An application of the Heckman Selection Model to the Analysis of GIS benefits

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Abstract

Previous studies have identified several characteristics that likely affect the incidence of senior poverty. However, no research addresses the relationship between personal characteristics and the *amount* of GIS benefits received, which would help to predict directly the demands placed by the senior population on the GIS. In this paper, I expand on the existing literature by using the Heckman two-step selection model to estimate the probability that seniors receive GIS benefits as well as the amount of GIS benefits received, given the senior's characteristics. The results of the Heckman two-step estimation procedure indicate that selection bias exists. The results also show that seniors who participate in the job market, are highly educated, live in Ontario, are non-immigrants, and speak English have lower probabilities of receiving GIS benefits. In contrast, as age increases, seniors are increasingly likely to receive GIS benefits regardless of the type of household living arrangement, especially seniors who are lone parents, are living with non-relatives only, or are living alone. The marginal effects of gender for the 65 to 69 and 70 to 74 age groups show that men are more likely to receive GIS benefits. This result contradicts those of other researchers. Furthermore, a senior who speaks French only has a higher probability of receiving GIS benefits as age increases. The results of the second-stage equation modelling the amount of annual GIS benefits received fill an existing gap in previous research. The estimates imply that the average predicted annual amounts of GIS annual benefits, conditional on receipt of benefits, are $5,780, $6,011, $4,590, $4,586 and $5,167 for the five age groups considered, respectively. Individuals who had been employed at some time in the past or who have a higher level of education receive on average smaller amounts of GIS benefits, but these effects diminish as age increases. Immigrant status and the type of household living arrangement also affect the amount of benefit received. Seniors who are lone parents, living alone, or immigrants receive more GIS benefits per year, and the impacts of household living arrangements are fairly large. The marginal effects of gender for the 65 to 69 and 70 to 74 age groups show that on average, men receive more GIS benefits than women.

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1. Introduction

In 2016, the senior population of Canada (the number of Canadians over the age of 65) was 5,990,511, which is more than double that of the 1989 population of 2,942,304 (Statistics Canada 2016a). According to projections, the ratio of the number of people aged 20-64 to those aged 65 and over will drop from 3.8 in 2016 to 2.8 in 2025 (Office of the Superintendent of Financial Institutions Canada, 2015). The growing senior population increases the likelihood that Canadians' retirement income will be inadequate. Moreover, younger Canadians will feel the fiscal burden of the decreasing ratio of non-seniors to seniors, because Canada's public retirement income system is a hybrid of pay-as-you-go and fully-funded public pension plans. [1]

The concern stems not only from the growing senior population, but also the growing low-income senior population. Data from Statistics Canada show that the number of low-income seniors in 2014 was 677,000, which is double that of the 2004 population of 338,000 (Statistics Canada 2017b.). In Canada, eligible seniors receive the Guaranteed Income Supplement (GIS), which is financed entirely from federal government tax revenues, to help them overcome financial difficulties. According to the 9th OAS Actuarial Report (2009), GIS expenditures increased every year between 1992 and 2006 due to an increasing number of GIS recipients and to enhancements to the GIS.

Notwithstanding, the level of GIS benefits is not sufficient to independently keep seniors above the low-income cut off. For instance, the maximum payment for single people in 2010 under the combined OAS pension, GIS and Allowance (to be presented below) is $14,075.82

[1]. A "pay-as-you-go" pension plan is one in which current contributions fund benefits paid in a given year. A "fully-funded" pension plan is one in which contributions are invested, and benefits are financed by the revenues generated by the resulting investment fund. For further information on the financing of the CPP, see Office of the Superintendent of Financial Institutions (2014).

(Government of Canada 2017). The Low Income Cut-offs (LICOs) for a community with population between 100,000 and 499,999 are $15,865 for one person, $19,308 for two persons, and $24,043 for 3 persons in 2010 (Statistics Canada 2014, 15). While some seniors live with low-income temporarily, poverty tends to be persistent for many others (National Advisory Council on Aging, 2005). To explore long-term strategies for fighting poverty, which would consequently relieve fiscal pressure on the public pension system and financial pressure on individual retirees, researchers have analyzed the relationship between personal characteristics (among other factors) and the incidence of senior poverty. (Finnie, Gray and Zhang, 2013; Schirle, 2013) Previous studies have also addressed whether Canadian pension policies encourage individuals to better prepare for their retirement. (Messacar, 2015; Veall, 2014). However, no research addresses the relationship between personal characteristics and the *amount* of GIS benefits received, which would help to predict directly the demands placed by the senior population on the GIS.

In this paper, I expand on the existing literature by using the Heckman two-stage selection model to estimate the probability that seniors will receive GIS benefits as well as the amount of GIS benefits received given the characteristics of seniors. This two-stage strategy is designed to correct for sample selection bias. The paper continues in the next section with a brief discussion of the Canadian retirement income system, followed by a discussion of how public pension plans provide income to seniors. Also, the cost and shortcomings of the programs as well as previous research on how personal characteristics affect GIS benefits received are reviewed. The third section introduces the methodology used, and is followed by a description of the data used. The fourth section analyses the results, which includes the results of a descriptive analysis, the Heckman selection model, and a comparison of the Heckman outcome equation to an OLS model. The conclusions are presented in the last section.

2. Background

2.1. The Canadian retirement income system

Canadian seniors' retirement income comes from public and private pension plans, savings and other assets. Old Age Security, the Guaranteed Income Supplement and the Spousal Allowance form the first pillar in the form of a basic income guarantee for Canadian seniors.2 The second pillar of Canada's retirement income system is composed of the Canada Pension Plan and the Quebec Pension Plan (CPP/QPP), which are designed "to provide contributors and their families with a minimum level of income replacement upon the retirement, disability or death of a wage earner." (Employment and Social Development Canada 2017, iii). The third pillar includes private pension plans and tax-assisted savings and investment plans. In addition, many Canadians also have other assets for their retirement.

Old Age Security, the Guaranteed Income Supplement and the Spousal Allowance constitute the OAS program, which is funded by general government tax revenue. The first similar pension program began in 1927, and then was replaced by the OAS program in 1952. Old Age Security provides a monthly flat rate to seniors, which is adjusted annually to inflation and subject to residency requirements. The OAS pension is clawed back when annual income is above a certain threshold, and so high-income seniors do not benefit.[3]

Established in 1967, the GIS provides an additional monthly payment to OAS recipients whose income is below the GIS cut-off threshold (Young and Prisner 2007). As mentioned in Section 1, the GIS cut-off threshold is different from a measure of low income, and is usually

[2] For further information, see Young and Prisner (2007); some provinces provide income tested top-ups to the OAS and GIS.

[3]For further information, see http://www.esdc.gc.ca/en/cpp/oas/payments.html.

lower than the low income cut-off. The amount of monthly assistance is determined by an OAS recipient's income and marital status, and is indexed to inflation as measured by the Consumer Price Index.4 GIS benefits are not subject to income tax.

The Spousal Allowance was established in 1975. The Allowance provides a monthly additional income payment for an eligible spouse or common-law partner or a widowed spouse or common-law partner aged 60 to 64 years of an OAS/GIS recipient who lives in low-income and meets the residency requirements.[5] The beneficiaries of the GIS are also provided with other benefits such as drug insurance, etc., by the provinces and territories, some of which use receipt of the GIS as an eligibility criterion. According to Employment and Social Development Canada (2017), "in 2014-15, 5.6 million Canadians received almost $44.1 billion in OAS benefits and 1.7 million Canadians received almost $10.1 billion in GIS benefits."

The CPP was introduced in 1965 and came into force in 1966 (Young and Prisner 2007). The CPP has adapted to meet the needs of Canadians. Before 1997, the CPP was a pay-as-you-go system;[6] since 1998, it has become a hybrid of pay-as-you-go and fully-funded public pension plans.[7] This change improved the financial sustainability of the CPP and "fairness across generations" (Government of Canada 2015, 12). Funding of the CPP comes from mandatory contributions by employees, their employers and the self-employed, as well as revenue earned on the CPP surplus investments. CPP benefits include CPP retirement pensions, CPP survivor benefits

[4] Income for calculating GIS benefit excludes the OAS pension and the first $3,500 of employment income. For further information, see https://www.canada.ca/en/services/benefits/publicpensions/cpp/old-age-security/guaranteed-income-supplement/benefit-amount.html.

[5] The residency requirement is that the individual must have lived in Canada for at least ten years since the age of 18. For further information, see https://www.canada.ca/en/services/benefits/publicpensions/cpp/old-age-security/eligibility.html

[6] Pay-as-you-go social security can make all consumers better off if the population grows at a sufficiently high rate.

[7] For further information on the nature of "a hybrid of pay-as-you-go and fully-funded public pension plans", see Office of the Superintendent of Financial Institutions (2014).

and CPP disability benefits to contributors and their families. The benefits are based on contributions made during the contributors' working years and the age at which benefits are first received. They are intended to replace up to 25 percent of average pensionable pre-retirement earnings (Department of Finance Canada 2010). The CPP retirement pension is a monthly taxable benefit for contributors who are at least 60 years old. The CPP survivor benefits provide payments to a surviving spouse or common-law partner and dependent children. They include a one-time death benefit, a monthly payment to the surviving spouse or common-law partner, and a monthly benefit paid to the dependent children. The CPP disability pension provides support to contributors and their dependent children when they are prevented from working due to disability.

The third pillar consists of employer-sponsored pension plans and tax-assisted personal retirement savings. Employer-sponsored pension plans are provided by employers on a voluntary basis. Employers and/or employees are responsible for contributing to the plans. In general, there are two designs: defined benefit plans promise a pension benefit based on a formula set out in the pension plan; and defined contribution plans provide retirement income based on accumulated contributions and investment returns. Tax assisted savings provide retirement saving opportunities through Registered Retirement Savings Plans (RRSPs), Pooled Registered Pension Plans (PRPPs), and Tax Free Savings Accounts (TFSAs) to supplement senior retirement income. (Canada Revenue Agency, 2017).[8]

[8]According to Canada Revenue Agency (2016c) and Canada Revenue Agency (2016d), for Registered Retirement Savings Plans (RRSPs) and Pooled Registered Pension Plans (PRPPs), contributions and investment earnings are tax free until withdrawn. According to Canada Revenue Agency (2016b), the TFSAs are not established specifically to generate retirement income but "Any amount contributed as well as any income earned in the account is generally tax-free, even when it is withdrawn." For further information, see http://www.cra-arc.gc.ca/tx/rgstrd/rpp-rpa/fq-eng.html; http://www.cra-arc.gc.ca/tx/ndvdls/tpcs/prpp-rpac/menu-eng.html; http://www.cra-arc.gc.ca/tx/ndvdls/tpcs/tfsa-celi/mpct-eng.html

In addition, many Canadians also have other assets such as investment income, interest and capital gains, sales of property, etc., for their retirement.

2.2. Canadian public pension plans and senior poverty

As shown in Figure 1, the senior low-income rate in Canada displays a declining trend from 1976 to 2007 using the Low-income Cut-offs (LICOs) (Murphy, Zhang and Dionne 2012). However, this trend may not accurately reflect the standard of living of seniors. According to Shillington (2016), since the LICOs are based on 1992 expenditure data, the LICO does not reflect current consumption patterns. Using the Low-income Measure-based thresholds (LIMs), the percentage of seniors with low income displays a declining trend from 33.1% in 1977 to 3.7% in 1995; then the low-income rate displays an increasing trend from 1996 to the present.[9] This trend is consistent with the number of seniors in low income (Figure 2).

The decline in poverty rates from 1976 through 1995 could be due to the maturation of the CPP and QPP. As mentioned in section 2.1, the CPP and QPP were introduced in 1965 and were implemented in 1966, providing full benefits after 10 years of contributions. In 1976, the first contributors receiving full CPP and QPP benefits turned 65, and the CPP and QPP became major forces in reducing the number of low income seniors over the 1980s (Myles 2000). OAS/GIS benefits have also contributed to the decline in low income seniors. As mentioned in Section 2.1, OAS recipients with little or no other income began to receive an additional monthly payment in the form of GIS benefits in 1967 to ensure their incomes did not fall below a specific threshold.

[9] For further information on how low income thresholds are constructed, see Statistics Canada (2016b)

Meanwhile, OAS pension amounts also increased during this period. For a single person, the total annual payment of OAS and GIS benefits increased from $1,260 in 1967 to $10,426 in 1995.[10]

The increase in the low-income rate from 1996 to 2007 indicates that seniors' incomes did not grow as quickly as those of the other Canadians, which may be due to slower growth in government transfers to seniors (Murphy et al. 2012).[11] After comparing seniors' median income and the GIS level from 1984 through 2011, Shillington (2016, 10) reaches a similar finding: "The median income of seniors (singles and couples) has increased by about 45 per cent, after adjusting for inflation. In contrast, the OAS/GIS guarantee levels have increased by about 7 per cent for senior couples and 15 per cent for single seniors." Furthermore, the influence of CPP and QPP as well as OAS/GIS in reducing low-income declined due to policy changes. As Myles (2000, 13) points out, for seniors "income taxes rose from about 10% of total income in 1980 to almost 16% by 1995," which included the claw back rule of OAS benefit starting in 1989.

2.3. Sources of retirement income

Previous research indicates that the Canadian pension system is an important source of retirement income for an increasing number of seniors. The share of each source in seniors' income varies among income groups. Using data from Statistics Canada's Longitudinal Administrative Database, LaRochelle-Côté, Myles and Picot (2008) selected a cohort of workers who were aged from 54 to 56 in 1983 and tracked their incomes over twenty years. They found that retirement income sources varied among income distribution quintiles. For instance, when individuals in the bottom quintile in 1983 retired in 1996, public pension plans including CPP and QPP benefits and

[10] Author's calculations based on data from "Maximum Monthly Amounts for The Old Age Security Program, by Type of Benefit and Quarter from 1952 to 2017" (Government of Canada 2017).

[11] See Figure 3 of Murphy et al. (2012).

the OAS and GIS were their main source of income, jointly accounting for 53.1% of retirement income before taxes, while private pensions and RRSPs accounted for 16.7% of retirement income before taxes. Among individuals in the middle quintile, 39.4% of retirement income before taxes was derived from CPP/QPP benefits and the OAS and GIS, and 32.4% of retirement income before taxes was from private pensions and RRSPs. In the top quintile, CPP/QPP, OAS and GIS accounted for 18.1% of retirement income before taxes, and private pensions and RRSPs accounted for 29.6% of retirement income before taxes.[12] The share of public pension plans of retirement income declined from the bottom quintile to the top quintile. This is a progressive income redistribution pattern.

In response to the objectives of the OAS program, Human Resources and Skills Development Canada (2012a) examined the importance of the OAS pension, the GIS and the Allowances in contributing to the reduction of low income among seniors and the low-income gap. Examining the difference in income situations with and without the OAS program, the analysis indicated that the OAS program cannot eliminate poverty on its own, but can lower the incidence of low income. For instance, according to analysis derived from the Longitudinal Administrative Database (LAD), in 2006 the incidence of low income before tax was 26.7 percentage points lower for individual seniors than it would have been in the absence of the OAS program. The report also examined how much money was needed to eliminate the low-income gap, which it defined as "the aggregate dollar amount necessary to elevate all seniors up to the low-income benchmark" (Human Resources and Skills Development Canada 2012a, 26). It concluded that the OAS program led to "a 79 percent reduction of the low-income gap (before-tax) for single seniors in 2001, and an 82 percent reduction of the low-income gap (before-tax) for families with one senior member in 2001"

[12] These numbers were derived from Table 3, Table 4, and Table 5 of LaRochelle-Côté et al. (2008).

(Human Resources and Skills Development Canada 2012a, 27). Overall, even if the OAS program has not eliminated poverty among seniors, it has been successful in reducing the incidence of low income during retirement.

2.4 Shortcomings of public pension plans

Canadian pension policies encourage individuals, their employers and governments to share the responsibility for maintaining their standard of living in retirement. A good example is the third pillar consisting of tax-assisted personal retirement savings and employer sponsored-pension plans for retirement savings. By providing tax advantages for RRSPs and employer pension plans, these vehicles encourage Canadians to save for their retirement, so as to decrease the likelihood of seniors living in low-income. However, researchers have found that employer-sponsored pension plans, which are pensions or retirement savings plans offered by employers as a benefit to their employees, are affected by the contribution rate of the CPP. Regarding the relationship between employer-sponsored pension plans and tax-assisted personal retirement savings, employer-sponsored pension plans "partially crowd out contributions into registered retirement savings plans----by approximately $0.50 per $1.00" (Messacar 2015, 5).

In addition, certain groups may not benefit from these various savings and work incentive policies. For instance, there are a lot of workers who simply cannot afford to save for retirement. When people with low income put their money into a RRSP, they may not save on income taxes due to their low income. By contrast, if they are entitled to GIS benefits when retired, since GIS benefits are income tested benefits, GIS benefits would be reduced due to the GIS clawback if they earn income from any other source, including employment, pensions, etc.:

> GIS benefits: reduced at the rate of 50 cents for every dollar of income received on top of the OAS/GIS pension and the first $3,500 of employment income. The reduction is 25

> cents for every dollar on top of the OAS and GIS benefits and the first $2,000 of income ($4,000 for couples) for the GIS top-up. (Employment and Social Development Canada 2017, 29).

Thus, according to these rules, GIS benefits would be reduced by $500 for each $1,000 of RRSP income due to the GIS clawback of 50 percent. Therefore, if the combination of the interest rate and the marginal personal income tax rate at the time of contribution is lower than the GIS clawback rate of 50 percent, the individual would not benefit from contributing to an RRSP (National Advisory Council on Aging 2005). Veall (2014) reports that a range of 15 percent to 30 percent of recipients of RRSPs/ RPPs were subject to a GIS clawback when they cashed out their RRSPs/RPPs after they retired. Furthermore, Veall also states that three fifths of RRSP recipients would lose at least $1,000 yearly due to the GIS clawback of RRSP withdrawals. The same issue would arise if seniors' income came from registered pension plans.

Furthermore, other policies, such as enhancing the CPP, would also not help some groups. For example, policies that enhance the CPP will not help unattached seniors who never worked accumulate money for retirement, since the CPP is a work-related investment. Also, since allowances for spouses would not provide benefits to single seniors, single seniors would not receive any benefit from this policy change either (Cross 2014).

2.5 Program expenditures

To address these particular financial circumstances, one option is to create alternative saving mechanisms where contributions to savings would be from after-tax income, but the withdrawals are tax-free during retirement (National Advisory Council on Aging, 2005). Such a savings vehicle would be the opposite of investing in an RRSP, and might encourage low income earners to save for retirement. In 2009, the Canadian government launched the Tax-Free Saving

Account (TFSA) program. Although the TFSA was not created specifically to generate retirement income, earnings in the account and withdrawals are tax-free.[13] Another recommendation is to provide a small exemption for RRSP and RRIF income when calculating income for the GIS (Veall 2014). However, these suggestions may raise the fiscal costs of the GIS. According to Veall's calculations, there are 180,000 seniors receiving both GIS and RRSP or RRIF income. Thus, an exemption of just $1,000 provided to each beneficiary would increase federal government expenditure annually by $90 million. As Veall (2014, 388) stated: "There is a good argument for the latter reform, but it would increase the cost to the treasury."

In fact, even if no new cost is added, OAS costs would still increase every year. Data from the 9th OAS Actuarial Report (2009) show that from 1992 to 2007, expenditures from the OAS, GIS, and the Spousal Allowance increased every year. In 1992, $14,292 million of OAS was paid to beneficiaries, rising to $24,711 million in 2007, while GIS payments rose from $4,227 million in 1992 to $7,346 million in 2007. The Spousal Allowance increased from about $438 million in 1992 to $513 million in 2007. This increasing trend can be explained by the increase in the number of seniors over time and the indexation of benefits to inflation. In addition, administrative expenses also display an increasing trend over time, from $77 million in 1992 to $112 million in 2007. Furthermore, the number of beneficiaries of the program is expected to double between 2010 and 2030.[14] The increasing expenditures of the OAS program have created financial pressure on the federal government over time, since the federal government is responsible for funding the program. For the fiscal year ending on March 31, 2014, 15 cents of each tax dollar were spent on Old Age

[13] For further information, see http://www.cra-arc.gc.ca/tx/ndvdls/tpcs/tfsa-celi/menu-eng.html.

[14] These values are from Table 7 of Office of the Superintendent of Financial Institutions Canada (2009, 27)

Security (OAS), Guaranteed Income Supplement (GIS), and Allowance for Spouses (Department of Finance Canada, 2014).

2.6 Factors affecting seniors' income

Since OAS benefit payments have increased government expenditures, which may lead to other economic consequences, researchers are looking for the causes of low income, in hopes of eliminating the roots of poverty. Previous studies have confirmed that some personal characteristics are associated with a higher risk of low income. Using the Longitudinal Administrative Data (LAD) file from 1982 to 2008, Finnie, Gray, and Zhang (2013 s76) estimate, using a linear probability model, that the incidence rate for receiving GIS benefits among single female seniors "is 8 percentage points higher than that of single men," holding all other factors constant. Furthermore, the incidence rate for receiving GIS benefits among female seniors increases as their age increases (Uppal, Wannell and Imbeau, 2009). In terms of regional factors, Ontario has the lowest incidence rate (Finnie et al., 2013).

Besides the effects mentioned above, other characteristics come into play as well. Schirle (2013) conducts a decomposition analysis that examines how the characteristics of seniors contribute to the likelihood of living in poverty over time. According to Schirle's study, although the results were different for different datasets and different measures of low income, variables related to education level, age, birthplace, family composition and the location of residence are all factors that can predict the likelihood of poverty among seniors.[15]

[15] Schirle's data included the Survey of Consumer Finances and Survey of Labour and Income Dynamics (1977-79, 1994-96, and 2006-08).

3. Methodology

In this paper, I want to estimate the effect of various factors on the amount of GIS benefits received. A simple linear regression model for the amount of GIS benefits received could be written as

$$y_i = \mathbf{x}_i'\beta + \varepsilon_i, \qquad (1)$$

where y_i is the amount of GIS benefits received, $\mathbf{x}_i$ represents a vector of explanatory variables (to be discussed in the next section), and ε_i is an error term that is assumed to be independently and identically normally distributed with a zero mean.

A potential problem with OLS estimation of this equation is that the amount of GIS benefits received depends on whether or not the senior meets the residency and annual income requirements, which means that the amount of GIS benefits received is a censored random variable.[16] Many individuals receive no GIS benefits. Thus, the assumption that the dependent variable is normally distributed is violated. Furthermore, if equation (1) is estimated using only the observations for which $y_i \neq 0$, the parameter estimates will be biased. To see this, let the equation that determines whether an individual receives GIS benefits be

$$z_i = \boldsymbol{w}_i'\gamma + u_i, \qquad (2)$$

where z_i is an unobservable index of eligibility for GIS, $\mathbf{w}_i$ is a vector of seniors' characteristics, and the random error u_i is assumed to have a standard normal distribution. If $z_i > 0$, individual *i* is eligible to receive GIS benefits. Then, the sample selection rule is that y_i is observed only when z_i is greater than zero. The expected GIS benefit, given that the individual is eligible, is thus

[16] Note that the individual must also be aged 65 or over to receive GIS benefits.

$$E[y_i \mid z_i > 0] = \mathbf{x}_i'\beta + \beta_\lambda \lambda_i(\boldsymbol{w}_i'\gamma), \quad (3)$$

where $\lambda_i(\mathbf{w}_i\gamma)$ is the inverse Mills ratio.

Thus, the expected value of y_i is equal to $\mathbf{x}_i'\beta$ plus an additional term, $\beta_\lambda\lambda_i(\mathbf{w}_i\gamma)$. Therefore, OLS estimation of equation (1), which excludes the additional term, would lead to biased and inconsistent estimates of β (unless $\beta_\lambda = 0$). Due to this selection bias, estimates of equation (1) could not be used to forecast outcomes for all seniors.

In order to correct for this sample selection bias, the Heckman two-step estimator will be used. The Heckman estimator improves the estimates of the parameters, relative to OLS estimation of equation (1), by allowing me to use all the observations to estimate a probit model of the probability that seniors receive GIS benefits in the first step. The inverse Mills ratio for each observation, $\lambda_i = \varphi(w_i\gamma)/ \Phi(w_i\gamma)$, will then be calculated. Lastly, using only the GIS recipients subsample in the second step, an OLS regression is estimated in which the amount of GIS benefits received is the dependent variable, and $\mathbf{x}_i$ and the inverse Mills ratio λ_i are the explanatory variables:

$$\begin{aligned} y_i|z_i > 0 &= E[y_i|z_i > 0] + \upsilon_i \\ &= \mathbf{x}_i\beta + \beta_\lambda\lambda_i(\mathbf{w}_i\gamma) + \upsilon_i. \end{aligned} \quad (4)$$

where v_i is a new error term that is heteroskedastic. Because the inverse Mills ratio is included as an additional explanatory variable, the sample selection bias is corrected. This procedure will give consistent estimates of the parameter vector β. The estimators from this two-step procedure are consistent and asymptotically normal.[17]

[17] For further information, see Greene (2012) or Wooldridge (2010). Note that in estimating the variance of the OLS estimator of the parameters of equation (4), one must take into account both heteroskedasticity and the fact that the inverse Mills ratio is a generated variable. An appropriate formula is given on page 877 of Greene (2012).

According to Cameron and Trivedi (2005, 551), the parameters of this two-equation sample selection model are identified even in the case where $\mathbf{x}_i = \mathbf{w}_i$. However, in practice they may not be, due to multicollinearity between the inverse Mills ratio and the other explanatory variables, if $\mathbf{x}_i = \mathbf{w}_i$. To avoid this problem, in my empirical analysis I will exclude from $\mathbf{x}_i$ some of the variables that are included in $\mathbf{w}_i$.

To test for selectivity bias, I examine the estimate of β_λ. If I cannot reject the null hypothesis that $\beta_\lambda = 0$, then sample selection does not result in significant bias, and so applying OLS to the outcome equation based on the selected sample without including the inverse Mills ratio is appropriate. Otherwise, sample selection causes significant bias, and the inverse Mills ratio should be included when the GIS benefits model is estimated.

4. Data and its Limitations

The data source is the Individuals File of the 2011 National Household Survey (NHS). According to Statistics Canada (2017, 5), "the NHS covers all persons who usually live in Canada, in the provinces and the territories. It includes persons who live on Indian reserves and in other Indian settlements, permanent residents, non-permanent residents such as refugee claimants, holders of work or study permits, and members of their families living with them." In this paper, the sample is restricted to individuals who are aged 65 and over. The NHS contains 117,741 seniors, which is 13.27 % of the total sample. The distribution of observations among age groups, the percentage of the total senior population, and the percentage of the entire sample are as follows:

60 to 69 years	39,413	33.47%	4.47% [18]
70 to 74 years	28,978	24.61%	3.28%
75 to 79 years	22,629	19.22%	2.56%
80 to 84 years	15,713	13.35%	1.78%
85 years and over	11,008	9.35%	1.25%

[18] The entire sample in the dataset: 882,287

According to the 2011 NHS, 92.04% of seniors received OAS/GIS benefits, and 7.96% of seniors did not receive OAS/GIS benefits.

4.1 Creation of the new variable GIS

Although the NHS Public Use Microdata File (PUMF) contains detailed information on income from different sources, it combines OAS and GIS payments in one variable. However, OAS eligibility depends only on the individual's age and a residency requirement, while GIS eligibility depends on income as well. Thus receipt of GIS benefits is an indicator of senior poverty. To generate a measure of GIS benefits, OAS payments must be removed from the variable as it appears in the NHS.

In the NHS, the unit of analysis is the individual, for whom certain characteristics are provided. Furthermore, periods of residence, legal status as well as income have already been factored in when determining eligibility for OAS program benefits by administrative processing officers; therefore, the values of the combined variable OASGI are the actual total amounts seniors received from OAS and GIS in 2010. Thus, the effect of income on GIS entitlements (either individuals' income or their family income) has already been considered before generating the GIS variable.

In 2010, the maximum basic OAS pension for individuals who have lived in Canada for at least 40 years after age 18 is as follows:

January to March: $516.96
April to June: $516.96
July to September: $518.51
October to December: $521.62
Total full OAS benefit in 2010 was $6,222.15.

In addition, since the analysis is restricted to those individuals aged 65 and over, individuals aged 60 to 64 years old who receive spousal allowance are automatically excluded from the analysis. Thus, the new variable **GIS**, defined as the amount of GIS benefits received, is constructed using the following formula:

$$\mathrm{GIS} = \mathrm{OAS/GIS} - 6222, \tag{5}$$

where OAS/GIS is given by the NHS variable OASGI, and $6,222 is the maximum amount that could be received from the OAS benefit in 2010. After deducting $6,222 from the NHS variable OASGI, the remainder is in principle GIS benefits. However, $6,222 is the benefit received by seniors having resided in Canada at least 40 years after turning 18. Senior individuals who have lived in Canada at least 10 years but less than 40 years would receive only a partial OAS pension.[19] Thus, the actual GIS benefits for those receiving partial OAS benefits will be higher than the amount implied by equation (5) by an amount equivalent to the difference between the maximum OAS and their actual OAS benefits, but there is no way to correct for this in this analysis. Second, GIS is set equal to zero whenever the difference in equation (5) was less than or equal to 0; otherwise, the estimated GIS benefit is equal to the remainder after 6,222 is deducted. Thus, the new variable **GIS**, which will be used as the dependent variable in the analysis, is a proxy for the actual GIS benefit received from the federal government. After the adjustment to eliminate negative values, 46.62% of seniors in the sample received GIS benefits, and 53.38% did not receive GIS benefits in 2010.

[19] For further information about partial OAS pensions, see Government of Canada (2016c).

4.2. Comparison of the proportion of seniors receiving GIS benefits in the NHS with that in other dataset

In order to put the analysis in perspective, the maximum OAS and GIS benefits received, and the proportions of seniors who received GIS benefits in 2010 are compared between the NHS and the Survey of Labour and Income Dynamics, 2011 [Canada]: Person File (SLID). In the NHS, the maximum combined OAS and GIS received is $21,200, while the maximum combined OAS and GIS benefit amounts are $20,500 in the SLID. Though not identical, these two numbers are similar. The estimated proportion of seniors who received GIS benefits is 46.62% in the NHS, and 35.86% in the SLID. The proportion of seniors who received GIS benefits seems be higher in the NHS according to the new variable **GIS**.

While the two datasets cannot provide the answer as to why the proportions of seniors who received GIS benefits are different, possible causes are proposed. First, the sample NHS respondents may be different from the respondents in the SLID. The SLID has a smaller sample size, so different samples would produce different estimates. The NHS contains 117,741 seniors, while the SLID contains only 3,628. Second, the datasets are from self-administered surveys, and the calculation of received OAS and GIS benefits could be complicated for some seniors, which may cause a difference between actual amounts of GIS received and the amount reported.

Furthermore, since both datasets are self-administered surveys, they cannot be more accurate than data obtained directly from the Canada Revenue Agency or Employment and Social Development Canada (These data are restricted, so I cannot access these datasets.). Nevertheless, it is possible that the high proportion of GIS recipients calculated with the NHS data is accurate. The report of the Organisation for Economic Co-operation and Development (OECD) (2013, 1) supports this possibility, stating that during the crisis period from 2007 to 2010, the poverty rates for seniors increased in Canada: “while old-age poverty fell in 20 OECD countries between 2007 and 2010, old-age poverty in Canada increased by about 2 percentage points over the same period." Based on the reasons stated above, and the fact that the actual GIS benefits for those receiving partial OAS benefits will be higher than the amount implied by the calculations, I think that the new generated variable GIS is a reasonably good indicator of seniors' poverty in 2010. (Recall that since GIS benefits are means-tested, receipt of GIS benefits indicates that the individual's non-GIS income was low.)

4.3. Independent variables in the selection model and the outcome model

In the selection equation, the independent variables refer to the date last worked for pay or in self-employment, household living arrangements, immigrant status, sex, education, province or territory of residence in 2010, and official language. These variables are selected to determine the likelihood that seniors receive GIS benefits. In the outcome equation, the independent variables also refer to the date last worked for pay or in self-employment, household living arrangements, immigrant status, sex, education and the inverse Mills ratio λ_i. These variables are selected to model the amount of GIS benefits received. Furthermore, since all the independent variables except the inverse Mills ratio are categorical variables, to analyze the difference between categories, each category of the variable will be treated as a separate covariate, with the first category of the respective variable selected as its base. Thus, the coefficients reflect the deviation in the dependent variable (predicted probabilities or amounts) for that particular category relative to the reference category. In addition, as noted in section 3, if all the variables in the selection equation are also included in the outcome equation, a multicollinearity problem may exist in the outcome equation that makes it difficult to identify its parameter estimates. As a result, the estimated coefficients of the outcome equation may be imprecise. Thus, the variables related to place of residence in 2010 and official language are not included in the outcome equation.

The date last worked for pay or in self-employment has four categories: last worked before 2010, last worked in 2010, last worked in 2011, and never worked. The results would disclose how labour force participation in the specified year affects the probability of receiving GIS and the amount of GIS. Household living arrangements are also important, since they not only reflect marital status, but also family composition, which may affect both income level and the qualification threshold for GIS benefits. Household living arrangements include the categories of married or common-law without children, married or common-law with children, lone parent, child of a couple, child of a lone parent (these two categories do not seem relevant for the population of seniors, but in fact, there is information on these two categories for certain age groups in the data set), person living alone, person living with non-relatives only, and person not in a census family but living with other relatives. The categories for the immigration status dummies are non-immigrants, immigrants, and non-permanent residents. The results will disclose whether immigration status affects the ability of seniors to accumulate financial assets; immigrants may be at risk of having an inadequate retirement income.

Moreover, since receipt of GIS benefits depends only on seniors' incomes and the residency requirement, gender should not be related to whether or not seniors receive the GIS. However, if there is inequity in earnings or in other types of income between men and women, it might indirectly affect seniors' retirement incomes. Thus, the differences in the probability of receiving GIS and the amount of GIS benefits received between males and females will also be discussed.

Education level is recoded into the categories of no certificate, diploma or degree; high school diploma; trades or Registered Apprenticeship certificate; college, CEGEP, or other non-university certificate; university; degree in medicine, dentistry, veterinary medicine or optometry; master's degree; and earned doctorate degree. It is well-known that education has been identified as a determinant of income, and therefore is likely to affect receipt of GIS benefits.

Province or territory of residence in 2010 includes Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, and Northern Canada. The place of residence is included because various local economic characteristics might affect individuals' incomes, which ultimately determine whether or not the senior receives the GIS, and what level of benefit is. Official language is classified into English only, French only, both English and French, and neither English nor French. Since language skills impact the likelihood of people participating in the job market as well as their income, this factor also is included in the models.

Table 1 lists the means and standard deviations of all the dummy explanatory variables disaggregated by age group. Since all the independent variables used in the analysis are categorical variables, computing means and standard deviations of the original categorical variables does not make sense. However, it does make sense to do so for the individual dummy variables for each category, as the mean of a dummy variable discloses the proportion of individuals in the sample who fall into corresponding category. For instance, the mean of immigrants in the 65 to 69 age group is 0.2869, which indicates that 28.69% of individuals in this subsample fall into that category. Furthermore, Table 1 helps to identify atypical cases where the number of individuals constitutes a very small percentage of the sample or is non-existent. For instance, the number of individuals in the categories of lone parent, child of a couple, and child of a lone parent are 1158, 2, and 97 in the 65 to 69 age group. Thus 2.94%, 0.01%, and 0.25% of individuals in this age group fall into the corresponding categories. In the 85 years and over age group, the number of individuals in the categories of lone parent, child of a couple, child of a lone parent are 1119, 0, and 0. Thus 10.17%, 0.00%, and 0.00% of individuals in this age group fall into the corresponding categories.

5. Results and discussion

In this section, I begin with a descriptive analysis of seniors' incomes in 2010. The Heckman two-step selection model is then used to examine the probability of receiving GIS benefits and the amount of GIS benefits received, by age group. I analyze the effects of the independent variables by age group because I find that there are common patterns among those in the same age group.

5.1. Descriptive analysis

In 2010, 45.99% of seniors (all ages combined) received GIS benefits. Table 2 lists the percentage of female GIS recipients and male GIS recipients in each age group. The female column is calculated as follows: (number of female seniors aged 65-69 who receive GIS/total number of seniors aged 65-69 who received GIS) *100, and the male column is calculated in the same fashion. Thus, I can compare the proportions by gender within each age group. The patterns are different for men and women. While the percentage of female GIS recipients out of the total population of the age group clearly increases with age, the pattern is not clear for men. In the 65 to 69 age group, women who receive GIS benefits account for 19.28% of seniors in that age group. In the 85 years and over age group, female GIS recipients account for 41.61% seniors in that age group, which is more than double than that of the 65 to 69 age group. For men between the ages of 65 and 79, the data show an increasing trend from 15.75% in the 65 to 69 age group to 21.14% in the 75 to 79 years age group. Then the table shows a decreasing trend for men aged 80 and above. In the 85 years and over age group, men who receive GIS benefits constitute 17.23% of seniors in that age group. The differences across age groups are thus not big for men.

Overall, the percentages receiving GIS benefits in each age group increase as age increases when gender effects are ignored. As age increases, more and more seniors claim and qualify for GIS benefits. In the 65 to 69 age group, 35.03% of seniors received GIS benefits, while 58.84% of seniors aged 85 and over rely on GIS benefits. When gender effects are considered, it is clear that the incidence trends are driven by women.

Table 3 reveals seniors' sources of income by income level. OAS/GIS benefits are a critical component of seniors' incomes for the lower income strata. For the lowest (first) decile, OAS/GIS benefits are the most important source of income, constituting 65.57% of total income. In the second decile, OAS/GIS benefits represent 60.34% of total income. On the other hand, higher-income seniors have more diverse income sources. For instance, among individuals in the ninth and highest deciles, OAS/GIS benefits account for 10.40% and 3.13% of total income, respectively. Employment income and private pension income are relatively more important for these deciles. Employment income and private pensions account for 22.99% and 41.60% of total income respectively in the ninth decile. In the highest decile, they account for 43.31% and 23.45% of income, respectively.

Table 4 presents the distribution of income within each senior age group. In all age groups, seniors are most likely to fall in the second income decile, followed by the third decile, as these two deciles account for the largest shares within each age group. In general, seniors are concentrated in the second to the fifth income deciles. As age increases from 65 to 84, the percentages of seniors in the second and third deciles increase. Then the percentage decreases slightly in the third decile for the 85 years and over age group. More importantly, as age increases, fewer seniors remain in the highest decile, with a similar downward trend apparent from the fifth decile to the highest. More specifically, only 5.54% of seniors in the 85 years and over age group are in the highest decile, which is about half of the 9.17% of seniors in the highest decile in the 65-69 years age group.

Furthermore, the importance of different income sources varies according to seniors' age (Table 5). For individuals from 65 to 69 years old, employment income accounts for 32.52% of total income, while OAS/GIS benefits account for 15.74%, CPP/QPP benefits for 15.12%, investment gains for 9.34%, and private retirement pensions for 27.27%. For seniors aged 85 and over, employment income accounts for only 1.56% of total income, while OAS/GIS benefits account for 28.02%, CPP/QPP benefits for 21.73%, investment gains for 16.35%, and retirement pensions account for 32.34%. Thus as age increases, private pensions eventually become the main source of retirement income, followed by OAS and GIS. Overall, the shares of CPP/QPP, OAS/GIS, investment income, and retirement income display an upward trend with age, while the share of employment income in total retirement income decreases with age.

The remainder of this section looks at the characteristics of GIS recipients. The data in Table 6 show that as age increases, seniors show an increasing need for financial assistance regardless of the type of household living arrangement. For couples with children, or for seniors who are lone parents, the trend is much more prominent; although these are not typical cases at all, they are the groups that rely most heavily on GIS benefits In 2010, the percentage of lone parents receiving GIS jumped to 65.36% within the age group of 70 to 74 years, as compared to 49.74% for the age group of 65 to 69 years. Furthermore, the data reveal that unattached seniors need more assistance as they become older. For example, 65.18% of seniors living with non-relatives receive GIS in the age group 70 to 74 years, compared to 48.13% of seniors in the category 65 to 68 years.

Table 7 presents the percentage of senior receiving GIS by education level for each age group. The table suggests that education plays an important role in determining seniors' retirement incomes. As the level of education increases, fewer and fewer seniors rely on GIS. Another interesting pattern is that in each educational attainment category, the incidence rate for GIS increases as age increases. This relationship between education and seniors' incomes is obvious among younger seniors as well as those who are 85 years and over (These sample sizes are small.). For instance, in the category "earned doctorate degree," 14.95% of seniors aged 65 to 69 years rely on GIS benefits; the percentage increases to 36.92% of those 85 and over.

All in all, OAS and GIS are the major sources of income for seniors in the bottom two income deciles. In contrast, those who are wealthier receive a higher proportion of income from employment and private pensions. Thus, changes to OAS/GIS would directly affect the well-being of low-income elderly individuals. Second, the share of OAS/GIS in seniors' incomes displays an upward trend with age, especially for seniors who are lone parents or who are living alone. Moreover, more seniors fall into the lower income deciles as they get older. The combined information from Tables 3 and 5 indicates that once seniors receive OAS/GIS benefits, many of them remain reliant on the program for the rest of their lives. Finnie, Gray, and Zhang (2016) find that about three quarters of seniors aged between 66 and 70 years are persistent users. Finally, the relationship between education and seniors' incomes is obvious. As the level of education increases, fewer and fewer seniors rely on GIS benefits through the link between earnings and educational attainment.

5.2. Heckman two-step estimation results [20],[21]

This section discusses selection bias issues, the Heckman selection equation (i.e., the first-stage probit model of the incidence of GIS benefits), and the Heckman outcome equation (i.e., the second-stage equation for the level of GIS benefits). For the Heckman selection equation, the average marginal effects of the explanatory variables on the probability of receiving GIS will be discussed. In other words, holding all other independent variables constant, what is the difference in the average probability of receiving GIS between the base category and the representative category of a particular variable? Also, the results will be compared with those of previous studies. However, in the case of the Heckman outcome equation, I compare the average marginal effects on the amount of GIS received only to the corresponding coefficients of an OLS model, since there is no previous research to which they can be compared.

Table 8 presents the results of a Wald test of the null hypothesis that all the coefficients of the selection equation are jointly zero. Since the p-values are less than 0.05 for all age groups, I can reject the null hypothesis at 0.05 significance level for all age groups. This indicates that including all the variables leads to a statistically significant improvement in explanatory power.

5.2.1. Selection bias issues

Table 8 also presents the values of the estimated coefficients of the inverse Mills ratio. The results indicate that selection bias exists, since the coefficients of the inverse Mills ratio are

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[20] In the Heckman two-step model, because of missing data the sample sizes for the five age groups are reduced as follows:

60 to 69 years	from 39,413 to 39,112
70 to 74 years	from 28,978 to 28,777
75 to 79 years	from 22,629 to 22,511
80 to 84 years	from 15,713 to 15,649
85 years and over	from 11,008 to 10,948

[21] Estimation was carried out using the “heckman” command in Stata.

statistically significant for all age groups at a significance level of 0.01. Thus, the application of standard regression techniques such as OLS to the outcome equation without including the inverse Mills ratio variable would yield biased results, since they would not account for the censoring of the sample (The nature of the biases will be discussed in section 5.3). The numbers of censored and uncensored observations also are displayed in Table 8. The percentages of uncensored observation are 35.10%, 48.00%, 50.90%, 53.92% and 58.88% for the five age groups arranged in ascending order. The negative sign of λ suggests that the error terms in the selection and outcome equations are negatively correlated. More specifically, in the model, unobservable influences are negatively related to the probability of receiving GIS, but are positively related to the amount of GIS benefits received. Alternatively, unobservable influences may be positively related to the probability of receiving GIS, but negatively related to the amount of GIS benefits received.

5.2.2. The first-stage probit model of the incidence of GIS benefits

Table 9 lists, by age group, the average predicted probabilities of receiving GIS benefits, which are 0.3515, 0.4805, 0.5094, 0.5395, and 0.5891 for the five age groups respectively. These values provide a point of reference for the marginal effects. After comparing the average predicted probabilities to the marginal effects, one can see that in some cases, the changes are dramatic. For instance, the average predicted probability of receiving GIS benefits is 0.4805 for the 70 to 74 age group, while on average, the marginal effect of holding a master’s degree reduces the probability of receiving GIS benefits by about 0.2951. Thus overall, it reduces the average probability of receiving GIS to just 0.1854. Household living arrangements can have similarly large effects. The average predicted probability of receiving GIS benefits is 0.3515 for the 65 to 69 year-old age group, and on average, the marginal effect of being a senior living alone increases the probability of receiving GIS benefits by about 0.1375. Thus it increases the average probability of receiving GIS to 0.4890 for 65 to 69 year-olds.

The marginal effects on the probability that seniors received GIS benefits also are presented in Table 9. The estimated values for the work status variables show that the average marginal effects for seniors who participated in the job market in 2010 or 2011 are negative, which implies that on average, the probability of receiving GIS benefits is lower for individuals who worked in 2010 than for individuals who had stopped working in 2010. This is true regardless of the individual's age bracket. The reason for this is that when seniors participate in the job market, their employment income increases their total income. Even if their income does not exceed the threshold for receiving GIS benefit, since GIS benefits are income-tested benefits, after the exclusion of a certain amount of employment income and OAS pension income, the additional income is subjected to the GIS claw-back. In contrast, the signs are positive for seniors who have never worked, which indicates that never having worked increases the chance of seniors receiving GIS benefits, holding all else constant. Moreover, seniors participate less in the labour market as they get older. These results correspond to previous research, and to my expectations: retirement income levels are not only determined by pre-retirement income, they are also correlated with seniors' current income. These results are broadly consistent with those of Finnie, Gray and Zhang (2013), although they used income earned between 50 and 52 years of age rather than current income (they used that as a proxy for income while working). In addition, all coefficients are statistically significant except for the coefficient of the last worked in 2010 dummy variable for the 80 to 84 years and 85 and over age groups, since hardly anyone in those age groups fits into the categories. One explanation for the insignificant coefficients could be that as Table 1 indicates, relatively few individuals in these age groups fall into this category, causing the estimates of the coefficients to be imprecise.

The results in Table 9 also show that the impact of household living arrangements is notable. In most categories, the need for GIS benefits appears to increase as age increases. For lone parents, the effect is even stronger: the probability of receiving GIS benefits increases by 16.17 percentage points on average in the 65 to 69 age group and by 18.35 percentage points on average in the 70 to 74 age groups, relative to those who are married or common-law without children. Persons living alone, persons living with non-relatives only, and persons not in a census family but living with other relatives are also more likely on average to receive GIS benefits, and therefore are more likely to be seniors living in low-income. For instance, for a person living with non-relatives only in all five age groups, the probability of receiving GIS benefits is on average higher than if the person had been married or living common-law without children by 16.15, 20.62, 18.17, 19.22, and 15.21 percentage points respectively, holding all else constant. These results for household structure correspond to the results with respect to marital status of previous studies. Finnie, Gray, and Zhang (2013) found that marital status strongly affects the incidence of GIS benefits, with both men and women with partners being less likely to receive GIS benefits. Schirle (2013) found that compared to unmarried seniors, married seniors were less likely to have income below the low-income threshold no matter what data were used. However, no previous studies have investigated the effect of children living in the home or seniors living with others, so no comparisons can be drawn with respect to these results.

When comparing immigrants to non-immigrants, the positive marginal effects of the immigrant dummy variable imply that immigrants have a higher probability of receiving GIS benefits. In each age group, the marginal effects are statistically significant. However, the marginal effects for non-permanent residents are statistically insignificant for the age groups 70 to 74 and 80 to 84 years. This result is consistent with pension policy, since only citizens or permanent residents or a legal resident of Canada are eligible to be beneficiaries of this program. The results are also similar to those of other researchers. Schirle (2013) found that Canadian-born seniors are less likely to fall below the low-income thresholds, while Finnie, Gray, and Zhang (2013) found that immigrants have a very high rate of incidence of receiving GIS benefits compared to native-born Canadians. In addition, there is an upward trend as age increases. For instance, in the 65 to 69 age group, seniors who are immigrants have a 2.43 percentage point higher probability of receiving GIS benefits, and the difference increases to 4.71 percentage points for seniors in the 75 to 79 age group.

The effect of gender on the probability of receiving GIS benefits is interesting. In the 65 to 69 and 70 to 74 age groups, men are more likely to receive GIS benefits. The marginal effects for men are on average higher than those for women by 1.05 and 0.2 percentage points respectively in these two age groups. However, in the 75 to 79, 80 to 84 and 85 and over age groups, men are on average less likely to receive GIS benefits than women by 0.8, 3.64, and 7.11 percentage points respectively. In the 70 to 74 years and 75 to 79 years age groups, the dummy variable for males has no explanatory power according to the coefficient estimates. Thus, this variable does not seem to have a consistent relationship with the probability of receiving GIS benefits in the data. It should be noted that the marginal effects for the 65 to 69 and 70 to 74 age groups contradict those of other researchers. Schirle (2013) found that compared to females, males are less likely to live in low income status. Similarly, Finnie, Gray, and Zhang (2013) found that the incidence rate for GIS benefits for women is 8.1 percentage points higher than for men, all other factors held constant.

With regards to the level of education, the marginal effects of all education levels show that higher education levels are strongly tied to reduced probability of receiving GIS, especially for seniors with "university" and above, since the signs of all the marginal effects for the education level variables are negative. In addition, the magnitudes of the marginal effects of the education variables are large. The marginal effects show that seniors in the 65 to 69 age group who have a college, university, or master's degree are 15.98, 21.93, and 24.86 percentage points less likely to receive GIS benefits, respectively. These results are consistent with the conclusions of Schirle (2013). Furthermore, a senior who has a master's degree has an increasingly reduced probability of receiving GIS as age increases.

The results with respect to the region of residence indicate that the probability of receiving GIS benefits is higher on average in Newfoundland than in all other provinces and territories, except in Northern Canada among seniors age 75 to 79 years and 85 years and over. The magnitudes of the marginal effects differ across regions and age groups. However, if Northern Canada is not included, no matter where the seniors live, the provincial disparities in the probability of receiving GIS benefits become larger as the age increases from 65 to 69 to 75 to 79. For instance, in the 65 to 69, 70 to 74 and 75 to 79 age groups, seniors living in Ontario are on average less likely to receive GIS benefits than seniors living in Newfoundland and Labrador by 12.59, 19.54, and 27.65 percentage points respectively. When comparing the 80 to 84 and the 85 and over age groups, a senior in the 80 to 84 age group has a lower probability of receiving GIS benefits. For those aged 65 to 69 years, 75 to 79 years, 80 to 84 years, and 85 and over, seniors living in Ontario have the lowest probability of receiving GIS benefits among all provinces and territories. The result is similar to the result of Finnie, Gray, and Zhang (2013), who found that Ontario has the lowest incidence rate among all provinces and territories, and Newfoundland has the highest incidence rate. In addition, another point of interest is that, as age increases, the probability of receiving GIS benefits in a particular province tends to decrease. More specifically, the coefficients of the provincial dummies for Nova Scotia, New Brunswick, Quebec, Saskatchewan, and British Columbia decrease as age increases from 65 to 84. For instance in Quebec, the probability of receiving GIS benefits is 6.73 percentage points lower compared to the base group of Newfoundland and Labrador in the age group 65 to 69, and 20.50 percentage points lower in the 85 and over age group.

The influence of official language skills is obvious. Compared to seniors who speak English only, the marginal effects show that seniors who speak French only have a higher probability of receiving GIS benefits. In the age group of 65 to 69 years, seniors who speak French only have a 2.34 percentage point higher probability of receiving GIS benefits. The difference increases to 14.49 percentage points for seniors in the 85 and above age group. Those who speak both English and French have a lower probability of receiving GIS benefits in the 65 to 69 years age group and in the 70 to 74 years of age group, but have a higher probability of receiving GIS benefits for those aged 75 and over. An inability to speak either English or French has no significant effect on the probability of receiving GIS for the 65 to 69 year-old and 70 to 74 year-old age groups, but such seniors have a higher probability of receiving GIS when they reach age 70 and above. No similar previous research regarding the impact of this variable was found.

5.2.3. Comparison of the marginal effects of the corrected outcome equation (the second-stage equation for the level of GIS benefits) and the coefficients of the OLS equation

The equation for the amount of GIS benefits provides further insight into the association between the characteristics of eligible recipients and the amount of GIS benefits they received, which could help to predict the fiscal burden that the senior population will place on the GIS benefits system. Table 10 contains the marginal effects after estimating the second-stage equation that includes the inverse Mills ratio as a regressor as well as the results of the ordinary least squares (OLS) regression. The dependent variable is the amount of GIS benefits received. Since there is no similar previous research for comparison, I will discuss only the estimated average marginal effects of the second-stage equation, and examine whether the estimated marginal effects differ between the equation corrected for selection bias and the OLS equation. The values in the second column entitled "Margin 1" are the discrete changes from the base level, conditional on receipt of GIS benefits, after applying the Heckman correction. The Heckman two-step model implies that the average predicted amounts of annual GIS benefits received are $5,780, $6,011, $4,590, $4,586 and $5,167 for the five age groups considered, respectively. The values in the third column are the sum of the marginal effects and the average predicted amount of GIS benefits.

First of all, the magnitudes of the marginal effects of the employment status variables are smaller in the model corrected for selection bias than the coefficients in the OLS model, which suggests that the selection bias did indeed distort the estimated relationship between employment and the amount of GIS benefits received. In addition, it is notable that the significance levels and the signs of the coefficients in the OLS equation and the associated marginal effects in the corrected model sometimes differ. For instance, in the 75 to 79 age group, the coefficient of the dummy variable "last worked in 2011" in the OLS equation is significant at the 1% level, but the associated marginal effect in the corrected model is not; the sign of this marginal effect also differs across models.

In the 65 to 69 age group, the marginal effect of the dummy variables "last worked in 2010" and "last worked in 2011" are both significant at the 1% level with negative signs. They imply that when individuals participate in the job market, the annual amount of GIS benefits is reduced by

$260 and $233 respectively, depending on the year in which they were last employed. The marginal effects of participation in the job market for the 65 to 69 and 70 to 74 age groups show that the reduction in the amount of GIS benefits received falls as age increases. However, when individuals are 75 years of age or older, the dummy variables for participation in the job market no longer have much explanatory power; their marginal effects in the corrected equation are insignificant (except in the case of the dummy variable for working in 2011 for those 85 and older). In contrast, the marginal effect of the dummy variable for people who never worked is significant with a positive sign in all age groups. It implies that people who have never worked will receive higher GIS benefit amounts compared to the base group. Holding all else constant, their annual GIS benefits will be higher by $505, $469, $483, $324, and $461 correspondingly. To see how the average predicted total benefits for individuals who differ only in terms of when they last worked for pay changes with age, one can look at the "Margin 2" column. For instance, for seniors in the 65 to 69 age group who worked in 2010, the average predicted total benefit per year is $4,330, holding all other factors constant.

For the household living arrangements variables, the pattern of comparison between the magnitudes of the marginal effects of the corrected outcome equation and the coefficients in the OLS equation is not clear in the 65 to 69, 70 to 74 and 75 to 79 age groups. However, in other age groups, the magnitudes of the marginal effects of the corrected outcome equation are less than the coefficients of the OLS equation, which indicates that the sample selection process was overstating the effect of these factors on the amount of GIS benefits received in the OLS equation. The marginal effects show that the impact of household living arrangements is nearly always statistically significant at the 1% level and fairly large in magnitude. For instance, compared to the base group "married or common-law without children", the marginal effects of the dummy variables “lone parent”, “person living alone”, and “person living with non-relatives only” are $1,342, $1,330 and $1,553 per year respectively for the 65 to 69 age group. In addition, although the marginal effects of household living arrangements decrease as age increases, the amount of GIS benefits seniors receive is still relatively large. For example, the marginal effect of the dummy variable “person living with non-relatives only” in the 70 to 74 age group is $1,367 annually. Furthermore, when the marginal effects for household living arrangements are added to the average predicted amount of GIS benefits for each age group (see the “Margins 2” columns in Table 10), one finds that the total average predicted annual GIS benefits increase with age for individuals in different types of households. The reason is that as age increases, the increase in the average predicted annual amount of GIS benefits received more than offsets the decrease in the marginal effect that occurs as age increases. These marginal effects strongly support the argument that household living arrangements are the key determinant of seniors’ poverty.

With respect to immigration status, when compared to the corresponding OLS coefficients, the magnitudes of the marginal effects of the corrected outcome equation fluctuate, which indicates that whether the selection process raises or lowers the estimated amount of GIS benefits associated with immigration status depends on the senior’s age. For the dummy variable “immigrants”, the magnitudes of the marginal effects in the corrected outcome equation are larger than the coefficients in the OLS equation, except for the 85 years and over age group, which indicates that the selection process caused the effect of immigration status to be understated. For the dummy variable “non-permanent residents”, the magnitudes of the marginal effects in the outcome equation are less than the coefficients in the OLS equation, except for the 80 to 84 age group, which indicates that there was an upward bias in the OLS results.

As was the case in the selection equations, the marginal effects of the dummy variable for immigrants are significant at the 1% level in each age group, and they all have positive signs, which means that immigrants tend to receive higher GIS benefits, holding other factors constant. In addition, the marginal effects of the difference in GIS benefits between immigrants and non-immigrants display a downward trend with age, from $532 for those aged 65 to 69 to $460 for those aged 75 to 79 years. For the "non-permanent residents" dummy variable, the marginal effects are significant at the 10% level in the corrected outcome model for those aged 65 to 69 years, 70 to 74 years, and 80 to 84 years, and are insignificant for those aged 75 to 79 years and 85 years and over. These marginal effects also display a downward trend, from $1112 for those aged 65 to 69 to $544 for those aged 75 to 79 years. Although seniors must have legal status in Canada in order to qualify for GIS benefits, the data do not define who is classified as a "non-permanent resident," these unreasonable results may be caused by the fact that very few individuals in these age groups fall into the category. (The sample counts for the non-permanent residents are 70, 46, 45, 27 and 24 for the five age groups respectively.) It is also interesting to note that the significance levels of the marginal effects of the non-permanent residents variable for the age groups 75 to 79 years and 85 years and over in the second-stage model are the opposite of those in the OLS equation. When the marginal effects for immigrants are added to the average predicted amount of GIS benefits for each age group (see the columns entitled "Margins 2" in Table 10), one finds that the average predicted annual GIS benefits of immigrants increase with age when age is above 70. The reason is that the average predicted amount of GIS benefit received increases more than the discrete change from the base level (i.e., the marginal effect) as age increases. Meanwhile, the predicted GIS benefits for "non-permanent residents" fluctuate as age increase.

The magnitudes of the marginal effects of the gender variables are greater in the corrected model than in the OLS model for the 65 to 69 and 70 to 74 age groups, which indicates that the selection process was underestimating the effect of this attribute on the amount of GIS benefits received in the OLS equation. The magnitudes of the marginal effects of the gender variables are smaller in the corrected model than the magnitudes of the coefficients in the OLS equation for seniors aged 75 and above, which indicates that the selection process was overstating the effect of these factors on the amount of GIS benefits received in the OLS equation. The marginal effects of gender for the 65 to 69 and 70 to 74 age groups show that on average, men receive higher GIS benefits than women. However, the marginal effects of gender for seniors aged 75 and above show that on average, women receive higher GIS benefits than men, holding all else constant. Nonetheless, the "Margins 2" column indicates that total annual GIS benefits are predicted to increase for men as age increases.

Educational attainment is another factor that affects the amount of GIS benefits seniors receive. The magnitudes of the marginal effects of the educational attainment variables in the corrected outcome equation tend to be smaller than the magnitudes of the corresponding coefficients in the OLS model, suggesting that once again the OLS estimates overstate the true impact of the variables. In the age group 65 to 69 years, the estimated marginal effects are significant at the 5% level with negative signs, with the exception of the marginal effects for "earned doctorate degree" and "degree in medicine, etc."

The dummy variable "high school diploma" has a significant coefficient in all age groups except for the age group 75 to 79 years. As age increases, the effect of education diminishes; for instance, the marginal effects of the dummy variable "trades or registered apprenticeship certificate" are statistically significant up to age 79, but then become insignificant for seniors 80 and above.

Similarly, the marginal effects of the dummy variable “college, CEGEP or other non-university certificate” become insignificant after age 75. In addition, the econometric pattern of opposite statistical significance and signs in the corrected equation and the OLS equation appears for some educational attainment groups as well. For instance, the marginal effect of “degree in medicine, etc.” is insignificant in the corrected outcome equation for the 70 to 74 age group, but it is significant in the OLS equation for this age group; the signs of the marginal effect in the corrected outcome model and the coefficients in the OLS equation are opposite. Overall, as the person’s education level increases, the amount of GIS benefits received decreases for younger seniors, and the effects of education diminish as age increases.

6. Conclusion

This paper examines the relationship between the Guaranteed Income Supplement benefit, seniors’ income, and the characteristics of GIS recipients. The results of the descriptive analysis indicate that regardless of age group, seniors are most likely to fall into the second lowest income decile, followed by the third lowest income decile. More importantly, as age increases, fewer seniors remain in the highest income decile, with the decline in the share of seniors apparent from the fifth income decile to the highest. Furthermore, OAS/GIS benefits are a critical component of seniors’ incomes for the lower income strata. As age increases, more seniors qualify for financial assistance in the form of GIS benefits regardless of the type of household living arrangement, especially for seniors who are lone parents or who are living alone. On average, the incidence rate for GIS benefits among seniors rises as seniors become older. However, while this increase in reliance on GIS is most pronounced for women, the relationship is less clear for men.

The results of the Heckman two-step estimation procedure indicate that selection bias exists as far as modelling the benefit amounts is concern. The results also show that seniors who participate in the job market, are highly educated, live in Ontario, are non-immigrants, and speak English have lower probabilities of receiving GIS benefits. In contrast, as age increases, seniors are increasingly likely to receive GIS benefits, regardless of the type of household living arrangement in the 65 to 69 and 70 to 74 age groups, especially seniors who are lone parents, are living with non-relatives only, or are living alone. The marginal effects of gender for the 65 to 69 and 70 to 74 age groups show that men are more likely to receive GIS benefits. This result contradicts those of other researchers. Furthermore, a senior who speaks French only has a higher probability of receiving GIS benefits as age increases.

The results of the second-stage equation modelling the amount of annual GIS benefits received fill an existing gap in previous research. The estimates imply that the average predicted annual amounts of GIS benefits, conditional on receipt of benefits, are \$5,780, \$6,011, \$4,590, \$4,586 and \$5,167 for the five age groups considered, respectively. Individuals who had been employed at some time in the past or who have a higher level of education receive on average smaller amounts of GIS benefits, but these effects diminish as age increases. Immigrant status and the type of household living arrangement also affect the amount of benefit received. Seniors who are lone parents, living alone, or immigrants receive more GIS benefits per year, and the impacts of household living arrangements are fairly large. The marginal effects of gender for the 65 to 69 and 70 to 74 age groups show that on average, men receive more GIS benefits than women.

An important limitation of this study is that because I could not obtain access to data that directly show the amount of GIS received, I had to create a proxy variable for the amount of GIS benefits by subtracting the maximum amount of OAS that could be received from the GIS/OAS variable of the NHS. The resulting variable suffers from measurement error, but while this measurement error may make the estimates less precise, it is unlikely to bias the parameter estimates because it is the dependent variable that is affected, not an explanatory variable. In addition, although the amount of GIS in the created GIS variable should underestimate the amount actually received for those receiving partial OAS benefits, the average predicted amount of GIS benefits is still quite large. Interestingly, I found that for some groups of explanatory variables, the signs and statistical significance of the coefficients in the selectivity-corrected second-stage equation were the reverse of those in the OLS equation that excludes the inverse Mill's ratio. For example, this pattern was present in the coefficients of some educational attainment groups.

One possible direction for future research would be to pool the data for all age groups and include age as an explanatory variable. However, it was not possible to do this using the NHS public use file, since it includes age only as a categorical variable. It would also be interesting to test the ability of the model to forecast GIS benefit amounts.

According to the empirical results, seniors are more likely to receive GIS benefits as they get older. This means that the current upward trend in the size of the Canadian senior population will place an increasing fiscal burden on the Canadian public pension system. However, while simply cutting the magnitude of GIS benefits might reduce the financial burden that the increasing demand for GIS will impose on the federal government, doing so would increase the incidence of low income among Canadian seniors since OAS and GIS are major sources of income for seniors in the bottom income deciles. This is especially true for seniors who are lone parents, are living alone, or are female. Fortunately, the estimated coefficients of the education variables provide us with a way to confront the issue in the long run. According to my results, higher education reduces the probability of receiving GIS. Thus, policy that encourages higher educational attainment will ultimately help maintain a fiscally healthy Canadian public pension system in the future.

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Table1 Means and standard deviations, by age group

	65 to 69 years		70 to 74 years	
	Mean	StandardDeviation	Mean	StandardDeviation
When last worked for pay				
Base group: Last worked before 2010	0.5846	0.4928	0.7029	0.4570
Last worked in 2010	0.0605	0.2383	0.0305	0.1721
Last worked in 2011	0.2710	0.4445	0.1356	0.3424
Never worked	0.0840	0.2773	0.1309	0.3373
Household living arrangement				
Base group: Married or common-law without children	0.6068	0.4885	0.5876	0.4923
Married or common-law with children	0.1008	0.3010	0.0785	0.2690
Lone parent	0.0294	0.1689	0.0343	0.1819
Child of a couple	0.0001	0.0071		
Child of a lone parent	0.0025	0.0495	0.0009	0.0305
Person living alone	0.2043	0.4032	0.2360	0.4247
Person living with non-relatives only	0.0217	0.1458	0.0201	0.1404
Person not in a census family but living with othe relatives	0.0345	0.1825	0.0425	0.2018
Immigrants				
Base group:Non-immigrants	0.7114	0.4531	0.6907	0.4622
Immigrants	0.2869	0.4523	0.3077	0.4616
Non-permanent residents	0.0018	0.0421	0.0016	0.0398
Sex				
Base group:Female	0.5169	0.4997	0.5271	0.4993
Male	0.4831	0.4997	0.4729	0.4993
Education				
Base group: No certificate, diploma or degree	0.2489	0.4324	0.3313	0.4707
High school diploma	0.2351	0.4241	0.2238	0.4168
Trades or Registered Apprenticeship certificate	0.1239	0.3295	0.1205	0.3256
College, CEGEP or other non-university certificate	0.1543	0.3613	0.1353	0.3421
University	0.1776	0.3822	0.1409	0.3480
Degree in medicine, dentistry, veterinary medicine， optometry	0.0052	0.0719	0.0054	0.0733
Master's degree	0.0418	0.2001	0.0321	0.1764
Earned doctorate degree	0.0131	0.1138	0.0105	0.1020
Province or territory of residence in 2010				
Base group: Newfoundland and Labrador	0.0168	0.1287	0.0174	0.1309
Prince Edward Island	0.0034	0.0581	0.0042	0.0643
Nova Scotia	0.0306	0.1722	0.0298	0.1700
New Brunswick	0.0233	0.1508	0.0234	0.1511
Quebec	0.2727	0.4453	0.2563	0.4366
Ontario	0.3717	0.4833	0.3848	0.4866
Manitoba	0.0326	0.1775	0.0336	0.1803
Saskatchewan	0.0266	0.1610	0.0282	0.1656
Alberta	0.0798	0.2709	0.0790	0.2697
British Columbia	0.1409	0.3479	0.1426	0.3496
Northern Canada	0.0017	0.0410	0.0007	0.0263
Official Language				
Base group: English only	0.6414	0.4796	0.6574	0.4746
French only	0.1542	0.3612	0.1556	0.3625
Both English and French	0.1724	0.3777	0.1398	0.3467
Neither English and French	0.0320	0.1761	0.0472	0.2122

Source: Author’s calculations based on data from the 2011 NHS

Table1 Means and standard deviations, by age group (continued)

	75 to 79 years		80 to 84 years		85 years and over	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
When last worked for pay						
Base group: Last worked before 2010	0.7513	0.4322	0.7795	0.4146	0.7769	0.4164
Last worked in 2010	0.0170	0.1293	0.0081	0.0899	0.0034	0.0579
Last worked in 2011	0.0707	0.2563	0.0293	0.1688	0.0126	0.1117
Never worked	0.1610	0.3675	0.1830	0.3867	0.2071	0.4053
Household living arrangement						
Base group: Married or common-law without children	0.5261	0.4993	0.4267	0.4946	0.2634	0.4405
Married or common-law with children	0.0594	0.2364	0.0460	0.2095	0.0281	0.1652
Lone parent	0.0469	0.2115	0.0615	0.2402	0.1017	0.3022
Child of a couple						
Child of a lone parent	0.0002	0.0133	0.0001	0.0080		
Person living alone	0.2968	0.4569	0.3742	0.4839	0.4824	0.4997
Person living with non-relatives only	0.0165	0.1275	0.0161	0.1259	0.0132	0.1140
Person not in a census family but living with othe relatives	0.0540	0.2261	0.0755	0.2642	0.1113	0.3145
Immigrants						
Base group:Non-immigrants	0.6897	0.4626	0.6743	0.4686	0.6676	0.4711
Immigrants	0.3083	0.4618	0.3239	0.4680	0.3302	0.4703
Non-permanent residents	0.0020	0.0446	0.0017	0.0414	0.0022	0.0466
Sex						
Base group:Female	0.5428	0.4982	0.5804	0.4935	0.6458	0.4783
Male	0.4572	0.4982	0.4196	0.4935	0.3542	0.4783
Education						
Base group: No certificate, diploma or degree	0.4027	0.4904	0.4472	0.4972	0.4851	0.4998
High school diploma	0.2177	0.4127	0.2223	0.4158	0.2232	0.4164
Trades or Registered Apprenticeship certificate	0.1102	0.3131	0.0969	0.2959	0.0836	0.2768
College, CEGEP or other non-university certificate	0.1153	0.3193	0.1061	0.3079	0.0922	0.2893
University	0.1169	0.3213	0.0986	0.2981	0.0893	0.2851
Degree in medicine, dentistry, veterinary medicine or optometry	0.0058	0.0762	0.0043	0.0657	0.0056	0.0749
Master's degree	0.0228	0.1492	0.0169	0.1289	0.0150	0.1217
Earned doctorate degree	0.0087	0.0930	0.0077	0.0875	0.0059	0.0767
Province or territory of residence in 2010						
Base group: Newfoundland and Labrador	0.0159	0.1249	0.0123	0.1102	0.0133	0.1145
Prince Edward Island	0.0044	0.0661	0.0030	0.0547	0.0034	0.0580
Nova Scotia	0.0280	0.1648	0.0304	0.1717	0.0345	0.1826
New Brunswick	0.0228	0.1493	0.0212	0.1442	0.0252	0.1568
Quebec	0.2484	0.4321	0.2450	0.4301	0.2189	0.4135
Ontario	0.3903	0.4878	0.3998	0.4899	0.4026	0.4904
Manitoba	0.0345	0.1825	0.0330	0.1785	0.0406	0.1974
Saskatchewan	0.0311	0.1736	0.0326	0.1777	0.0369	0.1885
Alberta	0.0801	0.2714	0.0764	0.2657	0.0717	0.2580
British Columbia	0.1440	0.3511	0.1460	0.3531	0.1527	0.3597
Northern Canada	0.0005	0.0231	0.0002	0.0138	0.0002	0.0135
Official Language						
Base group: English only	0.6628	0.4728	0.6600	0.4737	0.6866	0.4639
French only	0.1521	0.3591	0.1505	0.3576	0.1326	0.3392
Both English and French	0.1305	0.3369	0.1244	0.3301	0.1091	0.3118
Neither English and French	0.0546	0.2272	0.0650	0.2466	0.0717	0.2580

Source: Author’s calculations based on data from the 2011 NHS

Table 2 Percentage of GIS recipients, by age group and sex

	Female	Male	Total
65 to 69 years	19.28%	15.75%	35.03%
70 to 74 years	26.87%	21.07%	47.94%
75 to 79 years	29.73%	21.14%	50.87%
80 to 84 years	34.09%	19.79%	53.88%
85 years and over	41.61%	17.23%	58.84%

Source: Author's calculations based on data from the 2011 NHS

Table 3 Sources of income by income decile group, Canadian seniors, 2010

	CPP/QPP	OAS/GIS	Employment Income	Investment Income	Retirement Pensions
First decile	24.89%	65.57%	1.76%	2.80%	4.97%
Second decile	20.43%	60.34%	0.10%	10.75%	8.38%
Ninth decile	13.24%	10.40%	22.99%	11.76%	41.60%
Highest decile	6.44%	3.13%	43.31%	23.67%	23.45%

Source: Author's calculations based on data from the 2011 NHS

Table 4 Income distribution, by age, Canadian seniors, 2010

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85years and over
Lowest decile	3.23%	1.83%	1.83%	1.94%	1.93%
Second decile	13.78%	17.97%	20.35%	22.00%	26.11%
Third decile	11.15%	14.19%	15.85%	17.56%	17.20%
Fourth decile	11.49%	12.82%	12.54%	12.77%	12.16%
Fifth decile	11.50%	11.96%	11.51%	11.23%	10.48%
Sixth decile	10.89%	10.72%	9.95%	9.54%	8.05%
Seventh decile	10.66%	9.42%	8.51%	7.37%	7.09%
Eighth decile	9.67%	8.17%	7.71%	6.67%	5.87%
Ninth decile	8.47%	6.60%	6.34%	5.58%	5.57%
Highest decile	9.17%	6.32%	5.42%	5.34%	5.54%

Source: Author's calculations based on data from the 2011 NHS
Note: The percentages sum to 100 across deciles within each age group.

Table 5 Sources of income, by age group

	CPP/QPP	OAS/GIS	Employment Income	Investment Income	Retirement Pensions
65 to 69 years	15.12%	15.74%	32.52%	9.34%	27.27%
70 to 74 years	18.39%	22.22%	14.26%	10.62%	34.51%
75 to 79 years	19.84%	23.93%	7.28%	11.94%	37.01%
80 to 84 years	21.22%	25.86%	3.28%	13.90%	35.74%
85 years and over	21.73%	28.02%	1.56%	16.35%	32.34%

Source: Author's calculations based on data from the 2011 NHS

Table 6 Incidence rates for GIS receipt, by household living arrangement and age group

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85years and over
Married spouse or common-law partner without children	30.01%	41.34%	43.06%	44.62%	46.03%
Married spouse or common-law partner with children	32.69%	49.34%	55.65%	53.80%	54.37%
Lone parent	49.74%	65.36%	66.67%	69.98%	70.87%
Child of a couple	50.00%	0.00%	0.00%	0.00%	0.00%
Child of a lone parent	46.39%	70.37%	50.00%	100.00%	0.00%
Person living alone	45.28%	57.76%	57.77%	57.93%	60.40%
Person living with non-relatives only	48.13%	65.18%	62.57%	66.40%	66.21%
Person not in a census family but living with othe relatives	47.94%	59.33%	66.39%	70.40%	71.67%

Source: Author's calculations based on data from the 2011 NHS

Table 7 Incidence rates for GIS receipt, by education level and age group

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85 years and over
No certificate, diploma or degree	50.70%	62.52%	64.13%	65.48%	70.75%
High school diploma	35.43%	48.22%	48.76%	51.51%	55.28%
Trades or Registered Apprenticeship certificate	35.31%	46.48%	45.88%	47.76%	48.47%
College, CEGEP or other non-university certificate	29.39%	39.53%	40.35%	43.48%	45.75%
University degree	23.31%	30.64%	33.32%	32.60%	35.92%
Master's degree	19.07%	26.70%	24.90%	25.28%	25.45%
Earned doctorate degree	14.95%	19.74%	18.78%	21.49%	36.92%
Degree in medicine, dentistry, veterinary medicine or optometry	10.78%	18.59%	17.42%	22.06%	24.19%
Total	35.05%	47.94%	50.87%	53.87%	58.88%

Source: Author's calculations based on data from the 2011 NHS

Table 8 Mills lambda, rho, Wald test and number of observations, by age group

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85years and over
Mills Lambda	-1514.17	-1809.90	-2513.68	-3228.67	-3402.17
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Rho	-0.5572	-0.6723	-0.8325	-0.9503	-0.9919
Wald chi2	1116.32	1279.99	830.18	480.21	291.19
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N.	39112	28777	22511	15649	10948
Censored observation	25382	14964	11052	7211	4502
Uncensored observation	13730	13813	11459	8438	6446
% of uncensored observation	35.10%	48.00%	50.90%	53.92%	58.88%

*****The values in parentheses are p-values.
* % of uncensored observation are slightly different than is the case for Table 7 due to missing data when estimating the Heckman two-step model. See footnote number 19 for detail.
Source: Author's calculations based on data from the 2011 NHS

Table 9 Estimated marginal effects of the first-stage probit model

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85 years and over
When last worked for pay					
Base group: Last worked before 2010					
Last worked in 2010	-0.1530	-0.0918	-0.0931	-0.0174	-0.0743
	(0.00)	(0.00)	(0.00)	(0.68)	(0.33)
Last worked in 2011	-0.1602	-0.1202	-0.0871	-0.0924	-0.1084
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Never worked	0.0652	0.0485	0.0579	0.0845	0.0523
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household living arrangement					
Base group: Married or common-law without children					
Married or common-law with children	0.0276	0.0652	0.0962	0.0654	0.0508
	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)
Lone parent	0.1617	0.1835	0.1703	0.1741	0.1432
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Child of a couple	0.1933	**	**	**	**
	(0.57)				
Child of a lone parent	0.1230	0.2044	-0.0615	0.5230	**
	(0.01)	(0.02)	(0.79)	(0.00)	
Person living alone	0.1375	0.1447	0.1170	0.0924	0.0832
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Person living with non-relatives only	0.1615	0.2062	0.1817	0.1922	0.1521
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Person not in a census family but living with othe relatives	0.1282	0.1240	0.1541	0.1571	0.1279
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Immigrants					
Base group:Non-immigrants					
Immigrants	0.0243	0.0326	0.0471	0.0265	0.0510
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Non-permanent residents	0.1052	0.0625	0.1754	-0.0568	0.1713
	(0.09)	(0.41)	(0.01)	(0.54)	(0.06)
Sex					
Base group:Female					
Male	0.0105	0.0020	-0.0084	-0.0364	-0.0711
	(0.03)	(0.74)	(0.22)	(0.00)	(0.00)

*****The values in parentheses are p-values
** The number of individuals constitutes a very small percentage of the sample or is non-existent
Source: Author’s calculations based on data from the 2011 NHS

Table 9 Estimated marginal effects of the first-stage probit model (continued)

	65 to 69 years	70 to 74 years	75 to 79 years	80 to 84 years	85 years and over
Education					
Base group: No certificate, diploma or degree					
High school diploma	-0.1172	-0.1151	-0.1133	-0.1025	-0.1166
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Trades or Registered Apprenticeship certificate	-0.1120	-0.1192	-0.1241	-0.1015	-0.1324
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
College, CEGEP or other non-university certificate	-0.1598	-0.1831	-0.1750	-0.1579	-0.1895
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
University	-0.2193	-0.2696	-0.2436	-0.2597	-0.2622
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Degree in medicine, dentistry, veterinary medicine or optometry	-0.3187	-0.3422	-0.3980	-0.3193	-0.3322
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Master's degree	-0.2486	-0.2951	-0.3172	-0.3231	-0.3647
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Earned doctorate degree	-0.2816	-0.3632	-0.3731	-0.3385	-0.2172
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Province or territory of residence in 2010					
Base group: Newfoundland and Labrador					
Prince Edward Island	-0.0479	-0.0841	-0.0855	-0.0836	-0.0580
	(0.30)	(0.08)	(0.09)	(0.24)	(0.43)
Nova Scotia	-0.0390	-0.0879	-0.1295	-0.1518	-0.1184
	(0.09)	(0.00)	(0.00)	(0.00)	(0.00)
New Brunswick	-0.0154	-0.0788	-0.1131	-0.1450	-0.1132
	(0.53)	(0.00)	(0.00)	(0.00)	(0.01)
Quebec	-0.0673	-0.1156	-0.2132	-0.2222	-0.2050
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Ontario	-0.1259	-0.1954	-0.2765	-0.2726	-0.2593
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Manitoba	-0.1126	-0.1725	-0.2286	-0.1848	-0.1771
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Saskatchewan	-0.0703	-0.1163	-0.1888	-0.2043	-0.1505
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Alberta	-0.1215	-0.2080	-0.2507	-0.2235	-0.2121
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
British Columbia	-0.0854	-0.1501	-0.2287	-0.2301	-0.2222
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Northern Canada	-0.0063	-0.3955	0.0733	-0.1627	0.1927
	(0.92)	(0.00)	(0.56)	(0.55)	(0.00)
Official Language					
Base group: English only					
French only	0.0234	0.0689	0.1354	0.1278	0.1449
	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)
Both English and French	-0.0193	-0.0011	0.0205	0.0334	0.0331
	(0.03)	(0.92)	(0.10)	(0.03)	(0.06)
Neither English and French	-0.0135	0.0223	0.0957	0.1180	0.1450
	(0.32)	(0.13)	(0.00)	(0.00)	(0.00)
Average predicted probability	0.3515	0.4805	0.5094	0.5395	0.5891
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sample size	39112	28777	22511	15649	10948

*****The values in parentheses are p-values
Source: Author’s calculations based on data from the 2011 NHS

Table 10 Estimated marginal effects of the corrected outcome equation and the coefficients in the OLS equation

	65 to 69 years			70 to 74 years			75 to 79 years		
	Margin 1	**Margin 2**	**OLS**	**Margin 1**	**Margin 2**	**OLS**	**Margin 1**	**Margin 2**	**OLS**
When last worked for pay									
Base group: Last worked before 2010									
Last worked in 2010	-260.43	4329.77	-705.43	-206.30	4379.95	-531.14	22.93	5190.2	-439.81
	(0.01)		(0.00)	(0.05)		(0.00)	(0.90)		(0.00)
Last worked in 2011	-233.18	4357.02	-704.36	-112.77	4473.48	-587.30	96.85	5264.12	-421.45
	(0.01)		(0.00)	(0.10)		(0.00)	(0.31)		(0.00)
Never worked	505.36	5095.56	633.38	469.54	5055.79	602.26	483.37	5650.64	793.77
	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Household living arrangement									
Base group: Married or common-law without children									
Married or common-law with children	373.92	4964.12	250.71	263.70	4849.95	426.12	-10.92	5156.35	440.23
	(0.00)		(0.00)	(0.00)		(0.00)	(0.90)		(0.00)
Lone parent	1342.48	5932.68	1363.94	1395.97	5982.22	1791.01	1108.59	6275.86	1692.34
	(0.00)		(0.00)	(0.00)			(0.00)		(0.00)
Child of a couple	1512.55	6102.75	1846.71	**	**	**	**	**	**
	(0.51)		(0.19)						
Child of a lone parent	1207.95	5798.15	1058.63	885.34	5471.59	1542.55	4311.25	9478.52	2157.34
	(0.00)		(0.00)	(0.07)		(0.00)	(0.02)		(0.05)
Person living alone	1329.80	5920.00	1204.12	1191.56	5777.81	1397.00	984.40	6151.67	1213.44
	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Person living with non-relatives only	1553.00	6143.20	1445.41	1366.84	5953.09	1881.35	1342.95	6510.22	1848.54
	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Person not in a census family but living with othe relatives	1768.45	6358.65	1412.89	1883.17	6469.42	1750.42	1332.32	6499.59	1793.34
	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Immigrants									
Base group:Non-immigrants									
Immigrants	532.11	5122.31	197.95	506.13	5092.38	245.19	459.71	5626.98	283.83
	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)
Non-permanent residents	1112.39	5702.59	1252.57	757.84	5344.09	852.72	543.96	5711.23	1231.03
	(0.01)		(0.00)	(0.10)		(0.01)	(0.24)		(0.00)
Sex									
Base group:Female									
Male	291.94	4882.14	165.82	101.62	4687.87	61.33	-28.17	5139.1	-94.40
	(0.00)		(0.00)	(0.00)		(0.02)	(0.52)		(0.00)
Education									
Base group: No certificate, diploma or degree									
High school diploma	-166.19	4424.01	-643.49	-137.49	4448.76	-674.48	75.89	5243.16	-682.22
	(0.01)		(0.00)	(0.01)		(0.00)	(0.23)		(0.00)
Trades or Registered Apprenticeship certificate	-211.01	4379.19	-628.84	-247.84	4338.41	-747.62	-187.13	4980.14	-866.35
	(0.00)		(0.00)	(0.00)		(0.00)	(0.01)		(0.00)
College, CEGEP or other non-university certificate	-362.53	4227.67	-865.81	-299.46	4286.79	-1059.24	-67.07	5100.2	-1092.24
	(0.00)		(0.00)	(0.00)		(0.00)	(0.45)		(0.00)
University	-276.76	4313.44	-1032.84	-106.21	4480.04	-1251.64	18.34	5185.61	-1261.06
	(0.01)		(0.00)	(0.30)		(0.00)	(0.86)		(0.00)
Degree in medicine, dentistry, veterinary medicine or	922.11	5512.31	-932.20	610.69	5196.94	-1019.54	1984.87	7152.14	-1205.69
	(0.07)		(0.00)	(0.13)		(0.00)	(0.00)		(0.00)
Master's degree	-412.22	4177.98	-1121.0	-62.39	4523.86	-1327.74	635.80	5803.07	-1295.36
	(0.01)		(0.00)	(0.69)		(0.00)	(0.00)		(0.00)
Earned doctorate degree	325.14	4915.34	-1054.74	545.13	5131.38	-1322.66	1086.73	6254	-1311.12
	(0.26)		(0.00)	(0.07)		(0.00)	(0.00)		(0.00)
Average predicted amount of GIS benefits	4590.2			4586.25			5167.27		
Uncensored observation	13730			13813			11459		

*****The values in parentheses are p-values

* Margin 1: the discrete change from the base level after running Heckman's sample selection correction procedure.

* Margin 2: average predicted amount of GIS benefit is included

** The number of individuals constitutes a very small percentage of the sample or is non-existent

Source: Author's calculations based on data from the 2011 NHS

Table 10 Estimated marginal effects of the corrected outcome equation and the coefficients in the OLS equation (continued)

	80 to 84 years			85 years and over		
	Margin 1	**Margin 2**	**OLS**	**Margin 1**	**Margin 2**	**OLS**
When last worked for pay						
Base group: Last worked before 2010						
Last worked in 2010	-176.48	5604.23	-146.90	-42.78	5968.28	-591.45
	(0.55)		(0.47)	(0.94)		(0.14)
Last worked in 2011	235.93	6016.64	-360.98	795.98	6807.04	-296.77
	(0.21)		(0.00)	(0.02)		(0.16)
Never worked	324.41	6105.12	911.03	461.16	6472.22	910.94
	(0.00)		(0.00)	(0.00)		(0.00)
Household living arrangement						
Base group: Married or common-law without children						
Married or common-law with children	-151.49	5629.22	245.32	95.60	6106.66	361.13
	(0.21)		(0.01)	(0.61)		(0.01)
Lone parent	851.43	6632.14	1700.99	804.26	6815.32	1522.17
	(0.00)	(0.00)		(0.00)		(0.00)
Child of a couple	**	**	**	**	**	**
Child of a lone parent	-250.56	5530.15	2333.39	**	**	**
	(0.92)		(0.31)			
Person living alone	751.01	6531.72	983.09	614.76	6625.82	867.12
	(0.00)		(0.00)	(0.00)		(0.00)
Person living with non-relatives only	630.65	6411.36	1578.86	881.81	6892.87	1615.92
	(0.00)		(0.00)	(0.00)		(0.00)
Person not in a census family but living with othe relatives	1248.68	7029.39	1994.06	1149.33	7160.39	1787.52
	(0.00)		(0.00)	(0.00)		(0.00)
Immigrants						
Base group:Non-immigrants						
Immigrants	503.52	6284.23	313.65	401.65	6412.71	447.50
	(0.00)		(0.00)	(0.00)		(0.00)
Non-permanent residents	1705.29	7486	612.18	797.62	6808.68	2035.25
	(0.01)		(0.17)	(0.21)		(0.00)
Sex						
Base group:Female						
Male	-52.30	5728.41	-299.23	-124.58	5886.48	-578.05
	(0.38)		(0.00)	(0.12)		(0.00)
Education						
Base group: No certificate, diploma or degree						
High school diploma	176.51	5957.22	-641.28	250.22	6261.28	-818.29
	(0.03)		(0.00)	(0.01)		(0.00)
Trades or Registered Apprenticeship certificate	-111.58	5669.13	-823.30	-9.99	6001.07	-1058.19
	(0.27)		(0.00)	(0.94)		(0.00)
College, CEGEP or other non-university certificate	85.48	5866.19	-1025.55	177.24	6188.3	-1318.11
	(0.46)		(0.00)	(0.23)		(0.00)
University	595.12	6375.83	-1183.68	702.91	6713.97	-1324.50
	(0.00)		(0.00)	(0.00)		(0.00)
Degree in medicine, dentistry, veterinary medicine or	533.33	6314.04	-1193.21	1692.34	7703.4	-1340.78
	(0.34)		(0.00)	(0.01)		(0.00)
Master's degree	1312.65	7093.36	-1172.42	670.80	6681.86	-1749.61
	(0.00)		(0.00)	(0.08)		(0.00)
Earned doctorate degree	931.58	6712.29	-1253.19	518.87	6529.93	-1240.71
	(0.04)		(0.00)	(0.28)		(0.00)
Average predicted amount of GIS benefits		5780.71			6011.06	
Uncensored observation		8438			6446	

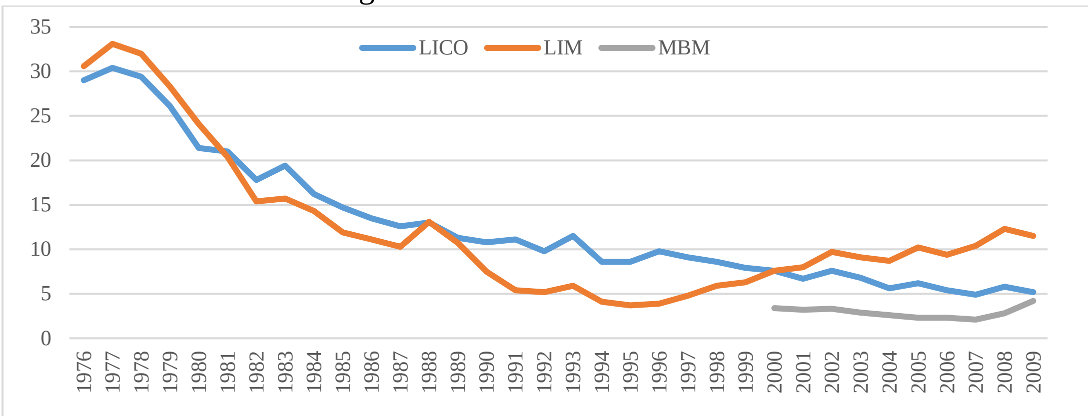
*The values in parentheses are p-values

*Margin 1: the discrete change from the base level after running Heckman's sample selection correction procedure.

*Margin 2: average predicted amount of GIS benefit is included

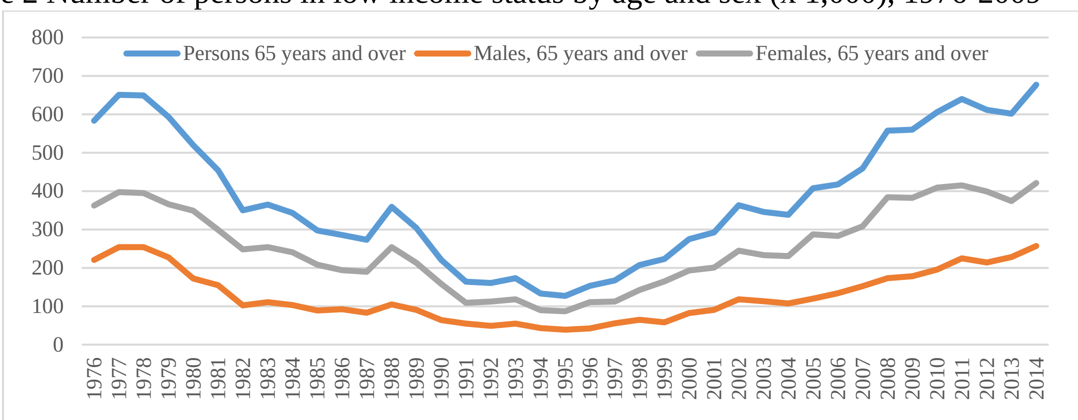
Source: Author's calculations based on data from the 2011 NHS

Figure 1 Low income rates among seniors 1976 to 2009



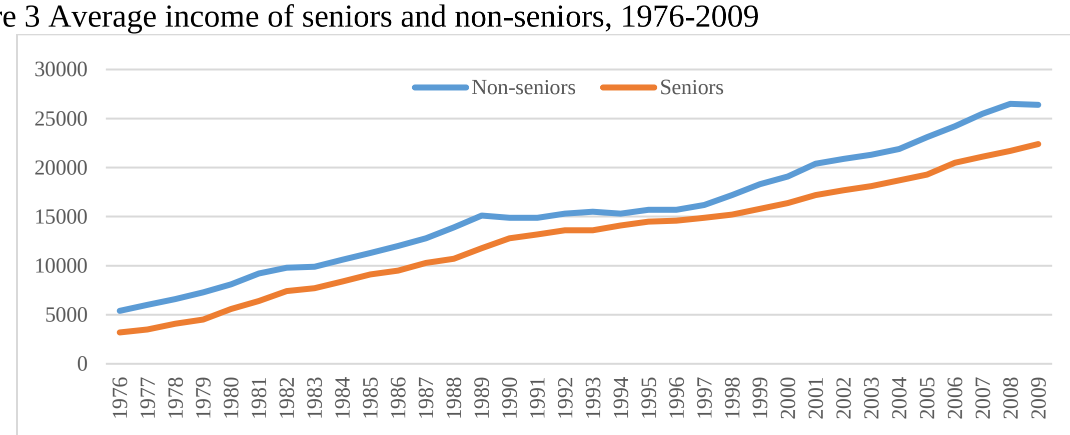
Source: The Figure was completed using data from Description for Figure 3.2 of Murphy et al. (2012).

Figure 2 Number of persons in low income status by age and sex (x 1,000), 1976-2009



Source: Author's calculations based on data from CANSIM Table 206-0041 Low income statistics

Figure 3 Average income of seniors and non-seniors, 1976-2009



Source: The Figure was completed using data from Description for Figure 3.2 of Murphy et al. (2012).