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# The value of fixed-reimbursement healthcare insurance – evidence from cancer patients in Ontario, Canada.

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**Abstract**

Critical illness insurance (CII) is a fixed-reimbursement scheme conditioned on the event of a loss, not the size of the loss. We investigate demand for CII. Consumers will be willing to purchase CII depending on their degree of risk aversion to the cost of treating illness, their forgone income, and desire for being compensated for utility loss when sick. Using a theoretical model based on Eeckhoudt (2003), we run simulations using Canadian data for CII policy reimbursement dollar values of purchases, family income, cancer expenditure, and net wealth. We then evaluate how well these models predict actual CII purchases.

Keywords: health insurance, healthcare insurance, fixed-reimbursement insurance, state-utility transfer, expected utility, cancer

## Introduction

A variety of healthcare insurance products are available in the market today. Each offer unique benefits, and can be effective in mitigating risk for the insured who desire protection from the high cost of health care services, and their impacts on personal savings and future income streams. Yet each of these healthcare insurance products is administered in different ways, and the result is that specific insurance products have high demand in some markets and little or no demand in others. Some discussion of the fundamental motivations, for both the insurer and the insured, underlying these different healthcare insurance models is presented to allow the reader to more fully appreciate the value of different healthcare insurance policy purchasing choices[1].

Health and illness present a variety of financial uncertainties for the general population. First, there is uncertainty in the occurrence and severity of the illness or health status deterioration; we will call this “severity uncertainty”. Second, there is uncertainty in the medical cost of treatment (the amount of the loss) in case of full recovery; we will call this “loss uncertainty”. Third there is uncertainty in the probability of recovering; we will call this “recovery uncertainty”. Fourth there is some individual variation in the non medical cost of the treatment and the illness itself; we will call this “non-medical uncertainty”. In considering the variety of healthcare insurance products we need to evaluate which of these uncertainties the product is designed to address.

A general healthcare insurance scheme provides coverage for severity uncertainty and some of portion of loss uncertainty, but little if any coverage for recovery or non-medical uncertainty. General healthcare insurance is in this way similar to auto insurance; the policy will cover the costs of repairing the damage due to an uncertain event and these costs might vary around the mean with some characteristics that are beyond the control of the insurer. However, in auto insurance the amount of uncertainty is limited by stop-loss provisions in the policy (maximum reimbursed cost) as well as conditioning reimbursement (the insured is not reimbursed if it can be observed that the “incident” was due to his negligence or behavior or if it is found ex post there is no “event”). General healthcare insurance typically does not have these kinds of stop-loss provisions, for obvious demand-side reasons, and, moreover, the range of potential costs can often be much wider than in most other types of insurance. As a result, general healthcare insurance policies work as a price pay-off scheme through which the insured buy a right to discounted health care services and are subject to moral hazard (of insured) that

[1] This discussion borrows extensively to Cutler and Zeckhauser (2000), Glied (2000), Nyman (2003), Pauly (2000), and Zweifel and Manning (2000).

increases total payout and costs[2]. A consequence of moral hazard is that the price of insurance (the loading fee) might become too high and some individuals will be unable to afford the level of coverage their risk aversion would suggest they prefer. To counter these effects of moral hazard on the cost of coverage general healthcare insurance policies use standard tools such as co-payments and deductibles. However, because the demand for coverage for catastrophic cases and repeated events (the so-called premium risk) is much stronger in health than in other types of insurance[3], these demand-side mechanisms to control moral hazards cannot apply as fully in healthcare insurance as in automobile or other damage insurance policies. As a result, the insurer must rely on health care providers as agents to control the amount of the loss as well as on a strict definition of the goods and services the insurer reimburses, through the formulary for drugs or utilization review for hospital procedures. A consequence is that some components of the cost of the treatment such as access to the latest technology (when standard alternative treatments exist and are covered by insurance plans) or non-medical financial consequences of treatment (transportation costs in Canada are rarely covered by insurers) are entirely paid out of pocket by the patient at the time of use. Assuming that any item not on the list of most insurers is not strictly necessary from a medical perspective (it can be beneficial but the marginal cost exceeds the marginal capacity to benefit the patient from an insurers' perspective) we bundle these non covered costs in the "non medical uncertainty" bundle. Thus the non-medical uncertainty is left unaddressed by this type of insurance product.

In most healthcare insurance cases the amount of the loss due to non-medical uncertainty is known to the insured but cannot be priced before the fact by the insurer; it is the result of decisions and behaviors of the insured and the insurer cannot rely on any agent to control and limit the insured. Additionally there may be costs beyond the actual medical care that are particularly relevant yet unaddressed by these general healthcare insurance policies. One such cost is that of forgone income if the individual can no longer participate in the labor force due to their condition or because of the treatment[4]. Another incurred cost is for treatments needed and associated with improved quality of life by the patient even in the absence of any proven clinical benefit, and typically not covered by general healthcare insurance policies. Last, one cost of illness not coverable by standard healthcare insurance is the loss of utility associated with having an illness (and not fully recovering to the prior health state).

[2] Other factors of increase in the cost of coverage include self-selection and asymmetries of information as illustrated by Cutler and Zeckhauser, (2000).
[3] The assumption here is that many health events are catastrophic and that multiple events related to an illness are not uncommon.
[4] We note that to some degree this can be addressed through the separate purchase of disability insurance, but it may not fully compensate for all lost income.

All these types of costs of illness (out-of-pocket costs of treatment and transportations, forgone income, utility loss) cannot be covered by standard price pay-off policies typically used in general healthcare insurance policies. However they can be covered through fixed-reimbursement insurance; the insured purchases the right to an income transfer, known in advance, in case of a given illness (therefore conditioned on the realization of the illness)[5]. The insured is then free to use the income as they see fit, to buy new technologies or treatments not covered by public or private insurance plans, compensate for lost earnings, to pay for transportation costs linked to the treatment, buy extra tests or diagnostics, or simply compensate their loss of utility incurred as a consequence of their illness. Hence under a variety of circumstances one can imagine that these fixed-reimbursement policies can be of value to the insured.

We have recently observed that Canadian statistics on fixed-reimbursement healthcare insurance, commonly referred to as critical illness insurance (CII), have shown strong growth in the marketplace between 2001 and 2005. The average annual growth was 22%[6] over this period and individual policies are now approaching 400,000, with similar numbers of individuals belonging to group plans, hence totaling approximately 800,000 insured individuals[7]. These numbers are significant when you consider that the Canadian population is approximately one tenth that of the United States, and hence it would represent the equivalent of approximately 8 million policies in the United States. Although these figures represents only 5% of the 16 million in the Canadian labor force[8], we expect that when considering those who are financially able to afford the policies, are not covered by any mechanism compensating forgone incomes such as employer-sponsored disability insurance, and would not be excluded for medical reasons, this likely represents closer to 20% of the attainable market in the working population. This is remarkable considering the effects of adverse selection and cream skimming, the role of which will be discussed later in this paper. This growth is of interest when you consider that many insurance demand theorists consider fixed-reimbursement healthcare insurance to be highly unattractive under most circumstances (Cutler & Zeckhauser, 2000).

This raises the question, what behavioral, economic, or marketplace variables are influencing Canadians' demand for CII? Additionally, what can this tell us regarding the demand for utility loss compensation when sick? We ask this in the context of those who choose to

[5] Indemnity payment generally is conditioned on a 30 day survival post diagnosis.
[6] Munich Re's Critical Illness Survey 2006, Munich Re Canada
[7] Data provided by Munich Re Canada, Oct 2008
[8] Statistics Canada, 2006 Census

purchase CII policies, since we are unable to assess those who do not choose to purchase policies. Although this represents a limited segment of the Canadian population, we believe understanding the demand characteristics of those who do purchase is important. Understanding the variables that influence demand for these products will improve our understanding of the motives behind the demand for healthcare insurance (a highly disputed issue, see Nyman, 2003, and Blomqvist, 2001). This will in turn shed light on the debate of the normative consequences related to moral hazard in healthcare insurance, an issue that has considerable bearing on options regarding implementing universal and public insurance.

In this paper we study the determinants of the demand for CII in the Canadian setting. We use a variety of data sources to evaluate our models. Additionally, we use aggregate data on CII policy face amounts[9] across age and gender categories[10]. We use a unique dataset describing out-of-pocket costs of cancer patients collected in Ontario to measure the expected gain of a CII coverage in terms of the loss uncertainty described earlier. We then complement these datasets with aggregate level information on forgone income and run simulations to capture the other expected benefits (compensation for utility loss of being sick and the uncertainty of recovery) of receiving an income transfer when sick. We aim to deduct a value of the state-dependent utility loss of being sick from the guaranteed income transfer in CII just as Zeckhauser has done (in 1973) for the value of life deducted from willingness to pay for catastrophic illness insurance policies. Our idea here is straightforward: we want to use the opportunity provided by the data we have at hand to estimate the value of covering the financial risk involved in critical illness, and then to use any excess between that value and the policy face value individuals actually purchase as an indicator of the value attached to being compensated for the utility loss of being sick. This is a rare opportunity to contribute empirical evidence to the so far purely theoretical literature on state dependent utility and insurance. We recognize that observed excesses (if seen) may be explained through a variety of causal pathways other than state dependent utility transfer (e.g. wealth management, access to care) and we consider these other pathways in turn later in the paper.

We start our investigation by applying an existing model for fixed-reimbursement insurance presented by Eeckhoudt et al. (2003) to CII. We then consider modifications to this model, and finally we test both models' ability to predict Canadian purchase patterns based on

[9] Policy face amounts indicate the value of the maximum payment should an insured qualify for a policy claim
[10] Data on file, Munich Re Canada, Oct 2008

actual expenditure and insurance purchasing data. We posit that the existing fixed-reimbursement model may not fully explain purchasing patterns, and that modified models that incorporate other behavioral, economic or market variables may better predict insurance purchasing patterns. This investigation is expected to add to the debate in the literature (see Cutler et al.[2008]) on whether demand for healthcare insurance is purely motivated by risk-aversion and wealth management, or whether other behavioral, economic or market variables are important components of demand in these markets.

This article proceeds as follows. In "fixed-reimbursement healthcare insurance model" we discuss the value of these policy offerings, from both an insurer and insured perspective, and outline a basic fixed-reimbursement model as proposed by Eeckhoudt et al. (2003), with a focus on its application for healthcare insurance. We then evaluate other behavioral, economic and marketplace pathways (or variables) that may impact the purchase of fixed-reimbursement healthcare insurance and then outline a modified model that assumes part of the purchase decision is influenced by these identified variables. Each of the pathways will be discussed outlining the justification and feasibility of including them in the model. In "Methods and Canadian Data Sources" we provide details and simulation strategies for the data we have on hand about cancer patients' costs. Additionally we provide detail and simulation strategies on insurance data describing the purchase patterns for critical illness insurance, cancer incidence data in Canada by age category, and net wealth data for Canadians. We outline the methodology employed to combine this disparate data, which should provide an indication of each variables' influence. We focus on cancer as Canadian insurance data shows that 70% of CII claims are for cancer[11]. In "Results from Application of models" we use this aforementioned data and apply it to both the Eeckhoudt model and the Eeckhoudt plus additional variable(s) model and report on their ability to predict purchase patterns for CII, with some interpretation of these results. "Conclusions" contains a summary of our findings, and the implications for the theory of demand for healthcare insurance. Some future research opportunities are also discussed in brief.

## Fixed-reimbursement healthcare insurance model

It is often said that, because of the characteristics of healthcare insurance, there is no role for a fixed-reimbursement offering, where a lump-sum payment is transferred to the

[11] Source Canada Life Critical Illness Policies 2007, accessed Oct 2008

insured, conditional on a diagnosis provided by a doctor, acting in that respect as the insurer's agent (Cutler & Zeckhauser, 2000). This theory seems appropriate when discussing usual medical practice delivered through the doctor as agent of the insurer. However, as the insurer cannot verify the magnitude of the non-medical expenditures associated with an illness (non-medical uncertainty) or of medical expenditures not deemed absolutely necessary from a medical perspective, but perceived as better quality care by the insured/patient, the fixed-reimbursement strategy can become a more desirable solution for the insurer (Gollier, 1996). Additionally, in the Canadian setting limitations associated with the Canada Health Act prohibit charging for services delivered in a hospital, even in cases where the patient is able and willing to pay[12]. However providing lump sum payments to be used to support unfunded or underfunded health care related costs would not violate this Act, provided they seek care outside of the hospital setting. Hence, in Canada there is motivation for the supply of fixed-reimbursement schemes in health, called CII or what Eeckhoudt et al. (2003) refers to as dread disease insurance. The Canadian market appears to be one example where the conditions may be optimal for this type of healthcare insurance policy, as it facilitates extending the comprehensiveness of health care coverage without violating the Canada Health Act itself.

*Insurer perspective*

The fixed-reimbursement model is attractive for the insurer as underwriting and actuarial calculations for health are relatively straightforward provided some reliable data exist on the incidence of the illness by age, gender, and a few other relevant observable characteristics like smoking status, other comorbidities, and family history of disease. These types of statistics will allow the insurer to estimate the likelihood of a payout, and determine an appropriate premium after adjusting for other expected factors like adverse selection and policy lapses. In fact we know that the National Cancer Institute of Canada provides annual statistics on cancer incidence by age and gender, which allows insurers to calculate their estimated risk of a payout for cancer patients. This calculation assumes all persons who wish to purchase a CII policy are accepted. However insurance data suggests that in fact only 71% of these applications are accepted. It is also noteworthy that those policies that are conditionally accepted with a health rating[13] list the primary reason being medical (74%), or family history (23%).[14] Previous

[12] We note that in Canada 70% of health care is funded through the public purse (OECD, 2007)
[13] Health rating is based on factors such as comorbidities, smoking status, and family history.
[14] Munich Re's Critical Illness Survey 2006, Munich Re Canada

literature on cancer suggests higher cancer risks associated with a family history of cancer in 8% of stomach cancers and 3% of colorectal cancers (Steinburg,1990), 4.6% of prostate, 9.6% of ovarian/breast cancers (Cerhan, 1999) and 6.0% of lung cancers (Samet, 1986). Hence the true risk to insurers of facing a payout is reduced when those at highest risk are screened out, or offered a policy with exclusions.

Insurers must also factor in the effect of lapsed policies, as no payout is made in the majority of these cases. Lapsed policies occur when an individual discontinues their insurance before making a claim. Although the frequency of lapsed policies across age and gender is not publicly available, industry survey data suggests that lapsed polices range between 1.3% and 8.3% depending on the age, smoking status, and type of policy purchased[15]. Insurers generally set their policy premiums based on an expected lapse rate, and hence the effect on their profitability depends on whether they overestimate (lower profits) or underestimate (higher profits) lapse rates.

Finally insurers can partially adjust for policy holders misrepresentation when adjudicating claims and determine whether indemnity claims are invalid[16]. This can often be accommodated through medical records that may demonstrate that applicants were aware of conditions that would have excluded them from eligibility for policies. Data suggests that between 24% and 29% of claims are rejected and includes rejections based on conditions not being covered, definition of illness not met, moratorium exclusion, and material misrepresentation[17].

*Insured perspective*

We have focused exclusively on theories that incorporate the utility derived from a fixed-reimbursement contract for healthcare from the perspective of a prospective policy holder. We develop our reasoning on the assumption that demand for CII follows the tenets of expected utility theory. In our discussion section though, we qualify our findings based on an alternate theoretical model namely prospect theory (Kahneman and Tversky, 1979). The model that best describes the basic properties of fixed reimbursement insurance under expected utility has been presented by Eeckhoudt et al. (2003). The authors describe a fixed reimbursement contract C

[15] Munich Re's Critical Illness Survey 2006, Munich Re Canada
[16] Occurs typically when an insured makes a claim, but it is later discovered that full disclosure of relevant disease information was not provided to the insurer
[17] Munich Re's Critical illness Survey 2006, Munich Re Canada

as a pair (R,Z) where R is the lump sum reimbursement, and Z is the premium. Following their notation the premium is the product of probability of the event (e.g. cancer diagnosis) and the indemnity plus a loading factor (□□ .

$$Z = p(1 + \square)R, \qquad (1)$$

They then describe the expected utility derived from purchasing such a contract (V) for an insured with initial wealth $W_0$ as,

$$V = (1-p)U(W_0 - Z) + pEU(W_0 - Z - \tilde{L} + R), \qquad (2)$$

Where $\tilde{L}$ is the random loss (out-of-pocket cost of cancer treatment and/or forgone income) and U is the utility of wealth, and EU is the expected utility with respect to $\tilde{L}$ .

They propose that the optimal fixed reimbursement is the sum of the expected loss plus the precautionary equivalent premium as defined by Kimball (1990). Kimball's model predicts that the optimal reimbursement R*, when there is a positive loading factor, is strictly lower than the largest possible loss $\tilde{L}$. Their model proves that the income elasticity of this type of insurance is dependant on whether absolute prudence[18] is decreasing. A more general model allowing individuals to buy R* greater than the maximum observed loss should incorporate other variables such as state-dependant utility. Eeckhoudt et al. however do not factor in the state-dependant utility component in his model. In fact in their 2003 publication Eeckhoudt et al. state "... many fixed-reimbursement insurance policies arise in setting what are naturally cast within a state-dependent utility framework...extending the present article in that direction is also a potential area for future study". We agree with this statement, and endeavor to investigate the incorporation of state-dependent utility as well as other potential variables into the existing formula to determine if any of these variables improve the ability to predict actual demand and purchasing characteristics for fixed-reimbursement healthcare insurance in the Canadian setting.

We propose to build on the Eeckhoudt model by evaluating a variety of additional variables including the role of state-dependent utility transfers. As an illustration one possible model modification includes a state-dependent utility variable: utility is a function of wealth but

[18] Prudence is defined by Kimball (1990) as "the propensity to prepare and forearm oneself in the face of uncertainty, in contrast to "risk aversion", which is how much one dislikes uncertainty and would turn away from uncertainty if possible"

when an individual is diagnosed with cancer their functional relationship between wealth and utility changes (Cook and Graham, 1977). As a result, they use a portion of the lump-sum payment R to compensate for that change in their level of utility due to health shocks:

$V = (1\text{-}p)U_{H2}(W_0 - Z) + pEU_{H1}(W_0 - Z - \tilde{L} + R),$

(H2 equals healthy state; H1 equals the sick state) (3)

Since the utility functions are not known (it is not even clear whether the marginal utility in the sick state is greater or smaller than in the healthy state at the same level of utility) we do not derive the optimal levels of compensation for the financial loss (motivated by prudence) and compensation for the utility loss. Suffice here to mention that, following Kimball (1990), if an individual purchases a fixed reimbursement greater than the largest possible loss, the one possible motivation for it is a monetary compensation for the effect of the health on utility. As a result, in this example we use any difference between an approximation of the reasonable maximum perceived financial loss and the fixed reimbursement purchased through policies in Canada as a lower bound for the monetary equivalent of a cancer diagnosis that insured want to be compensated for: they buy a policy for prudence motives linked to the cost of repairing their health (which includes income replacement if they need to quit their job temporarily because of their illness) but also to get an income transfer as a pure compensation for their loss of utility as a consequence of developing an illness covered under the policy.

In fact we have reason to believe that variables like state-dependant utility could be important in fixed-reimbursement healthcare insurance in the Canadian setting. The Canadian expenditure data that we have from previous research suggests that most cancer patients will have expected observable costs of less than $25,000[19], so that most purchases above this point could be an indication of an influence from some other variable in addition to loss recovery. Data from the reinsurer Munich Re suggests that for the Canadian insured between the age of 20 and 50 the average face amount of a CII policy is approximately $80,000 suggesting that more than half of the policy face value may be attributed to other variables, as yet undefined including variables like state dependent utility (Table 1). We note that the average face amount for 60 plus year olds is closer to $63,000 which may reflect face amount limitations based on the larger premiums for this age category, a decline in the loss of utility due to critical illnesses when they occur later in life, or some other behavioral, economic, or market variable.

[19] 8.2% spent more than $25,000 on medical costs, travel and forgone wages, 4.8% spent more than $50,000, and only 2% spent more than $100,000; data on file

*Plausible explanatory pathways*

We will investigate the respective strengths of other pathways, beyond state-dependent utility, by using data on the purchase of CII in Canada[20]. We feel it is appropriate to investigate the ability of these other pathways to reliably predict the demand dynamics for fixed reimbursement healthcare insurance and provide explanations for their inclusion or exclusion from our modified Eeckhoudt et al. model. These additional pathways include prudence (wealth management) and motives of access to costly treatments. These pathways could influence either the degree of perceived risk (and risk aversion) or the attractiveness of the purchase.

The basic model of fixed-reimbursement insurance (Eeckhoudt et al. 2003) represents it as closely mimicking the role of precautionary savings in inter-temporal saving models. Hence one plausible explanation is that the utility function can be reduced to a wealth management function. Trends related to policy face values in relation to costs and potential lost income will allow us to determine whether the precautionary savings or “prudence” explanation is supported. If the prudence model is supported we would expect to see increases in policy face values as income and expenses increase, and that the value of policies be on average roughly equal to the sum of these two financial risks.

We note that the cost of treatment for cancer can be substantial when factoring in out-of-pocket costs for medical and non-medical services related to cancer treatment, lost income, and travel costs (Longo, 2006, 2007). Hence, it is plausible that at lower levels of wealth insurance is a way of accessing care when net wealth is below the expected cost of treatment (Nyman 1999, 2006). Insufficient net wealth or net income might therefore be a strong motivation for buying these policies. When looking at the data we would expect that as the variability of patient expenses increases that those purchasing CII based on an access motive would be inclined to purchase a policy with a larger face amount (larger payout). We also assume that individuals behave rationally when making these purchases. Trends in the data are expected to either support (increase in face value correlates with increased variability in expenditures) or refute (no relationship between face value and variability) the access motive.

[20] Data provided by Munich Re Canada, October 2008

*Confounding factors*

Although not specifically explaining demand behavior of the insured, other factors may affect the likelihood that individuals purchase policies. These factors impact the insurer's offerings both in terms of adjustments in loading fees, premiums, and exclusions. As a result of these factors individuals may purchase less than optimal face amounts. The impact of these factors, if significant, would likely result in a conservative estimate of the value of state dependent utility.

The true actuarial cost of CII for the insured is the loading fee, the percentage of the lump sum reimbursement charged on top of the actuarially fair premium (see equation 1). We have access to aggregate data from the Canadian insurance industry combined with aggregate data on the incidence of cancer by age that allow us to calculate crude loading ratios for these contracts. We also have data from the Munich Re Critical Illness Survey 2006 that provides some indication of overall loading fees, although not age specific. These data will allow us to determine whether variation in loading fees is suggestive of either adverse selection or cream skimming.

The extent of adverse selection in healthcare insurance is empirically disputed and seems to be strongly context-related. In fact there is some evidence that suggests that this type of insurance does exhibit adverse selection. Data from the "Critical Illness Survey 2006" suggests that up to 65% of claims are made within the first three years following policy issue[21]. This despite the fact that potential policyholders must be screened before acceptance and the insurer attempts to identify those at high risk for filing a claim. Additionally in the event an insured had some prior knowledge of a risk factor and chose not to disclose it there is an increased likelihood that the indemnity will not be paid by virtue of misrepresentation of risk information. Hence because of these factors we expect that adverse selection should be mitigated, but test for this by measuring loading ratios based on premiums and cancer statistics against industry standards for loading ratios (typically about 1.25: 1 for these products).

Cream skimming is a way for insurers to reduce their risk of an indemnity payout. Data suggests that those who have pre-existing medical conditions or a family history of covered medical conditions are likely to be refused policies, providing evidence suggesting that to some degree cream skimming is undertaken by insurers. We use Canadian cancer incidence data and premium schedules to determine the crude loading ratios and test this against industry

[21] Source, Munich Re Canada

standards to evaluate whether cream skimming is present across age and gender categories and report on this in our results.

**Methods and Canadian data sources**

Using data from a variety of sources we attempt to simulate the expected losses across 7 age categories from 30-65 years of age. We compare this data to the aggregate data on the face amount of policies purchased. Data for those younger than 30 years of age is not included because very few policies are purchased, and very few cases of the common cancers occur at these younger ages. In our base case we report on male non smokers (82% of male policy holders), and on families with two incomes (34% of sample)[22]. We assume that policy holders attempt to replace 67% of family income (or the income of the primary income earner), but run sensitivity analyses assuming 50% and 100% of family income. We validate these results by looking at non-smoking females (86% of female policy holders) in two income families. In order to test the robustness of our findings we investigate average values, as well as 90th, 80th, 70th, 60th, and 50th percentiles of the data for cancer costs, income, and policy face amounts. We also run scenarios using 90th percentile for cancer costs, and average values for income and face amount to simulate highly risk averse individuals. We present the results for non-smoking males, and describe differences (if any) to those of non-smoking females and those other than two income families. In each case we determine the expected face amount of policies and then identify “differences” or discrepancies (if any) and evaluate the possible role of other variables in explaining these differences.

We note that although we have individual level data for cancer expenditures, net income, and net wealth we are unable to link these records. We also note that in terms of data on CII policies purchased by age and gender, and the face values of these policies by age and gender these are aggregate data, and hence conclusions are only suggestive rather than predictive. Hence the use of data from the insurance industry on the retention rates by age, gender, and risk categories (smokers/non-smokers), combined with data on wealth by age from Statistics

[22] We do this to increase the homogeneity of the sample, but test this in a sensitivity analysis by examining all family incomes, rather than two income families only.

Canada although providing estimates of the influences of prudence and compensation for health shocks, we are unable to provide clear cause and effect relationships.

More specifically we use the following data sources. We first include data from previous work by Longo et al (2006, 2007) that provides cancer patient costing at the individual level for a sample of patients from Ontario, Canada including costs of: medical treatments, non-medical treatments related to cancer treatment, travel costs, and foregone income for both patients and their caregivers. This data is a sample of 282 subjects with cancer, although samples in our analysis may be smaller as a consequence of missing data fields for some subjects. This data allows us to report on averages as well as variances, and we assume the sample is representative of Canadian patients. As an informal validation we note that the data in Longo et al are similar across multiple dimensions to data published by Lauzier (2008) in Quebec, Canada. We run analyses that exclude lost income, based on the fact that there is some evidence to suggest that the insured consider income replacement as part of their motivation to purchase CII so including income replacement and actual lost income may result in a double counting of income risk. In Longo's study it was noted that the average duration of treatment was approximately 11 months, hence the assumption was that individuals would require compensation for up to a year of lost work. Data by Lauzier (2008) in Quebec, Canada found that the average time away from work was approximately 6 months, with 21% of the sample still away from work at one year. Hence our data and that of Lauzier would suggest that the loss of one year's employment is a reasonable worst case scenario representing the 20% of the population most affected by their illness, despite an average of less than a year in both Lauzier (2008) and Longo (2007). We have assumed this worst case scenario in all of our simulations. It may also be worth noting that in many cases this lost time from work may not be a behavioral influence (one chooses to leave work), but rather a functional one (one is not able or their employer is not willing to allow them to continue employment). We also use data on incidence of cancer by gender and across age categories obtained from the "Canadian Cancer Statistics, 2008" published annually by the National Cancer Institute of Canada as a method of determining crude loading ratios, and report on these values for determination of adverse selection and cream skimming effects.

We include data on annual costs of policies, derived from Canada Life 10 year term policies and based on non-smokers in average health, with face amounts of $25,000 (common expenditure for cancer patients including lost income) through $100,000 face amount (typical value of purchased policies in the most recent full year recorded) across age and gender categories (as of Oct 2008). We also obtained premiums based on average values within age and gender categories for non-smokers (Table 1). The use of non-smokers is based on industry sources data that shows 82% of male policy holders are non-smokers, and 86% of female policy holders are non-smokers[23] .

Additionally we use data from the "2005 Canadian Survey of Financial Security" from Statistics Canada, which outlines net wealth based on surveys of 9,000 family dwelling in Canada. This survey provides income and wealth data by age and gender among other variables. We classify data across age and gender categories for the primary wage earner in the household. We note that we are unable to link the net wealth and income data to cancer expenditures and hence the results will be suggestive only. These results should assist in determining which theories remain plausible under a variety of assumptions.

Lastly we incorporate data on individual critical illness policies purchased between 1996 and 2008 as provided by Munich Re, representing approximately 80-85% of purchased policies in Canada (personal communication, Helene Michaud, Munich Re, Oct 2008). We focus on the periods 2002-2007 as these data represent similar time periods to the cancer expenditure data (2002-2003) and the net wealth survey (2005). As data was presented in three year blocks we include data from 2006 -2007 for policy face values, which may introduce some error in estimating the true policy face amount.

## Model assumptions

We have made some key assumptions in our fixed-reimbursement healthcare insurance model. First, we have assumed that individuals are risk averse. A significant body of literature supports this premise (Arrow, 1965; Pratt, 1964; Friedman, 1974; Szpiro, 1986), although there is some variability in the degree of risk aversion, and some discussion of whether this is just an artifact of diminishing marginal utility of income (Nyman, 2006).

Second, we assume that critical illness insurance payout requirements demand that the diagnosis is appropriately documented and policyholders survive 30 days post-diagnosis. Although these factors will result in a decrease in claims, data on the percentage of individuals that do not meet these conditions is not publicly available across age categories, so for this

[23] Source: Munich Re's Critical Illness Survey 2006, Munich Re Canada

reason we have not included this factor in our model. We believe that this factor would increase the loading ratio in favour of the insurer.

Third, we assume that individuals transition from a state of perfect health to critical illness with no intermediate states. They therefore can afford premiums (in the healthy state), or are drawing on insurance or net worth if they become ill (based on their decision to be fully insured or not).

Fourth, we assume expenditures for cancer treatment in Ontario would be representative of expenditures in other regions of Canada, and we also assume that the costs of other illnesses (i.e. heart attacks) would have similar out-of-pocket expenditures to that of cancer. Although levels of coverage vary between provinces it is not expected that these differences would be significantly different across most health services.

Fifth, we are only investigating individual CII policies and not group policies. This distinction is important as individual policies are purchased based on a persons personal or family situation, whereas group policies are by and large purchased by employers without input from the individuals who would benefit. The motivations for each of these policy purchases are quite different, and we are not attempting to assess corporate demand or motivations in this manuscript.

Finally, it is assumed for simplicity that this examination is based on an individual risk rather than the collective risk of all family members. Otherwise we should employ an algorithm that factors in the net cost should multiple family members become ill, and would require multiple premiums. Although this can be calculated based on both incidence and health record data this paper has chosen not to address this more complex scenario. However in the income section we do make assumptions regarding the role of each family member as an income earner, and run sensitivity analysis using a variety of income sharing assumptions.

**Results from Application of Models**

We find that when policies are purchased according to expected losses the predictive value of the model is reasonably good (based on average values in our base case), but consistently suggests policy face amounts lower than the average policy purchased, and these differences are especially pronounced in those in the 30-35 and 35-40 age categories (Figure

1). We note that insufficient data below age 30 is available; hence the 30-35 age category represents the youngest category examined.

*Sensitivity analyses*

Sensitivity analysis using replacement of 100% of family income, and 50% of family income all show similar discrepancies in face amounts purchased, with the 50% assumption providing the largest differential (data not shown). If we use cancer expenditures, income and face amounts based on the $90^{th}$ percentile (a theoretical worst case scenario) we find that policy values cover expenditures and lost income with excess coverage remaining in only the lowest age categories (30-35 and 35-40). However data from the $80^{th}$, $70^{th}$, $60^{th}$, and $50^{th}$ percentile for cancer costs, income and face amount suggest that excess coverage occurs at 30-35, 35-40, 40-45, and 45-50 [Figure 2]. Additionally we found that when using the $90^{th}$ percentile for cancer costs, but average values for income and policy face amounts that excess coverage occurred in 30-35, 35-40 and 40-45 age categories (data not shown). In the most extreme risk averse case where individuals expect $90^{th}$ percentile for cancer cost, and purchase $90^{th}$ percentile for policy face amount, we see excess coverage in all age categories (data not shown). Results using all family income data (not just 2 income families) show similar outcomes to those in the average scenario (data not shown).

The results assuming replacement of 100% of family income for non-smoking males (instead of 67% in our base case) suggest that all cases except the $90^{th}$ percentile show that the face amount exceeds income and cancer expenditure data in the age categories of 30-35, 35-40, and 40-45. Analysis using 50% of family income shows excess coverage in all analyses for ages 30-35, 35-40, and 40-45 (results not shown).

Results from the non-smoking female analysis provide similar results to those of the males with the only difference being that all analyses resulted in excess coverage for ages 30-35, 35-40, and 40-45, and in all but the $90^{th}$ and $80^{th}$ percentiles 45-50 age category as well.

These base case results and the results from sensitivity analyses are not supportive of the influence of prudence alone which would predict that face amounts that exceed lost income and expected financial expenditure would not be expected to occur. This conclusion appears robust as we see evidence of excess coverage in almost all simulations of the models for 30-45 year olds.

*Plausible explanatory pathways*

As the data does suggest that other factors are influencing the purchase amount in the policy, we investigate other plausible explanations. One possible explanation addressed earlier was the access motive (Nyman, 2006). However we would expect, assuming rational behavior of the insured, that as the variability increases the size of the policy would also increase yet although variability of cancer expenditure mostly increases with age (Table 1), we do not see a resulting increase in the size of the policies face amount, hence we reject the notion that the access motive is instrumental in determining the face amount of the policy.

The other possible explanation is related to affordability[24]. We have assumed that policy premiums in excess of 4.5% of family income would be considered unattractive or unaffordable. We use this figure as many publicly funded health care systems use between 2.5% and 4.5% of family income as an affordability threshold criterion in setting co-payments for health services[25]. We note that in all but the 60 and over age category for males the current premiums for non-smokers (representing 82% of policy holders) vary between 0.6% (30 yrs) and 1.67% (50 yrs) of family income. Similar results are seen in the female population with ranges from 0.7% (30 yrs) to 1.58% (50 yrs), but with values for the 60 and over category being just outside the 4.5% threshold (4.81%) if policies similar to younger age categories are applied. We do note that premiums increase dramatically for those above 60 and that policy values equal to those of younger cohorts would exceed 5% of family income, but the face amount typically purchased ($61,000 males, $47,000 females) results in a premium that is 3.4% (male policies) and 3.8% (female policies) of family income, which is within most publicly set affordability thresholds[26]. Hence affordability is an additional plausible influencing factor for purchasing behaviors in those over the age of 60, but not for those under this age, and might also account for the lack of excess coverage in these age categories.

[24] There is no unanimous definition of “affordability” of insurance. A recent contribution by Bundorf and Pauly (2006) suggests that all households with an income at least the sum of the premium and a socially defined minimum level of consumption on all goods other than insurance should be deemed able to afford the insurance. In most applied social policy contributions it is assumed that when the cost of insurance goes beyond a given percentage of income (typically 4.5%) the household cannot afford it.

[25] Means testing for pharmaceutical co-payments in Ontario and Manitoba, Canada are examples.

[26] We used average ages within the age category (62.5 years in the 60-65 age range) and note that this would slightly underestimate premiums for a 65 year old ($3,018) and overestimate premiums of a 60 year old ($1940) compared to the average ($2601); all examples male, non smoker.

Another possible explanation for the policy purchasing behavior relates to the insured net wealth. Data from Statistics Canada suggests that net wealth (and our own calculation of net liquid wealth that excludes real estate equity) suggest that those in the younger age groups would be most likely to purchase policies beyond income and cancer expenses, as is the case in our results. However the other possible explanation is that the younger insured use the excess value above income replacement and expected disease expenditures as a state dependent utility compensation, and as net wealth grows this utility compensation is accommodated through net wealth rather than the purchase of an excess face value on CII. Data on net wealth across age categories is reported in Table 1.

Finally we could consider that the insured purchase amounts in excess of their needs due to uncertainty, and out of fear of bankruptcy as a consequence of their illness. This however does not explain the fact that the older cohorts appear to have a diminished uncertainty or fear of bankruptcy, since they typically purchase little or no excess coverage. In light of this we consider this explanation at best incomplete.

*Confounding factors*

We note that in our crude calculations of loading ratios that it appears for younger age categories that loading ratios of less than 0.50 occur frequently (pay out less than 50 cents on the dollar), yet for some of the older age categories the loading ratio is above 0.80. Industry survey results suggest that the true loading ratios are likely between 0.70 and 0.80, suggesting that adverse selection is influencing the loading ratios for the younger insured, and that cream skimming is occurring for the older insured[27]. This data is suggestive only, as insufficient data is available on rejected policies, denied claims, and indemnities paid across age and gender categories.

*Interpretation of results*

We note that these results provide support for a modification of the existing Eeckhoudt model. The fact that in most simulations there existed policy face amounts well in excess of expected cancer expenditure and income loss, in many age categories, supports the notion that other variables are influencing the insured decision on the face value of policy purchased. This

[27] We note that data from the Munich Re Critical Illness Survey 2006 states that 65% of claims are submitted within 3 years, suggesting some adverse selection was likely present.

clearly suggests these policies are often not being purchased as a wealth management strategy, or at least not exclusively as a wealth management strategy. We considered explanations related to access and recognized that as variability in cancer expenditure mostly increases with age this should result in an increase in face amount with age (Table 1), yet this was not observed, and hence on this basis we have rejected the access motive as proposed by Nyman. A consideration of state-dependent utility compensation seems plausible as an explanation yet appears to diminish and in many simulations disappears by age 40 or 45. Although this is not fully supportive of the state-dependent utility compensation we observe that net wealth (less real estate equity) grows significantly in these later years and could be an alternate source of state dependent utility compensation. In this regard and in support of this notion is the fact that as premiums rise CII purchasers tend to purchase amounts consistent with just covering cancer expenditures and income losses only which allows them to stay below the typical threshold for affordability of 4.5% of family income.

One other aspect of the data requires some comment, namely the distribution of policies purchased by age and policy face amount. We note that overall the mean values are typically around $80,000 in the years we investigated (2002-2007). However overall data suggests that approximately 17% purchase policies in excess of $100,000, and that the distribution seems to be bimodal with the largest percentage of policies having face amounts between $25,000 - $50,000 (27.5% of issued policies) and $75,000 - $100,000 (37.8% of issued policies)[28]. It is not clear why this bimodal distribution has occurred. One possible explanation is that two distinct groups of consumers exist. First, those who are working without other healthcare insurance policies that protect them when unable to work (similar to disability insurance) so purchase policies to compensate them when sick ($25,000-$50,000 policies), and the other being self-employed individuals who choose to cover their loss from business revenues when unable to work due to illness ($75,000-$100,000 policies).

## Conclusions

We investigated the existing Eeckhoudt model and a modified Eeckhoudt model to determine whether either reliably predicts trends in CII purchase in the Canadian setting. Our results suggest that the existing Eeckhoudt model seems to underestimate the size of the policies purchased and this effect is especially pronounced in those in the 30-35 year and 35-40

[28] Data on file, Munich Re Canada

year categories and is consistent in almost all sensitivity analyses. These results suggest that other factors are likely influencing purchasing behaviors of the insured, especially in the younger cohorts. The trends in our empirical analysis did not support either an explanation based exclusively on prudence (or wealth management), nor did it support the notion of an access motive. Our modified Eeckhoudt model therefore suggest that the incorporation of state-utility transfers and/or affordability variables as both of these are supported by the empirical data. Incorporating these variables allows a better prediction of purchasing behaviors, but it still provides an imperfect prediction based on the available Canadian data sources used (Figure 2). It is not clear exactly what amount of state-utility compensation the insured is seeking, but the amounts purchased were as high as CDN$45,000, suggesting it represents as much as 50% of the face amount in younger cohorts. In fact it is possible that at older age categories it is the affordability issue that is masking the state-utility transfer to some degree, as we see examples of policy amounts staying below the typical affordability threshold of 4.5%. We note however that net wealth may also play a role in minimizing the degree of state-dependant utility since accumulated savings could be used instead of the CII indemnity for those in older age categories.

We would be remiss if we did not consider prospect theory as a plausible explanation (Kahneman & Tversky, 1979). Prospect theory suggests that individuals tend to over-react to losses generated by rare events, such as the incidence of cancer in a given year for a given individual or the incidence of a very expensive treatment in out-of-pocket spending (an even less frequent scenario). This could account for the fact that those who purchase CII for cancer tend to focus on extremely high cost cases and purchase an income transfer far beyond the expected sum of out-of-pocket medical and non medical costs linked to the treatment and the illness. However, if prospect theory can predict that individuals cover beyond expected costs, it cannot predict that they cover beyond maximum costs[29], as appears in a majority of our sensitivity analyses. It is certainly the case that more refined data at the individual level would allow us to test more convincingly state-dependant utility versus prospect theory.

Overall, we believe this empirical test of Eeckhoudt's model suggests that state dependent utility and affordability variables must be included in the model to more accurately reflect consumer behavior related to CII purchases. We have based our conclusions on the central tendencies of aggregate data, and some sensitivity analysis using the 90th through 50th percentiles of the data and although the results are suggestive additional research is warranted

[29] Maximum costs represent the maximum observed costs related to the specified event

to verify if our conclusions are valid. These results are intriguing but suggestive only because we are unable to link cancer expenditure data and income data directly to patient purchase behavior. Hence, we caution the reader in making causal assumptions based on the simulations presented in this paper. We expect that other unmeasured or unavailable information might be required in order for us to better predict the demand across age and gender categories, and to determine what portion of these differences are accounted for by state utility transfer and affordability limitations. Additional research would be required to verify these demand characteristics more fully.

We note that these results only provide information on those individuals choosing to purchase policies, and provide no information on those who choose not to purchase CII. We expect that there are several reasons that individuals may choose not to purchase CII. The first reason may be regarding affordability as those with lower incomes might find that the premiums exceed the typical 4.5% of family income threshold. Data from the Survey of Labour and Income Dynamics (SLID) 2005 suggests that up to 20% of the Canadian population would be unable to afford the CII premiums[30]. Second, others may have other healthcare insurance policies like disability insurance that address the larger part of their risk, namely lost income and hence make CII redundant or at least less attractive. We note that data from Marshall (2003) indicates that 56% of employees have disability insurance in Canada. Third, individuals may be unaware of the financial risk associated with illness as many assume that all medical costs will be covered through the publicly funded healthcare system and that non-medical costs will be trivial, although previously published work by Longo (2006, 2007) suggests otherwise. We note that if these populations just described are not considered good candidates for critical illness insurance the current market penetration likely represents as much as 25% of the available market[31]. Again additional research might shed some light on what factors influence the choice of whether or not to purchase CII.

There are a number of follow-up research studies that could inform the suggested fixed-reimbursement model. A survey of individuals who have purchased CII policies including the collection of information on premiums paid, family income, and face amount of their policy would facilitate or refute our stated model. Additionally follow-up work on out-of-pocket costs for

[30] In the more specific case of those 35-54 up to 35% of individuals are ineligible due to income or health limitations (Personal communication Helene Michaud, Munich Re Canada)

[31] However, when all those beyond income restrictions are considered Munich Re estimates that only about 7% of the potential market currently has CII (personal communication, Helen Michaud, Dec 2008).

cancer patients that also investigates whether CII insurance was purchased would provide information on whether the policy face values were sufficient or in fact exceeded the needs of the policyholder. It would also facilitate a better understanding of why individuals choose to purchase (or not) CII policies. Specific questions regarding state utility transfer and affordability could easily be incorporated in either of these research efforts and would help clarify whether either or both of these factors played a significant role in CII purchasing behavior by the insured. Finally we find it curious that there exists a bimodal distribution for policy face amounts. An investigation to evaluate whether two distinct consumer groups exist would be informative and should be considered as a potential area for further research.

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## Table 1 - Data and Sources

| Males | Policy face value[1] | Liquid Wealth[2,3] | Annual Income[3] | Income 95% CI | Premium affordability 4.50% | Premium affordability Actual Premium[4] | Cancer expenditure[5] | Expenditure SD | Cancer incidence[6] |
|---|---|---|---|---|---|---|---|---|---|
| 30-35 | $83,226 | $79,247 | $68,772 | 62033-75510 | $3,095 | $335.00 | $4,984 | NA | 0.0669% |
| 35-40 | $85,473 | $163,412 | $78,496 | 67674-89317 | $3,532 | $423.00 | $1,126 | 1,868 | 0.0669% |
| 40-45 | $81,826 | $294,048 | $84,605 | 74616-94593 | $3,807 | $577.00 | $5,026 | 9,612 | 0.1848% |
| 45-50 | $75,877 | $378,742 | $80,694 | 67979-93409 | $3,631 | $783.00 | $10,610 | 15,765 | 0.1848% |
| 50-55 | $71,725 | $407,781 | $73,881 | 65629-82132 | $3,325 | $1,142.00 | $5,962 | 7,870 | 0.6580% |
| 55-60 | $66,358 | $439,792 | $77,633 | 69339-85928 | $3,493 | $1,644.00 | $2,339 | 3,612 | 0.6580% |
| 60-65 | $63,247 | $649,888 | $57,790 | 50508-65071 | $2,601 | $2,343.00 | $5,896 | 21,262 | 1.7105% |
| Females | | | | | | | | | |
| 30-35 | $74,873 | $146,627 | $57,995 | 48371-67619 | $2,610 | $303.00 | $4,984 | NA | 0.1270% |
| 35-40 | $73,676 | $237,267 | $63,352 | 52067-74637 | $2,851 | $373.00 | $1,126 | 1,868 | 0.1270% |
| 40-45 | $67,456 | $167,640 | $56,374 | 48578-64171 | $2,537 | $483.00 | $5,026 | 9,612 | 0.3188% |
| 45-50 | $61,878 | $501,497 | $62,510 | 42999-82022 | $2,813 | $606.00 | $10,610 | 15,765 | 0.3188% |
| 50-55 | $56,903 | $413,929 | $68,572 | 51111-78774 | $3,086 | $757.00 | $5,962 | 7,870 | 0.6689% |
| 55-60 | $53,434 | $487,586 | $63,277 | 52714-73840 | $2,847 | $1,020.00 | $2,339 | 3,612 | 0.6689% |
| 60-65 | $47,365 | $271,258 | $55,689 | 42470-68909 | $2,506 | $1,263.00 | $5,896 | 21,262 | 1.1305% |

1. Source; Munich Re Canada, data on file, 2001-2007
2. Liquid wealth equals net wealth less real estate equity: Source - 2005 Survey of Financial Security (Canada)
3. Data from two income families;  Source - 2005 Canadian Survey of Financial Security (Canada)
4. Premiums based on average age for category; Source - Canada Life (December 2008)
5. Cancer expenditure (both sexes); includes medical, non-medical, and travel expenditures; Source - Longo 2006,2007
6. Cancer incidence annualized; Source - National Cancer Institute of Canada 2008

Figure 1 – CII face amount(CII), cancer expenditure (CC), income loss (IL), where difference is CII- (CC+ IL), All values are averages

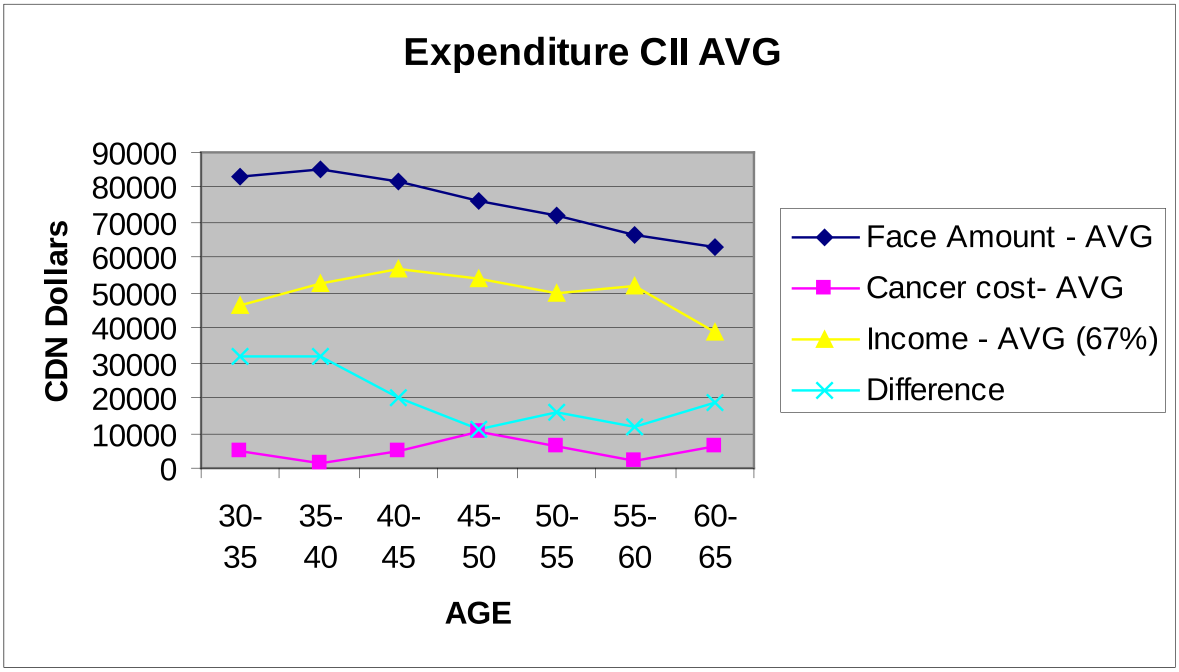


Figure 2 – Differences [CII-(CC+IL)] for all values using 90th through 50th percentiles and Average as reference to Figure 1