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# Valuation of Health under State-Dependence: A Study of Cancer

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# VALUATION OF HEALTH UNDER STATE-DEPENDENCE: A STUDY OF CANCER

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## Abstract

Cancer is one of the leading causes of the high adult mortality rate in India. The exponential increase in the incidence of cancer has resulted in catastrophic health shocks, both in terms of financial status and productivity life lost. The adverse health effect of cancer not only demands a necessary increase in the budgetary provision but also requires rationalisation of health care resources based on individual preferences for maximum social welfare. Investigating how an individual would mitigate the mortality risk associated with cancer would provide value addition in formulating a wide range of health policies. In this direction, our objective is to analyse the following: patients' valuation for complete remission of cancer, health-wealth utility function under health state dependence, and the individual's risk attitude towards health. The state-dependence study requires information on those who are affected by cancer and those who are at risk but not affected by cancer. The data of cancer affected households are collected on the referrals of patients from senior gynaecologic-oncologists, while the data of non-cancer affected households are collected from the general population, via face-to-face interviews. We have used the contingent valuation method to elicit the hypothetical scenario for valuation analysis and multiple linear regression and non-linear least square method for estimation procedure. The result indicates that cancer affected households, on average, are prepared to pay Rs 2,112 - Rs 3,123 per month for five years for complete remission of cancer. The major factors positively influencing valuation are chronic co-morbidity, years of education of the responsible household member, income, and insurance coverage of the patient. In the extended contingent valuation method, we estimated the state-dependence utility function and found that there exists negative state-dependence. In a low cancer mortality risk scenario, the marginal utility of cancer-affected significantly reduced to two-thirds while the marginal utility of non-cancer affected reduced to only four-fifth. The same pattern is observed in the high cancer mortality risk scenario but the difference in marginal utility is very low. It implies that under a severe health risk, the health-wealth utility function becomes state-dependent and the monetary equivalent model is not suitable for assessing large adverse health risks, specifically for diseases with severe health effects like cancer. The standard gamble reveals divergent risk attitude under health state-dependence. A non-cancer affected household is relatively more resistant in discounting its risk preference than a cancer-affected household.

**Key Words:** Cancer, Valuation, Utility Function, Prevention, Treatment

**JEL:** I11, I12, I13, I18

# Section 1

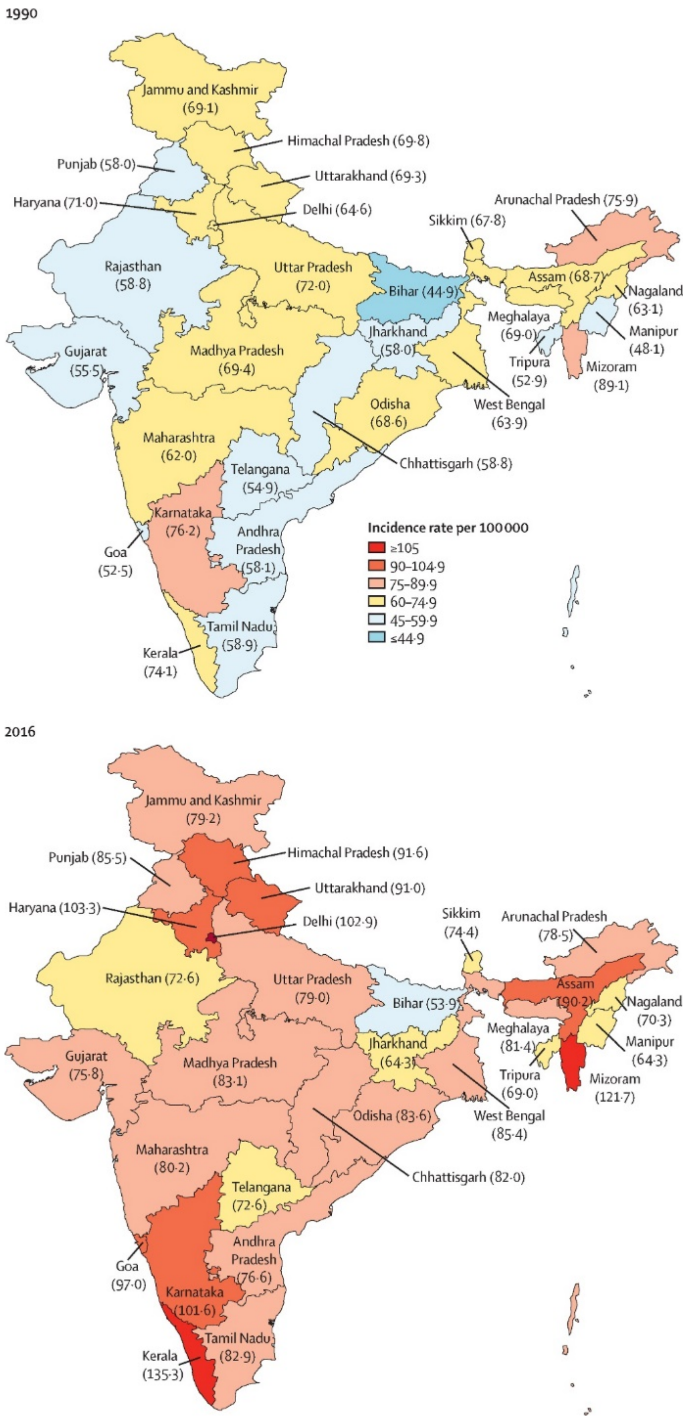
## 1.1. Introduction

The abnormal mutation of cells that develops into a malignant tumour is called cancer.[1] It may be either genetically inherited, develop due to carcinogenic environmental exposure, or occur due to DNA replication error (Jones and Baylin, 2007). Environmental factors like obesity, alcohol, infection, etc., account for 85-90 per cent of all cancer cases while genetics account for only 5-10 per cent of cancer cases (Anand, et al., 2008). In India, cancer accounts for more than 9 per cent of all deaths due to non-communicable diseases (NDCs) and is the second and the fourth leading cause of adult mortality in urban and rural regions, respectively.[2] The incidence of cancer is increasing exponentially with a surprising geographical concentration across India (see Figure 1). It is expected to double by the year 2040 (WHO, 2020). The disconcerting fact is that a rising trend of cancer is being observed even among the younger population, specifically among women in the reproductive age group (Kastor and Mohanty, 2018; Rajpal, et al. 2018). The most common types of cancer among males are lung, oesophagus, larynx, mouth, and tongue cancers while those among females are breast, cervix, and uterus cancers (Rajpal, et al. 2018). The cancer treatment protocol involves high social and economic cost, and the affected household faces a huge dilemma in resource allocation, especially women with cancer episodes (being traditionally neglected in the patriarchal societies of India) are more vulnerable. It is reflected in the fact that breast cancer is the most common cancer among urban women and the second most common among rural women (Agarwal and Ramakant, 2008), while cervical cancer is more prevalent among rural women than urban women (Das and Patro, 2010). The survival rate of cancer among women is also very low. According to the Indian government's Operation Framework for the Management of Common Cancers, the five-year survival rate for early-stage breast cancer is 76.3 per cent while for cervical cancer, it is only 73.2 per cent, which is significantly low as compared to many high-income countries (MoHFW, 2016). The high incidence of gynaecological cancers and opportunity to interview female patients and the accompanying households in hospital has encouraged us to carry out this study.

[1] https://www.cancer.gov/about-cancer/understanding/what-is-cancer

[2] Office of the Registrar General and Census Commissioner, India, Ministry of Home Affairs, Government of India: Causes of death statistics.
http://www.censusindia.gov.in/vital_statistics/causesofdeath.html Google Scholar

**Figure 1: Crude Annual Cancer Incidence across Indian States during 1996-2016**




*Source:* "The Burden of Cancers and Their Variations across the States of India: The Global Burden of Disease Study 1990–2016"; *The Lancet Oncology* (2018).

Cancer-detecting therapy is very expensive and grossly top-loaded, imposing a significant burden on the affected households (Sikora and James, 2009). Health shocks, cumulated with financial shocks, can potentially push vulnerable households into chronic poverty. According to NSS Report (2018), the average cost of in-patient care is highest among cancer patients, with more than 40 per cent of the patients suffering from financial distress in the form of accumulated debt and selling of assets (see Table 1). More than 75 per cent of cancer inpatients incur catastrophic health expenditures, much higher than by patients of any disease. Apart from the excessive direct cost, the empirical studies have also found that the long-term cancer treatment protocol involves a high opportunity cost in terms of a sharp reduction in man-days in the labour market (Heinesen and Kolodziejczyk, 2013; Barnay, et al., 2019), withdrawal of a child from school due to the need for domestic supplements (Zahlis, 2001), and loss of productive hours of the household members to accommodate the care time for the patient (Robinson, 1992; Mosher, et al., 2013; Sumandari, et al., 2015). The estimated workforce participation rate of an adult with cancer is lower by 2.4 - 3.2 percentage points, as compared to that of an adult with non-cancerous diseases (Mahal, et al., 2013). Children of parents diagnosed with cancer are more likely to suffer from anxiety and distress, and to drop out to compensate for the livelihood lost (Visser, 2004). The cumulative outcome of the indirect cost is reflected in a long-term economic burden, future uncertainty, and the potential threat of a poverty trap. Given the economic burden, the public health expenditure support is very minuscule (1.28 per cent of GDP in 2018) and is largely dictated by the supply-side factors, which is bereft of individual preferences and their capacity to pay, and is hence reflected in high catastrophic health expenditure. The adverse health effect of cancer requires a necessary increase in the budgetary provision along with rationalisation of resources based on the individual preferences for optimal social welfare benefit (Arrow, 2003; Wang, et al., 2016).

**Table 1: Economic Burden of Diseases (2017-18)**

| *Disease* | *Inp. Exp (Rs)* | *CHE (%)* | *Finan. Dist (%)* |
|---|---|---|---|
| *Infection* | 94,88.06 | 20.15 | 20.42 |
| *Cancers* | **87,559.53** | **75.31** | **44.42** |
| *Blood Diseases* | 17,402.60 | 38.15 | 25.46 |
| *Endocrine Metabolic Nutritional* | 20,496.03 | 41.54 | 23.37 |
| *Psychiatric Neurological* | 33,725.54 | 52.54 | 31.24 |
| *Eye* | 14,555.00 | 40.37 | 19.73 |
| *Ear* | 20,632.19 | 41.07 | 23.81 |
| *Cardio-Vascular* | 41,828.36 | 49.79 | 26.54 |
| *Respiratory* | 16,327.54 | 30.09 | 23.43 |
| *Gastro-Intestinal* | 21,667.64 | 44.05 | 26.84 |
| *Skin* | 22,762.50 | 34.29 | 22.86 |
| *Musculo-Skeletal* | 32,366.86 | 47.61 | 27.55 |
| *Genito-Urinary* | 29,508.11 | 57.00 | 32.02 |
| *Obstetric* | 15,457.63 | 30.36 | 24.93 |
| *Injuries* | 30,795.61 | 50.06 | 30.89 |

Source: Author's calculations; Social Consumption: Health Survey- NSS 75th Round (2012-18).
*Note*: INP. EXP: In-patient health expenditure; CHE: Catastrophic health expenditure at 10% threshold; FINAN. DIST: Financial Distress in the form of accumulated debt and selling off assets

The supply-side healthcare policy in India has encouraged an influx of private entities in the health sector[3] (National Health Policy, 2017). Although the accessibility to healthcare services has improved significantly over the decades, due to inadequate development of the regulatory framework, the unintended outcome has resulted in healthcare inequity, longer waiting time in public healthcare institutions, and exorbitant

[3] https://www.devex.com/news/india-turns-to-private-sector-to-boost-health-coverage-90006

treatment in private health care facilities (Lakshminarayanan, 2011; Sheikh, et al., 2015). Subsequently, in order to relieve the households from health shocks, specifically among the vulnerable sections, the government, post-1990s, has gradually shifted focus towards a health insurance policy (Duran, et al., 2014). The public insurance policy attempts to be one-size-fits-all, irrespective of disease and the preference of consumers. Without accounting for the individual's demands and preferences, asymmetrical information would accentuate moral hazards in the health care sector, which from a social welfare perspective would lead to sub-optimal health care distribution (Peters, et al., 2002; Arrow, 2003; Prinja, et al., 2014). For efficient healthcare policies, it warrants incorporation of the preference and demand of both the infected individuals as well as those who are at risk of getting infected by the disease (Bosworth et al., 2010). Hence, the interesting economic questions are: *Should the health policy be guided by the valuation of those who are in a good health state but face the risk of the disease or should it be based on the valuation of those who are in bad health due to the direct effect of the disease? If there is a difference in valuation, how should it affect medical decision-making and policy intervention?* Economists have been utilising various methods to answer these questions. As a result, a substantial body of literature has been developed to study the valuation of the risk of adverse health effects (Evans and Viscusi, 1993). The survey based contingent valuation method has been useful in unravelling the demand and preferences of individuals at risk. There are studies which have pointed out that people actively participate in health programmes when they cater to their health needs. In the context of universal health coverage, experiences indicate that people are willing to make rationing decisions in healthcare, and non-insured individuals have a higher willingness to enrol in insurance schemes when they cater to their medical needs (Coast, 2001; Asfaw, 2003; Danis, et al 2004; De Allegri, et al 2006). Jones-Lee et al., (1995) used a survey-based approach to investigate the preference of individuals in reducing the causes of death (accident, heart diseases, and cancer) and observed that 76 per cent of the individuals preferred reducing the causes of death by cancer. They also noted that people are willing to pay (WTP) substantially more to avoid death due to cancer. Another empirical study observed that people value reduction of risk from dying from cancer more than the risk of dying from other causes (Van Houtven, et al 2008, Viscusi, et al., 2014).

The valuation of individuals at risk of adverse health outcomes depends on the health-wealth utility function. If the utility function under *state-dependence*[4] assumes a different shape, then it would impact several economic analyses central to problems in public finance, including the optimal the health insurance, optimal life-cycle savings, prevention, insurance, and compensation for injuries and illness[5] (Evans and Viscusi, 1993). It is because not all illness is tantamount to income loss but some illnesses are

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[4] *Health state-dependence* can be defined as the effect of health on the marginal utility of other (nonmedical) consumption (Finkelstein, et al 2009).

[5]Finkelstein, et al., 2009 has conducted stylised numerical calibrations which suggest that even a moderate amount of state dependence can have a substantial effect on the optimal level of health insurance benefits and a noticeable effect on the optimal level of life-cycle savings.

The theoretical insights on the sign of the second order cross partial derivative, on individual's utility under any health state dependence is ambiguous (see Finkelstein, et al 2009). On the one hand, the marginal utility of consumption may decline with deteriorating health (negative state dependence), as many consumables are likely complements to good health (like clothes, travel). This will have a negative impact on the optimal amount of health insurance benefits and optimal life-cycle savings (as compared with state-independent preference). The reverse will be true if the marginal utility of consumption increases with deteriorating health severe enough to alter the structure of the utility function. It would be a valuable addition to the policy framework if it discriminates between diseases that have a temporal or transformative impact on the utility function (Viscusi, 2019). There is virtually very little to no empirical study available in India which attempts to investigate the health-wealth relationship under state-dependence. The study is important given its broad range of health policy implications.

In this context, we intend to investigate how individuals would like to mitigate the risk of mortality under health state-dependence. We attempt to answer the following questions: What is the valuation of cancer-affected households for complete remission of cancer? Is there a structural change in health-wealth utility? What is an individual's risk attitude (or maximum acceptable risk preference) towards health?

This paper is structured as follows. In Section 1, we provide an Introduction and cover the literature review, objectives, survey design, methodology, and inclusion and exclusion criteria. In Section 2, we discuss the conceptual framework of the contingent valuation method. In Section 3, we discuss the variables of interest and their corresponding summary statistics. In Section 4, we analyse the cancer-affected households' willingness to pay for complete remission of cancer. In Section 5, we have extended the conceptual framework of the contingent valuation method to analyse the health-wealth utility function under health state-dependence. In Section 6, we analyse and discuss the maximum acceptable risk preference under health state-dependence. In Section 7, we conclude the discussion with validity and reliability of estimates and highlight the usefulness of valuation of under health state-dependence and its policy implication.

## 1.2. Literature Review

The willingness to pay techniques based on contingent valuation methods are increasingly being used in the economic evaluation of advanced healthcare treatment intervention. They are extensively applied for studying the feasibility of advanced medical treatment for cancer (Dickie and Gerking, 1996; Frew, et al., 2001; Milligan, et al., 2010; Lang, 2010; Bernard, et al., 2011). In India, most of the available work is skewed towards minor diseases or social insurance policy (Asfaw, 2003; Amin and Khondoker, 2004; Bawa and Ruchita, 2011; Coast, 2001; Danis, et al., 2004; De Allegri, et al., 2006; Dror, et al., 2007; Hadaye and Thampi, 2018; Mishra and Nair 2015; Mathiyazhagan, 1998; Whittington, et al., 2009), however, no such study is available in the context of a severe disease like cancer. We have used the framework to determine the valuation for the complete remission of cancer and study the health-wealth utility function under health state-dependence.

The conceptual framework of valuation under state-dependence is well developed. It is extensively applied in the study of wage-risk and fatality-risk trade-offs in the labour market (Evans and Viscusi, 1993). Over the last three decades, the framework has been successfully extended to study the non-fatality health risk trade-off (Thompson, 1986; Viscusi and Evans, 1990; Bleichrodt and Quiggin, 1999; Finkelstein, et al., 2013; Hall and Jones, 2007). However, not much has been explored on the valuation under health state-dependence when the individual is at an adverse health risk *or* is experiencing deadly diseases like cancer. *How do individuals perceive mortality risk and* *how are they willing to trade wealth to reduce risk under different health states?* The survey-based contingent valuation method has opened up the opportunity to explore health-wealth trade-offs under different health circumstances (Viscusi, 2019). According to Viscusi, (2019), the adverse health effects on the health-wealth utility function could vary with the severity of the disease; some are tantamount to monetary loss and some may have a transformative impact on the utility function. If the empirical result indicates different utility for different ill-health states, then it is not evidence of inconsistency rather it is recognition of the diverse impact of adverse health effects. Finkelstein et al. (2009) have summarised some of the important methods and empirical findings that attempt to estimate the extent to which health state-dependence affects the marginal utility of income (Edwards, 2008; Lillard and Weiss, 1997; Sloan, et al., 1998; Viscusi and Evans, 1990; 1993; 1998; Evans and Viscusi, 1991; Finkelstein, et al., 2009; 2013). However, in addition, to our knowledge, there are just five more studies that subsequently attempt to investigate the health effect on the marginal utility of income (Rey and Rochet, 2004; Levy and Nir, 2012; Tengstam, 2014; Hansen, 2016; Ameriks, et al., 2015; Viscusi, 2019). Some studies have observed positive health state-dependence while others have observed negative health state-dependence on the marginal utility of income. In one instance, the association was found to be neutral (Gyrd-Hansen, 2017). The variation in the sign of marginal utility in these studies is because different studies have used different types of health shocks to analyse the association between health and wealth under state dependence. Hence, investigating preference, risk attitude, and valuation of individuals towards different diseases under state-dependence is crucial for formulating an efficient disease-specific health policy.

## 1.3. Aims and Objectives

The catastrophic experience of cancer-affected households encourages us to explore important questions central to the problem of health security. Our main aim is to investigate the valuation of health improvement under state-dependence by exploring the following questions:

- *What is the valuation of cancer-affected households for the complete remission of cancer?*
- *Does ill-health fundamentally transform the utility function or leave the structure of the utility unaltered?*
- *What is the maximum acceptable risk preference for the complete remission of cancer?*

## 1.4. Survey Design and Methodology

### 1.4.1. Cancer Survey

The nature of our study demands information on those who are afflicted with the disease and those who are at risk but not afflicted with the disease. Hence, the cross-sectional survey was conducted at hospitals and households in the Indian State of West Bengal during 2019-21. After much deliberation with medical experts and with the ethical committee, we were able to get access to study gynaecological cancer cases like breast, cervix (including endometrium), and ovarian cancer (see Table 2). Therefore, our study, to an extent, is specific to the most common cancers in women. The data has been collected via face-to-face interviews at hospitals and households. The hospital survey was conducted between 1 December 2019 and 23 March 2020.[6] The hospital data has been collected from two hospitals: (1) the government-financed Chittaranjan National Cancer Institute (CNCI), and (2) the non-profit Saroj Gupta Cancer Centre and Research Institute (SGCCRI). These institutes mostly cater to the medical needs of low- to middle-income households, and therefore, our hospital sample is specific in representation (see Table 4). In the hospital survey, a total of 228 patients were advised by gynaecologic-oncologists to give interviews along with their accompanying *responsible household member*[7] for research purposes. However, only 190[8] sample respondents were able to complete the interview while the rest were reluctant or left in between. We can assume that their time price is much higher than the willingness to participate. The hospital survey is divided into five schedules, covering; 1) Household; 2) Patient's activity information; 3) Patient's subjective health profile; 4) Patient's clinical profile; and 5) Willingness to Pay. Schedules 1 and 5 have been answered by a responsible household member, Schedules 2 and 3 have been answered by patients, and information in Schedule 4 was recorded from hospital documents. On the other hand, the household survey was conducted between 16 November 2020 and 30 March 2020 in four districts: North 24 Parganas, South 24 Parganas, Kolkata, and Bankura, to make the sample representative (see Table 4). For the household survey, we approached 663 households for the interview but only 528 completed the survey, while the rest either left the interview in between or were reluctant to participate due to the fear of COVID-19 or insecurity because of CAA+NRC[9] even though we provided proof that it was purely research work.

**Table 2: Types of Cancer Cases Presented in the Hospital Survey and Household Survey**

| *Cancer* | *Hospital Survey* | *Household Survey* |
|---|---|---|
| *Breast* | 12 | 184 |
| *Ovarian* | 42 | 169 |
| *Cervical and Endometrium* | 136 | 175 |
| *Total* | 190 | 528 |

*Source*: Author's calculations.

[6] The discontinuity in the field survey was due to the nationwide lockdown and subsequent restrictions due to the emergence of COVID-19.
[7] A 'Responsible Household Member' is one who decides where to seek treatment and bears all the medical and travel costs involved. The responsible household member can also be a patient if she happens to be a decision-maker. In a majority of the interviews, the patients were not much educated and were not actively participating in the household decision-making process. The respondents are all female but to arrive at an approximate and realistic figure of valuation, we asked the question from responsible household members (in a majority of cases, either the husband or father of the patient).
[8] Usually, the consultation time for patients in hospital was 10 AM to 2 PM. They were referred for the survey interview only after the medical review was completed by the doctor. Given the restricted time, I was only able to complete interviews of 2-3 patients per day. However, we believe the sample size is sufficient for our analysis considering the previous literatures (Viscusi and Evans, 1990; Sloan, et al., 1998; Levy and Nir, 2012).
[9] Protests against the recent Citizen Amendment Act (CAA) and the National Register of Citizens (NRC) have created scepticism among households about any survey, as a result of which there was a high hesitancy rate. However, it has not the hospital survey much because patients were encouraged to respond by their doctors (gynecological-oncologists).

### 1.4.2. Inclusion and Exclusion Criteria

The treatment protocol of cancer depends on the stage of cancer. Advanced cancer requires aggressive intervention and thus takes a longer period for treatment. To arrive at an approximately realistic health value, we need to set the inclusion and exclusion criteria. We have selected patients who have been diagnosed and treated since 2017 onwards because we believe that cases of patients diagnosed before 2017 would be too old and would under-estimate the valuation due to their specific experiences at the time. Eligible patients are those who completed their course of treatment and are in a state of remission, while patients who have been excluded are those who, according to the medical investigators, are not suitable or do not fulfil our inclusion criteria. Written informed consent was received from eligible patients before the interview. The household survey was collected with the help of survey experts. They were educated about the research and were trained on questionnaires before visiting the respective districts. We used both the pictorial method and as well as a short video clip to educate the respondents before they were presented with hypothetical scenarios.

**The inclusion and exclusion criteria of the subjects under investigation are as follows:**

**Inclusion criteria:**
**Hospital**

a. Post-operative follow-up[10] (remission)
b. Respondent's age above 25 years, and
c. Patient's ability to provide answers to questions seeking basic information.

**Household**

a. Household with no cancer patients
b. Responsible household member must be earning
c. Respondent's age above 25 years, and
d. Respondent's ability to provide the basic information

**Exclusion criteria:**
**Hospital**

a. Patients with multiple recurrences are excluded from the study due to the complex nature of their medical history (William, 2011; Friedlander and Grogan, 2002);
b. Patients who are accompanied by other than the responsible household members;
c. End-stage patients suffering from terminal illness to avoid upward bias in willingness to pay;
d. Respondent's refusal to participate in the survey;
e. Patients age below 25 years;
f. Patients unable to provide answers to questions seeking basic information; and
g. Treatment started before 2017.

**Household**

a. Households with cancer patients;
b. Responsible household member not earning;
c. Respondent's refusal to participate in the survey;
d. Respondent age above 25 years; and
e. Respondent unable to provide answers to questions seeking basic information.

[10] We initially intended to collect data for inpatients too but due to psychological stress and after-effects of operative intervention, patients were not found to be in a stable condition. So, we restricted our analysis to only follow-up patients (in a state of remission).

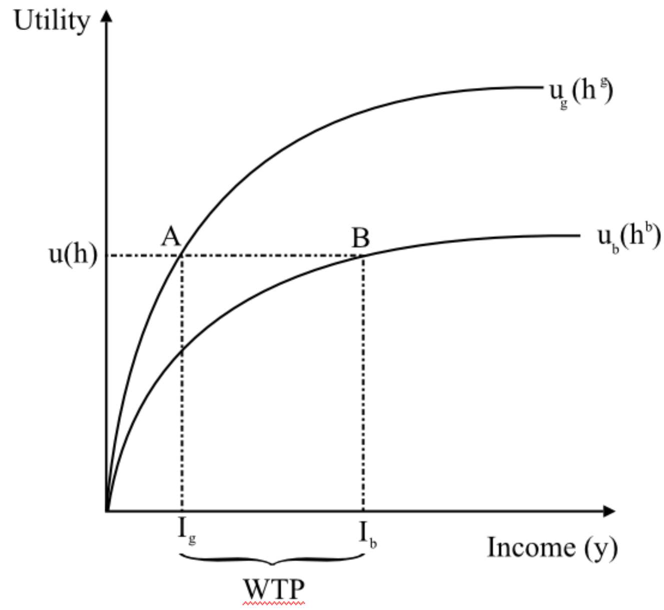
# Section 2

## 2.1. The Conceptual Framework: Contingent Valuation Method

The cost-benefit analysis is an approach used to evaluate the potential benefit of goods and services that are not exchanged in the market. The conceptual foundation of the cost-benefit analysis is appealing at least for three reasons: (i) it has a theoretical foundation in welfare economics, specifically the Kaldor-Hicks's criterion; (ii) it directly calculates the programme net benefit and thereby avoids ambiguity associated with 'cost-effectiveness analyses'; and (iii) the conceptual framework has external validity. However, the detriment to the analysis is the valuation of benefit in the monetary term. The WTP is one of the methods used for valuing the benefit associated with health improvement or mortality risk reduction (Bleichdrodt and Quiggin, 1999; Hammitt, 2002; Boadway and Bruce, 1984; Alberini and Krupnick, 2000). It captures not only the demand for goods and services (yet to be introduced in the market) but also the intangible attributes of the product embedded in the questions asked (Olsen and Smith, 2001; Sadri, et al., 2005). Subsequent empirical studies on WTP took two main directions in the valuation analysis; (i) revealed-preference approach, and (ii) stated-preference survey approach. In the revealed-preference approach, the individual choice of trade-off concerning the new existing product in the market is observed. The survey-based approach is termed as the contingent valuation method (CVM) because the respondents are asked to value intangible goods on the contingency of the market existence. Since health is not directly purchased in the market, the CVM survey is most appropriate for driving the valuation of health under state-dependence. Given the nature of our study, we formalised a *hypothetical market* and provided respondents with the hypothetical choice set. We then observed the trade-off that the individual would make in the given circumstances.

Theoretically, *WTP is based on subjective utility and is equivalent to the compensating variation*. In order to drive the maximum WTP for complete remission of cancer, we assume there are two health states (good health and bad health), and individuals prefer good health state $U_G(\sigma_i,y)$ over bad health state $U_B(\sigma_i,y)$, assuming the *marginal utility of income with respect to health state remains constant*. The subjective utility $U(\sigma_i,y)$ under state-dependence is a function of factors influencing the length and quality of life (say $\sigma_i$) and disposable income (say $y_i$). Now, suppose due to a deterioration in the health state, individual utility reduces to $U_B(\sigma_i,y)$. If it is possible to trade some wealth for good health to reach point A, corresponding to utility $U_G(\sigma_i,y)$, the question is how much the individual *i* would be willing to pay (sacrifice proportion of wealth) to get back to point A?

**Figure 2: Trade-off between Health and Wealth**



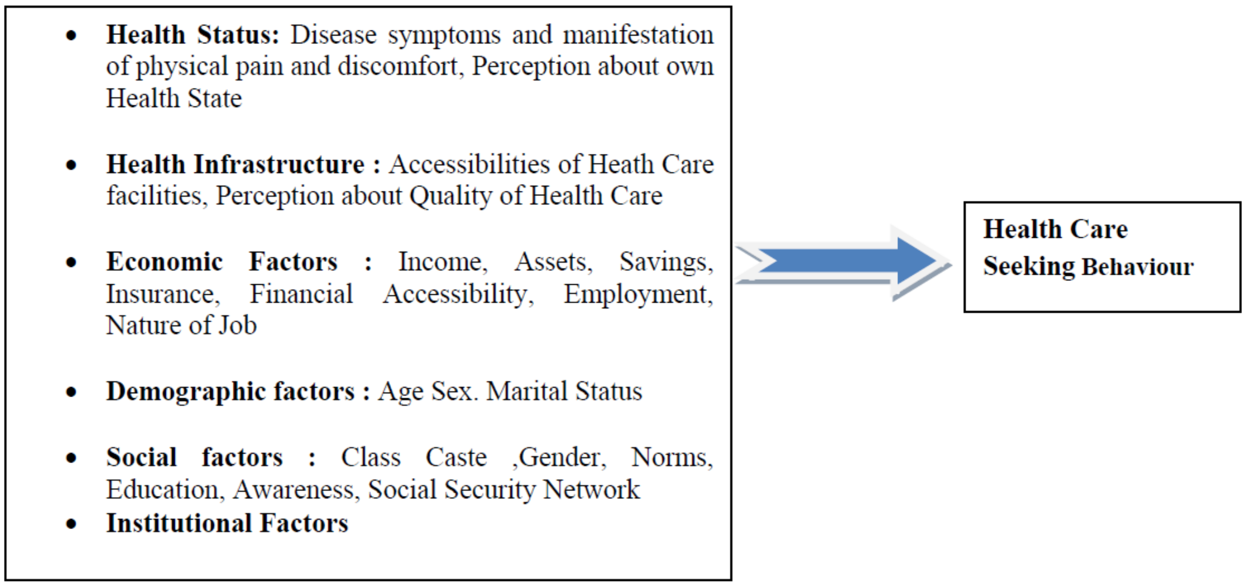

An individual would be willing to trade off wealth for perfect health to the point where the expected utility in the two-health state becomes equal,

$$EU_G(\sigma_i^1, y_i) = EU_B(\sigma_i^2, y_i - WTP) \quad \ldots (1)$$

The WTP is determined using the open-ended method. In this method, we asked the respondents a series of questions with differing amounts of payment till the value was reached wherein a patient is indifferent between taking the treatment or remaining in the present health state (Hanemann, et al., 1991; Liu, et al., 2000). The conceptual framework depicted in Figure 3 highlights the procedure to determine the valuation for health.

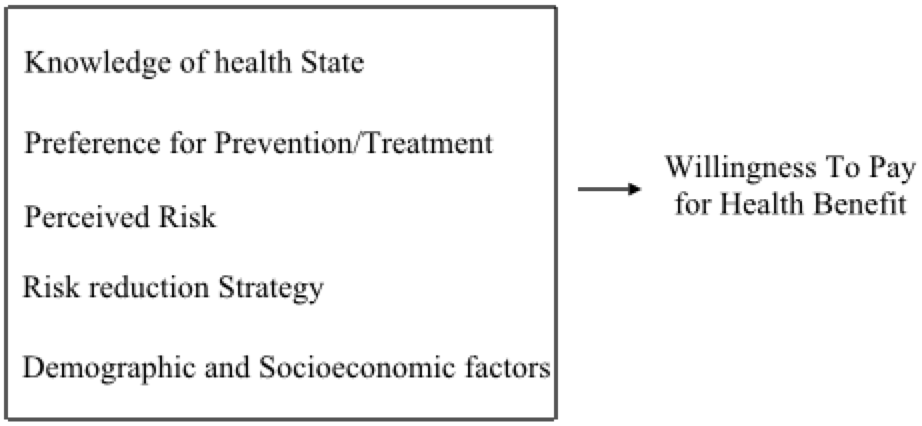
**Figure 3: Conceptual Framework of Valuation of Health**

The following conceptual framework highlights the modalities on treatment-seeking behaviour:



The following conceptual framework highlights the procedure for determining the valuation for health:

Valuation of Health Under State Dependence




# Section 3

## 3.1. Data and Summary Statistics

The description of variables of interest and corresponding summary statistics are provided in Tables 3 and 4, respectively. The $WTP_{CA}^{Patient}$ is the willingness to pay by the CA household for the complete remission of cancer, while $WTP^{LR}$ and $WTP^{HR}$ refer to the households' willing to pay for the reduced cancer risk. The value for cancer risk reduction is determined using hypothetical scenarios discussed in Section 5. The independent variables included in the analysis are used as possible determinants of $WTP_{CA}^{Patient}$. The question on the willingness to pay for both the complete remission of cancer as well as reduced cancer mortality risk is asked based on monthly payment. Questions seeking information on the subjective health status, age, chronic co-morbidity,[11] insurance, and urban were asked from the patient while education and income are asked from the responsible household member.

[11] An individual is said to suffer chronic co-morbidity when he/she has multiple diseases with long-term health impact. The co-morbidities included in the survey are: Diabetes-1; Cardiovascular disease-2; Asthma-3; Psychiatric and Neurologolical-4; Genito-urinary-5; Gastro-intestinal-6; Skin Disease-7; Arthritis-8; Others-9 (other than the major diseases mentioned above). We have not included cancer in the household survey because it comes under our exclusion criteria.

**Table 3: Description of Variables**

| VARIABLES | DESCRIPTION |
|---|---|
| WILLINGNESS TO PAY ($\boldsymbol{WTP_{CA}^{Patient}}$) | CA household payment per month for an advanced new drug for complete remission |
| WILLINGNESS TO PAY ($\boldsymbol{WTP^{LR}}$) | Willingness to pay per month by CA/NCA household for low-risk scenario |
| WILLINGNESS TO PAY ($\boldsymbol{WTP^{HR}}$) | Willingness to pay per month by CA/NCA household for high-risk scenario |
| **INDEPENDENT VARIABLE** | |
| HEALTH STATUS | The current state of Health ranked from 1 (worst) to 5 (best) |
| AGE | Age of patients |
| CO-MORBIDITY | 1, if the individual is suffering at least one chronic co-morbidity, 0, otherwise |
| HOUSEHOLD SIZE | Number of members in the family |
| EDUCATION | Years of education of responsible household member |
| PER-CAPITA INCOME | Per capita income of the household |
| INSURANCE | 1 if the individual has insurance coverage, 0 otherwise |
| URBAN | 1 if the individual resides in an urban region, 0 otherwise |

## 3.2. Summary Statistics

Table 4 represents the summary statistics of cancer-affected (CA) households and non-cancer-affected (NCA) households across demographic and socio-economic factors. The t-value is the test of mean significance between the variables under CA and NCA. The average $WTP_{CA}^{Patient}$ of a CA household is Rs 2,618 – Rs 3,123 per month for five years for complete remission of cancer. In a comparative analysis of the CA households' and NCA households' behaviour towards cancer mortality risk, we found that in both low-risk and high-risk scenarios, the average WTP for reduced cancer mortality risk is twice as high for a CA household as compared to an NCA household, which indicates that a CA household is more sensitive towards reducing the risk of mortality from cancer. The subjective health status (also called the 'quality of life') of the CA individuals' post-treatment (or in a state of remission) and NCA individuals are measured on the ranking scale from 1 (worst health) to 5 (perfect health). CA individuals have a significantly lower health ranking, on average, as compared to NCA individuals. More CA individuals suffer from co-morbidity as compared to NCA individuals. The average number of years of education of a responsible member of a CA household was 8 years while that of an NCA household was 11 years. An NCA household is much richer than a CA household. On an average, CA households have per capita income of less than Rs 4,000 as compared to NCA households. Insurance coverage is also very low among both the groups.

**Table 4: Sample Distribution of Cancer-affected and Non-Cancer-affected Households**

| | *All* | *CI (All)* | *CA* | *CI (CA)* | *NCA* | *CI (NCA)* | *t-test* |
|---|---|---|---|---|---|---|---|
| ***Outcome Variables*** | | | | | | | |
| $WTP_{CA}^{Patient}$ | - | - | 2618.42 | [2112.85 3123.98] | - | - | - |
| $WTP^{LR}$ | 1118.97 | [979.92 1258.01] | 1807.63 | [1406.76 2208.5] | 871.15 | [754.77 987.53] | 5.05 |
| $WTP^{HR}$ | 692.28 | [613.67 770.90] | 1023.85 | [821.17 1226.53] | 572.97 | [496.83 649.10] | 5.97 |
| *Determinants of* $WTP_{CA}^{Patient}$ | | | | | | | |
| *Health Status* | 3.83 | [3.75 3.90] | 3.2105 | [3.10 3.31] | 4.0473 | [3.96 4.13] | -10.42 |
| *Cancer* | 0.26 | [0.2322 0.2969] | 1 | - | 0 | - | - |
| *Age* | 42.53 | [41.63 43.41] | 51.79 | [50.37 53.20] | 39.20 | [38.25 40.14] | 13.74 |
| *Co-morbidity* | 0.37 | [0.3309 0.4016] | 0.43 | [0.3553 0.4972] | 0.34 | [0.3040 0.3853] | 2.01 |
| *HS* | 4.15 | [4.01 4.28] | 4.66 | [4.37 4.95] | 3.97 | [3.81 4.11] | 4.58 |
| *Edu* | 10.16 | [9.81 10.5] | 7.96 | [7.31 8.62] | 10.94 | [10.56 11.33] | -7.77 |
| *PCI* | 7400.48 | [6701.85 8099.11] | 4625.29 | [3967.36 5283.21] | 8399.13 | [7492.97 9305.28] | -4.03 |
| *Insurance* | 0.33 | [0.2987 0.3679] | 0.29 | [0.2293 0.3601] | 0.35 | [0.3064 0.3880] | -1.32 |
| *Urban* | 0.72 | [0.6914 0.7570] | 0.60 | [0.5297 0.6702] | 0.77 | [0.7328 0.8050] | -4.53 |

*Source*: Author's calculations.
*Note*: The values calculated are at mean; HS: Household Size; Edu: Years of education of responsible household member; PCI: Per-Capita Income; The t-test is the significance mean difference between a variable under CA and NCA households. CI: 95% Confidence Interval.

# Section 4

## 4.1. Patients' Willingness to Pay for Complete Remission of Cancer

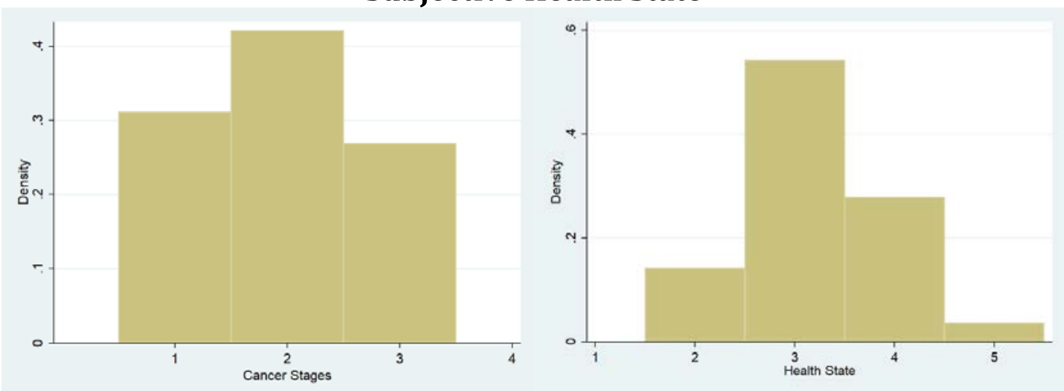
Understanding the post-treatment quality of life of a patient's and the CA households' valuation of health improvement would provide valuable information for designing feasible social security and pricing upcoming new advanced treatment. In this section, we explore the following questions: *At what stage do most cancer patients visit a hospital? What is their subjective health status post-treatment? How much are they WTP for complete remission from cancer?* and *What are the factors influencing WTP?* We found that 69 per cent of the patients have their first doctor consultation at an advanced stage (second and third stage) (see Figure 4), which corresponds to the national average[12] (WHO, 2017). It indicates deferred medical treatment potentially due to the lack of knowledge and financial constraints. A majority of the patients said that they have been experiencing, on an average, a low quality of life, which indicates that the disease has a long-term impact on patients both psychologically and physically. In the analysis of the WTP for complete remission of cancer, we have not distinguished between the type of cancers because the valuation was asked on the basis of subjective health state. It is manifested physical and psychological trauma that drives the demand for perfect health and not exactly the clinical attributes of the disease. It is no wonder why so many patients first consult a medical expert at an advanced stage (see Figure 4). We have asked the following questions from the responsible household member:

[12] https://www.business-standard.com/article/news-ians/70-cancer-patients-in-india-consult-doctor-at-terminal-stage-february-4-is-world-cancer-day-117020301268_1.html

*Suppose that there was a new advanced drug that would completely cure your disease, instantaneously and without any side effects. You will take one pill per day, eliminating the need for any drugs you currently take for this specific disease. How much will you be willing to pay for this drug every month from now on for five years? Please denote the maximal monthly sum that you would be willing to pay for the drug, assuming there are no other means of receiving the drug (i.e. HMO, Insurance, etc.) ___________*

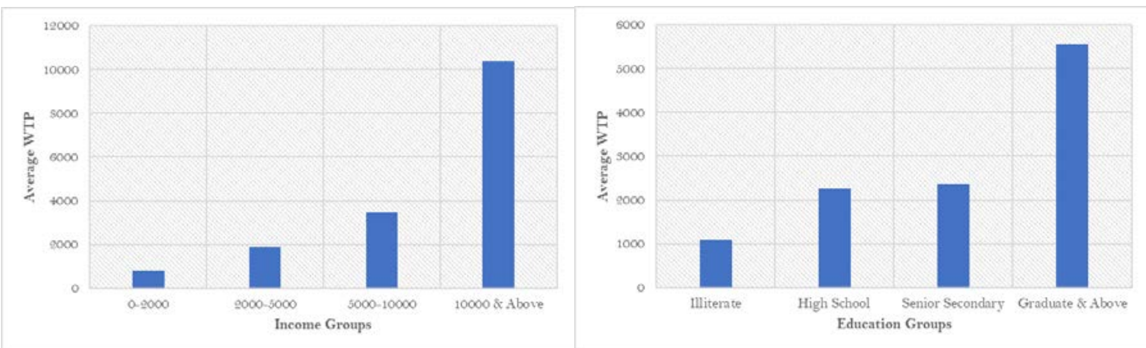
Figure 5 shows the WTP for complete remission of cancer with respect to income and education. The WTP increases with an increase in the number of years of education and income of the responsible household member. Households with per capita incomes in the range of Rs 0 – Rs 2000 are WTP, on an average, Rs 808 [Rs 615 – Rs 1,000] per month for five years, while households with per capita incomes of more than Rs 10,000 are WTP Rs 10,406 [Rs 6,448 – Rs 14364] per month for five years. The WTP with respect to the educational status of the responsible household member reflects the same pattern but has a different magnitude. Illiterate responsible household members are WTP Rs 1,086 [Rs 683 – Rs 1,489] per month for five years while the responsible household members who have graduated are WTP Rs 5,567 [Rs 3,054.09 – Rs 8,081.62] per month for five years.

**Figure 4: Distribution of Cancer Patients across the Diagnostic Stage and Subjective Health State**




*Source*: Author's calculations.
*Note:* The left image represents the distribution of cancer patients across cancer stages; the right image represents the distribution of cancer patients ranked on subjective health state.

**Figure 5: Willingness to Pay across Per Capita Income and Education Status of the Responsible Household Member**




*Source:* Authors' calculations.
*Note:* Left image represents the distribution of WTP across income of CA household; Right image represents the distribution of WTP across educational status of responsible household member in CA household.

## 4.2. Log-Linear Regression Analysis

We assume that the variation in WTP for complete remission of cancer is explained by the following regression equation:

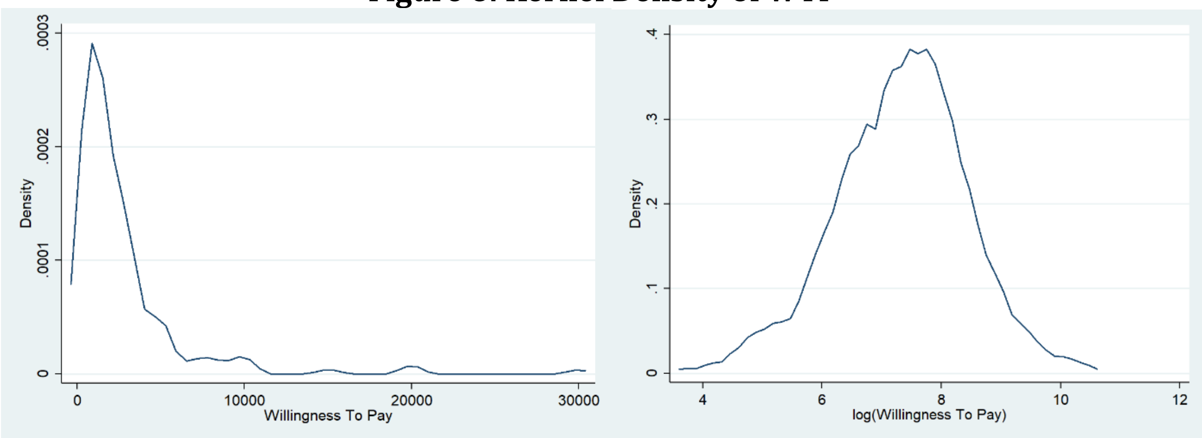
$$WTP_{CA}^{Patient} = X_i\beta + \varepsilon_i \qquad \text{... (2)}$$

The WTP is the willingness to pay of the *ith* individual and $X_i$ is the explanatory variable. We assume that ε is normally distributed with mean zero and $\sigma^2 I$ as the SE. The WTP is a function of subjective health state, age, co-morbidity, household size, education, income, insurance and region. In earlier empirical studies, it was found that WTP are often skewed and estimates based on linear regression would be biased. Therefore, we check the normality of WTP using non-parametric kernel density estimation method. The kernel density in Figure 6 indicates that the distribution is not normal but rightly skewed. We take log transformation of WTP to normalise the variable. Thus, the appropriate model is:

$$\log(WTP_{CA}^{Patient}) = X_i\beta + \varepsilon_i \qquad \text{... (3)}$$

where X is the matrix of determinants of WTP, $\beta$ is the matrix of coefficient estimates, and $\varepsilon$ is the matrix of the error term.

**Figure 6: Kernel Density of WTP**




*Source*: Author's calculations.

## 4.3. Result of Log-Linear Analysis

The log-linear regression result using Equation (3) is shown in Table 5. The major factors influencing the WTP are co-morbidity, number of years of education, household income, and insurance. CA households with co-morbidity are WTP 22 per cent more than CA households without any co-morbidity. This implies that additional chronic disease makes patients worse-off in terms of health and they are WTP more for complete remission from cancer. The years of education of the responsible household member's income also play a crucial role in the determination of WTP. With an additional increase in a year of education, the expected WTP increases by 3 per cent, while a rupee increase in income level in the expected WTP increases by 0.01 per cent. Interestingly, CA households with insurance are WTP more than those without it.

**Table 5: Regression Result of Willingness to Pay for Complete Remission of Cancer**

| | *CA* | *CI* |
|---|---|---|
| *Health Status* | -0.01951<br>(0.0699) | [-0.1565<br>0.1175] |
| *Age* | -0.0059<br>(0.0055) | [-0.0168<br>0.0049] |
| *Co-Morbidity* | **0.2248***<br>**(0.1236)** | **[-0.0175<br>0.4672]** |
| *HS* | 0.0594<br>(0.0371) | [-0.0027<br>0.1215] |
| *Edu* | **0.0315***<br>**(0.0166)** | **[-0.0010<br>0.0641]** |
| *PCI* | **0.0001*****<br>**(0.0008)** | **[0.0001<br>0.0001]** |
| *Insurance* | **0.2228***<br>**(0.1247)** | **[-0.0216<br>0.4672]** |
| *Urban* | -0.0254<br>(0.1356) | [-0.2913<br>0.2405] |
| *Constant* | **6.9698*****<br>**(0.3932)** | **[6.1990<br>7.7406]** |
| | | |
| *Observation* | 190 | |
| *Wald Chi2* | 318.07 | |
| *Prob > Chi2* | 0.0000 | |
| *Pseudo R-Squared* | 0.6018 | |
| *Log pseudolikelihood* | -<br>106271.86 | |

*Source*: Authors' calculations.

*Note:* *p<0.05; **p<0.01; ***p<0.001 HS: Household Size; Edu: Years of education or responsible household member; PCI: Per-Capita Income Standard Error is robust and is in parenthesis; CI: 95% Confidence interval.

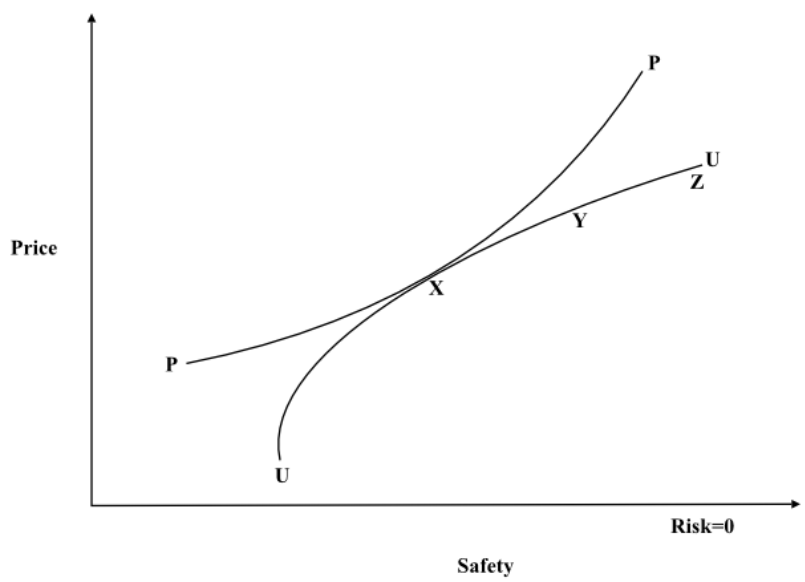
# Section 5

## 5.1. The Utility of Health and Wealth: Risk-Income and Risk-Risk Trade-off

We extended the CVM and used the survey-based framework of Viscusi and Evans, (1990) to study the health-wealth utility function under state-dependence. Generally, in economics, it is assumed that individuals are risk-averse with respect to income, i.e., the marginal utility of income decreases as income increases, but the marginal utility of income does not vary with health state (monetary equivalent) (Arrow, (1974); Evans and Viscusi, 1993; Johannesson, 1996; Viscusi and Evans, 1990; 1998). However, if health is *n* discrete states and curvature varies under any health state, then the marginal utility of income with respect to the health state would vary, and it would affect several health care policies formulated on the assumption of the monetary equivalent (Evans and Viscusi, 1993; Viscusi and Evans, 1990; 1998). An adverse health effect potentially imposes a loss to an individual's utility and lowers the welfare, but it is not sufficient to fully characterise the economic implications. How one perceives the losses and incorporates them in the economic analysis has a profound effect on the welfare consequences of illness and injuries. The adverse health effect is not always tantamount to the loss of a monetary equivalent but it also impacts the structure of the utility function, which has significant ramifications across policies like prevention and treatment expenditure, insurance, and pricing of new advanced monopolistic drugs (Viscusi, 2019). The value of statistical life (VSL) is one of the methods to determine the value of small change in risk. However, when there is a substantial change in risk, like cancer, the application of VSL would lead to an overstatement of valuation for risk decrease. Hence, how the utility function is affected by adverse health effects (monetary equivalent or state-dependence) is an empirical issue (Viscusi and Evans, 1990; 1998; Evans and Viscusi, 1991, 1993; Levy and Nir, 2012; Johannesson, 1996).

Here, we graphically illustrate the estimation of the utility function based on Rosen's hedonic framework. Suppose health improvement is a function of only two factors, safety (safety is nothing but the opposite of mortality risk) and price (WTP). To map the curvature of the state-dependent utility function, we need at least two points on the curvature. In Figure 1, the price-risk schedule is an upward sloping PP curve with an increasing rate, indicating that the provision for lower mortality risk (safety) comes with a higher cost. On the other hand, health consumers have constant expected utility locus UU, sloping upward indicating a higher WTP for a lower mortality risk (safety). It's not possible to identify the locus of the expected utility curve from market data because market data provide information on local trade-off corresponding to point of tangency, in our case such as point X. Also, the analysis of variation of local trade-off is not intuitive for understanding the underlying structure of the utility function because the slope at different points reflects the trade-off of different people and is not observable along the constant expected utility curve. Hence, in order to estimate the underlying utility function in good health state and bad health state, we need to have multiple observations (X, Y, Z) along the constant expected utility locus, EU(X) = EU(Y) = EU(Z).

**Figure 7: The Utility Function**



The locus of the risk-price trade-off along the constant expected utility function would enable us to identify the specific curvature of the utility function. Assume that there is $n$ discrete health state of the world ($j$ =1,2,3…$n$) and each health state $h_j$ is associated with income level $y_j$. Then the expected utility in each health state would be the sum of the weighted utilities in each health state. The weight is assigned accordingly with the probability $s_j$ that health state $h_j$ realised (Phelps, 1974; Arrow, 1974),

$$EU = \sum_{i=1}^{n} s_i U(h_i, Y_i) \qquad \text{… (4)}$$

Since the continuous measure of health is practically impossible to measure, following Viscusi and Evans, 1990, we are interested in binary health state-good health and bad health. Assuming the role of health in state-dependent utility function as follows,

$$EU = \sum_{i=1}^{n} s_i U(Y_i) \qquad \text{… (5)}$$

Let U(Y) be the utility in good health and V(Y) be the utility in bad health. Then the expected utility would be,

$$EU = (1-s)U(Y) + sV(Y) \qquad \text{… (6)}$$

It is obvious that good health is preferred over bad health, then

$$U(Y) > V(Y) \qquad \text{… (7)}$$

But the particularly less obvious and more problematic issue is whether the marginal utility of income increases, decreases, or remains neutral in ill health.

$$\begin{aligned} &i.\, MU_U > MU_V \\ &ii.\, MU_U < MU_V \\ &iii.\, MU_U = MU_V \end{aligned} \qquad \text{… (8)}$$

If severe health decreases (or increases) the marginal utility then (i) (or ii) would hold, indicating that there is a shift in the structure of the utility function under state-dependence. Hence, we validate the class of health state-dependent model against the monetary equivalent.

Now, assuming that a household is at risk of cancer mortality under a hypothetical scenario shown in Tables 6 and 7. The household would become indifferent towards switching the place when expected utility in the current location and expected utility in the new location become equal:

$$\begin{aligned} EU_{basline} &= EU_{Post-Treatment} \\ (1-s)U(Y) + sV(Y) &= (1-t)U(Y-c) + tV(Y-c) \end{aligned} \qquad \text{… (9)}$$

Here c is the willingness to pay ($WTP^{LR}$ *or* $WTP^{HR}$) for reduced cancer mortality risk, $s$ is baseline probability of cancer mortality in current location and $t$ is the probability of cancer mortality in new location $s>t$.

By Taylor's series linear approximation, we get:

$$c = \frac{(s-t)[U(Y)-V(Y)]}{(1-t)U\prime(Y)+tV\prime(Y)} \qquad \text{… (10)}$$

Now, assuming $U(Y) = \ln(y)$ *and* $V(Y) = \alpha\ln(y)$ and substituting it in Equation (10), we get;

$$c = \frac{(s-t)\ln(y)(1-\alpha)y}{(1-t)+\alpha t} \qquad \text{… (11)}$$

Our interest lies in the value of $\alpha$. If $0 < \alpha < 1$ (condition {ii}) it implies the severe health state reduces the marginal utility of income. This result is interesting because if we divide both sides of Equation (11) by ($s$-$t$), we would get the value of $c/(s\text{-}t)$, which is a standard formula for calculating the value of statistical life (VSL).

To account for the average influence of WTP we adjust equation (11) as follows:

$$c = \gamma + \frac{(s-t)\ln(y)(1-\alpha)y}{(1-t)+\alpha t} \quad \text{... (12)}$$

Given the values of $s$, $t$, and $y$, the parameter $\alpha$ is estimated using the non-linear least square method (Gallant A R., 1975; Viscusi and Evans, 1990; 1998; Evans and Viscusi, 1993; Viscusi, 2019).

To compare how adverse health (cancer) affects the marginal utility between those who are at risk and those who are affected, we stressed a balanced hypothetical scenario to both groups. We first asked them whether they would like to relocate to a location B if the risk of cancer is reduced to 10 per cent (low-risk scenario) but with a higher cost of living. Subsequently, we repeat the same question but with a higher cancer risk, instead of risk-reducing to 10 per cent, we proposed reduction only to 50 per cent (high probability scenario) in a new location C. If the households preferred to switch, then we asked them about their maximum WTP, till they were indifferent and their expected utility in two locations were equal. Similarly, if the households opted to stay at current location A, we then incentivised them with a successive reduction in WTP till they preferred to switch their location.

***Risk-Income Trade-off: Case of Low-risk Scenarios***

*Imagine that your current location is A and also imagine that there is another location B where the risk factors of cancer are very less, as a result, the mortality risk due to cancer is close to negligible. However, the cost of living is high in location B. Would you like to relocate to location B with the higher cost of living? If yes, please denote the maximum monthly sum that you would be willing to pay:*

***Table 6: Risk-Income Trade-off*: Case of Low-risk Scenarios**

| | ***Current Location A*** | ***Location B*** |
|---|---|---|
| *Cost of Living (per year)* | *Same as your area* | *Rs x higher* |
| *Cancer Mortality Risk (per year)* | *100 Per 1 lakh* | *10 per 1 lakh* |

*If you have to live in one of these locations, which location, would you rather live in?*

1. *Location A*
2. *Location B*

***Risk-Income Trade-off: Case of High-risk Scenarios***

*Imagine that your current location is A and also imagine that there is another location C, where the risk factors of cancer are less, as a result, the mortality risk due to cancer is also low. However, the cost of living is relatively high in location C. Would you like to relocate to location C with the higher cost of living? If yes, please denote the maximum monthly sum that you would be willing to pay:*

**Table 7: Risk-Income Trade-off: Case of High-risk Scenarios**

| | ***Current Location A*** | ***Location C*** |
|---|---|---|
| *Cost of Living (per year)* | *Same as your Area* | *Rs x higher* |
| *Cancer Mortality Risk (per year)* | *100 Per 1 lakh* | *50 per 1 lakh* |

*If you have to live in one of these locations, which location, would you rather live in?*

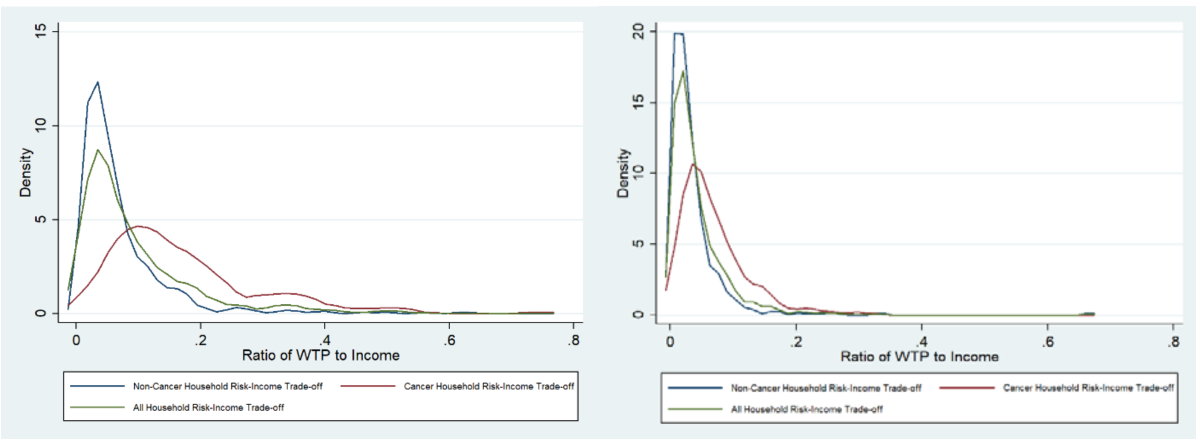
1. *Location A*
2. *Location C*

## 5.2. Risk-Income Trade-off

We observed a substantial difference in the proportion of WTP to income between the CA and NCA households in the respective scenarios (see figure 9: A and Figure B). In the low-risk scenario, the distribution of the CA households is spread more towards right, implying a higher willingness to sacrifice wealth for reduced mortality risk (i.e., from $100x10^{-5}$ to $10x10^{-5}$). In the high-risk scenario, the distribution of both the household groups is steep, indicating less willingness to sacrifice wealth for a relatively small cancer mortality risk reduction (i.e., from $100x10^{-5}$ to $50x10^{-5}$). In a low-risk scenario, CA households were willing to sacrifice 15-18 per cent of their monthly income while the NCA households were only willing to sacrifice 6-7 per cent of their monthly income, which is only one-third of the income share of the CA households. In the case of a high-risk scenario, the CA households were WTP 6-7 of their monthly income while the NCA households were WTP only 2-3 per cent of their monthly income (see Appendix: Table 9). The difference is not as stark as we found in the low-risk scenarios. It indicates that when the reduced risk of cancer is marginally small, households are less willing to switching places for the higher cost. This behaviour is also observed in earlier findings (Sloan, et al., 1998). Further, the change in the share of WTP from low risk to high risk indicates that the affected households are more sensitive towards mortality risk reduction as compared to the non-affected households. The difference in the trade-off is a reflection of health state-dependence and the opportunity cost of the respective groups.

**Figure 8: Kernel Density of Ratio of Willingness to Pay to Income for Low and High Probability Risk Scenario**

**A** **B**




*Source:* Author's calculations.

*Note:* A: Shows share of income household WTP for low Mortality Risk Scenario; B: shows share of income household WTP for high Mortality Risk Scenario.

## 5.3. Non-Linear Regression Analysis

The difference in WTP for cancer mortality risk reduction can be the due adverse impact of diseases and the opportunity cost that a household faces under health state-dependence. In a low-risk probability scenario, the estimated WTP by a CA household is Rs 200 per month while the estimated NCA households are WTP more than Rs 700 per month, on average, for reducing the risk of mortality. The difference in average WTP between a CA household and an NCA household is due to the fact that CA households are relatively from the lower income group. Overall, the average WTP for mortality risk reduction is slightly more than Rs 1018. Nevertheless, our main concern is the utility function parameter α. The value of α for CA is 0.3679 with confidence interval (0.2802 0.4557) while for NCA the value α is 0.8285 with confidence interval (0.7590 0.8979). The level of the marginal utility of CA individuals is about two-third less than in the good health state, while for NCA the level of marginal utility is somewhat one-fifth less than in the good health state. We subsequently check the consistency of results for high-risk probability scenarios. Along with low average WTP by both the CA and NCA households, the difference is also relatively less as compared to the low-risk probability scenario. Nevertheless, the average utility function parameter α is significantly less than 1 in both the low-risk and high-risk scenarios, which is consistent with cancer diminishing marginal utility.

**Table 8: Non-Linear Least Square Regression of WTP under State-dependence**

| | *Low-Risk Probability Scenario* | | | | | |
|---|---|---|---|---|---|---|
| | CA | CI | NCA | CI | All | CI |
| $\gamma$ | 218.33 (333.47) | [-439.49 876.16] | 719.56*** (104.28) | [514.68 924.42] | 1018.39*** (139.72) | [744.07 1292.72] |
| $\alpha$ | **0.3679*** (0.0444)** | **[0.2802 0.4557]** | **0.8285*** (0.0353)** | **[0.7590 0.8979]** | **0.7895*** (0.0475)** | **[0.6961 0.8830]** |
| *Observation* | 190 | | 528 | | 718 | |
| *Adj. R-Square* | 0.4849 | | 0.1486 | | 0.1044 | |
| | *High-Risk Probability Scenario* | | | | | |
| | CA | CI | NCA | CI | All | CI |
| $\gamma$ | 107.87 (147.80) | [-183.68 399.43] | 409.25*** (56.46) | [ 298.33 520.17] | 492.39*** (67.54) | [359.78 625.00] |
| $\alpha$ | **0.8851*** (0.027)** | **[0.8417 0.9286]** | **0.9864*** (0.005)** | **[0.9766 0.9961]** | **0.9815*** (0. .007)** | **[0.9679 0.9950]** |
| *Observation* | 190 | | 528 | | 718 | |
| *Adj. R-Square* | 0.439 | | 0.0654 | | 0.0679 | |

*Source:* Author's calculations.
*Note:* *p<0.05; **p<0.01; ***p<0.001; Standard Error is robust and is in parenthesis; CI: 95% Confidence interval;

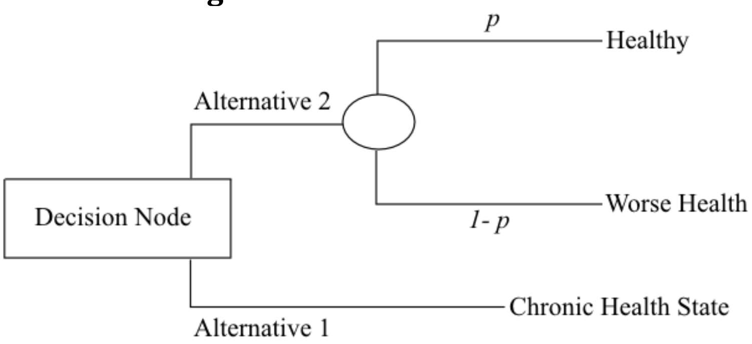
# Section 6

## 6.1. Risk-Risk Trade-off: Maximum Acceptable Risk Preference

In order to understand the risk preference under health state-dependence we also estimated the probability of maximum acceptable risk (MAR) for the complete remission of cancer. We asked the following question:

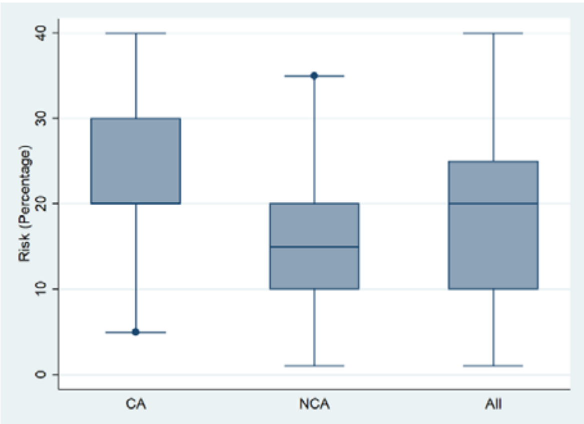
*Imagine you are in a state of ill health, and also imagine that there is a medicine that can either protect/cure you completely, or would cause worse health. What is the maximal probability for which you would accept this medicine?*

**Figure 9: Standard Gamble**




Similarly, there is considerable variation in response to a risk-risk question by the two groups. Figure 10 presents the Box and Whisker plot for MAR preference. The CA households, on an average, have a MAR preference of 22 per cent (20-30 per cent) while the NCA households, on an average, have a MAR preference of 15.26 per cent (10-20 per cent). The average difference in MAR preference between the two household groups is 6.74 per cent (see Appendix Table 10). This result is in contrast to the earlier findings (Sloan, et al., 1997). The NCA households are relatively more resistant to discounting their risk preference. It indicates that the experience of the adverse health effect of cancer has a transformative impact on the utility of individuals.

**Figure 10: Maximum Acceptable Mortality Risk Preference for Complete Cure from Cancer**




*Source*: Author's calculations.

*Note*: CA: Cancer Affected Households; NCA: Non-Cancer Affected Households; All: Combined Households; Risk; Maximum Acceptable risk Preference

# Section 7

## 7.1. Validity and Reliability of Estimates

The validity and reliability of the study depend on how key scenario elements of CVM are made understandable, meaningful, and plausible to respondents (Mitchell and Carson, 2013). To estimate the valuation of intangible health loss, utility function, and preference for prevention versus treatment, the hypothetical scenarios should be clear and coherent, and respondents, in prior, should be familiar with the diseases and the cost it entails. Therefore, before finalising the questionnaires, we conducted a pilot study to improve the language, CVM framework, context, and content to make it reasonably easy for the layman to understand. For the non-cancer affected households, we did a pictorial demonstration and showed videos of the selected cancers so that they could grasp the severity of the disease and the cost it involves. To check whether the respondents are reliable and are capable of following the instructions and answered the questions rationally, we have played a lottery with them. We expected a rational choice if they were cognitively capable. We hypothetically offered the individual a choice as to whether they would like to have a sure amount of Rs 5,000 or a higher amount of Rs 10,000 but with a 50 per cent chance of winning. Almost 92 per cent of the individuals preferred receiving a sure amount but when they were asked about the amount, they would like to trade off a sure amount with the risky lottery, the average was between Rs 38,948.75 and Rs 45,741.52. Similarly, 6 per cent of the individuals opted for the risky lottery but when they were offered a trade-off option with a slightly higher sure amount they eventually switched. On an average, the amount they demanded was Rs 7,320.28 – Rs 8,021.825. It is expected that most of the individuals would be risk-averse. The choice of the lottery differed based on how individuals perceive risk, but their demand for a trade-off was rationally consistent. The validity of the study would hold if the empirical results are theoretically consistent. One logic of the construct validation is to check whether the set of relevant predictor variables of the WTP show an appropriate size and sign, and are consistent with the expected theoretical association or not. If we look at important predictors like education and income, we would find that both factors positively influenced WTP. Thus, our results are consistent with the economic theory.

## 7.2. Conclusion

India is experiencing an exponential rise in the incidence as well as the mortality rate of cancer. A long morbidity period, along with highly expensive treatment episodes, significantly impacts households, particularly the vulnerable sections, in terms of high economic cost and productive life loss. In the absence of any effective social health security, more than 75 per cent of the CA households bear catastrophic health expenditure, reflecting the incompetency of the health policy. The main shortcoming of the public health care policy is that it is mostly oriented towards the supply side factor, which from a social welfare perspective, is sub-optimal when the demand side factors are not appropriately accounted for. Hence, investigating the health care preference of households while mitigating the risk of life-threatening diseases can be a valuable addition to the policy framework.

In this context, we attempt to investigate the valuation of health under state-dependence and the factors influencing it. We have used CVM to determine the valuation under hypothetical scenarios. The average WTP of a CA household for the complete remission of cancer is around Rs 2,600 per month for five years. The major factors influencing the WTP are co-morbidity, the number of years of education, income, and insurance coverage. In the extended CVM framework, we attempt to determine the curvature of the utility function under state-dependence. The policymaker should consider the CA households' ability to pay for treatment while making decision regarding the social security. Further, we find in a low-risk probability scenario, the marginal utility in a bad health state is two-thirds less than in the good health state for CA households, while it was only one-fifth less than in the good health state for NCA households, thereby indicating the transformative impact of severe health state on the utility function, which legitimizes the use of state-dependence model for assessing the large risk. The MAR preference is relatively higher for CA households, indicating the degree of desperation for the complete remission of cancer. The natural extensions of the study are to: (1). capture the possible role of risk misperception in the estimation of utility function; (2) determine whether there is heterogeneity due to socioeconomic factors in the utility function under state-dependence; and (3) assess if the finding holds true for other severe diseases.

Our results are theoretically consistent with economic literature. However, there are few criticisms of survey-based CVM method. It may be true that the WTP in a hypothetical scenario may be lower than the WTP in reality. The WTP determined in this context is not actual monetary value but realisation of satisfaction when paying (the so-called warm glow). The households that participated in the survey are mostly from the lower-to-middle income group, who are relatively more dependent on government subsidies, and may therefore be psychologically resistant to expensive medical treatment, and hence probably would have bid lower bound WTP. It might be also at the risk of "strategic bias" due to ongoing the COVID-19 pandemic and CAA+NRC issues. There are a few limitations of our study. We did not conduct any interview of people who were not included in the study. Medical experts excluded those patients whose diagnoses were not yet confirmed. Our survey is specific to gender in a specific region, and the results might not be generalisable to the entire country due to spatial heterogeneity in terms of socio-economic factors and social security coverage across the State. First, can we trust the results we get? Second, is there a valuation difference between those who are affected and those who are not? And if so, what section of the population should be targeted for policymaking? Third, does the WTP depend on socio-economic factors? And if so, how should it be incorporated in policy decisions?

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# Appendix

### Table 9: Proportion of Willingness to Pay to Monthly Household Income

| | ALL | CI | CA | CI | NCA | CI |
|---|---|---|---|---|---|---|
| **LOW PROBABILITY** | 0.0961 | [0.0882 0.1039] | 0.1698 | [0.1528 0.1868] | 0.0696*** | [0.0619 0.0771] |
| **HIGH PROBABILITY** | 0.0426 | [0.0390 0.0462] | 0.0684 | [0.0609 0.0758] | 0.0333*** | [0.0295 0.0370] |

*Source*: Authors' calculation.
*Note*: ***p<0.001

### Table 10: Maximum Acceptable Mortality Risk for complete cure from Cancer

| | CA | CI | NCA | CI | ALL | CI | T- TEST |
|---|---|---|---|---|---|---|---|
| **MAR** | 22.03 | [ 20.84 23.22] | 15.26 | [14.45 16.06] | 17.05 | [16.35 17.77] | **8.7376** |

*Source*: Author's calculations.
*Note:* The t-test is the significance mean difference between a variable under CA and NCA households.