and column 6 reports the incidence of both a work and non-work limitation. The omitted category, which is the difference between column 1 and columns 2 through 5, is disabilities that are both home and leisure/other limiting, but not work-limiting. Four facts are evident from the table: (1) Limiting disabilities are much more prevalent in all years than latent disabilities. (Put another way, most identifiable disabilities do impact on economic life.) (2) Non-work disabilities (home or leisure/other) are more prevalent than work-limiting disabilities. (3) The majority of limiting disabilities affect individuals in more than one way, and a plurality of multiple-limitation disabilities affect both work and non-work activities. (4) There is an upward trend in disability reporting among Canadians, with the trend concentrated among limiting disabilities.

Table 2.2 breaks down the results from table 2.1 by age and sex. To save space, we combine the 'home-limiting', 'other/leisure-limiting' and both 'home' and 'other'-limiting categories into one aggregate 'non-work limiting' category. Therefore, the sum of columns 2 through 5 equals the value reported in column 1. The results are otherwise identical to those in table 2.1. Not surprisingly, we see that older adults (over 45) are much more likely to report any kind of disability than younger adults (ages 20 to 45), though the effect is not very strong for work-limiting disabilities with no associated non-work limitation. Women in both age categories are more likely to report a disability of any time. Breaking this down by type of disability, women are substantially more likely than men to report a non-work limitation, but slightly less likely than men to report a latent disability.

concurrently report being divorced or never-married but also reporting "living with a spouse". These individuals are categorized as married. In our cross-sectional results, however, we take the SLID marital status categorization variable as a sufficient indicator of marital status and take its values as given.

Table 2.1: Components of latent and limiting disability: All individuals

| (%) | Any | Latent | Only $n$-lim | Only $h$-lim | Only $l$-lim | $n$ and $h/l$-lim |
|---|---|---|---|---|---|---|
| 1999 | 22.27 | 5.45 | 0.84 | 1.29 | 1.07 | 9.42 |
| 2001 | 23.04 | 5.20 | 1.18 | 1.29 | 1.28 | 9.96 |
| 2003 | 25.82 | 5.53 | 1.17 | 2.04 | 1.61 | 11.00 |
| 2005 | 27.08 | 5.74 | 1.35 | 2.30 | 1.46 | 12.12 |
| 2007 | 28.53 | 5.27 | 1.39 | 2.93 | 1.68 | 12.23 |

Table 2.3 provides further information contained in the SLID about the severity and consequences of disability (of any type) for economic life. The means in this and the subsequent tables are detrended predictions from the 2002-2007 SLID cross-sectional file rather than raw weighted means, and reflect the incidence of disability as of 2007. The proportions in the first panel correspond to the subset of the population who are currently reporting a work-limiting disability, which under our definition means that they report that they are limited in work and work-related activities "sometimes", "often" or that they had a condition that "completely" prevented them from working in the reference year. Of these, about 42% report that their condition limits them "sometimes", and about half as many (21%) say their limitation affects them "often'. The remaining 37% report that their disability was severe enough to prevent them from working at all in the previous year.[5] Women are more likely than men to report having been completely prevented from working in the reference year.

The proportions in the middle panel of table 2.3 are taken over the subset of SLID respondents reporting a non-work ($h$ or $l$) limitation in a given year. Individuals are about somewhat more likely to report being "sometimes" as "often" limited in home- or leisure/other activities. As was also clear from table 2.1, among non-work limitations, individuals are slightly more likely to report a home than a leisure/other limitation while around two thirds of this population report having some incidence of both types of limitation. Slightly less than one half report at least one more-severe ("often") limitation in either home or leisure/other activities.

Finally, the last panel of table 2.3 reports some additional potential

[5]Since these responses come from different questions, some of the "completely" limited individuals also report that their condition limits them "sometimes" or "often". An affirmative answer to the complete-limitation response overrides either of the milder positive responses to the general work-limitation question. Consequently, the proportions in the three rows of panel 1 sum to one.

Table 2.2: Components of latent and limiting disability: by age and sex

| Men 20-45 (%) | Any | Latent | $n$-lmting | $h/l$-lmting | $n$ & $h/l$-lmting |
|---|---|---|---|---|---|
| 1999 | 12.09 | 3.21 | 1.00 | 1.51 | 6.36 |
| 2001 | 12.83 | 2.86 | 1.19 | 1.67 | 7.10 |
| 2003 | 13.96 | 3.19 | 0.93 | 2.34 | 7.49 |
| 2005 | 15.44 | 2.96 | 1.38 | 2.75 | 8.35 |
| 2007 | 15.99 | 3.16 | 1.49 | 2.66 | 8.68 |
| Men 46-70 (%) | Any | Latent | $n$-lmting | $h/l$-lmting | $n$ & $h/l$-lmting |
| 1999 | 27.04 | 7.11 | 1.03 | 3.71 | 15.20 |
| 2001 | 27.92 | 7.34 | 1.81 | 3.68 | 15.09 |
| 2003 | 32.04 | 7.92 | 2.13 | 5.01 | 16.98 |
| 2005 | 33.89 | 8.12 | 1.90 | 5.77 | 18.10 |
| 2007 | 31.97 | 6.15 | 1.73 | 6.67 | 17.42 |
| Women 20-45 (%) | Any | Latent | $n$-lmting | $h/l$-lmting | $n$ & $h/l$-lmting |
| 1999 | 13.18 | 2.92 | 0.84 | 1.91 | 7.51 |
| 2001 | 13.98 | 2.79 | 1.04 | 2.02 | 8.13 |
| 2003 | 15.97 | 2.48 | 1.03 | 3.23 | 9.23 |
| 2005 | 17.35 | 3.33 | 1.04 | 3.53 | 9.44 |
| 2007 | 17.11 | 2.30 | 1.16 | 3.61 | 10.04 |
| Women 46-70 (%) | Any | Latent | $n$-lmting | $h/l$-lmting | $n$ & $h/l$-lmting |
| 1999 | 28.33 | 6.10 | 0.89 | 5.09 | 16.26 |
| 2001 | 28.36 | 4.54 | 1.40 | 5.36 | 17.06 |
| 2003 | 31.59 | 5.14 | 1.43 | 6.76 | 18.25 |
| 2005 | 34.59 | 5.89 | 1.78 | 7.05 | 19.87 |
| 2007 | 35.16 | 4.87 | 1.92 | 8.41 | 19.95 |

effects of disability on economic life. The proportions are taken over the entire population reporting some kind of disability, whether latent or limiting, since positive responses are not limited to individuals reporting a current work-limitation. About 16% of the disabled sample, more men than women, reported having difficulty in changing jobs, which can have important consquences for the evolution of human capital over the life cycle. A smaller share—around 4%—expressed frustration at not being able to work as much as wanted due to their condition. Fewer than 0.5% of the currently-disabled population—more women than men—reported that they wanted to work fewer hours than they were required do to their condition.

Table 2.3: Components of limiting disability (2007)

| Component | All (%) | Men (%) | Women (%) |
|---|---|---|---|
| Limited in work sometimes | 41.70 | 44.38 | 39.42 |
| Limited in work often | 21.04 | 22.08 | 20.14 |
| Limited in work completely | 37.27 | 33.54 | 40.44 |
| Home-limited: sometimes | 48.78 | 47.96 | 49.42 |
| Home-limited: often | 39.51 | 39.09 | 39.83 |
| Leisure-limited: sometimes | 41.95 | 42.41 | 41.60 |
| Leisure-limited: often | 34.85 | 34.23 | 35.32 |
| Both home and leisure-limited | 65.08 | 63.68 | 66.16 |
| At least one h/l limitation severe | 46.19 | 45.63 | 46.61 |
| Difficulty changing jobs | 16.03 | 18.23 | 14.18 |
| Prevented from working more | 3.61 | 4.08 | 3.21 |
| Wanted to work less | 0.48 | 0.40 | 0.55 |

### Disability and demographics

Next, we disaggregate disability incidence, still by gender and age, along additional demographic lines: educational attainment ("high" and "low") and marital status (never married (NM), married (M), divorce/separated (D/S) and widowed (W)). Tables 2.4 and 2.5 report predicted (detrended) incidences of limiting (not home-, work-, or both) disability as of 2007, for men and women in their 20s, 30s, 40s, 50s and 60s.

In addition to trends we have already noted—slightly higher disability incidence rates for women and strongly increasing incidence in age—education also emerges as a strong predictor of disability incidence. Higher-educated individuals are less disabled in all age groups, with an average differential of around seven percentage points for men and women in their forties and fifties. Marital status is also an important predictor of observed disability for individuals between 30 and 60 of both genders. Both married men and married women between 30 and 60 are on average only 60% as likely to be currently disabled than their never-married or divorced counterparts. The effect of marriage appears to be equally strong for men and women and strongest for individuals in their 50s. Widows (omited for the under 30 groups due to small cell counts) are harder to compare because of the relatively small sample sizes of widows before age 60; typically, their incidences lie somewhere between married and never married/divorced individuals.

Table 2.4: Men: Incidence of disability by age and demographics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Age group 20-29 | | | | | | | |
| All men | | | | | | | |
| 0.095 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.103 | | | | 0.086 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.102 | 0.101 | 0.190 | | 0.084 | 0.084 | 0.173 | |
| Age group 30-39 | | | | | | | |
| All men | | | | | | | |
| 0.120 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.139 | | | | 0.110 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.169 | 0.122 | 0.172 | 0.012 | 0.142 | 0.096 | 0.145 | |
| Age group 40-49 | | | | | | | |
| All men | | | | | | | |
| 0.171 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.211 | | | | 0.143 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.302 | 0.175 | 0.253 | 0.260 | 0.245 | 0.118 | 0.196 | 0.201 |
| Age group 50-59 | | | | | | | |
| All men | | | | | | | |
| 0.243 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.280 | | | | 0.216 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.386 | 0.244 | 0.384 | 0.415 | 0.328 | 0.186 | 0.325 | 0.356 |
| Age group 60-69 | | | | | | | |
| All men | | | | | | | |
| 0.312 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.357 | | | | 0.264 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.463 | 0.335 | 0.452 | 0.341 | 0.373 | 0.245 | 0.361 | 0.251 |

### 2.3.2 Chronicity

The incidence measures reported above give us an idea of the cross-sectional patterns of disability in Canada; however, we can also exploit the longitudinal nature of the SLID to gain some insight into how disability affects

Table 2.5: Women: Incidence of disability by age and demographics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Age group 20-29 | | | | |
| All women | | | | | | | |
| 0.104 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.151 | | | | 0.072 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.148 | 0.151 | 0.197 | | 0.069 | 0.072 | 0.118 | 0.344 |
| | | | Age group 30-39 | | | | |
| All women | | | | | | | |
| 0.148 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.210 | | | | 0.122 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.270 | 0.181 | 0.297 | 0.231 | 0.184 | 0.095 | 0.212 | 0.144 |
| | | | Age group 40-49 | | | | |
| All women | | | | | | | |
| 0.213 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.240 | | | | 0.196 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.333 | 0.211 | 0.313 | 0.296 | 0.289 | 0.167 | 0.268 | 0.250 |
| | | | Age group 50-59 | | | | |
| All women | | | | | | | |
| 0.281 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.315 | | | | 0.247 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.426 | 0.277 | 0.449 | 0.420 | 0.351 | 0.202 | 0.374 | 0.345 |
| | | | Age group 60-69 | | | | |
| All women | | | | | | | |
| 0.343 | | | | | | | |
| Low ed | | | | High ed | | | |
| 0.354 | | | | 0.327 | | | |
| NM | M | S/D | W | NM | M | S/D | W |
| 0.398 | 0.309 | 0.507 | 0.402 | 0.369 | 0.281 | 0.479 | 0.374 |

individuals over a period of years, i.e. patterns of chronicity. The sample for the results reported below is taken from the SLID panel beginning in 2002 (with appropriate longitudinal weights) restricted to those individuals who are present in all six waves. We again analyze individuals by gender, educational attainment and marital status, with marital status taken as that reported in the final year of the panel (2007). We report predicted values from an ordered probit regressing the number of reports in the six year interval (ranging between zero and six) on age category dummies and dummies for education (high/low) or marital status (NM /M / D/S / W), as well as interactions between the age category and education/marital status dummies. The regressions are again performed separately by gender. Tables 2.6-2.9 collect results for men and women 20-44 and 45-69. Tables showing similar results for work-limiting disability, as opposed to all types of disability, are available from the authors.

For the most part, the trends in incidence reported above carry over to the analysis of chronicity. Women in the 25-44 (45-69) age group are 5.8% (3.3%) more likely than their male counterparts to report at least one disability and 3.1% (2.8%) more likely than men to report an active disability five or more times or more. Similar patterns hold for other age groups. Having more education reduces both the likelihood of reporting a disability at least once and reporting one in five or more periods. The negative effects of being married on the likelihood of having a disability, and of having a chronic disability, are especially striking, especially for women. Older women are roughly half as likely to report a disability in five or more periods than divorced women, and 60% as likely to report in five or more periods than never-married women. Married men are about 75% as likely to report a disability in five or more periods than comparable divorcees or never-marrieds. Widows fare very poorly, but this may be due to small sample problems; older female widows, for which we have the most observations, have chronicity experiences very similar to older never-married women, and slightly lower chronicity than older female divorcees.

Table 2.6: Age-adj chronicity by education, marital status: Men 20-44

| Frequency of reports (z) | All (%) | Low Ed (%) | High Ed (%) | NM (%) | M (%) | S/D (%) | W (%) |
|---|---|---|---|---|---|---|---|
| 0 | 66.8 | 62.0 | 69.2 | 63.0 | 68.2 | 67.8 | 29.3 |
| 1 | 13.6 | 14.7 | 13.1 | 14.5 | 13.3 | 13.2 | 16.1 |
| 2 | 6.3 | 7.1 | 5.9 | 7.0 | 6.1 | 6.1 | 10.4 |
| 3 | 4.0 | 4.6 | 3.6 | 4.5 | 3.8 | 3.8 | 8.1 |
| 4 | 3.5 | 4.1 | 3.1 | 4.0 | 3.3 | 3.4 | 8.9 |
| 5 | 2.9 | 3.6 | 2.6 | 3.4 | 2.7 | 2.8 | 9.7 |
| 6 | 3.0 | 3.9 | 2.5 | 3.7 | 2.7 | 2.9 | 17.6 |

Table 2.7: Age-adj chronicity by education, marital status: Men 45-69

| Frequency of reports (z) | All (%) | Low Ed (%) | High Ed (%) | NM (%) | M (%) | S/D (%) | W (%) |
|---|---|---|---|---|---|---|---|
| | 43.7 | 38.1 | 48.1 | 40.5 | 45.3 | 38.1 | 24.1 |
| | 16.4 | 16.4 | 16.4 | 16.6 | 16.5 | 16.2 | 15.1 |
| | 9.3 | 9.8 | 9.0 | 9.7 | 9.2 | 9.7 | 10.3 |
| | 6.7 | 7.3 | 6.3 | 7.1 | 6.6 | 7.2 | 8.4 |
| | 6.8 | 7.6 | 6.2 | 7.3 | 6.6 | 7.6 | 9.4 |
| | 6.8 | 7.9 | 5.9 | 7.4 | 6.5 | 7.9 | 10.8 |
| | 10.2 | 12.8 | 8.1 | 11.4 | 9.3 | 13.4 | 22.0 |

Table 2.8: Age-adj chronicity by education, marital status: Women 20-44

| Frequency of reports (z) | All (%) | Low Ed (%) | High Ed (%) | NM (%) | M (%) | S/D (%) | W (%) |
|---|---|---|---|---|---|---|---|
| 0 | 61.0 | 54.0 | 64.0 | 56.2 | 64.3 | 47.9 | 34.5 |
| 1 | 14.7 | 15.9 | 14.2 | 15.7 | 14.2 | 16.4 | 16.7 |
| 2 | 7.6 | 8.8 | 7.1 | 8.5 | 7.1 | 9.6 | 10.9 |
| 3 | 4.4 | 5.2 | 4.0 | 5.0 | 4.0 | 6.0 | 7.4 |
| 4 | 3.8 | 4.6 | 3.4 | 4.4 | 3.4 | 5.5 | 7.2 |
| 5 | 3.3 | 4.2 | 2.9 | 4.0 | 2.9 | 5.2 | 7.3 |
| 6 | 5.2 | 7.2 | 4.4 | 6.4 | 4.1 | 9.5 | 16.0 |

### Movement across disability types

Finally, table 2.10 provides some information on how individuals transition across disability types. The rows indicate current reported disability type and the columns indicate potential next-period reported type. The exact types of limitations imposed by a disability demonstrate some fluidity over time. Unconditional on a specific history of shocks, disabled individuals with a latent disability or with a single type of limitation are always most likely to transition back into the non-disabled state, and second most likely to remain in their current latent or limiting state (the diagonal). Multiple-limitation disabilities are stickier. In all states, however, the likelihood of reporting a *different* type of disability in the following period is also reasonably high, and typically, but not exclusively, involve moving from a latent or single-limitation to a multiple-limitation disability. (This basic result is similar for

Table 2.9: Age-adj chronicity by education, marital status: Women 45-69

| Frequency of reports (z) | All (%) | Low Ed (%) | High Ed (%) | NM (%) | M (%) | S/D (%) | W (%) |
|---|---|---|---|---|---|---|---|
| 0 | 40.4 | 37.8 | 42.8 | 33.1 | 45.5 | 27.6 | 33.0 |
| 1 | 16.5 | 16.6 | 16.5 | 16.4 | 16.7 | 15.5 | 16.5 |
| 2 | 10.3 | 10.5 | 10.1 | 10.9 | 9.9 | 10.9 | 11.0 |
| 3 | 6.7 | 7.0 | 6.5 | 7.4 | 6.3 | 7.7 | 7.5 |
| 4 | 6.3 | 6.7 | 6.0 | 7.3 | 5.8 | 7.9 | 7.4 |
| 5 | 6.3 | 6.7 | 5.9 | 7.6 | 5.5 | 8.5 | 7.6 |
| 6 | 13.5 | 14.7 | 12.1 | 17.4 | 10.3 | 21.9 | 17.1 |

Table 2.10: Transitions across disability types: All individuals

| | Non-disabled | Latent | Only $n$-lmting | Only $h/l$-lmting | Both $n$ and $h/l$-lmting |
|---|---|---|---|---|---|
| Non-disabled | 90.9 | 2.8 | 2.0 | 0.7 | 3.6 |
| Latent | 53.9 | 27.2 | 6.1 | 2.1 | 10.6 |
| $n$-limited | 48.3 | 7.4 | 19.6 | 2.1 | 22.6 |
| $h/l$-limited | 44.6 | 8.1 | 4.8 | 9.9 | 32.6 |
| $h/l$&$n$-limited | 26.7 | 4.2 | 6.6 | 3.2 | 59.3 |

all the demographic subgroups examined above, and disaggregated tables are omitted for space.) In a dynamic sense, this is consistent with the idea of disability as described by Nagi. The limitations imposed by specific impairments may change as individuals adapt to their conditions by developing new skills, tastes and associated optimal behaviour sets. Conversely, chronic disabilities can worsen over time imposing new limitations on economic life. In the next section, we try to shed some light on which of these effects dominates by exploring the longitudinal responses of and consequences to individuals experiencing disability in a 12-year window surrounding onset.

## 2.4 Longitudinal effects of disability: household responses and outcomes

We now turn to examine the economic responses to and consequences of disability among Canadian households over time. Our sample for this analysis combines the six-year 1999 and 2002 waves of the SLID, plus observations from the corresponding cross-sectional files for the years between 1999 and 2007. We restrict our sample to individuals who appear in the SLID at least four times, and we omit individuals who report a disability that was present at birth or manifested for the first time before the individual reached age 20. (Note that these eliminated individuals are mostly single and lower-educated.) We omit the official SLID weights from our longitudinal analysis, and instead use sampling weights that we construct to give representative samples of the disabled and control populations as discussed in the introduction and below. We examine households and individuals within a window lasting from two and more years prior to disability onset (the control group, augmented with a matched sample of individuals who never report a disability), until ten years following the first report of a disability. Since we obviously cannot follow a single household over the entire 13-year period, we derive the timing of disability from retrospective reporting on current (that is, currently active) conditions.

As discussed in the introduction, there are two obvious limitations with using retrospective data to pin down the timing of onset for individuals who report longer term disabilities. First we only receive retrospective reports from individuals experiencing recurrent conditions. Disabilities that pass quickly—those individuals who experience what [59] categorize as the "one-time", or "non-chronic" disability spells—are unlikely to be recognized as being part of the post-onset population at long durations from onset. Therefore, we only observe individuals whose disability is sufficiently chronic, which is an obvious source of negative selection at longer durations from onset. Second, even restricting the analysis to households with reasonably chronic disability, we may face selection bias if individuals observed at long durations from onset differ systematically from those for whom we observe earlier durations or for a number of years before onset for reasons other than the development of their disability. A third, related, problem is that the short panel dimension of the SLID makes it difficult to achieve adequate control groups for the analysis—in our case people two or more years before onset.

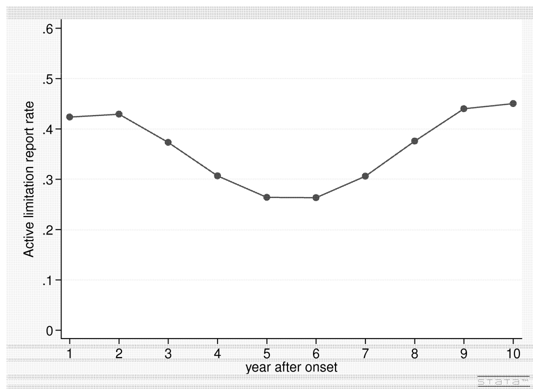
We address each of these potential problems facing our estimations before turning to our results. To deal with the the first and second (selection) problems, we use reweighting to create different chronicity-based subsets of the disabled population, similar to the subsets examined by [59]. We also re-weight the pre-onset population based on the predicted likelihood that they would show up in the specific post-onset sample in a different random sample of Canadians. We show that this chronicity-based reweighting is sufficient to eliminate major differences across year from onset based on a variety of observable characteristics of individuals such as blue-collar career status, education, and urban/region status. This gives us some confidence that it is also eliminating, or at least substantially reducing, differences across year-from-onset in terms of unobservables. Second, we use a nearest-neighbor propensity-score match to increase our pre-onset control groups and show that the matched control group differs significantly from the remaining never-disabled SLID population but not from the observed pre-onset population. We then turn to our results.

### 2.4.1 Creating chronicity-based disability samples

We conduct our analysis based on two disability subsamples that vary by the average chronicity, or frequency, of the reported disabilities. The first sample, which we call the "NPHS-All" sample, is created using information on economically-limiting disability from the first six waves of the National Population Health Survey (NPHS), the main longitudinal health survey in Canada. NPHS interviews are conducted only biannually and the questionnaire solicits limited information in labour supply and income relative to the SLID. However, the disability questions are fairly similar to those in the SLID questionnaire, allowing easy comparability across the surveys. More importantly, the current release of the NPHS has followed the same panel of individuals for six waves, or twelve years, from 1994 to 2006. Taking individuals who report a new limiting condition in the first two waves of the NPHS, we can therefore construct ten-year panels and estimate the recurrence rate of the disability—the likelihood of reporting an active limitation—in each year of the the decade following onset. This average recurrence rate for men by year from onset is plotted in figure 2.1. The rate of disability recurrence (either of the same or a new condition) falls gradually until five years after onset, and then begins to rise again as the subjects age. We re-weight the SLID post-onset sample to reflect these average recurrence rates at every post-onset year in order to approximate the entire post-onset population in the SLID.

The second cohort is our "chronic" cohort, designed to reflect the subset of the disabled population whose disabilities re-occur at a relatively high frequency. The average recurrence rate for the chronic sample is 65%, or nearly two out of every three periods. This is similar level of chronicity to [59]'s "chronic" groups from the PSID, and is akin to combining the "chronic severe" and "chronic-not-severe" groups defined by these authors. To create this group, we simply reweight individuals so that the average recurrence,

Figure 2.1: Average post-onset recurrence rate of active limitations




or active limitation, rate at each year from onset is 65%. Because the resulting analysis is based on relatively few individuals—especially when we disaggregate by demographic characteristics—we combine individuals into seven year-from-onset groups $\{-1\}$, $\{0\}$, $\{1,2\}$, $\{3,4\}$, $\{5,6\}$, $\{7,8\}$, $\{9,10\}$ for analysis.

As discussed above, a potential problem remains with both these disability subsamples—but especially the chronic group—that we may face selection based on the year from onset in which an individual is first observed. That is, an individual who reports an actively limiting condition that has lasted for many years at a given age is likely on average to differ in observable and unobservable ways from an individual who we first observe multiple years prior the onset of his first disability. To address this problem, we also reweight the pre-onset population (those individuals observed between three and zero years before onset) based on their predicted likelihood of being part of the post-onset population in the future. The probability is based on predetermined characteristics including age, education, marital status, parental education and province of residence, plus interactions of these characteristics.

Table 2.11 provides some evidence on selection from these reweighted samples of men, for both NPHS-All and chronic samples. The characteristics considered are (1) attainment of 13 years of education (at least high school); attainment of 16 years of education (typically high school plus a 4-year degree); (3) lives in a city of at least 500,000 people; (4) lives in one of the Atlantic province (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland); (5) works in a blue-collar occupation (primary industry, transportation or processing) in at least one observed period; (6) has been previously divorced. Table 2.11 show coefficients (standard errors) from a linear probability model in which we regress each of these potentially exogenous regressors on indicators for the period during the evolution of disability for which the individual is first observed: "early onset" ($k \in \{1, 5\}$), "later onset" ($k \in \{6, 10\}$), with "pre onset" ($k \in \{-3, 0\}$) as the omitted category. We also include as regressors a cubic of age and controls for the SLID panel from which the observation is drawn. The coefficients in general go in the direction we would expect—at higher years from onset individuals are less educated, live in smaller cities and poorer provinces and are more likely to be previously divorced. (The likelihood of being blue collar becomes negative at long durations from onset for the chronic group since much of the weight in this sample falls on individuals who do not work in any year and therefore report no occupation.) However, following our reweighting strategy, none of the coefficients for the NPHS-All sample are significantly different from zero at 5% confidence (denoted $**$). For the chronic sample, there is some evidence of negative selection effects for education, but they are relatively small and barely significant at 5%.[6] This provides some evidence that our reweighting procedure is doing a reasonble job of shutting down the confounding effects of selection on estimations of the economic effects of disability.

[6] As a robustness check we further adjusted the pre-onset samples by dropping some pre-onset individuals with high education. This had negligible effects on the results reported below.

Table 2.11: Changes in demographic characteristics by year from onset

| | Men: NPHS-All | | Men: Chronic | |
|---|---|---|---|---|
| | $\{1,5\}$ | $\{6,10\}$ | $\{1,5\}$ | $\{6,10\}$ |
| $\geq$ 13 yrs ed | $-.0199$ | $-.0217$ | $-.0213$ | $-.0436^{**}$ |
| | (.0128) | (.0196) | (.0152) | (.0219) |
| $\geq$ 16 yrs ed | $-.0196$ | $-.0148$ | $-.0173$ | $-.0353^{**}$ |
| | (.0103) | (.0166) | (.0122) | (.0169) |
| city $\geq$ 500,000 | $-.0185$ | $-.0147$ | $-.0112$ | $-.0106$ |
| | (.0126) | (.0199) | (.0149) | (.0214) |
| Atlantic province | .0154 | .0211 | .0037 | .0069 |
| | (.0103) | (.0162) | (.0127) | (.0185) |
| blue collar | .0170 | $-.0144$ | .0014 | $-.0523^{***}$ |
| | (.0127) | (.0196) | (.0022) | (.0151) |
| previously | .0150 | .0133 | .0184 | .0167 |
| divorced | (.0126) | (.0111) | (.0132) | (.0133) |

[a] ** denotes significance at 5%; *** denotes significance at 1%. Coefficients are predicted changes in likelihood; standard errors in parantheses

### 2.4.2 Creating control groups using propensity score matching

Ideally, we would like to choose as a control group for our longitudinal regressions all individuals $x$ or more years prior to disability onset and applying the weights discussed above. In previous U.S. studies, $x$ is typically set to four or five years. Unfortunately, the shorter panel length of the SLID does not allow us to follow individuals multiple years before onset. Instead, we keep as our control observations on individuals who are two and three years prior to onset, and we combine them with a group of individuals selected from the population of SLID respondents who do not ever report a disability. To draw an appropriate sample from the non-disabled population we use nearest-neighbor propensity score matching. Specifically, for both the NPHS-All and chronic groups, we match each individual at two years from onset in the "pre-disabled" group with an individual of the same age, education and marital status from the "never-disabled" group (the population that does not report a disability during the course of the SLID). Matching is performed based on other demographic and labour market characteristics, including self-assessed health, own and spousal participation and full time work status, region of residence, reported stress level, total household income, blue collar status, presence of children and interaction terms. All observations of a selected never-disabled individual over time are kept in the control group and are assigned the weight of the matched pre-onset observation for the longitudinal regression.

Table 2.12 shows the performance of the matching estimator for choosing a comparable control group from the never-disabled population for the NPHS-All male sample. The first column reports the estimated difference between the pre-onset and selected never-disabled controls for a series of economic and demographic characteristics. The second column reports the same differences this time between the pre-onset group and the full sample of men in the SLID who never report a disability. For both groups, the matched never-disabled sample is nearly identical in terms of labour market characteristics to the pre-onset group. However, the full never-disabled sample is significantly more likely to have more than a high school education and to be married; is slightly but significantly younger, has higher earnings, individual and household-level income, and fewer government transfers. There is not much evidence that hours or work or participation rates are lower for the pre-disabled population than for the general non-disabled population. This result contrasts with findings from previous studies based on U.S. data which in general find declining hours of work for the pre-onset population leading up to onset of a work-limiting disability.

Results for the chronic male workers are qualitatively similar. In each case, propensity score matching results in a set of never-disabled controls that do not differ in observable ways from the weighted pre-onset group. Using an expanded control group generally increases the precision, and hence significance, of the estimated coefficients reported in the next section relative to those estimated using only the pre-onset group. A control group is also necessary to fully identify year effects, since otherwise only post-onset individuals are observed in the last three years of the panel. However, as a robustness check we drop the matched controls and use only observed pre-onset individuals as the base group. Results from these regressions of are qualitatively very similar to those reported below and are omitted for space.

Table 2.12: Comparison of pre-onset and never-disabled SLID population

| Men: NPHS-All | Matched never-disabled | All never-disabled |
|---|---|---|
| Age | $-0.46$ | $-1.75^{***}$ |
| | $(-0.26)$ | (0.19) |
| Marital status | 0.01 | $0.09^{**}$ |
| | (0.01) | (0.04) |
| More than hs | 0.02 | $0.34^{**}$ |
| | (0.02) | (0.17) |
| Avg wkly hours | 0.37 | 0.29 |
| | (0.48) | (0.32) |
| Annual participation | 0.01 | 0.00 |
| | (0.01) | (0.00) |
| Avg wkly hh income | 13.07 | $51.73^{***}$ |
| | (9.98) | (9.52) |
| Avg wkly gov't transfer | $-1.74^{*}$ | $-4.41^{**}$ |
| | (1.87) | $(-1.22)$ |
| Avg wkly individual earning | 32.21 | $107.25^{***}$ |
| | (17.51) | (18.14) |
| Avg wkly spouse hours | 0.42 | 0.29 |
| of married | (0.58) | (0.40) |

[a] * denotes significance at 5%; ** denotes significance at 5%; *** denotes significance at 1%. Coefficients in both columns give differences—in the appropriate units—between the given never-disabled sample and the sample of mean observed -2 and -3 years from onset; standard errors in parantheses

### 2.4.3 Onset

Finally, this section briefly describes how we define disability "onset". For all individuals, onset is calculated based on the *longest duration* disability reported while the individual is active in the SLID. Individuals who report a new disability (that is, they report a condition that has lasted zero years and do not report a previous disability during the panel) are defined as being in year zero of onset, or "year of onset". Note that, because disability questions refer to a current condition (with interviews typically taking place in January following the reference year), new disabilities may have little or no effect on observed labour supply at onset. Roughly 85% of individuals are fully consistent in their duration reporting. Some inconsistency is natural, because individuals may suffer from different active limitations in different years of the survey. The most common type of inconsistency is for individuals first reporting a disability to report it having lasted one year, though they did not report it in the previous year. These individuals are coded as being one year from onset at the time of their first report. For later post-onset years, more than 95% of duration reports are consistent in the sense that if an individual has an active limitation for two consecutive years, and reports that it has lasted for eight years in the first year, he will report it having lasted nine years in the next.[7]

### 2.4.4 Longitudinal estimates

At the last stage—after sampling adjustments are made—our methodology adheres closely to [59]. We estimate using pooled OLS the following equation:

$$y_{it} = \alpha_i + \gamma_t + \kappa f(age) + X_{it}\beta + \sum_k \delta_k A_{kit} + e_{it} \tag{2.1}$$

where $X$ contains observation-specific information; $f$ is a cubic polynomial; $i$ indexes the individual or household; $k$; ranging from -1 to +10, represents the number of periods from onset of a disability; and $y$ is the economic variable of interest. Our main $y$s are hours of work, participation, hourly wage, before-tax income at the person- and household-level, and government transfers, in total and disaggregated by source. We also run, but omit for space, regressions analyzing additional aspects of saving behaviour and general well-being, including withdrawals from RRSPs, personal expenditures on medical care, and receipts from private pensions. We focus on men, and also estimate 2.1 by education category (whether or not the individual has a degree beyond a high school diploma), age (under 45 or 45 years and over) and by marital status (married or living with a common-law spouse, or not). For the latter disaggregation, we consider only individuals who do not change marital status over the four to six years we observe them. A few

[7] In some cases, individuals report a condition that first manifested more than one year earlier in the panel, though they did not report it in that earlier year. Again, while some recollection and interpretation is inevitable when dealing with self-assessed disability status, this is most likely a product of the snapshot nature of the most of the disability questions and the fact the conditions are most likely only reported if they are active at the time of the interview. The relatively comprehensive set of disability-based questions in the SLID, and the fact that there are no significant pre-onset drops in labour supply, give us confidence that we are able to capture the timing of onset reasonably well.

men report being unmarried but living with a spouse; we characterize these men as being married.

The vector $X$ contains regional indicators (representing Ontario, Quebec, the Atlantic provinces, or the Prairie provinces plus British Columbia), an indicator for living in a city of 500,000+, indicators for educational attainment (more than 13 and more than 16 years of education, or degree equivalent), indicators for aboriginal, immigrant and visible minority status, the annual provincial minimum wage, the number of people in the individual's household, his number of children, his marital status and dummies to indicate from which panel the observation is drawn. $\gamma_t$ is captured by a set of year dummies. Because of the short panel and the fact that we cannot observe pre-onset years for every observation, a standard within-effects estimator is not well-identified and, indeed, most of the sample variation is found between rather than within observations. However, we proxy $\alpha_i$ by adding the mean value of each control in $X$ taken across the years in the panel.

### Labour supply following disability onset

We begin by reporting how labour force activity changes for individuals following disability onset. Figure 2.2 presents the $\hat{\delta}_k$ from 2.1 for $k \in \{-1, +10\}$ and $y =$ average weekly hours of work.[8] The first panel shows results for all men in the NPHS-All and chronic samples. The second panel shows results disaggregated by marital status. The third panel shows results disaggregated by whether or not the man has the degree equivalent of 13 years of education. The fourth and bottom panel disaggregates the results by age: below 45 and 45 years of age and over. In the bottom three panels, the dotted line typically located above the $x$-axis plots interaction terms between the disaggregating characteristic (married, high education, under 45) and $k$ from a separate regression. In all the the figures, small dots indicate where the $\hat{\delta}_k$ is significant at 90% confidence and larger dots in dicated where the $\hat{\delta}_k$ is significant at 95% confidence. The standard errors for the all the results are clustered at the individual level.[9]

The figures indicate that labour supply is lower following after disability onset and the difference grows slightly for all men at later years from onset with, unsurprisingly, larger differences pre- and post-onset for the chroni-

[8] Tables corresponding to the figures are omitted for space but are available from the authors.

[9] The significance levels for essentially all the results are robust to clustering at a higher level of aggregation, such as the household.

cally disabled. The long-run difference for the NPHS-All sample is around three hours per week, or around 8% of average pre-onset labour supply. For the chronic group, the long-run drop is much larger, around 9.0 hours per week, or 23% of mean pre-onset labour supply. For both chronicity samples, the pre- and post-onset differences are smallest and least significant for high-educated men and for married men—between three and six hours per week with slight evidence of long-run recovery for high-educated men. Single men demonstrate the largest difference in labour supply pre- and post-onset, with an estimated long-run difference of around 12 (20) hours per week following disability onset for the NPHS-All (chronic) samples. The difference in responses between married and single, and high and low educated, are significant for both groups at most four and more years after onset. (The relatively small number of single men in the sample relative to the other groups makes significance harder to achieve for this group.) Both the older and younger samples work fewer total hours post-onset, with the total difference growing to around 9 hours per week; however, there is little evidence of systematically different responses by age.

The next two figures disaggregate the total labour supply changes into participation (extensive margin) and hours-or-work (intensive margin) responses. Figure 2.3 shows the post-onset difference in annual participation rates—the likelihood that the man works positive hours in a post-onset year. The pre- and post-onset differences are very large and persistent, reaching 10% in the pooled NPHS-all sample and 20% in the pooled chronic sample. Again, the effects are largest for single men (a total decline of 16% in NPHS-All and more than 35% in the chronic sample) and less-educated men (a total decline of 14% in NPHS-All and 30% in the chronic sample). This time, there also appears to be a difference across age groups, with older men's participation drops appearing more persistent than younger workers, with the difference between the age groups becoming significant around eight years post-onset. Interestingly, low-educated men, and to a lesser extent younger men, in the chronic samples appear to participate slightly more in the year just before onset relative to the control group, possibly because these groups are mostly likely to be subject to workplace injuries.

By contrast, conditional on working positive hours, the effects of disability on average weekly hours are small, with an average post-onset difference of between one and two hours per week for men who are employed at some point in the reference year, about 5% of pre-onset labour supply. Once again, the responses are larger and more persistent for single, low-educated and younger men than for married, higher-educated and older men. Other than single workers whose post-onset difference in hours worked is around five hours per week, the effects for all other groups are only spottily significant. Effectively, these intensive margin results suggest that responses to disability among Canadian men are concentrated on the participation (extensive) margin. A potential reason for this is that hours of work at any given job are inflexible, and men face large fixed costs from quitting a career job, as assumed in Chapter 4. However, as reported in Section 2.3 (table 2.3), relatively few men report wishing they could work *fewer* hours than currently possible due to a disability, providing some subjective evidence that nonconvexities in the hours decision is not a major determinant of the small intensive hours responses. Another possibility is selection: men with relatively low labour market attachment and few hours of work prior to onset are most likely to drop out of the labour force when confronted with a disability, leaving a pool of more attached workers post-onset. The selection story receives some support in the wage results reported below.

As a note of caution, in comparing responses to disability across subgroups, it is important to realize that differences arise both in the type or severity of the disability experience and because of differential responses to the same type or severity of disability shock. In section 2.3, we saw that the subgroups differ in the chronicity and type of their disabilities, with older, less educated, and single men having more chronic disability than younger, more educated and married men. These differences persist in the chronicity-adjusted samples. While it is difficult, and beyond the scope of this exercise, to disentangle the two components of the differentials in post-onset differences across demographic subgroups, we note that differences in chronicity at least are not sufficient to explain the patterns we observe. For example, older men report much higher chronicity of disability than younger men but exhibit similar differences between pre- and post-onset labour supply, while single men report much higher chronicity than married men (by about 8 pp or 17% in the NPHS-All sample) and also exhibit much larger post-onset differences in labour supply. As well, we note that the differential responses between the married and single, and between high and low education, sub groups do not disappear, and in fact in general become more defined, when we limit the analysis to a very high-chronicity group in which sub-sample differences are compressed.

We conclude this section by looking at the labour supply response of wives of married disabled men. Figure 2.4 plots the results for the NPHS-All and chronic samples. The top panel shows the total hours response of wives. The next two panels disaggregate total hours into extensive and intensive margin responses respectively. The last two panels show results, respectively, for a sample of wives restricted to those whose husbands identify as main earners in the first period the couple is observed, and spouses in opposite gender relationships (actually more than 98% of the sample of couples.) The plots show no evidence of an added worker effect. If anything, wives appear to work less in the year directly before onset and again to work less at very long durations from their spouse's onset, particularly in terms of their participation decision. The negative effect is stronger, and marginally significant, if we consider only the wives of main earner husbands, about 75% of the sample.

The lack of an added worker effect for wives whose husbands experience a spell of disability is consistent with previous U.S. evidence (see [28] or [26]). It is also consistent with the relatively small differences in husbands' labour supply following onset, at least in the NPHS-All sample. The added worker effect occurs because the couple experiences a negative wealth shock. If husbands do not reduce their work effort or significant suffer wage losses (see below) then theory does not predict that we should observe an added worker effect; nevertheless, the *reason* for the relatively small declines in labour supply for husbands with disabilities compared to unmarried men with disabilities remains at least partly unexplained; it is addressed in detail in Chapter 3.

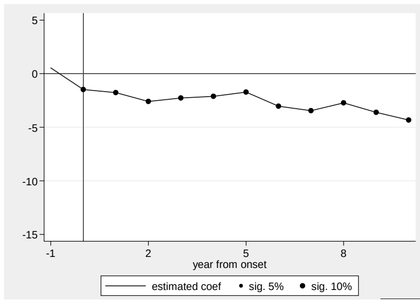
### 2.4.5 Disability and labour productivity

Figures 2.6 and 2.7 shows the evolution of ln hourly wages across years from onset, again disaggregated by chronicity of the condition and by demographics. Figure 2.6 shows differences in wages from an estimation of (2.1) with composite hourly wage from all jobs as the dependent variable, without any effort to control for selection into and out of the labour force. Figure 2.7 shows results from a regression in which we control at the first stage for the probability of observing a wage. In the selection regression, we assume that wages are a direct function of experience (current age minus the age the individual reports first having worked) plus education and a subset of other demographic controls in $X$. Additional variables used as predictors of participation at the first stage include number of children, household size and age—variables we expect to have no *direct* effect on the wage once we control for labour market experience.

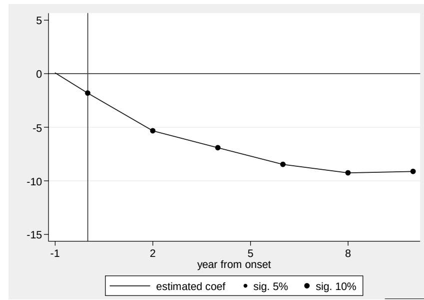
As expected, the unselected regressions give generally small and insignificant results. In the selection-adjusted regressions, however, wage differences are larger, more significant, and for some groups appear to be quite persistent. Single men face lower wages as the period of time from onset increases, reaching approximately a 12% difference from pre-onset wages by seven years post-onset for the NPHS-All sample, and 20% for the chronically disabled sample. More educated men experience larger proportional post-onset differences than less educated men, possibly because lower-educated men are more likely to be protected from wage losses by minimum wage legislation, and also because more educated men tend also to be younger. As shown in the bottom panel of figure 2.7, younger men—those under 45—are subject to surprisingly large, persistent, and strongly identified wage differences. At four and more years post-onset the average wage is only 85% and 90% of mean pre-onset wage for the chronic group. These drops appear to be disproportionate to the drops in hours worked of younger men. Since disabilities at ages prior to 45 are relatively unusual, the large wage effects may indicate that disabilities experienced by young workers are different than the type of disability experienced by more senior workers—for example, they could disproportionally represent work place accidents. This conjecture, however, is not strongly supported by the cross-sectional results, since, from table 2.2, the share of all limitations reported to affect work does not vary significantly between younger and older men.[10]

[10] To preserve degrees of freedom in our selection-controlled wage regressions, we do not include interaction terms for all years from onset. Instead we interact the demographic characteristic of interest with a cubic in time from onset. The dashed grey line plots the estimated difference over time from onset. Nodes indicate that the three interaction terms in the cubic function are jointly significant at 5%.

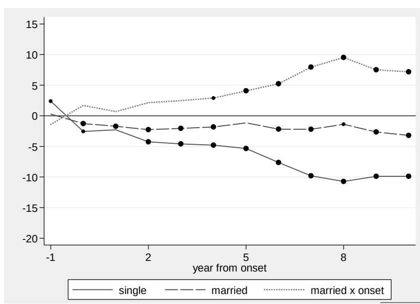
Figure 2.2: Average weekly hours following disability onset



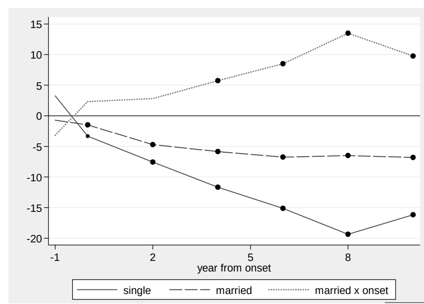

(a) All men, NPHS-All



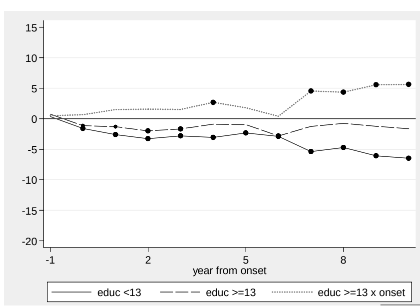

(b) All men, chronic



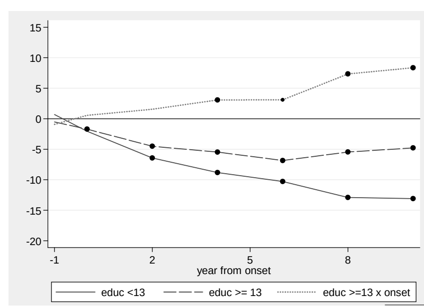

(c) Men by mar status, NPHS-All



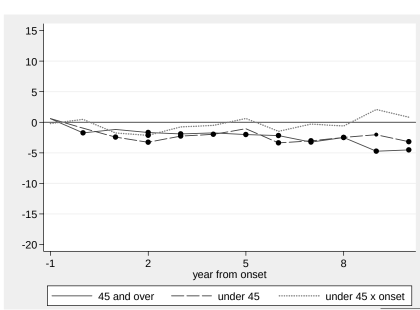

(d) Men by mar status, chronic



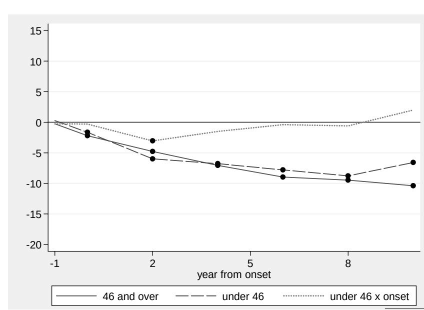

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

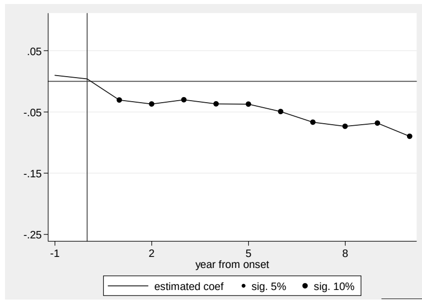



(g) Men by age, NPHS-All

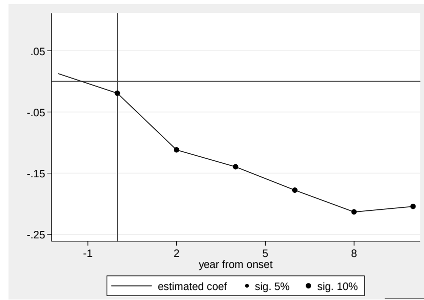



(h) Men by age, chronic

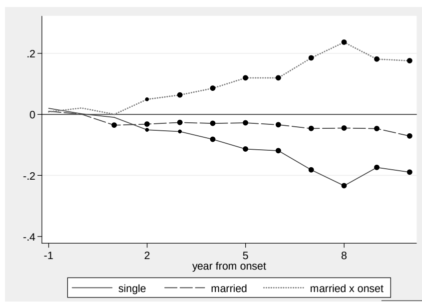
Figure 2.3: Annual participation following disability onset



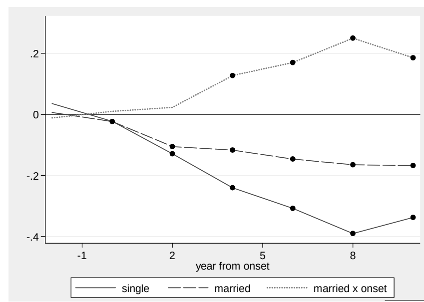

(a) All men, NPHS-All



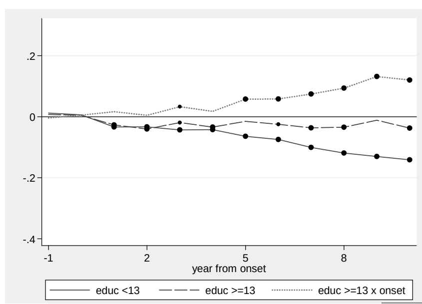

(b) All men, chronic



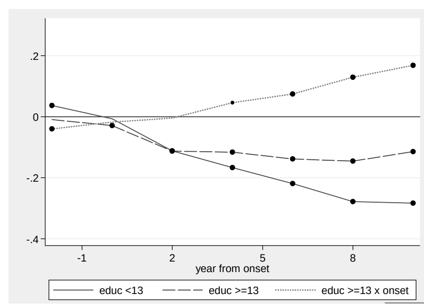

(c) Men by mar status, NPHS-All



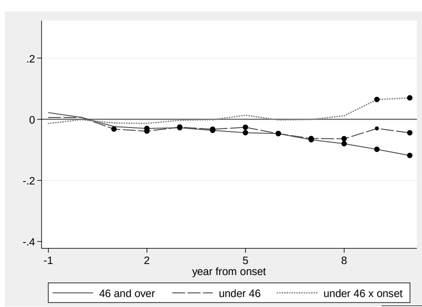

(d) Men by mar status, chronic



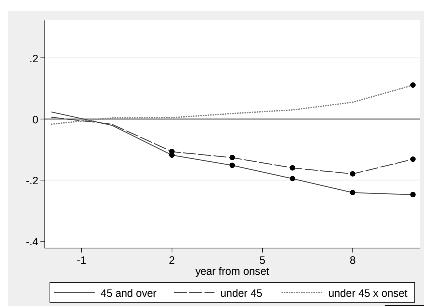

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

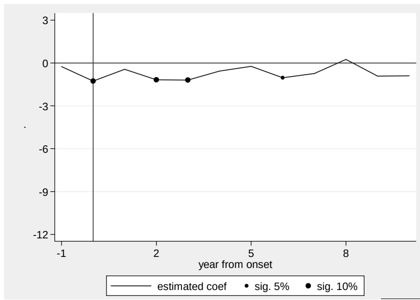



(g) Men by age, NPHS-All

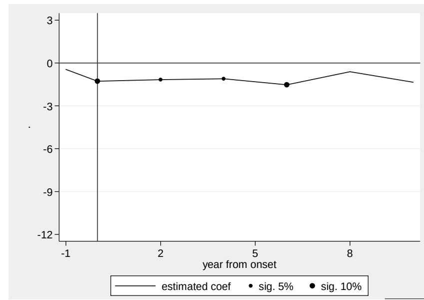



(h) Men by age, chronic

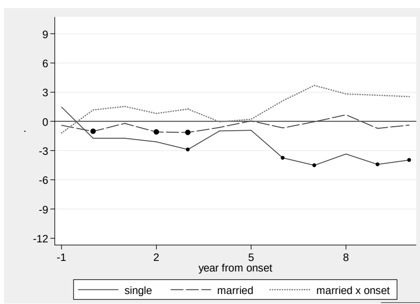
Figure 2.4: Average weekly hours of workers following disability onset



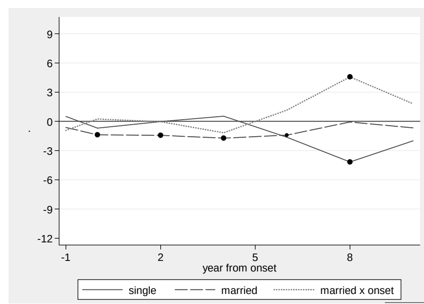

(a) All men, NPHS-All



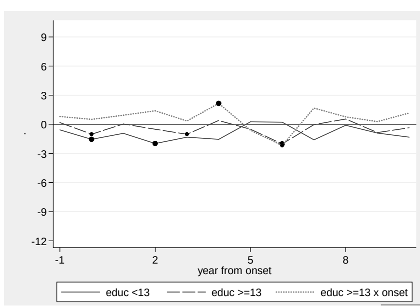

(b) All Men, chronic



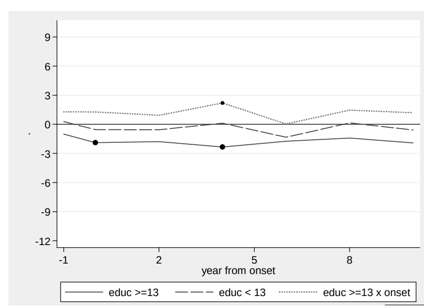

(c) Men by mar status, NPHS-All



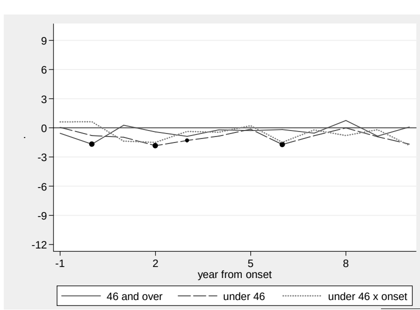

(d) Men by mar status, chronic



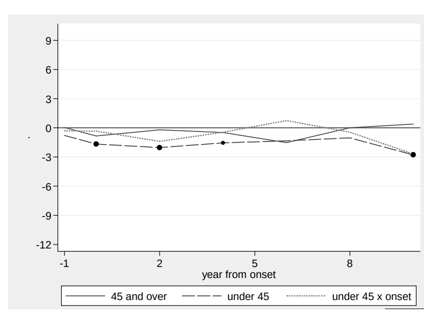

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

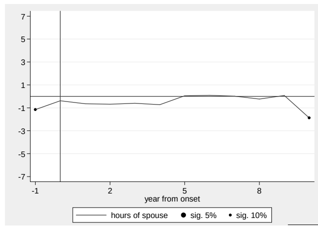



(g) Men by age, NPHS-All

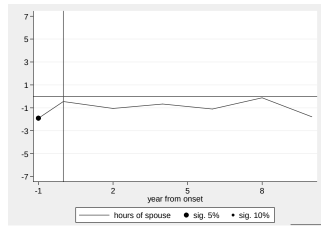



(h) Men by age, chronic

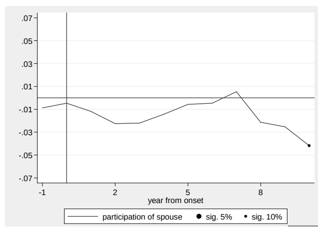
Figure 2.5: Labour supply of wives following husband's disability onset



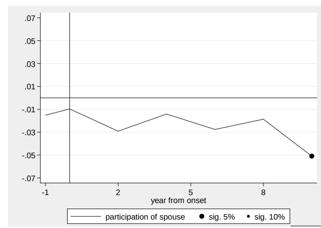

(a) Total hours, NPHS-All



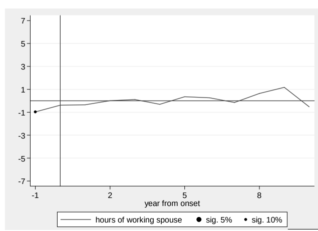

(b) Total hours, chronic



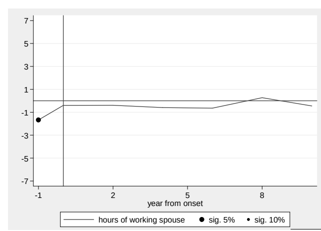

(c) Participation, NPHS-All



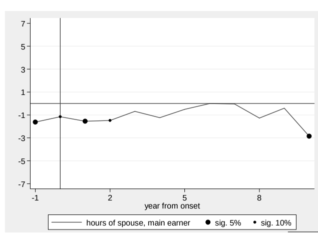

(d) Participation, chronic



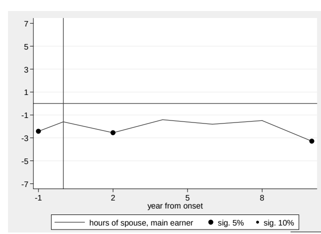

(e) Hours of workers, NPHS-All



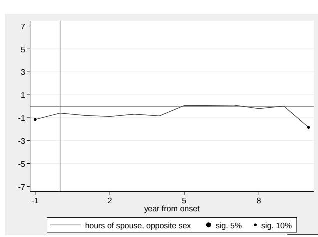

(f) Hours of workers, chronic



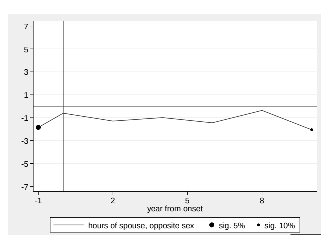

(g) Wives of mn earners, NPHS-All




(h) Wives of mn earners, chronic

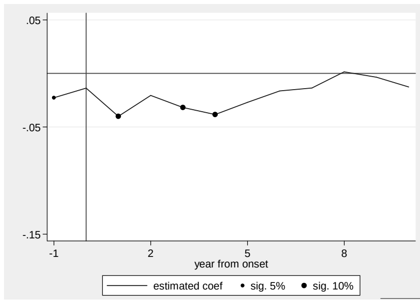



(i) Wives of opp sex, NPHS-All

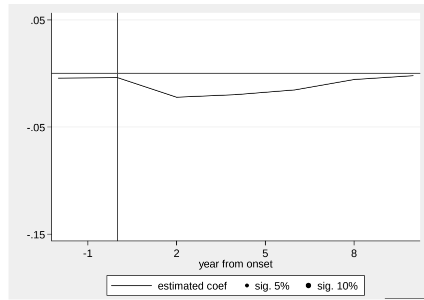



(j) Wives of opp sex, chronic

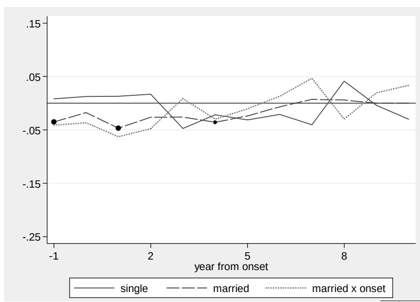
Figure 2.6: Hourly wage after disability onset (no selection controls)



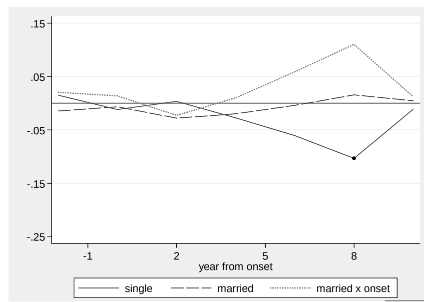

(a) All men, NPHS-All



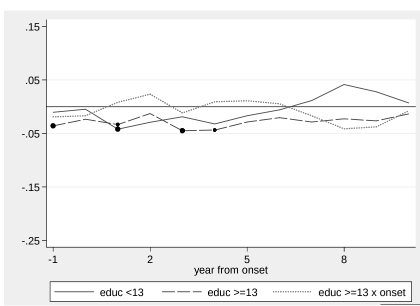

(b) All men, chronic



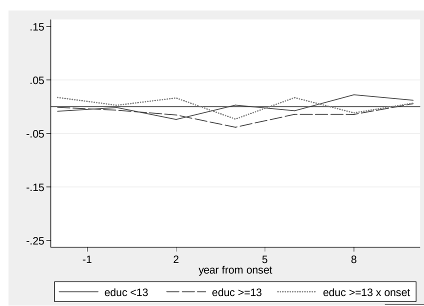

(c) Men by mar status, NPHS-All



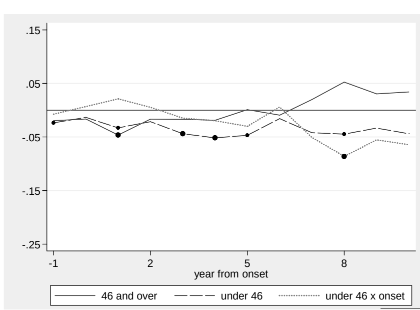

(d) Men by mar status, chronic



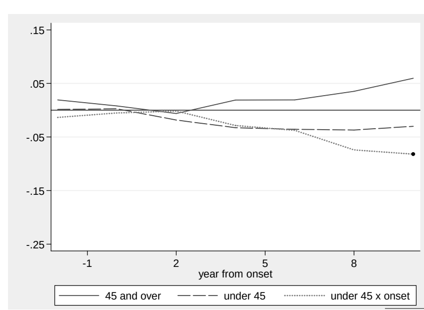

(e) Men by education, NPHS-All




(f) Men by education, chronic




(g) Men by age, NPHS-All




(h) Men by age, chronic

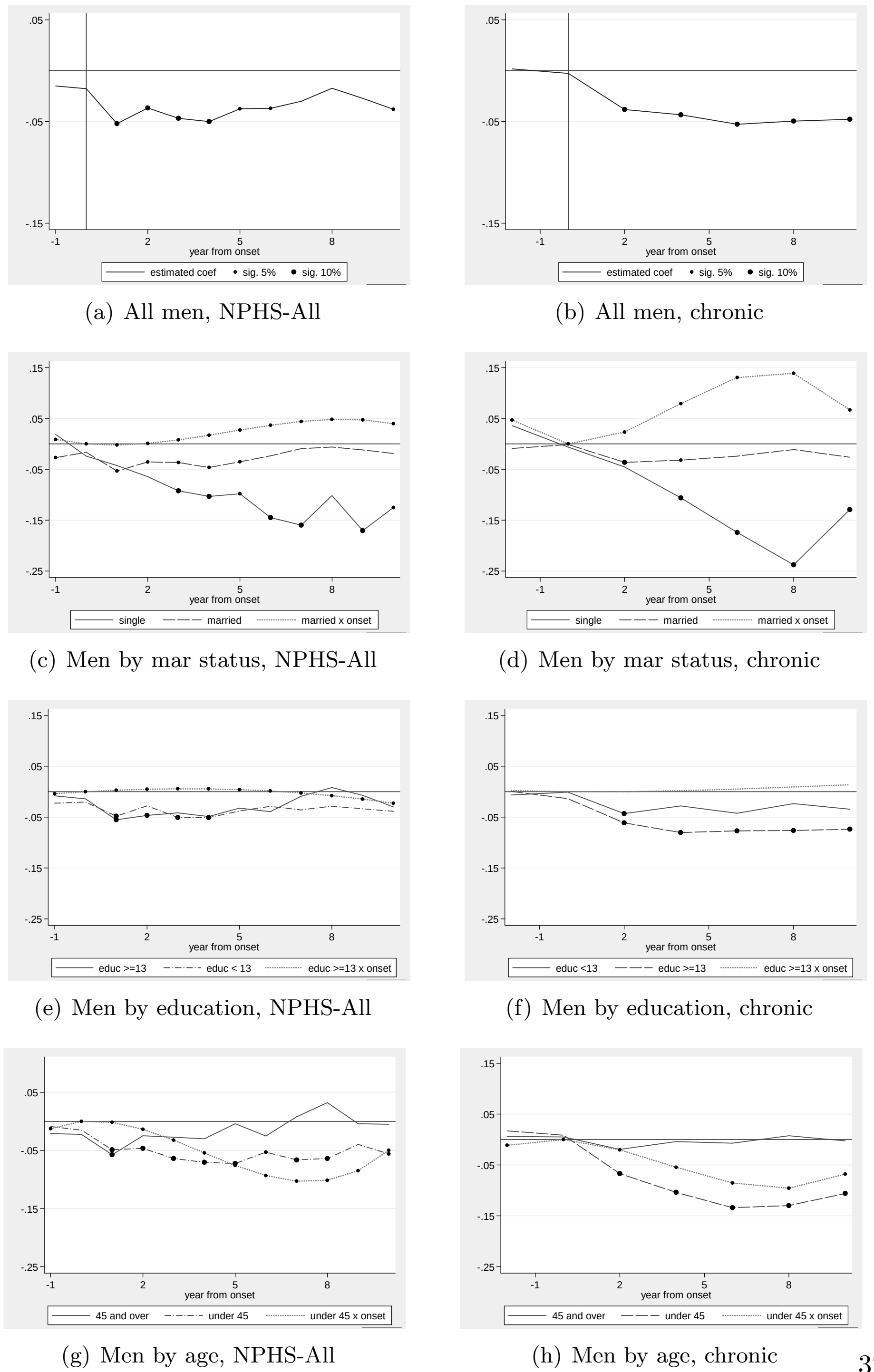
### 2.4.6 Income and transfers

How to the previous labour market results translate into differences in total personal and household income? Figures 2.8 and 2.9 plot differences in average weekly ln after-tax income (including transfers) for post-onset men for the NPHS-All and chronic samples. Figure 2.8 shows the path of ln weekly personal income and figure 2.9 shows the path of ln weekly household-level income. Consistent with the results reported above, income effects of disability onset are substantial, but in general are concentrated on specific subgroups of the disabled population. In the NPHS-All pooled sample, men experience an initial decline in personal ln income relative to the pre-onset group of about 10 ln points, which then climbs to close to zero ln points at longer durations from onset. This recovery holds for all groups with the notable exceptions of single men and younger men, whose declines in predicted income continue to increase with years from onset, reaching 30 ln points for singles and 15 ln points for marrieds. The income loss for men under 45 is consistent with the wage losses experienced by this group.

For the chronic group, pre- and post-onset personal weekly income differences, in percentage terms, are much larger and more persistent, leveling out at just over 20 ln points for the pooled sample. Differences across groups persist, however: the expected income loss of singles drops to over 50 ln points and approaches 40 ln points for lower-educated and younger men. Men 45 and older experience the smallest post-onset difference in income in the chronic group, around 15 ln points over the long run, and significantly smaller than the difference for younger men at more than 6 years after onset.

Income differences pre- and post-onset are smaller when aggregated to the household level, as can be seen from the top panel of figures 2.8 or 2.9, and by comparing any of the lower panels across 2.8 and 2.9. For the chronically disabled group, mean weekly household income is lower post-onset by about 10-15 ln points compared to 15-20 ln points at the individual level. While this mitigating effect holds for all men and for both chronicity groups, it is noticeably larger for lower educated men compared to higher educated men, and for married men compared to single men. Indeed, the significance of the difference in the change in ln weekly income (a noisy variable) between married and single men becomes quite a bit stronger at most post-onset years when ln weekly household income rather than ln weekly personal income is the dependent variable, as can be seen by comparing the left-hand middle panels of figures 2.8 and 2.9. Indeed, for married men in the NPHS-All sample, there is almost no significant post-onset income difference at all. Note this is consistent with the lack of added worker effect discussed

Figure 2.7: Hourly wage after disability onset (controlling for selection)




(a) All men, NPHS-All

(b) All men, chronic

(c) Men by mar status, NPHS-All

(d) Men by mar status, chronic

(e) Men by education, NPHS-All

(f) Men by education, chronic

(g) Men by age, NPHS-All

(h) Men by age, chronic

above. Even if wives' labour supply is theoretically sensitive to husbands' declining hours of work and earnings, the husband's pre-onset earnings form a relatively smaller share of total household resources, mitigating the wealth effect of his loss in earning power.

Figures 2.10 and 2.11 show the evolution of average weekly public transfers (in 2002 Cdn$) following disability onset at the individual and household level respectively. As wages and hours are smaller post-onset, public transfers play a role in mitigating the income and welfare losses of disability. Public transfers in general are not significantly above average prior to onset, but they rise immediately for the group observed at onset, and continue to climb over the ten year post-onset window. As we would expect, the chronically disabled receive relatively more transfers—reaching an average payment of $50 per week, close to one sixth of average pre-onset income, as compared to $30 a week for the NPHS-all group. Single men and low educated men receive more transfers than married and higher educated men, with the difference between the groups, and between pre- and post-onset transfers, becoming larger with reported duration of disability. The sample of men aged 45 and older receive only marginally higher transfers after onset than the sample of men under 45. This may reflect a tradeoff: given the nature of the Canadian safety net, benefits are generally more readily available to older than to younger workers. However, disability constitutes a larger negative shock on average for younger workers. Regardless, the net effect is that differences in outcome by age are small compared to the differences by education and by marital status.

Comparing individual-level to household-level public transfers in the top panels of figure 2.10, and between the lower panels in 2.10 and 2.11 shows little variation between changes in individual and household-level transfer receipts following disability onset. Disability benefits appear to be quite directly targeted to the disabled population. This finding is not surprising as Canadian policy safety net has few provisions that allow spouses or other household members to claim against a disabled non-dependent member.

Finally, figure 2.12 shows how total public transfers are divided across four major benefits affecting the disabled: Canada Pension Plan (CPP) benefits, Workers Compensation, provincial Social Assistance and Unemployment Insurance. The top panels report results for all the men in the NPHS-All and Chronic samples. The lower panels show the demographic break-downs as usual, using the larger NPHS-All sample.

From the figures, it is clear that, with the exception of single males who receive the majority of their post-onset transfer income from Social Assistance and eventually CPP, the largest payer in the NPHS-All sample is Workers Compensation (WC). WC payments are highest immediately after onset and then gradually decline in the cross-section, except for high-educated men, and chronically disabled men, whose WC benefits continue to rise modestly over the whole post-onset period. CPP payments follow the opposite pattern, starting off at low levels for men immediately after onset, and becoming larger for men with longer-term disabilities until they eventually make up the largest share of transfer income in the NPHS-All sample at ten years after onset. These patterns are consistent with the stated roles of workers compensation and CPP—the latter (mostly) to provide replacement income and rehabilitation services during relatively short-spell disabilities incurred in the workplace, and the former to provide permanent income replacement for men who are unable to work over the long run due to illness or disability, regardless of the nature of the disability and whether was a produce of work-related causes.

The last two types of benefit, Social Assistance and Unemployment Insurance (UI) play generally smaller roles.[11] Post-onset differences in total UI receipts are actually negative, reflecting the lower labour market attachment of individuals post-onset and the availability of alternative, disability-specific transfers for non-workers. This is consistent with evidence from [23] who find that Sickness Benefits under Canadian UI play almost no role in providing replacement income for the short- or long-run disabled. Social Assistance payments do appear to rise over time and eventually make up a significantly larger share of transfer income for both NPHS-All and chronic samples. However, the recipients of higher SA payments at long durations from onset are highly concentrated on the worse-off demographic groups: low-educated and single men who have the worst disability experiences, and men under 45. Since the Canadian benefit system in general is geared toward families and older Canadians, universal Social Assistance may one of the only transfers available to younger and unattached males who do not have access to Workers Compensation and whose CPP entitlements generate insufficient income.

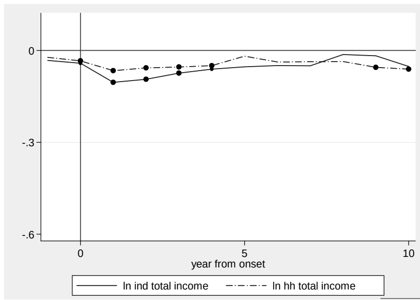
### 2.4.7 Additional sources of income

Another potential source of income for disabled men is private transfers—payments from family members in cash or in kind. In unreported regressions, we find that in fact there is a small, marginally significant difference in the

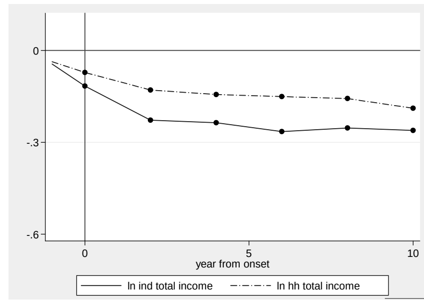
[11] In the SLID data, all Social Assistance payments are assigned to the wife in married households. I therefore assign husbands half of the reported Social Assistance of the Economic Family.

amount of, and likelihood of receiving, transfers from individuals outside the household in the initial years following onset but that effect appears to peter out at longer durations. The effect is not strong enough to disaggregate across groups. Private pensions are another potential sources of replacement income. We find that payments from private pensions are higher for men in the year directly after onset, particularly for older workers, but that these payments tend to peter out in the sample of men at later years from onset. We find ineligible changes in either the level or likelihood of withdrawals from an RRSP. We find significant but quite small increases in out-of-pocket medical expenses between the pre-disabled and post-disabled pooled populations, with the increase also disappearing at long durations from onset. We find no evidence that men who become disabled return to school (i.e. there is no difference the likelihood of being a full time student in any post-onset year). Finally, men are more likely to report having a high level of stress in their lives at the year of onset, but in no other post-onset years.

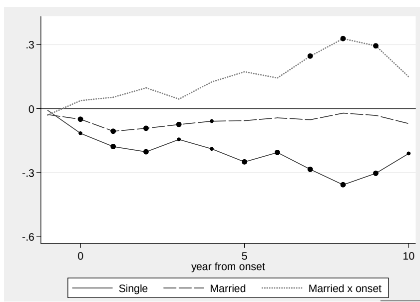
Figure 2.8: Total personal weekly income (ln) following disability onset



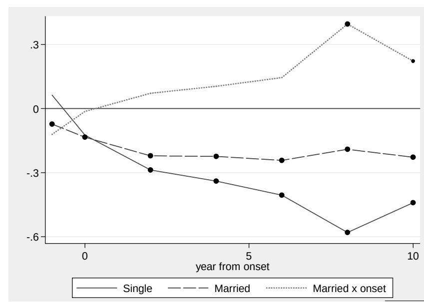

(a) All men, NPHS-All



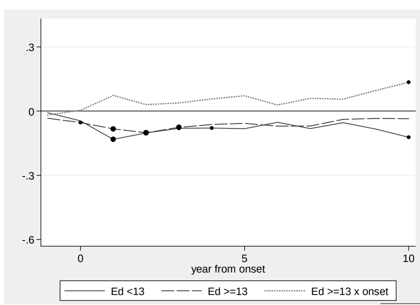

(b) All Men, chronic



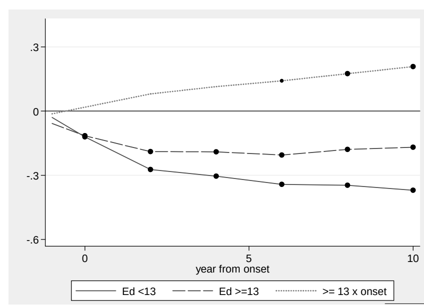

(c) Men by mar status, NPHS-All



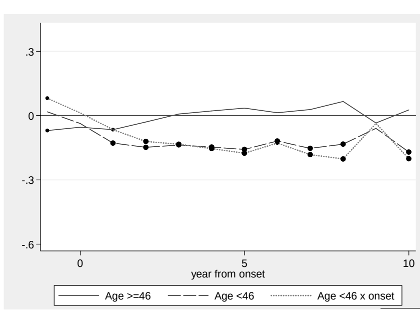

(d) Men by mar status, chronic



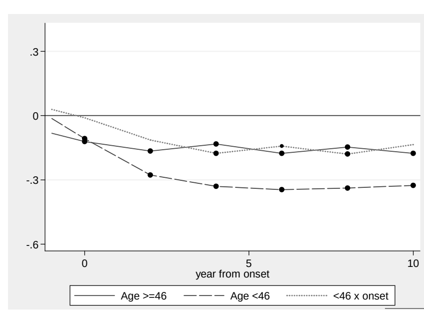

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

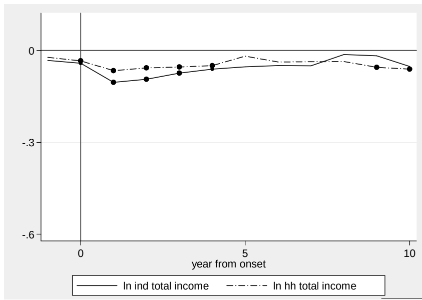



(g) Men by age, NPHS-All

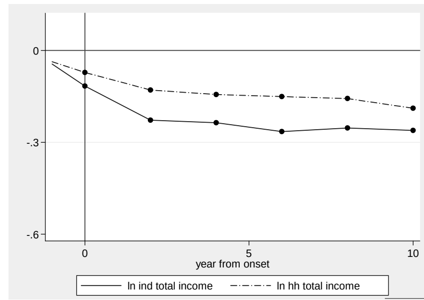



(h) Men by age, chronic

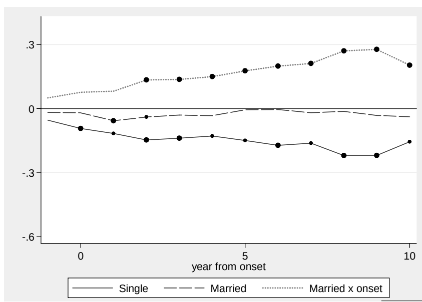
Figure 2.9: Total household weekly income (ln) following disability onset



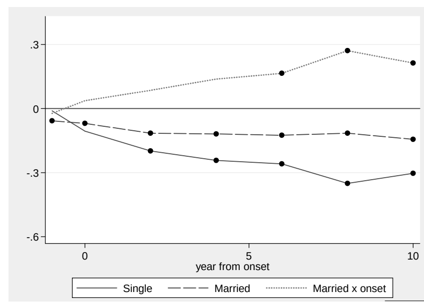

(a) All men, NPHS-All



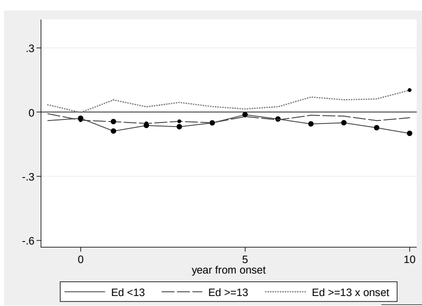

(b) All Men, chronic



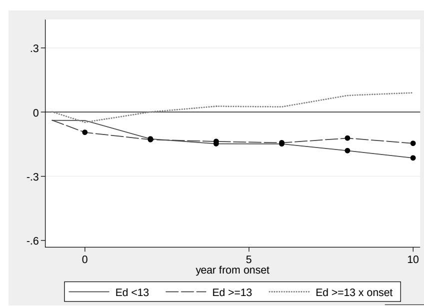

(c) Men by mar status, NPHS-All



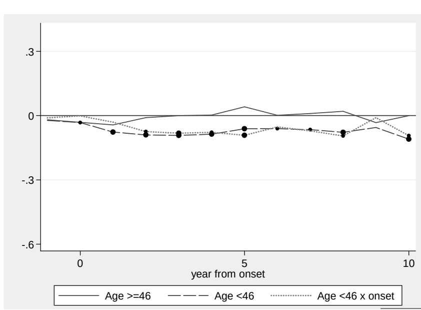

(d) Men by mar status, chronic



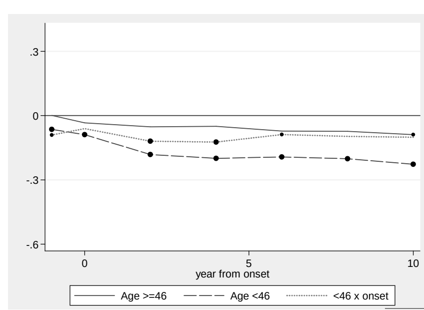

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

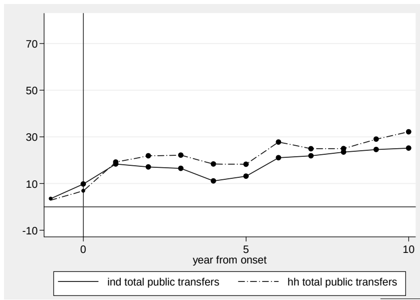



(g) Men by age, NPHS-All

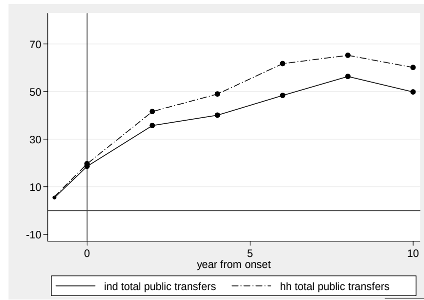



(h) Men by age, chronic

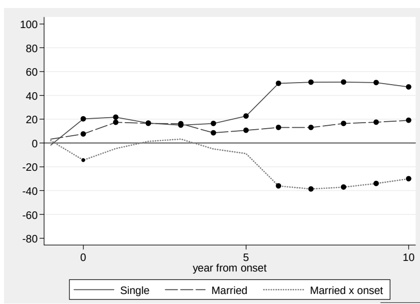
Figure 2.10: Total public transfers following disability onset



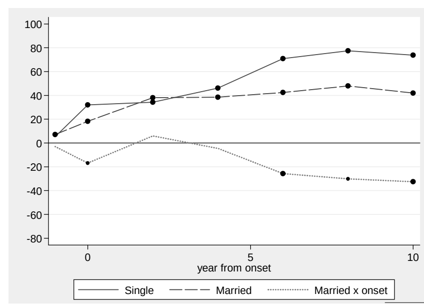

(a) All men, NPHS-All



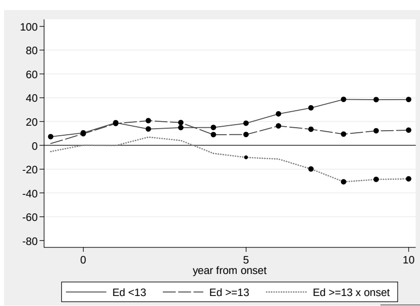

(b) All Men, chronic



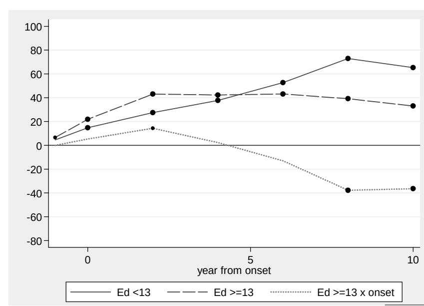

(c) Men by mar status, NPHS-All



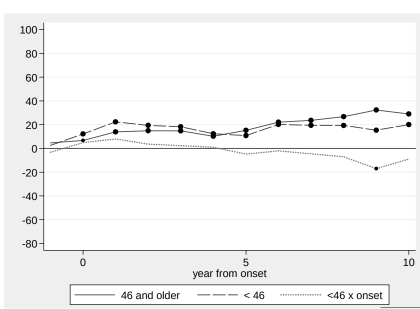

(d) Men by mar status, chronic



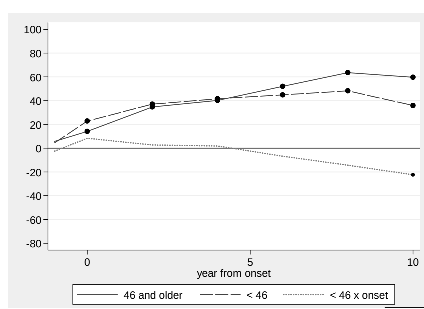

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic

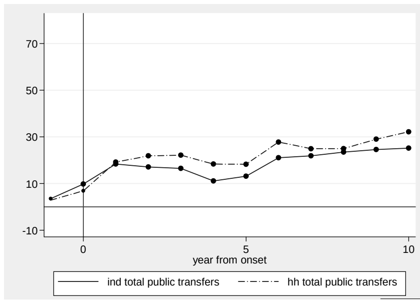



(g) Men by age, NPHS-All

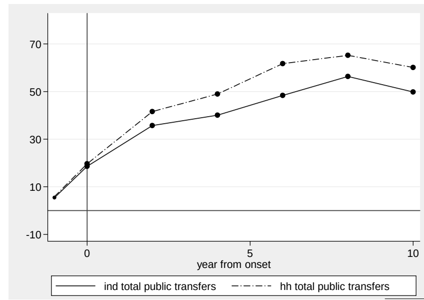



(h) Men by age, chronic

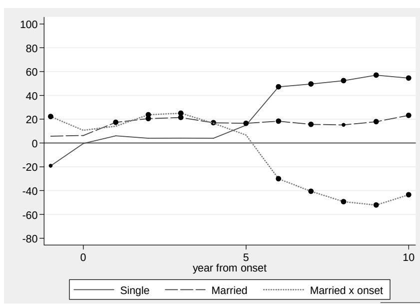
Figure 2.11: Total hh public transfers following disability onset



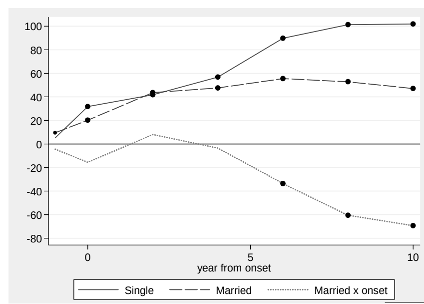

(a) All men, NPHS-All



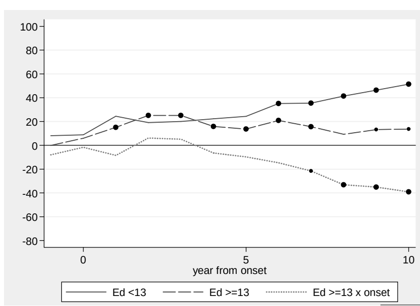

(b) All Men, chronic



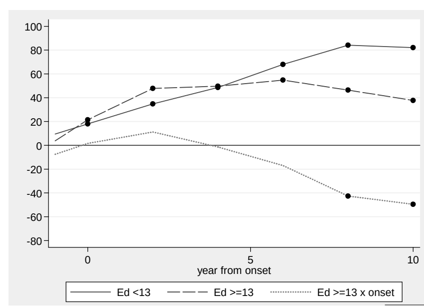

(c) Men by mar status, NPHS-All



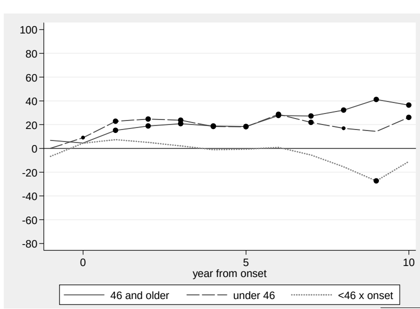

(d) Men by mar status, chronic



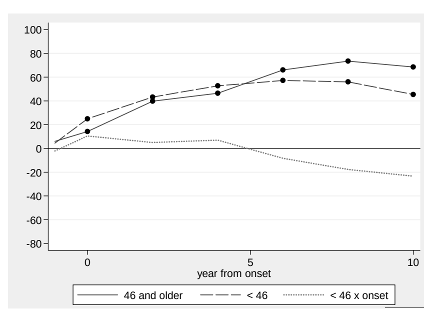

(e) Men by educ status, NPHS-All




(f) Men by educ status, chronic




(g) Men by age, NPHS-All



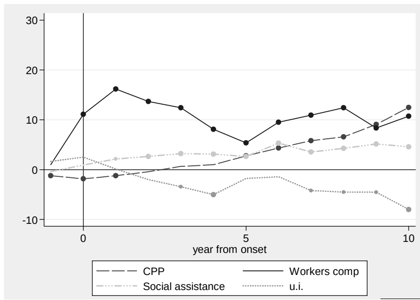

(h) Men by age, chronic

## 2.5 Conclusion

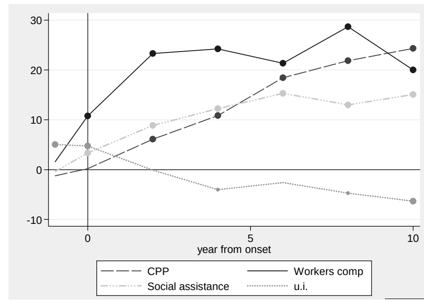
In this chapter we offer a descriptive overview of disability as experienced by Canadian individuals and households. We provide cross-sectional and longitudinal evidence on how men and their families cope with the onset of a disability and how the responses to and economic consequences of disability change over the duration of the disability. The results are largely consistent with previous U.S.-based descriptive studies of disability, with a few novel findings. Disability is very prevalent in Canada with nearly 30% of men and women over 45 reporting being currently limited in some facet of economic or physical life; however, only a subset (between 45% and 50%, depending on the year) of reported disabilities directly affect an individual's ability to work, the usual metric for a person to be classified as disabled in income studies such as the PSID. We also find large discrepancies among men of different ages, educational backgrounds and family structures in observed ability to cope with the onset of a disability. While the negative welfare impacts of disability appear to be concentrated on specific subgroups, the negative impacts of disability, in terms of participation, wages and income, are quite substantial for the population as a whole. In our NPHS-All sample, which approximates the "typical" post-onset experience of Canadian working-age males, long-run reductions in labour supply reaching about three hours per week or 8% for men between 25 and 60 while additional transfer payments per household with a disabled male member rise to about $1600 annually.

Focusing on differences across subgroups, the negative effects of disability for single men are particularly striking. In our NPHS-All sample, single males ten years after onset have personal incomes around 30% below the incomes of pre-onset single men and are around 20% less likely to be working. While we make a serious effort to eliminate confounding effects of selection (at least on observables) for men at different durations of disability, our estimates cannot fully inform us as to whether, and to what extent, the negative outcomes for single men are due mainly to negative selection effects (poor and unhealthy men are unlikely to marry or are more likely to divorce when a poor health shock is received) or to other factors, such as a lack of support from a spouse or other household members. In the next chapter we offer one potential explanation for our findings. A more complete investigation is left to future research.

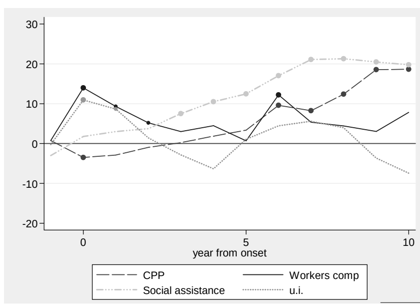
Figure 2.12: Type of transfers following regular and chronic disability onset



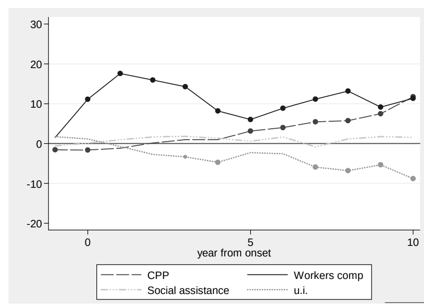

(a) All men, NPHS-All



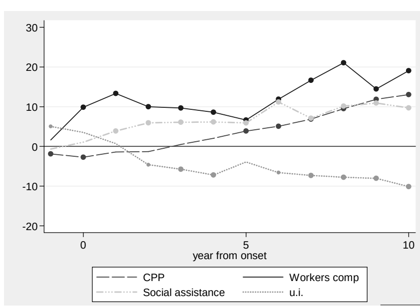

(b) All Men: chronic



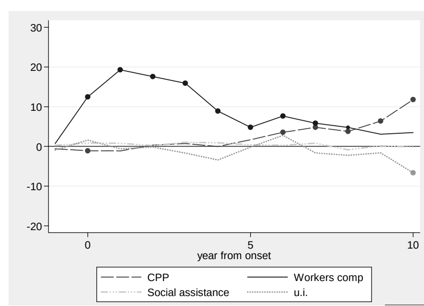

(c) Single, NPHS-All



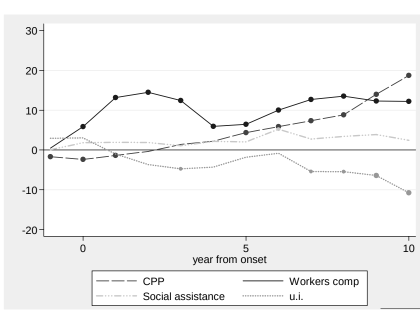

(d) Married, chronic



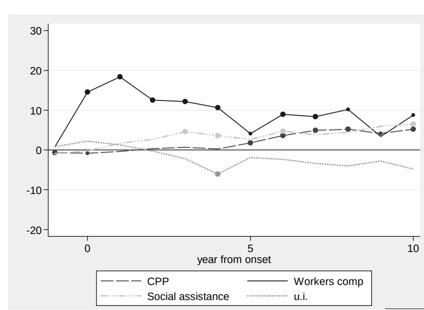

(e) HS or less, NPHS-All




(f) More than hs, NPHS-All




(g) Under 45, NPHS-All




(h) 45 and over, NPHS-All

# Chapter 3

# Household Responses to Individual Shocks: Disability and Labour Supply

Idiosyncratic risk is a pervasive feature of economic life and its measurement and effects have been the subject of extensive research.[12] In the incomplete markets literature, idiosyncratic shocks are often modeled as persistent perturbations to the wage process. This approach simplifies the statistical analysis of income risk but it also presents some shortcomings: it restricts responses to different types of idiosyncratic risk–e.g., job risk, wage risk and health risk–to be identical, and it does not distinguish the direct effect of a shock from the effects due to agents' optimal responses to shocks.[13] These limitations of the standard model become more apparent when looking at optimal behavior of families. Shocks are often experienced at the individual level; yet, responses to shocks may be determined at the couple, or even the household, level. Thus, the effects of idiosyncratic shocks on individual outcomes are partly the result of joint decisions which cannot be directly observed.

In this chapter we use micro-data information on disability shocks to investigate the way in which individuals and couples handle risk over the life cycle. We build on the existing literature on disability, which provides measures of the costs (in terms of income and labour time loss) experienced by households with a sick or disabled member.[14] Several studies document individual workers' responses to declining health or disability onset, with a focus on the incentives provided by disability insurance programs, as well

[12] Early contributions to the literature on idiosyncratic risk include [1], [32] [61], [3], [75], and [58]. The related literature on risk-sharing is extensive; see, just to cite a few, [44], [13], [4], [48], [67], [5], [38] and [46].

[13] An example is a protracted loss of human capital over time due to 'optimal' reductions in labour supply, following an initial, efficiency-reducing shock.

[14] See important contributions by [59], [25], [72] using U.S. data and [71] for Canada.

as the optimal responses of spouses–so called 'added worker effects'.[15] We report comparable evidence on the consequences of disability for Canadian households using data beginning with the 1999 wave of the Survey of Labour and Income Dynamics. Our analysis highlights two interesting facts: much larger long-run negative responses to disability onset by prime-age single men, relative to married men; and very small second-earner added worker effects. The latter finding confirms evidence from U.S. data on responses by female spouses of disabled workers.

These observed responses of individuals and couples are *not* consistent with a basic household decision problem. A dynamic household model with persistent efficiency shocks, or with a process of time-stealing disability, predicts that married men should *generally* work less than single men following one, or a series, of negative shocks. The reason for this is that the costs of negative shocks can be shared with the wife through changes in spousal leisure (added worker effects), while income pooling provides insurance and mitigates the wealth effect of the shocks. We find, however, that the standard model goes a long way towards explaining observed responses once two of its implicit assumptions are relaxed. First, we allow for dynamic human capital accumulation which provides a life cycle motive for agents' responses to health shocks. Second, we remove the restriction that intra-household transfers can occur only through income pooling (i.e. consumption transfers from higher to lower earner), allowing for optimal sharing of home-work and other types of 'non-labour, non-leisure' activities among spouses.

The interaction of a dynamic human capital motive with optimal intra-household time reallocation generates an effective mechanism for couples to handle disability shocks and helps rationalize the responses of single men, married men and spouses of married men. Dynamic complementarities between human capital accumulation and labour supply provide an incentive for households to support a disabled member in maintaining his original level of labour supply, especially when disability shocks limit a person's ability to perform tasks in the home as well as in the market.[16] We show that intra-marital task-sharing provides an effective mechanism through which this support can be provided. In the model with endogenous home production,

[15] Recent contributions based on American data include [19], [45], [7], [51], while contributions based on the Canadian experience include [23], [35], [22] and [14]. Recent work on the 'added worker effect' by [28] uses the HRS, while [24] uses the PSID. [72] examines longitudinal evidence of added worker effects following job displacement of husbands.

[16] We use a framework similar to that of [69], [40], [65] or [60], in which labour supply decisions – including reductions in labour supply due to disability onset – are dynamically linked to future wages.

households allocate home duties optimally as the solution to a wealth maximization problem, similar to the framework discussed in [43] and drawing on work pioneered by Gronau (1973,1977). A by-product of optimal home production is the ability of spouses to 'care' for each other during periods of time-stealing disability, through what are effectively intra-household transfers of time. The interaction of dynamic human capital motive and intra-household task-sharing produces life cycle behavior consistent with relatively smaller responses in married men' labour supply following a disability, and with the observed absence of added worker effect, as increases in wife's share of home production leave less time for her to work in the market. At the end of the chapter we provide micro-data evidence in support of this mechanism.

The layout of the chapter is as follows. In section 3.1 we introduce a basic life cycle model of the household, denoted as the 'workhorse' model, with and without an explicit process for disability. This model generates predictions – larger responses of married men to disability onset and added worker effects – which are inconsistent with data. Section 3.2 reports empirical evidence and documents observed responses. Section 3.3 presents the two simple extensions which characterize our unrestricted, or 'extended', model (denoted as model E): (i) a dynamic motive linking human capital accumulation and labour supply; (ii) intra-household insurance through channels other than consumption. We show analytically that these simple extensions can help explain the facts documented in section 3.2. Estimation and parametrization of the numerical counterpart of the model are also discussed. Section 4.4 presents simulation results, comparing the extended model to the workhorse model, and assessing the role of the dynamic human capital motive and intra-household transfers in shaping observed responses. Finally, we consider some extensions to check robustness of model's predictions and present additional data evidence supporting the empirical relevance of the intra-household time-sharing mechanism. Section 3.5 concludes.

## 3.1 A simple model and two puzzles

In this section we use a basic model to derive predictions about intra-household allocations in two simple economies: the first in which all individual-level risk is subsumed (and later estimated) as idiosyncratic wage shocks; the second in which an explicit disability process is included, in the context of evolving health over the life cycle. The disability process draws on information available in the SLID on the timing, chronicity, and economic effects of disability. The main features of the latter model carry over into the unrestricted model developed and estimated in Section 3.3. The basic model, with or without an explicit disability process, does a poor job of explaining dynamic responses of different types of household to health shocks.

### 3.1.1 A basic model of the household

Individuals are indexed by their gender $g$, each of them with current wage $w_g$. Wages change with observable characteristics $Y_g$ as well as with a random idiosyncratic shock, evolving as an AR(1).

In the first period of life a fixed share of men and women of similar age are matched. Couples engage in risk sharing by pooling their income, but no other transfers are allowed. Marriage and the evolution of family is effectively exogenous and couples do not optimize over dynamic family considerations such as fertility or divorce. This simplifying assumption is convenient given that the focus of this chapter is on understanding responses of agents of a *given marital status*, rather than marital status choices.[17] Nevertheless, we nest this simple model within a broader dynamic collective framework by assuming that matched couples bargain over a marriage contract (utility weight of wife) $\lambda$ in the initial period, with the weight remaining constant in subsequent periods. Any non-pecuniary attributes of marriage are residually captured by an additive utility parameter $\theta_g$.

In each period the choice variables are leisure $l$, consumption $c$, and carry-forward household assets $a'$. Individuals have gender-specific discount rates $\beta_g$, and age-, gender- and health-specific survival probabilities $\varsigma_g(j, X_g)$, shortened to $\varsigma_g$ for simplicity. With probability $p_{div}$ couples experience a (purely exogenous) divorce shock, in which case they separate and return to singlehood, each receiving assets $a_g^D$.

Denoting the expectation operator with respect to random shocks as $E(\cdot)$, a single individual at age $j$ solves the following dynamic optimization problem

$$V_{j,g}^S(X_g, a) = \max_{\{c,l,a'\}} u(c,l) + \beta\varsigma_g E[V_{j+1,g}^S(X_g', a'|X_g)] \tag{3.1}$$

For married individuals we define a household-level value function $U_j^H$ as follows:

[17] In related work we allow for endogenous marriage and separations to evaluate the changing risk-sharing value of marriage over the life cycle and, more generally, to address questions regarding the extent of risk-sharing and renegotiation in a limited-commitment environment.

$$U_j^H(X_f, X_m, a|\lambda, \theta_m, \theta_f) = \max_{\{c_f, l_f, c_m, l_m, a'\}} (1-\lambda)V_{j,m}^M + \lambda V_{j,f}^M \tag{3.2}$$

$U_j^H(\cdot)$ is the household value function for a husband and wife with state vectors $X_f$ and $X_m$, marriage contract $\lambda$ and residual non-pecuniary gains $\theta_g$ to each member. The individual value of marriage, for partner $g$ with spouse '$-g$' and household characteristics $X = \{X_g, X_{-g}\}$), is

$$\begin{aligned} V_{j,g}^M(X,a) = u(c_g, l_g) + & \quad \varsigma_g\varsigma_{-g}(1-p_{div})\beta_g E[V_{j+1,g}^M(X', a'; \lambda', \theta_g|X)] \\ + & \quad \varsigma_g(1-\varsigma_{-g}(1-p_{div}))\beta_g E[V_{j,g}^{'S}(X_g', a_g^D|X_g)] \end{aligned} \tag{3.3}$$

In equation (3.2) the individual value of marriage is imputed, rather than independently maximized, because the optimal levels of consumption, leisure and savings are determined at the household level as the solution to a planner's maximization problem given $\lambda$.[18]

### 3.1.2 Responses to disability in the basic model

A single individual of gender $m$ and age $j$ solves (3.1) subject to constraint set

$$\begin{aligned} \xi_1 &: (T - \overline{h}_m - l_m)w_m + (1+r)a + b(\cdot) = c_m + a' \\ \xi_2 &: l < T - \overline{h}_m \end{aligned}$$

[18]A matched couple determines $\lambda$ in the initial period of marriage by solving the following cooperative (Nash) bargaining problem:

$$\begin{aligned} \lambda^* &= \arg\max_{\lambda} S\,(j, a_f, a_m, X_f, X_m|\lambda, \theta_f, \theta_m) \\ &s.t. \\ &S(.) = \left[V_{j,m}^M(a_m + a_f, X|\lambda, \theta_m) - V_{j,m}^S(a_m, a_f, X)\right] \\ &\qquad\qquad \left[V_{j,f}^M(a_m + a_f, X|\lambda, \theta_f) - V_{j,m}^S(a_m, a_f, X)\right] \\ &V_{j,m}^M(a_f + a_m, X|\lambda, \theta_m) - V_{j,m}^S(a_m, a_f, X_m) \geq 0 \end{aligned}$$

Here, $S\,(\cdot)$ is the product of the partners' individual surplus from marrying, conditional on at least one partner's surplus being positive. Household-level assets at the time of marriage are equal to the sum of both members' privately accumulated assets. The $\theta$s are assumed sufficiently large that all matches result in marriage and no marriage ends in divorce. In the numerical section, the relative values of $\{\theta_f, \theta_m\}$ pin down the $\lambda$'s and, indirectly, the relative labour supplies of married vis-a-vis single men.

where $\xi_1$ and $\xi_2$ give the shadow values of the budget and time constraints respectively. For married couples the solution to (3.2) is subject to constraint set

$$\begin{aligned}&\xi_1 : (T - \overline{h}_m - l_m)w_m + (T - \overline{h}_f - l_f)w_f + (1+r)a + b(\cdot) = c_f + c_m + a^{'}\\ &\xi_{2a} : l_m < T - \overline{h}_m; \qquad\qquad \xi_{2b} : l_f < T - \overline{h}_f \end{aligned} \tag{3.4}$$

The function $b(\cdot)$ in the budget constraint captures all benefits and entitlements, net of taxes, to which single or married households have access, conditional on age, wealth, productivity and current labour market participation. $T$ is a fixed time endowment of weekly hours and $T - \overline{h}$ is the amount of disposable time an individual has left once 'non-labour, non-leisure' ($nll$) activities, such as errands or work at home, are subtracted. A final constraint is that $a \geq \underline{a}$, i.e. households cannot borrow beyond a given limit. The wage process is described as

$$\begin{aligned} w_m &= \frac{\exp(Y_m)}{\exp(\delta)}\\ \delta' &= \rho\delta + \epsilon; \qquad \epsilon \sim (0, \sigma_\epsilon^2) \end{aligned} \tag{3.5}$$

This wage process representation is common in the applied literature on dynamic labour supply. Positive realizations of the shock $\delta$ decrease productivity and negative realizations increase it.

Solving[19] (3.2) with respect to (3.4), differentiating the resulting first order conditions with respect to $\delta$, and substituting the change in marginal utility of wealth with the change in marginal utility of consumption for each spouse, gives the following uncompensated semi-elasticities of leisure $\mu_\delta^l$ and labour $\mu_\delta^n$ for the head ($m$) and spouse ($f$).[20]

$$\mu_\delta^{l_m} = -\frac{u_l}{u_{ll}} + \frac{\partial c_m}{\partial \delta}\frac{u_{cc} w_m \delta}{u_{ll}} \gtreqless 0 \qquad \mu_\delta^{n_m} = -\mu_{w_m}^{l_m} \gtreqless 0 \tag{3.6}$$

$$\mu_\delta^{l_f} = +\frac{\partial c_f}{\partial \delta}\frac{v_{cc} w_f \delta}{v_{ll}} \leq 0 \qquad \mu_\delta^{n_f} = -\mu_{w_m}^{l_f} \geq 0 \tag{3.7}$$

[19] We assume that $u_j > 0$, $u_{jj} < 0$, $v_j > 0$, $v_{jj} < 0$, and Inada conditions hold, where $j \in \{c, l\}$. For analytical convenience we focus on preferences for which $u_{jk} = 0$, i.e, consumption and leisure are separable. Here we assume interior solutions for labour, that is, we solve the Lagrangian in which $\xi_2 = 0$.

[20] We report semi-, or more accurately lin-log, elasticities because, both in the data and numerical analysis, we focus on changes in observed levels of hours worked following a percentage change in the shock.

For main earners the uncompensated wage elasticities can be decomposed into the usual substitution (the first term) and wealth (the second term) effects, while for the spouse a husband's disability imposes a pure wealth effect.

Comparing married to single men's own responses, a crucial implication is that wealth effects should in general be smaller for marrieds. Analytically, this is because the consumption loss resulting from the same drop in effective resources of a married man is shared among two people, diluting the total utility loss given concave preferences. This implication is strengthened further by the fact that married households, in both the U.S. and Canada, typically higher per-capita wealth than single households and by the fact that, in our data, single men between 23 and 60 work an average of 5 hours per week less than prime-age married men. Given preferences that are separable in consumption and leisure, with utility of leisure equal to $\gamma\frac{l^{(1-\psi)}}{(1-\psi)}$, we get $\mu_{\delta}^{n_m} = \frac{l_m}{\psi}(-1 + \frac{kw_m\delta l_m^{\psi}}{\gamma})$, for given $k = \frac{\partial\xi_1}{\partial\delta} > 0$. This expression is increasing in the level of pre-onset leisure. Since disability induces declines in $n$, single men who choose a higher level of leisure when healthy should exhibit smaller drops in labour hours, even after controlling for differences in shadow values of wealth across marital states. In summary, comparative statics suggest that:

1. other things constant, married men should experience larger reductions (or smaller increases) in labour supply following negative efficiency shocks, such as disability.

2. an 'added worker effect' should be present, conditional on the shock being partly unexpected and large enough to change a household's perception of permanent income.

These predictions are at odds with the empirical evidence presented in the next section.

### 3.1.3 Adding disability to the work-horse model

The counterfactual predictions outlined above might be due to a coarse representation of idiosyncratic risk as pure wage shocks. However the predictions of the 'workhorse' model are robust to the introduction of a finer representation of risk through the explicit modeling of disability shocks. Drawing from information available in the SLID, disability in our model takes two forms: 'labour limiting' and 'home-limiting', denoted as $\delta_n$ and

$\delta_h$, respectively. These $\delta$ shocks are modeled as multiplicative factors 'stealing' time from individuals by increasing the amount of total time required to complete a given amount of market or home work. When $\delta_n = \delta_h = 1$, the main earner is healthy.[21]

Time-stealing disability affects the household period budget constraint ($\xi_1$) as well as the husband's feasible time constraint ($\xi_{2a}$). The effects are described in figure 3.1 for the case of a $\delta_n$ shock. As long as an interior solution for leisure is optimal, a positive $\delta_n$ shock operates exactly like a negative wage shock, by rotating the household budget constraint inward along the x-axis (consumption). However, unlike a wage shock, a $\delta_n$ shock has the additional effect of rotating inward the feasible time frontier between labour and leisure, along the y-axis (labour).[22]

Under the assumption that disability shocks affect only the husband, the couple's constraint set (3.13) becomes

$$\begin{aligned}
&\xi_1 : \frac{(T - \delta_h \overline{h}_m - l_m)}{\delta_n} w_m + (T - \overline{h}_f - l_f) w_f + (1+r)a + b(\cdot) = c_f + c_m + a^{'} \\
&\xi_{2a} : l_m \leq T - \delta_h \overline{h}_m; \qquad \xi_{2b} : l_f \leq T - \overline{h}_f \qquad (3.8)
\end{aligned}$$

Solving this system and differentiating the first order conditions[23] with

respect to $\delta_n$ and $\delta_h$ gives the following uncompensated own (married and single) and spousal semi-elasticities:

$$\mu^{l_m}_{\delta_n} = -\frac{u_l}{u_{ll}} + \frac{\partial c_m}{\partial \delta_n} \frac{u_{cc} w_m}{u_{ll}} \gtreqless 0 \qquad \mu^{n_m}_{\delta_n} = -\frac{\mu^{l_m}_{\delta_n}}{\delta_n} - n_m \gtreqless 0 \quad (3.10)$$

$$\mu^{l_m}_{\delta_h} = \frac{\partial c_m}{\partial \delta_h} \frac{u_{cc} w_m \delta_h}{u_{ll} \delta_n} \leq 0 \qquad \mu^{n_m}_{\delta_h} = -\frac{\mu^{l_m}_{\delta_h}}{\delta_n} - \frac{\delta_h}{\delta_n} \overline{h}_m \gtreqless 0$$

$$\begin{aligned}
\mu^{l_f}_{\delta_n} &= \frac{\partial c_f}{\delta_n} \frac{v_{cc} w_f \delta_n}{v_{ll}} \leq 0 \qquad & \mu^{n_f}_{\delta_n} &= -\mu^{l_f}_{\delta_n} \geq 0 \qquad (3.11) \\
\mu^{l_f}_{\delta_h} &= \frac{\partial c_f}{\delta_h} \frac{v_{cc} w_f \delta_h}{v_{ll}} \leq 0 \qquad & \mu^{n_f}_{\delta_h} &= -\mu^{l_f}_{\delta_h} \geq 0
\end{aligned}$$

[21] The notion of disability as stealing time from individuals is fairly common in the health literature: see, for instance, [10] or, more recently, [49].

[22] The effect of a $\delta_h$ shock would shift the budget line inward, parallel to the original line.

[23] The FOCs for the problem with disability are

$$(1-\lambda) u_l = \xi_1 \frac{w_m}{\delta_n}; \qquad \lambda v_l = \xi_1 w_f \qquad (3.9)$$

.

These semi-elasticities are similar to (3.6)-(3.7) in the single-shock model with two exceptions. First, there is no substitution effect present in the elasticities for home-limiting shocks $\mu_{\delta_h}$, since a $\delta_h$ shock simply increases the time-cost of $\overline{h}$ without affecting the relative time-costs of work and leisure. Second, there is now an additional term in the semi-elasticities of labour $\{\mu_{\delta_n}^{n_m}, \mu_{\delta_h}^{n_m}\}$: the 'time loss' effect, capturing the restriction imposed by the disability in the husband's feasible allocation of labour and leisure, as described in the second panel of figure (3.1). This time loss effect should obviously drive down the labour supplies of all disabled men. However the predictions documented in Section 4.2 still come through: relatively larger negative labour supply responses for married men and added worker effects.[24]

A few caveats are in order: first, data suggest that married and single men have different processes for health risk, which may result in different responses to disability shocks; second, prime-age married couples and unattached individuals (who typically have lower resources) may face different replacement rates for benefits. In Section 4.4 we use numerical simulations to show that these effects are not sufficient to reverse the predictions from the basic models discussed above. In particular, the larger labour supply drops of single men cannot be fully accounted for through differences in benefits or health risk alone.[25]

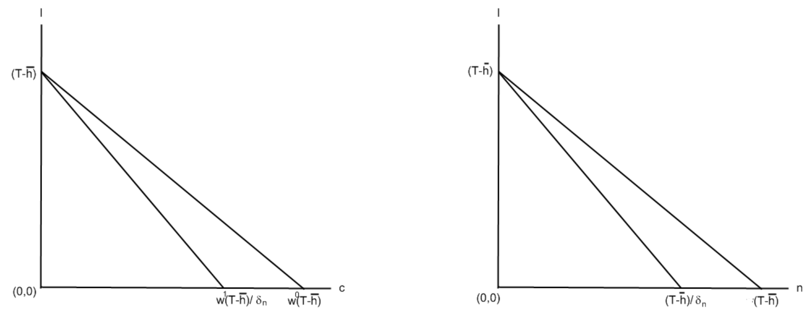
## 3.2 Responses to disability: Empirical evidence

The main data source for this study is the Canadian Survey of Labour and Income Dynamics (SLID), a longitudinal survey of Canadian Households maintained by Statistics Canada. The SLID follows a sample of about 8,500 households per wave, for a period of up to six years, with the majority of income data taken directly from tax records. A new wave begins every three years, so two waves are always active. Compared to other income panel studies, the SLID contains very detailed information about disability and its direct consequences on economic life. The relative richness of these data allows us to develop a more sophisticated model of the effects of disability than would be possible using the basic work-limitation measures available

[24] As discussed later, Canadian time use data suggest that married men have slightly higher level of $\overline{h}_m$ than single men. Thus, the time loss effect of a $\delta_h$ shock—and hence the expected reduction in hours worked—should be higher for married men, confirming the predictions of this section.

[25] Differences in health risk might be the result of sorting and transfers associated to endogenous marriage selection. We study these issues in related work.

Figure 3.1: Disability and household optimality constraints




(a) labour-limiting disability: Household budget

(b) labour-limiting disability: Feasible time allocation

in the PSID.

Our measures of disability are constructed from responses to a series of questions in the SLID disability module.[26] We classify disability into three broad types. Disability is denoted as 'latent' if it limits physical activity but does not directly limit activity at work, home or in other occupations. Disability is 'work-limiting' if it limits the respondent at work or in other work or human-capital based activities such as school or job-search.[27] Finally, disability is 'home-limiting' if the individual reports being limited in home-based or other non-work activities such as transportation or leisure. Table 3.1 reports the incidence of disability by type in 2004 for individuals aged 20-44 and 45-69 (the ages for which all types of limitation are reported).[28] More than half of all reported disabilities are both work- and home-limiting, while relatively few are exclusively work-limiting. Moreover, the incidence of all types of disability is high and increases sharply with age. Nearly 30% of working-age respondents over the age of 45 report at least some dimension

[26] Disability is self-reported. 'Justification' bias, where individuals with lower incomes or worse labour market prospects report more disability is a problem with all subjective measures. Studies by [6] (for health measures) and [21], using Canadian data from the National Population Health Survey, find that justification bias is small enough to be of less concern than measurement error or attenuation bias. Similar evidence for the U.S. is discussed in [49].

[27] Disability can have indirect effects on work even if no direct effect is present: for instance some respondents report being limited in their ability to change jobs, or work their optimal number of hours, even though they did not report a direct work-limitation in the current period.

[28] Incidence statistics are weighted using cross-sectional weights provided by Statistics Canada so to represent the Canadian population as of 2004.

of disability.

Table 3.1: Incidence of reported disability by type in 2004

| age | no disability | latent | $h$-limiting | $n$-limiting | $h$ and $n$-limiting |
|---|---|---|---|---|---|
| 20-44 | 85.5% | 3.0% | 2.6% | 1.1% | 7.7% |
| 45-69 | 70.9% | 5.8% | 5.1% | 1.5% | 16.6% |

### 3.2.1 Methodology and measurement of disability responses

Our methodology is similar to the methodology described in chapter 2.[29] The estimating equation is

$$y_{it} = \alpha_i + \gamma_t + \kappa f(age) + X_{it}\beta + \sum_k \delta_k A_{kit} + e_{it} \tag{3.12}$$

where $X$ contains demographic and life cycle information including education, household size, number of children, a dummy for living in a city of at least 50,000, the provincial minimum wage, a measure of self-assessed health, and regional dummies.[30] We control for individual or family fixed effects $\alpha_i$ through the inclusion of time averages of the covariates in $X$ taken for each individual over the years he is observed in the SLID. Index $k$, ranging from -1 to +10, denotes the number of periods from initial disability onset. $A$ is an indicator variable indexing $k$. The coefficients on $A$, $\widehat{\delta}_k$, are plotted in the graphs in the following subsections.

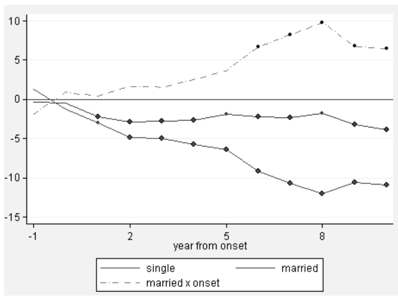
### 3.2.2 Labour supply responses to disability

Figure 3.2 reports estimated changes in labour supply following disability onset by marital status. The sample of unmarried men pools never-married, separated/divorced and widowed men, and the sample of married men includes common-law partners and individuals who report being single but, in a separate question, also report "living with a spouse". The sample is adjusted to reflect, as best as possible, the average rate of active disability

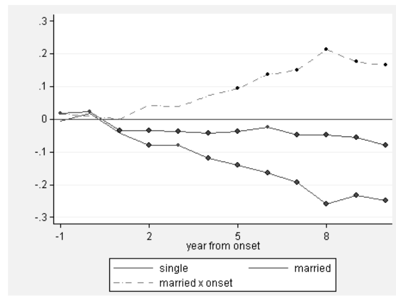
[29] The sample preparation and empirical methodology is identical to the methodology in Chapter 2 except that, for simplicity, we omit the step nearest-neighbour propensity score matching to increase the pre-onset control group, and we include a control for self-assessed health in $X$. One result of the smaller control group is that the estimates reported in this chapter, while otherwise similar to those reported in the previous chapter, tend to be less significant.

[30] The regions are the Atlantic provinces, Ontario, Western provinces and B.C., Quebec.

Figure 3.2: Male labour supply following disability onset by marital status




(a) Total hours




(b) Participation

reporting in each year from initial onset among Canadian men (see Chapter 2). The figures show the $\widehat{\delta}_k$'s estimated from (3.12), in levels, from one year prior to ten years after reported onset of the disability. Large dots highlight estimates which are significant at 95% confidence level, and small dots indicate significance at 90% confidence. The dotted line above the $x$-axis in each figure plots the estimated differences between married and single responses, after directly controlling for marital status. The left panel reports changes in total annual hours worked, divided by 50 to give an average weekly level. The right panel shows average percentage changes in participation.[31] Figure 3.3 shows long-run responses of female spouses to the husband's disability shock, for total hours and participation.

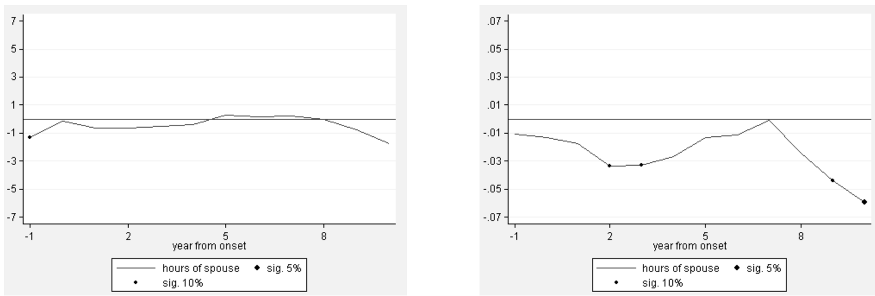
Three striking features make figure 3.2 interesting. Single men clearly experience larger and more persistent drops in labour supply than their married counterparts. Five years post-onset the drop in total hours is twice as large for singles as for marrieds; at ten years post-onset it is more than three times as large.[32]

Second, labour supply effects of disability shocks appear to be persistent. On average neither married nor single men return to their pre-onset level of work, despite the fact that the probability of recurrence of the active limitation is not very large (under 35%) in most periods after onset. This finding is consistent with previous U.S. studies, especially with [59].

[31] (3.12) is estimated as a linear probability model with binary dependent variable taking a value of one if the disabled individual worked positive hours during the previous year and zero otherwise.

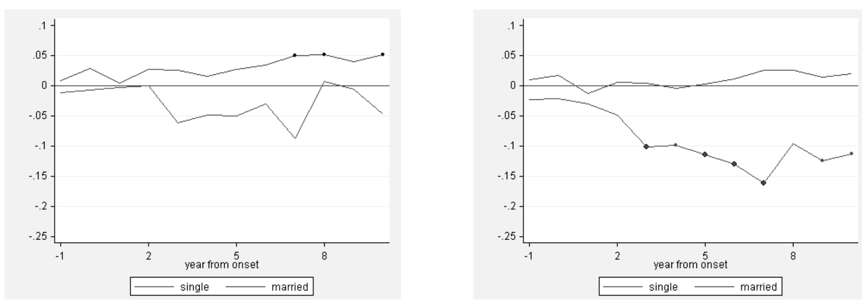
[32] Considerable differences also exist for hours of workers and participation, though declines in hours worked on the intensive margin are smaller and less significant for both married and single men.

Figure 3.3: Spousal labour supply following disability onset shocks




(a) Total hours (b) Participation

Figure 3.4: Male ln hrly wages following of disability onset




(a) No selection correction (b) With selection correction

Third, we observe small added worker effects for the wives of disabled men. Evidence suggests that wives may *decrease* their participation somewhat, although the effect is only significant at long durations from onset. The finding of a negligible added worker effect for wives is consistent with U.S. findings by [28] using the HRS and [24] using the PSID.[33]

### 3.2.3 Disability onset and wages

Next, we examine the effects of disability onset on the (ln of) hourly wage of males, disaggregated by marital status. We plot results from two equations, respectively with and without adjustment for selection into the labour force. In the unadjusted model, we regress the composite hourly wage reported

[33] [73] provides some evidence from the PSID that long-run added worker effects following job displacement are significant, eventually replacing 25% of husband's lost annual income.

in all jobs in the reference year on a cubic in labour market experience, education, plus indicator variables for urban status, regional status, year and SLID panel, and the provincial minimum wage, plus time averages for all the controls. The model with selection estimates a first stage including all these regressors plus a cubic in age, children and household size—variables we expect to have no *direct* effect on the wage.

Figure 3.4 shows the results. In the unadjusted regressions, there is no significant decline in wages for either married or single men. In the selection-adjusted sample, the observed rise in married male wages disappears. For single men, the decline in wages over the post-onset period becomes larger and significant, reaching 16%. Combining married and single men, the drop in wages is estimated to be around 4%.[34] The larger drop for singles is consistent with the idea that wages move endogenously with hours worked.

## 3.3 Explaining the evidence: A dynamic household model

Given the apparent discrepancy between theory and data, we choose to relax some implicit restrictions of the workhorse model. We proceed in two steps. First, we tie disability and wage shocks together through a dynamic human capital process which gives individuals some control over future wages through the choice of hours worked. Second, we allow for a richer set of intra-household transfers by introducing home production in the form of task-sharing by married couples and optimal time management. We show analytically that these simple extensions have the potential to reverse the counterfactual implications of the workhorse model; in addition, we use numerical simulations to quantify their effects. Details about the numerical implementation are at the end of this section.

### 3.3.1 Disability with human capital accumulation

One puzzling aspect of observed responses to disability shocks is the persistent fall in both labour supply and wages, with the first leading the second. Responses outlast shocks. This pattern suggests a role for a dynamic human capital mechanism. Based on a combination of our own data evidence and findings from the empirical literature on returns to experience (see for example [69], [69], [40], [40] and [65], [65]), we assume that current human capital

[34] These are slightly smaller effects than [59] find using a selection estimator for PSID male household heads.

depends on previous period human capital stock and previous period labour supply, given realizations of disability state $\delta_n$ and residual idiosyncratic wage risk. Married households' constraint set becomes:

$$\begin{array}{ll} \xi_1 : \frac{(T-\delta_h \overline{h}_m - l_m)}{\delta_n} w_m + (T - \overline{h}_f - l_f) w_f & +(1+r)a + b(\cdot) = c_f + c_m + a' \\ \xi_{2a} : l_m \leq T - \delta_h \overline{h}_m & \xi_{2b} : l_f \leq T - \overline{h}_f \\ \xi_{3a} : Ew'_m = H_m(l_m | w_m, \overline{h}_m, \delta_n); & \xi_{3b} : Ew'_f = H_f(l_f | w_f, \overline{h}_f) \end{array}$$

where $Ew'_m = H(l_m | w_m, \overline{h}_m, \delta_n)$ denotes the expected wage as a function of current labour supply choice, conditional on relevant states. As before, the constraint set for singles is identical to the married constraint set, with all $f$-indexed variables set to zero.

In Appendix A we report first order conditions, as well as relevant comparative statics, for leisure and labour (equations A.2 and A.4), for the model with human capital. Introducing human capital has an ambiguous effect: married men, who work more than single men, also have endogenously higher wages, increasing the relative wealth effect of a disability shock to them. On the other hand their wives also have an extra incentive to supply more labour when husbands are hit by shocks, since by doing so they can increase their own future wages. Over time, wives' rising wages can reduce the overall household wealth loss due to husband's disability, which can in turn lead to larger drops in labour for married men. In section (4.4) we provide evidence that pure human capital considerations do indeed lead to larger added worker effects and larger drops in husbands' labour supply over the long run. For singles, where no other intra-household considerations are present, we show that a dynamic human capital motive goes a long way towards reconciling theory and observed responses.

### 3.3.2 Home production and intra-household time management

The second extension to the basic model is to allow for optimal time management within marriage through task-sharing. Analytically this amounts to a form of home production in which couples solve a wealth-maximization problem by optimally allocating home-production activities between spouses, as in [43]. In the presence of disability, 'time transfers' play an additional role, allowing a lower-wage healthy spouse to alleviate the time loss experienced by the disabled partner, raising both his utility and his potential for market work.

Time endowments and optimal time choices are defined as follows. Out of their natural time endowment $T$, every individual must devote some number of hours to 'non-labour, non-leisure' (*nll*) activities. The amount of *nll* tasks varies by age, education, the presence of children and gender, but is otherwise inflexible; *nll* activities must be completed before labour and leisure decisions can be taken. The time cost associated to the necessary task when single is denoted as $\overline{h}_g$. The time actually devoted to *nll* tasks by each spouse is $h_g$ for $g \in \{m, f\}$.

For single people, $\overline{h}_g = h_g$, just as in the basic model. However, married couples are able to 'pool' their *nll* bundles and allocate the *nll* tasks through a home-task technology $\phi_g(h_g)$, $g = \{f, m\}$, with $\phi'_g \geq 0$ and $\phi''_g \leq 0$. Through task-sharing members of a couple are able to maximize the value of the couple's market worth by allowing the potentially more productive partner to specialize in market activities.

The couple's full problem is a maximization of (3.2) with respect to $\{c_m$, $c_f$, $l_m$, $l_f$, $h_m$, $h_f$, $a'\}$, subject to

$$\begin{aligned} \xi_1 \quad &: \quad (T - l_m - \delta_h h_m)\frac{w_m}{\delta_n} + (1+r)a + b + (T - l_f - h_f)w_f - c_m - c_f = 0 \\ \xi_{2a} \quad &: \quad l_m \leq T - \delta_h h_m - \delta_n n_m \qquad \xi_{2b} : l_f \leq T - h_f - n_f \\ \xi_{3a} \quad &: \quad Ew'_m = H_m(l_m, h_m | w_m, \delta_n) \qquad \xi_{3b} : Ew'_f = H_f(l_f, h_f | w_f) \\ \xi_4 \quad &: \quad \phi_f(h_f) + \phi_m(h_m) = \overline{h}_f + \overline{h}_m \end{aligned} \tag{3.13}$$

The FOCs for leisure are unchanged from those in (3.3.1). The FOC with respect to $h_m$, the husband's share of *nll*, is

$$\xi_1 \left( -\frac{\delta_h w_m}{\delta_n} + \Phi'_f \phi'_m \right) = -\xi_{3a}\frac{\partial H_m}{\partial h_m} + \xi_{3b}\frac{\partial H_f}{\partial h_m}\Phi'_f \phi'_m \tag{3.14}$$

where $\Phi_f$ is the inverse of $\phi_f$. Leaving aside dynamic human capital considerations, and assuming an interior solution in which both spouses engage in both market and house work, this first order condition reduces to a two-stage wealth-maximization problem in which the couple first allocates time to maximize joint labour earning potential, then allocates the resulting wealth between leisure and saving/consumption. What does this equation imply for the optimal labour supply responses to disability onset in the husband? The elasticities reported in section (3.3.1) are now complicated by changes in the respective shares of *nll* tasks. On the one hand, disability shocks make the husband less productive in the labour market by increasing the total time lost to the household for each hour that he works. However, $\delta_h$ shocks also make him less productive at home, which can have the effect of inducing the wife to take over *nll* tasks that a healthy husband would otherwise perform, thereby reducing the amount of time she can devote to market activities. The direct net effect of a $\delta$ shock depends on the relative extent of home and work limitation. There is however a second, indirect effect operating through the human capital accumulation motive. Following her husband's disability, the wife may have an incentive to take over additional tasks in the home to support her husband's current level of market labour supply and, by so doing, the main earner's human capital stock and future household income.

### 3.3.3 The numerical counterpart of the model

The interaction of dynamic human capital incentives and intrahousehold time sharing delivers a mechanism which could rationalize observed responses to disability shocks. However, since the theoretical predictions of the mechanism are ambiguous, we require a numerical counterpart of the model to test its ability to explain the empirical patterns.

The simulated economy is populated by one-member (single) and two-member (married) households. Households differ by education level, $ed \in \{high, low\}$ which is the same for both members. The individual state space for men and women is $X_m = \{w, ds, rsk\}$ and $X_f = \{w\}$, where $w$ is the current wage (or stock of human capital), $ds$ is the disability state, $rsk$ is the relative risk of becoming or remaining disabled compared to other men of similar age. For married households $X = \{X_m, X_f\}$.[35] Households, whether one-member or two-member, differ also by the age of their head, $j$ (which is also the age of the spouse, where applicable), and by their asset holdings, $a$.[36] All values in the model are expressed in 2002 Canadian dollars.

We solve the model using standard backward recursion. Individuals make a discreet choice over hours of market work and (for two-member households) hours of home work for each member, and a continuous choice over asset holdings and the intrahousehold division of consumption at any period. Given the large number of parameters needed for a numerical implementation we proceed in two steps. First, a number of parameters are directly estimated from micro data using model restrictions. These estimates

[35] The assumption that only males experience disability is a convenient and tractable way to focus on disability among 'main earners', though of course not all men in either data or model are main earners in their households, either before or after disability onset. This modeling choice reduces complexity without affecting our conclusions in substantial ways.

[36] We assume throughout a real interest rate of 4.2%.

are employed to numerically simulate the model and estimate the value of remaining parameters through the simulated method of moments. We use the downhill simplex method to minimize the sum of squared percentage deviations between simulated and empirical targets.

**Demographics** A model period is one year, but all flow values and results are expressed for one representative week of the year. Maximum lifespan is 90 years. Age/gender-specific survival probabilities, $\varsigma_j^g$, are set to unity for working-age individuals and taken from Canadian vital statistics for individuals over 65.[37] Men and women in the model may work until age 65. 75% (85%) of high (low) educated individuals are matched in the first period of life, while the others remain single. Each married couple has two children at age 29, who are supported for 19 years. The exogenous divorce hazard is .0061% per year up to age 65 and zero thereafter, giving a divorce rate of 21%, roughly the break-up rate of first marriages in Canada. Upon divorce parents share consumption costs of children, but only the wife devotes time to them. Single men and women have no children.

**Preferences** Period utility of men and women is defined as

$$u^m = \theta^{ed}(ms) + \frac{\left(\frac{c}{\tilde{n}}\right)^{1-\omega^m}}{1-\omega^m} + \gamma^m \frac{l^{1-\psi^m}}{1-\psi^m} \tag{3.15}$$

$$v^f = \theta^{ed}(ms) + \frac{\left(\frac{c}{\tilde{n}}\right)^{1-\omega^f}}{1-\omega^f} + \gamma^f \frac{l^{1-\psi^f}}{1-\psi^f} \tag{3.16}$$

where $\tilde{n}$ is an age/marital status-specific consumption weight reflecting economies of scale from cohabiting and the possible presence of children[38]. Parameter $\omega$, which governs the intertemporal elasticity of consumption is set to 1.5, which is a standard value in the literature. The last three sets of parameters, $\psi$, $\gamma$ and $\theta$ are estimated, with details provided in section 3.3.4. $\psi$, governs the intertemporal (Frisch) elasticity of labour supply. $\gamma$ captures the relative preference weights of consumption and leisure in current utility; and $\theta^{ed}(ms), ms \in \{S, M\}$ captures additive psychic value (or cost) of marriage, which varies by education.

Men and women differ in their relative preferences for *nll* activity. Since some types of *nll* may yield leisure utility to the couple (see discussion in [2],

[37] We thank Kevin Milligan for providing us with Canadian mortality data.

[38] Following the traditional OECD equivalence scale, $\tilde{n}$ is set to 1 for the first adult in a household, .7 for every additional adult and .5 for every child. Since approximately 40% of single men and women in the SLID live with family members other than a spouse, we assign a $\tilde{n}$ of .85 to 38.5% of the never-married and divorced population and a $\tilde{n}$ of 1 to the other half.

[2]), we assume that $l_m = T - \pi_m \delta_h h_m - \delta_n n_m$ and $l_f = T - \pi_f h_f - n_f$ and normalize $\pi_f = 1$. $\pi$ does not affect the individual's physical time constraint, but provides a measure of relative leisure obtained through housework, child care and other *nll* activity. This parameter is irrelevant in the models in which $h_g$ is fixed exogenously, but it pins down husbands' share of *nll* in the full, unconstrained model where $h_g$ is endogenously determined.

**Time and home production** *nll* duties, denoted by $\overline{h}$, are modeled by gender, marital status and number of children. Data on total *nll* activities are taken from the public use version of the Canadian General Social Survey 2005, which includes detailed information on time use. Measured *nll* includes all 'non-labour, non-leisure' activities that individuals in the sample perform during a diary day, including child-care related tasks other than spending leisure time with children.[39] Table 3.2 reports means and standard deviations of weekly *nll* hours spent by married and single individuals. Married women devote substantially more time to *nll* tasks than single women, while *nll* time is only slightly higher for married than for single men.[40]

Table 3.2: Time devoted to *nll* task by gender and marital status: GSS

| Men | | Women | |
|---|---|---|---|
| Married | Single | Married | Single |
| 27.01 | 25.48 | 40.32 | 34.76 |
| (20.07) | (22.48) | (22.43) | (22.87) |

We assume a simple functional form for the *nll* transfer technologies:

$$\phi_m(h_f) = a h_f^{q_1} \tag{3.17}$$
$$\phi_f(h_m) = b h_m^{q_2} \tag{3.18}$$

Under our assumptions $a h_f^{q_1} + b h_m^{q_2} = \overline{h}_f + \overline{h}_m$ $(*)$, so that we can estimate the parameters of $\{\phi_m, \phi_f\}$ using data on married men and women's time inputs into *nll* (the left hand side), and single *nll* activity by gender (the right hand side). Unfortunately we are not aware of any Canadian data providing information about *nll* activities for more than one member of a household. Therefore we turn to the 1999-2005 waves of the Panel Study

[39] An advantage of the GSS over the American Time Use Survey is that the survey methodology allows diary days to be aggregated up to weekly weighted averages.

[40] Since all *nll* tasks are assumed to be subject to home-limiting shocks, the relative responses of single and married men cannot be explained by a lower average *nll* burden for married men.

of Income Dynamics (PSID) which provide information on hours of 'housework' (a subset of total *nll* activities) performed by a longitudinal sample of US households.[41] Estimation results using non-linear least squares to estimate ($*$) are given in table (3.3), with further details on estimation given in Appendix B.2. Our estimates suggest that men's and women's time are relatively good substitutes in household production, with women becoming relatively more efficient at high levels of *nll* (levels above twenty hours a week), mostly occurring for adults in households with children.

Table 3.3: Estimated time-transfer technology

| | | | |
|---|---|---|---|
| $a$ | 2.037 | $q_1$ | .776 |
| | (.00) | | (.00) |
| $b$ | 2.248 | $q_2$ | .741 |
| | (.00) | | (.00) |
| | $n = 10,172$ | | $r^2 = .969$ |

**Disability process** The process of disability for males is summarized by two state variables: *ds*, which indexes current disability status, and *rsk*, which captures a man's underlying risk of becoming, or remaining, disabled. The *rsk* matrix has three states. *rsk* 1 and 2 denote high and low disability risk (or, good and poor health). Men move from *rsk* 1 to 2 randomly over the life cycle.[42] A third *rsk* state captures 'chronic' disability, in which a limiting *ds* status becomes permanent.[43]

The *ds* vector comprises six states in ascending order of severity: healthy (*ds* 1); latent disability (*ds* 2); *h*-limiting only (*ds* 3); *n*-limiting only (*ds* 4); *h*- and *n*-limiting, both milder, (*ds* 5), and severe (*ds* 6). For non-

[41] Examples of *nll* activities that do not fall under the PSID definition of 'housework' include grocery shopping or dealing with household finances, as well as personal activities like doctors' visits.

[42] To estimate the process for *rsk*, we run a probit regression on SLID data in which the dependent variable is an indicator for having a disability during the course of the panel and the regressors include a variety of standard demographic controls, including age terms and self-assessed health. We cut the resulting predicted probabilities at the median so that half of the male SLID population is 'high' *rsk* and half 'low' *rsk*, and these respective populations are used to estimate the high- and low-risk *ds* matrices described above. The age-dependent probabilities of transitioning into *rsk* 2 from *rsk* 1 are chosen to replicate the shares of married and unmarried individuals in *rsk* 1 and 2 at ages 20-25, 40-45 and 60-65.

[43] In the simulation, $rsk \geq 3$ also states capture greater benefit entitlements based on the highest wage of the individual since he entered the *rsk* state. *rsk* is strongly increasing in age; by age 66, more than 98% of men have transitioned into *rsk* 2 and about 7% are chronically disabled.

Table 3.4: Type of limiting *ds* by marital status for prime-age men

| | Married (%) | Single (%) |
|---|---|---|
| *ds* 3 | 22.3 | 13.3 |
| *ds* 4 | 7.6 | 9.0 |
| *ds* 5 | 45.4 | 47.5 |
| *ds* 6 | 24.9 | 30.2 |
| *ds* frequency over 6 years | 2.58 | 2.98 |

chronic disabled men, transitions across *ds* states follow an age- and *rsk*-specific Markov transition matrix estimated directly from the SLID. The probability that any limiting disability becomes chronic (*ds* 3) is calibrated to loosely replicate the distribution of men across *ds* states by education and marital status. This distribution, across marital states for men age 30-60, is described in table 3.4.

The structure described above allows us to control very tightly for the fact that single men appear to face a harsher experience of disability, which means that they have both greater expectation of becoming disabled (because greater *rsk* at avery age), and more chronic and limiting disability spells once an initial shock occurs. As we show below, this accounts for some, but by no means all, of the difference between married and single responses to disability onset.[44]

**Wage dynamics and human capital accumulation** The basic model, with or without explicit disability risk, assumes an exogenous wage process. We estimate a wage equation with controls for age, cohort, education and other demographic factors, and employ the two-stage fixed-effect selection estimator proposed by [78] to control for the combination of selection into the labour market and fixed effects. We model the residual as an AR(1) random disturbance with autocorrelation coefficients $\{\rho^f, \rho^m\}$, for women and men respectively, and variance of idiosyncratic shock $\{\sigma_u^f, \sigma_u^m\}$. We estimate $\rho^f = .96$, $\sigma_u^f = .48$ and $\rho^m = .94$, $\sigma_u^f = .46$. Results are presented in the left panel of table B.1 in Appendix B.1.[45]

To estimate the endogenous wage process used in Model E, we draw on work by, among others, [69], [40] and [65]. We posit the following human capital process:

[44] For individuals over 65, states 3 through 6 correspond to increasing levels of $\delta_h$.

[45] For the two-shock model, we include disability a an additional regressor for men; in the one-shock model, the effects of disability are left as part of the residual. Coefficients reported in table B.1 are from the two-shock model. The returns to age and education are nearly identical in the one-shock model.

$$\begin{aligned} H_{i,t+1} &= H(n_{i,t}|H_{i,t}, \delta_{n,i,t+1}, ed_i, age_{t+1}, v_{i,t+1}) \\ &= \kappa_{it} + (\alpha_1 + \alpha_2 n_{i,t} + \alpha_3 n_{i,t}^2) H_t + v_{i,t+1} \\ w_t &= R_t H_t \end{aligned} \tag{3.19}$$

where $R$ is the wage rate per unit of human capital, $n$ is average weekly hours worked in the previous year, and $H$ is the start-of-period human capital stock. The individual- and age-specific intercept $\kappa = \{\kappa_0 + \kappa_1 \times age + \kappa_2 \times ed\}$ approximately pinpoints the minimum human capital level a person can have given his age and education.[46] Parameter $\alpha_1$ captures the rate of depreciation of $H$, while $\alpha_k = \{\alpha_{k1} \times age + \alpha_{k2} \times age^2\}$, for $k = 2, 3$, governs the rate at which $H$ is replenished through market activity over the life cycle. $\nu$ is an i.i.d. shock, which we estimate to be heteroskedastic in a person's age and current human capital stock. Since individuals may be able to predict and react to upcoming realizations of $\nu$, we instrument for the terms involving lagged hours with three-year lags of each term age-hours interaction term. We control for selection in a first stage regression using as selection restrictions demographic indicators, such as the presence of young children in the household.[47] Following [40], we let $R_t = R$ for all years in our sample and normalize $R = 1$. Parameter estimates, from separate regressions of (3.19) for men and women, are reported in the right panel of table B.1 in Appendix B.1.

**Policy environment** Government transfers summarize the existing patchwork of Canadian federal and provincial programs. Table 4.7 reports all transfers and whether they are or assigned or estimated as part of the SMM procedure for fitting model.[48] All working-age individuals receive a basic benefit in every period that varies by gender and marital status and captures child benefits, unemployment benefits and other benefits not directly related to disability or retirement. Households whose members have no work-limiting disabilities but (a) all choose not to work and (b) have assets below a given cut-off level, receive an additional 'welfare' benefit equal to the average welfare entitlement available to singles and couples through Social Assistance. Retirees (non-workers 60 and over) receive a flat-rate

[46]Given our estimation strategy parameters $\kappa_0$, $\kappa_1$ and $\kappa_2$ are not identified and are therefore estimated as part of the model (see section 3.3.4).

[47]Disability measures are included both at the first and second stage but we find no evidence of any direct effect of disabilities on human capital depreciation.

[48]Where estimated, the targets and resulting values from the extended model are reported.

transfer equal to the federal Old Age Security (OAS) benefit, plus 25% of expected weekly earnings based on their marital status and wage at age 60. Finally working-age men facing permanent work-limitations ('chronic disabled' health status), and who opt not to work, receive a disability benefit equal to a flat rate of \$87 plus a share of expected earnings' loss, based on pre-onset wage and marital status. The transfer is based on Canadian disability benefits under the Canada Pension Plan as well as other programs. The replacement rate is identified in the model by the average transfers received by single disabled men. Men with non-chronic work-limiting disabilities who work less than full-time receive a benefit equal to one sixth of their chronic benefit, approximating temporary payments from Workers Compensation, the typical duration of which is about two months.[49]

Table 3.5: Government programs and benefits

| Benefit | Demographic | Value | Assigned or SMM | SMM target |
|---|---|---|---|---|
| Universal benefits | single men | \$28.5 | SMM | \$29.3[a] |
| | single women | \$69.2 | SMM | \$90.5[b] |
| | couples | \$141.3 | SMM | \$98.5[c] |
| Welfare benefits[d] | single men | \$124 | assigned | |
| | single women | \$124 | assigned | |
| | couples | \$214 | assigned | |
| | asset cut-off: sin | \$400 | assigned | |
| | asset cut-off: mar | \$600 | assigned | |
| Retirement benefits | | | | |
| Old Age Security | all | \$107 | assigned | |
| Replacement rate | all | 25% | assigned | |
| Disability benefits | | | | |
| Flat-rate benefit | all men | \$87 | assigned | |
| Replacement rate | all men | 22% | SMM | \$70.8[e] |
| Temporary disability benefit | all men | 1/6 perm ben | assigned | |

[a] Total transfers received by working-age healthy single males
[b] Total transfers received by working-age single females
[c] Total transfers received by working-age couples
[d] Total transfers received by unmarried disabled males
[e] Source: National Council of Welfare 2009 benefit tables

[49]To fund retirement and disability benefits, individuals face a payroll tax of 9.9%, which is the CPP payroll tax rate for covered workers. There is also a progressive income tax with brackets of $\{21.2; 31.8; 42.1; 46.4\}$ on income above $\{\$9,600; \$47,485; \$84,320; \$132,784\}$, which are approximately equal to 2008 rates and brackets (federal + provincial) for the median Canadian taxpayer. Tax revenues not spent on benefits are wasted.

### 3.3.4 Model estimation

Apart from the four policy parameters described in the previous section, there are seven sets of parameters to estimate in the full model. They are: (1) relative tastes for leisure for men and women $\{\gamma_f, \gamma_m\}$; (2) intemporal labour supply elasticities $\{\psi^{-1f}, \psi^{-1m}\}$; (3) time-costs of $n$ and $h$ in $ds$ states 3 through 6 $\{\delta_l^3, \delta_n^4, \delta_n^5, \delta_l^6\}$; (4) discount rates $\{\beta^f.\beta^m\}$ and allowable debt holdings $\{\underline{a}\}$; (5) education- and age-specific intercepts for the male and female human capital regressions $\{\kappa_0^f, \kappa_0^m, \kappa_1^f, \kappa_1^m, \kappa_2^f, \kappa_2^m\}$; (6) non-pecuniary gains from marriage for men by education state $\{\theta_m^{high}(M), \theta_m^{low}(M)\}$; and (7) men's relative preference for $nll$ activity $\pi_m$.

The parameters are estimated jointly through SMM. Below we report the information used to identify them. The $\gamma$'s are primarily identified by, respectively, average labour supplies of prime-age (25-59 year old) men in $ds$ 1, and all prime-age women under 45. The $\psi$ are adjusted in order to replicate the Frisch elasticity of .278 estimated using equation (3) and reported in column 1 of Table 2 in [66] for men between 20 and 64.[50] Since there is less conclusive empirical evidence on Frisch elasticities of female labour supply, we constrain $\psi^f = \psi^m = \psi$. The $\delta$'s in each state are primarily identified by labour supplies of unmarried prime-age men in each limiting $ds$ state, under the restrictions that $\delta_h^3 = \delta_h^5$ and $\delta_n^4 = \delta_n^6$. The time-discount rates $\beta^g$ are primarily identified by the median wealth-to-after-tax-income ratios of all Canadian households with male members (couples and lone males) and female members (couples plus lone females) using information from the public use version of the 2005 Survey of Financial Security. The maximum debt allowance for all households, $\underline{a}$, replicates the median debt-to-after-tax-income ratio for households with debt. Education-specific constant terms and age trends in the HC accumulation/wage equations for men (women) are primarily identified, respectively, by wages of prime-age working men (women); the average difference in hours between high educated and low educated prime-age single men (women); prime age single male labour supply in $ds$ 2 (labour supply of prime age females over 45). These terms are important for generating accurate life cycle earnings profiles for men and their spouses within which to analyze the effects of disability.

Finally, the residual utilities from marriage— $\theta_g^{ed}(M)$'s—are used to ensure that all marriages occur, while the ratio of $\frac{\theta_f^{ed}(M)}{\theta_m^{ed}(M)}$ generates an average 'married vs. single' male labour supply difference of 9.1 hours per week

[50] In our replication regressions, we do not instrument for hours worked since measurement error is not a problem in the simulated data.

for low-education men and 5.0 hours per week for high-education men. For any choice of $\theta_f^{ed}(M)$ sufficient to ensure that matches result into marriages, there is a unique $\theta_m^{ed}(M)$ and resulting $\lambda$ utility weight giving correct labour supplies.[51] Table 3.6 reports the estimated parameters for the full model (Model E in Section 4.4).[52]

Table 3.6: Simulated Method of Moments: Parameters

| Parameter | Value: model | Target | Targeted value: data | Targeted value: model |
|---|---|---|---|---|
| $\gamma^f$ | 1.24 | $n_f$ under 45 | 27.5 hrs | 27.4 hrs |
| $\gamma^m$ | 1.91 | single $n_m$ in $ds1$ | 35.8 hrs | 36.0 hrs |
| $\psi$ | 1.5 | male Frisch elasticity | .278 | .283 |
| $\delta_{h,ds\in\{3,5\}}$ | 1.16 | single $n_m$ in $ds3$ | 29.9 hrs | 29.2 hrs |
| $\delta_{n,ds\in\{4,6\}}$ | 1.24 | single $n_m$ in $ds4$ | 21.6 hrs | 21.6 hrs |
| $\delta_{n,ds=5}$ | 1.20 | single $n_m$ in $ds5$ | 21.8 hrs | 21.7 hrs |
| $\delta_{h,ds=6}$ | 2.21 | single $n_m$ in $ds6$ | 9.8 hrs | 10.2 hrs |
| $\beta^f$ | 0.969 | wealth/inc ratio: females | 2.75 | 2.72 |
| $\beta^m$ | 0.970 | wealth/inc ratio: males | 2.60 | 2.58 |
| $\underline{a}$ | $325 | debt/inc ratio: all | .370 | .386 |
| $\kappa_0^f$ | -3.87 | mean wage: female | $17.40 | $17.41 |
| $\kappa_0^m$ | 0.11 | mean wage: male | $22.70 | 22.87 |
| $\kappa_1^f$ | .113 | mean $n_f$ over 45 | 25.1 hrs | 25.4 hrs |
| $\kappa_1^m$ | .027 | single $n_m$ in $ds2$ | 35.2 hrs | 35.0 hrs |
| $\kappa_2^f$ | .290 | high - low ed $n_f$ in $ds2$ | 6.0 hrs | 5.8 hrs |
| $\kappa_2^m$ | -.132 | high - low ed single $n_m$ | 5.0 hrs | 5.2 hrs |
| $\lambda^{ed=l}$ | .466 | mar - single $n_m$, low ed | 9.1 hrs | 8.9 hrs |
| $\lambda^{ed=h}$ | .639 | mar - single $n_m$, high ed | 5.0 hrs | 5.3 hrs |
| $\pi$ | 1.037 | married male $h$ | 27.0 hrs | 26.9 hrs |

## 3.4 Results

This section presents our numerical results. We begin by evaluating the fit of the extended Model E to some basic observations about life cycle labour

[51] In practice we estimate the $\lambda$'s directly for high and low education households. This is equivalent to estimating $\theta_m$ given $\theta_f$ large enough so that marriage occurs and: (i) additivity of $\theta$'s; (ii) equal-weight Nash bargaining over $\lambda$ at time of marriage; (iii) the fact that matched individuals are identical ex-ante.

[52] Estimated parameters for each of the other models presented in Section (4.4) are available from the authors.

supply and asset accumulation across marital states. Next we discuss its performance relative to the workhorse models from Section 3.1 in matching untargeted dynamic labour supply and participation responses after disability onset. Third, we assess the relative contribution of different elements of the full model by separately shutting out (1) home production, (2) human capital motive, and (3) ex-ante differences in health and education across marital states. Table 3.7 provides a synopsis of the models compared in this numerical analysis.

Table 3.7: Model specifications compared in numerical analysis

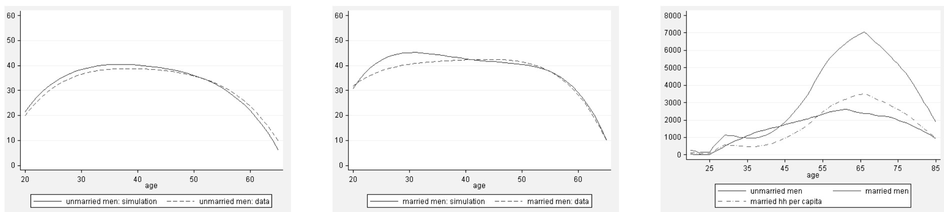
| Name | Description |
|---|---|
| model WH1 | work-horse model w/o explicit disability process |
| model WH2 | work-horse model with explicit disability process |
| Model E | full extended model |
| Model E1 | Model E w/o home production |
| Model E2 | Model E w/o human capital motive (exogenous wages) |
| Model E3 | Model E w/o ex-ante differences between married and singles |

To conclude this section we examine few extensions and provide micro-data results in support of our findings: we assess the specific roles of home vs. work-limiting shocks; we present direct empirical evidence regarding changes in intra-household home-time allocation associated to husband's disability; we allow single people to receive time transfers from friends and other family members.

### 3.4.1 Life cycle patterns

We begin by assessing the model's ability to generate reasonable life cycle patterns of labour and assets. Figures 3.6(a) and 3.6(b) show the evolution of hours worked for healthy single and married men, respectively, and figure 3.6(c) shows the life cycle evolution of assets and per-capita assets of households with at least one male member. Labour supply rises then falls over the life cycle due to conflicting incentives in human capital accumulation, as well as age-varying returns to work. At age 60, hours drop, especially for single men, in response to the initial availability of regular retirement benefits. Asset accumulation is higher for married than single households in both aggregate and per-capita levels reflecting both the fact that households headed by married men tend to be wealthier, and that the wife's preferences (higher relative preference for consumption and longer expected life span) induce greater per-capita retirement savings. This observation is consistent with empirical evidence on household asset accumulation, see [55].[53]

Figure 3.5: Life cycle profiles of male labour and assets




(a) labour supply of non-disabled single men

(b) labour supply of non-disabled married men

(c) Assets of male-headed households

### 3.4.2 Own and spousal responses to disability onset

Figure 3.6 documents the main findings of the chapter.[54] It plots $\hat{\delta}$'s in equation 3.12 for model $WH1$ (top panel), model $WH2$ (middle panel), and Model E (bottom panel).[55] In each panel, the left graph shows the response of weekly hours for all men (the thick solid dark line), and the estimated difference in responses in average weekly hours between married men and unmarried men (the thick solid lighter line). These responses are plotted against the corresponding estimates from the data (the thin dashed dark and lighter lines). The middle graph shows the same set of results with participation as the dependent variable. The right graph shows the weekly

[53]We also check additional untargeted moments. In the model 4.6% of prime-age men receive disability benefits (over and above welfare benefits) compared to about 4.4% of Canadian men. Married men earn \$3.62 per hour more on average than single men, compared to a difference of \$4.50 in the data. Married women work an average of 26 hours compared to 24 hours in the data. The variance of ln wages of male workers is .307 compared to .273 in the data.

[54]Tables for these results are omitted for space but are available from the authors.

[55]Results from our simulated data set are obtained by randomly sampling six panel observations for each simulated individual. The control group consists of men observed at -3, -4 and -5 years from onset. The treatment, or 'post-onset', group consists of men who report at least one current disability during the six-year window in which we observe them (that is, who would be classified as disabled in our SLID sample). We weight the data to generate a comparable degree of chronicity—the share of reported disability—as in the SLID sample over a ten-year post-onset period. Finally we pool real and simulated data and we run OLS regressions (separately for married and single men between 23 and 59) controlling for education and a cubic in age. The plots show average estimates from 20 replications of this sampling and estimation process.

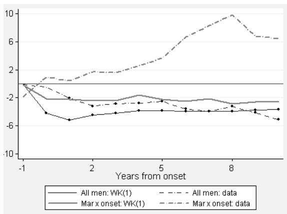
hours of wives following a husband's disability onset (the thick solid line) against estimated added worker effects from the SLID (the thin dashed line). As in Section 3.2, nodes indicate significant estimates, different from zero with 90% confidence.

The numerical results confirm the analytical predictions from Section 3.1: the workhorse models $WH1$ and $WH2$ fail to match several patterns of post-onset labour supply and participation from the SLID. In the workhorse model with no health shocks a disability spell is represented as a series of negative (iid) wage shocks sufficient to induce the average drop in hours worked for *all* men, over a ten year period following disability onset. By construction, the basic its dynamic labour responses of all males in the sample reasonably well. However, the response of single men is much smaller than the corresponding response of marrieds, while the participation responses for both single and married men are too small. As well, there is a relatively small but significant added worker effect induced by the negative wealth effects of repeated bad wage shocks.

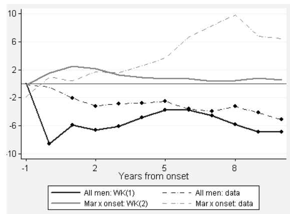
The fit of the model is marginally improved for total hours, and strongly improved for participation, when explicitly modeling health shocks in model $WH2$. The time loss effect of disability leads both types of men to drop out of the labour force and take up benefits following onset (the middle panel of figure 3.6). The poorer health of single men is sufficient to account for the lack of a gap between married and single responses, but not enough to induce the *larger* post-onset response of single males observed in the data. The added worker effect in model $WH2$ is smaller, though still significant, due to the fact that disability implies no long-term productivity loss beyond the duration of the disability itself. However the timing of responses still gives a poor fit to the data. Both single and married men drop their labour supplies precipitously upon onset, but recover—especially in terms of total hours worked—as the disability spell progresses. Since men's responses depend almost entirely on current $ds$ state, rather than the history of shocks, this gradual recovery is not surprising.

By contrast, the extended Model E goes a long way in reconciling theory and evidence, producing cross-sectional labour supply responses that are very similar to those in the data. In particular Model E generates large and persistent drops in labour supply and participation following disability onset in single men, and relatively small drops in labour supply following onset in married men, as well as no significant added worker effects. The mechanisms driving the fit are described in section 3.3, and we investigate them further below.

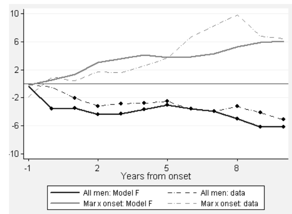
Figure 3.6: Own and spousal responses: Workhorse models vs. Model E



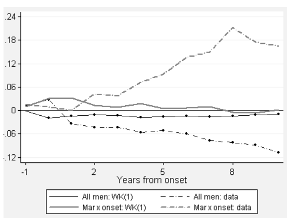
(a) Total hours: Model $WH1$



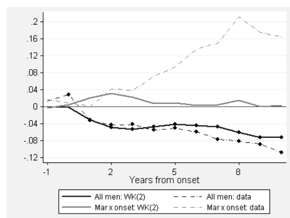
(b) Total hours: Model $WH2$



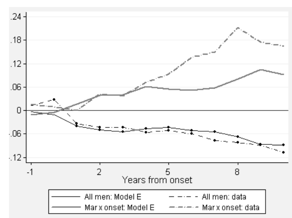
(c) Total hours: Model E



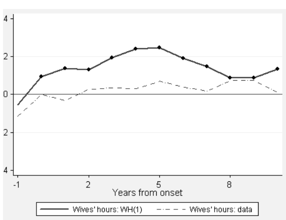
(d) Participation: Model $WH1$



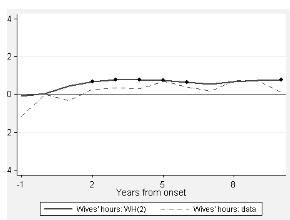
(e) Participation: Model $WH2$



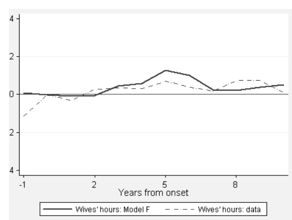
(f) Participation: Model E



(g) Wives' hours: Model $WH1$



(h) Wives' hours: Model $WH2$

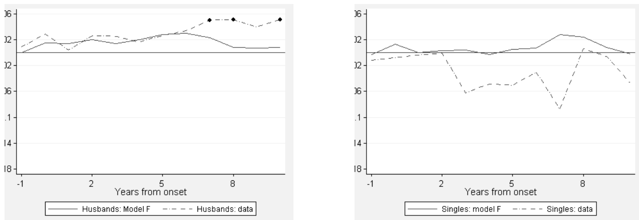


(i) Wives' hours: Model E

### 3.4.3 Productivity following disability onset

Figure 3.7 and 3.8 plot the evolution of ln hourly wages following disability onset in Model E against its counterpart in the data, disaggregated by marital status. Figure 3.7 shows the wages of workers, that is, wages following disability unadjusted for selection into the labour force. In both Model E and data, single men show a small, insignificant decline in wages, while married men actually show an insignificant *increase*. Results change when we account for selection effects. In figure 3.8 we plot wages of all post-onset men in Model E against the selection-adjusted estimates from the data, where the selection procedure is the one described in Section 3.2. In the

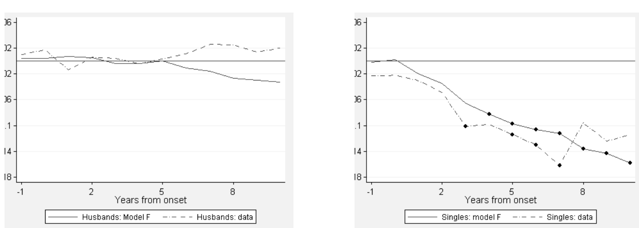
Figure 3.7: Wage declines in Model E vs. data, unadjusted for selection




(a) Married men: ln wages (b) Single men: ln wages

selection-adjusted results, married men experience basically no change in wages following disability onset; in the model there is an insignificant decline in ln wages. For single men, however, male ln wages begin to decline and are significantly below pre-onset wages within four years post-onset. They continue to fall, reaching -16% in the data and -18% in the model. This is unsurprising given that single men experience large drops in labour supply. With reduced participation, wages decline over time. Results for models $WH1$ and $WH2$ are not shown to preserve space. In model WH1 the wage drops are very large for both married and single men, by definition of disability in this model. In model $WH2$ there is no effect of wages (controlling for selection by including only workers in the regressions) since wages are independent of hours worked.

Figure 3.8: Wage declines in Model E vs. data, controlling for selection




(a) Married men: ln wages (b) Single men: ln wages

### 3.4.4 Inspecting the mechanism of the extended model

We next turn to inspecting the mechanisms at work behind labour supply responses to disability, by alternately shutting down three components of the extended Model E: human capital, home production and ex-ante differences in health and education between married and single men. For each restriction we all policy parameters, in particular benefit schedules, constant at the levels estimated in Model E, and allow all other parameters in the model, including the time-costs of disability, to adjust.

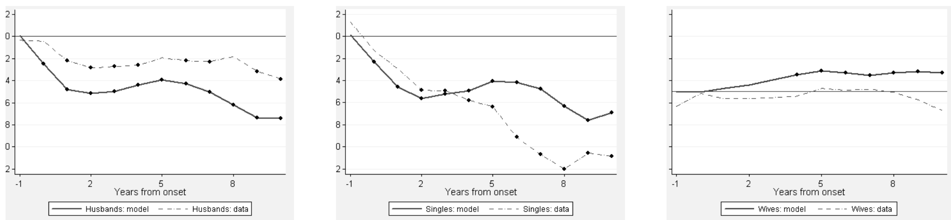
Figure 3.9 plots results for average weekly hours worked by married men, single men, and spouses with disabled husbands[56] from a model in which we shut down the process for home production, replacing *nll* for married men and women with the mean estimates from the 2005 Canadian GSS. Figure 3.10 shows comparable estimates for a model in which we replace the human capital accumulation process with the exogenous wage process from model WH2, while still allowing optimal home production choices. Finally figure 3.11 plots optimal average weekly hours worked following onset from model E3, in which married and single/divorced men face an identical health and disability process and have the same mean levels of education.

The results suggest that a combination of home production and health differences are needed to solve the "puzzle" of lower cross-sectional labor supplies of unmarried men in the data post-onset, while the human capital motive plays the major role in accounting for the longitudinal profile of responses. When home production is shut down, a significant and consistent added worker effect emerges at three years post-onset, on the order of two hours per week, and married hours drop to the level of single hours. The greater prospect of recovery and higher pre-onset wages (higher education) for single men in Model E-3 relative to Model E reduce the optimal negative response of labour supply to disability shocks for single men, resulting in only a slightly higher post-onset drop in labour supply compared to married men. By contrast, the married vs. single difference is preserved in Model E-2, but the lack of human capital motive results in unrealistically large drops for single, and to a lesser extent married, men at onset that then fade over time. Note, however, that this result gives a misleading implication about the role of human capital in optimal household responses. In a model with exogenous wages, men are simply assumed to be *exogenously* more productive on average than women, which—given a relatively flexible home production function—leads wives to optimally absorb the time-loss impact of the husband's disability. In a model with human capital accumulation, however, the relative market-productivity of the spouses is determined in part by optimal decision making early in life cycle. This decision will take into account future likelihood and ability to manage shocks received by the main earner. The husband's human capital is therefore an "investment" by

[56]Participation results are omitted for space but are readily available from the authors.

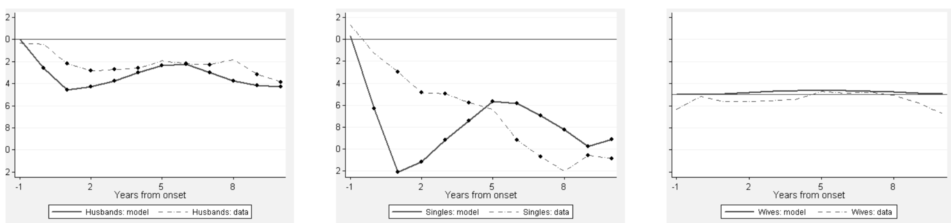
the couple that must be protected against health and other types of shock.

Figure 3.9: Weekly hours responses in Model E1: No home production



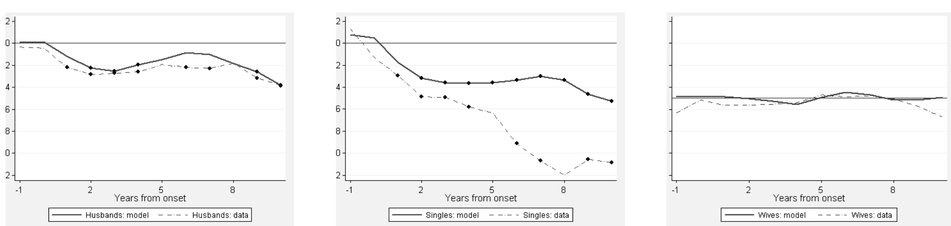

(a) Married: Total hours (b) Single: Total hours (c) Wives: Weekly hours

Figure 3.10: Weekly hours responses in Model E2: Exogenous wages




(a) Married: Total hours (b) Single: Total hours (c) Wives: Weekly hours

Figure 3.11: Weekly hours responses in Model E3: No intrinsic differences




(a) Married: Total hours (b) Single: Total hours (c) Wives: Weekly hours

### 3.4.5 Testing model fit

Table 3.8 reports coefficients and $\chi^2$ statistics for tests comparing simulated data to SLID data. Pooling together real and simulated data we estimate the following reduced form (unbalanced) system of equations:

$$\begin{aligned} y_{it}^g = \zeta_0^g X_{it} + \mathrm{S}_i + \mathrm{M}_i \ &+ \ \sum_k [\zeta_{1k}^g A_{kit} + \zeta_{2k}^g A_{kit} \times \mathrm{S}_i \\ &+ \ \zeta_{3k}^g A_{kit} \times \mathrm{M}_i + \zeta_{4k}^g A_{kit} \times \mathrm{S}_i \times \mathrm{M}_i] + \epsilon_{it}^g \end{aligned}$$

where $g \in \{m, f\}$; $y_{it}$ is the economic measure of interest for disabled men; S is an indicator variable taking the value 1 if the observation is from the SLID and zero otherwise; M is an indicator variable taking the value 1 if the individual is married and zero otherwise; and $X$ contains all the demographic variables from 3.12 interacted with S, health status (which is available for both SLID and simulated samples), and a constant. As in (3.12), $A_k$ is an indicator variable for year from onset $k \in \{0, 10\}$. M is a dummy flagging individuals who are married. Coefficient vector $\boldsymbol{\zeta_2^m}$ roughly captures how post-onset changes in $y$ for single men differ between the real and simulated sample; $\boldsymbol{\zeta_4^m}$ captures the difference-in-differences in the responses single and married men across the real and simulated samples; $\boldsymbol{\zeta_2^f}$ is constrained to be zero since spouses work zero hours in single male households in both samples by definition; and $\boldsymbol{\zeta_4^f}$ captures the difference in wives' responses to a husband's disability onset across the real and simulated samples. We apply a seemingly unrelated regression estimator adjusted to allow for clustering of the errors at the individual level as well as covariation across equations. A joint $\chi^2$ test of $\{\boldsymbol{\zeta_2^m}, \boldsymbol{\zeta_4^m}, \boldsymbol{\zeta_4^f}\}$ provides a test of whether the model can fit dynamic responses to disability onset for a given $y$ among SLID households.

We report results for the case where $y$ is total hours worked. Coefficient values for $\{\boldsymbol{\zeta_2^m}, \boldsymbol{\zeta_4^m}, \boldsymbol{\zeta_4^f}\}$ are given in the first, third and fifth columns of table 3.8 respectively, with $**$ denoting significance of the coefficients at the 5% confidence level and $***$ denoting significance at the 1% level. The even-numbered columns report cumulative $\chi^2$ statistics for each relevant $\zeta$ vector. The $\chi^2$ statistic and associated $p$ value from the joint test of $\{\boldsymbol{\zeta_2^m}, \boldsymbol{\zeta_4^m}, \boldsymbol{\zeta_4^f}\}$ from 0 to 10 years from onset is given in the last row of the table. As it is often the case with this kind of tests, the overall model is just rejected at 1%. However, the cumulative $\chi^2$ tests for each $\zeta$ tell a slightly nicer story. The simulations slightly understate the decline in single men's labour supply, and the resulting difference between married and single responses, at later years from onset, with the effects becoming cumulatively significant around seven years post-onset. There are no significant differences between the simulated and empirically observed added worker effects either individually or cumulatively.[57]

[57]Results using participation as the dependent variable are omitted for space but are qualitatively similar.

Table 3.8: Testing model responses following shocks - different lags

| | $\zeta_2^m$ | Cum $\chi^2$ | $\zeta_4^m$ | Cum $\chi^2$ | $\zeta_4^f$ | Cum $\chi^2$ |
|---|---|---|---|---|---|---|
| 0 | 0.68 | 0.20 | 0.82 | 0.25 | $-0.2$ | 0.04 |
| 1 | 1.97 | 1.82 | $-0.41$ | 0.31 | $-1.29$ | 2.00 |
| 2 | 2.03 | 3.06 | $-0.46$ | 0.38 | $-2.27$ | 6.85 |
| 3 | 0.95 | 3.18 | 0.81 | 0.57 | $-2.15$ | 9.47 |
| 4 | $-0.4$ | 3.35 | 1.26 | 0.96 | $-1.73$ | 10.26 |
| 5 | $-1.04$ | 3.85 | 2.03 | 1.86 | $-0.62$ | 10.46 |
| 6 | $-5.59$ | 11.42 | 6.06** | 8.76 | $-0.62$ | 10.57 |
| 7 | $-7.56$** | 21.11*** | 9.56*** | 21.69*** | $-1.04$ | 10.58 |
| 8 | $-6.40$** | 28.59*** | 9.50*** | 35.59*** | $-2.19$ | 11.76 |
| 9 | $-3.09$** | 30.10*** | 5.89*** | 40.68*** | $-1.44$ | 11.90 |
| 10 | $-4.15$** | 32.98*** | 5.94** | 46.06*** | $-3.46$ | 15.63 |
| | $H_0 : \zeta_2^m = \zeta_4^m = \zeta_4^f$ | $\chi^2 = 55.6$, p=0.009 | | | | |

[a] ** denotes significance at 5%; *** denotes significance at 1%. Coefficients in odd-number columns give reported coefficients; coefficients in the even-number columns give cumulative $\chi^2$ tests of the coefficients in the previous column.

### 3.4.6 Robustness checks and additional empirical evidence

#### Home vs. work-limiting shocks

In both model and data we distinguish between work-limiting and *nll*-limiting shocks. The latter are important because they limit the gains from substituting spousal labour supply in the market when husbands experience a shock. This section reviews the relative effects of marital status on labour supply for different types of shock, comparing simulated data to the 2002-2007 cross sectional files of the SLID.

Table 3.9 shows results from an OLS regression of average weekly hours worked on marital status, dummies for home-limiting or work-limiting disability, interactions between marital status and both types of disability, and other demographic variables both current and averaged over time if the individual appears in more than one year. Standard errors are clustered at the individual level in both regressions. As we would expect, work-limiting disability ($\delta_n$) has a larger level effect on hours worked than home-limiting disability ($\delta_h$). The former induces both a substitution and time-loss effect on labour supply, while the latter induces only a time-loss effect. Reduced form correlations between marital status and labour supply are similar be-

Table 3.9: Married and single responses to home- and work-limiting shocks

| | SLID coef | Proportional change | Model coef | Proportional change |
|---|---|---|---|---|
| $\delta_h$ | -3.39 | | -3.10 | |
| | (.978) | | (.513) | |
| $\delta_n$ | -10.90 | | -13.39 | |
| | (1.05) | | (.475) | |
| *married* | 2.46 | | 3.41 | |
| | (.440) | | (.095) | |
| $married \times \delta_h$ | 2.09 | .62 | 3.10 | 1.0 |
| | (1.13) | | (.610) | |
| $married \times \delta_n$ | 4.58 | .42 | 5.63 | .42 |
| | (1.23) | | (.696) | |

tween the model and the data. The model somewhat overstates the "return" to marriage in terms of hours lost to to home-limiting shocks. However, in both model and data, this 'return' is larger in absolute value for work-limiting shocks, but larger in relative terms (the second and fourth columns of table 3.9) for home-limiting shocks.

**Data evidence on time use and disability**

Our results suggest that added worker effects may exist, albeit concentrated in the informal household sector, rather than in the formal market sector. In general it is difficult to find direct evidence of changes in home production due to disability onset. Time spent on *nll* activities, such as housework, is not available in most income surveys (including the SLID), while time-use surveys, like the 2005 General Social Survey for Canada and the American Time Use Study (ATUS), typically provide time-use and demographic information only for one household member. Our model makes no direct predictions about the time that a disabled individual would spend on household tasks, even conditional on a given level of market work.[58] The model does, however, predict that *wives* of disabled men increase their own share of home production, conditional on husbands remaining the main household earners and continuing to work close to pre-onset hours. When a husband supplies only few hours of market work, we would expect to see small or negative

[58]A disabled husband substitutes away from *nll* activities because they are costly in terms of time and effort (substitution effect). However *nll* activities in which he does engage consume more of his time (time-loss effect).

effects of his disability on wife's *nll*.

Table 3.10 reports empirical evidence in support of this conjecture. Using the same sample from the 1999-2005 PSID files which provided information about the *nll* sharing technology, we regress wives' average weekly reported hours of housework on an indicator for dual-earner status, the couple's wage ratio (interacted with dual-earner status; for single-earner or non-working households $wr$ is not observed), family income, a dummy for husbands reporting work-limiting disability, husband's average weekly market hours, and interaction of disability and market hours ($inter_m$).[59] Column 1 reports results from this regression for all couples under 66. The next three columns document this relationship by age category: 51-65; 36-50 and 35 and under. The first six rows report estimated coefficients (and standard errors); the seventh row presents average reported hours of housework for wives in the age range; the last row shows results of a $F$ test for joint significance of $ds_m$ and $inter_m$.

The results support the general implication of the model: for men who work very little, a husband's disability reduces the wife's time devoted to *nll*, but this effect is reduced, and eventually reversed, for disabled husbands contributing sufficient hours of market work. The joint effect of disability, and disability interacted with hours, on predicted housework is jointly significant for all groups except the youngest, for which we only have 150 observations on disabled husbands, at conventional levels; the joint test of $n_m$, $ds_m$ and $inter_m$ (not reported) is always significant at 1%.

To put these results into perspective, the wife of a currently disabled husband working 45 hours a week, performs on average 1.6 hours – or about 9% – more housework per week than the average wife.

### Cohabitation and endogenous marital status

Our extended Model E helps explain differences in labour supply by disability status for individuals, conditional on not changing marital status over a six-year window. However, we simplify by excluding some important aspects of household life. In these final extensions, we modify the model to take into account two of them: first, the possibility that single men may receive transfers of time from household adults other than spouses, including parents or grown children; second, that the likelihood of marital dissolution rises for individuals experiencing chronic work-limiting disability.

[59] The sample is the one used to estimate the *nll* technology, with the restriction that spouses may not be more than five years apart in age.

Table 3.10: PSID: Wives' housework and husband's disability status

| Wife's hours of housework $h_f$ | All | 51-65 | 36-50 | 20-35 |
|---|---|---|---|---|
| $n_m$ | 0.099 | 0.103 | 0.108 | 0.078 |
| | (0.550) | (0.020 | (0.021) | (0.0383) |
| $ds_m$ | $-3.326$ | $-1.817$ | $-5.435$ | $-5.536$ |
| | (1.236) | (1.757) | (1.617) | (3.556) |
| $n_m \times ds$ | 0.106 | 0.090 | 0.135 | 0.156 |
| | (0.030) | (0.046) | (0.038) | (0.083) |
| average $h_f$ | 18.8 | 19.2 | 18.6 | 18.7 |
| $F_2$ | 1% | 10% | 1% | 20% |

Several recent papers have considered the economic consequences of cohabitation (see, for instance [31]). While the literature has focused on cohabitation between couples, in our model the ability to receive time transfers, from household adults *other than* spouses, could be an important determinant of the relative effects of disability between marrieds and singles. We therefore extend the model to allow unmarried men who live with other adults other than spouses (approximately 38.5% of the sample of prime-age single men in our data, with 25% of these living with non-family friends and the remaining 75% living with parents or other family members) to acquire time from their cohabitors. Cohabitors are assumed to have the same *nll*-completing ability as wives, $nll_{ch} = ah_{ch}^{\alpha} = 2.037h_{ch}^{.776}$, where $h_{ch}$ is the amount of time other household members spend on the individual's *nll* tasks.[60] Each unit of $h_{ch}$ costs the cohabiting single man $p_{ch}$. For simplicity we treat $p_{ch}$ as a pecuniary cost rather than the psychic, or utility, cost of asking family members for help. Further details of the estimation are given in Appendix B.3.

In our second extension, we allow for the probability of divorce to vary with disability status. Couples in which husbands have severe work-limiting disabilities (*ds* 4 and *ds* 6) are made five times more likely to be hit with a divorce shock, with the divorce arrival rates of healthy and non-work-limited men adjusted to achieve the same divorce rate of 21%, and the same distribution of men across health status, as in the base model. Figure 3.12 plots simulation results for participation of single men, married men and wives following disability from these extensions. In each figure, the thick

[60] In general, the results are not locally sensitive to changes in the time-transfer technology.

line shows the extended model described above and the thin line shows the result from Model E. The dashed lines show the usual estimates from the data.

Allowing for time transfers from cohabitors marginally improves the fit of the model for single men on the participation margin—for instance, the sum of squared differences between the model line and the data line for total hours responses falls from .062 to .058. However, introducing time transfers from cohabitors reduces the fit overall due to the higher estimated disability costs required to generate the observed weekly hours drops for singles. In general, the effects of cohabitation do not appear crucial in explaining responses to disability onset by marital status.

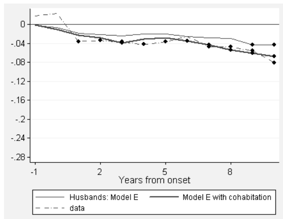
Our crude measure of endogenous divorce hazard, by contrast, does improve the fit for singles while having almost no effect on the responses of married men. For married men, there is a tradeoff between a reduced incentive to cooperate due to increased likelihood of divorce following disability onset and a generally less disabled pool of married men due to the negative selection out of marriage. For singles, the selection effect out of marriage improves the fit of the model by creating a larger observed cross-sectional drop in participation, more or less eliminating the discrepancy between model and data described in Section 3.4.5. We leave further explanation of endogenous marriage—and the possibility that divorce is an optimal choice variable rather than a shock—to future research.

## 3.5 Conclusion

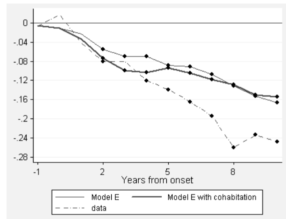
This chapter investigates the way cross-sectional risk can be insured over the the life cycle. Using panel information about the timing, persistence and responses to disability shocks among Canadian men, we show how a model allowing for human capital and endogenous intra-household allocations of time is consistent with observed patterns of labour supply and wages following disability onset across married and single households.

Perhaps the major limitation of the model presented in this chapter is that it is concerned only with how individuals and their partners deal with shocks *conditional* on being sorted into a specific match. Most likely, however, health and wealth outcomes are determined simultaneously with marital status. Endogenous marital sorting obviously has major implications for the type and quality of insurance against health shocks provided by the family. In future research, we will extend the model to focus on the way individuals select themselves into marriages and thereby gain, and lose,

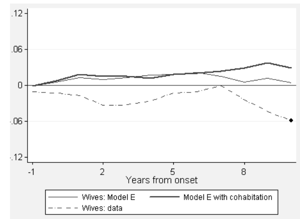
Figure 3.12: Participation responses: Cohabitation and endog. marriage



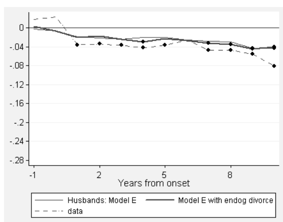

(a) Married men: Model with cohabitation



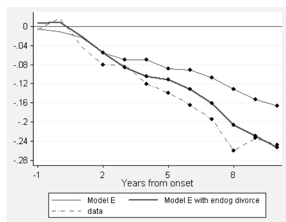

(b) Single: Model with cohabitation



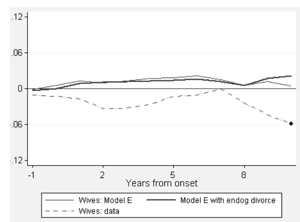

(c) Wives: Model with cohabitation




(d) Married men: Model with endog mar




(e) Single men: Model with endog mar




(f) Wives: Model with endog mar

access to marital insurance.

# Chapter 4

# Social Security, Endogenous Retirement and Intrahousehold Cooperation

## 4.1 Introduction

A significant body of research has developed studying the retirement incentives of public pension systems, and especially those associated with the U.S. Social Security benefit system.[61] A major theme in this literature is the difficulty of explaining observed patterns of retirement: the large peak in regular retirement at age 62, the first year at which Social Security retirement benefits are available to most workers; and the tendency of husbands and wives to retire together when the husband reaches 62.[62] The peak in retirement at 62 is puzzling in the context of a standard representative-agent life cycle model with asset accumulation, because individuals can increase the size of the (riskless) claimed benefit at a rate of around 6.5% a year (under 2000 SSA rules) by delaying retirement up to age 70, which is, on average, approximately actuarially fair and should therefore be an attractive option for individuals who expect to live a long time. Joint retirement is difficult to reconcile with standard preferences since men and women have different incentives to delay retirement: women live longer on average and are more likely to rely primiarly on household-level savings or on a partner's accumulated benefit income both before and after widowhood.

In this chapter I develop a standard life cycle model of a two-person household with a retirement decision[63], and examine two modifications to

[61] See, for instance, [29] on incentives for early or delayed retirement for workers in their 60s, or [7] on incentives for younger workers to apply for disability benefits.

[62] [37] provide a recent overview of the structural and empirical literature on retirement patterns, and propose a solution to the early retirement puzzle based on heterogeneous discount rates.

[63] See [45] or [19] for examples of dynamic models with a retirement decision, or [68] for an example for a married household.

this benchmark model that can potentially reconcile observed retirement behaviour. The first is a model in which members of married couples benefit from complementarities in leisure during retirement. Several authors have advanced leisure complementarities as a potential explanation for the early joint retirement patterns of couples.[64] The mechanism driving this result is straightforward: the utility boost from joint retirement induces couples to forego the economic benefits of delaying retirement, and raises their incentive to retire together or within one or two years of each other. Indeed, when calibrated to replicate the share of individuals leaving work by age 64, I find that the complementarities model can easily explain the observed retirement patterns. However, it does a poorer job of explaining some other aspects of life cycle retirement behaviour: in particular, it predicts too much delayed claiming of Social Security benefits; too little use of "bridge jobs" as transitions into retirement; and much shorter durations on disability insurance (SSDI) than are observed in the data.

An alternative model places the retirement problem, and related career decisions, in a household model in which retirement choices are individual-level decisions that may be made "non-cooperatively". In all the models, I adopt a standard approach from the dynamic collective household literature by assuming that couples make choices according to a fixed "power-sharing" rule or "marriage contract" that assigns a weight $\lambda$ in the household problem to one member's private continuation function and (1-$\lambda$) to the other. The twist to this standard framework is that, while household members follow the rules of their marriage contract conditional on their career or retirement status, they may find it optimal to violate the contract in choosing when to retire from work or quit a career job. Effectively, this is because the marriage contract imposes a positive externality on the less productive spouse and, conversely, prevents individuals from internalizing all the benefits of career work. Since the household planner imposes the efficient solution to the period-by-period problem, a high-productivity ("career") worker has obligations to provide for his spouse that he can forego by changing his labour force state ($lfs$) and the parameters of the household planner's problem.

The theoretical framework I develop to examine the implications of non-cooperation over career decisions is similar to [36], with the addition of productivity and health risk that increases over the life cycle and a more flexible model of retirement in which individuals can move between $lfs$ states—i.e. can "unretire"—up until age 75. It turns out that this model can potentially capture several features of observed retirement patterns: step retirement by

[64]See [53] for the U.S. case, and [42] for Europe.

the use of non-career bridge jobs, early retirement under the Social Security Disability Insurance (SSDI) program; and return to work by older workers who have previously claimed their social security benefits. The introduction of "unretirement" and bridge jobs produces additional testable implications for the model. In the non-cooperative model, in contrast to the complementarities model, individuals who enter SSDI rarely exit again before death or reaching regular retirement age as they benefit from the shift of primary earner status to their spouse. They are also much more likely to shift into lower-paid bridge work prior to retirement in order to escape primary earner responsibilities. Th resulting lower earning potential in the later part of life in turn reduces the incentives of the spouses to delay retirement leading to a large spike in retirement at age 62.

The models developed below—the benchmark, complementarities- in-leisure, and non-cooperative model—are designed to capture the salient features of the U.S. social safety net, SSDI, early and delayed retirement (SSR) benefits, spousal and widow benefits. Individuals are subject to productivity and health risk processes that intensify over the life cycle. Within this framework, I examine the effects of retirement policy and resulting patterns of retirement in a world in which households are fully cooperative over all aspects of married life, and a model in which they are cooperative only over continuous variables—consumption, labour supply and asset accumulation—that are chosen within, and conditional on, household members' labour force status. Both the complementarities and the non-cooperative models perform reasonably well at replicating rates of retirement from the labour force among married couples. However, the non-cooperative models do a better job at matching patterns of SSR claiming, SSDI application and exit patterns and a somewhat better job of explaining bridge job behaviour. The different models also have non-trivial implications for policy. In the cooperative models, with and without complimentarities, the status quo produces a net welfare gain for essentially all individuals born into the economy, relative to either an across-the-board benefit cut or elimination of either SSD or early retirement benefits under SSR. This is not true for the non-cooperative case. In particular, husbands are better off in the non-cooperative world if the spousal benefit under Social Security were eliminated. This is because the existence of the spousal benefit reduces the wife's attachment to the labour force and her likelihood of being in a career job in late middle age, and forcing the husband into primary earner status under the marriage contract.

The rest of the chapter proceeds as follows. I present the household problem and the nature of the non-cooperative retirement game in Section

4.2. In section 4.3, I introduce the model economy and describe the sources of risk and the policy environment faced by individuals and households. In Section 4.4, I present the results from the chapter. In Section 4.4.1 I examine how well the three models do in replicating several features of household behaviour among the 1998-2006 panel of the Health and Retirement Study—in particular, patterns of social security benefit (SSR) take-up during the retirement window ages 62-69 within and across households; bridge job behaviour of married men and women; and use of the SSDI program for individuals with poor health. In Section 4.4.2, I compare the welfare results from the two models under the existing Social Security program (the "benchmark") and three policy experiments described above. Section 4.5 concludes.

## 4.2 Individuals and households

Life in the model is as follows: households, either one-member or two-member, form at age 25 and survive to a maximum age of 90 years. A model period is one year. Lifespan of individuals and households is uncertain ex-ante. $\varphi^{j}_{\delta,i}$ (hereafter $\varphi_i$ for brevity) is the time invariant probability of living from age $j$ to $j{+}1$ for an individual of gender $i$ and disability/health status $\delta$. 15% of households in the model are single, and the remaining 85% are married in the first period of life.[65] Individuals of each gender are identical ex-ante, but households form with different levels of assets: 80% of individuals are born into the economy with zero assets. 20% are born with assets equivalent to $40,000, which gives a reasonable approximation to the wealth distribution of the lower 98% young households observed in the 1989-2001 wealth files of the PSID. Individuals value consumption $c$ and leisure $l$. They have gender-specific time discounting factors $\beta_i$ and face a time-invariant interest rate $r = .042$. Disposable time, $\tilde{T}$, is the amount of time individuals can divide between labour ($n$) and leisure, net of sleep, time lost to sickness or disability, and mandatory non-labour, non-leisure activities (see section 4.3.1 for further discussion of these.)

At every age $j$, males and females find themselves in one of a theoretically infinite number of six-dimensional variable states. The dimension are (1) accumulated non-human wealth holding $a$; (2) wage/productivity level $w$; (3) health/disability status $\delta$; (4) accumulated Social Security credit from previous work $E$; (5) marital status $ms \in \{0, 1, 2\}$ (0 for single; 1 for low-quality marriage; 2 for high-quality marriage), and (6) labour force status $lfs$, which takes three values: "career-job", "non-career job" or "retired".

[65] Actual average ages of first-marriage which are 25 for women and 27 for men.

There are two major sources of life cycle risk: productivity risk, which affects $w$, and disability/health risk, which imposes a cost in terms of disposable time, $\chi(\delta)$, increases mortality risk, and imposes medical costs on individuals under 65 in who are currently in non-career jobs. The $ms$ state has three potential direct effects on welfare, the first two of which are common to all three models developed. The first arises through fertility, which generates dependency costs of children $\widetilde{\eta}$ early in the life cycle. The second arises due to the economies of scale in shared household-level consumption.[66] Third, married individuals may receive utility from leisure enjoyed jointly.

Current $lfs$ is endogenous for individuals under a maximum retirement age of 75. Individuals are retired when they are not working and are receiving benefits under the Social Security or Supplemental Security Income (SSI) programs. Non-retired individuals may be in either career- or in non-career jobs. Wages are exogenously lower in non-career jobs, and individuals do not have access to health insurance in these jobs. Individuals can choose to move from a career to a non-career job by quitting the career job; while in a career job individuals work a minimum of 40 hours per week, but may choose to work part time, full time or not at all while doing non-career work. Non-career jobs become career jobs at rate $p_C$ when individuals work at least 40 hours a week and at rate 0 otherwise.

In terms of the model state space, $lfs \in \{C, NC, R, A\}$. $C$ ($NC$) denotes an individual who is currently working in a career (non-career) job. $R$ denotes an individual who is fully retired and receiving Social Security retirement benefits.[67] The final state, $A$, denotes an individual who is currently not working while applying for benefits. Unsuccessful SSD applicants who apply from the career job state forfeit their job and fall off the career track into non-career work.

### 4.2.1 Life cycle optimization

Below, I sketch out the dynamic optimization problem for single and married households. I begin with single households whose problem is the simplest,

[66] The "consumption boost" from marriage is calibrated to generate reasonable spousal labour supplies. In future work, the extent to which marriage generates consumption economies of scale can relate to the quality of the match.

[67] Once individuals claim retirement benefits, they do not work. Under SSA rules, individuals do not have to retire from their career job to claim SSR benefits. However, they are subject to a reduction in their benefit of \$13,560 for every dollar earned before regular retirement age. After regular retirement age, many career jobs contain incentives to force or induce career workers to retire. These incentives are also captured in the model.

and also is the same in all the models, regardless of my assumptions about intrahousehold cooperation and preferences.

**Singles**

In the standard cooperative, the non-cooperative, and the complementarities in leisure regimes, a single individual with gender $i$ and age $j$ has a generalized value function $V_j^i$, which can be carried across $lfs$ states. The state vector is $x = \{a, E, w, \delta, 0\}$. The dynamic optimization problem of the individual in a career job (with corresponding value function $V_j^{i,C}$) and state vector $x$ is:

$$V_j^{i,C}(x) = \max_{\{c,l,a^{'}\}} u(c,l) + \beta_i \varphi_i \mathtt{E}_j[V_{j+1}^i(x')] \tag{4.1}$$

subject to budget set $B_S$:

$$\begin{aligned} \xi_1 : &\quad (\tilde{T} - \chi(\delta) - l)w + (1+r)a + b(.) = c + a^{'} \\ \xi_2 : &\quad l < \tilde{T} - \chi(\delta) \\ \xi_3 : &\quad a^{'} \geq 0 \end{aligned} \tag{4.2}$$

where

$$V_{j+1}^i = \max \left\{ V_{j+1}^{i,C}, V_{j+1}^{i,NC}, V_{j+1}^{i,A} \right\} \tag{4.3}$$

The expectation $\mathtt{E}$ at age $j$ is taken with respect to $\delta$ and $w$. The problem for a non-career worker is similar:

$$V_j^{i,NC}(x) = \max_{\{c,l,a^{'}\}} u(c,l) + \beta_i \varphi_i \mathtt{E}_j[V_{j+1}^i(x^{'})] \tag{4.4}$$

subject to $B_S$, and

$$V_{j+1}^i = \max \left\{ p_C(l^*) V_{j+1}^{i,C} + (1 - p_C(l^*)) V_{j+1}^{i,NC}, \;\; V_{j+1}^{i,A} \right\} \tag{4.5}$$

The dynamic program for a retiree is:

$$V_j^{i,R}(x) = \max_{\{c,a^{'}\}} u(c, l^{max}) + \beta_i \varphi_i \mathtt{E}_j[V_{j+1}^i(x^{'})] \tag{4.6}$$

subject to $B_S$, and

$$V_{j+1}^{i} = \max\left\{V_{j+1}^{i,NC}, V_{j+1}^{i,R}\right\} \quad \text{if} \quad j < 75$$
$$V_{j+1}^{i} = V_{j+1}^{i,R} \quad \text{if} \quad j \geq 75 \tag{4.7}$$

Finally, the dynamic program for an applicant is:

$$\begin{aligned} V_j^{i,A}(x) &= p_\delta V_{j+1}^{i,R}(x) + (1-p_\delta)(u(c, l^{max}) + && \text{if} \quad j < 62 \\ &\qquad \beta_i \varphi_i \mathtt{E}_j[V_{j+1}^{i,NC}(x')] - c_A) && \\ V_j^{i,A}(x) &= V_j^{i,R}(x) && \text{if} \quad j \geq 62 \end{aligned} \tag{4.8}$$

The solution to the optimization problem gives optimal intratemporal choices $c^*$ and $l^*$. The term $l^{max} = T - \xi(\delta)$ is the leisure the individual obtains when he or she does not work. The parameter $b(.)$ corresponds to the net transfer the individual receives from the government, after taxes are paid and transfers, including Social Security benefits, are received. It is described in detail in Section 4.3. Career workers (under the maximum retirement age) have three $lfs$ options each period: remaining in their full-time career job, quitting to a lower-paid, flexible-hours non-career job, or applying for retirement benefits. Non-career workers have two options: to continue in their non-career jobs (with potential to move back into career jobs conditional on $l^*$) or to apply for retirement benefits. Individuals who have not yet reached the early retirement age of 62 cannot access their regular social security benefits, but may apply for disability benefits. Application requires a full year not working, regardless of whether the application is successful. The probability of acceptance $p_\delta$ depends on current health status and whether the worker is over or under age 55. As well, there is a one-shot non-pecuniary cost associated with rejection, $c_A$, which I take to be a stigma or hassle cost. This cost does not apply to individuals who are eligible for regular retirement benefits; for age-eligible individuals, applications are always successful.

At 62, individuals become eligible for regular retirement (SSR) benefits, and SSD recipients have their benefits converted to the regular retirement-age SSR benefit.[68] Retirees, under SSD or SSR, may leave the rolls and re-enter the labour force in a non-career job to work in any year before they reach the maximum retirement age of 75.

[68] Elimination of SSD application after 61 is a simplification given that, empirically, we observe individuals continuing to apply for SSD benefits into their 60s. This is because of the regular benefit reduction before age 66, described in Section 4.3, does not apply to disability benefits claimed after age 66. In the model, however, I assume that individuals who retire between 62 and 65 receive the regular retirement age benefit with probability $p_\delta(x)$ and the age-adjusted benefit with probability $1 - p_\delta$.

### Marrieds: The household-level optimization problem

The dynamic problem for married couples at the household level is conceptually similar to that for singles. I define the individual value function for husbands ($i = m$) and wives ($i = f$) $\Upsilon^i_j$. The married household has a global value function $U_j$, a weighted sum of the individual members' $\Upsilon$s. $U$ can be understood as the value function maximized by a household social planner whose task is to implement a predetermined marriage contract.

$$U_j(x_M) = \lambda \Upsilon^f_j(x_M) + (1-\lambda)\Upsilon^m_j(x_M) \tag{4.9}$$

The household's state vector is $x_M = \{a, E_m, E_f, w_m, w_f, \delta_m, \delta_f, \lambda\}$. Assets are accumulated at the household level, but social security benefit accumulation, wages and health are individual-level, $\imath-$ indexed states. The utility weight $\lambda$ is chosen in the initial period of the couple household's existence. A typical assumption, dating to [54] is that $\lambda$ is chosen through cooperative (Nash) bargaining, in which both household members' threat points are $V^i_1$ from the single person's optimization problem defined above. The exact value of $\lambda$ is then partly a function of the partners' unobserved relative psychic gains from marriage: how much the husband and wife respectively value being married for non-economic reasons. In practice, I do not parameterize psychic gains from marriage, but choose a constant $\lambda$ for all couples that generates realistic mean labour supplies for husband and wives.

The household budget set for marrieds, $B_M$ is:

$$\begin{aligned}
\xi_1: &\quad (\tilde{T}_m - \chi(\delta_m) - l_m)w_m + (\tilde{T}_f - \chi(\delta_f) - l_f)w_f + (1+r)a + b(.) = \\
&\quad c + a^{'} \\
\xi_2 a: &\quad l_m < \tilde{T}_m - \chi(\delta_m) \\
\xi_2 b: &\quad l_f < \tilde{T}_f - \chi(\delta_f) \\
\xi_3: &\quad a^{'} \geq 0
\end{aligned} \tag{4.10}$$

$B_M$ is analogous to $B_S$ for a two-member household, and consumption $c$ is household-level, rather than individual-level, consumption.

The household planner's dynamic program and choice over $lfs$ states of the household members is similar to the problem solved by singles, except that the planner chooses the optimal $l$ and $lfs$ for *both* members concurrently. There are sixteen possible $lfs$ states for a married household, the product of the vectors $\Psi\Psi^{'}$ where $\Psi = [C_f, NC_f, A_f, R_f]$. Each member of the household faces the same transition possibilities between $lfs$ states for given age and individual state vector $x$ as his or her single counterpart defined above, though the *payoffs* within each $lfs$ state depend not on $x$ but on $x_m$.

For expositional purposes, the value function for the husband and wife of a couple both in career jobs is:

$$\begin{aligned} \Upsilon_j^{m,CC}(x_M) &= u^m(c^*, l_m^*, l_f^*) \\ &+ \beta_m \varphi_m \mathtt{E}_j[\varphi_f \Upsilon_{j+1}^{m,*}(x_M^{*'}) + (1-\varphi_f) V^m(x_m^{*'})] \\ \Upsilon_j^{f,CC}(x_M) &= u^m(c^*, l_m^*, l_f^*) \\ &+ \beta_f \varphi_f \mathtt{E}_j[\varphi_m \mathtt{E}\Upsilon_{j+1}^{f,*}(x_M^{*'}) + (1-\varphi_m) V^f(x_f^{*'})] \end{aligned} \tag{4.11}$$

Here, the $*$'d choice parameters are the values chosen by the planner given $\{j, x_m\}$. These choices include the next-period household $lfs$. So long as the marriage continues, both partners passively accept the planner's choices over household level $\tilde{c}$ and $a$, and individual $l$ and $lfs$, which are chosen to maximize a weighted sum of the partners' individual $\Upsilon$s. Upon the death of one or the other household member, which occurs with probability $1-\varphi_i$ for spouse $i$, the surviving spouse $i$ reverts to the single optimizing state (with value function $V^i(x)$), and inherits the household's stock of assets (that is, the planner's choice of carry-forward assets). $\Upsilon_j^i, i \in \{m, f\}$ may, in theory, be greater or less than the payoffs to autonomous optimization in the single state, $V$, depending on whether the economic and psychic gains from marriage outweigh the loss of autonomy. Note that period utility $u$ depends on household consumption, own leisure and spousal leisure. In the benchmark model and non-cooperative models, spousal leisure carries a weight of zero in $u$; in the complimentarities-in-leisure model, however, own and spousal leisure enter period utility as complements.

### Marrieds: non-cooperation

The non-cooperative model outlined here can be best thought of as adding an additional step to the household optimization problem outlined above. The household social planner first chooses the optimal allocation and $lfs$ of members according to the marriage contract as described above. Before accepting the planner's decisions, individual household members determine whether or not they can individually benefit from *deviating* from this allocation by choosing a different $lfs$—for example, quitting their career job or putting in for social security benefits. In a final stage of the problem within any age and realization of state space, individual $i$ (with spouse $-i$) finds his optimal individual payoff from across the feasible choices of $lfs$. For a career worker, this final-stage problem is:

$$\hat{\Upsilon}j^i = \max \begin{Bmatrix} p(\delta)\hat{\Upsilon}_j^{i,R,lfs_{-i}|A} + (1-p(\delta))\hat{\Upsilon}_j^{i,A,lfs_{-i}|A}, \\ \hat{\Upsilon}_j^{i,C,lfs_{-i}|C}, \quad \hat{\Upsilon}_j^{i,NC,lfs_{-i}|NC} \end{Bmatrix}$$

For a non-career worker, the problem is:

$$\hat{\Upsilon}j^i = \max \left\{ p(\delta)\hat{\Upsilon}_j^{i,R,lfs_{-i}|A} + (1-p(\delta))\hat{\Upsilon}_j^{i,A,lfs_{-i}|A}, \quad \hat{\Upsilon}_j^{i,NC,lfs_{-i}|NC} \right\} \tag{4.12}$$

For a retiree under 62, the problem is:

$$\hat{\Upsilon}j^i = \max \left\{ \hat{\Upsilon}_j^{i,R,lfs_{-i}|R}, \ \hat{\Upsilon}_j^{i,NC,lfs_{-i}|NC} \right\} \tag{4.13}$$

In these equations, $\hat{\Upsilon}$ is the within-marriage value function for individuals who accept the household planner's choices within any given $lfs$ but who deviate from the planner's choice over $lfs$—in other words, it is the analogue of $\Upsilon$ within the non-cooperative regime. Note that, in the non-cooperative world, $\hat{\Upsilon}$ is also the value function that enters the planner's problem $U$, which can lead to different household outcomes even when individuals end up following life cycle paths of retirement that involve no direct deviations. In this regard, the problem presented in (4.12-4.13) is somewhat similar to a married individual's optimization problem in an economy with divorce as an outside option (see, for instance, [57] or [27]), with one crucial difference: once it becomes the optimal choice for $i$ to divorce his spouse, he no longer cares about how $-i$ responds. However, non-cooperative decisions over retirement are examples of *internal* threat points (see [52]). In this case, $i$'s optimal choice depends on $-i$'s optimal response to his own retirement decision. This is true whether or not $i$'s non-cooperative decision coincides with the planner's allocation.

If neither spouse is in a career job, and the household is under the maximum retirement age of 75, the spouses play the relevant game defined by 4.12-4.13 simultaneously. Therefore, there is not a unique outcome for all realizations of state space. I impose the following assumptions on non-cooperative retirement behaviour:

1. Assumption #1: Spouses never play mixed strategies.

2. Assumption #2: If no (pure) Nash equilibrium exists, the spouses revert to the planner's solution.

3. Assumption #3: If more than one (pure) Nash equilibrium exists, the players revert to the planner's solution.

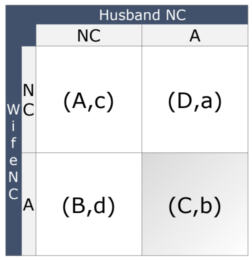
4. Assumption #4: If a Nash equilibrium exists that makes both spouses worse off, the players revert to the planner's solution

For a couple made up of non-career workers, or retirees under 75, assumptions #1-#4 together imply that the couple deviates only in the event that at least one spouse has a dominant strategy over the feasible choices of $lfs$, and that the Nash equilibrium outcome that results differs from the planner's. Figure 4.2 shows four types of outcome that can arise: the first of which give rise to potential deviations and the other three which do not. In each case, the payoffs are given by $(wife, husband)$, with A>B>C>D for the wife and a>b>c>d for the husband. Figure 4.2(a) shows the case in which the $NC$ husband applies for benefits regardless of the wife's decision. The wife applies for benefits only if the husband also does so: the Nash equilibrium is $\{A, A\}$. Subfigure 4.2(b) shows a case in which both partners have dominant strategies to retire, but that playing these strategies leaves both members of the couple worse off than following the jointly optimal decision. Here, the couple finds itself in a "prisoner's dilemma" and cooperates to avoid this outcome, landing on {NC,NC} with payoffs {B,b}. In figure 4.2(c), there is no pure strategy Nash equilibrium. In (4.2(d)), both $\{A, A\}$ and $\{NC, NC\}$ are Nash equilibria.

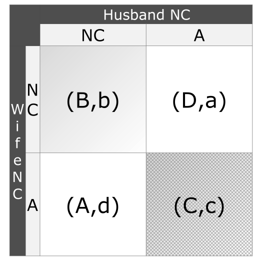
The assumptions that require that figures 4.2(c) and 4.2(d) do not result in deviant outcomes are motivated by three facts: (1) the single-shot Nash game played once per period is actually an approximation to a repeated static game that is played within a period until a stable outcome is reached; (1) retirement (or benefit application) is not a binding state for individuals under 75; at any point, an individual can opt back into non-career work; (3) spouses find uncertainty over their $lfs$ status within a model period costly and therefore avoid it (a form of risk aversion not formally captured by preferences), converging instead on the focal point provided by the planner's solution.

The 2x2 case holds for pairs neither of whom is currently in a career job: for the $\{R, R\}$, $\{NC, R\}$ and $\{R, NC\}$, the potential resolutions of the game are identical except that state $A$ is is replaced by $R$ for spouses who are currently receiving disability benefits. The problem is slightly more complicated, with greater potential for deviant behaviour, if at least one spouse is in a career job, $lfs^i = C, i \in \{f, m\}$. This is because, unlike applying for benefits, retiring from a career job *is* a binding decision that

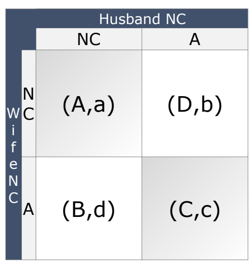
Figure 4.1: Non-cooperative outcomes for non-career workers



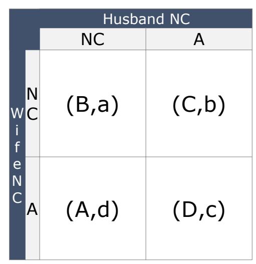

(a) Husband dominant retirement strategy




(b) NE: Husband and wife dominant retirement strategies




(c) Multiple NE: Revert to planner's solution

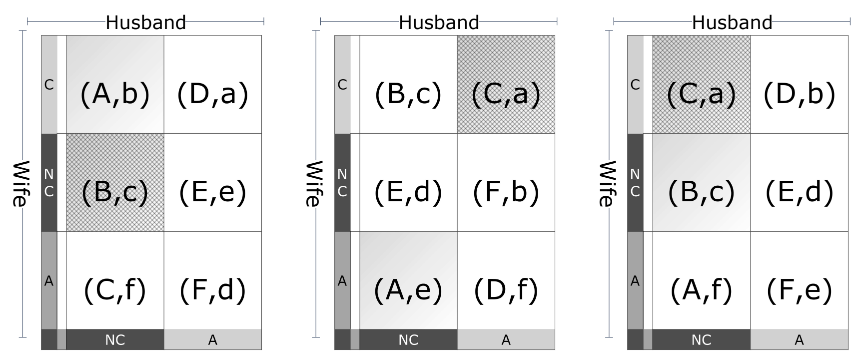



(d) No pure NE: Revert to planner's solution

cannot be undone. Figure 4.2 shows potential solutions to the game that arise when the wife is a career worker and the husband a bridge worker. The wife solves this game by backward induction, first resolving the 2x2 game that results if she retires, and then comparing this outcome to that which occurs if she does not retire. If the wife is better off playing the 2x2 game with her husband, she quits her career job. Otherwise she remains in her career job and accepts the outcome of the 3x2 Nash game. In the first panel of figure (4.2), no Nash equilibrium exists in the 3x2 game, but a Nash equilibrium ($\{NC, NC\}$) does exist in the 2x2 game induced by the wife's quitting her career job. However, the wife will not retire but will cooperate with her husband in reverting to the planner's solution $\{C, NC\}$

since otherwise both spouses are worse off. In figure 4.3(b), there are two Nash equilibria ($\{C, A\}$ and $\{A, NC\}$), but the wife can eliminate the $\{C, A\}$ equilibrium by quitting her career job. Since this raises her payoff from C to A, she quits. Note that, if no unique solution exists to the derived 2x2 game, the wife may still quit since the planner's solution to the 2x2 game might still improve her outcome. This possibility is depicted in figure 4.3(c). There is no Nash equilibrium in either the 3x2 or 2x2 game. However, if the planner chooses $\{C, NC\}$ as the cooperative solution and either $\{A, NC\}$ or $\{NC, NC\}$ ($\{A, NC\}$ as shown) as the cooperative solution to the 2x2 game induced by the wife's quit, the wife quits to receive the higher payoff associated with this reduced game. The degree of deviation for either spouse clearly depends on $\lambda$: how much the planner's solution favours him or her. A symmetric game exists for the case of a career husband and non-career or currently retired wife.

Figure 4.2: Non-cooperative outcomes for a career and a non-career worker



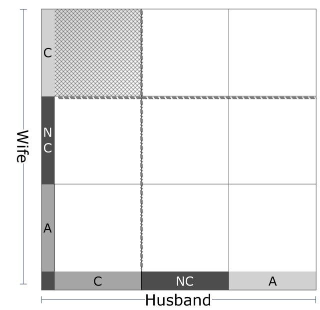

(a) Single NE (b) NE by wife quit 1 (c) NE by wife quit 2

The final game that arises in the model is played between a career husband and a career wife. The resulting 3x3 Nash game can be conceived as a pair of sequential games. At the first stage, both partners chose whether or not to quit ($Q$) or not quit ($NQ$) conditional on their spouse's quitting decision. If the husband, for instance, plays $NQ$ at the first stage, the wife faces a choice over the 2x3 game induced by quitting (the area under the thick dotted line passing to the south of the hatched $\{C, C\}$ square in figure 4.3) or remaining in $\{C, C\}$. The husband has a symmetric choice set when the wife plays $NQ$ at the first stage. If the husband quits, the wife has a choice between the 3x2 game described in the previous paragraph (playing $NQ$) and the 2x2 game described at the beginning of this section (playing $Q$). If she is indifferent between these choices, that must mean that quitting is the outcome of the 3x2 game between a career wife and non-career/applicant husband given $x_M$. In this case, $\{Q, Q\}$ is a Nash solution to the first stage game and the couple locates and plays the 2x2 game defined in the hatched square in the bottom of figure 4.3. Thus, indifference over outcomes in the first stage game is resolved in favour of quitting. Otherwise, the solution to the first-stage game follows the same assumptions that govern the 2x2 and 3x2 games: if no pure strategy Nash equilibrium exists, or if multiple pure strategy Nash equilibria exist (say $\{NQ, Q\}$ and $\{Q, NQ\}$), then the spouses revert to the planner's solution.

The different games, and deviations from the cooperative outcome, outlined above arise because neither member of the couple receives the full benefit of being in a "good" (i.e. highly-productive) $lfs$ state. The resulting externalities clearly lead to potential for non-cooperative deviations, though the importance of such deviations for explaining observed retirement and benefit-claiming behaviour is an empirical question that we address with the numerical model developed below.

Before turning to the numerical model, however, it is worth underlying some less rigourous assumptions underlying the non-cooperative model. Effectively, the main assumption driving the model is that $lfs$-decisions, in contrast to saving or consumption decisions, are personal and can be taken unilaterally. A spouse may be able to observe her partner's general state of health, but may not be able to judge exactly, or effectively argue, how much that health affects his ability to work, leaving scope for deviation into state $A$. As well, an individual can quit a career job by resigning; since work decisions are made in the workplace and not in the home, the scope of spousal interference may be limited, at least in the short run. (Of course, the threat of divorce could play a role; however, divorce is relatively rare among couples approaching retirement age.) More generally, conflict over which spouse plays the primary earner role, and when it is acceptable to retire, is likely to be reflected in social norms. It turns out in the numerical analysis that it is *wives*' deviations from the $lfs$-specific marriage contract through early retirement and avoidance of career job is the main driver of the results, with husbands playing a reactionary role. This is intuitively more consistent with the "war babies" cohort of the HRS, which represents the first generation in which the majority of married women participated in the labour force, albeit mainly as second earners. However, we might ex-

Figure 4.3: Non-cooperative outcomes for career workers




pect a different result for later cohorts in which women face smaller earnings differentials compared to their husbands and and in which "career wives" are both more common and popularly considered necessary for economic survival of many marriages.

## 4.3 The numerical model

In this section, I outline the estimation and calibration of the numerical model economy: the processes for risk faced by agents and the policy environment they face. Individuals are subject to two main types of risk: productivity (wage) risk and health or disability risk, both of which increase over the life cycle. As well, individuals face mortality risk that depends on health and age. Finally, individuals face variations in the amount of disposable time that can be devoted to labour and leisure, due to changing family and work obligations over the life cycle.

**Life cycle effects and sources of risk**

### 4.3.1 Disposable time endowments

Disposable time in the model is time that the individual can devote to either labour or leisure. It is equal to his temporal time endowment of 168 hours a week minus required sleep time of 42 hours[69] and time lost to non-labour,

[69] Six hours a night is a standard estimate from the psychology literature of the mean hours per night required for normal functionality. See, for instance, [76].

non-leisure (*nll*) activities that are requirements of daily life. I calculate *nll* time from information available in the 1981-1997 panels of the PSID and the 2005 and 2006 American Time Use Surveys (ATUS). I calculate imputed measures of *nll* time loss for single, married and divorced/widowed men and women explicitly, controlling also for the number of children associated with each age and marital status. Appendix C describes the method by which time endowments are calculated from the PSID and ATUS. Our calculated average *nll* time across all genders and ages is 37 hours using the 2005-2006 ATUS samples and 34 hours from the PSID. Disposable time rises in early life as individuals' gain back the *nll* time devoted to education. It falls again, especially for women, during childbearing years and when younger children (under 6) are in the house. Finally, disposable time rises gradually through middle age as children leave, but declines slightly for married women through the retirement window 62-70, while continuing to rise slightly for singles and divorcees of both genders.

### Career and non-career jobs and productivity shocks

Workers who are not currently retired may be in either a career- or a non-career job. In the data, I define career workers as those who report having worked at least 1600 hours in the previous year and also report being employed at the time of the survey. Conditional on $lfs$, wages evolve exogenously according to the following process:

$$\begin{array}{lll} \ln w_{it} = & \ln w_t + \varphi^C X_{it} + \mu_{it}^C & if \quad Z_{it}\varsigma + \nu_{it} \geq 0 \\ \ln w_{it} = & \ln w_t + \varphi^{NC} X_{it} + \eta_{it}^{NC} & if \quad Z_{it}\varsigma + \nu_{it} < 0 \end{array} \tag{4.14}$$

where $\{\nu, \mu, \eta\}$ $X$, are distributed normally, conditional on $X$:

$$\Omega = \begin{bmatrix} 1, & . & . \\ \sigma_{C1}^2 & \sigma_C^2 & . \\ \sigma_{NC1}^2 & . & \sigma_{NC}^2 \end{bmatrix} \tag{4.15}$$

[47] shows that the MLE estimator is consistent when the residuals are serially correlated and/or heteroskedastic. I assume that both serial correlation and heteroskedasticity in age are present in the error process for wages:

$$\begin{array}{ll}
\mu_{it} = \mu_{it}^{\rho} + \mu_{it}^{me} & \mu_{it} = \eta_{it}^{\rho} + \eta_{it}^{me} \\
\mu_{it}^{\rho} = \rho^{C}\mu_{it-1}^{\rho} + \upsilon_{it}^{C} & \eta_{it}^{\rho} = \rho^{NC}\eta_{it-1}^{\rho} + \upsilon_{it} \\
\upsilon_{it} \sim N(0, \sigma_{\rho,C}^{2}(j)) & \upsilon_{it}^{NC} \sim N(0, \sigma_{\rho,NC}^{2}(j)) \\
\mu_{it}^{me} \sim N(0, \sigma_{me,C}^{2}) & \mu_{it}^{me} \sim N(0, \sigma_{me,NC}^{2})
\end{array}$$

and

$$X \equiv \{age, age^2, age^3, educ, race, health\}$$

$$Z_{PSID} \equiv \{children, marital\ status, religion\}$$

$$Z_{HRS} \equiv \{Z_{PSID},\ pension\ coverage, employer\ health\ insurance\}$$

In the system described above, $w_t$ is the market price of labour in year $t$ (a constant term shifted by a year dummy) and $X$ contains a cubic in age, years of education, indicators for race and (for workers observed in years 1984 and later) an index for self-assessed health. The vector of first-stage regressors, $Z$, depends on whether the individual is drawn from the PSID or the HRS. $Z_{PSID}$ contains all the variables in $X$, plus an indicator for marital status, number of children in the household, and a dummy for Catholic. $Z_{HRS}$ contains these variables plus an indicator for being covered by a employer pension, for receiving health insurance through work, through the spouse's work, and whether own employer health insurance also covers the spouse. Following [78], I also include in $X$ and $Z$ time averages of the covariates in $X$ for each individual to control for a possible fixed effect affecting both wages and selection into career jobs.

To run the regressions, I first pool individuals from the 1976-1993 waves of the PSID with the first eight waves of the HRS (1992-2006), and keep all individuals born between 1932 and 1942. This allows me to follow this cohort back in time to a minimum age of 34. Since the PSID and HRS represent different populations (the PSID represents the whole US population circa 1969), I use data from the overlapping year, 1992, to estimate the likelihood of any individual in the PSID sample also appearing in the HRS, and use the resulting propensity scores to weight the PSID observations in the switching regression. At the third stage, I estimate the process for wage shocks, comprised of an autocorrelated and a white noise component, the latter which I assume to be pure measurement error. I use a piece of the generalized non-linear estimation process described by [9], in allowing the variance of the autocorrelated part of wages to be heteroskedastic in age. In the final stage, I use the residuals to compute the variance and first eight autocorrelations in the error. I then take the sample average of each moment by age and stack them. Finally, I use nonlinear least squares to compute the population model parameters that best match the sample moments, according to (4.16):

$$ar_i = \sigma^2_{fx} + I_{ar0}\sigma^2_{me} + \sum_{k=0}^{8} \rho^{2k+i}(\gamma_0 + \dot{\gamma_1}(j-k) + \dot{\gamma_2}(j-k)^2)$$
$$i = \{1, ..., 9\} \tag{4.16}$$

where $I_{ar0}$ indicates that measurement error only shows up in the variances. Because the Wooldridge panel estimator controls for fixed effects by including sample averages of the independent variables at both stages, there is, by assumption, no fixed-effects component in the third-stage regression. The resulting second- and third-stage results that parameterize the model are given in the bottom panel of table 4.1. As expected, non-career work provides lower compensation than career work, and the relative wage loss becomes larger with age. For men, especially, predicted non-career wages decline over the working life while predicted career wages rise to around age 45 and then remain fairly constant. The coefficients on $\dot{\gamma_1}$ and $\dot{\gamma_2}$ suggest that, for men and women, the variance of shocks first decreases and then increases over the working life, similar to the pattern found by [9].[70][71]

### Health/disability shocks

Health/disability shocks ($\delta$) are similar to productivity shocks in that they increase the leisure cost of work shocks—are "time stealing" in the sense imagined by [10]. I estimate health transition matrices based on self-assessed health and subjective reports of work-limiting disability.[72] Individuals are

[70]Note that, for non-career workers, I do not always observe the wage, as some non-career workers are out of the labour force. Thus, the non-career parameters are likely to be somewhat inconsistent and require additional calibration in the model. In the current results, the parameters reported below are treated as the true parameters in the model.

[71]The data also allow me to estimate $p_C$, the probability of transitioning from a non-career to a career job. This can potentially vary by age and sex. In this chapter, however, I set $p_C = 15\%$, which is roughly the unconditional empirical probability of transitioning into a career job for workers over 40.

[72]The PSID contains only subjective global measures of disability and health. These measures have come under scrutiny in the empirical disability literature. (See, for instance, [28] for a brief overview.) The case against this type of measure is that it may be susceptible to justification bias if workers with high valuation of leisure or exogenously low returns to work are more likely to report themselves disabled, which would bias estimates

Table 4.1: Wage equation parameters: Career and non-career workers

| | Career workers | | Non-career workers | |
|---|---|---|---|---|
| | Women | Men | Women | Men |
| $age$ | .340 | .587 | -.678 | -1.631 |
| | (.780) | (.092) | (.0163) | (.808) |
| $age^2$ | -.0066 | -.0118 | .0149 | .0328 |
| | (.0159) | (1.033) | (.808) | (.021) |
| $age^3$ | .00004 | .00007 | -.00011 | -.00022 |
| | (.00011) | (.00004) | (.00011) | (.002) |
| $cons$ | -4.30 | -7.32 | 10.9 | 29.0 |
| | (12.7) | (10.2) | (13.3) | (16.9) |
| $\sigma_{me}$ | .030 | .028 | .134 | .052 |
| | (.049) | (.092) | (.016) | (.047) |
| $\rho$ | .923 | .891 | .984 | .803 |
| | (.042) | (1.033) | (.016) | (.026) |
| $\dot{\gamma}_0$ | .532 | .737 | .057 | 1.849 |
| | (.158) | (.00004) | (.0010) | (.448) |
| $\dot{\gamma}_1$ | -.023 | -.031 | -.0016 | -.076 |
| | (.0065) | (1.033) | (.0010) | (.0174) |
| $\dot{\gamma}_2$ | .000297 | .000337 | .000015 | .000799 |
| | (.000068) | (.000040) | (.00015) | (.00017) |
| N | 5236 | 5593 | | |
| $Wald(9)$ | 451.3 | 268.0 | | |

disabled if they report that a “physical or nervous condition” limits their ability to perform work “sometimes”, “often” or if they can do no work due to the condition; or if they report their current health level as “poor”. I estimate Markov transitions between disability states by multivariate OLS of current disability status on lagged disability status. There are three states: not disabled, currently disabled and recently disabled (that is, disabled in th previous period), the latter which helps to capture the fact that the likelihood of being disabled decreases for those who have been disabled before.

of disability effects on labour market activity and outcomes away from zero. Working in the opposite direction, subjective global assessments may be measured with error since the researcher captures cross-sectional variation in the interpretation of the question as well as in health states. Using Canadian data, [21] finds that that second effect dominates when using self-reported disability status to predict the participation decision of older men, leading to an underestimate of the role of disability. [6] find a similar result for the effect of self-assessed health status on participation, also using Canadian data.

For marrieds, I estimate a nine-state transition matrix for the couple, which allows for arbitrary correlation between the husband and wife's physical conditions over time. Transition matrices are estimated for each household age $j$ using all relevant observations in an eleven year interval with $j$ at the center. The size of the $\delta$ shock associated with each state is assumed to be constant over the life cycle and is calibrated to match observed labour supplies in each state, with $\delta$ normalized to 1 in the non-disabled state.

### Mortality risk

Following [68], I calculate disabled and non-disabled mortality profiles from PSID data and the National Vital Statistics Report (2003) using Bayes Rule. The healthy and disabled profiles can be written as:

$$\begin{aligned}
\varphi^j_{\delta=1,i} &= Pr(Surv|\delta=1) = \frac{\widehat{Pr}(Surv)\widehat{Pr}(\delta=1|Surv)}{Pr(\delta=1)} \\
\varphi^j_{\delta>1,i} &= Pr(Surv|\delta>1) = \frac{\widehat{Pr}(Surv)\widehat{Pr}(\delta>1|Surv)}{Pr(\delta>1)}
\end{aligned} \tag{4.17}$$

where hats indicate that the information comes from the PSID micro data. Figure 4.4 plots the relative survival probabilities of healthy and disabled males and females using the subjective PSID measures of disability defined below. The figure, and corresponding regressions (not reported) show that (1) the importance of subjective good health increases with age and (2) that the effects of subjective good health on survival probabilities are significantly more important for men than for women at most ages.

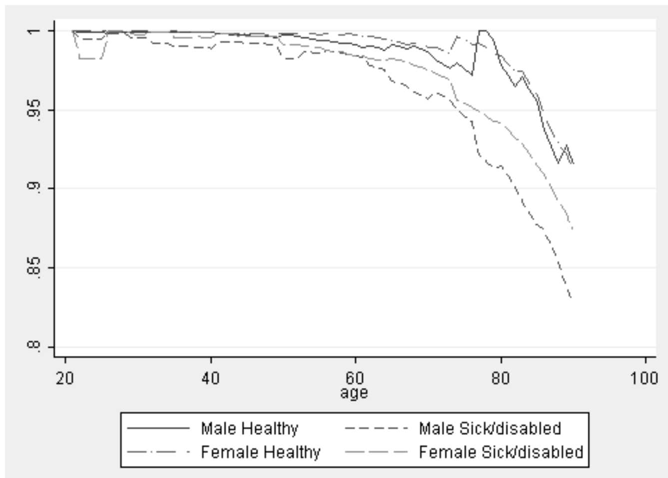
### Preferences

I adopt Cobb-Douglas preferences in period-utility. Evidence from the vast literature on household consumption and labour supply has for the most part found that consumption and leisure are best modeled as complementary in utility (see, e.g. [11]). In the standard and non-cooperative models, utility is given by:

$$u_i(c_i, l_i) = \frac{[\psi_C(ms)(\frac{c_i}{\tilde{\eta}_{j,ms}})^{\gamma_i}(l_i)^{1-\gamma_i}]^{1-\omega_i}}{1-\omega_i} \tag{4.18}$$

For the complementaries-in-leisure model, period utility is given by

Figure 4.4: Health-conditional survival indexes for males and females




$$u(c_i, l_i) = \frac{[(\frac{c_i}{\tilde{n}_{j,ms}})^{\gamma_i}(l_i + I_{rr}\psi_L(ms)\min[l_i, l_{-i}])^{1-\gamma_i}]^{1-\omega_i}}{1-\omega_i} \tag{4.19}$$

In the above expressions, $\gamma$ measures the consumption share in utility, $\omega$ is the coefficient of intertemporal risk aversion and $\tilde{\eta}_{j,i,ms}$ is the age-, gender-, marital-status-specific weighted measure of dependents supported by the individual. Fertility in the model is exogenous. For dependency costs of children, I use the modified OECD scale, assigning a weight of 0.3 to children under 17 and 0.5 to children over 16. The average number and timing of children are calculated from the 1994-2005 PSID sample by head's gender and age. Half of single women have one child, at age 19, whom they support for 24 years; the rest have no children. Single men do not have any children for tax and transfer or purposes but share the consumption-costs of the children of single women proportionately to their income (i.e this is a world of perfect paternity tests), and also devote the associated *nll* time for fathers. Married couples also have two children at 23 and 34 and support them for 23 and 19 years respectively. Married couples consume household resources jointly, with parameter $\psi_C(ms = M) \geq\leq .5$ governing the relative individual-level consumption gain from joint consumption (with $\psi_C > .5$ indicating the presence of a household-level public good). In the complimentarities model, $\psi_L$ captures the additional utility gain the individual receives from leisure enjoyed with her spouse with neither is working ($I_{RR} = 1$); in theory, both of these parameters are likely to vary with the quality of the marriage.

The main drawback of Cobb-Douglas preferences is that they do not allow us to disentangle relative risk aversion in consumption from risk aversion in leisure (or intertemporal elasticity of labour supply). There is some evidence from the micro literature that women are more risk averse in consumption than men ([56]), and also that they have higher Frisch elasticities of labour supply ([12]). These facts are difficult to reconcile with Cobb-Douglas preferences because, holding the ratio of labour to leisure constant, the Frisch elasticity is decreasing in $\omega$.[73] However, [62] argues that *uncompensated* elasticities of female labour supply are similar to those for men in a well-specified model. For my benchmark models, I set $\gamma$ to capture to gender-specific prime-age (25-59) labour supplies observed in U.S. data. For men, the resulting $\gamma$ is around .45 in both the cooperative and non-cooperative models. By setting a value for $\omega$ of 2.5 for men, I arrive at an average Frisch elasticity of about .6, which is just at the high end of the Frisch elasticities estimated in the empirical life cycle literature on male labour supply under the assumption of separable preferences[74] (while $\omega - 2.5$ is just at the high end of estimated coefficients of intertemporal risk aversion for males). Women have a slightly smaller calibrated $\gamma$ of around .35, corresponding to their lower labour supplies. Setting $\omega_f$ to 3.0 gives me roughly the same Frisch elasticity of about .6 for women as for men.

### Calibration

The program described above gives me a total of fourteen parameters to calibrate (fifteen in the complementarities model). They are listed, along with the corresponding targets, in table 4.2. All calibration is done using PSID data. I calibrate the cooperative and partial/fully non-cooperative model separately and report the resulting parameter values for each. However, many of the results, especially utility and welfare results, are always given in reference to the calibration of the cooperative model.

[73] Frisch elasticity of labour under Cobb-Douglas preferences is:

$$\frac{1-\alpha(1-\omega)}{\omega}\frac{l}{n}.$$

The derivative with respect to $\omega$ is $(\frac{\gamma}{\omega} - \frac{1-\gamma(1-\omega)}{\omega^2})\frac{l}{n}$ which is decreasing so long as $\gamma < 1$.

[74] [30] estimate a Frisch elasticity for men in the absence of borrowing constraints of .5.

Table 4.2 gives an indication of the size of disability costs, $\chi(\delta)$, the values of which have a straightforward interpretation as weekly hours lost to disability. The resulting costs are very large, in the order of 46 hours for men in the worst health state and 33 hours for women in the worst health state. Moving down the table, the gender-specific discount rates are set to reflect the fact that single households headed by women hold proportionally more wealth as a ratio of income than single households headed by men. Acceptance rates into SSD are set to match the share of individuals between 30 and 65 in each health state who begin receiving benefits in a given year. The rejection cost $c_A$ controls the gross number of applicants. I target a number that, combined with the $p$s, leads to an overall rejection rate[75]—of around 50%, which [35] and [16] separately cite as the prevailing post-appeal rejection rate of SSD applicants. Finally, planner's utility weight for the wife $\lambda$ and the consumption gain to marriage $\psi_C(M)$ are set to generate an accurate joint labour supply of (healthy) married houseeholds conditional on married males supplying the correct number of hours. In the complementarities model, the leisure boost to joint retirement $\psi_L$ is set to replicate the correct share of individuals who are working zero hours by age 64. Intuitively, the higher is the leisure gain to joint retirement, the fewer individuals should be working into their late 60s.

[75]Because individuals in the simulated economy can continuously apply for benefits, while appeals in the U.S. are actually limited to three after initial application, the rejection rate in the model refers to all "spells" of applications—i.e. groups of one or more consecutive application periods. In practice, less than 1% of simulated SSD application spells last more than four consecutive periods.

Table 4.2: Calibrated parameters and targets

| Parameter | Benchmark | Non-coop | Compl. | Target | Target value |
|---|---|---|---|---|---|
| $\gamma_f$ | .45 | .41 | .44 | Unmarried healthy female labour supply 25-60 | 32.0 hrs |
| $\gamma_m$ | .47 | .47 | .47 | Unmarried healthy male labour supply 25-60 | 39.6 hrs |
| $\omega_f$ | 3.0 | 3.0 | 3.0 | Assigned | n/a |
| $\omega_m$ | 2.5 | 2.5 | 2.5 | Assigned | n/a |
| $\beta_f$ | .985 | .982 | .984 | HH wealth-income ratio for homes w female member | 2.50 |
| $\beta_m$ | .983 | .977 | .980 | HH wealth-income ratio for homes w male member | 2.35 |
| $\chi(\delta_{2f})$ | 15 | 22 | 14 | Unmarried female labour supply $\|\delta_f = 2$ | 22.5 hrs |
| $\chi(\delta_{3f})$ | 45 | 40 | 45 | Unmarried female labour supply $\|\delta_f = 3$ | 9.6 hrs |
| $\chi(\delta_{2m})$ | 12 | 15 | 11 | Unmarried male labour supply $\|\delta_m = 2$ | 26.4 hrs |
| $\chi(\delta_{3m})$ | 53 | 50 | 52 | Unmarried male labour supply $\|\delta_m = 3$ | 9.0 hrs |
| $p(\delta_1)$ | .16 | .18 | .19 | Share of new SSD recipients among pop with $\delta = 1$ | .2% |
| $p(\delta_2)$ | .27 | .21 | .24 | Share of new SSD recipients among pop with $\delta = 2$ | 1.5% |
| $p(\delta_3)$ | .36 | .63 | .33 | Share of new SSD recipients among pop with $\delta = 3$ | 5.7% |
| $c_A$ | 1.01 | 1.02 | | Total share of SSD application ending in success | 50% |
| $\lambda$ | .57 | .55 | .58 | Married male labour supply | 44.8 hrs |
| $\psi_C(M)$ | .71 | .72 | .71 | Joint labour supply of married households | 70.7 hrs |
| $\psi_L(M)$ | n/a | n/a | .254 | Share of individuals not working by age 64 | .81 |

### 4.3.2 The policy environment

#### Social security

Under the rules of the U.S. Social Security system, individuals "save" for retirement by effectively paying a share of their per-period wage earnings to the Social Security Administration. Payments into the system by current workers finance the benefits of the current generation of retirees. The contributions of workers into the system function as IOUs from the government. When the current generation retires, their benefits will in turn be financed by the next generation of workers. Social Security is primarily a retirement program. However, it offers insurance to workers who become incapacitated in the form of disability benefits and to the spouses of workers who die prematurely in the form of spousal benefits. Social Security currently accounts for about 37% of total federal expenditure in the U.S.

Here, I outline the major features of Social Security that are captured in the model:

***Benefit accrual and determination.*** SSR and SSD benefits for new applicants are determined as a function of previous Social Security contributions. The Average Indexed Monthly Earnings, or AIME, is the average monthly wage income from the worker's applicable work history, which comprises the 35 highest-earning years, or the highest 80% of earnings-years for applicants to SSD, up a maximum of five excluded years. From the AIME, the Primary Insurance Amount (PIA), and the actual retirement-age or disability benefit, $b$, are determined from the following well-known formula:

$$\begin{aligned} PIA &= 0.9\min(0.2\overline{w}, E) \\ &\quad +0.32\max(\min(E-0.2\overline{w}, 1.3\overline{w}-0.2\overline{w}), 0) \\ &\quad +0.15\max(E-1.3\overline{w}, 0) \\ a_t < \overline{a}^{mt}: &\quad b_{\cdot} = \max(PIA, \underline{b}) \\ a_t > \overline{a}^{mt}: &\quad b_{\cdot} = PIA \end{aligned} \tag{4.20}$$

where $\overline{w}$ is the average per-capita wage earnings in the economy, $E$ is shorthand for the AIME, and $\underline{b}$ is a floor benefit, equal to \$151 weekly for an individual (\$222 for a couple). This benefit is administered by the Social Security Administration as a separate program (Supplemental Security Income: SSI) for workers and non-workers who do not qualify for regular Social Security benefits or whose accrued earnings are too low.[76] Since SSI

[76] The SSA requires that individuals earn at least 20 "credits", where one credit is equal

is means-tested as opposed to work-tested, $\overline{a}^{mt}$, equal to $4000 for a single household head or $6000 for a couple, is the maximum level of asset holding for which an individual or household can be guaranteed the floor benefit.[77]

State space limitations prevent an accurate accounting of which years should be included in benefit determination in the simulated economy.[78] Instead, I exclude earnings from all years before age 26 and over 61 in the accumulated calculation, which gives five years of accumulation before individuals in the simulated economy first apply for disability benefits. Given the shape of the life cycle profile of earnings, these tend to be the lowest-earning years. The benefit accumulation calculation for workers is:

$$\begin{aligned} j < 60: \qquad & E_t = \frac{E_{t-1}(j_t - j_1) + w_t n_t}{j_t - j_2} \\ j \geq 60: \qquad & E_t = \frac{E_{t-1}(j_t - j_1) + w_t n_t}{j_t - j_2} \end{aligned} \tag{4.21}$$

When benefits are determined, the AIME is adjusted for growth up to the year the individual turns 60. In this stationary model, the growth rate is zero.

***Disability benefit eligibility and receipt.*** In order to receive disability benefits under SSD, applicants must pass an eligibility test which insures that the disability is "total" in the sense that it precludes all "substantial gainful activity" and is expected to last at least 12 months. Slightly more lenient eligibility rules apply to individuals over 55. If rejected for benefits, an applicant may appeal up to four times, to four different levels of SSD adjudicators, a process that can take several years.[79] In separate studies, [17] and [35] report a final rejection rate of about 50% of initial applicants to the program, with a first-time applicant rejection rate around 67%.

In the model, these provisions are captured by acceptance rates that vary across age (pre- and post-55) and the disability/health index of the applicant. I use the shares of new SSD recipients in each self-assessed health/disability state in the PSID, and the share of benefit recipients older

to wage earnings of $4200 in current dollars, over 10 years prior to application. Some exceptions are made for younger workers.

[77] These figures are adjusted to exclude the average share of assets in housing wealth, which is not included in the determination of SSI resources. See 4.3.2 for further discussion.

[78] [39] discuss a similar technical difficulty in their calibrated analysis of the Boskin Social Security reform proposal.

[79] An initial Request for Reconsideration goes to the SSA, after which the rejection may be appealed to an Administrative Law judge, to the Social Security Appeal Council, and finally to a federal court.

than 55 among the recipient population, to calibrate these acceptance rates. Individuals older than 35 may apply for benefits in any period they want, from any $d$ state, but at a cost of forgoing a year of work in order to demonstrate incapacity. Since the decision process for an application takes five months in the real world, successful applicants in the simulation receive only 60% of their benefit in the year they are accepted.

***Early and delayed retirement.*** Under the SSA's rules, individuals may retire at any age between 62 and 70, subject to an adjustment of benefit size that roughly equates the expected discounted stream of benefits across retirement ages. For early retirees, benefits are reduced by 5/9 of a percent for every month before the full retirement age of 66. As of 2008, the factor of adjustment for later retirees is 8% of the PIA per year. As well, individuals can continue to replace lower-earning years in the calculation of their AIME until they formally retire. Both of these effects - adjustment and continued accumulation - are captured in the model.

***Survivor and spousal benefits.*** Under current SSA rules, surviving spouses whose own Social Security benefit is smaller than their partner's receive their partner's benefit until their own death. As well, secondary earners during the working life of a married household are entitled to the greater of either their own accumulated benefit or one half of their partner's benefit upon retirement. Both of these features of the program are captured in the simulated economy.[80]

***Post-retirement work and "unretirement".*** Finally, I take seriously the argument made by [20] and others that retirement is not a once-for-all decision that spells the end of work. SSR recipients in the model can continue to work after taking up Social Security benefits. In keeping with current SSA policy, workers 66 and older suffer no reduction in benefits regardless of how much they work, though the taxation of benefits is likely to change (see Section 4.3.2). Retirees aged 62-65 are subject to a reduction in their present benefits and an increase (due to additional accumulation) in future benefits. SSD recipients younger than 62 cannot work while receiving benefits,[81] but may leave SSD at any age prior to 62. The SSA has run a se-

[80] Under the rules for spousal benefits, spouses are not entitled to receive a half share in increases in the main earner benefit due to delayed retirement by the couple. Additional rules may provide benefits for the pre-majority age or disabled children of deceased parents. These rules are ignored in the simulated economy.

[81] Under the SSA's rules, SSI and SSD beneficiaries may not earn more than an amount indicating "minimal gainful activity", equal to $940 USD in 2008. For nearly all workers in the model, this amount is less than half what would be earned at the lowest positive labour grid point.

ries of programs designed to help SSD beneficiaries transition back to work, allowing recipients to maintain their benefits during a trial work period of up to nine months. To capture this effect, individuals may receive a three-quarters benefit during their first year of "unretirement". After returning to work, individuals retain their pre-retirement accumulation and continue to accumulate benefits like normal, healthy workers. Relatively few American SSD recipients - on the order of 12% in 2004 - leave the rolls and return to work ([8]). This figure is not targeted in the model, providing a test of the model's ability to adequate capture the interaction of Americans with their full Social Security system.

### Non-Social Security policy

The model also incorporates the following non-Social Security features of the U.S. policy environment.

***Taxes.*** Policy in the model is designed to reflect several features of the current U.S. policy environment in addition to Social Security. I model a progressive income tax with % rates of $\{10, 15, 25, 28, 33\}$, levied on (average weekly) income above $\{\$358, \$679, \$1660, \$2987, \$4364\}$ for marrieds and $\{\$179, \$340, \$830, \$1756, \$3470\}$ for singles. These numbers are based on the following assumptions: (1) all married individuals file jointly; (2) all filers claim the standard deduction and personal (but not dependent) exemptions; and (3) that only 2008 federal rates apply. Further, I follow a standard convention in the life cycle literature by assuming a 100% estate tax (no bequests), and a flat-rate consumption tax of 5.5% as in [41]. I treat capital and labour income identically in the tax calculation, ignoring potentially favourable tax treatment of retirement savings or capital gains. The payroll tax is 15.3%, which has the combined employer-employee OASDI and Hospital Insurance (HI) payroll tax rate in the U.S. since 1990. It is levied on weekly average earned income up to $2040.

Social security benefits are taxed at a special rate modeled on 1993 federal legislation. Up to 50% of SSR/SSD benefits are taxable as income if total non-Social Security income plus 50% of benefits (called "adjusted income") fall above a certain threshold ($400 for singles; $640 for marrieds). In this case, taxable benefits are then the lesser of 50% of total benefits and the difference between adjusted income and the threshold. In 1993, a second threshold ($680 for singles; $880 for marrieds) with an associated rate of 85% was added. For individuals with post-retirement incomes higher than the second threshold, benefits subject to taxation equal the lesser of the amount calculated using the brackets and 85% of total SSD/SSR benefits.

These features of benefit taxation are captured in the model. Revenues from taxation of Social Security benefits are added to the Social Security Trust Fund along with payroll taxes, which is a relevant detail only in the general equilibrium version of the model.

***Food stamps.*** Besides Social Security, the Food Stamp program is the most significant U.S. federal transfer and the only universal means-tested program. In 2006, food stamps were paid out to an average of 10.3% of households during any month at a total benefit cost of $31 billion USD. Eligibility for food stamps requires that applicants meet a gross income, a net income and an asset test. I model only the latter explcitly. The asset test varies across type of household. Households containing at least one member over 60 or who is disabled (which I take to mean receiving SSD benefits) may hold $700 in (weekly-adjusted) current liquid assets while younger and healthy households may hold $470. SSI recipients do not face an asset test for food stamps. Since some assets—in particular, housing—are exempt from the means test, I adjust the assets subject to the test in the model by calculating the average share of wealth in housing by age, gender, marital status and total stock of wealth using the 1999 and 2001 PSID wealth files.[82]

Conditional on passing the asset test, a formula gives food stamps as a maximum monthly allotment minus 30% of "net income", where net income under the USDA food stamp rules is equal to gross income minus a standard deduction of about $30 and a further deduction of 20% of current earned income.[83] Actual foodstamp payments are then equal to the maximum of zero and this number. The maximum allotments vary by household size. To approximate how the program impacts various types of household and individual, I use the number of children by age estimated from the PSID and used to derive equivalence scales in 4.3.1 above. Two final simplifying assumptions about food stamps follow [50]. First, unlike other public transfers and private transfers between households, I assume that access is universal to qualifying households; that is, the takeup rate is 100%. Second, I assume that food stamps are interchangable with cash for recipient households.

***Earned income tax credit.*** The EIC (formerly EITC) is a wage sup-

[82]The calculation is performed only on household with non-negative non-housing wealth. The resulting mean share of housing wealth is 61.5%, which is slightly higher than a similar estimate by [77], who finds that Americans hold about 50% of wealth in housing. However, he includes pension wealth in his calculation while I exclude it. For simplicity, I also assume that all defined-contribution retirement savings is subject to the means test, though fact 401(k) wealth is ineligible for food stamps means-testing under federal law. Four states currently also exclude wealth held in IRAs.

[83]Other small deductions may apply that I do not consider.

plement to low- and medium-income workers that is paid annually as a refundable tax credit. Similarly to food stamps, the income limits for which a refund can be attained vary by marital status and number of children and on having income from investments falling below a threshold of (weekly adjusted) \$700. The maximum eligible incomes and associated refunds are calculated from tables given in the 2007 edition of the IRA's Publication 596 and reach a maximum of \$800 in weekly earnings for married couples with two children. The maximum benefit in the model is about \$94, also for a married couple with two children earning between \$250 and \$350 a week.

***Medicare, Health Insurance and Private Pensions.*** Disabled workers ($\delta \in \{2,3\}$) are subject to out-of-pocket medical costs of \$30 and \$101 respectively, calculated from the 2006 HRS as differentials from average out-of-pocket expenses for individuals in excellent or very good health. These costs are reduced to \$24 and \$73 for individuals in households in which at least one spouse is in a career job, since these individuals are covered by employer-based health insurance. They are also reduced for individuals receiving SSDI benefits. Starting from the cost level of a career worker at age 64, medical expenses for individuals 65 and over increases linearly with age at a rate of .61 per year for healthy, .68 per year for recovering (poor health in a recent period) and .78 per year for currently unhealthy (poor health) individuals. Note that these costs understate the risk associated with health status especially for younger workers. Unhealthy individuals under 65 who are in career jobs pay only about 25% less out of pocket than those in non-career jobs, but the variance of their expenditure is cut by over a third, from \$211 to \$139.

Lastly, individuals (only single workers and married males for simplicity) in career jobs are eligible for pensions. The pensions themselves are subsumed into assets; however, several studies have demonstrated that defined benefit pensions create incentives for early retirement and penalize delayed retirement. This is due to several features of the accrual formula (see [74]); a simple reduced-form way to capture these penalties is by assuming that pension payouts obey the formula:

$$pn = k w_r y_s$$

where $pn$ is the current pension annuity entitlement, $k$ is a constant replacement rate, $w_r$ is the wage in the last year worked, and $y_s$ is a measure of years of service in the career job. In general, since wages begin to decline around age 60 for career workers, the rate of pension accumulation also begins to fall. The decline in accrual from age 60 to age 75 acts like a reduction in the interest rate faced by the household with a career worker since the pension is accumulating slower than if the worker could lock in his pension entitlement in the peak accrual year and receive compensation for the remainder of his career entirely in the form of spot wages which could then be invested. Based on the estimates in table 4.1, and assuming that retirement with replacement rate $k$ is not possible until 60, the pension-penalty-adjusted interest rate $\hat{r}_p$ falls from 97% of $r$ to -25% of $r$ for career males between 61 and 74, with the effect only becoming large after age 67. Non-career workers are not affected.

## 4.4 Results and discussion

I now turn to the results from the simulated economies described in Sections 4.2 and 4.3. Section 4.4.1 examines the respective ability of the benchmark, non-cooperative and complementarities models to replicate certain aspects of U.S. household behaviour, in particular the retirement and benefit claiming patterns of older married men and women. Section 4.4.2 examines the implications of the models for current retirement policy and for three basic modifications to this policy.

### 4.4.1 Retirement and program usage

#### Retirement patterns

The HRS provides two useful measures of retirement transition behaviour: the age at which individuals first claim Social Security benefits, and the year when they first self-assess as "fully retired"—that is, no longer working. In figures 4.5 - 4.8 I report the simulated patterns of retirement using both measures for married men and women, and plot these against the same patterns estimated from the 1998-2006 waves of the Health and Retirement Survey corresponding to the 1932-1942 birth cohort. Because members of households are the same age in the model, I restrict the HRS comparison sample to households in which the head and wife are less than two years apart in age. In the simulations, the year of benefit claiming corresponds to the *first* year benefits are claimed, even if the individual returns to work in a bridge job in a later period. In the data, many bridge workers continue to receive their benefits; for computational reasons, this is not the case in the model: Individuals must be either working in bridge jobs or retired and claiming benefits, but can move between the two states costlessly, and receive benefit adjustment to compensate for the benefits forgone during the working year (see section 3.3.3).

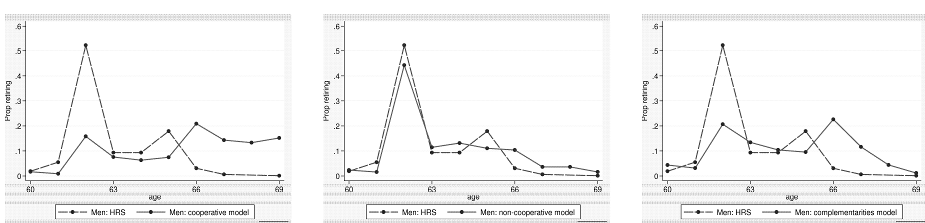
The figures show the main results of the chapter. Unsurprisingly, the benchmark cooperative model performs the worst of all the models. Given that returns to delayed retirement are close to actuarially fair for the whose retiring population, some individuals—particularly those who are healthy and who expect to live, or expect their dependent spouse to live, a long time—should delay retirement. For men, a small "bump" in retirement at age 62 accounts for individuals who would have preferred to retire earlier due to poor health, low labour market returns or high accumulated wealth but have waited for the availability (and costlessness) of regular retirement benefits. Afterward, there is a relatively constant exit hazard from work into retirement as individuals reach their optimal retirement point over the retirement window. In all the models, a large share of women retire at 62 because their labour market returns are relatively low, having waited until after their children left the home to try to move into a career, and they expect to receive a spousal (and later a survivor) benefit. The "two peaked" retirement for women—at age 62 and age 69 when returns to delayed retirement end—is also a function of women's second earner status. A share of married women do find careers and even become equal or primary earners in their home. These women delay retirement to increase their own benefit because they do not plan to rely on a spousal benefit. This is evidenced by the fact that the average wage of wives retiring at 69 is \$17.94, while the average wage of wives retiring at 62 is only \$13.04.

Note that the large peak in retirement at 62 in the benchmark model is somewhat special to the cohort under consideration. Later cohorts of women, who are typically more active contributors to household income and receive higher wages over the working life, are likely to provide an even worse fit in the benchmark (and also the complementarities) model due to a greater incentive to postpone retirement to increase their benefits.

Next we consider the complementarities model. The model provides a good fit for women with the main peak in benefit claiming at 62, no peak in retirement at age 69, and also a reasonable departure hazard from the labour force in figure (4.7(c)). However, the model performs only slightly better for men than the benchmark in predicting the empirical pattern of benefit claiming, with the largest peak in retirement occurring at age 66 as pension penalties become large. This is because, while spouses have an incentive to *quit work* together, there is still a joint incentive for the main earner to delay claiming. The wife claims her benefit early and the couple consumes her benefits and their asset holding and enjoy each other's leisure. Later in the retirement window, the husband claims his appreciated benefit, which in many cases also serves as the spousal, and later the widow benefit. There is empirical evidence that delayed claiming of benefits matters (see [16]) but the average delay is typically on the order of six months, not multiple years as predicted by the complementarities-in-leisure model.

Finally, the non-cooperative model gives overall the best fit for benefit claiming, replicating the peak in benefit claiming for males at 62 and almost no claiming for either spouse after age 66. The model overpredicts the rate of women's final exit from the labour force at age 62 relative to the complementarities model, but gives the best fit for male exit hazards. The reason for early joint benefit claiming rests on the fact that the much of the benefit of delayed claiming accrues to wives rather than husbands. In the non-cooperative model husbands have a heightened incentive to deviate from the planner's solution and retire right away. As discussed below, the effect is strengthened by the incentive of husbands to leave their career track before the retirement window which has the effect of forcing some of the earnings burden onto the wife and reduces the value of continued work to the husband (see below). Wives may respond to their husbands' early retirement by delaying their own retirement; however, they typically do not if their own retirement benefit is still likely to be smaller than the survivor benefit they receive upon the husband's death. The wife also cares about asset accumulation. However, when the husband retires, his action raises the marginal utility of consumption of the household, which reduces the optimal amount of saving. (Since non-cooperation can be predicted, there should not be a major offsetting wealth effect.) This also reduces the wife's incentive to keep working.

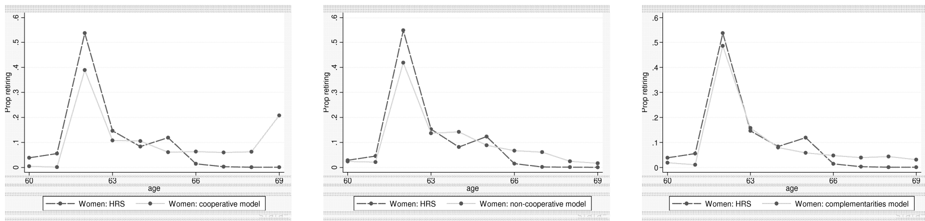
Figure 4.5: Age of benefit take-up for husbands: Data and models




(a) Benchmark model (b) Non-coop model (c) Compl-in-leis model

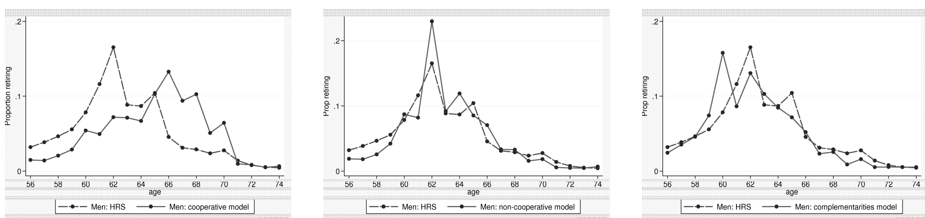
Table 4.3 provides a somewhat more formal measure of fit for the respective models, reporting the average cumulative difference between the observed and predicted results in each of the graphs—i.e. the CDF of the

Figure 4.6: Age of benefit take-up for wives: Data and models



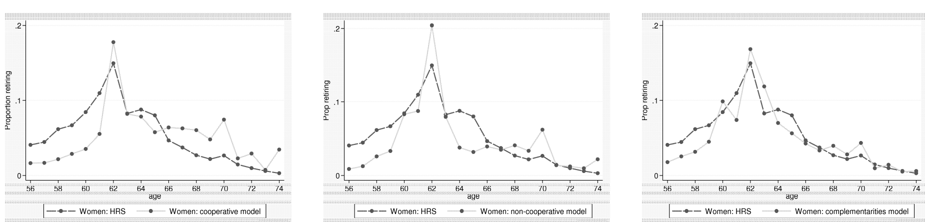

(a) Benchmark model (b) Non-coop model (c) Compl-in-leis model

Figure 4.7: Final year working for husbands: Data and models




(a) Benchmark model (b) Non-coop model (c) Compl-in-leis model

Figure 4.8: Final year working for wives: Data and models




(a) Benchmark model (b) Non-coop model (c) Compl-in-leis model

HRS retirement hazards minus the CDF of the model retirement hazards. The non-cooperative model performs best for both men and women at predicting the cumulative distribution of benefit claiming. The complementarities and non-cooperative model perform nearly identically at predicting labour market exit. The complementarities model does approximate the ac-

Table 4.3: Differences in cumulative retirement across the models

| | Benchmark | Non-coop | Compl-in-leis |
|---|---|---|---|
| Benefit claiming: Wives | 1.029 | .369 | .815 |
| Benefit claiming: Husbands | .722 | .362 | .333 |
| Labour market exit: Wives | .610 | .273 | .288 |
| Labour market exit: Husbands | .504 | .328 | .297 |

Table 4.4: Husband retirement minus wife retirement in years

| Difference in years | HRS 1998-2006 | Benchmark model | Non-coop model | Compl-in-leis model |
|---|---|---|---|---|
| −6 | 0.2 | 13.9 | 1.0 | 5.1 |
| −4 | 4.6 | 10.0 | 0.5 | 3.5 |
| −2 | 3.7 | 4.8 | 0.4 | 2.1 |
| 0 | 72.8 | 39.1 | 80.1 | 51.5 |
| +2 | 10.1 | 5.8 | 12.1 | 12.1 |
| +4 | 8.4 | 12.0 | 8.1 | 20.5 |
| +6 | 0.2 | 14.3 | 0.5 | 5.3 |

tual distribution slightly better for women and the non-cooperative model approximates the empirical distribution slightly better for men.

Table 4.4 shows the performance of the models vis-a-vis the data in replicating the distribution of the proximity within which husbands and wives retire by claiming their Social Security benefits. Negative numbers in the table indicate that the husband retires ahead of the wife while positive numbers indicate that the wife retires first. We again find the counterintuitive result that couples in the non-cooperative model are *more* likely (in fact, too likely, relative to the data) to retire within two years of each other than in either of the other models. The share of husbands and wives retiring together is lowest in the cooperative model since husbands and wives have different returns to delayed claiming and continued work. The complementarities model underpredicts joint claiming, but does a better job or replicating the distribution of joint self-assessed retirement (not shown).

### Disability benefits and program use

Another important comparison point for the models is their predictions for patterns of SSD use, specifically the models' predictions for the rate at which individuals *exit* the SSD program. Individuals can exit SSD by three means: dying; reaching regular retirement age and transitioning to SSR benefits; or returning to the labour force. Table 4.5 shows the distribution of these three alternatives for the cooperative and fully non-cooperative models (results from the benchmark model are similar to those from the complementarities model omitted for brevity.) The first column reports figures taken from SSA data, reported by [8]. The last two columns present corresponding results from the models. As can be easily seen, both the models greatly underpredict the number of deaths that occur among recipients[84]. However, the non-cooperative model generates better predictions regarding the likelihood of returning to work. In the complementarities model, a spouse on SSDI will return to the labour force if he recovers because he receives a relatively small utility gain from leisure while the wife is working and it is in the best interest of both spouses to work at the same time and accumulate assets. In the non-cooperative model, a spouse on SSDI has much less incentive to leave the roles and return to state $NC$ because doing so reduces his leisure and increases his effective obligation to his spouse under the marriage contract.

Table 4.5: Transitions into and out of retirement: Data and models

| Transitions out of SSDI | | | |
|---|---|---|---|
| | SSA data (Autor & Duggan [2006]) | Non-coop | Compl-in-leis |
| Exit by death | 42.0% | 23.8% | 23.0% |
| Exit by retirement | 44.0% | 61.1% | 52.4% |
| Exit by return to work | 12.0% | 15.1% | 24.6% |

### Two-step retirement and bridge jobs

Using the 1992-2002 waves of the HRS and focusing on the 1931 to 1941 cohort, [20] estimate the rates at which individuals transition into full retirement via non-career or "bridge" jobs. The authors argue that two-step retirement represents the most important recent shift in the behaviour of

[84]Note that mortality in the models depends on disability status, but, under current calibrations underpredicts the amount of severe sickness leading to terminal illness among the disabled population.

older workers, with an estimated 62-66% of men and 57-61% of women in the 1931-1941 cohort exiting the labour market via a bridge job. As [20] stress, however, the reasons for bridge job behaviour remain somewhat uncertain. Table 4.6 shows the retirement transitions generated in each of the three models among simulated workers who have held career jobs (that is, who have been in $lfs$ state $C$) in the past. Again, the benchmark model seriously understates the degree of two-step retirement. Since bridge work is relatively poorly compensated, individuals have an incentive to remain in their career jobs as long as possible. Some bridge work is still observed, because individuals may be forced out of career jobs due to health problems that raise the marginal value of leisure. However, this actually produces a second counterfactual prediction of the benchmark model. In the data, bridge job behaviour is positively correlated with good health outcomes; yet poor health outcomes are the main driver of bridge behaviour in the benchmark model. In the simulation, bridge workers are 50% less likely to be in $\delta$ state 1 than regular workers.

The complementaries model understates the bridge behaviour of men and women. For women, the reason is obvious: the couple's incentive is for the wife to stay in her career job until age 62 then claim her Social Security benefits and retire. Husbands technically do transition out of career jobs and into non-career work before entering retirement. 68.5% of men use bridge work transitions under this simple definition. However, under the marriage contract, many of these (in fact, 42%) work zero hours while waiting to claim their benefit. Since these men would not be recognized as bridge workers in the data, removing them reduces the amount share of men who work bridge jobs to only 51.5%, as reported in the table.

Finally, the non-cooperative model generates the most realistic distribution of bridge work transitions. The reason is that both spouses have an incentive to avoid main earner obligations since this raises their required work load under the marriage contract and induces their spouse to reduce their own work further. Between the ages of 48 and 60, this dynamic leads to a fair amount of quitting. As well, in the non-cooperative model, bridge job behaviour is correlated with good health outcomes. Individuals in poor health who wish to quit do so mainly by applying for benefits under SSD. Healthier individuals prefer to avoid the hassle cost of applying and simply quit into lower-paying bridge work.

Table 4.6: Share of individuals using two-step retirement

| | HRS data (Cahill et al [2005]) | Benchmark | Non-coop | Compl-in-leis |
|---|---|---|---|---|
| Men | 66.0% | 49.5% | 69.7% | 51.5% |
| Women | 61.0% | 33.7% | 52.5% | 41.7% |

### 4.4.2 Policy implications

I conclude this section by examining the model's basic implications for policy. Table 4.7 reports results (ex-ante lifetime utilities in the first period of life) from the complementarities and non-cooperative models examined above, plus results from three standard Social Security policy experiments: (1) a 50% non-redistributive reduction in the size of the program; (2) elimination of the disability insurance program; (3) elimination of the spousal benefit. In each case, I reduce payroll taxes by the amount that finances the corresponding reduction in total Social Security payouts. The best outcome by gender in each model is denoted in italics, and the worst outcome in bold.

From table 4.7 we see that in partial equilibrium the Social Security system is welfare-improving for all married individuals in the complementarities model. By contrast, husbands in the non-cooperative model prefer a world in which the spousal benefit is eliminated. The explanation is that, in the complementarities model, the existence of a spousal benefit reduces the need for the wife to work through her 60s. She and the husband are able to effectively retire at age 62 and live off her regular benefit and their combined assets until it becomes optimal for him to claim benefits. The spousal benefit imposes costs on the the husband under the marriage contract—forcing him to trade off current for future consumption to benefit the wife—but the increase in wealth (in partial equilibrium) and facilitation of jointly enjoyed leisure is enough to offset these costs, at least given the calibrated $\lambda$. In the non-cooperative world, by contrast, the existence of the spousal benefit reduces the wife's attachment to the labour force, raising the likelihood of her applying for benefits under SSD when semi-healthy (in $\delta$ state 2) and encouraging her to quit work permanently as soon as she reaches age 62. The obligations of primary earner status are therefore left to the husband. For similar reasons, the wife supports SSD more strongly in the non-cooperative than the complimentarities model.

Table 4.7: Lifetime utility under four policy experiments

| Regime | Non-coop | | Compl-in-leis | |
|---|---|---|---|---|
| | Wives | Husbands | Wives | Husbands |
| Value functions | | | | |
| benchmark | *-2.030* | -2.394 | *-1.955* | *-2.378* |
| 50% | **-2.095** | **-2.436** | **-2.009** | **-2.422** |
| SSD elim | -2.038 | -2.397 | -1.956 | -2.383 |
| Spouse ben elim | -2.048 | *-2.390* | -1.967 | -2.379 |

Table entries are ex-ante expected life time utilities under each model and policy experiment. Bolded entries denote the worst payoffs across the policy regimes; italicized entries represent the best payoffs across policy regimes.

## 4.5 Conclusion

In this chapter I have considered the retirement behaviour of married households under different assumptions about intrahousehold interaction and cooperation. In a non-cooperative model, spouses deviate from household-level optimization rules in deciding when to unilaterally retire or transition out of career work, because they cannot internalize the entire benefit from their own productivity (i.e. their career status). This mechanism produces early retirement and Social Security benefit claiming patterns than appear at odds with standard household intertemporal theory, but are consistent with empirical observation. A competing model for explaining intrahousehold retirement patterns is one in which couples benefit from complementarities in leisure when neither spouse is working. This model can also explain observed labour force departure hazards as well or marginally better than the non-cooperative model, but it does a poorer job of explaining the early spike in Social Security benefit claiming at age 62, use of the Social Security disability benefit program, or transitions into retirement via bridge jobs. The non-cooperative model can explain both of these phenomena as results of individual desire to the externalities of main earner status under the marriage contract. First, individuals who enter the disability roles rarely exit back into the labour force since doing so requires the individual to give up leisure for her partner's benefit, which is much more likely to occur in a cooperative complementarities model. Second, spouses in the non-cooperative model enter into lower-paying bridge jobs in their fifties in part to reduce main-earner burden after children leave the house.

The different models also generate different implications for policy. In the cooperative or complementarities model, the current policy environment increases welfare relative to any scenario in which benefits are reduced or a piece of the Social Security program eliminated. The progressivity of Social Security and its availability to individuals in poor health states provides insurance against permanent or transitory bad luck. Intracouple obligations reduce the distortionary effects of early retirement incentives. In the non-cooperative retirement model, by contrast, these distortionary effects are larger, effectively enabling destructive strategic behaviour. As a result, the spousal benefit under current SSA rules is actually welfare-reducing for husbands, even in partial equilibrium. Note, however, that an across-the-board benefit cut is still welfare-reducing even in the non-cooperative world. This is because the gains from retirement do not depend very strongly on the amount of benefit received since the retiree gains leisure from his retirement. Premature retirement, however, impacts negatively on the partner of the retiring spouse. Reductions in Social Security benefits further increase the welfare loss due to a spouse's retirement, without inducing an a sufficient reduction in the *amount* of premature retirement to compensate.

Some issues remain. A major limitation is that the model in its current form does not take into account the possibility of endogenous marriage. Specifically, the threat of divorce could reduce the potential for non-cooperative behaviour if consumption and non-pecuniary gains from marriage are not too large. As well, the model currently has nothing to say about the retirement behaviour of singles. Single men and women in all the models, unsurprisingly, behave much like married couples in the standard cooperative model, choosing optimal retirement dates that occur later than those observed in the data. However, if marital status is determined endogenously rather than given exogenously as in the current model, so that single men and women are drawn from the parts of the wealth and health distributions that are most likely to retire early, then we might derive more realistic predictions about retirement behaviour across types of household. This possibility is left for future work.

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# Appendix A

# Analytical predictions for labour supply in a model with disability and human capital

This section provides the comparative static results for section 3.3.1 of Chapter 3. When we extend the model with a dynamic human capital function linking labour supply, disability and wages, the semi-elasticities of hours worked in response to labour- and home-limiting shocks are complicated by the effect of the shock on the incentive to accumulate additional human capital. To derive analytical expressions, we maintain the assumptions that $\frac{\partial w_m}{\partial \delta} = 0$, and also that $\frac{\partial H^M(.)}{\partial \delta} = 0$, i.e. there is no direct effect of disability on wages, or on the evolution of wages, which is consistent with our estimates and has no major implications for the relative responses of married vs. single agents:

$$(1-\lambda)u_l = \xi_1 \frac{w_m}{\delta_n} - \xi_{3a}\frac{\partial H_m}{\partial l_m} \qquad \lambda v_l = \xi_1 w_f - \xi_{3b}\frac{\partial H_f}{\partial l_f} \tag{A.1}$$

$$\begin{aligned}
\mu^{l_m}_{\delta_n} &= X^m(-(1-\lambda)u_l + \frac{\partial c_m}{\partial \delta_n}(1-\lambda)u_{cc}w_m - \frac{\partial \xi_4}{\partial \delta_n}\frac{\partial H_m}{\partial l} - \xi_{4a}\frac{\partial H_m}{\partial l \partial l}\delta_n) \gtreqless 0 \\
\mu^{n_m}_{\delta_n} &= -\frac{\mu^{l_m}_{\delta_n}}{\delta_n} - n_m \gtreqless 0 \\
\mu^{l_m}_{\delta_h} &= X^m(\frac{\partial c_m}{d\delta_h})((1-\lambda)u_{cc}w_m\frac{\delta_h}{\delta_n} - \frac{d\xi_4}{d\delta_h}\frac{\delta_h}{\delta_n}\frac{\partial H_m}{\partial l}) \leq 0 \\
\mu^{n_m}_{\delta_h} &= -\frac{\mu^{l_m}_{\delta_h}}{\delta_n} - \frac{\delta_h}{\delta_n}\overline{h}_m \gtreqless 0
\end{aligned} \tag{A.2}$$

$$\begin{aligned}
\mu^{l_f}_{\delta_n} &= X^f(\tfrac{\partial c_f}{\delta_l}\lambda v_{cc}w_f\delta_n - \tfrac{\partial \xi_{4b}}{\partial \delta_n}\tfrac{\partial H_f}{\partial l}) \leq 0 & \mu^{n_f}_{\delta_n} &= -\mu^{l_f}_{\delta_n} \\
\mu^{l_f}_{\delta_h} &= X^f(\tfrac{\partial c_f}{\delta_l}\lambda v_{cc}w_f\delta_h - \tfrac{\partial \xi_{4b}}{\partial \delta_h}\tfrac{\partial H_f}{\partial l}) \leq 0 & \mu^{n_f}_{\delta_h} &= -\mu^{l_f}_{\delta_l} \geq 0
\end{aligned} \tag{A.3}$$

where $X^m = \frac{1}{(1-\lambda)u_{ll}+\xi_{4a}\frac{\partial H_m}{\partial l \partial l}}$ and $X^f = \frac{1}{\lambda v_{ll}+\xi_{4b}\frac{\partial H_f}{\partial l \partial l}}$.

To interpret these equations, we consider the special case in which $\frac{\partial H_m}{\partial l \partial l} \approx 0$ and $\frac{\partial H_m}{\partial l \partial w} < 0$. This case is consistent with human capital estimates by [69] and [40] and the equation reduces to (3.13) except for an additional term capturing the effect of disability on the shadow value of the wage. Since $H_l < 0$, the sign of this term depends on the sign of $\frac{\partial \xi_4}{\partial \delta_n}$, which in general should be positive since disability shocks decrease the time available to work and thus make earning power per unit of time more valuable.[85] The returns-to-labour effect therefore goes in the same direction as the wealth effect on leisure and labour.

[85]Note that this claim is complicated by the addition of disability benefits if they reduce the role of labour earnings in total available household resources.

# Appendix B

# Calibration and estimation for the numerical simulations in Chapter 3

In this section we discuss issues related to the measurement of different processes used in the numerical simulations.

### B.0.1 Disability risk status

This section provides additional details on the process by which individuals move between $rsk$ status in the model. The three $rsk$ states are 'low' ($rsk = 1$), 'high' ($rsk = 2$) and 'chronic' ($rsk \geq 3$), the latter which are absorbing state implying recurring disability in the $ds$ state from which it was entered (higher $rsk$ states capture greater benefit entitlements based on the wage of the individual when he entered the $rsk$ state.) To estimate the process for $rsk$, we run a probit regression on the SLID data in which the dependent variable is an indicator for having a disability during the course of the panel and the regressors include a variety of standard demographic controls, including age terms and self-assessed health. We cut the resulting predicted probabilities at the median so that half of the male SLID population is 'high' $rsk$ and half 'low' $rsk$, and these respective populations are used to estimate the high- and low-risk $ds$ matrices described above. Transitions between the three $rsk$ states are as follows: at every age in $rsk$ 1, individuals run the risk $p_2(j, ms)$ of switching permanently to $rsk$ 2. The $p_2$, for single and married men respectively – modeled as a quadratic function of age – are chosen to replicate the shares of married and unmarried individuals in $rsk$ 1 and 2 at ages 20-25, 40-45 and 60-65. On average, $rsk$ status is strongly increasing in age: by age 66, about 98% of the simulated and SLID populations of men are in $rsk$ level 2 and about 7% are chronically disabled.

## B.1 Human capital process for men and women: empirical specification and results

To estimate the dynamic human capital process given in table B.1, we adopt a three-stage estimation process that controls for possible endogeneity. In the first stage, run a selection equation and calculate inverse Mills ratios for the likelihood of observing a wage for all individual-year observations in the sample. We include time-averages of the non-lagged covariates to help control for a possible selection fixed effect, as suggested in [78]. Our exclusion restrictions are: current household income from investments, household size and number of children, a dummy for having experienced a death in the family in the previous year, and measures of the annual provincial unemployment rate and the deviation in this rate from its 10-year average. In the second stage, we instrument for the lag of hours using hours in first year an individual is observed in the SLID, which should be correlated with future choices of hours, but uncorrelated with the error terms in later years. In the third stage, we estimate 3.19 using our instrumented lagged hours. Our final-stage sample consists of the last three observations in the 1999 and 2002 panels who appear and report all information needed for the regression in all six years of the panel. In the fourth stage, we substitute the actual lags of hours and wages for the instruments and use the consistent marginal effects from the third stage to compute a new set of residuals. In the fourth stage, we apply a non-linear least squares estimator to the residuals to estimate the parameters of the individual shock process. Our estimates at this stage strongly suggest that the error process is i.i.d. We also re-estimated the entire system without instrumenting for the lags of hours and wages and also find no evidence that $\nu_{it}$ is autocorrelated.

We do, however, find evidence that $\nu$ is heteroskedastic in age and $H$, which we account for in the models. Results from a linear regression of $\sigma_\nu^2$ on a cubic in age and lagged values of human capital $H$ are reported in the right panel of table B.1 below.

Table B.1: Exogenous and endogenous wage parameter estimates

| Exogenous wages (Models WH1 and WH2) | | | Endogenous wages ($H(\cdot)$) (Model E) | | |
|---|---|---|---|---|---|
| | Male | Female | | Male | Female |
| $age$ | .172 | .245 | $\alpha_1$ | .616 | .751 |
| | (.021) | (.028) | | (0.057) | (0.090) |
| $age^2$ | -.002 | -.006 | $\alpha_{21}$ | $4.42e^{-4}$ | $1.89e^{-4}$ |
| | (.0005) | (.0006) | | ($1.57e^{-4}$) | ($1.66e^{-4}$) |
| $age^3$ | 0.00002 | .00005 | $\alpha_{22}$ | $-3.91e^{-6}$ | $-2.04e^{-6}$ |
| | (.00001) | (.000005) | | ($2.75e^{-6}$) | ($1.78e^{-6}$) |
| $ed$ | .021 | .018 | $\alpha_{31}$ | $-2.59e^{-6}$ | $2.25e^{-6}$ |
| | (.004) | (.005) | | ($1.80e^{-6}$) | ($3.14e^{-6}$) |
| $\sigma^2_\delta$ | .021 | .023 | $\alpha_{32}$ | $9.71e^{-9}$ | $-6.28e^{-8}$ |
| | (.007) | (.006) | | ($2.56e^{-8}$) | ($5.89e^{-8}$) |
| $\rho_\delta$ | .944 | .957 | $\sigma^2_\nu$ | 20.4 | 18.0 |
| | (.007) | (.006) | | | |
| | Model 2: $\delta_n$ included | | Heteroskedasticity structure for $\sigma^2_\nu$ | | |
| $\delta_n$ | -.145 | -.131 | $H_t$ | .117 | -2.11 |
| | (.018) | (.023) | | (.463) | (.651) |
| $\sigma^2_\delta$ | .020 | .021 | $H_t^2$ | $-2.01e^{-4}$ | .057 |
| | (.003) | (.002) | | (.012) | (.020) |
| $\rho_\nu$ | .942 | .953 | $H_t^3$ | $5.20e^{-4}$ | $7.17e^{-4}$ |
| | (.008) | (.007) | | ($9.13e^{-5}$) | ($1.59e^{-4}$) |
| | | | $age$ | -.291 | 1.643 |
| | | | | (3.129) | (4.393) |
| | | | $age^2$ | -.016 | -.058 |
| | | | | (0.075) | (0.107) |
| | | | $age^2$ | $2.84e^{-4}$ | $5.64e^{-4}$ |
| | | | | ($5.88e^{-4}$) | ($8.35e^{-4}$) |
| $AdjR-sq$ | .384 | .321 | $Adj.R-sq$ | .855 | .789 |

$\alpha_2$ and $\alpha_3$ are jointly significant for both men and women at the 1% level.

## B.2 Home production technology

To arrive at the estimates reported in tableTHC, we use a two stage approach in which we first instrument for married men and women's inputs into home production as a function of their own, and their partner's, characteristics including age of both spouses and its square, years of education of both spouses and its square, number of children in the household, presence of children under six, self-reported health of both spouses, whether or not the individual receives help from relatives, whether or not the individual is Catholic, whether the individual or the spouse are union members, own and spousal race (white or non-white), individual and spousal wage and its square, and year dummies corresponding to the given wave. The first-stage regressions are necessary to eliminate endogenous variation of housework in the data, which is introduced by the fact that only one member of the couple reports housework hours for both himself and his spouse, and by measurement error due to different interpretations of the term 'housework' as defined in the questionnaire. The first and second stage regressions include all households in the 1999-2005 panels for which at least one member does positive hours of household and the total amount of reported housework is less than 150 hours.

At the second stage, the non-linear estimating equation is

$$\hat{\overline{h}}_f + \hat{\overline{h}}_m = \phi_m(\hat{h}_m) + \phi_f(\hat{h}_f) \tag{B.1}$$

where hats indicate that we are using instruments from the first stage and the $\overline{h}$—the amount of time the individual would have to devote to accomplish her *nll* bundle if she were single—are estimated for single men and women in our PSID sample using the same set of regressors as used for the instruments. One exception is that omit child indicators for single men, under the assumption that children live with their mothers in the event of divorce or widowhood, but omitting all spousal characteristics.

## B.3 Calibrating time transfers from cohabitation

Here we describe calibration of the model with time transfers from cohabitors. Let $\overline{nll}_{ch}$ be the total *nll* requirement in excess of $\overline{h}(j)$ which generates the average $h$ of single men observed in data after *nll* 'purchases' are made. We calibrate the "price" of time transfer $p_{ch}$ and $\overline{nll}^{ed}_{ch}$ for high and low *ed* households by targeting the mean and standard deviation of observed $h$ for single men in our time-use data. The mean *nll* hours, $\overline{h}$, of single men is 26.1 hours for high-ed and 24.9 for low-ed men, and the standard deviation is 24.5 hours. The calibrated values are $p_{ch} = \$19.20$; $\overline{nlls^{ed=l}_{ch}} = 6.20$ and $\overline{nlls^{ed=l}_{ch}} = 10.80$.

# Appendix C

# Disposable time calculations in Chapter 4

The process for arriving at a measure of *nll* time, hence total time, is as follows. I use the 2005 and 2006 cross-sectional files of the American Time Use Survey (ATUS) with appropriate weights supplied by the Bureau of Labour Statistics. I use only the 2005 and 2006 files because they are very comparable and therefore easy to merge. In particular, the 2004 wave excludes information on household size which I need for some time use estimations. I first calculate total *nll* time for each ATUS individual by summing the minutes spent on all *nll* activities during the ATUS diary day, and adjusting it to a weekly-hours variable, where the relevant numbers are given below Of this total *nll* time, a share is devoted to housework, which is measured in both ATUS and PSID. I next take these individual shares of housework, regression-adjusted for age, marital status, number of children[86], number of babies (under three), number of pre-school age children (under six) and sex, and use them to impute *nll* time to the PSID sample, based on the total annual hours of housework reported by PSID heads and spouses. The logic behind this final imputation step—as opposed to using the ATUS estimates directly—is twofold: first, because the fertility process in the model is estimated from the PSID sample, the final step allows me to better capture the correlation between these estimated fertility processes and *nll* time in the model. Second, and more importantly, the PSID and ATUS samples do not represent exactly the same population of households. The PSID universe, even after weighting, reflects the US population circa 1968, while ATUS cross-section reflects the sample universe of the Current Population Survey (CPS), i.e. the current U.S. population. Since most of my calibrations are necessarily taken from the PSID, I want to avoid as much as possible conflating estimates from the different surveys, which may generate unrealistic household profiles.

[86] The children variable is top-coded at two, with parents of five or more children excluded from the regression.

I calculate non-labour, non-leisure (*nll*) waking time as the sum of the activities listed here, as described in the 2005-2006 ATUS Activity Lexicons (grouped by category). Excluded (non-*nll*) activities include work and all work-related activities except job search; eating and drinking; "socializing, relaxing and leisure"; "sports and recreation"; volunteer activities; and religious/spiritual activities. Within the *nll* categories listed in table C.1, I also exclude phone calls from personal acquaintances, friends and family; traveling associated with these non-*nll* activities; classes taken for personal interest; and leisure activities related to work.

While I believe our choices are straightforward and similar to those described in [2], classifying activities as leisure or non-leisure is to some degree arbitrary. One concern is the uncategorized activities within each broad time use category. Fortunately, these activities account for just over .6% of all *nll* time computed from the survey. A total of 29 cases (out of 37920) report *nll* time during the diary day that implies more than 126 *nll* hours a week, the maximum feasible after imputing 42 hours of required sleep. These individuals I top-code at 168 hours for the subsequent calculations described in the body of the chapter.

Table C.1: List of *nll* activities for disposable time calculations

| | |
|---|---|
| Personal care | Grooming |
| | Health-related self-care |
| | Personal care emergencies |
| | Uncategorized personal care[a] |
| Household activities | Housework |
| | Food and drink prep and clean-up |
| | Interior maintenance |
| | Exterior maintenance |
| | Lawn, garden and houseplants |
| | Animals and pets |
| | Vehicles |
| | Appliances, tools and toys |
| | Household management |
| | Uncategorizable hh activities |
| Caring for and helping hh/non-hh members[b] | Activities related to children's educ |
| | Caring for/helping children |
| | Activities related to children's health |
| | Caring for adults |
| | Helping adults |
| | Uncategorized caring |
| Work and work-related activities | Job search |
| Education | Taking class[c] |
| | Research/homework[d] |
| | Registration/administrative activities |

[a] Excludes "personal/private activities".

[b] "Hh" and "non-hh" are two distinct categories in ATUS, but with identical subcategories.

[c] Excludes classes for personal interest

[d] Excludes research/homework for personal interest

| | |
|---|---|
| Consumer purchases | Shopping for groceries<br>Shopping for gas<br>Shopping for food |
| Professional and personal care services | Childcare services<br>Financial services and banking<br>Legal services<br>Medical and care services<br>Personal care services<br>Real estate<br>Veterinary services<br>Related security procedures<br>Uncategorized p/pc services |
| Household services | Household services[a]<br>Home maintenance<br>Pet services<br>Lawn and garden services<br>Vehicle maintenance<br>Uncategorized hh services |
| Government services and civic participation | Using government services<br>Civic obligations<br>Associated waiting<br>Associated security procedures |
| Telephone calls | Telephone calls[b]<br>Associated waiting |

[a]These include housework-based activities bought commercially
[b]Excludes calls to or from family, friends and acquaintances