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ESSAYS IN FORENSIC ECONOMICS: EXPLORING ISSUES OF LOST EARNINGS FROM PERSONAL INJURY AND WRONGFUL DEATH IN SOUTH AFRICA

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A thesis submitted to the School of Economics & Finance, Faculty of Commerce, Law and Management, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the Degree of Doctor of Philosophy in Economics.

SUPERVISOR:

Prof. Oluyele Akinkugbe

May 2025

DECLARATION

I, Joe Chirowodza, hereby declare that this thesis entitled “Essays in forensic economics: exploring issues of lost earnings from personal injury and wrongful death in South Africa” is my own work except where indicated or acknowledged. The thesis is being submitted for the degree of Doctor of Philosophy to the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Signed…….

Date: …23/05/2025…….

ABSTRACT

Economic loss estimates are fundamental in providing compensation to victims in personal injury or wrongful death cases. Such estimates, calculated by forensic economists assist judges and lawyers to make evidence-based decisions on civil litigation matters. In particular, lost earnings estimated for vulnerable groups in society can provide financial or quantifiable compensation vital for the sustainability of the victim or surviving family members. Yet, there is an inadequate evaluation of personal injury and wrongful death cases in the South African courts, due to challenges, such as insufficient resources, expertise, and court procedural delays. In addition, this has led to the inaccurate assessment of civil litigation cases in the country. The impact is devastating, especially to vulnerable groups, who may rely on the court systems to provide fair and reliable economic loss estimates.

The thesis estimates work life expectancies for four labour states and future lost earnings for workers in formal and informal employment in South Africa, with the use of the National Income Dynamics Survey (NIDS) dataset from 2008 to 2017. Work life expectancies were estimated using the Stochastic Markov-chain transition model whilst future lost earnings were estimated the using Benham-La Croix present value formulae. Work life expectancies are an essential component for estimating future lost earnings. The results showed that male and female workers who are in formal employment have higher work life expectancies and greater future lost earnings, when compared to male and female workers in the informal sector. Furthermore, the results revealed that informal employment is an important sector for women because they had longer work life durations, when compared to men. However, future lost earnings for women remain lower in the informal sector as compared to future lost earnings for men. The thesis showed the presence of racial disparities in the labour market—White population had the highest work life expectancies and future lost earnings as compared to the Black, Coloured and Asian/Indian populations in the formal sector. There is a need for policy makers to legislate specific policies that especially integrate women into the formal labour market, such as policies that create a sustainable work-life balance, such as subsidising child care activities or programmes to incentivise women to participate in the formal labour force. In addition, there is a need for the government to provide regulations and social protection to informal workers as well as promote skills development programmes for minority groups and anti-discriminatory policies in the work place.

The thesis estimates personal consumption rates in wrongful death in South Africa for single female parents' households using a method known as Krueger's expenditure allocation approach. Personal consumption rates are important in estimating compensation in wrongful death for households as the proportion of income which is consumed by the deceased is removed from household income. The remaining income is then awarded as compensation to the surviving family members. For this analysis, the thesis used wave 5 data from the NIDS dataset. The results showed that as household income increases, personal consumption rates (PCRs) for a single female parent with one child and a single female parent with two children decrease. Furthermore, the thesis found that personal consumption rates for single female parents with one child were higher, as compared to personal consumption rates for single female parents with two children. The results also show that there were substantial differences in the personal consumption rates for low, middle, and high-income groups. There is a need for the government to provide more financial support programmes to assist single female parents, in particular, to sustain their families when they are alive or even when they wrongfully die.

To understand the compensation which could be awarded to minor children in case of wrongful death or injury, the thesis estimated educational probabilities and expected lifetime earnings for minor children in South Africa. The study used an ordered probit model with cluster robust standard errors together with the educational-probability -weighted lifetime earnings model to estimate educational probabilities and expected lifetime earnings. In addition, the study used the child dataset section of the NIDS for wave 1 and wave 5. The results of the study showed that on average, children in South Africa are more likely to achieve lower educational levels, such as high school education, as compared to achieving higher levels of education, such as an honours degree or higher. Furthermore, the results showed that male and female White children are more likely to have the uppermost expected life time earnings, as compared to the expected life time earnings of children of other races for all family structures. These results imply the urgent need for government intervention in subsidising education even at higher educational levels. In addition, there is also a need for government to embark on social and economic programmes that will reducing the systemic and intergenerational income inequality in the country.

In conclusion, forensic economics estimates provide a platform towards compensation for personal injury and wrongful death cases. This thesis provides new insights into compensation estimates, given the current limited scope of this area in developing countries and in South

Africa. Such economic loss estimates can prove to be vital for compensation especially to the vulnerable groups in society. The methodologies and estimates in the study may also assist the court systems to improve efficiency in civil litigation matters that involve personal injury and wrongful death cases.

DEDICATION

I dedicate this thesis to my mother, sister and my brother who have supported me in this journey. Thank you so much for believing in me.

ACKNOWLEDGEMENTS

"*The Lord is my strength and my shield; in him my heart trusts, and I am helped; my heart exults, and with my song I give thanks to him*"

Psalm 28:7

Firstly, I would like to thank my supervisor, Professor Oluyele Akinkugbe, for his wisdom, guidance and comments which assisted in the designing of this thesis. I owe him a debt of gratitude which I am unable to repay. My supervisor helped me to think outside the box in addressing my thesis's research questions. I thank my supervisor for all his advice and support in moulding me to become a forensic economic researcher. May God bless my supervisor in his future endeavours.

Secondly, I would like to thank my mother, sister and brother who have supported my education and development. I would like to thank them for always being there for me to listen to and to give me advice. I thank them for all the sacrifices which they have made for me to do my PhD studies. In challenging times, they have been there for me and have given me the strength to complete my studies. They are wonderful guys. I will always be grateful to them!

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LIST OF ABBREVIATIONS

APC	Average Propensity to Consume
BLS	Bureau of Labour Statistics
CES	Consumer Expenditure Survey
COVID-19	Corona Virus of 2019
CPS	Current Population Survey
CSM	Continuing Sample Members
GDP	Gross Domestic Product
GEM	Girls' Education Movement
IEJ	Institute of Economic Justice
ILO	International Labour Organisation
MPC	Marginal Propensity to Consume
NAFE	National Association of Forensic Economics
NIDS	National Income Dynamics Survey
NLSY	National Longitudinal Survey of the Youth
OECD	Organisation for Economic Cooperation and Development
PCRs	Personal Consumption Rates
PIH	Permanent Income Hypothesis
SALDRU	Southern Africa Labour and Development Research Unit
SAPS	South African Police Services
SARB	South African Reserve Bank
SHS	Survey of Household Spending
TSM	Temporary Sample Members
UN Women	United Nations Women
UN	United Nations
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNICEF	United Nations Children Fund
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

The foray of economics in the field of tort or civil litigation has grown over the past two decades as it offers theory and methodology for cases of economic damages (Thornton &Ward, 1999). Tort litigation aims at solving court cases involving a plaintiff's claim of personal injury or wrongful death caused by another person (Galligan et al., 2007; Lewis, 2019). Furthermore, Johnson (2015) highlights that tort, as interpreted in law, involves civil lawsuits due to negligence by one party that may include personal injury cases, product liability cases, medical malpractice cases, invasion of privacy cases and wrongful death cases, to mention a few.

Similarly, the growth of industrialisation and international trade in various countries meant the rise of risk and harm on factory floors, which also led to cases of people suing other parties for civil wrongdoing. Furthermore, the rise in tort cases and the complexity of the issues led to the rise of forensic economists assisting lawyers in the calculation of economic damages (Thornton &Ward, 1999).

Forensic economics is a sub-discipline in economics that applies theory and empirical methodologies to civil litigation matters (Tinari, 2016). More specifically, forensic economics can be defined as an economics field that deals with the calculation and analysis of economic and non-economic damages as well as civil litigation liabilities (National Association of Forensic Economics [NAFE], 2024; Tinari, 2016). According to Schap (2010), forensic economics is prominent in personal injury and wrongful death cases as compared to other civil legal matters.

In addition, forensic economics can be understood as a field dedicated to determining facts and underlying court cases at any law enforcement stage (Broulik, 2019). Furthermore, forensic economics allows economic analysis to inform legal issue matters. Zitzewitz (2012) highlights that forensic economics aims at unlocking covert behaviour carried out by economic agents. The subject area aims at generating evidence of behaviour as well as researching and quantifying such behaviour in order to influence decision-making by the courts.

Estimations in forensic economics have been done mostly in Western countries, such as the USA, the United Kingdom, Canada and New Zealand (Tinari, 2016). Forensic economic calculations have not yet been fully explored, organised, or well documented in developing countries, such as Africa in particular, although countries in this region have different civil laws which are determined by their socio-economic environment. Yet, forensic economic calculations provide important economic loss estimates for the retribution of personal injury or wrongful death in civil litigation cases. South Africa, as well as other African countries, utilises civil laws, which are used in the solving of civil court cases. In South Africa, civil law litigation falls under the South African Procedural Law (Van Loggerenberg, 2016). However, forensic economics estimations are not yet fully practised in the judicial systems of South Africa and serious research is needed to discern fair and accurate estimations.

South Africa has a distinctive legal system which combines English common law with Roman-Dutch civilian law and customary law (Lutchman, 2018). Designing forensic economic estimates which are tailored to this unique legal system will provide nuanced results. These may be overlooked by estimates from advanced countries which have different legal systems. In addition, South Africa's historic economic injustices from the apartheid period have yielded intergenerational consequences across different demographic groups, hence analysis that utilises the country's specific data will provide compensation estimates that reflect this peculiar socio-economic environment.

Moreover, the country has vulnerable groups which work and live in dire situations which exacerbate poverty. Vulnerable groups make up a significant percentage of the population in South Africa (StatsSA, 2011). These groups will be explained in more detail hereunder in this thesis. In addition, defenceless groups have characteristics, such as low household per capita incomes and living below the poverty datum lines (Vogel et al., 2021). Such helpless groups are likely to experience challenges in terms of accessing compensation, as a result of an injury or wrongful death caused by the negligence of another person or entity. This is because such weak groups may lack the resources and capacity to file for compensation. At the same time, the legal structures and processes in the country may be deficient in adequate infrastructure and expertise to provide judicious compensation to these susceptible groups.

Our thesis will include three vulnerable groups as part of our analysis for the estimation of lost earnings. These three susceptible groups consist of informal workers in the labour market, single female parents' households, and minor children in South Africa. Informal workers have

reduced access to finance and social protection (Pazarbasioglu & Devarajan, 2022). In addition, it has been well-documented that households who are headed by single female parents face high levels of poverty, discrimination and inequality (Chant, 2007; Zhang et al., 2024). Furthermore, minor children in developing countries are vulnerable as they have inadequate access to health care services, insufficient nutrition and a mediocre quality of education (Organisation for Economic Cooperation and Development [OECD], 2019).

Unfortunately, such vulnerable groups are not excluded from harm or wrongful death which could happen in any circumstances. Without proper estimates which could award compensation to these vulnerable groups in cases where there are injuries or wrongful deaths, the consequences would likely lead to considerable future harm and development as well as an increase in intergenerational vulnerability and poverty. Disability or mortality as a result of injuries sustained has disproportionate negative impacts on vulnerable groups of society (Swahn et al., 2012).

1.1.1 Economic Losses

To provide for compensation in a case where there has been a personal injury or wrongful death scenario, economic loss estimates must be calculated by forensic economists. Economic losses represent quantifiable financial consequences of a wrongful injury or death. In forensic economics, economic losses are also known as "economic damages". According to expert researchers, economic losses, which are commonly estimated in forensic economics, include lost earnings, lost earnings capacity, medical expenses, lost household services and lost enjoyment of life (DiGabriele & Lohrey, 2016). In the modern day, in case of a wrongful death scenario, personal consumption estimates are deducted from the possible compensation which could be awarded to the surviving household members (DiGabriele & Lohrey, 2016). Besides providing estimates which will be used for future wrongful injury or death cases, these economic loss results are valuable because they can be used to make comparisons and determine implications with actual civil law cases, which may occur in courts, as well as determining the implications of tort reforms (Thorton, 2009).

In this thesis, we concentrate on estimating lost earnings which result from personal injury or wrongful death. Lost earnings are comprised of claims of an amount which is based on particular income levels. They may be comprised of future lost earnings for workers and expected lifetime earnings for minor children in South Africa (Mills, 2014). In addition, we

estimate the rate of consumption relative to household income which would have been consumed by the deceased (personal consumption rates). These personal consumption rates are removed from household income to serve as compensation to the surviving family members in case the head of the household dies. Estimating lost earnings is important because it reveals the compensation that an injured individual would have earned if he or she was not injured. In addition, lost earnings show the financial support which is needed to be awarded to survivors of the deceased in case of a wrongful death scenario. The ordinary individual is not equipped to make estimates of fair and just compensation. Hence, it is the task of forensic economists to perform this important function.

1.1.2 Personal Injury and Wrongful Death

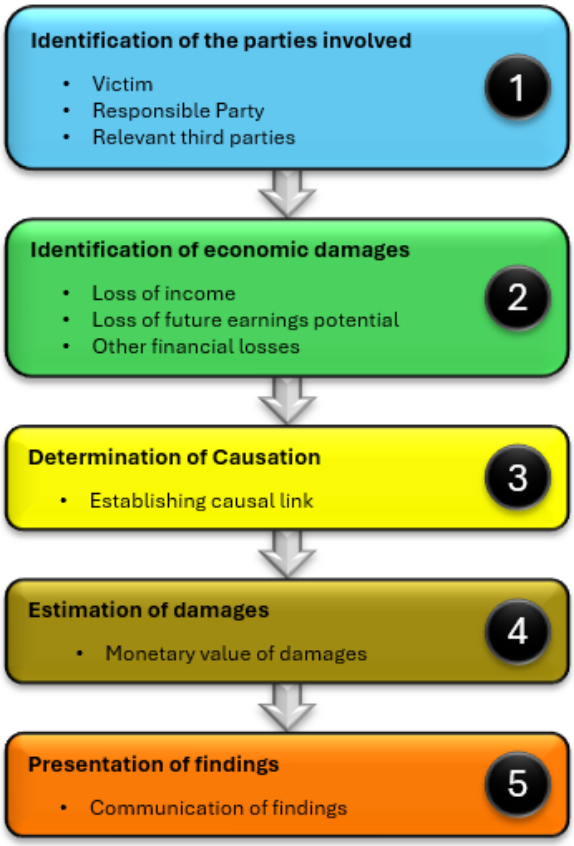
Personal injury refers to harm or pain inflicted on an individual due to another person's negligence (Swartz, 2024). Personal injury may consist of physical injuries or psychological trauma and may come from incidents, such as road accidents, workplace accidents and medical malpractices. Personal injury can disable or diminish an individual's ability to carry out economic activities. Personal injury per se is not measured in forensic economics. This may be left for the medical field. However, what is measured in forensic economics is the economic losses which occur as a result of personal injury. The estimates that quantify economic loss, as a result of personal injury, include lost earnings, lost earning capacity, future and past medical expenses, and lost household services.

By contrast, wrongful death refers to the death of an individual, which was not due to natural causes but rather, was due to the negligence of another person (Trout & Foster, 1993). Wrongful death leads to economic losses that are experienced by the surviving family members. These economic losses could be measured through quantifiable estimates, such as lost earnings, lost earning capacity, future and past medical expenses and lost household services. These quantifiable estimates provide a basis for compensation to the surviving relatives. The exact amount of the compensation is the challenge that legal practitioners face.

1.1.3 Conceptual Framework of Forensic Economics

A conceptual framework for analysing personal injury and wrongful death cases in forensic economics consists of the elements shown in Figure 1.1.

Figure 1.1: Conceptual framework of Forensic Economics



Source: Author's conceptualisation

Firstly, a forensic economist needs to identify the victim in the case, the responsible parties who caused the injury or death (this can be a defendant in a lawsuit case) and any other relevant third parties who may be involved in the case, such as government agencies and insurance companies. Secondly, the forensic economist needs to undertake a detailed analysis of the economic impact of personal injury and wrongful death on the victim and associated family members. Economic losses analysed include lost earnings (or loss of income), loss of potential future earnings and other financial losses.

Thirdly, the forensic economist needs to determine the causal link between the defendant's actions or omissions with the victim's potential economic damages or losses. Fourthly, the forensic economist will need to estimate these economic losses using analytical techniques, such as economic modelling, present value calculations and statistical analysis. Lastly, the forensic economist will present the findings of the estimates in court, to judges, lawyers or any other relevant stakeholders

a. Modelling

In forensic economics, there is no single best modelling technique for estimating economic damages, as this will depend on specific circumstances and data availability. Forensic economics uses a combination of modelling techniques to ascertain the required estimates. Some of the common modelling techniques used in forensic economics include the following:

- Regression analysis- this is a statistical technique which can be used to predict economic losses that can result from different economic damage scenarios. The technique can also be used to show the relationship of different demographic factors, such as age, gender, education and income with economic damages, which result from personal injury and wrongful death scenarios. Regressions are run in software such as Stata and R with an output of beta coefficients and conditional probabilities.
- Life care planning- This is a comprehensive approach to estimating economic damages which involves coming up with a detailed plan of an individual's personal care and future medical needs. The approach is more common in estimating personal injury estimates and costs which result in long-term disabilities.
- Markov Chain models- These models are used to estimate transitional probabilities which will then be used to estimate work-life expectancies and economic losses.
- Cost of illness models- This approach involves estimating direct and indirect medical costs which can be associated with an illness or injury.
- Decision Analysis-This approach involves developing a decision tree that considers the different possible outcomes of a particular decision as well as estimating the associated benefits and costs of each outcome.

1.1.3.1 Markov Chain Model and Mathematical Modelling

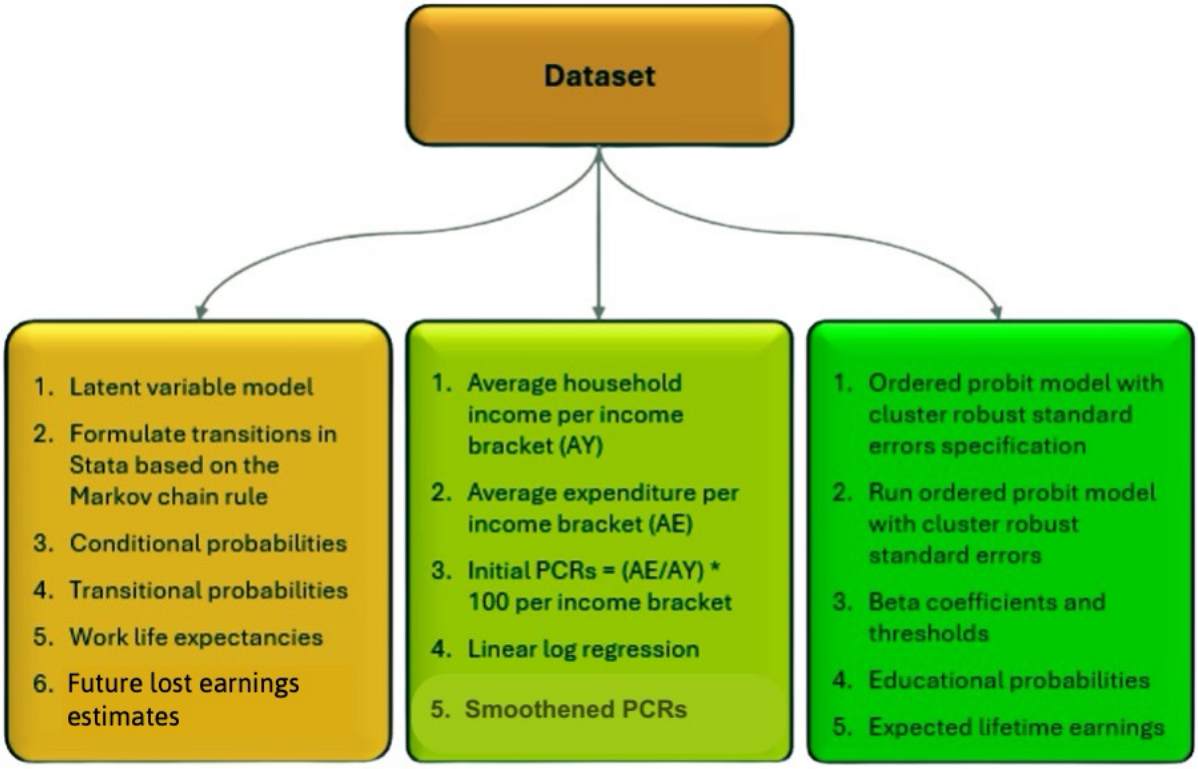
In Chapter Two of our thesis, we use the Markov chain model, which is a dynamic approach to estimating transitions and transitional probabilities of four labour states. Our four labour states are formal employment, informal employment, unemployment and being economically inactive. In other words, the Markov chain model creates transitions between our four labour states and provides the likelihood of an individual moving from one state to another. Such transitions and transitional probabilities provide the basis for estimating work-life expectancies.

Therefore, in Chapter Two, besides the use of regressions, we also use Markov modelling to create or generate transitions and transitional probabilities. We also use mathematical techniques or modelling when estimating future lost earnings using the present value formula. The present value calculation accounts for the time value of money and estimates the current value of future income and financial benefits that the deceased would have provided to their dependents. Our Chapter Three concerns personal consumption rates in wrongful deaths and Chapter Four concerns educational attainment probabilities and expected lifetime earnings for South African minors. These chapters explain the use of a combination of regression modelling and other methods like adding and averaging estimates. Detailed processes are provided in the respective chapters.

1.1.4 Conceptual Framework for this Study

A more specific and focused conceptual framework for this study is presented in Figure 1.2. The conceptual framework highlights the analysis undertaken in the three papers of our thesis. The conceptual framework also shows the dataset used and the processes followed to arrive at the estimates for each chapter. The concepts discussed above are all embedded in Figure 1.2.

Figure 1.2: Conceptual framework of the thesis



Source: Author's conceptualisation

We provide detailed explanations and illustrations of the methodologies in our respective chapters. However, in summary, Chapter Two is described by the first column (box) showing six stages. Using South Africa's National Income Dynamics Study (NIDS) dataset, Chapter Two uses a latent variable model in regression and formulates transitions of the four labour states. The formulation of transitions is according to the Markov chain rule. Since there are four states, 16 transitions are formulated and regressed using the multinomial probit model to arrive at the conditional probabilities. To obtain these transitional probabilities, conditional probabilities are averaged per age group. The transitional probabilities are then used to estimate work-life expectancies through a recursive process implemented first by Millimet et al., (2003) where we start at period T+1 which is the terminal age where no one is employed, and moving backwards. In other words, we start to calculate work life expectancies from the oldest age, where no one is assumed to be working, and going backwards to the younger ages. As mentioned, we adopt the Millimet et al., (2003) methodology of calculating work life expectancies from 86 years going backwards to age 16. However, at a later stage of the process,

age is trimmed to have work-life expectancies within the range of the working age groups, common in many labour markets—from 16 to 65 years. Work-life expectancies are used to calculate future lost earnings estimates using a widely accepted methodology formulated by (Lewis et al., 2003).

Column 2, which depicts Chapter Three, shows that we use our dataset to estimate the average household income for five income brackets which we formulate based on the household income data available in the broader NIDS dataset. We also calculate the average expenditures per income bracket. These average expenditures are further analysed using expenditure allocation rules, which are discussed further in the paper. The average expenditures are divided by the average household incomes to arrive at the initial personal consumption rates (PCRs) for the five income brackets. We then run a linear log regression for the five household incomes and five initial PCRs, to produce coefficients which are the constant and beta coefficients later used to estimate specific PCRs over specific household income levels from R100 000 – R3500 000. The PCRs estimated are known as smoothened PCRs.

Column Three, which is a summary of the contents of Chapter Four, shows that NIDS data is used to estimate an ordered probit model with cluster robust standard errors. The regression results are beta coefficients and theta estimates. The theta estimates are known as thresholds because the dependent variable is a dummy variable which takes a binary value for each educational level. These beta coefficients and thresholds are used to estimate educational probabilities using the cumulative density function in Excel. The educational probabilities estimated are later used together with median earnings to estimate expected lifetime earnings for a minor child using a formula first used by Spizman and Kane (1992), and was later modified by Kane et al., (2010).

1.2 PROBLEM STATEMENT

The role of civil litigation in courts offers a platform for cooperation and mediation between two or more parties to arrive at an arrangement for solving issues of personal injury and wrongful death cases. Furthermore, wrongful injury and death cases may include but are not limited to the following: road accidents, medical malpractice, and workplace accidents or illness (Witt, 2000). Such cooperation and mediation in civil courts are important as two parties may have challenges in resolving the dispute privately. OECD (2013b), highlighted that the

judicial system is important to maintain certain social values, protect property rights as well as enforce social contracts.

The South African Civil Procedural law provides important parameters by which courts need to abide, in order to fairly address cases of personal injury and of wrongful death. The magistrate courts, the high court, as well as the supreme court of appeal, handle civil procedure cases in South Africa. The courts in South Africa are independent and act under the South African constitution to provide fair justice and compensation to the involved victims. Van der Westhuizen (2008), highlighted that after South Africa's independence in 1994, the judicial system became independent and is mandated to be fair and act impartially in solving court cases.

It can be noted that civil litigation matters are very important in South Africa, and yet, the courts, which deal with civil law matters, face impediments that more often than not, make it difficult to achieve desirable outcomes. Greenbaum (2020) indicated that poverty and equity challenges in South Africa give a diminishing condition for South African citizens to access litigation services in courts, as there is a lack of capacity and knowledge of the legal system. Furthermore, Van Loggernberg and Boraine (2016), highlighted that South Africa faces challenges in making access to courts cost-efficient and attainable to vulnerable groups of society that include minor children and women who cannot usually afford these expensive court cases.

In addition, the civil courts in South Africa face several procedural delays, limited resources as well as outdated civil procedural laws, which govern the conduct in civil courts (Van Loggernberg & Boraine, 2016). This is also indicative of the position and status quo of civil courts in South Africa. Furthermore, the OECD (2013) highlighted that these trials, which took a long time to solve, as reflected in many countries including South Africa, reduced people's confidence in the judicial system.

As the country faces such impediments, it is a sad reality that the number of personal injury cases and wrongful death cases that remain either unattended or unresolved are likely to grow in the current and future periods. Shung-King et al., (2019), report that over 8 000 children in South Africa die each year due to injuries caused by household members or other unrelated people. Furthermore, Van Vuuren (2021), highlights that South Africa owned eight out of the ten biggest mines in the world. Mining is one of the most hazardous sectors in the world which

can cause workers to end up having chronic diseases, such as cancer and respiratory diseases such as silicosis (Neelakanti & Sriramula, 2019; Stephens & Ahern, 2001).

A notable case in this regard is that of a road tanker, carrying gas, that exploded in the residential area of Boksburg, Gauteng in December 2022. The explosion resulted in 41 fatalities and another 40 people seriously injured. The driver and the company that owns the road tanker were cleared by the courts of any criminal wrongdoing. However, the surviving families of the victims are yet to be compensated by the government or the driver's company for personal injury or wrongful death which occurred as a result of the explosion (Chironda, 2023). This example highlights the unexpected tragedies which can occur at any time and the dire need for compensatory practices to be in place.

Hence, it can be asserted that with the overwhelming cases of personal injury and wrongful death that remain in limbo, there is an inadequate evaluation of the magnitude and estimates of personal injury and wrongful death which the South African civil courts continue to contend with. The inadequate evaluation of these personal injuries and wrongful death cases results in individuals having less confidence in the country's judicial system—households are less likely to bring cases to the courts due to a lack of trust and confidence in the judicial system (Boateng & Makin, 2016; Dugard, 2006).

In addition, insufficient evaluation of personal injury cases and wrongful death cases can result in an incorrect assessment of these court cases by judges as well as lawyers, resulting in victims being granted unfair compensation. Unsatisfactory evaluation of these cases can also cause further delays in civil court proceedings and other instances lead to unresolved cases. Gloppen and Kanyongolo (2007), indicate that the lack of adequate legal protection for susceptible groups by the courts has the potential of manufacturing as well as re-manufacturing poverty. The impact can be severe, especially if the civil cases involve defenceless groups who need to be compensated, such as informal workers, single female parents with children and minor children themselves. These vulnerable groups may need to rely on the economic loss estimates and the court system in general for compensation, survival and sustainability of themselves and their families. Therefore inadequate evaluation of such civil cases can prove to be consequential, especially to these helpless groups.

1.3 RESEARCH OBJECTIVES

The study builds upon the notion that there is a deficient evaluation of the magnitude and estimates of personal injury and wrongful death cases, which are being handled by the South African civil courts. Hence, this study is an exploratory attempt at approximating lost earnings from personal injury and wrongful death.

The specific objectives of the study are to:

- Provide an exploratory estimation of work-life expectancies across labour market states and future lost earnings in formal and informal employment in South Africa.
- Predict and examine personal consumption rates in wrongful death in South Africa for single parents with one child and single parents with two children.
- Estimate educational attainment probabilities and expected lifetime earnings for South African minor children.

1.3.1 Research Questions

Deriving from the three research objectives, the following constitute research questions that are attended to under three major chapters of our thesis:

Chapter Two

- What are the estimates of work-life expectancies in formal and informal employment?
- How does the length of working life differ by gender, education and race within and across formal and informal employment?
- What are the estimates of future lost earnings and how do they vary within and across formal and informal employment?

Chapter Three

- What are the personal consumption rates for single female parents with one child and single female parents with two children in South Africa?
- How does household income influence the difference in personal consumption rates between single female parents with one child and single female parents with two children in South Africa?

- What is the effect size of the difference between personal consumption rates within single female-parent households and between different income groups of single female-parent households?

Chapter Four

- What are the educational probabilities and expected lifetime earnings for minor children in South Africa?
- What are the gender and racial disparities in expected lifetime earnings between different gender and population groups of minor children in South Africa?
- What are the differences in educational probabilities and expected lifetime earnings for minor children in South Africa, living under different family structures?

1.4 SIGNIFICANCE OF THE STUDY

Early research into forensic economic estimations has come from institutions and economists in the developed world. The early pioneers of forensic economic concepts and estimations also come from advanced countries and include the United States Bureau of Labour Statistics which estimated work-life expectancies, (Spizman and Kane, 1992) who developed and estimated educational probabilities and expected lifetime earnings, as well as from Patton and Nelson (1991) who estimated personal consumption rates. Other researchers, such as Millimet et al. (2010), Butt et al. (2008), Krueger (2014), Brown (2012), Spizman and Kane (2020) have carried out research in trying to understand some of the socioeconomic dynamics which affect forensic economics' estimates. Essentially, this has enlightened developed countries' understanding of how to work toward providing sustainable compensation to the injured and survivors in cases where there are personal injuries or wrongful death situations. Our thesis adds to the literature on forensic economics by providing estimates for compensation which are relevant to South Africa. Our study is valuable because it is more relevant to local conditions than overseas research and our thesis uses the South African dataset to estimate work life expectancies, future lost earnings estimates, personal consumption rates, educational probabilities and expected life-time earnings. These all reflect the country's current socio-economic environment.

The thesis focuses on forensic economic estimates for informal sector employees, female-headed households, and minor children. These are classified as the vulnerable groups in South Africa who face peculiar socioeconomic challenges, which need to be accounted for in forensic

economic valuations. In addition, although there have been a few studies on economic loss estimates for minor children (Spizman & Kane, 1992; Kane et al., 2010; Spizman, 2016) in general, these three distinct vulnerable groups have been underrepresented in conventional forensic economics estimates.

The unique labour markets in developing countries include a rather large informal sector. Therefore, the need to calculate and analyse work life expectancy and future lost earnings estimates for workers engaged in the informal sector. This is vitally important in the South African context, as against developed market economies, where the informal sector is usually much smaller and of less significance. Earlier researchers, such as Millimet (2003), Butt et al. (2008) only estimated work-life expectancies and future income loss estimates in formal employment. Our thesis provides work life expectancies and future income loss estimates for both the formal and informal sectors to understand the variations, differences and similarities in estimates, given the dual nature of the South African labour market.

Africa still grapples with high levels of extreme poverty as compared to other regions (McLachlan & Aikins, 2022). Hence, research needs to be focused on vulnerable groups or households in Africa if efforts aimed at poverty reduction are to yield desired results. In South Africa in particular, our thesis provides estimates of personal consumption rates for single females-parents with one or more children- to show the level of compensation which could be awarded to children who may become survivors in situations where the female parent is involved in a wrongful death. Female-headed households are a vulnerable family structure in South African society and are usually at the risk of high levels of poverty. Estimating the personal consumption rates of this family structure provides an avenue for investigating the level of welfare support that may need to be provided for such households. The aim would be to limit unfair compensation and intergenerational poverty. Some studies have been undertaken on the estimation of personal consumption rates, particularly for households with a nucleus setup of both a husband and wife (Patton & Nelson, 1991; Ajwa et al., 2000; Brown, 2012). Existing research is limited, and therefore our thesis contributes to the existing limited literature on personal consumption rates, with particular estimations for single female parents with one child and single female parents with two children.

Reducing and ending child mortality in the world continues to be a challenge as millions of children continue to die due to preventable diseases and accidents every year (UNICEF, 2024b). Injuries and violence are the leading causes of child mortality in South Africa (Van

Niekerk & Matthews, 2019). In this regard, our thesis estimates educational probabilities and expected lifetime earnings for minor children in South Africa. It is important to analyse and quantify the potential, which could have been reached by minor children had it not been for the occurrence of a personal injury and wrongful death scenario. This may assist the judicial system in providing compensation estimates which will need to be paid by the perpetrator of the crime to the relatives or survivors of the child. The growing literature on compensation for minor children includes the work of Spizman and Kane (2020), Kane et al. (2010) Christensen (2020), just to mention a few. Hence, our study adds to this literature by estimating educational probabilities and expected lifetime earnings for minor children in South Africa.

South Africa is one of the most unequal countries in the world (World Bank, 2022). Estimates for compensation on personal injury and wrongful death scenarios also need to consider the inequality dynamics which exist in the country. Consequently, our thesis estimates specific forensic economic estimates which are extremely important for our people. These estimates include: work-life expectancies, future income loss estimates, educational probabilities and expected lifetime earnings considering gender wage disparities, income disparities and existing racial disparities. We provide estimates based on gender, educational level and population groups in South Africa. Understanding compensation estimates based on these factors may facilitate the government and the private sector to institute measures that will improve the economic welfare of deprived genders, income groups or racial groups. A few studies in forensic economics have provided distinct compensation estimates for different social and economic groups (Millimet et al., 2003; Spizman & Kane, 2020a; Tinari, 2016). In this regard, we expand upon existing literature by providing distinct compensation estimates of different gender and population groups in the country. In South Africa, in particular, there are four population groups which are Blacks, Whites, Coloureds and Asians/Indians, of which estimates from previous forensic economic studies have not provided collective estimates for these dynamic population groups.

The thesis employs the Stochastic Markov Chain Transition model and the Benham-La Croix present value formula for estimating work-life expectancies and future lost earnings in Chapter 2. The Stochastic Markov Chain Transition model captures the dynamic and probabilistic nature of participation in the labour force. Work-life expectancies estimated by earlier researchers used fixed, static life tables that provided a deterministic measure of work-life expectancies. The life tables do not seem to fully capture the dynamic nature of work-force

engagements, especially the movement between different states of labour over some time (Krueger & Slesnick, 2014). The Markov model addresses this by estimating transitions between different labour states as a stochastic process. Furthermore, the Benham-La Croix formula incorporates the use of discount rates and growth rates when estimating future lost earnings. This is different from traditional discounting methods in forensic economics which apply uniform discount rates to future values but do not take into consideration productivity growth that has an effect on the growth of wages over time (Ireland, 2010). Other future lost earnings methods earlier employed, such as the "Total offset Method" also do not fully account for the differences between growth rates and discount rates (Smith, 2019).

In addition, the thesis estimates personal consumption rates in Chapter 3 using the Krueger expenditure allocation rules approach due to its economic sophistication and empirical foundation. The approach takes into consideration how consumption patterns across income levels change or vary. The approach also accounts for economic theory on the economies of scale and shared household expenditures (Krueger, 2014). Other estimations of personal consumption rates have used the Patton-Nelson tables which provide consumption rates based on the size of the family and income brackets. However, this method does not fully account for economies of scale within households. This is refined and corrected with the use of Krueger's approach.

The thesis estimates educational probabilities and expected lifetime earnings for minor children in Chapter 4 using the Ordered Probit model with cluster robust standard errors together with the educational probability weighted earnings model. Standard errors which are not clustered produce underestimated results. Previous papers used the standard ordered probit model, that do not fully recognise that fact that observations may not be independent when estimating educational outcomes. Hence, this may lead to the underestimation of results. The ordered probit model with cluster robust standard errors corrects for dependency and provides more robust standard errors and valid statistical inferences. Furthermore, the educational probability-weighted earnings model incorporates uncertainty in future outcomes in education (Becker & Tomes, 1986). This model reduces the bias in the results from assigning deterministic outcomes in education. Other previous methods used assign a single expected educational outcome which is based on the characteristics of the parent (Spizman & Kane, 1992). Doing this tends to disregard the uncertainty element in educational outcomes and may result in biased compensation estimates. Previous studies also failed to capture heterogeneity in earnings'

trajectories in different educational categories. These are addressed by the educational probability weighted earnings model, employed in this thesis.

1.5 FINDINGS OF THE STUDY

In Chapter Two, we estimate work-life expectancies across four labour states as well as estimate future lost earnings for workers in formal and informal employment sectors in South Africa. Using the longitudinal dataset of the National Income Dynamics Survey (NIDS), we estimate sixteen labour transitions which reflect the movement of workers from one labour state to another throughout the longitudinal dataset from 2008 to 2017. Our initial four labour states are formal employment (FE), informal employment (IE), Unemployment (UNE) and economically inactive (ECONI). We estimate the sixteen transitions using a multinomial probit regression model to come up with conditional probabilities. The conditional probabilities represent the probability that, in the second period, an individual will be in a certain labour state given the initial labour state in the first period. We then calculate the average of the conditional probabilities per age group to obtain the transitional probabilities. Our transitional probabilities are per gender, per race and educational level. We then use a recursive process to estimate work-life expectancies for the four labour states which are categorised by gender, race and educational level. Chapter Two estimates future lost earnings estimates for formal and informal employment using a formula proposed by Benham and La Croix in 1992 (Lewis et al., 2003). Our result reveals that, for those who were formally employed, work-life expectancies for male workers were higher as compared to female workers for all races. This suggests the presence of occupational opportunities which were still biased towards men in the formal sector as compared to women. Furthermore, we find higher future lost earnings for male workers as compared to female workers for both formal and informal employment sectors. However, although women have higher work-life expectancies in informal employment, men have higher future lost earnings estimates in informal employment. This reveals the gender wage disparity which continues to exist in the South African labour market. In addition, the White population, both men and women, have higher work-life expectancies as compared to other races. This may reveal the continued existence of racial and income disparities in the labour market.

Chapter Three estimates personal consumption rates in wrongful death for single parents with one child and single parents with two children in South Africa. We utilise wave 5 for the NIDS dataset, looking particularly at the household and expenditure data. The paper first provides

expenditure allocation rules. These rules are meant to calculate expenditures per individual because expenditures are divisible and indivisible. The goal was to retain the expenditures incurred by the single female parent only. Average expenditures per income bracket is divided by the average household income per income bracket, to determine the initial personal consumption rates for the five household income brackets. The paper uses a linear-log regression to smoothen consumption and obtain specific personal consumption rates over the household income range of R100,000 to R3,500,000. The chapter finds that as household income increases, the personal consumption rates for both single female parents with one child and single female parents with two children decrease, hence revealing the concept of average propensity to consume (APC). This suggests that as the income of households increases, savings and investment choices also rise. We find higher personal consumption rates for single female parents with one child as compared to personal consumption rates for single female parents with two children. This reveals the differences in consumption behaviours between the two single female parents. Single female parents with two children are likely to budget and channel resources more towards the welfare of their children as compared to single female parents with one child.

Chapter Four estimates educational probabilities and expected lifetime earnings for minor children in South Africa. Utilising child data for wave 1 and wave 5 of the NIDS dataset, we first estimate beta coefficients and threshold values for male and female children using the ordered probit model with cluster robust standards and robust errors. We then use these thresholds to estimate educational probabilities for five educational levels. The educational levels are as follows: for those with less than high school, those at high school, those with certificates and diplomas, those with Bachelor's degrees and those with an Honour's degree. We estimate educational probabilities categorised by gender, educational level and family structure. Our study utilises four-family structures. These are: children living with both parents, children living with a mother only, children living with a father only and children living without parents. Furthermore, using the Kane et al. (2010)'s formula, our educational probabilities and median earnings are calculated to estimate expected life-time earnings for children. The median earnings are calculated from the General Household Survey dataset of 2022. The chapter finds that, on average, children in South Africa, for all family structures, are more likely to achieve lower levels of education as compared to higher levels of education. This suggests the lack of educational resources for children in South Africa to learn and reach higher levels of education. In addition, male and female White children are more likely to achieve higher levels of

education as compared to other races, such as Black, Coloured and Asian/Indian. This suggests educational disparities, which exist in the educational sector in the country. Furthermore, the paper shows that male children of all races living with both parents are likely to have the highest expected lifetime earnings as compared to male children who live in other family structures. On the other hand, female children of all races who live without parents have the highest expected lifetime earnings as compared to other female children who live in other family structures. This suggests the importance of available resources and the need for mentorship for male children and the importance of extended family members in the growth of female children in South Africa.

1.6 SUMMARY

This chapter provides an overview of the importance of forensic economics in providing estimates of compensation in tort cases, especially to vulnerable population groups in society. Forensic economics analysis uses a combination of modelling techniques to calculate the relevant economic loss estimates. As revealed by the chapter, the importance of forensic economics assists the judicial system by estimating economic losses, which arise due to personal injury or wrongful death, as a result of the negligence of one party upon another.

In light of the above, our thesis is compartmentalised into three, interlinking chapters, which analyse, estimate, and address economic losses that may occur for vulnerable groups including informal workers, single female-parents and minor children. The rest of our thesis is as follows: Chapter Two conducts an exploratory estimation of work-life expectancies across labour states and future lost earnings in formal and informal employment in South Africa. Chapter Three estimates personal consumption rates in wrongful death in South Africa, while Chapter Four estimates educational probabilities and expected lifetime earnings for South African minor children. Chapter Five provides a summary of findings, implications and policy recommendations.

CHAPTER TWO

AN EXPLORATORY ESTIMATION OF WORK LIFE EXPECTANCIES ACROSS LABOUR MARKET STATES AND FUTURE LOST EARNINGS IN FORMAL AND INFORMAL EMPLOYMENT IN SOUTH AFRICA

2.1 INTRODUCTION

The employment status in sub-Saharan Africa is largely precarious, with 60 per cent of those employed in 2023 living under the international poverty line of US$ 3.65(approximately ZAR 67.53) per individual in purchasing power parity terms (Ananian et al., 2024). The dynamic labour markets of the region, coupled with shifting global geopolitics, and economic and health developments, have exacerbated future labour and financial insecurities, especially in cases of unforeseeable occupational injury or wrongful death of workers.

According to the International Labour Organisation (ILO,2023b), globally, 395 million workers had work-related injuries whilst 2.93 million workers died from workplace factors in 2019. Africa had the highest number of work-related deaths at 7.93 per cent the same year (ILO, 2023b). Understanding labour market projections and the future economic impact on formal and informal workers is crucial for policymakers to evaluate the extent of vulnerability to economic shocks and to plan for their financial and economic welfare.

This paper estimates work-life expectancies and future lost earnings for formal and informal employment in South Africa, bearing in mind labour market transitions in the broader context. Specifically, we seek answers to questions about how the length of working life differs by gender, education and race within and across formal and informal employment. Other relevant questions relate to the estimates of future lost earnings and how they vary within and across formal and informal employment.

Some studies estimate work-life expectancies based on a number of socio-economic factors, such as education, gender and race (Dudel et al., 2018a; Dudel & Myrskylä, 2017a; Millimet et al., 2003; Nurminen, 2004) to investigate labour market disparities. However, limited earlier studies have examined other disparities in work-life expectancies that may exist in racially diverse societies, such as South Africa.

Various earlier studies estimate work-life expectancies based on a three-state model of employed, unemployed and inactive (Millimet et al., 2010; Butt et al., 2008) with limited information on other specific employment categories. Krueger et al., (2006) estimate work-life expectancies of a three-state model on different labour market states of full-time, part-time employment and inactive. Krueger and Slesnick (2014) estimate work-life expectancies of market work, non-market work and inactive states. Krueger et al. (2006), argued that estimating work life expectancies of more than a three-state model would require a larger sample size than what was currently being provided in the USA. Yet Millimet et al. (2003) highlighted that a three-state model also has its criticism as it may not capture all the labour market information of the available data. Furthermore, Millimet et al. (2003) explained the possibility of a fourth state model, quoting a study by Jones and Riddell (1999) who introduced a fourth category called "marginally attached" to try and capture more labour market information using the available Canadian dataset. In developing countries, particularly in Southern Africa, labour states such as formal employment and informal employment are prominent. In addition, there is also a large proportion of individuals who are unemployed and not active in the labour force. This thesis aims to fill the gap in current knowledge regarding research in South Africa, therefore, this thesis is tailor-made to fit the South African situation.

Abdychev et al. (2018) highlighted that most employment opportunities that were created in Sub-Saharan Africa since 2000 have been in the self-employment or low-productivity sectors. Labour force growth in Sub-Saharan Africa has been positive but at a slower rate since 2020, due to the COVID-19 pandemic, with workers mostly transitioning from unemployment to low-productivity employment opportunities (ILO, 2022b).

2.2 BACKGROUND

2.2.1 South African Context

The structural changes that have taken place in the South African economy over the past two decades also resulted in changes in the employment structure (Bhorat et al., 2021). The country's main sectors which have hitherto contributed the larger share to the gross domestic product (GDP) include agriculture, mining and manufacturing. However, trade liberalisation in the 1990s, industrial changes and other economic factors that transpired led to the rise of the service sector since the early 2000s. This in turn influenced growth rates and changes in employment structure. (Bhorat et al., 2021).

Changes in employment structure also took place during the COVID-19 pandemic, as lockdown restrictions were implemented by the government to minimise the spread of the virus. The economy lost about 1.4 million jobs between the first quarters of 2020 and 2021(Department of Employment and Labour [DEI], 2020). Although the general populace was negatively affected by the employment decline due to COVID-19, the most severely affected group was that concerning the youth aged 15 to 34 years, as well as unskilled women and other vulnerable individuals. Those who had a previous history of long-term unemployment and those from poor backgrounds were badly impacted due to the significant decline in employment levels (Köhler et al., 2021). The lockdown restrictions impacted the informal employment sector more negatively than the formal employment sector, especially when rigid restrictions were imposed (Köhler et al., 2023).

Economic activities improved after the lockdown restrictions were lifted in 2021, accompanied by an increase in employment from 15.9 million in the fourth quarter of 2022 to 16.2 million in the first quarter of 2023 (StatsSA, 2023b). Employment continued to rise, reaching 16.7 million in the fourth quarter of 2023 (StatsSA, 2023c) and remained steady in the first quarter of 2024 at 16.7 million (StatsSA, 2024). However, unemployment increased in the economy from about 7.9 million in the first quarter of 2023 to about 8.1 million in the first quarter of 2024 (StatsSA, 2024). The unemployment rate increased by 0.8 percentage points from 32.1% in the fourth quarter of 2023 to 32.9% in the first quarter of 2024.

2.2.2 Formal and Informal Employment in South Africa

Although formal employment in South Africa remains higher as compared to informal employment (StatsSA, 2021b), the informal employment level continues to grow steadily in the economy. The contribution to employment in the informal sector is significant to social inclusion and economic development. Informal employment was overlooked in South Africa, especially during the COVID-19 period, as most policy and business interventions were aimed at formal employment sustainability and this focus left the informal sector vulnerable (DEL, 2021). Yet informal employment is estimated to contribute about 6% to the Gross Domestic Product in the economy (DEL, 2021). Formal employment accounted for 68.5% of total employment in 2022 whilst informal employment was about 18.8% (StatsSA, 2022b).

Although the formal sector still commands a larger share of employment in South Africa, StatSA (2020b) recorded that, in 2020, about 1.5 million workers were employed in the

informal sector as compared to total employment of about 15.1 million. Furthermore, informal sector employment increased from about 1.7 million to 1.9 million workers from the second quarter of 2021 to the second quarter of 2022 (StatsSA, 2022c). In addition, the South African economy experienced a decline in formal employment by 0.9% from June 2021 to June 2022.

According to StatsSA (2024), about 11.5 million individuals were employed in the formal sector (non-agricultural) as compared to 3.1 million employed in informal employment (non-agricultural) during the first quarter of 2024. Employment trends from the third quarter of 2023 to the third quarter of 2024 are shown in Table 2.1.

Table 2.1: Formal and Informal Employment from the third quarter of 2023 to the third quarter of 2024 (All values in thousands (000))

	Jul-Sept 2023 (000)	Oct-Dec 2023 (000)	Jan-Mar 2024 (000)	Apr-Jun 2024 (000)	Jul-Sept 2024 (000)
Formal sector	11616	11488	11544	11467	11589
Informal sector	3058	3181	3082	3129	3295
Others*	2072	2054	2119	2056	2063

** Others refers to the agriculture sector and private household data.*
Source: StatsSA (2024)

Given the immense contribution of formal and informal sectors to the South African economy, there is a need for the protection and compensation of workers from occupational injuries or death to sustain productivity and growth. The International Labour Organisation (ILO) came up with various conventions including the 1964 Employment Injury Benefits Convention which articulates the importance of protecting and compensating workers against occupational injuries (ILO, 2010). South Africa has a Compensation Fund which compensates formally employed workers who are injured at the work-place. Unfortunately, no compensation mechanisms are yet in place for those who are informally employed. The informal sector in South Africa is given low priority and there is inadequate allocation of financial and human resources to assist the sector (Pillay et al., 2018).

Although there is a significant impact that informal employment plays on economic development, there is a lack of awareness of the potential of informally employed workers in economic activities. Not much attention has been given to informal employment potential and

yet, this sector continues to grow in South Africa. The lack of awareness of the earnings potential of informal employment leads to unaccounted economic losses and an increase in poverty. Workers in informal employment are vulnerable to poverty and, hence, the failure of realising their potential intensifies poverty.

Our paper contributes towards the limited but growing literature on work-life expectancies and future lost earnings, specifically in South Africa. Firstly, we are the first to estimate work life expectancies for four labour market states which are formal employment, informal employment, unemployment and inactive. Our paper introduces the state of informal employment which, in previous articles, has not been estimated. Informal employment is a crucial sector, especially in developing countries' labour markets and needs to be taken into account. Secondly, our paper adds to the paucity of relevant literature, by estimating the length of work life, based on socio-economic factors, such as gender, education and race, to identify the existing labour market disparities in South Africa. Additionally, we provide a unique dimension by estimating work-life expectancies for Blacks, Whites, Coloureds and Asians/Indians in South Africa, to reveal racial disparities which may exist in the labour market. Thirdly, our paper estimates work-life expectancies and future lost earnings in the unique context of a developing country, such as South Africa. Previous studies have been concentrated in developed countries such as the United States of America, Canada, Finland and the United Kingdom.

2.2.3 Labour Market Transitions and Retention Rates in South Africa

Labour market transitions show the movement of individuals from one employment state to another, over some time. On the other hand, the retention rate shows those individuals who did not change their employment status during the study period (StatsSA, 2022). The knowledge of labour market transitions helps in understanding the extent of labour market re-allocations (Causa et al., 2021). Transitions reflect labour market events which take place, such as job market entry, job training and unemployment episodes, whilst individual events which may affect transitions include family events, such as marriage and having children (Vaccaro et al., 2023a).

Labour market outcomes and unemployment in the South African labour market are determined by socioeconomic factors, such as education, experience, age, race and sex (StatsSA, 2021). Experienced individuals are more likely to get employment than those without

experience. This unfortunate fact adversely affects an entire generation of young people in the economy who may be looking for first-time jobs (StatsSA, 2021). The transition rate for the youth entering the job market declined to 3.5% in 2021 from the 5.6% that was recorded in 2016 (StatsSA, 2021). During the same period, the transition rate for adults dropped from 6.8% in 2016 to 6.7% in 2021. Individuals with tertiary education had a transition rate to employment of 8.8% in 2022 compared to those with a matric education and those with less than a matric education who had a transition rate to employment of 6.9% and 4.6% respectively that same year. (StatsSA, 2022). Retention and transition rates in the economy from 2017 to 2022 are shown in Table 2.2.

Table 2.2: Transition and Retention Rates between the third quarter of 2018 and the fourth quarter of 2018 and between the third quarter of 2023 and the fourth quarter of 2023

Q3: 2018 and Q4 2018	**Employed**	**Unemployed**	**Economically inactive**	**Total**
Employed	94.0%	3.1%	2.9%	100%
Unemployed	10.6%	71.8%	17.6%	100%
Economically inactive	3.3%	6.7%	90.1%	100%
Q3: 2023 and Q4:2023	**Employed**	**Unemployed**	**Economically inactive**	**Total**
Employed	91.4%	4.3%	4.2%	100%
Unemployed	10.5%	73.0%	16.5%	100%
Economically inactive	3.8%	7.5%	88.7%	100%

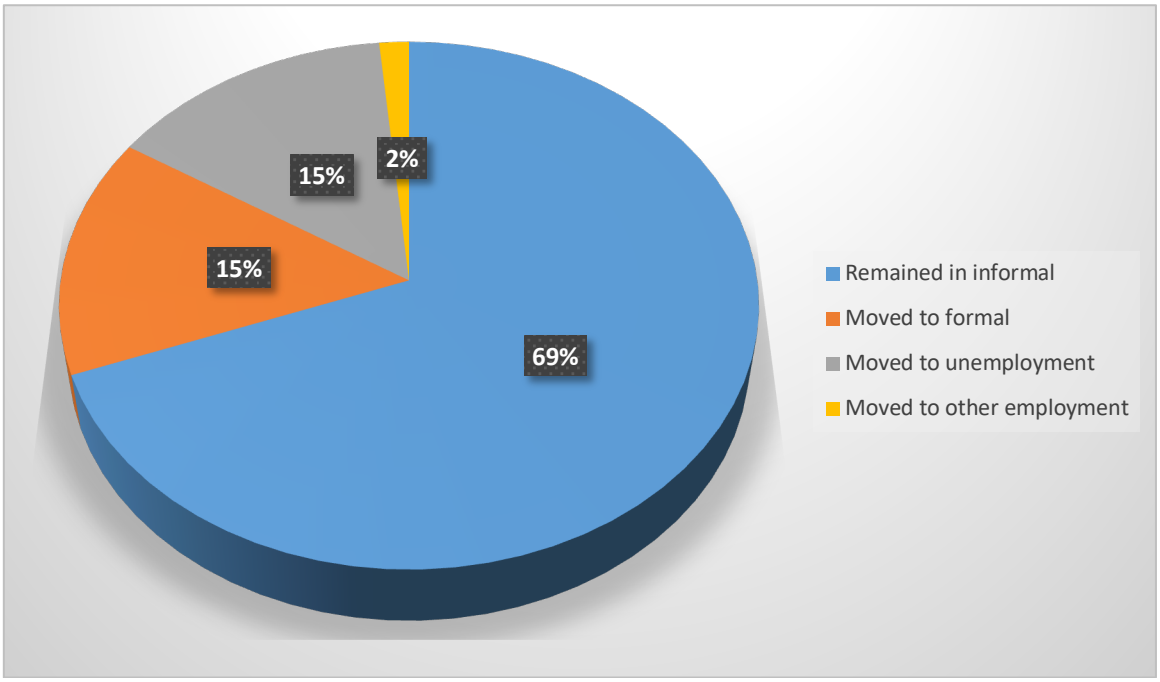
Source: StatsSA, (2023)

Table 2.2 shows the retention and transition rates between the third quarter of 2018 and the fourth quarter of 2018, and between the third quarter of 2023 and the fourth quarter of 2023 During the third and fourth quarters of 2018, 94.0% of workers remained employed whilst 10.6% moved from unemployed to employed. 71.8% remained unemployed whilst about 90.1% remained economically inactive. 17.6% of the working-age population moved from unemployment to economically inactive whilst 3.1% moved from employed to unemployed.

During the period Q3 and Q4 of 2023, 91.4% remained employed. This was a 2.6 % retention rate decline as compared to the Q3 and Q4 period of 2018. About 73.0. % remained unemployed whilst 88.7 % of the working-age population remained economically inactive. The retention rate for the unemployed increased by about 1.2 % comparing the two phases of Q3

of 2018 to Q4 of 2017 (71.8%) and Q3 of 2023 to Q4 of 2023 (73.0%), whilst the retention rate for the economically inactive declined by 1.4% (90.1% Q3:2018 to Q4:2018 and 88.7% Q3:2023 to Q4:2023). During the period Q3 of 2023 to Q4 of 2023 the transition rate from unemployment to employment was 10.5 % which was a decrease of 0.1% as compared to the period Q3 of 2018 to Q4 of 2018. Since informal employment is an important sector in the South African labour market, transitions and retention rates also exist between formal and informal employment. This is reflected in the following diagram.

Figure 2.1: Transition and Retention Rates for the Informal Sector Q3 of 2023 to Q4 of 2023



Source: StatsSA (2023).

Figure 2.1 shows the transition and retention rates for the informal sector from the third quarter of 2023 to the fourth quarter of 2023. 69% of the working-age population during this period remained in informal employment whilst 15% moved to formal employment. This reveals that the informal sector continues to be an important source of livelihood and sustainability for some parts of the populace. 15% moved to be unemployed, whilst 2% moved to other types of employment which are agriculture or private households.

The research on labour market transitions is an important aspect in shaping the future of work (ILO, 2021). Understanding the process of workers shifting from one economic sector to another is a key aspect of our research. Labour market transitions are an important factor in understanding how social inequalities evolve (Vaccaro et al., 2023b). Furthermore, in diverse

economies, such as South Africa, with employment in the formal and informal sectors, transitions can be vital in understanding other economic factors which affect the labour market. Recently labour market transitions have been an important ingredient in estimating transition probabilities which are later used to estimate work life expectancies. This approach has been employed by researchers, such as Millimet et al. (2003), Dudel and Myrskla (2017), and others.

2.2.4 Work-Life Expectancies

Work-life expectancies refer to the average period that individuals are expected to be in the labour force (Skoog & Ciecka, 2016). The labour force implies individuals in employment and those who are actively looking for work (Wessels, 2005). Work-life expectancies are used to calculate economic losses or damages that may include future lost earnings and future earnings capacity. According to Dudel et al. (2018) the length of work-life shows a complete picture of transitions in the labour market, labour market inequalities and the extent of the sustainability of social protection frameworks.

Early researchers developed interests in quantifying economic losses incurred due to war and understanding the composition of one's life expectancy when in and out of the labour force (Tinari, 2016). To address some of these issues, work life expectancies began to be calculated by the United States of America, Bureau of Labour Statistics (BLS) in the early 1900s (Tinari, 2016). The early work-life expectancies were calculated based on the "work-life traditional model" which was based on the assumption that men transitioned into and out of the work-force once in their lifetime, whilst for women, changes in parental and/or marital status determined their transition into and out of the work-force (Tinari, 2016). Work-life expectancies based on the increment-decrement model were published by the BLS in 1982 and 1986. These work-life tables were based on the assumption that individuals (both men and women) could enter and exit the labour force at any period in time continuously over their lifetime. Furthermore, the work-life expectancies were based on socio-economic factors, such as age, education, race and gender (Foster & Skoog, 2005).

In forensic economics, work-life expectancies are estimated from transitional probabilities. The framework for creating transitions—the movement from one labour state to the other—and the transitional probabilities is based on the Markov assumption or Markov chain model. The Markov assumption highlights that the likelihood of remaining in the labour force in the following year is determined by current employment status, not by past employment history

(Foster & Skoog, 2005). A Markov process is a stochastic process which highlights that a future state is determined by the current state of events and not by past states. At the same time, a stochastic process is a model which explains how a variable changes over time. Stochastic processes occur randomly rather than being deterministic (Foster & Skoog, 2005). This implies that the outcomes of the process are based on the likelihood or probability of occurring rather than being predictable.

Complexities in accounting for every individual's work history in the labour force is one of the reasons forensic economists have used the Markov assumption in formulating transitions and transitional probabilities which, in turn, determine work life expectancies. In the labour force, an individual may have a history of multiple job turnovers and individual characteristics which may affect his or her work trajectories and provide challenges in estimating future work trajectories. Hence, the transitional probabilities estimated depend only on the current state to predict the future (Foster & Skoog, 2005).

2.2.5 Estimating Future Lost Earnings

In case of a work-related personal injury or wrongful death, employees, as a result, are likely to lose earnings and other labour benefits over time if no compensation is calculated. Work-life expectancies are important estimates which are used to calculate future lost earnings for employees. Particular courts, such as the New York courts in the United States of America (USA) have provided work-life tables which are used by forensic economists to estimate compensation to the plaintiff (Baum et al., 2017). In fact, the use of work-life expectancies as estimates used in calculating future lost earnings for workers involved in personal injury or wrongful death, has been well established in the USA and Canada since the US Bureau of Labour Statistics began publishing work-life tables in the early 1950s (Butt, et al., 2008). However, these estimations of future lost earnings through work-life expectancies, although relevant overseas, remain limited in other regions, particularly in South Africa.

Work-life expectancies take into consideration labour market trends, changes in employee characteristics and transitions in the labour market which are important factors in the calculation of future lost earnings. As a result, litigation experts in developed countries have, over time, become interested in procuring work-life tables which, in turn, are used to calculate future lost earnings for victims injured or involved in wrongful death (Alter & Becker, 1985; Butt et al., 2010).

2.2.6 Policies which affected formal and informal employment in South Africa

The South African government has implemented numerous policies post-apartheid aimed at addressing the systemic and structural challenges in the labour market, focusing particularly on the dynamics of formal and informal employment. Sector Education and Training Authorities (SETAs) were established through the 1998 Skills Development Act to enhance the skills of the workforce and improve employment chances in the formal sector (Department of Labour South Africa, 1998). In addition, the 2004 Expanded public Works Programmes (EPWP) served as a bridge between formal and informal employment as it provided temporary employment opportunities (Department of Public Works, 2009). The steps taken by the government influenced directly employment transitions between labour states, a vital component in the estimation of work-life expectancies.

According to the Department of Small Business Development (DSBD, 2015) the National Informal Business Upliftment Strategy (NIBUS) was introduced in 2014 to integrate informal businesses into the mainstream economy, providing market access for informal business products, providing financial support and having skills development initiatives for these informal businesses. Furthermore, this same department established also in 2014 complemented NIBUS's efforts by implementing the Township and Rural Entrepreneurship Programme (TREP) to strengthen informal businesses in areas which are economically marginalised (DSBD, 2015). These interventions have potentially changed the steadiness and duration of informal employment spells which directly affects work life expectancy estimates.

In addition, the Employment Reconstruction and Recovery Plan of 2020 has prioritised job creation through industrial development and infrastructure investments with provisions which support informal sector integration (Government of South Africa, 2021). Furthermore the 2020 Presidential Employment Stimulus implemented by the government was a response to the employment challenges in the labour market through providing public and social programs (Government of South Africa, 2021). These policy directions change the composition of employment in the labour market as well as the probability transitions between employment states.

2.3 LITERATURE REVIEW

The United States (US) Bureau of Labour Statistics (BLS) has been one of the pioneers in estimating work-life expectancies since the beginning of the twentieth century (Skoog &

Ciecka, 2016). Before 1982, work-life expectancies were estimated using the traditional work-life model which estimated work life expectancies of the labour force as part of life expectancy tables (Skoog & Ciecka, 2009). This traditional model assumed that men only entered the labour force once, and only exited at retirement or death, whilst women were assumed to enter and exit the labour force when there was a change in their parental or marital status (Skoog & Cieka, 2016).

The BLS moved from the use of the traditional model for work-life expectancy to estimating work-life expectancy through the Markov process of the increment-decrement methodology in 1982 (Skoog & Ciecka, 2016). The 1982 publication entitled "Bulletin 2135" assumed that individuals, both men and women, entered the labour market on a repeated basis during their lifetime. The 1986 publication by BLS, "Bulletin 2254", also published work-life expectancies which were based on the increment–decrement methodology (Skoog & Ciecka, 2016).

The BLS 1982 and 1986 work life expectancies were based on two labour states which are active and inactive. However, the two-state work-life expectancies did not capture all the labour market dynamics which transpired. This spurred the interest of researchers (e.g. see Dudel et al., 2018b; Dudel & Myrskylä, 2017b; Krueger et al., 2006; Millimet et al., 2003, 2010a) in the area who then estimated work-life expectancies based on a three-state model. The three-state model namely the employed, unemployed and inactive states, was an improvement in revealing labour market information. Krueger et al. (2016) projected work-life expectancies for a different set of labour states which were full-time, part-time and inactive states. Moreover, the three-state model does not capture all labour market dynamics occurring in the labour markets, especially in developing countries, which include formal and informal employment.

In addition, some earlier studies, (see Krueger & Slesnick, 2014b; G. R. Skoog & Ciecka, 2010; W. Wessels, 2012; W. J. Wessels, 2005) adopted the BLS methodology of increment-decrement in estimating work life expectancies. The increment and decrement method did not capture specific individual work-life behaviour in the labour market. Millimet et al. (2003) estimated work-life expectancies with the use of regression models to capture these specific individual behaviours. The paper used a nine-year dataset of the US Current Population Survey (CPS) which is a deviation from the BLS which utilised a single wave of the CPS data (Millimet et al., 2003). The study found that work-life expectancies tended to be higher for the employed as compared to those who were unemployed or inactive. Regression analysis is important in

showing work-life expectancies which are based on demographic and economic conditions facing individuals in the labour market.

An important aspect which was incorporated in regression modelling (Millimet et al., 2003) was the estimation of work-life expectancies of different categories, such as race, gender and education. A few years later, Millimet et al. (2010) added marital and parental status together with other categories, such as gender, race and education, in estimating work-life expectancies. The study found that compared to married men, married women had lower work-life expectancies. The studies which used regression modelling to estimate work-life expectancies categorised race into two major racial groups, White and non-White groups (Millimet et al., 2003; Millimet et al., 2010). A few studies have estimated work-life expectancies across diverse racial groups to show the racial disparities which exist in the labour force. Dudel & Myrskylä (2017b) used a multinomial logistic regression and multi-state life tables to estimate transitional probabilities which were later used to estimate work life expectancies covering the period of the Great Recession of 2007 to 2009. The study found that the work-life expectancies for Whites were less affected by recession as compared to Hispanics and Blacks.

The majority of studies on work life expectancies have been done in the USA (Ciecka & Skoog, 2001; Dudel & Myrskylä, 2017c; Krueger et al., 2006; Land et al., 1994; Millimet et al., 2003, 2010a; W. J. Wessels, 2005). Dudel et al. (2018) estimated and analysed work-life expectancies using the Sullivan approach in Spain, and Spanish data from 2004 to 2014. The study found that the financial crisis of 2007 to 2009 reduced work-life expectancies more for men than women. The study mentioned that the work life expectancies for men who worked in unskilled trades reduced by about 14 years. Robroek et al. (2020) analysed educational differences in work-life expectancies estimated in the Netherlands for men and women, using monthly data from 2001 to 2015. The study found out that there was a loss of work-life expectancy for poorly educated individuals who had disability benefits, with a loss of 3.4 years of work life for men and a loss of 3 years of work life for women.

Nurminen (2012) estimated work life expectancies in Finland analysing the trends and differences over the years from 2000 to 2015 i.e. ten years. The study used a multistate life table with multivariate regression models to come up with male and female work-life expectancies for ages 15 to 60 years. The report found out that as life expectancies for men and women grew by 2.6 and 2.2 years respectively, work life expectancies for males and females also grew by 1.2 and 2.8 years respectively. There have been upcoming extensive studies on

work-life expectancies and yet, few studies have been done for developing countries, South Africa in particular. Palamuleni (2013) analysed the South African labour force using life expectancy Tables for the period 1996 to 2001. The paper highlighted that a male aged 15 years had a work life expectancy of 34 years whilst, for a female of the same age, a 50-year work-life was expected.

Butt et al. (2008) modified reduction factors in the United Kingdom (UK) to account for the risk of disability in estimating future lost earnings. In the UK, the reduction factors are found in the Ogden Tables which present discounted present value of future earnings that workers should earn until retirement or death. Butt et al. (2008), argued that the reduction factors used were outdated and needed re-adjusting to account for the current risk of disability. The reduction factors are calculated as the ratio of work life expectancies divided by the expected number of years remaining until retirement. Although the paper did not calculate future lost earnings for all ages in the UK, it calculated specific case examples to show the differences and impact. The paper found that future lost earnings were underestimated by about 42% by using standard reduction factors as compared to the use of disability-adjusted reduction factors. Butt et al. (2010), build on the previous paper of Butt et al. (2008), by acknowledging that the concept of disability-adjusted reduction factors had been incorporated into the sixth edition of the UK's Ogden Tables. However, the paper highlighted that the judges in courts who still used unadjusted reduction factors estimated unfair compensation to victims and their families. This shows that the judges in courts often lag behind modern research findings and strategies in their methods to cope with civil cases.

Douglas et al. (2019) provided a review of the importance of work-life expectancies in calculating future lost earnings. Work-life expectancies incorporate individual and demographic factors, such as age, gender and education which are crucial in calculating and adjusting future lost earnings (Douglas et al., 2019). The paper highlighted how work-life expectancies and future lost earnings are estimated in the US and the UK and mentioned the need for other developed countries, like Australia, to estimate work-life expectancies and future lost earnings in cases where workers are injured or have died.

Work-life expectancy estimates by race and gender unavoidably reveal structural inequalities which may exist in the labour market. A crucial factor affecting the differences in work-life expectancies is discrimination in the labour market which affects career progression employment probabilities and future lost earnings. Several studies have been written on labour

market discrimination by gender and race in the context of South Africa. Casale and Posel (2002) examined labour market trends in post-apartheid South Africa and found that African women had significant barriers to employment and earned low wages than men even after considering observable characteristics such as experience and educational attainment. Their study concluded that the country's labour market was characterised by systematic labour market discrimination and that gender disparities in earnings and employment were not explained by differences in skills or education. In addition, Seekings (2008) highlighted that racial discrimination is prominent in South Africa's labour market even after apartheid. The author mentioned that African workers continued to experience high unemployment rates and low earnings as compared to white and coloured employees. The study found that there were substantial wage gaps between workers of these races even after considering differences in skills and education. Furthermore, Anand et al. (2016) analysed South Africa's unemployment determinants using individual-level longitudinal data and found that job exit rates were significantly influenced by race and educational attainment showing the existence of structural inequalities in South Africa's labour markets.

2.4 METHODOLOGY

Forensic economics in practice usually includes more than one methodology. Hence, in what follows, we present the steps of our methodology. This is followed by detailed functional forms employed in the analysis. The steps are as follows:

Step 1

We start with a latent variable model and the National Income Dynamics Study (NIDS) dataset. According to the responses of workers for the type of employment they were in, we developed four labour states which were formal employment, informal employment, unemployment and economically inactive.

Step 2

To reflect on the changes in employment over time in Stata, we then estimate 16 transitions of our four labour states. Our longitudinal dataset of NIDS is from 2008 to 2017, hence, it is important to capture the employment changes of that period. The framework for formulating these transitions is based on the Markov chain rule. How this framework impacts the transitions is provided in detail below.

Step 3

We run a multinomial probit regression model in Stata for each of these 16 transitions. Each transition is a dependent variable in the multinomial probit model which also consists of independent variables which affect the dependent variable, such as age and health status. Beta coefficients and conditional probabilities are some of the results of the multinomial probit regression. After each regression of the multinomial probit model, a Stata regression formula is implemented to generate conditional probabilities from the results of the multinomial probit model.

Step 4

In Stata, the conditional probabilities are averaged per age group to create transitional probabilities.

Step 5

The transitional probabilities are then used to estimate work life expectancies through a recursive process formula, implemented first by Millimet et al. (2003), a methodology which calculated work-life expectancies from 86 years going backwards to age 16. In this regard, we start at period T+1 which is the terminal age—the oldest age where no one is assumed to be working—and then moved backwards. However, at a later stage of the process, the age is trimmed to have work life expectancies within the range of the working age groups, common in many labour markets—age 16 to 65 years. The work-life expectancies are categorised by employment type, gender, race and educational level.

Step 6

We calculate future lost earnings using work-life expectancies in Table 2.3, real wage growth rate and real discount rate. The real wage growth rate for South Africa was obtained from the International Labour Organisation (ILO) global wage data from 2022 to 2023. The real discount was obtained from the South African Reserve Bank (SARB) website for the rate on long-term government bonds, adjusted for inflation. We use the widely accepted methodology of estimating future lost earnings in forensic economics (e.g., see Benham and La Croix (1992), explained in Lewis et al., 2003). Our future lost earnings are categorised by employment type and gender.

a. The Markov Chain Model

Before we explain the formal methodology of our paper, we first explain the framework which leads to the generation or estimation of transitions and transitional probabilities which is the Markov chain model. The transition to different states in the labour force can be estimated using the Markov chain assumptions (Dudel & Myrskylä, 2017c; Hoem, 1977; G. R. Skoog & Ciecka, 2010). A Russian mathematician, Andrei Markov, in his 1906 paper (Seneta, 1996), first presented the Markov chain methodology. A Markov chain is a stochastic process, which is used to estimate random variables, systems, or events that change over time (Yusuf, 2014).

The Markov chain model is usually explained with the use of the Markov chain property. The Markov chain property states that the future state of an event is dependent upon the current state, not on the past states. Markov Chain models used by researchers in estimating states in labour force are discrete rather than continuous, and represent values or events, which are infinite and independent of time.

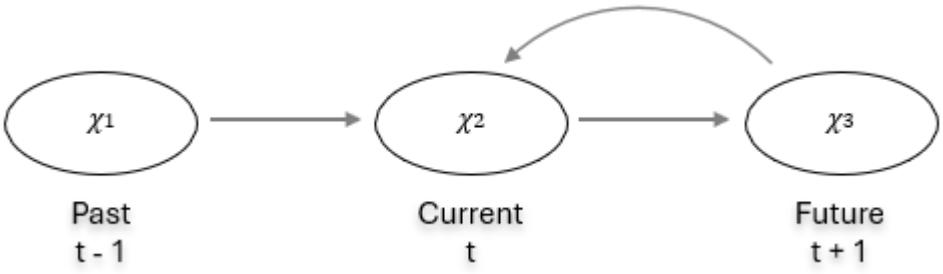
The Markov chain is such that there is a random variable X of an event at time t which is given by χ_t. Furthermore, the state space of events is given by:

$$S = \{\chi_1, \chi_2, \chi_3 \dots \dots \dots\} \dots\dots\dots\dots (1)$$

Where χ_1, χ_2, χ_3 ... are discrete random variables.

The Markov Property highlights that a future state of event χ_3 is only dependent on a current state event χ_2 not on χ_1. χ_3 which is the future state had time *t+1* whilst χ_2 which was the current state had time *t*.

Figure 2.2: Initial state space



Another way of expressing the random variables together with the time element is as follows:

χ_t is the current event, $whilst\ \chi_{t+1}$ is the future event and χ_{t-1} is the past event. Furthermore, the Markov Property can be expressed in terms of conditional probability as follows:

$$P_{ij} = P(\chi_{t+1} = \frac{j}{\chi_t} = i \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation 2 highlights that the probability from state *i* to state *j* is equal to the probability that the process would be in state *j* in the next step of time or period on condition that the current process is in state *i*. Given the above Markov assumption of states, this study implements five labour force states that show the movement or transitions of the workforce in the labour market. The five states are: (1) formal employment; (2) informal employment; (3) unemployment; (4) economically inactive; and (5) death. The fifth state, death, is regarded as a reference state.

Figure 2.3: State space of the chapter

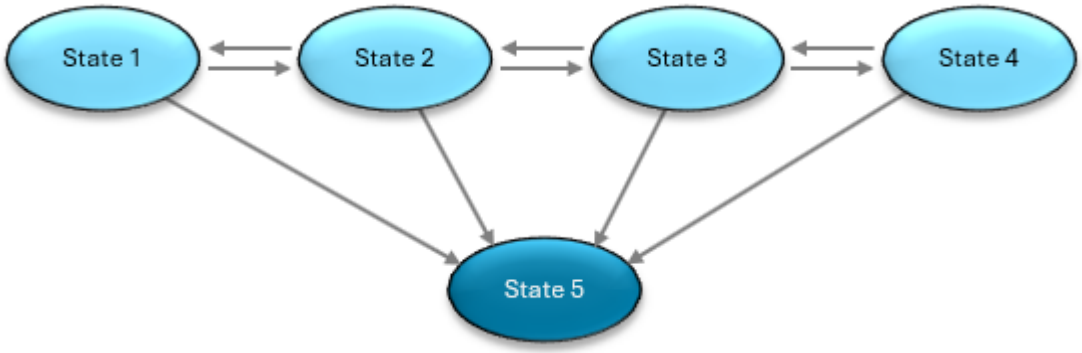


Figure 2.3 illustrates the state space for the study using the Markov chain methodology. The arrows shown in the diagram represent transitional probabilities between the states. Death is regarded as a reference state because once an individual transitions into this state he or she cannot transition out of it. Similar to other studies which estimated work-life expectancies, death is regarded as a reference state and represents retirement. This reference state enabled us to estimate work life expectancies only for workers in their working age years. Hence, our analysis involves only four states (formally employed, informally employed, and economically inactive), excluding death since it's a reference state. Hence, the reference state, which is death, enables the Markov chain modelling to be realistic because without this state it could reflect that individuals would continue working forever.

As previously used by Millimet et al. (2003) and others, this paper uses the Markov property assumption in determining the movement across labour states in the state space. The Markov property, which enables forensic economists and other data analysts to model complex systems

assumes that the outcome of a future state is dependent upon a current state, not on other past events. For example, relating to this study, the probability of transitioning from state 1 (formally employed) to state 2 (informally employed) depends on the individual being in the current state which is state 1 (formally employed). The probability of transitioning from state 1 (formally employed) to state 2 (informally employed) does not depend on whether that individual was in previous states, such as state 3 (unemployed) or state 4 (economically inactive). Hence, in essence, in using the Markov property to forecast, a forensic economist can predict a future state of an event dependent upon the current event. There is no need to know the whole history of past events of the model as this would complicate the modelling.

b. Formal Methodology

Our paper closely follows the methodology of estimating work-life expectancies used by Millimet et al. (2010) and Millimet et al. (2003) known as the Stochastic Markov chain transition model. The model has four distinct states: Formally employed (FE); Informally Employed (IE); Unemployed (UNE) and Economically Inactive (ECONI). The expanded state space provides better accuracy than two or three state models in capturing the nuanced transitions between labour force categories that affect future lost earnings projections. Transition probabilities are estimated using the maximum likelihood estimation based on observed transition frequencies in the longitudinal data. The Stochastic Markov chain transition model captures short-term and long-term labour market volatility particularly crucial when modelling future lost earnings for workers in unstable employment sectors. Our model answers and extends the work by Krueger et al. (2006) who argued that the conventional two- state model of (active and inactive) fails to capture the complex dynamics of different labour markets and could lead to systematic biasness in estimating work-life expectancies. In this sense, labour markets in developing countries include labour states such as the informal economy, hence, a failure to incorporate this can lead to biased work life expectancies in the context of developing economies. Furthermore, we use the Benham- La Croix present value formula in estimating future lost earnings to account for both the time value of money and expected wage growth rates in income changes over time. The failure to account for the time value of money and expected wage growth rates can lead to inaccurate estimations of future lost earnings.

We employ a four-state model where for each individual *i* and time *t*, we specify y^*_{itj} as a latent variable which shows the rate of labour force participation in state *j*. State *j* is an element of the four labour states which are Formally employed (FE), Informally Employed (IE),

Unemployed (UNE) and Economically Inactive (ECONI). The latent variable can be written formally in a functional form as follows:

$$y_{itj}^{*} = Z_{it}\beta_j + \varepsilon_{itj} \dots\dots\dots\dots\dots\dots\dots (3)$$

Where β_j is the coefficient vector of state *j*; Z_{it} is a vector of individual *i*'s attributes at time t and ε_{itj} is the error term.

However, this model is theoretical, since it is an unobserved latent variable, y_{itj}^{*}. In multinomial probit modelling, an individual selects the state which maximises his or her latent utility. Hence, y_{it} is the state with the highest latent utility. This allows for the connection of observed data to the theoretical basis of the model. Hence, the following step is important to convert the latent variables into observable variables. The observed labour market outcome is as follows:

$$y_{it} = \arg \max_{j\in\{FE,IE,UNE,ECONI\}} y_{itj}^{*} \dots\dots\dots\dots. (4)$$

Where y_{it} is the observable labour market status at individual *i* and time *t*.

Equation (2) states that an individual *i* is observed at time *t* and state *j* if y_{itj}^{*} is the latent variable with the highest ranking. The multinomial probit model is estimated with an observable y_{it}. The results allow for generating conditional probabilities which are a pre-requisite for estimating transition probabilities. The conditional probabilities $P\left(y_{it} = j \middle| Z_{it}, y_{i,t-1}\right)$ for each labour state (FE, IE, UNE, ECONI) can be derived and written as follows:

$$P\left(y_{it} = j \middle| Z_{it}, y_{i,t-1}\right) = \phi(Z_{it}\beta_j - \max_{k\neq j} Z_{it}\beta_t) \dots\dots\dots\dots. (5)$$

Equation (3) allows for the calculation of the conditional probabilities for individual *i* who is in time *t* and state *j* given the characteristics Z_{it} of the individual and the previous state of the individual.

- $Z_{it}\beta_j$ is the linear independent variable at time *t* for state *j*.

- $\max_{k \neq j} Z_{it}\beta_j$ is the estimated maximum linear independent variable for all states $k \neq j$. This part of the equation assists in finding the normalisation factor that makes all probabilities across all states to be equal to 1.
- $\phi\,(.)$ represents the cumulative distribution function of the normal distribution. It converts the independent linear variables, which are normally distributed to probabilities for a chosen state *j* given the previous state $y_{i,t-1}$ and characteristics Z_{it}.

Since our paper has four states, the multinomial probit model generates 16 specific conditional probabilities, which are the following:

- P_x^{FE-FE} – The probability of an individual being formally employed (FE) at age *x,* and remaining formally employed at age *x*+1.
- P_x^{FE-IE} – The probability that an individual who is formally employed at age *x,* will be informally employed (IE) at age *x*+1.
- P_x^{FE-UNE} – The probability that an individual who is formally employed at age *x,* will be in unemployed (UNE) at age *x*+1.
- $P_x^{FE-ECONI}$ – The probability that an individual who is formally employed at age *x,* will be economically inactive (ECONI) at age *x*+1.
- P_x^{IE-FE} – The probability that an individual who is informally employed at age *x,* will be formally employed at age *x*+1.
- P_x^{IE-IE} – The probability that an individual who is informally employed at age *x,* will remain informally employed at age *x*+1.
- P_x^{IE-UNE} – The probability that an individual who is informally employed at age x, will be unemployed at age x+1.
- $P_x^{IE-ECONI}$ – The probability that an individual who is informally employed at age *x* will be economically inactive at age *x*+1.
- P_x^{UNE-FE} – The probability that an individual who is unemployed at age *x* will be formally employed at age *x*+1.
- P_x^{UNE-IE} – The probability that an individual who is unemployed at age *x* will be informally employed at age *x*+1.
- $P_x^{UNE-UNE}$ – The probability that an individual who is unemployed at age *x* will remain unemployed at age *x*+1.

- $P_x^{UNE-ECONI}$ – The probability that an individual who is unemployed at age *x* will be economically inactive at age *x*+1.
- $P_x^{ECONI-FE}$ – The probability that an individual who is economically inactive at age *x* will be formally employed at age *x*+1.
- $P_x^{ECONI-IE}$ – The probability that an individual who is economically inactive at age *x* will be informally employed at age *x*+1.
- $P_x^{ECONI-UNE}$ – The probability that an individual who is economically inactive at age *x* will be unemployed at age *x*+1.
- $P_x^{ECONI-ECONI}$ – The probability that an individual who is economically inactive at age *x* will remain economically inactive at age *x*+1.

Conditional transition probabilities per labour state need to add up to 1 as follows:

$P_x^{FE-FE} + P_x^{FE-IE} + P_x^{FE-UNE} + P_x^{FE-ECONI} = 1;\ P_x^{IE-FE} + P_x^{IE-IE} + P_x^{IE-UNE} + P_x^{IE-ECONI} = 1$; $P_x^{UNE-FE} + P_x^{UNE-IE} + P_x^{UNE-UNE} + P_x^{UNE-ECONI} = 1$; $P_x^{ECONI-FE} + P_x^{ECONI-IE} + P_x^{ECONI-UNE} + P_x^{ECONI-ECONI} = 1$.

The transition probabilities depend on an individual's survival from age *x* to age *x*+1. Consistent with Millimet et al. (2010) and Millimet (2003), the study assumes that the probability of death is represented by q_x, and if l_x is the number of survivors, then survivors at age *x* for the states of formally employed, informally employed, unemployed and economically inactive are represented by $l_x^{FE}, l_x^{IE}, l_x^{UNE}, l_x^{ECONI}$ respectively. If we assume that labour force transitions and probability of death are independent, we can estimate the number of individuals in each of the four labour states (formally employed, informally employed, unemployed and economically inactive) at age *x*+1 as follows:

$$l_{x+1}^{FE} = l_x^{FE} P_x^{FE-FE} + l_x^{IE} P_x^{IE-FE} + l_x^{UNE} P_x^{UNE-FE} + l_x^{ECONI} P_x^{ECONI-FE}$$

$$l_{x+1}^{IE} = l_x^{FE} P_x^{FE-IE} + l_x^{IE} P_x^{IE-IE} + l_x^{UNE} P_x^{UNE-IE} + l_x^{ECONI} P_x^{ECONI-IE}$$

$$l_{x+1}^{UNE} = l_x^{FE} P_x^{FE-UNE} + l_x^{IE} P_x^{IE-UNE} + l_x^{UNE} P_x^{UNE-UNE} + l_x^{ECONI} P_x^{ECONI-UNE}$$

$$l_{x+1}^{ECONI} = l_x^{FE} P_x^{FE-ECONI} + l_x^{IE} P_x^{IE-ECONI} + l_x^{UNE} P_x^{UNE-ECONI} + l_x^{ECONI} P_x^{ECONI-ECONI}$$

Where $l_x = l_x^{FE} + l_x^{IE} + l_x^{UNE} + l_x^{ECONI}$ and $l_{x+1} = l_x(1 - q_x)$

Transition Probabilities

After estimating conditional probabilities, transition probabilities are calculated and have the following functional form:

$$P\left(y_{i,t+1} = j \middle| Z_{it}\right) = \phi(\beta_j Z_{it} - \max_{k \neq j} \beta_k Z_{it}) \ldots\ldots\ldots\ldots (6)$$

Where $y_{i,t+1}$ represents individual *i* state at time *t*+1

Z_{it} represents covariates for individual *i*.
β_j represents the coefficients of state *j* estimated from the multinomial probit model.
ϕ represents the cumulative distribution function (CDF) of the normal distribution.
β_k represents the vector of coefficients for the *k-th* state.
$k \neq j$ stands for all other states except *j*.

$P\left(y_{i,t+1} = j \middle| Z_{it}\right)$ represents the probability that individual *i* moves to state *j* at time *t*+1 given that at time *t* the covariates are Z_{it}.

To express the transitional probabilities in a functional form for four states, we assume that *j*=0 for (formally employed); *j*=1 for (informally employed); *j*=2 for (unemployed) and *j*=3 for (economically inactive).

Transition from formally employed to economically inactive:

$$\mathrm{P}\left(y_{i,t+1} = 3 \middle| Z_{it}, y_{i,t} = 0\right) = \phi(\beta_3 Z_{it} - \max_{k \neq 3} \beta_k Z_{it})$$

For example, this represents the probability of individual *i* moving to an economically inactive state given that he or she was employed at time *t*.

Transition from formally employed to unemployed:

$$\mathrm{P}\left(y_{i,t+1} = 2 \middle| Z_{it}, y_{i,t} = 0\right) = \phi(\beta_2 Z_{it} - \max_{k \neq 2} \beta_k Z_{it})$$

Transition from formally employed to informal employment:

$$\mathrm{P}\left(y_{i,t+1} = 1 \middle| Z_{it}, y_{i,t} = 0\right) = \phi(\beta_1 Z_{it} - \max_{k \neq 1} \beta_k Z_{it})$$

Transition from formally employed to employed:

$$P\left(y_{i,t+1}=0\middle|Z_{it},y_{i,t}=0\right)=1-\sum_{k=1}^{3}\phi(\beta_k Z_{it}-\max_{j\neq k}\beta_j Z_{it})$$

Transition from informally employed to economically inactive:

$$\mathrm{P}\left(y_{i,t+1}=3\middle|Z_{it},y_{i,t}=1\right)=\phi(\beta_3 Z_{it}-\max_{k\neq 3}\beta_k Z_{it})$$

Transition from informally employed to unemployed:

$$\mathrm{P}\left(y_{i,t+1}=2\middle|Z_{it},y_{i,t}=1\right)=\phi(\beta_2 Z_{it}-\max_{k\neq 2}\beta_k Z_{it})$$

Transition from informally employed to informal employment:

$$\mathrm{P}\left(y_{i,t+1}=1\middle|Z_{it},y_{i,t}=1\right)=\phi(\beta_1 Z_{it}-\max_{k\neq 1}\beta_k Z_{it})$$

Transition from informally employed to formally employed:

$$P\left(y_{i,t+1}=0\middle|Z_{it},y_{i,t}=1\right)=1-\sum_{k=1}^{3}\phi(\beta_k Z_{it}-\max_{j\neq k}\beta_j Z_{it})$$

Transition from unemployed to economically inactive:

$$\mathrm{P}\left(y_{i,t+1}=3\middle|Z_{it},y_{i,t}=2\right)=\phi(\beta_3 Z_{it}-\max_{k\neq 3}\beta_k Z_{it})$$

Transition from unemployed to unemployed:

$$\mathrm{P}\left(y_{i,t+1}=2\middle|Z_{it},y_{i,t}=2\right)=\phi(\beta_2 Z_{it}-\max_{k\neq 2}\beta_k Z_{it})$$

Transition from unemployed to informal employment:

$$\mathrm{P}\left(y_{i,t+1}=1\middle|Z_{it},y_{i,t}=2\right)=\phi(\beta_1 Z_{it}-\max_{k\neq 1}\beta_k Z_{it})$$

Transition from unemployed to formally employed:

$$P\left(y_{i,t+1}=0\middle|Z_{it},y_{i,t}=2\right)=1-\sum_{k=1}^{3}\phi(\beta_k Z_{it}-\max_{j\neq k}\beta_j Z_{it})$$

Transition from economically inactive to economically inactive:

$$\mathrm{P}\left(y_{i,t+1}=3\middle|Z_{it},y_{i,t}=3\right)=\phi(\beta_3 Z_{it}-\max_{k\neq 3}\beta_k Z_{it})$$

Transition from economically inactive to unemployed:

$$\mathrm{P}\left(y_{i,t+1}=2\middle|Z_{it},y_{i,t}=3\right)=\phi(\beta_2 Z_{it}-\max_{k\neq 2}\beta_k Z_{it})$$

Transition from economically inactive to informal employment:

$$\mathrm{P}\left(y_{i,t+1}=1\middle|Z_{it},y_{i,t}=3\right)=\phi(\beta_1 Z_{it}-\max_{k\neq 1}\beta_k Z_{it})$$

Transition from economically inactive to formally employed:

$$P\left(y_{i,t+1}=0\middle|Z_{it},y_{i,t}=3\right)=1-\sum_{k=1}^{3}\phi(\beta_k Z_{it}-\max_{j\neq k}\beta_j Z_{it})$$

After estimating the 16 transition probabilities, average predicted transition probabilities are calculated, such that individual movements are grouped per transition. This simplifies the calculations as individuals may vary due to differences in covariates. The average predicted transition probabilities are as follows:

Formally employed transitions:

$$P_x^{FE-FE}=\frac{1}{N_x^{FE}}\sum_{i=1}^{N_x^{FE}}P(y_{i,t+1}=0|Z_{it},y_{i,t}=0)$$

$$P_x^{FE-IE}=\frac{1}{N_x^{FE}}\sum_{i=1}^{N_x^{FE}}P(y_{i,t+1}=1|Z_{it},y_{i,t}=0)$$

$$P_x^{FE-UNE}=\frac{1}{N_x^{FE}}\sum_{i=1}^{N_x^{FE}}P(y_{i,t+1}=2|Z_{it},y_{i,t}=0)$$

$$P_x^{FE-ECONI}=\frac{1}{N_x^{FE}}\sum_{i=1}^{N_x^{FE}}P(y_{i,t+1}=3|Z_{it},y_{i,t}=0)$$

Informally employed transitions:

$$P_x^{IE-FE} = \frac{1}{N_x^{IE}} \sum_{i=1}^{N_x^{IE}} P(y_{i,t+1} = 0 | Z_{it}, y_{i,t} = 1)$$

$$P_x^{IE-IE} = \frac{1}{N_x^{IE}} \sum_{i=1}^{N_x^{IE}} P(y_{i,t+1} = 1 | Z_{it}, y_{i,t} = 1)$$

$$P_x^{IE-UNE} = \frac{1}{N_x^{IE}} \sum_{i=1}^{N_x^{IE}} P(y_{i,t+1} = 2 | Z_{it}, y_{i,t} = 1)$$

$$P_x^{IE-ECONI} = \frac{1}{N_x^{IE}} \sum_{i=1}^{N_x^{IE}} P(y_{i,t+1} = 3 | Z_{it}, y_{i,t} = 1)$$

Unemployed transitions:

$$P_x^{UNE-FE} = \frac{1}{N_x^{UNE}} \sum_{i=1}^{N_x^{UNE}} P(y_{i,t+1} = 0 | Z_{it}, y_{i,t} = 2)$$

$$P_x^{UNE-IE} = \frac{1}{N_x^{UNE}} \sum_{i=1}^{N_x^{UNE}} P(y_{i,t+1} = 1 | Z_{it}, y_{i,t} = 2)$$

$$P_x^{UNE-UNE} = \frac{1}{N_x^{UNE}} \sum_{i=1}^{N_x^{UNE}} P(y_{i,t+1} = 2 | Z_{it}, y_{i,t} = 2)$$

$$P_x^{UNE-ECONI} = \frac{1}{N_x^{UNE}} \sum_{i=1}^{N_x^{UNE}} P(y_{i,t+1} = 3 | Z_{it}, y_{i,t} = 2)$$

Economically inactive transitions:

$$P_x^{ECONI-FE} = \frac{1}{N_x^{ECONI}} \sum_{i=1}^{N_x^{ECONI}} P(y_{i,t+1} = 0 | Z_{it}, y_{i,t} = 3)$$

$$P_x^{ECONI-IE} = \frac{1}{N_x^{ECONI}} \sum_{i=1}^{N_x^{ECONI}} P(y_{i,t+1} = 1 | Z_{it}, y_{i,t} = 3)$$

$$P_x^{ECONI-UNE} = \frac{1}{N_x^{ECONI}} \sum_{i=1}^{N_x^{ECONI}} P(y_{i,t+1} = 2 | Z_{it}, y_{i,t} = 3)$$

$$P_x^{ECONI-ECONI} = \frac{1}{N_x^{ECONI}} \sum_{i=1}^{N_x^{ECONI}} P(y_{i,t+1} = 3 | Z_{it}, y_{i,t} = 3)$$

Where N_x^{FE}, N_x^{IE}, N_x^{UNE} and N_x^{ECONI} are the number of individuals who are formally employed, informally employed, unemployed and economically inactive at age *x*. Similar to Millimet et al. (2010) and Millimet et al. (2003), in this study, we replace the transition probabilities with a nine-year moving average to reduce fluctuations. These transition probabilities are then used to estimate work life expectancies. We assume a terminal age *T+1*, where no one is formally employed. The work-life expectancy for an individual who is formally employed at age *T* is similar to the likelihood of remaining formally employed at age *T+1*. For other states, such as informally employed, unemployed and economically inactive at age *T*, the length of working life is estimated as 0.5 times the likelihood of moving to formally employed at age *T+1*. The 0.5 factor is important to account for uncertainty in the occurrence of potential employment movements. These estimations are applied recursively to work-life expectancies starting from the terminal age and then moving backwards. The length of working life for a formally employed individual at age *T-1* is given by:

$$E_{T-1}^{FE} = P_{T-1}^{FE-FE}(1 + E_T^{FE}) + P_{T-1}^{FE-IE}(0.5 + E_T^{IE}) + P_{T-1}^{FE-UNE}(0.5 + E_T^{UNE}) + P_{T-1}^{FE-ECONI}(0.5 + E_{T)}^{ECONI} \dots\dots\dots\dots (7)$$

For an informally employed individual at age *T-1* the length of working life is given by:

$$E_{T-1}^{IE} = P_{T-1}^{IE-FE}(0.5 + E_T^{FE}) + P_{T-1}^{IE-IE}(E_T^{IE}) + P_{T-1}^{IE-UNE}(E_T^{UNE}) + P_{T-1}^{IE-ECONI}(E_T^{ECONI}) \dots\dots\dots (8)$$

For an unemployed individual at age *T-1* the length of working life is given by:

$$E_{T-1}^{UNE} = P_{T-1}^{UNE-FE}(0.5 + E_T^{FE}) + P_{T-1}^{UNE-IE}(E_T^{IE}) + P_{T-1}^{UNE-UNE}(E_T^{UNE}) + P_{T-1}^{UNE-ECONI}(E_T^{ECONI}) \dots . (9)$$

For an economically inactive individual at age *T-1* the length of working life is given by:

$$E_{T-1}^{ECONI} = P_{T-1}^{ECONI-FE}(0.5 + E_T^{FE}) + P_{T-1}^{ECONI-IE}(E_T^{IE}) + P_{T-1}^{ECONI-UNE}(E_T^{UNE}) + P_{T-1}^{ECONI-ECONI}(E_T^{ECONI}) \dots\dots\dots (10)$$

The process is repetitive up to the age *T-(T-16)*.

c. Future lost earnings estimates

Work life expectancies together with other factors can be used to estimate future lost earnings estimates. Future lost earnings estimates are important to quantify the economic burden of a potential injury or wrongful death of a worker. If available, the estimates may assist South African courts and policy-makers to understand, in depth, the factors which affect future lost earnings in civil lawsuit cases. The future lost earnings formulae used are based upon Benham and La Croix (1992), as explained in Lewis et al., (2003). Hence, the widely accepted formulae for calculating future lost earnings estimates are:

$$\sum_{j=0}^{T} \frac{W_j \prod_{i=1}^{j}(1+g_i)}{\prod_{i=1}^{j}(1+r_i)} \dots\dots (11)$$

Where $W_j$denotes the wage for each year (j) over a T-year working life, g_i is the real wage growth rate and r_i is the real discount rate.

Future lost earnings estimate for males and females who are formally and informally employed from ages 16 to 65 are calculated and presented in this study, based on this formulae.

Equation (1) is expanded to show the multinomial probit regression nature where several beta coefficients are estimated based on demographic and socio-economic variables. The equations estimated ((10) – (13)) are of the following functional forms:

$$y_{it}^{fe} = \beta_0 + \beta_1 a_{it} + \beta_2 a_{it}^2 + \beta_3 marr_{it} + \beta_4 hs_{it} + \mu_{it} \dots\dots (12)$$

$$y_{it}^{ie} = \beta_5 + \beta_6 a_{it} + \beta_7 a_{it}^2 + \beta_8 marr_{it} + \beta_9 hs_{it} + \mu_{it} \dots\dots (13)$$

$$y_{it}^{une} = \beta_{10} + \beta_{11} a_{it} + \beta_{12} a_{it}^2 + \beta_{13} marr_{it} + \beta_{14} hs_{it} + \mu_{it} \dots\dots (14)$$

$$y_{it}^{econi} = \beta_{15} + \beta_{16} a_{it} + \beta_{17} a_{it}^2 + \beta_{18} marr_{it} + \beta_{19} hs_{it} + \mu_{it} \dots\dots (15)$$

2.5 DEFINITION OF VARIABLES

Data for estimating work-life expectancies and future income loss is first categorised into different samples for analysis. This provides a targeted analysis, important in identifying patterns and trends of specific sample groups. The data is grouped according to gender, specifically male and female. The data is also grouped into four major population groups in South Africa which are Black, White, Coloured and Asian/Indian populations. Furthermore, data is categorised into different education groups with one data for less than high school education, high school with some college and college degree and more. In total fifteen samples of data categorised according to race, gender and education are developed from the NIDS dataset. Race, gender and education categories are further explained below.

Our paper implements a multinomial probit regression which consists of labour market states as the dependent variable and four independent variables which are age, age squared, married and health status. The variables mentioned below are used in the estimation based on equations (12), (13), (14) and (15).

2.5.1 Regression Variables

a. Labour market status (y_{it})

Labour market status is the categorical dependent variable for the multinomial probit model. In this paper, the dependent variable has four labour states which are formal employment, informal employment, unemployed and economically inactive. Every labour market state takes the value of 1 if an individual is in that state and zero if in another state. Labour market status is an important indicator of the quality of life and economic well-being. Informal employment consists of work arrangements carried out by individuals without stipulated regulations and health or social protection (ILO, 2023a). This is in contrast to formal employment which involves work arrangements which follow rules and regulations at the work- place and workers normally have health insurance and other social protection benefits.

In addition, formally employed individuals earn a salary or wage over a certain period. Informally employed individuals may also earn an income every month, over a period, but it may not be clearly defined. Furthermore, an unemployed individual is someone who is not employed and actively looking for a job (StatsSA, 1998). StatsSA uses the definition of unemployment which is in line with the International Labour Organisation (ILO) definition. In

addition, economically inactive people are those who are neither employed nor unemployed in the labour market (Leaker, 2009). This may include elderly people who may have retired from work or young people who are still studying. In this study, formal employment is represented by those individuals in the NIDS questionnaire who indicated that they were formally employed and earned a wage or salary. Informally employed was recorded for those individuals who highlighted that they were self-employed. Unemployed individuals in the questionnaire answered that they were unemployed whilst those economically inactive people included those who highlighted that they were at home not employed or not actively looking for a job.

b. Age (a_{it})

Age is a demographic and continuous variable which shows how long someone has lived up to a certain period. Age as a social construct is important in research since it is associated with various key outcomes (Johfre & Saperstein, 2023). Age is an important factor in labour market status as it shows the experience and career stage of an employee. The age of individuals in the dataset is obtained by subtracting the year of the survey from the year the individual was born. For example, if it is wave 5 of the NIDS dataset, age is calculated by subtracting 2017 when wave 5 was conducted from the recorded birth year of the respondent. For work- life expectancies, it is expected that age should have a positive relationship with labour market status for young adults and then decline with old age.

c. Age squared (a_{it}^2)

It is the square of the calculated age of individuals in the dataset. The variable age squared is an independent variable which aims to capture the non-linear relationship between age and the dependent variable of labour market status. This is because it is expected that the impact of age will differ across certain age groups, such as the youth, the middle-aged and the old. The use of age squared as an exploratory variable is consistent with what other papers produced which estimated work-life expectancies (Dudel & Myrskylä, 2017d; Millimet et al., 2003, 2010a).

d. Married ($marr_{it}$)

This is a dummy independent variable used in the paper and takes the value of 1 if an individual is married and zero if not married. Marriage is a socially approved union between two people with rights and obligations which need to be followed (Ember, 2021). Marital status is a key variable which influences the labour market status of individuals. For example, individuals may be married to share financial responsibilities if they have jobs which earn low incomes.

Data is extracted directly from NIDS dataset where an individual answered if he or she was married or not.

e. Health Status (hs_{it})

This is a dummy independent variable which takes the value of 1 if an individual replied that he or she was healthy and zero if not healthy. Health status is an important factor which influences an individual's ability to work. A healthy person relates to an individual who is not affected by diseases and has a complete state of well-being (Leonardi, 2018; WHO, 1946). We expect a positive relationship between health status and labour market status as it is anticipated that those who are healthy will most likely have the ability to work and be productive.

2.5.2 Variables used for Creating Categories

a. Gender

Gender can be defined as a social concept, which shows differences in the attributes and responsibilities between male and female people (UNICEF, 2017). Gender analysis in studies is important to show disparities, which may exist, between men and women (Sultana & Lazim, 2011). In this paper, data is categorised into male and female. The NIDS questionnaire consisted of a question which asked individuals to code their gender. In the dataset, male was recorded under the variable of gender 1 and female was recorded under gender 2. Categorised data analysed by gender is important to generate gender-specific work life expectancies.

b. Race

Race can be seen as a socio-economic concept, which distinguishes people due to physical appearances, such as skin colour and facial characteristics (Williams et al., 1997). Race is important as it explains some of the differences in circumstances and behaviour amongst different groups of people (Gaines et al., 1997). In this paper, data is categorised according to four common races in South Africa, which were Blacks, Whites, Coloureds and Asians/Indians. In the NIDS questionnaire, individuals were asked which population group they belonged to. Blacks were coded 1, Coloureds were coded 2, Asian/Indians were coded 3 and Whites were coded 4. Categorising data by race is important to see the influence of different races in South Africa on work-life expectancies.

c. Education

Educational attainment can be viewed as the highest category of education, which a person would have completed at a certain period (OECD, 2015). In addition, educational attainment can be measured in terms of the proportion of people found in that specific age group (OECD, 2015). Educational attainment is an important factor for households to gain employment, and adequate health facilities as well as for income generation (Belfield & Levin, 2016). In this paper, data is categorised into three education groups, which are less than high school education, high school with some college and college degree and above. These categories are consistent with what other papers used when estimating work-life expectancies (Krueger et al., 2006; Millimet et al., 2003). Categorising data using education is important to understand the estimated impact of education on work-life expectancies.

2.6 DATA SOURCES

Our paper uses the National Income Dynamics Survey (NIDS) dataset from the Southern Africa Labour and Development Research Unit (SALDRU). NIDS is a longitudinal dataset which ran from 2008 to 2017. Specifically, the longitudinal data was grouped into waves, where Wave 1 is a dataset from the 2008 survey, Wave 2, from the 2010 to 2011 survey, Wave 3 from 2012, Wave 4 , from the 2015 survey and Wave 5 from the 2017 survey.

The NIDS dataset captured various household and demographic characteristics of South African citizens over time. The survey began in 2008 with a national representative sample of 7,300 households, which had over 28,000 individuals in the nine provinces of South Africa. Interviewees known as Continuing Sample Members (CSMs) were tracked over time to capture similarities and changes in living standards and well-being. Other members of the same households who were interviewed but not tracked in the following survey periods were known as Temporary Sample members (TSMs). As a result of high levels of attrition in waves 1 to 4 from population groups, such as the Whites and Asian/Indians, an additional sample was added to Wave 5, which ended up having 39,434 individuals who were interviewed successfully. On average, 73% of CSMs who were interviewed in wave 1 were also successfully interviewed in wave 5. For our paper, the number of observations is16,918 observations merging the five waves into one dataset and data cleaning. However, specific to our paper for regressing and analysing the data into different transitions of the labour states later, we append the five waves. The number of observations after appending the five waves is 107,651.

2.7 RESULTS

2.7.1 Work Life Expectancies

Table 2.3: Work life expectancies for males and females for all four labour states

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	22.12	11.89	7.94	5.47	18.36	12.74	11.01	2.80
17	21.50	11.48	7.52	5.12	17.71	12.38	10.53	2.68
18	20.87	11.06	7.11	4.78	17.07	12.03	10.07	2.56
19	20.27	10.68	6.74	4.48	16.45	11.69	9.61	2.45
20	19.66	10.29	6.36	4.18	15.77	11.31	9.13	2.33
21	18.97	9.80	5.83	3.73	14.97	10.90	8.50	2.16
22	18.30	9.34	5.33	3.32	14.28	10.54	7.94	2.00
23	17.71	8.95	4.92	3.00	13.59	10.18	7.38	1.87
24	17.07	8.52	4.50	2.67	12.97	9.85	6.87	1.74
25	16.43	8.06	4.07	2.36	12.35	9.49	6.37	1.63
26	15.84	7.66	3.71	2.10	11.79	9.17	5.92	1.54
27	15.31	7.31	3.39	1.87	11.24	8.85	5.49	1.44
28	14.73	6.92	3.07	1.65	10.73	8.56	5.09	1.37
29	14.21	6.57	2.78	1.47	10.24	8.26	4.72	1.29
30	13.72	6.24	2.51	1.29	9.74	7.94	4.36	1.22
31	13.23	5.91	2.27	1.14	9.24	7.62	4.00	1.14
32	12.76	5.58	2.02	0.98	8.82	7.36	3.70	1.09
33	12.33	5.30	1.84	0.89	8.39	7.07	3.42	1.04
34	11.94	5.07	1.69	0.82	7.96	6.77	3.14	0.98
35	11.50	4.80	1.53	0.72	7.55	6.49	2.88	0.93
36	11.05	4.53	1.37	0.64	7.16	6.20	2.64	0.88
37	10.68	4.32	1.25	0.57	6.77	5.90	2.42	0.82
38	10.27	4.09	1.13	0.51	6.42	5.66	2.22	0.78

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
39	9.83	3.87	1.01	0.44	6.07	5.40	2.03	0.73
40	9.42	3.65	0.90	0.39	5.72	5.12	1.85	0.68
41	8.97	3.43	0.80	0.33	5.37	4.84	1.67	0.63
42	8.53	3.21	0.70	0.28	5.05	4.60	1.51	0.58
43	8.09	2.98	0.60	0.23	4.78	4.40	1.38	0.55
44	7.68	2.81	0.54	0.19	4.47	4.15	1.24	0.51
45	7.25	2.62	0.47	0.17	4.21	3.96	1.13	0.48
46	6.80	2.42	0.41	0.14	3.93	3.73	1.02	0.44
47	6.37	2.23	0.36	0.12	3.68	3.52	0.91	0.41
48	5.94	2.05	0.31	0.10	3.43	3.32	0.82	0.38
49	5.53	1.88	0.27	0.08	3.18	3.10	0.74	0.35
50	5.14	1.72	0.23	0.07	2.94	2.89	0.66	0.32
51	4.76	1.57	0.20	0.05	2.70	2.68	0.58	0.29
52	4.38	1.44	0.17	0.04	2.47	2.48	0.51	0.25
53	4.03	1.30	0.14	0.04	2.26	2.29	0.45	0.22
54	3.67	1.16	0.12	0.03	2.05	2.10	0.39	0.18
55	3.34	1.05	0.10	0.02	1.85	1.90	0.34	0.15
56	3.01	0.94	0.10	0.03	1.65	1.70	0.29	0.11
57	2.71	0.84	0.08	0.02	1.45	1.51	0.24	0.08
58	2.36	0.72	0.07	0.02	1.27	1.34	0.21	0.07
59	2.03	0.61	0.05	0.02	1.09	1.15	0.17	0.06
60	1.71	0.50	0.04	0.01	0.91	0.98	0.14	0.05
61	1.43	0.42	0.04	0.01	0.74	0.79	0.11	0.04
62	1.13	0.33	0.03	0.01	0.58	0.63	0.08	0.03
63	0.84	0.25	0.02	0.01	0.43	0.46	0.06	0.02
64	0.53	0.16	0.01	0.00	0.28	0.30	0.04	0.01
65	0.22	0.07	0.01	0.00	0.12	0.13	0.02	0.01

WLEfe- Working Life Expectancies for formal employment; WLEie-Work Life Expectancies for informal employment; WLEune-Work Life Expectancies for unemployed; WLEeconi-Work Life Expectancies for economically inactive

Table 2.3 shows the work life expectancies for males and females, aged 16 to 65 for all labour states. The work life expectancies decrease as age increases from 16 to 65 years. All work-life expectancies are relevant however, we interpret selected years highlighted in yellow in all tables of this study. On average, males have higher work-life expectancies for those who are formally employed from 16 to 65 years as compared to their female counterparts. A 20-year-old male, for example, who is formally employed has a work-life expectancy of 19.66 years, whilst a 20-year-old female who is also formally employed has a work-life expectancy of 15.77 years. By contrast, females have slightly higher work-life expectancies on average for those who are in informal employment as compared to the male population from ages 16 to 65 years. A 30-year-old female who is informally employed, for example, has a work-life expectancy of 7.94 years which is 1.70 years higher than the male work-life expectancy of 6.24 years for the same labour state. The differences between male and female work-life expectancies for formal employment on average are higher for all ages as compared to the differences between female and male work-life expectancies of the informally employed. The highest difference between male and female work-life expectancies for formal employment is 4 years for 21 (18.97 years for male formal employment minus 14.97 years for female formally employed work-life expectancies). This is different from the highest difference between male and female work-life expectancies for informal employment, which is 1.78 years for the age of 32 (7.36 years for female informal employment minus 5.58 years for male informally employed work-life expectancies). The work-life expectancies for unemployed females are higher as well on average as compared to male work-life expectancies for those unemployed also higher for those economically inactive as compared to male counterparts after 32 years. For all ages, the work-life expectancies for those formally employed for both male and female are the highest as compared to other labour states. This is followed by those who are in informal employment.

Table 2.4: Work-life expectancies by gender and race (Blacks)

	Black Male				Black Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	15.01	9.31	7.99	4.92	12.94	11.18	11.01	4.48

	Black Male				Black Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
17	14.58	8.96	7.58	4.60	12.60	10.96	10.52	4.21
18	14.15	8.59	7.17	4.29	12.26	10.71	9.99	3.94
19	13.74	8.22	6.80	4.02	11.91	10.50	9.50	3.68
20	13.31	7.85	6.43	3.75	11.56	10.31	9.00	3.43
21	12.84	7.37	5.93	3.35	11.18	10.09	8.35	3.04
22	12.35	6.88	5.41	2.97	10.84	9.94	7.77	2.73
23	11.96	6.52	5.03	2.70	10.47	9.71	7.14	2.41
24	11.44	6.11	4.61	2.40	10.15	9.56	6.58	2.13
25	10.91	5.67	4.15	2.11	9.80	9.29	6.05	1.87
26	10.41	5.23	3.78	1.87	9.49	9.06	5.58	1.67
27	9.92	4.87	3.41	1.63	9.16	8.72	5.15	1.47
28	9.44	4.45	3.08	1.42	8.85	8.45	4.75	1.30
29	9.04	4.07	2.78	1.25	8.54	8.25	4.35	1.14
30	8.61	3.75	2.45	1.05	8.23	7.95	3.96	1.00
31	8.25	3.38	2.19	0.90	7.91	7.56	3.60	0.84
32	7.93	3.16	1.88	0.73	7.64	7.31	3.35	0.74
33	7.77	2.99	1.69	0.65	7.35	6.97	3.07	0.65
34	7.53	2.79	1.51	0.60	7.04	6.60	2.79	0.56
35	7.33	2.63	1.34	0.51	6.75	6.28	2.50	0.47
36	7.20	2.46	1.19	0.46	6.48	5.99	2.28	0.42
37	7.12	2.38	1.07	0.40	6.20	5.68	2.07	0.36
38	6.95	2.21	0.94	0.35	5.94	5.32	1.89	0.31
39	6.79	2.05	0.84	0.31	5.69	5.06	1.72	0.27
40	6.68	2.01	0.72	0.28	5.42	4.84	1.52	0.23
41	6.49	1.82	0.63	0.23	5.15	4.58	1.32	0.19
42	6.29	1.64	0.53	0.19	4.89	4.31	1.16	0.16
43	6.16	1.49	0.44	0.15	4.67	4.10	1.04	0.14

	Black Male				Black Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
44	6.04	1.38	0.38	0.12	4.42	3.82	0.94	0.11
45	5.87	1.29	0.32	0.11	4.21	3.57	0.83	0.09
46	5.64	1.16	0.26	0.09	3.97	3.33	0.72	0.08
47	5.42	1.07	0.22	0.08	3.75	3.11	0.62	0.07
48	5.14	0.92	0.16	0.07	3.54	2.90	0.55	0.06
49	4.83	0.74	0.12	0.05	3.32	2.61	0.48	0.05
50	4.56	0.61	0.09	0.05	3.11	2.31	0.41	0.04
51	4.31	0.52	0.07	0.03	2.89	2.04	0.36	0.04
52	4.06	0.50	0.06	0.02	2.68	1.82	0.30	0.03
53	3.80	0.46	0.06	0.02	2.48	1.62	0.26	0.03
54	3.52	0.39	0.05	0.01	2.28	1.44	0.20	0.02
55	3.26	0.34	0.05	0.01	2.07	1.21	0.17	0.02
56	2.97	0.31	0.04	0.02	1.87	1.01	0.14	0.02
57	2.75	0.30	0.04	0.01	1.66	0.79	0.10	0.01
58	2.49	0.30	0.04	0.01	1.47	0.68	0.08	0.01
59	2.18	0.26	0.03	0.00	1.28	0.54	0.06	0.01
60	1.88	0.22	0.03	0.00	1.08	0.43	0.04	0.01
61	1.59	0.16	0.02	0.00	0.89	0.27	0.03	0.00
62	1.27	0.12	0.02	0.00	0.70	0.20	0.02	0.00
63	0.94	0.09	0.01	0.00	0.52	0.15	0.01	0.00
64	0.60	0.06	0.01	0.00	0.33	0.10	0.00	0.00
65	0.25	0.03	0.01	0.00	0.14	0.06	0.00	0.00

Table 2.4 shows the work-life expectancies for Black males and females, for all labour states. The work-life expectancies for all labour states are decreasing as age is increasing from 16 years to 65 years. Black male work-life expectancies for those formally employed are higher as compared to Black female work-life expectancies for those also in formal employment. A 25-year-old Black male who is formally employed has a work-life expectancy of 10.91 years

as compared to a Black female formal employee with a work-life expectancy of 9.80 years. In contrast, Black female informal workers have higher work-life expectancies as compared to their Black male counterparts in informal employment. A 20-year-old Black female informal worker has a work-life expectancy of 10.31 years as compared to a 20-year-old Black male informal worker who has a work-life expectancy of 7.85 years. Female Blacks have higher work-life expectancies for being unemployed as compared to Black males. A 35-year-old Black female who is unemployed has a work-life expectancy of 2.50 years as compared to a 35-year-old Black male who is unemployed and has a work-life expectancy of 1.34 years. Furthermore, on average work-life expectancies for male Blacks are higher as compared to Black females.

Table 2.5: Work-life expectancies by gender and race (White)

	Male White				Female White			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	29.10	13.93	8.87	6.15	25.57	15.94	11.11	1.85
17	28.31	13.43	8.42	5.74	24.93	15.35	10.56	1.84
18	27.49	12.93	7.97	5.34	24.31	14.83	10.00	1.82
19	26.66	12.43	7.55	4.98	23.77	14.40	9.71	1.82
20	25.80	11.90	7.12	4.62	23.05	13.84	9.19	1.81
21	24.88	11.25	6.52	4.06	22.25	13.14	8.50	1.78
22	23.95	10.56	5.97	3.58	21.47	12.60	7.91	1.76
23	23.19	9.99	5.53	3.20	20.57	12.14	7.37	1.75
24	22.41	9.37	5.14	2.82	19.73	11.66	6.84	1.74
25	21.59	8.76	4.73	2.49	18.83	11.19	6.40	1.74
26	20.78	8.16	4.35	2.18	17.93	10.78	5.99	1.72
27	20.08	7.52	4.13	1.93	16.98	10.40	5.65	1.72
28	19.22	6.93	3.84	1.69	16.05	9.97	5.26	1.69
29	18.40	6.42	3.54	1.49	15.29	9.58	4.89	1.67
30	17.75	5.84	3.39	1.31	14.48	9.19	4.59	1.61
31	16.97	5.35	3.15	1.13	13.73	8.75	4.31	1.57
32	16.44	4.88	3.01	0.98	13.03	8.30	4.03	1.56
33	15.86	4.56	2.85	0.89	12.34	7.91	3.79	1.50

	Male White				Female White			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
34	15.47	4.21	2.74	0.82	11.74	7.49	3.54	1.45
35	14.88	3.94	2.61	0.72	11.15	7.15	3.33	1.39
36	14.21	3.75	2.38	0.63	10.58	6.70	3.09	1.33
37	13.65	3.57	2.27	0.56	10.00	6.29	2.88	1.27
38	13.01	3.31	2.16	0.49	9.46	6.00	2.74	1.23
39	12.30	3.18	1.96	0.42	8.90	5.64	2.54	1.16
40	11.75	3.01	1.90	0.39	8.31	5.34	2.36	1.09
41	10.96	2.83	1.73	0.32	7.79	5.04	2.19	1.01
42	10.21	2.63	1.60	0.26	7.27	4.78	2.07	0.94
43	9.39	2.47	1.45	0.21	6.80	4.53	1.95	0.90
44	8.72	2.31	1.36	0.17	6.28	4.22	1.81	0.83
45	8.03	2.21	1.25	0.15	5.83	3.97	1.69	0.79
46	7.40	2.07	1.15	0.13	5.36	3.72	1.58	0.73
47	6.85	1.96	1.07	0.11	4.89	3.49	1.48	0.66
48	6.25	1.76	1.01	0.09	4.45	3.28	1.39	0.61
49	5.65	1.58	0.93	0.07	4.06	3.01	1.29	0.56
50	5.08	1.47	0.83	0.05	3.67	2.76	1.19	0.51
51	4.57	1.35	0.78	0.03	3.31	2.54	1.11	0.46
52	4.14	1.30	0.74	0.02	2.93	2.36	1.04	0.41
53	3.75	1.21	0.70	0.02	2.63	2.17	0.97	0.37
54	3.36	1.08	0.68	0.01	2.32	1.98	0.89	0.32
55	3.00	0.96	0.64	0.00	2.02	1.76	0.82	0.28
56	2.70	0.86	0.65	0.01	1.73	1.57	0.76	0.23
57	2.40	0.78	0.63	0.00	1.48	1.36	0.70	0.20
58	2.05	0.74	0.58	0.00	1.25	1.15	0.63	0.18
59	1.72	0.65	0.52	0.00	1.05	0.96	0.56	0.15
60	1.43	0.56	0.47	0.00	0.86	0.77	0.49	0.12

	Male White				Female White			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
61	1.15	0.45	0.40	0.00	0.68	0.62	0.41	0.10
62	0.89	0.35	0.33	0.00	0.53	0.48	0.32	0.06
63	0.65	0.26	0.25	0.00	0.38	0.34	0.24	0.05
64	0.41	0.17	0.16	0.00	0.24	0.24	0.16	0.03
65	0.16	0.08	0.07	0.00	0.11	0.11	0.08	0.01

Table 2.5 shows the work-life expectancies for the White male and female population, aged 16 to 65, across all four labour states. The white male population who are formally employed have higher work-life expectancies as compared to the white female population. A 23-year-old White male who is formally employed has a work-life expectancy of 23.19 years. This is about 2.62 years higher as compared to the work-life expectancy of 20.57 years for a 23-year-old White female who is also formally employed. On the other hand, White female work-life expectancies for those informally employed are higher than informally employed White male work-life expectancies. A 20-year-old White female who is informally employed has a work-life expectancy of 13.84 years as compared to a similar-aged White male, informally employed, with a work-life expectancy of 11.90 years. Furthermore, unemployed and economically inactive work-life expectancies for White females are higher than White males who are unemployed and economically inactive (up to 61 years for those unemployed and after 28 years for those economically inactive).

Table 2.6: Work-life expectancies by gender and race (Coloured)

	Male Coloured				Female Coloured			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	21.50	11.90	9.79	6.98	14.68	8.29	6.83	2.78
17	20.93	11.59	9.29	6.57	14.26	8.22	6.45	2.59
18	20.34	11.23	8.79	6.15	13.81	8.13	6.06	2.40
19	19.79	10.97	8.36	5.80	13.35	8.00	5.70	2.23
20	19.21	10.65	7.90	5.44	12.88	7.92	5.35	2.06
21	18.60	10.37	7.29	4.92	12.36	7.87	4.84	1.79

	Male Coloured				Female Coloured			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
22	17.98	10.05	6.68	4.44	11.86	7.91	4.37	1.56
23	17.37	9.70	6.11	4.02	11.41	7.95	3.94	1.37
24	16.72	9.35	5.58	3.62	10.93	7.97	3.54	1.20
25	16.07	8.88	5.01	3.22	10.47	7.86	3.19	1.05
26	15.54	8.51	4.54	2.92	10.01	7.79	2.86	0.92
27	15.09	8.28	4.09	2.68	9.61	7.67	2.60	0.82
28	14.50	7.83	3.66	2.41	9.26	7.61	2.36	0.73
29	14.05	7.44	3.26	2.18	8.87	7.54	2.13	0.66
30	13.73	7.22	2.87	2.02	8.48	7.38	1.92	0.59
31	13.42	6.91	2.54	1.87	8.11	7.09	1.75	0.53
32	13.02	6.62	2.17	1.67	7.73	6.82	1.59	0.46
33	12.63	6.36	1.91	1.53	7.37	6.56	1.45	0.42
34	12.19	6.08	1.66	1.42	7.01	6.26	1.31	0.38
35	11.81	5.83	1.43	1.28	6.67	6.03	1.18	0.34
36	11.41	5.58	1.24	1.14	6.31	5.72	1.07	0.31
37	11.17	5.41	1.06	1.03	5.96	5.40	0.97	0.27
38	10.82	5.26	0.91	0.90	5.65	5.15	0.88	0.25
39	10.35	4.85	0.76	0.75	5.33	4.91	0.80	0.23
40	9.92	4.70	0.61	0.60	5.01	4.72	0.71	0.21
41	9.53	4.51	0.52	0.51	4.71	4.48	0.63	0.19
42	9.14	4.28	0.41	0.40	4.43	4.25	0.56	0.18
43	8.76	4.04	0.30	0.29	4.18	4.04	0.52	0.16
44	8.33	3.86	0.23	0.22	3.95	3.77	0.48	0.15
45	7.89	3.56	0.14	0.13	3.71	3.56	0.43	0.14
46	7.41	3.34	0.08	0.07	3.46	3.33	0.38	0.13
47	6.96	3.12	0.07	0.06	3.25	3.13	0.34	0.13
48	6.50	2.94	0.07	0.06	3.03	2.95	0.31	0.12

	Male Coloured				Female Coloured			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
49	6.09	2.74	0.06	0.05	2.80	2.68	0.28	0.11
50	5.65	2.44	0.05	0.04	2.59	2.43	0.25	0.11
51	5.24	2.18	0.05	0.04	2.38	2.20	0.22	0.10
52	4.81	1.98	0.05	0.04	2.17	2.04	0.20	0.09
53	4.43	1.77	0.04	0.03	1.96	1.83	0.17	0.09
54	3.99	1.54	0.03	0.02	1.78	1.65	0.15	0.08
55	3.61	1.35	0.03	0.02	1.59	1.41	0.13	0.08
56	3.19	1.13	0.03	0.02	1.42	1.21	0.11	0.07
57	2.83	0.92	0.02	0.01	1.25	0.96	0.10	0.07
58	2.42	0.69	0.02	0.01	1.08	0.72	0.08	0.06
59	2.10	0.56	0.02	0.01	0.92	0.55	0.07	0.06
60	1.76	0.44	0.01	0.00	0.77	0.38	0.06	0.05
61	1.50	0.39	0.01	0.00	0.63	0.27	0.05	0.04
62	1.18	0.28	0.01	0.00	0.50	0.19	0.04	0.04
63	0.86	0.21	0.01	0.00	0.36	0.11	0.02	0.03
64	0.53	0.13	0.00	0.00	0.24	0.09	0.01	0.02
65	0.21	0.06	0.00	0.00	0.10	0.04	0.01	0.01

Table 2.6 shows the work-life expectancies for Coloured male and female population, aged 16 to 65, across all four labour states. The Coloured male population who are formally employed have higher work-life expectancies than the Coloured female Coloured population. At age 30 years, Coloured males who were formerly employed have a higher work-life expectancy of 13.73 years as compared to Coloured females who have a work-life expectancy of 8.48 years for the same age. The informally employed Coloured male population have higher work-life expectancies as compared to the Coloured female population for the ages 16 to 56 years. At age 57, the Coloured female population who were informally employed have a slightly higher work-life expectancy of 0.96 years as compared to the Coloured male population's work-life expectancy of 0.92 years for the same state. Work-life expectancies for the unemployed are higher for Coloured males as compared to Coloured females from ages 16 to 38 years. The

work-life expectancy for Coloured females who are unemployed at age 52 is 0.20 years, which is higher than the work-life expectancy of 0.05 years for Coloured males at the same age. Work-life expectancies for Coloured males who are economically inactive have been higher as compared to work-life expectancies for Coloured females who are also economically inactive up to the age of 44 years.

Table 2.7: Work-life expectancies by gender and race (Asian/Indian)

	Male Asian/Indian				Female Asian/Indian			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	22.86	12.42	5.12	3.83	20.00	15.57	15.04	2.10
17	22.17	11.94	4.80	3.58	19.10	15.00	14.53	2.09
18	21.51	11.49	4.51	3.34	18.06	14.44	14.12	2.07
19	20.90	11.10	4.25	3.12	17.21	13.85	13.53	2.06
20	20.32	10.75	3.98	2.91	16.23	13.18	12.99	2.02
21	19.57	10.21	3.57	2.59	15.22	12.48	12.32	2.02
22	18.92	9.87	3.27	2.29	14.11	11.73	11.72	1.96
23	18.33	9.59	3.01	2.07	12.93	10.91	10.83	1.94
24	17.73	9.25	2.67	1.84	11.90	10.21	10.11	1.91
25	17.14	8.92	2.38	1.62	11.06	9.64	9.84	1.85
26	16.64	8.74	2.16	1.43	10.27	9.07	9.25	1.83
27	16.15	8.58	1.92	1.24	9.70	8.59	8.56	1.77
28	15.78	8.48	1.70	1.08	9.08	8.19	8.00	1.75
29	15.36	8.36	1.54	0.95	8.31	7.66	7.51	1.69
30	14.80	8.14	1.33	0.79	7.74	7.26	6.97	1.68
31	14.29	8.00	1.21	0.67	7.48	7.10	6.34	1.63
32	13.64	7.66	1.01	0.54	7.27	6.99	5.83	1.61
33	13.05	7.29	0.91	0.48	6.94	6.82	5.37	1.57
34	12.59	7.21	0.85	0.44	6.49	6.72	4.93	1.54
35	11.97	6.79	0.74	0.37	6.03	6.52	4.52	1.51
36	11.38	6.33	0.66	0.34	5.80	6.40	4.12	1.46

	Male Asian/Indian				Female Asian/Indian			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
37	10.79	5.92	0.60	0.29	5.51	6.22	3.76	1.39
38	10.31	5.58	0.50	0.25	5.33	6.18	3.37	1.32
39	9.89	5.39	0.48	0.22	5.00	5.98	3.06	1.24
40	9.32	4.88	0.37	0.20	4.42	5.59	2.81	1.19
41	8.90	4.56	0.32	0.17	4.00	5.28	2.54	1.12
42	8.50	4.28	0.26	0.13	3.65	5.05	2.25	1.06
43	8.06	3.93	0.21	0.10	3.46	4.95	2.02	1.01
44	7.65	3.68	0.20	0.08	3.34	4.82	1.73	0.94
45	7.22	3.42	0.17	0.08	3.09	4.73	1.57	0.90
46	6.76	3.12	0.15	0.06	2.83	4.54	1.39	0.84
47	6.26	2.77	0.13	0.06	2.57	4.35	1.19	0.77
48	5.88	2.58	0.10	0.05	2.33	4.14	1.04	0.74
49	5.56	2.46	0.10	0.05	2.22	4.08	0.91	0.69
50	5.28	2.36	0.09	0.05	2.07	4.06	0.78	0.63
51	4.94	2.24	0.08	0.04	1.97	3.94	0.62	0.58
52	4.53	1.98	0.05	0.04	1.79	3.69	0.50	0.47
53	4.15	1.77	0.02	0.02	1.65	3.54	0.41	0.40
54	3.81	1.63	0.02	0.02	1.46	3.31	0.31	0.30
55	3.50	1.55	0.01	0.02	1.33	3.22	0.23	0.21
56	3.17	1.45	0.02	0.02	1.18	3.02	0.15	0.13
57	2.87	1.36	0.01	0.01	1.10	2.94	0.06	0.05
58	2.50	1.16	0.01	0.01	1.00	2.80	0.04	0.03
59	2.12	0.98	0.00	0.01	0.89	2.56	0.03	0.03
60	1.76	0.77	0.00	0.01	0.74	2.33	0.02	0.01
61	1.48	0.69	0.02	0.01	0.63	2.01	0.02	0.01
62	1.19	0.57	0.02	0.01	0.49	1.64	0.02	0.01
63	0.88	0.44	0.01	0.01	0.37	1.25	0.01	0.01

	Male Asian/Indian				Female Asian/Indian			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
64	0.55	0.28	0.01	0.00	0.24	0.79	0.01	0.00
65	0.23	0.12	0.01	0.00	0.11	0.32	0.01	0.00

Table 2.7 shows the work-life expectancies for the Asian/Indian male and female Asian/Indian population for all four labour states, aged 16 to 65. All work-life expectancies are decreasing as age increases for all four labour states. Asian/Indian males who are formally employed have higher work-life expectancies as compared to Asian/Indian females. At age 26, an Asian/Indian male, who is formally employed has a work-life expectancy of 16.64 years which is about 6 years higher as compared to work-life expectancy of 10.27 years for an Asian/Indian female, who is formally employed at the same age. Furthermore, Asian/Indian females who are informally employed have higher work-life expectancies than Asian/Indians males who are also informally employed, only up to the age of 27. Work-life expectancy for an Asian/Indian male who is informally employed is at 7.29 years for a 33-year-old as compared to a work-life expectancy of 6.82 years for an Asian/Indian female who is informally employed at the same age. Asian/Indian female work-life expectancies are higher for the unemployed up to 60 years as compared to male work-life expectancies for the unemployed. whilst Asian/Indian male work-life expectancies are higher than for Asian/Indian females work-life expectancies, for those economically inactive, only up to the age of 23.

Table 2.8: Work-life expectancies less than high school education

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	29.96	19.38	12.97	9.94	26.93	21.29	18.29	5.47
17	29.42	18.77	12.35	9.38	25.95	20.74	17.55	5.31
18	17.45	14.28	9.49	7.44	13.83	14.77	12.59	4.50
19	16.72	13.83	9.06	7.05	13.08	14.35	11.95	4.35
20	15.95	13.36	8.61	6.65	12.26	13.88	11.29	4.17
21	15.03	12.79	8.01	6.04	11.23	13.34	10.49	3.94
22	14.14	12.23	7.40	5.46	10.47	12.89	9.81	3.76
23	13.40	11.82	6.98	5.05	9.75	12.39	9.25	3.59

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
24	12.60	11.30	6.49	4.59	9.08	11.92	8.74	3.44
25	11.77	10.71	5.95	4.13	8.27	11.38	8.21	3.26
26	11.05	10.21	5.49	3.73	7.69	10.95	7.73	3.14
27	10.46	9.73	5.09	3.44	7.17	10.48	7.22	2.97
28	9.82	9.22	4.68	3.07	6.76	10.05	6.76	2.84
29	9.29	8.76	4.30	2.82	6.29	9.59	6.29	2.68
30	8.82	8.29	3.93	2.55	5.69	9.13	5.84	2.53
31	8.27	7.85	3.59	2.31	5.12	8.65	5.37	2.36
32	7.73	7.34	3.23	2.05	4.63	8.34	5.00	2.25
33	7.30	6.92	2.96	1.87	4.26	7.98	4.64	2.13
34	6.96	6.59	2.74	1.73	3.96	7.59	4.26	1.99
35	6.54	6.19	2.50	1.56	3.48	7.23	3.89	1.85
36	5.96	5.81	2.25	1.41	3.00	6.90	3.58	1.73
37	5.62	5.50	2.05	1.27	2.49	6.55	3.29	1.60
38	5.19	5.17	1.86	1.15	2.10	6.26	3.02	1.50
39	4.64	4.81	1.65	1.01	1.77	5.97	2.76	1.39
40	4.47	4.50	1.49	0.90	1.38	5.64	2.51	1.27
41	4.19	4.18	1.33	0.79	1.07	5.27	2.25	1.16
42	3.82	3.78	1.17	0.69	0.76	4.96	2.03	1.06
43	3.54	3.50	1.00	0.59	0.46	4.74	1.86	0.98
44	3.30	3.26	0.88	0.51	0.24	4.40	1.66	0.88
45	3.09	3.05	0.77	0.45	0.23	4.10	1.50	0.82
46	2.72	2.68	0.65	0.39	0.23	3.76	1.35	0.75
47	2.54	2.50	0.55	0.34	0.22	3.48	1.19	0.69
48	2.36	2.32	0.47	0.28	0.21	3.25	1.06	0.62
49	1.93	1.89	0.37	0.23	0.21	3.00	0.95	0.56
50	1.69	1.65	0.28	0.20	0.20	2.73	0.83	0.51

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
51	1.57	1.53	0.23	0.15	0.20	2.47	0.72	0.45
52	1.36	1.32	0.17	0.13	0.20	2.20	0.62	0.39
53	1.19	1.15	0.12	0.12	0.18	1.99	0.53	0.33
54	1.04	1.00	0.09	0.08	0.17	1.79	0.45	0.28
55	0.99	0.71	0.07	0.04	0.14	1.59	0.38	0.23
56	0.86	0.60	0.08	0.03	0.14	1.36	0.31	0.17
57	0.77	0.50	0.06	0.02	0.12	1.15	0.25	0.12
58	0.69	0.39	0.05	0.02	0.11	0.97	0.20	0.09
59	0.58	0.30	0.04	0.02	0.11	0.80	0.15	0.07
60	0.42	0.19	0.02	0.01	0.11	0.64	0.12	0.04
61	0.36	0.14	0.02	0.01	0.06	0.48	0.09	0.02
62	0.29	0.10	0.02	0.01	0.05	0.36	0.06	0.01
63	0.23	0.08	0.02	0.00	0.02	0.25	0.05	0.00
64	0.17	0.04	0.00	0.00	0.02	0.16	0.03	0.00
65	0.09	0.02	0.00	0.00	0.01	0.07	0.02	0.00

Table 2.8 shows work-life expectancies for both males and females who have less than a high school education for ages 16 to 65 years. All work-life expectancies for all labour states have a descending order where they are higher for the lower ages and lower for the higher ages. Male work-life expectancies are higher as compared to female work-life expectancies for those formally employed, whilst female work-life expectancies are higher than male work-life expectancies for those who are informally employed. A 21-year-old male with less than a high school education and formally employed has a work-life expectancy of 15.03 years, as compared to a work-life expectancy of 11.23 years for a 21-year-old female who is formally employed and has less than a high school education. In addition, a 25-year-old female who is informally employed and has less than a high school education has a work-life expectancy of 11.38 years as compared to a work-life expectancy of 10.71 years for a similarly aged and educated male. Female work-life expectancies are also higher than male work-life expectancies

for those unemployed, whilst male work-life expectancies are higher than female work-life expectancies for those economically inactive up to the age of 30.

Table 2.9: Work-life expectancies for high school with some college

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	35.99	16.29	10.85	6.48	28.16	16.93	14.75	2.94
17	34.62	15.67	10.21	5.99	27.18	16.40	14.04	2.73
18	20.98	11.21	7.35	4.16	15.10	10.49	9.17	1.90
19	20.15	10.79	6.92	3.86	14.46	10.18	8.65	1.77
20	19.27	10.35	6.48	3.57	13.74	9.82	8.10	1.63
21	18.17	9.71	5.79	3.00	12.87	9.35	7.40	1.36
22	17.13	9.13	5.17	2.53	12.20	8.92	6.77	1.11
23	16.24	8.67	4.67	2.17	11.66	8.52	6.34	0.97
24	15.36	8.21	4.20	1.85	11.23	8.15	5.95	0.85
25	14.51	7.75	3.74	1.57	10.64	7.75	5.56	0.74
26	13.78	7.35	3.34	1.32	10.25	7.43	5.19	0.65
27	13.22	6.99	3.00	1.17	9.99	7.11	4.83	0.60
28	12.57	6.61	2.66	0.95	9.78	6.81	4.49	0.54
29	12.03	6.28	2.36	0.85	9.60	6.52	4.17	0.49
30	11.63	5.97	2.10	0.75	9.26	6.23	3.87	0.46
31	11.20	5.71	1.85	0.66	8.90	5.93	3.57	0.43
32	10.91	5.44	1.62	0.57	8.59	5.75	3.31	0.40
33	10.64	5.21	1.45	0.52	8.40	5.53	3.07	0.38
34	10.37	5.02	1.29	0.49	8.30	5.32	2.81	0.36
35	10.00	4.78	1.14	0.42	8.06	5.16	2.59	0.35
36	9.47	4.57	0.99	0.38	7.72	4.98	2.38	0.32
37	9.20	4.42	0.89	0.34	7.38	4.79	2.19	0.31
38	8.75	4.22	0.78	0.31	7.12	4.63	2.01	0.29
39	8.21	4.02	0.66	0.26	6.90	4.47	1.84	0.27

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
40	8.02	3.82	0.56	0.23	6.65	4.31	1.69	0.24
41	7.70	3.63	0.49	0.20	6.50	4.10	1.53	0.23
42	7.34	3.45	0.40	0.17	6.27	3.93	1.38	0.21
43	7.09	3.27	0.32	0.13	6.05	3.81	1.27	0.18
44	6.87	3.16	0.27	0.11	5.91	3.59	1.13	0.16
45	6.66	3.01	0.22	0.11	5.56	3.41	1.04	0.15
46	6.24	2.84	0.16	0.09	5.37	3.21	0.94	0.15
47	6.11	2.70	0.13	0.08	5.16	3.03	0.83	0.13
48	6.05	3.25	0.10	0.07	4.87	2.90	0.75	0.12
49	5.75	3.09	0.07	0.05	4.58	2.76	0.68	0.10
50	5.50	2.91	0.06	0.04	4.28	2.60	0.60	0.10
51	5.29	2.73	0.04	0.04	3.98	2.45	0.53	0.08
52	5.08	2.58	0.04	0.03	3.81	2.28	0.47	0.07
53	4.88	2.41	0.03	0.03	3.52	2.16	0.41	0.05
54	4.69	2.24	0.03	0.02	3.27	2.04	0.35	0.04
55	4.51	2.42	0.02	0.02	2.88	1.89	0.30	0.04
56	4.25	2.20	0.02	0.01	2.58	1.72	0.25	0.04
57	3.98	2.01	0.02	0.01	2.30	1.59	0.21	0.03
58	3.62	1.76	0.02	0.01	2.01	1.43	0.18	0.03
59	3.25	1.52	0.02	0.01	1.67	1.30	0.14	0.03
60	2.88	1.30	0.02	0.01	1.20	1.13	0.12	0.02
61	2.45	1.11	0.01	0.01	0.86	0.94	0.10	0.02
62	1.96	0.89	0.01	0.00	0.63	0.76	0.07	0.02
63	1.45	0.68	0.01	0.00	0.47	0.57	0.06	0.01
64	0.90	0.44	0.00	0.00	0.30	0.38	0.04	0.01
65	0.35	0.19	0.00	0.00	0.13	0.17	0.02	0.00

Table 2.9 shows the work-life expectancies for males and females who have high school and some college education, for the ages 16 to 65 years. Male work-life expectancies are higher compared to female work-life expectancies for those who are formally employed and have high school and some college education. An 18-year-old male who is formally employed with a high school education and some college, has a work-life expectancy of 20.98 years, which is a 5.88-year difference as compared to a similar-aged and educated female with a work-life expectancy of 15.10 years. Furthermore, a 30-year-old female who is informally employed and has high school with some college education has a slightly higher work-life expectancy of 6.23 years as compared to a similar 30-year-old informally employed male worker who has a work-life expectancy of 5.97 years. However, after 47 years, male work-life expectancies become higher as compared to female work-life expectancies for those who are informally employed. Female work-life expectancies for those with high school and a college education are higher as compared to male work-life expectancies for those unemployed for all ages from 16 to 65 years, whilst male work-life expectancies are higher than female work-life expectancies for those economically inactive up to the age of 38 years.

Table 2.10: Work-life expectancies college degree and above

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
16	.	.	.	.	.	.	.	.
17	.	.	.	.	.	.	.	.
18	24.17	7.70	4.49	2.73	22.29	10.84	8.45	1.28
19	23.95	7.43	4.24	2.53	21.81	10.55	8.23	1.23
20	23.76	7.16	3.99	2.31	21.32	10.23	8.00	1.17
21	23.71	6.89	3.70	2.16	20.82	10.02	7.62	1.16
22	23.63	6.65	3.41	1.96	20.17	9.82	7.25	1.12
23	23.49	6.35	3.11	1.77	19.36	9.63	6.54	1.03
24	23.25	6.06	2.82	1.56	18.61	9.49	5.93	0.94
25	23.00	5.71	2.53	1.39	18.14	9.35	5.34	0.87
26	22.69	5.41	2.29	1.24	17.43	9.13	4.85	0.82
27	22.24	5.20	2.08	1.00	16.57	8.95	4.41	0.77
28	21.80	4.93	1.86	0.93	15.66	8.82	4.03	0.72

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
29	21.31	4.68	1.67	0.73	14.84	8.68	3.69	0.68
30	20.72	4.45	1.50	0.58	14.28	8.47	3.38	0.66
31	20.22	4.18	1.36	0.45	13.71	8.27	3.07	0.64
32	19.64	3.95	1.21	0.33	13.24	7.99	2.79	0.62
33	19.05	3.76	1.12	0.27	12.51	7.71	2.56	0.61
34	18.49	3.61	1.03	0.24	11.63	7.40	2.36	0.58
35	17.96	3.42	0.94	0.18	11.12	7.08	2.16	0.58
36	17.71	3.21	0.87	0.13	10.77	6.73	1.96	0.57
37	17.22	3.05	0.81	0.10	10.45	6.36	1.79	0.56
38	16.87	2.89	0.75	0.08	10.05	6.08	1.63	0.55
39	16.64	2.79	0.71	0.04	9.55	5.75	1.49	0.52
40	15.77	2.64	0.64	0.03	9.14	5.41	1.36	0.51
41	15.02	2.49	0.59	0.03	8.55	5.16	1.24	0.50
42	14.43	2.31	0.54	0.03	8.12	4.92	1.12	0.47
43	13.63	2.14	0.48	0.03	7.83	4.66	1.02	0.50
44	12.87	1.99	0.46	0.02	7.26	4.47	0.92	0.47
45	12.01	1.83	0.42	0.02	6.84	4.38	0.84	0.45
46	11.45	1.70	0.41	0.02	6.19	4.22	0.78	0.44
47	10.45	1.53	0.39	0.02	5.66	4.04	0.70	0.41
48	9.41	0.04	0.03	0.02	5.21	3.80	0.64	0.40
49	8.90	0.04	0.03	0.02	4.75	3.54	0.60	0.38
50	8.23	0.04	0.03	0.02	4.34	3.33	0.54	0.37
51	7.42	0.03	0.02	0.01	3.92	3.11	0.49	0.35
52	6.70	0.03	0.02	0.01	3.40	2.97	0.45	0.30
53	6.02	0.03	0.02	0.01	3.08	2.73	0.41	0.27
54	5.28	0.03	0.02	0.01	2.71	2.46	0.37	0.25
55	4.53	0.02	0.01	0.01	2.53	2.23	0.33	0.23

	Male				Female			
Age	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**	**WLEfe**	**WLEie**	**WLEune**	**WLEeconi**
56	3.93	0.02	0.01	0.01	2.23	2.01	0.30	0.20
57	3.37	0.02	0.01	0.01	1.93	1.79	0.27	0.18
58	2.77	0.01	0.01	0.00	1.69	1.61	0.25	0.17
59	2.27	0.01	0.01	0.00	1.49	1.36	0.21	0.16
60	1.84	0.01	0.01	0.00	1.42	1.18	0.17	0.16
61	1.48	0.01	0.01	0.00	1.30	0.95	0.14	0.15
62	1.14	0.00	0.00	0.00	1.06	0.76	0.10	0.12
63	0.84	0.00	0.00	0.00	0.80	0.57	0.08	0.09
64	0.52	0.00	0.00	0.00	0.52	0.37	0.06	0.06
65	0.22	0.00	0.00	0.00	0.22	0.16	0.03	0.04

Table 2.10 shows the work-life expectancies for males and females who have a college degree or above, for the ages 18 to 65 years. Male and female individuals with a college degree and above and formally employed have higher work-life expectancies for ages 18 to 65 than male and female individuals who are informally employed, unemployed and economically inactive. The work-life expectancy for a male at the age of 18 who has a college degree and is formally employed (24.17 years) is more than 3 times the work-life expectancy of a male individual who has a college degree and is informally employed (7.70 years). A 24-year-old female who is formally employed and has a college degree has a work-life expectancy of 18.61 years, which is almost two times the work-life expectancy for a female who has a college degree and is informally employed (9.49 years). Male work-life expectancies for those formally employed are higher for all ages 18 to 65 years as compared to female work-life expectancies. In contrast, female work-life expectancies are higher as compared to male work-life expectancies for those who are informally employed. Work-life expectancies for unemployed and economically inactive individuals are very low, and less than 9 years for both male and female individuals with college degrees and above.

Table 2.11: Comparison of male work-life expectancies by race.

	Black		White		Coloured		Asian/Indian	
Age	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**
20	13.31	7.85	25.80	11.90	19.21	10.65	20.32	10.75
25	10.91	5.67	21.59	8.76	16.07	8.88	17.14	8.92
30	8.61	3.75	17.75	5.84	13.73	7.22	14.80	8.14
35	7.33	2.63	14.88	3.94	11.81	5.83	11.97	6.79
40	6.68	2.01	11.75	3.01	9.92	4.70	9.32	4.88
45	5.87	1.29	8.03	2.21	7.89	3.56	7.22	3.42
50	4.56	0.61	5.08	1.47	5.65	2.44	5.28	2.36
55	3.26	0.34	3.00	0.96	3.61	1.35	3.50	1.55
60	1.88	0.22	1.43	0.56	1.76	0.44	1.76	0.77
65	0.25	0.03	0.16	0.08	0.21	0.06	0.23	0.12

Table 2.11 shows a comparison of male work-life expectancies by race. The male White population have the highest work-life expectancies for those who are formally employed, as compared to work-life expectancies of other races in formal employment before 50 years of age. The work-life expectancy for a 20-year-old White male is 25.80 years, whilst the work-life expectancies for male Blacks, Coloureds and Asian/Indians are 13.31 years, 19.21 years and 20.32 years respectively. A 25-year-old White male who is formally employed has a work-life expectancy of 21.59 years which is almost double the work-life expectancy of 10.91 years for a 25-year-old Black male. Work-life expectancies for formally employed Black males become higher as compared to White males who are formally employed, beginning at age 55 when the work-life expectancy for Black males is 3.26 years as compared to White males, whose work-life expectancy is 3.00 years for the same age and same labour state. For the ages 20 to 35 years, work-life expectancies for male Asian/Indians, who are formally employed, are the second highest after the White male population. However, the work-life expectancy for male Asian/Indians is overtaken by the Coloured population, who are formally employed at age 40. A 40-year-old Coloured male who is formally employed has a work-life expectancy of 9.92 years which is marginally higher than the work-life expectancy of a 40-year-old male who is Asian/Indian with a work-life expectancy of 9.32 years. The work-life expectancies for White males who are informally employed are the highest at age 20 with a work-life value of

11.90 years. The work-life expectancies for the Asian/Indian population who are informally employed are the highest as compared to the other races, between the ages 25 years to 40 years. Coloured work-life expectancies become the highest for those informally employed for the ages 45 (3.56 work-life expectancy) and 50 years (2.44 work-life expectancy). Work-life expectancies for Black males are the lowest as compared to other races for informal employment.

Table 2.12: Comparison of female work-life expectancies by race.

	Black		White		Coloured		Asian/Indian	
Age	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**
20	11.56	10.31	23.05	13.84	12.88	7.92	16.23	13.18
25	9.80	9.29	18.83	11.19	10.47	7.86	11.06	9.64
30	8.23	7.95	14.48	9.19	8.48	7.38	7.74	7.26
35	6.75	6.28	11.15	7.15	6.67	6.03	6.03	6.52
40	5.42	4.84	8.31	5.34	5.01	4.72	4.42	5.59
45	4.21	3.57	5.83	3.97	3.71	3.56	3.09	4.73
50	3.11	2.31	3.67	2.76	2.59	2.43	2.07	4.06
55	2.07	1.21	2.02	1.76	1.59	1.41	1.33	3.22
60	1.08	0.43	0.86	0.77	0.77	0.38	0.74	2.33
65	0.14	0.06	0.11	0.11	0.10	0.04	0.11	0.32

Table 2.12 shows a comparison of female work-life expectancies by race for selected ages. White females who are formally employed have the highest work-life expectancies as compared to other races between the ages 20 to 50 years. The work-life expectancy for a 20-year-old White female who is formally employed is 23.05 years as compared to a formally employed Black female, Coloured female and Asian/Indian female who have work-life expectancies of 11.56, 12.88 and 16.23 years, respectively. Work-life expectancies for Black females are the lowest as compared to other races for ages 20 and 25 years, with work-life expectancies of 11.56 and 9.80 years respectively. Furthermore, work-life expectancies for formally employed Black females are the highest as compared to other races at ages 55, 60 and 65 years with work-life expectancies of 2.07, 1.08 and 0.14 years respectively. In addition, work-life expectancies for an Asian/Indian female who is formally employed is the second

highest for ages 20 and 25 with work-life expectancies of 16.23 and 11.06 years respectively. White female work-life expectancies for those informally employed are the highest as compared to other races for the ages 20 to 35. White female work-life expectancies for those informally employed are 13.84; 11.19; 9.19 and 7.15 years for the ages 20, 25, 30 and 35 years respectively. From the ages 40 to 65, female Asian/Indian work-life expectancies for those informally employed are the highest as compared to work-life expectancies for other races. A 40-year-old informally employed Asian/Indian has a work-life expectancy of 5.59 years as compared to 5.34, 4.84 and 4.72 years for informally employed White females, Black females, and female Coloured, respectively.

Table 2.13: Comparison of male work-life expectancies by education

	Less than high school		High school with some college		College degree and above	
Age	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**
20	15.95	13.36	19.27	10.35	23.76	7.16
25	11.77	10.71	14.51	7.75	23.00	5.71
30	8.82	8.29	11.63	5.97	20.72	4.45
35	6.54	6.19	10.00	4.78	17.96	3.42
40	4.47	4.50	8.02	3.82	15.77	2.64
45	3.09	3.05	6.66	3.01	12.01	1.83
50	1.69	1.65	5.50	2.91	8.23	0.04
55	0.99	0.71	4.51	2.42	4.53	0.02
60	0.42	0.19	2.88	1.30	1.84	0.01
65	0.09	0.02	0.35	0.19	0.22	0.00

Table 2.13 shows a comparison of male work-life expectancies by education level for formal and informal employment. Male work-life expectancies for those formally employed are increasing as the education level increases for the ages 20 to 55 years. At age 20, formally employed male work-life expectancies increase from 15.95 years for those with less than high school education, 19.27 years for those with high school and some college, to 23.76 years for those with a college degree and above. At 35 years, male work-life expectancies for those who are formally employed increase from 6.54 years for those with less than a high school education, 10.00 years for those with high school and some college to 17.96 years for those

who have a college degree and above. Male work-life expectancies for those formally employed at age 60 increase from 0.42 years for those with less than high school education to 2.88 years for those with high school and some college education, but decline to 1.84 years for those with a college degree and above. This is a similar trend for male work-life expectancies of those aged 65 years who are formally employed. Male work-life expectancies for those formally employed decline from 0.35 work-life expectancy years, for those who have high school with some college, to 0.22 years for those who have college degrees and above respectively for the age of 65. From ages 20 to 45 years, male work-life expectancies for those informally employed is declining as education level increases. At age 25, male work-life expectancies for those informally employed decline from 10.71 years for those with less than high school education, 7.75 years for those with high school with some college to 5.71 years for those with college degree and above. At age 45, male work-life expectancies for those informally employed decline from 3.05 years for those with less than high school education, 3.01 years for those with high school with some college to 1.83 years for those with college degree and above. From ages 50 to 65, male work-life expectancies for those informally employed is increasing for those with less than high school education to those with high school education but declining for those with college degrees and above. At age 60 informally employed male work-life expectancy increases from 0.19 years for those with less than high school education to 1.30 years for those with high school and some college, but declines to 0.01 years for those with college degrees and more.

Table 2.14: Comparison of female work-life expectancies by education

	Less than high school		High school with some college		College degree and above	
Age	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**	**WLEfe**	**WLEie**
20	12.26	13.88	13.74	9.82	21.32	10.23
25	8.27	11.38	10.64	7.75	18.14	9.35
30	5.69	9.13	9.26	6.23	14.28	8.47
35	3.48	7.23	8.06	5.16	11.12	7.08
40	1.38	5.64	6.65	4.31	9.14	5.41
45	0.23	4.10	5.56	3.41	6.84	4.38
50	0.20	2.73	4.28	2.60	4.34	3.33
55	0.14	1.59	2.88	1.89	2.53	2.23

	Less than high school		High school with some college		College degree and above	
Age	WLEfe	WLEie	WLEfe	WLEie	WLEfe	WLEie
60	0.11	0.64	1.20	1.13	1.42	1.18
65	0.01	0.07	0.13	0.17	0.22	0.16

Table 2.14 shows a comparison of female work-life expectancies by education level for ages 20 to 65 years. Female work-life expectancies for those who are formally employed increase as education levels increase for ages 20 to 65 years. A 20-year-old female who is formally employed with less than a high school education has a work-life expectancy of 12.26 years. The work-life expectancy increases to 13.74 years if the 20-year-old increases education to high school with some college. Furthermore, work-life expectancy is 21.32 years for a 20-year-old who is formally employed and has a college degree and above. A 35-year-old female who has a college degree and above and is formally employed has a work-life expectancy of 11.12 years as compared to a work-life expectancy of 8.06 for a formally employed 35-year-old female who has a high school with some college education.

Work-life expectancies for females who are informally employed decrease as education level increases from less than high school education to high school with some college education. Work-life expectancies for females informally employed increase for those with college degrees and above. This trend happens between ages 20 to 50 years. The work-life expectancy for a 35-year-old female who is informally employed and has less than a high school education is 7.23 years. The work-life expectancy declines to 5.16 years for a 35-year-old female who is informally employed and has high school with some college. The female work-life expectancy for those informally employed has increased as education level increases for the latter ages of 55 to 65 years.

Table 2.15: Differences in male work-life expectancies for the three educational levels

	FE		IE	
Age	LHS to HS+SC	HS+SC to CD+	LHS to HS+SC	HS+SC to CD+
20	3.32	4.49	-3.01	-3.19
25	2.74	8.49	-2.96	-2.04
30	2.81	9.09	-2.32	-1.52
35	3.46	7.96	-1.41	-1.36

	FE		IE	
Age	**LHS to HS+SC**	**HS+SC to CD+**	**LHS to HS+SC**	**HS+SC to CD+**
40	3.55	7.75	-0.68	-1.18
45	3.57	5.35	-0.04	-1.18
50	3.80	2.73	1.25	-2.87
55	3.52	0.02	1.71	-2.40
60	2.46	-1.04	1.10	-1.29
65	0.25	-0.13	0.16	-0.19

LHS represents Less than High School; HS+SC represents High School with Some College; CD+ represents College Degree and above. FE represents Formal Employment and IE represents Informal Employment.

Table 2.15 shows the differences in male work-life expectancies after a change in education level for the ages 20 to 65. A positive value means that a higher education level has a higher work-life expectancy as compared to a lower educational level. Furthermore, a negative value means that a higher educational level has a lower work-life expectancy as compared to a lower educational level. A 20-year-old male who is formally employed and has a high school with some college education has a 3.32 higher work-life expectancy as compared to a 20-year-old male who is formally employed and has less than a high school education. Furthermore, a 20-year-old male who is formally employed and has an education of a college degree and above has a 4.49 higher work-life expectancy as compared to a 20-year-old male who is formally employed and has high school education with some college education. However, a 20-year-old male who is informally employed and has high school with some college education has work-life expectancies which are 3.01 years less than a similar 20-year-old male who is informally employed and has only less than a high school education. The work-life expectancies are less by 3.19 years if the 20-year-old who is informally employed has a college degree and above as compared to a similar 20-year-old who is informally employed and has a high school with some college education. For the ages of 60 to 65, a movement to a higher education level results in a lower work-life expectancy as compared to the previous education level. A 60-year-old male who is formally employed and has a college degree and above has a work-life expectancy of 1.04 years lower as compared to a similar 60-year-old male who is formally employed and has a high school education with some college education.

Table 2.16: Differences in female work-life expectancies for the three educational levels

	FE		IE	
Age	**LHS to HS+SC**	**HS+SC to CD+**	**LHS to HS+SC**	**HS+SC to CD+**
20	1.48	7.59	-4.06	0.41
25	2.37	7.50	-3.63	1.60
30	3.57	5.03	-2.90	2.24
35	4.58	3.07	-2.07	1.92
40	5.27	2.50	-1.33	1.10
45	5.33	1.28	-0.69	0.97
50	4.08	0.06	-0.13	0.73
55	2.74	-0.35	0.30	0.34
60	1.09	0.22	0.49	0.05
65	0.12	0.09	0.10	-0.01

LHS represents Less than High School; HS+SC represents High School with Some College; CD+ represents College Degree and above. FE represents Formal Employment and IE represents Informal Employment.

Table 2.16 shows the differences in female work-life expectancies due to the three education levels. A positive value means that a higher education has a higher work-life expectancy as compared to a lower educational level. Furthermore, a negative value means that a higher educational level has a lower work-life expectancy as compared to a lower educational level. A 30-year-old female who is formally employed and has high school with some college education has a work-life expectancy which is 3.57 years higher than a similar 30-year-old female who is formally employed and has less than a high school education. Furthermore, a 30-year-old who has a college degree and above has a work-life expectancy which is 5.03 years higher as compared to a 30-year-old female who is formally employed and has a high school education with some college education. A 25-year-old female who is informally employed and has a high school with some college education has a work-life expectancy that is 3.63 years lower as compared to a similar aged female who is informally employed and has less than a high school education. However, a 25-year-old female who is informally employed and has a college degree and above education has a work-life expectancy that is 1.60 years higher as

compared to a 25-year-old female who is informally employed and has high school with some college education.

2.7.2 Future Lost Earnings Estimates

Table 2.17: Future lost earnings estimates per age (per annum)

Age	FE Male	FE Female	IE Male	IE Female
16	**R1,176,070.00**	**R621,074.90**	**R286,547.00**	**R278,586.40**
17	R1,205,795.00	R674,733.50	R310,256.40	R306,472.00
18	R1,313,023.00	R712,591.30	R315,646.70	R314,331.10
19	R1,348,241.00	R718,526.50	R316,650.50	R315,168.70
20	R1,355,529.00	R723,965.20	R350,149.20	R315,744.40
21	R1,363,791.00	R726,240.10	R358,434.90	R317,177.60
22	R1,469,357.00	R791,266.70	R381,453.90	R337,233.40
23	R1,501,761.00	R802,825.70	R397,302.60	R347,876.50
24	R1,621,724.00	R816,498.60	R497,344.00	R372,486.30
25	R1,677,565.00	R834,194.70	R621,576.50	R399,354.70
26	R1,706,974.00	R848,245.90	R658,153.80	R471,949.50
27	R1,741,186.00	R941,454.50	R665,525.60	R476,311.50
28	R1,800,512.00	R945,046.30	R735,161.70	R490,029.30
29	R1,853,511.00	R992,184.50	R752,347.80	R503,981.60
30	R1,913,491.00	R1,001,544.00	R763,932.90	R513,767.10
31	R1,991,658.00	R1,026,329.00	R871,751.70	R526,562.20
32	R2,004,752.00	R1,039,401.00	R881,125.90	R530,068.90
33	R2,008,730.00	R1,087,665.00	R885,562.50	R535,809.50
34	R2,011,220.00	R1,102,486.00	R893,068.90	R539,014.60
35	R2,013,032.00	R1,178,917.00	R1,097,448.00	R552,945.20
36	R2,379,180.00	R1,208,650.00	R1,153,695.00	R578,840.20
37	R2,324,609.00	R1,278,185.00	R1,170,217.00	R588,496.50
38	R2,555,254.00	R1,466,158.00	R1,194,982.00	R588,254.60

Age	FE Male	FE Female	IE Male	IE Female
16	**R1,176,070.00**	**R621,074.90**	**R286,547.00**	**R278,586.40**
39	R2,833,164.00	R1,553,230.00	R1,203,783.00	R445,924.00
40	R2,944,161.00	R1,558,452.00	R911,656.70	R300,534.80
41	R2,939,645.00	R1,690,851.00	R907,401.30	R240,899.00
42	R3,953,700.00	R1,927,060.00	R903,702.50	R240,110.70
43	R3,961,585.00	R1,547,980.00	R604,993.70	R239,683.20
44	R3,506,807.00	R1,539,728.00	R602,729.50	R239,109.60
45	R3,631,798.00	R1,364,387.00	R602,712.30	R180,182.80
46	R3,128,064.00	R974,661.20	R600,661.40	R179,411.50
47	R3,127,424.00	R910,959.10	R599,651.00	R179,157.10
48	R2,618,783.00	R852,185.60	R598,624.90	R177,438.20
49	R2,615,828.00	R834,266.20	R300,512.80	R177,004.00
50	R2,614,946.00	R556,497.10	R299,903.90	R116,821.00
51	R2,100,220.00	R547,268.70	R298,832.30	R115,001.20
52	R2,095,663.00	R523,934.60	R298,381.40	R112,528.70
53	R2,095,588.00	R515,930.00	R297,906.90	R112,344.90
54	R1,575,019.00	R504,536.80	R297,610.10	R111,755.70
55	R1,573,797.00	R253,490.00	R294,810.20	R55,762.00
56	R1,572,748.00	R253,364.60	R293,856.50	R54,999.96
57	R1,052,155.00	R253,270.10	R293,169.40	R54,742.65
58	R1,050,846.00	R251,055.70	R293,146.10	R53,594.71
59	R1,028,806.00	R250,702.70	R292,703.50	R53,063.90
60	R505,813.40	R248,817.20	R292,698.10	R52,113.31
61	R502,519.60	R247,237.70	R292,458.90	R51,126.08
62	R498,876.00	R245,492.90	R286,170.50	R50,927.05
63	R494,724.30	R242,401.00	R283,107.50	R50,336.65
64	R478,868.50	R240,785.30	R282,244.00	R49,771.55
65	R474,681.60	R238,086.90	R278,405.00	R49,659.47

FE Male – Formal Employment for Male; FE Female – Formal Employment for Female; IE Male- Informal Employment for Male; IE Female – Informal Employment for Female

Table 2.17 shows the future lost earnings estimates by age, for males and females, who are formally and informally employed. The table shows that the future lost earnings start by increasing as age increase and later decrease at older ages. For male individuals who are formally employed, future lost earnings estimates increase from the age of 16 and reach a peak of R3,961,585.00 at age 43. Beyond the age of 43 years, future lost earnings start to decline reaching R2,095,588.00 at age 53, R1,028,806.00 at age 59 and R474,681.60 at the age of 65. Future lost earnings estimates for females who are formally employed increase from the age of 16 and reach a peak of R1,927,060.00 at the age of 42 years. Beyond 42 years, future lost earnings estimates start to decline reaching R556,497.10 at the age of 50, R248,817.20 at the age of 60 and R238,086.90 at the age of 65 years. Future lost earnings estimates for males who are informally employed increase from the age of 16 years and reach a peak of R1,203,783.00 at the age of 39. Future lost earnings estimates start to decline thereafter reaching R294,810.20 at the age of 55 years and R278,405.00 at the age of 65. The future lost earnings for females who are informally employed reach a peak of R588,496.50 at the age of 37 years after increasing from the age of 16. Afterwards future lost earnings start to decline reaching R116, 821.00 at the age of 50 and R49 659.47 at the age of 65.

The table also shows that future lost earnings for males who are formally employed are higher than future income loss estimates for females who are also formally employed for all ages between 16 to 65 years. In case of a personal injury or wrongful death, a male individual, aged 20 will earn future lost earnings estimates of R1,355,529.00, compared to a female individual aged 20 years who will earn R723,965.20 if involved in a personal injury or wrongful death. This is an R631,563.8 difference in future lost earnings estimates earned by a 20-year-old male and female. Although future lost earnings estimates for females who are formally employed are higher in early ages, future lost earnings estimates for males who are informally employed exceed these estimates at age 55. At age, 55 future lost earnings estimates for females who are formally employed are R253,490.00 whilst for males who are informally employed, future lost earnings estimates at the age of 55 are valued at R294,810.20. Future lost earnings estimates for females who are informally employed are the lowest as compared to other future lost earnings estimates. At the age of 25, future lost earnings estimates for females who are informally employed are valued at R399,354.70 whilst future lost earnings estimates for males

in informal employment, females in formal employment and males in formal employment are valued at R621,576.50, R834,194.70 and R1,677,565.00 respectively.

2.8 DISCUSSION OF RESULTS

The results reveal that for all races, work-life expectancies for male workers are higher as compared to female work-life expectancies, for those who are formally employed. This suggests that men still have greater occupational opportunities and incentives in formal employment as compared to women. Such occupational opportunities and incentives in formal employment allow men to continue in formal employment for longer periods than women. Women seem to take up household responsibilities, which limit their duration in formal employment. In developing countries, households' responsibilities explain about 62% of the gender imbalances in the labour force (ILO, 2024). Furthermore, women receive lower salaries as compared to men in developing countries (ILO, 2024), which can act as a disincentive to continue in the formal labour market. In addition, supply side factors such as occupational segregation from gender socialisation and differential family upbringing between boys and girls likely shape educational choices, career paths and labour market patterns. Family responsibilities and cultural norms often led women to more flexible but less secure jobs in the informal sector that accommodate caregiving duties. Hence, this behavioural conditioning can result in self-selection into certain sectors instead of reflecting on the challenges of entering formal employment. Our result is similar to Dudel and Myrskyla (2017), who found higher male work-life expectancies as compared to female work-life expectancies in the USA, for different periods of 1993-1997; 1998-2002; 2003-2007 and 2008-2011. The average work-life expectancies for males and females during the period 1993-1997 were 14.5 years and 11.4 years, respectively (Dudel & Myrskyla, 2017). Butt et al. (2008), also found higher work-life expectancies for disabled and non-disabled men in employment in the UK as compared to women, who were disabled and non-disabled in employment.

There is a variation of work-life expectancies across gender and race for informal employment status. Black females and White females have higher work-life expectancies as compared to their male counterparts in informal employment. Young female Asian/Indian adults of the ages from 16 to 27 have higher work-life expectancies than young male Asian/Indian adults, of a similar age, in informal employment. Middle and old aged female Coloured adults of the age range 29 to 58 years have higher work-life expectancies as compared to Coloured male adults of a similar age range in informal employment. This suggests that, on average, more females

are employed in informal sectors as compared to their male counterparts. This may signal that the country's labour market for formal employment has fewer opportunities for women, which may result in them being employed more in the informal sector. Over the last decade, women have faced many challenges in securing jobs as compared to men (ILO, 2023). In addition, because of household responsibilities, women may find it more flexible to be employed in the informal sector where there may be less rules and regulations. Since post-independence South Africa, there has been an increase in women in the informal sector and other low-paying jobs, which has exacerbated gender inequality in the country's labour market (Rogan & Alfers, 2019). 80% of jobs created for women in the world in 2020 were in the informal sector (ILO, 2023). This shows evidence of why the proportion of women may be larger than for men, in informal employment. This translates to females having higher duration of employment in informal work as compared to men. Krueger et al. (2006) finds more than double higher work-life expectancies for females who are in part-time employment, as compared to male work-life expectancies for those in part-time employment.

The idea that men seem to have higher work-life expectancies in formal employment, whilst women have higher work-life expectancies in informal employment, is also shown in the paper through work-life expectancies based on gender and education. On average, women have higher work-life expectancies in informal employment, whether they have less than a high school education, a high school education with some college education, a college degree and above, as compared to male work-life expectancies. Men also have higher work-life expectancies in formal employment as compared to women regardless of whether they have less than a high school education, high school with some college education or a college degree and above.

On average, males and females with higher education have higher work-life expectancies as compared to those males and females with lower education levels in formal employment. This suggests the importance of education in influencing work-life expectancies in formal employment, with those workers with a higher education more likely to have a longer work duration as compared to other workers who have a lower education. This is consistent with Millimet et al. (2010) who found that single non-White women with a college degree had 15.3 years higher work-life expectancy as compared to single non-White women with less than a high school education. However, in this paper, older male workers aged 60 to 65 years, who are in formal employment with a college degree and above, have a lower work-life expectancy

as compared to older male workers aged 60 years and above, but with a high school and some college education. This suggests that the role of education holds less relevance in determining the duration of employment, especially when male workers have reached their retirement ages.

In addition, on average, male work-life expectancies in the informal sector with a higher education are lower, as compared to male work-life expectancies for those with a lower education in the informal sector. This may be because there are higher opportunity costs for remaining in informal employment for those males with higher education, such that they may end up leaving the sector for formal employment in search of more opportunities. On the other hand, female work-life expectancies for informal employment, gender and education levels are fluctuating as education increases. However, the prominent observation is that between 20 to 50, years female work-life expectancies in informal employment have been higher for those with a college degree and above, compared to those with high school and some college education. This may be, because as females gain more skills due to advancement in education, they are able to utilise these skills in informal employment, where they are more concentrated, thereby increasing their work-life duration in that employment sector.

Males and females of the White population have higher work-life expectancies on average as compared to other population groups in formal employment. The South African labour market is highly racialised and the White population earn higher salaries as compared to other races (StatsSA, 2019b). Higher salaries are associated with higher-ranking jobs which gives more career opportunities, job satisfaction and, hence, longer work-life durations. Furthermore, those with higher salaries can afford medical care and other health benefits which reduces disability hence, also increasing the duration of work life. Dudel and Myrskyla (2017), find higher work-life expectancies for Whites across four separate time periods from 1993 to 2011 as compared to Blacks and Hispanics who have low work-life expectancies.

There are fluctuations in the population groups with the highest work-life expectancies in informal employment for both males and females. The population group with the highest work-life expectancies in informal employment have been fluctuating for both males and females. For young adults, White males have the highest work-life expectancies as compared to young adults of other races. For the middle-aged, male Asian/Indian work-life expectancies are the highest as compared to other middle-aged men of other races and then for the older male worker the Coloured population group has the highest work-life expectancies. Furthermore, for females who are informally employed, the Whites have the highest work-life expectancies from

the young adult workers to middle aged workers. The female Asian/Indian work-life expectancies are the highest as compared to other population groups for those who are middle-aged to old aged workers. Blacks have lower work-life expectancies for informally employed females and the lowest work-life expectancies for the informally employed males as compared to other population groups. This suggests that the Black population group has less job opportunities and income in the labour market which could extend their work-life as compared to other population groups. Blacks earn the lowest salaries as compared to other population groups in the labour market (StatsSA, 2019). Black unemployment is four or five times higher as compared to White unemployment (StatsSA, 2019).

Work-life expectancies for both males and females who are formally employed are higher as compared to other labour market states of informal employment, unemployment and economically inactive. Formal employment jobs are stable and less precarious as compared to informal jobs; hence, workers can remain in employment for longer periods as they plan for the future. Good working conditions are often a challenge in informal employment which may result in shorter work-life durations as compared to those in formal employment. Although the informal sector is growing in the country and is gaining recognition, informal jobs are still regarded as low priority governed by mixed attitudes (IEJ, 2018). Hence, in some cases, improving the working conditions in informal employment which may improve work-life duration, can be a challenge. Millimet et al. (2003) found higher work-life expectancies for males and females who were employed, as compared to males and females who were either unemployed or inactive.

Future lost earnings estimates, for males who are formally employed, are higher as compared to future lost earnings estimates for females who are formally employed. This suggests the existence of a gender wage gap in the South African labour market, where men earn more than women. Pleace et al. (2023) estimate a widening gender pay gap in South Africa. Women were estimated to be earning 80 cents for every one Rand earned by men in 2008 and down to 78 cents for every one Rand earned by men in 2021 (Pleace et al., 2023). Higher earnings for men also translate to higher future income loss estimates for men as compared to women. An interesting result in this paper is the high work-life expectancies for females who are in informal employment, and yet they have lower future lost earnings estimates as compared to their male counterparts in informal employment. This reflects that men also earn more income than women in informal employment.

Estimated future lost earnings for both male and female start increasing as age increases, reach peak future lost earnings estimates and then start decreasing as age approaches retirement. The increase in future lost earnings estimates in the early to middle years may represent career development and the acquisition of skills resulting in increased earnings potential. The peak period represents the maximum possible potential earnings as a result of career advancement and experience. Furthermore, the future lost earnings estimates start to decline after the peak period, as this shows the decline in earnings and possible retirement plans. This pattern is consistent with economic theories of the life cycle hypothesis written by Franco Modigliani and Richard Brumberg in 1954 (A. S. Deaton, 2005) as well as the human capital theory by Gary Becker (1975). The Human Capital Theory mostly explains the initial phase of the future lost earnings estimates, where investment in education would increase productivity which will in turn increase earnings potential over time.

Different peak levels of future lost earnings estimates for males and females in formal and informal employment reflect gender disparities which exist in the labour market. The male peak future lost earnings estimates for formal employment is 43 years, whilst for females in formal employment the peak future lost earnings estimate is 42 years. In addition, the males peak future lost earnings estimates for informal employment is 39 years, whilst for females it is 37 years. This may also reflect higher career progressions by males as compared to females, which results in higher earnings and earnings potential.

2.9 LIMITATIONS OF THE STUDY

A crucial assumption of this paper is the Markov Property assumption, which is used in estimating work-life expectancies. The assumption highlights that the movement of workers in different labour force states is only dependent on their current state, not on past labour force states. Although this is a novel assumption in simplifying complex labour force activities, there is path dependence which exists in the employment histories of workers. For instance, there can be reduced reemployment probabilities for those who have been unemployed for prolonged spells due to issues like skills deterioration. Hence, to some extent, this may potentially distort the extent of the work-life expectancies established. However, the Markov Property assumption continues to be widely used in simplifying transition states by forensic economists, as it provides reasonable approximations as compared to other sophisticated methods such as the higher-order Markov models or even duration- dependent models.

The estimation of work-life expectancies and future lost earnings assumes that historical employment participation rates continue into the future. This may not hold given the current dynamic work environment, movements in automation and changes in retirement behaviours. In this case, if the employment participation rates change from historical trends, this could potentially cause small differences in work-life expectancies estimated which will be expected.

2.10 CONCLUSION

This paper estimated work-life expectancies based on gender, race, education and employment categories, as well as future lost earnings, based on gender and employment categories. Our paper builds upon methodologies which have been used by Millimet et al. (2003). Our research attempts to update the findings of Millimet, which were done over 20 years ago, by using one of South Africa's recent panel datasets and consequently, is much more relevant to the country's real-life working conditions. Using the NIDS dataset, we first develop 16 transitions from four labour states—formally employed, informally employed, unemployed and economically inactive. Our study estimates the multinomial probit model on a latent variable using the 16 transitions to generate conditional and transitional probabilities. The transitional probabilities are later used to estimate work-life expectancies categorised by gender, race and educational level. The future lost earnings formula developed by Benham and LaCroix in 1992 (Lewis et al., 2003) is also employed to estimate future lost earnings for workers in the four labour states in South Africa.

The results reveal that male work-life expectancies are higher as compared to female work-life expectancies in formal employment, whilst there are variations in informal employment. In addition, on average, males and females who have higher education have higher work-life expectancies as compared to men and women who have lower education levels. The results show that both White males and females have higher work-life expectancies as compared to other population groups. This may reveal the widely suggested racial disparities in current earnings in the South African labour market. Future lost earnings for males are higher as compared to female future lost earnings estimates in both formal and informal employment. This indicates the existence of gender inequality in the labour market. Hence, employers and policy makers have an important role to play in terms of coming up with gender and racial inclusive policies which will benefit females and population groups who are left behind. This is important in improving the earnings potential of all workers in the labour market. Overall, our paper provides significant work-life expectancies and future lost earnings estimates which

can be adjusted, tailor-made and used in the South African legal system for workers in both the formal and informal sector, who could be injured or die from the negligent behaviour of another worker or employer.

CHAPTER THREE

PERSONAL CONSUMPTION RATES IN WRONGFUL DEATH IN SOUTH AFRICA: CONCEPTUALISATION AND ESTIMATION

3.1 INTRODUCTION

The occurrence of a wrongful death case requires survivors of the deceased to claim economic damages as compensation for the negligent action committed against the deceased. The legal system is responsible for upholding as well as assisting victims and survivors to acquire their fair share of compensation in wrongful death cases, such as medical malpractice, negligent accidents, and murder cases.

Wrongful death refers to the death of an individual caused by the negligence of another person (Trout & Foster, 1993). In cases where the surviving family members relied on the deceased person's income, wrongful death can have immediate adverse economic effects on the family. If a civil lawsuit is filed against the accused, compensation estimates for the wrongful death of the deceased need to be available. Such compensation needs to be reflective of the economic loss experienced by the family. Economic losses are measured through quantifiable estimates, such as lost earnings, lost earning capacity, future and past medical expenses and lost household services. These quantifiable estimates provide a basis for compensation to the surviving relatives.

However, public sector costs that are incurred due to wrongful death cases have negative effects on the economy. Alda and Cuesta (2011), highlighted that the cost of crime in South Africa was 7.8% of the GDP in 2007. Furthermore, medical malpractice claims have resulted in South Africa's health departments incurring close to R10 billion losses from 2014 to 2021 (Planter, 2021). Such costs negatively affect the operations of the health sector.

As a result, medical practitioners are practising defensive medicine to safeguard their reputation against charges of medical malpractice. However, this has resulted in health care provision for patients being compromised (Maimela, 2022). Moreover, the legal system seems ill-equipped to deal with medical malpractice claims (Planter, 2021). Furthermore, compounding the existing issue, the Planter (*ibid*.) highlights that South Africa lacks a legal framework that regulates legal cases which would have occurred in the health sector.

Furthermore, challenges in the functioning of law enforcement agencies have exacerbated crime in the country. Lamb (2021), highlighted that systemic corruption in the South African Police Service (SAPS) has weakened its legitimacy in terms of solving crimes in the country. This reduces the ability of the SAPS to deal with crimes. The website of Organised Crime Index (OCI, 2021) emphasised that murder cases, for example, in South Africa have increased by 40% over the past ten years from 2011 to 2021.

The prevalence of wrongful death in South Africa can have devastating effects on survivors of female-headed households. Female-headed households are regarded as a vulnerable group in society as they are more prone to poverty than male-headed households (Goebel and Dodson, 2011). At the same time, although men in South Africa are three times more likely to be victims of murder, as compared to women (Maluleke, 2018), the probability of crime against women, which may lead to wrongful death, is also significant. South Africa has one of the highest rates of violence against women, with one out of every five adult women having faced physical violence (UN Women, 2023). Some of these violent activities have led to fatalities. In the first three months of 2023, South Africa experienced 969 murders of women due to violence and crimes (Cruywagen, 2023). Given the vulnerability to poverty of female-headed households and the significant probability of wrongful death of women in South Africa, survivors of the deceased female are likely to face devastating economic consequences as a result.

Furthermore, in South Africa in 2021, households headed by females were estimated to be at 42.1% (StatsSA, 2021a) and at 42.3% in 2023 (Stats, SA, 2023a). Given that women are a vulnerable group in society, coupled by the existing risks of violence, crime and wrongful deaths which may occur to women, the consequences can be daunting for close surviving family members, in particular children, where the female parent, whom they were relying on for survival, wrongfully dies. In this regard, it is crucial to estimate the compensation that will be given to the surviving children if the female parent is involved in wrongful death. However, vulnerable and poor groups in South Africa have limited access to justice due to factors such as a lack of resources from them and inefficiencies which exist in the country's judicial systems (Greenbaum, 2020).

In this context, our paper seeks to estimate personal consumption rates in wrongful death in South Africa. In particular, we predict personal consumption rates for single female parents with one child as well as for single female parents with two children. The specific questions in this regard are: (i) what are the personal consumption rates in wrongful death in South Africa?

(ii) how does female household income affect the differences in personal consumption rates between single female-parent households with one child and those with two children; and (iii) what is the effect size of the differences in personal consumption rates within single female-parent households and between different income groups of single female- parent households.

Personal consumption rates (PCRs) are an important ingredient in calculating compensation to the surviving children. Personal Consumption Rates (PCRs), which represent the rate of consumption relative to household income are not the compensation per se, which are awarded to the surviving children. Rather, the PCRs of the deceased are estimated and removed from household income, such that, what is left, serves as the amount of compensation to be awarded to the surviving children (Patton & Nelson, 1991). Economic loss (compensation) to the surviving children is the amount which these children could have enjoyed if the deceased was still alive (Trout & Foster, 1993). Hence, personal consumption, which could have been consumed by the deceased if still alive was not going to benefit the surviving children in any way; hence, the reason why it is removed from household income.

Some earlier studies in forensic economics have estimated personal consumption rates that were used to estimate economic losses in case a wrongful death occurs. The early pioneers in this regard are Patton & Nelson (1991) and Kruger (2007; 2014), whose studies were based on the American Consumer Expenditure Survey (CES) data, Gilbert (1991), and Trout and Foster (1993). Brown (2004), employed the Canadian dataset to compute personal consumption rates (PCRs) estimates for a Canadian court that were then used to estimate compensation.

Our paper contributes to the limited literature on estimating personal consumption rates in wrongful death in three ways. Firstly, our paper estimates personal consumption rates for single parents with one child and single parents with two children, considering the vulnerability of women in South Africa. We recognise that the estimation of PCRs for this particularly vulnerable population group is crucial, as the impact can be devastating in cases where there is a wrongful death of a single female parent. Previous studies such as those by Krueger (2007), Patton and Nelson (1991), Ajwa et al. (2000) and Brown (2012; 2004), estimate PCRs mostly based upon nuclear families, which are households with a male adult, a female adult and children living together. These papers calculated separate PCR estimates for the male adult and female adult.

Furthermore, our paper provides additional insights by estimating the differences in PCRs of single female parents with one child versus single female parents with two children. We investigate how household income influences these differences in PCRs and estimate the magnitude or size of these PCR differences. Previous studies, such as Ruble et al. (2019), Krueger (2011), Ajwa et al. (2000), have mainly provided estimates of PCRs for use in the American legal court system. We aim to analyse and understand if the PCRs between our two groups contain nuances which could be important to consider when estimating economic losses in South Africa.

Lastly, our paper provides new insights for comparison with other PCRs estimations for developed countries. To the best of our knowledge, our paper constitutes the very first attempt in this area to deploy a developing country dataset. Therefore, our estimates are crucial in terms of comparisons with previous studies from the developed world in the existing consumption rates.

3.2 BACKGROUND

Wrongful death of a headship of the household results in economic loss to society and deprives income and consumption to the surviving households' members. King and Smith (1988) argue that the value of life is unquantifiable, such that compensation to survivors of the deceased can never be enough. However, the authors highlight that there should be some economic loss calculations and even settlement negotiations of some sort to give some form of relief. The calculation of personal consumption rates can provide an avenue towards estimating economic compensation to the surviving household members. Wrongful death in South Africa has occurred over the years due to different causes, which include: road accidents, medical negligence, violence and murder.

More than half of the approximately 1.3 million people who die due to road accidents are vulnerable road users (WHO, 2022). Vulnerable road users, such as motorcyclists, pedestrians and cyclists, do not have enough protection when experiencing high traffic volumes on the roads (Khayesi, 2020). Such vulnerable road users are the most at risk as compared to other road users who use vehicles, buses, etc. (OECD, 1998).

Klopper (2021) highlights that medical negligence claims after wrongful death, in courts and to the government in South Africa, have increased since 1991. Furthermore, such medical negligence claims have increased due to reasons such as poor hospital management and a

shortage of medical practitioners in the public health sector. In addition, litigation disputes over medical negligence claims have negative impacts on the overall expenditure in health care (Bonetti et al., 2016).

Freeman and Franklin (2016) argue that, as much as most products that consumers purchase and consume every day are safe, some of these products may be defective and cause injuries and death. Xiuli et al. (2012) add that defects on products negatively affect industry protection as much as they affect consumer protection. Butchelor and Chetty (2021) highlighted that due to the listeriotic foodborne disease, which erupted between 2017 and 2019, about 183 deaths were recorded in South Africa.

Unexpected death caused by the negligence of another person or institution has devastating consequences on family members and other people who rely on the deceased. The following table shows some of the non-natural mortality cases which have occurred in South Africa during 2014 to 2018. The number of deaths recorded in this instance were not self-intentional. In other words, the death cases recorded were caused directly or indirectly by another person.

Table 3.1: Non-Natural Mortality cases in South Africa for the period 2014 to 2018

	2014	2015	2016	2017	2018
Assault	5314	7201	7568	7688	7590
Complications of medical and surgical care	1660	1732	1001	1126	1033
Transport Accidents	5926	6300	6425	5890	6165

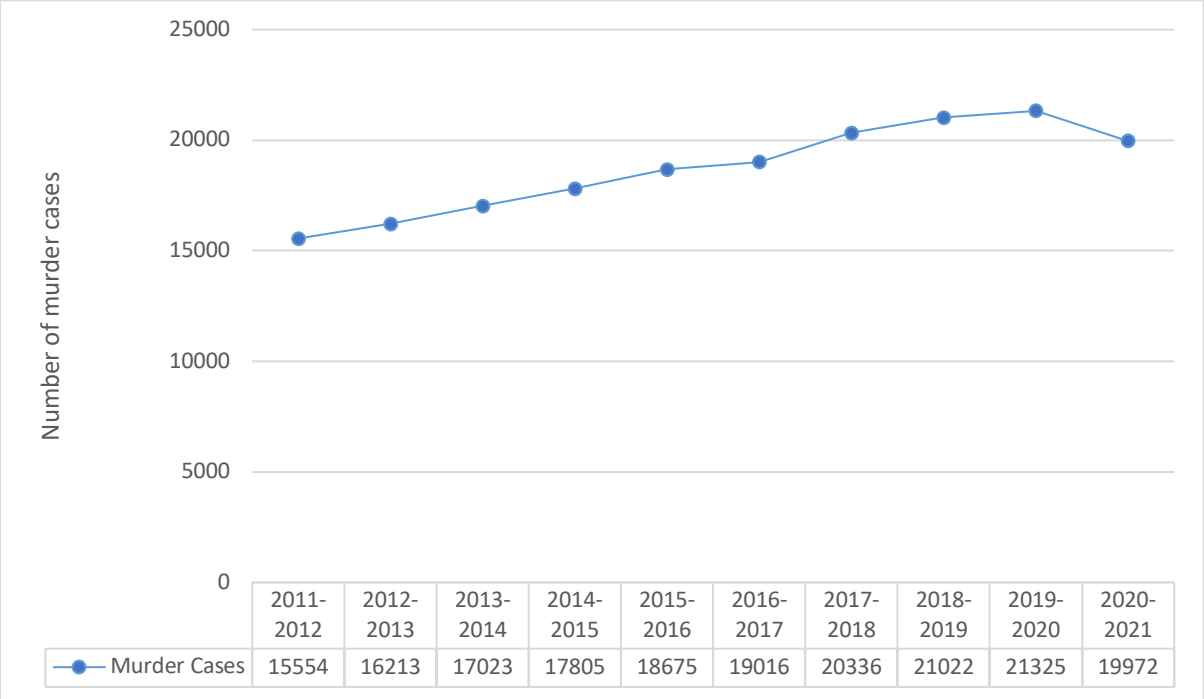
Source: StatsSA, (2014-2018)

Table 3.1 shows that the number of people who died as a result of assault, was 7201 in 2015, up from 5314 cases recorded in 2014. This represented a 36% increase in the number of assault cases in South Africa. Furthermore, assault cases continued to increase in South Africa, reaching 7568 cases in 2016, 7688 cases in 2017 and 7590 cases in 2018. In addition, deaths due to complications of medical and surgical care in South Africa rose in 2015 to reach 1732 cases from 1660 cases recorded in 2014, but declined by 42% to 1001 cases in 2016. However, the cases rose in 2017 to 1126 but declined to 1033 in 2018. Deaths as a result of transport accidents recorded were non-intentional and were separated from self-inflicted cases, which were also presented in StatsSA's, 2014, 2015, 2016, 2017 and 2018 reports on Mortality and

causes of death. Death cases as a result of transport accidents were 6300 cases in 2015, up from 5926 cases recorded in 2014. Furthermore, deaths as a result of transport accidents declined in 2017 reaching 5890 cases from 6425 cases recorded in 2016. This represented a 535-case decline in the number of deaths as a result of transport accidents. In addition, the trend of death cases increased in 2018, reaching 6165 cases.

In addition, South Africa continues to grapple with high societal crime rates that have negative implications for the economy. Bhorat et al. (2017) highlighted that crime has a positive correlation with other factors, such as poverty and unemployment. Murder cases are also one of the major crimes which adversely affect the wellbeing of households and society in South Africa. The following figure shows murder cases which have occurred in South Africa over the period 2011 to 2021.

Figure 3.1: Murder cases in South Africa during the period 2011 to 2021



	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Murder Cases	15554	16213	17023	17805	18675	19016	20336	21022	21325	19972

Source: SAPS (2020/21)

Figure 3.1 shows that murder cases in South Africa have consistently increased from the 2011-2012 season to the 2019-2020 season. Murder cases reached 20,336 during the 2017-2018 season up from 19016 murder cases recorded during the 2016-2017 season. This represented a 7% increase in murder cases. Furthermore, murder cases reached 21,325 cases in 2019-2020 before declining to 19,972 murder cases during the 2020-2021 period. This represented a 1,353 declined in the number of murder cases in South Africa. Although the number of murder cases

declined during the 2020-2021 period, murder cases in South Africa continue to be problematic.

In South Africa, the risk of wrongful death is high for any individual due to the plethora of causes of death which prevail. The negative impacts of wrongful death can be different in various households depending on their social and economic statuses. In particular, female-headed households are regarded to be more vulnerable and at risk of being in poverty as compared to households headed by men, and yet households headed by females have more caring responsibilities for children. Hence, the wrongful death of a single female parent can have huge consequences for the children who will be left behind.

Table 3.2 shows the number of children per household structure type in South Africa—and the percentage of children who are in male or female-headed households.

Table 3.2: Number of children per household structure type in South Africa

Number of Children	Male headed household	Female headed household
1-2 children	38.9%	61.1%
3-4 children	37.0%	63.0%
5 or above children	30.0%	70.7%

Source, Stats SA, (2022)

The table reveals that for all categories of the number of children, female-headed households have the highest percentage as compared to male-headed households. 61% of female-headed households live with one or two children as compared to only 38.9% for male-headed households with one or two children. In addition, 70% of female-headed households live with 5 or more children in South Africa, whilst only 30% of male-headed households live with five or more children. This means female-headed households live with more children as compared to male-headed households, which highlights the need to cater for the welfare of the children in the form of compensation, in case of the wrongful death of the mother who was the breadwinner and head of the household.

3.2.1 Policies which affected personal consumption rates

Targeted government policies and social programs have been implemented to improve the livelihood of vulnerable households such as female-headed households. The Child Support

Grant (CSG), introduced in 1998 by the South African government, issues monthly cash transfers to the primary caregivers of children who are from low-income households. The grant, which is part of the country's Social Assistance Programme, costs about 1.3% of GDP per annum (Oyenubi & Rossouw, 2024). The grant affects the household's consumption behaviours as studies have shown that recipients allocate a higher percentage of expenditure to healthcare, food and education for children as compared to non-beneficiary households (Patel et al., 2023).

Furthermore, the country's Expanded Public Works Programme and the Community Work Programme (Department of Public Works, 2009), have considered specific quotas for female participants, with priority given for single mothers. These employment initiatives, together with the National School Nutrition Programme, which provides meals to students daily, have indirectly affected consumption patterns by reducing food expenditure, which is required by households for school-aged children.

In addition, international organisations such as the United Nations Children's Fund (UNICEF) and the US Agency for International Development (USAID) have executed programs which are focused on women's economic empowerment in South Africa, with particular attention to single parents. (UNICEF, 2023). This has managed to influence not only the income levels of these households but also their consumption decision-making processes.

3.3 THEORETICAL LITERATURE REVIEW

Our paper presents four theories on consumption: the Keynesian Absolute Theory of Consumption, the Rational Income Hypothesis, the Life Cycle Hypothesis and the Permanent Income Hypothesis. In the literature, there are many other theories on consumption, especially those developed more recently. However, these four theories explain the proportion of income which is spent on personal consumption, which is the basis of our paper.

3.3.1 Keynesian Absolute Theory of Consumption

Keynes (1936) outlined one of the early theories of consumption, which assisted economists to understand consumer behaviour. In this theory, Keynes (1936) highlighted that current income was the main determinant of consumption. Keynes acknowledged that there were other factors which influenced consumption, such as wealth and interest rates. However, he emphasised that the current level of income of households was the major determinant. The theory highlighted

that as income increased, consumption also increased, but it increased less than income increase. In other words, Keynes said that the additional proportion of consumption out of an additional level of income should be less than 1. This is popularly known as the marginal propensity to consume (MPC). In mathematical notation:

$$MPC = \frac{\Delta C}{\Delta Y}$$

Where MPC is equal to a change in consumption (ΔC) divided by a change in income (ΔY). In addition, MPC should be less than 1. In other words, MPC is between 0 and 1 as follows:

$$1 > MPC > 0$$

Furthermore, the theory highlighted that there is a positive function of consumption with income. If income increased in a current period, it was likely that consumption would also increase in that current period. The theory came up with a foundational functional form in the area of consumption with this consumption function:

$$C = a + bY$$

Where C consumption expenditure is an autonomous consumption, b is the marginal propensity to consume (MPC), and Y is the level of disposable income. Keynes also explained what is known as the average propensity to consume (APC), which is the proportion of consumption to income. He highlighted that the average propensity to consume declines as disposable income increases. In other words, as income increases, the proportion of income which is saved also increases. Therefore, wealthy families are more likely to save more and consume less as they have higher incomes, as compared to average families.

The theory lays some groundwork for the understanding of issues of consumer behaviour and aggregate demand. It provides understanding for some policy implications, which governments can implement which may include the increase of disposable income for households during periods of recession through tax cuts, to boost consumption and aggregate demand in the economy. However, the theory has its criticisms as being simplistic and not including other factors which affect consumption.

Relating to forensic economics, the absolute theory of consumption supports the premise that personal consumption rates are determined by income. In the Keynesian Theory, as income

increases, consumption increases but at a diminishing rate. In addition, average propensity to consume (APC) falls when income increases. In terms of forensic economics, personal consumption rates can either fall or increase as income increases since personal consumption rates is the proportion of income which is personally consumed by an individual in a household. Other studies in forensic economics (Krueger, 2014, 2007; Patton-Nelson 1991), have found a negative relationship between household income and personal consumption rates. As income increases, personal consumption rates decrease. Our paper aims to provide more in-sight on this relationship from a developing country's perspective, in this case, South Africa.

3.3.2 The Relative Income Hypothesis

Another economist, Duesenberry, (1949), improved upon Keynes' work by including psychological and social factors, which affect consumption (Drakopoulos, 2020). Duesenberry's (1949) theory was known as the Relative Income Hypothesis which highlighted that a household's consumption did not only depend on their absolute income but was also relative to the income of other individuals and their consumption behaviours. The theory highlights that households which may have lower incomes but live in areas with high income earners end up spending more income as compared to the high-income earners. In other words, low-income households emulate the lifestyle and consumption behaviour of high-income earners, such that they will end up spending more than the high-income households. This was known as the demonstration effect.

In addition, Duesenberry (1949), highlighted that even when incomes for households fall, consumption may not fall proportionately to the income because households would want to maintain high levels of consumption to be similar or higher than high-income earners. This was known as the ratchet effect (Adhikari, 2022). This buttressed the theory of Duesenberry (1949), which highlighted that households would consume more, dependent or relative to what other households are doing in society.

The theory thus explained the importance of past consumption on current consumption behaviours. Current consumption patterns do not quickly fall as a result of the household having lower income levels. However, the theory has its criticisms, which include that the theory was not specific to which types of low-income and high-income households it was referring that may provide a complete picture of the impact. Additionally, there can be other factors as well, which affect consumer behaviour, such as interest rates, the wealth effect and

absolute income itself. Furthermore, as it relates to developing countries, this theory may have limited appeal, as developing economies may face different challenges, such as high levels of inflation which affect consumer behaviour.

In terms of forensic economics, this theory may imply that personal consumption rates may not only depend on the income of households, but also be relative to the incomes of other individuals. This may imply that two groups of households may have different personal consumption rates even though they may have the same absolute income. Psychological and social factors may come into play in explaining differences in personal consumption rates. In addition, even though a certain household may be experiencing some income loss, their personal consumption rate patterns may remain stable due to social expectations.

3.3.3 Life Cycle Hypothesis

Modigliani and Brumberg (1954), wrote the Life Cycle Hypothesis, which stipulated that consumption decisions by households were not only dependent upon current income but on future income and wealth. The theory highlighted that households aim to smooth their consumption over their lifetime. Hence, households are likely to save during their employment years and are likely to dissave in their retirement years to maintain the same level of consumption over their lifetime.

Thus, during their working years, households accumulate wealth which will be consumed later when they retire. The theory highlighted that the accumulation of wealth causes the consumption function to shift upwards, whilst an increase in household income only results in the movement along the consumption curve (Adhikari, 2022). In addition, the theory stated that the marginal propensity to consume changes with age, with younger aged households likely to save more, hence a lower marginal propensity to consume as compared to older aged households who are more likely to consume more by dissaving. Younger-aged households are likely to consume a smaller percentage of their income as income increases, due to saving for retirement and wealth accumulation, such as buying houses and other assets.

In addition, the Life Cycle Hypothesis also highlighted that the rate of savings by households is also influenced by economic growth in the country (Deaton, 2005). Hence, in an economy where there is high economic growth, it is likely that the younger aged household will increase their saving rates as compared to the older generation, who will likely spend more of their accumulated income and wealth (Deaton, 2005).

The Life Cycle Hypothesis has its limitations for consumer behaviour. The theory focuses mostly on consumption smoothing and does not explain in greater length how bequests may have an effect in decreasing dissaving activities for the older generations. For instance, from time to time, the older generation leaves or transfers their bequests to the younger generation. Hence, there may be circumstances where the rate of dissaving by older generations is lower than expected, reducing the periods of smooth consumption for the older generation. In addition, it may not be all circumstances where the older households dissave during their retirement years, as they may end up holding savings for precautionary motives such as paying future medical expenses when they get sick or even to consume in the long run if they are alive. In addition, the theory does not consider that in some economies, especially developing countries, there can be liquidity constraints which may limit households' ability to save over time (Drakopoulos, 2021).

In relation to forensic economics, personal consumption rates (PCRs) show the consumption rate for an individual in a household. The Life Cycle Hypothesis argues that households try to smooth their consumption over their lifetime. In addition to that, the theory highlights that households save income and wealth in their working years and dissave it in later years. Hence, personal consumption rates can reflect such changes on an individual basis. In situations where a younger person is saving more, personal consumption rates can be able to show patterns of consumption rates for that younger person.

3.3.4 Permanent Income Hypothesis

Deaton (1992), highlighted that the Permanent Income Hypothesis by Friedman was a major contribution to the literature on understanding the consumption behaviour and patterns of households. Friedman (1957), highlighted that actual receipts and expenditures in consumption purchases made by the consumer were observable, whilst permanent income and permanent consumption were unobservable. Furthermore, the Permanent Income Hypothesis highlighted that observable income was equal to permanent income and transitory income. Consumers, according to Friedman (1957), responded more to permanent changes in income than to transitory changes.

Willasen (1978) added that transitory income was uncorrelated to permanent income or even transitory consumption. Friedman argued that permanent income was the major factor which changed or influenced consumption. Furthermore, Parker et al. (2013) highlighted those

transitory changes to income fluctuated from permanent income, whilst permanent changes to income were expected to influence the long-run future of consumers. Hence, since permanent income was the income averaged over time, it was assumed to be smoother than transitory income.

The hypothesis also stated that consumption was divided into permanent and transitory consumption patterns in consumers (Parker et al., 2013). Permanent consumption is stable and anticipated over a consumer's lifetime, whilst temporary consumption is unanticipated consumption which was not part of consumer's budget initially. Meghir & Pistaferri (2002) highlighted that due to a consumer's desire to smooth consumption, it meant that a portion of permanent income was used or consumed by consumers every period. In other words, the change in consumption due to a change in income will be equal to a percentage of the income of commodities spent by consumers. Friedman argued that the Permanent Income Hypothesis also influenced policy measures which could be enacted by governments. For example, if a tax cut by the government to stimulate consumption is anticipated by consumers as temporary than permanent, then there will be a less positive outcome to the policy change.

Friedman initially came up with three equations of measured income, consumption and permanent consumption, which are the following:

$$y = y_p + y_t \dots\dots\dots\dots\dots (1)$$

$$c = c_p + c_t \dots\dots\dots\dots\dots\dots\dots (2)$$

$$c_p = k(i, b, x) y_p \dots\dots\dots\dots\dots (3)$$

Where equation (1) shows that measured income is equal to permanent income (y_p) plus transitory income (y_t). Furthermore, equation (2) highlights that observable consumption is equal to permanent consumption plus transitory consumption. In addition, equation (3) indicated that permanent consumption is equal to *k,* which is the marginal propensity to consume multiplied by permanent income. In other words, permanent consumption is equal to permanent income through a multiplier factor *k*. Furthermore, *k* depends on (*i*), which is the interest rate, (*b*) which is non-human wealth and (*x),* which are variables influenced by taste.

Friedman, in his hypothesis, later expressed the above three equations in terms of logarithms. The letters in the equations were now in capital letter format, which represented the logarithms.

He then argued that expressing the equations in a multiplicative form was preferred, especially for data related with income and consumption. The three equations highlighted by Friedman are as follows:

$$C_p = K(i, b, x) + Y_p \ldots\ldots (4)$$

$$Y = Y_p + Y_t \ldots\ldots\ldots\ldots (5)$$

$$C = C_p + C_t \ldots\ldots\ldots\ldots\ldots (6)$$

Friedman later highlighted that the relationship between consumption and income in, for example, budget studies of families, could also be expressed in terms of a linear relationship where *c* is the average consumption for given values of income (*y*). In his hypothesis, Friedman then expressed the linear relationship as follows:

$$c = \alpha + \beta y \ldots\ldots\ldots (7)$$

The Permanent Income Hypothesis has been a positive theory which further explains concepts of consumer behaviour. The hypothesis also incorporates the concept of future expectations, which shows how consumers behave with and anticipate their future incomes. The role of expectations has been crucial in explaining some of the changes in consumption and inflation behaviours in economies. In some instances, expectations that consumers have of future inflation shape the current inflation rates in an economy (Fuhrer, 2012).

However, the theory has some limitations as well. The theory highlights that consumers act rationally when they make their consumption decisions. However, this may be a limitation in other areas, such as behavioural economics, where individuals can have cognitive biases which may affect their consumption patterns. Furthermore, it could be challenging to measure permanent income in countries which have volatile economies. This could lead to inconsistencies in temporary versus permanent income. In addition, some empirical studies to test the Permanent Income Hypothesis have produced mixed results, with some supporting the propositions of the theory and others going against the theory (Yun et al., 2024).

In relation to forensic economics, personal consumption rates depend on transitory and permanent income. The theory highlights that when transitory income is above permanent income, households will increase saving as they anticipate that there will be no income increases in the future. In that scenario, personal consumption rates are likely to decrease. In

contrast, when transitory income is below permanent income, households are likely to use their savings to maintain their consumption levels. In other words, a decrease in income may result in an increase in personal consumption rates as households dissave and try to smoothen their consumption.

3.3.5 Random Walk Hypothesis

Hall (1978) wrote one of the most significant contributions to consumption theory in his seminar paper "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence." Hall assessed a key implication of rational expectations, which highlighted that consumers follow a random walk if they are forward-looking optimisers and are economic agents who use all the information which is available efficiently. Hall showed theoretically that the marginal utility of consumption develops as a random walk with trend when expected lifetime utility is maximised by consumers. The implication of this is that only information on consumption in the current period has the power to predict future consumption changes.

The hypothesis by Hall is crucial as it is different from previous consumption models that depended on past income distributed lags. Hall highlighted that rational consumers incorporated all information which were available on future income prospects into present consumption decisions. Only unanticipated new information should cause consumption changes. Hence, changes in consumption should be unforeseeable using information which is available when making consumption decisions.

Hall regressed current consumption on lagged values and estimated whether other lagged variables had additional predictive power. In his analysis, Hall found that lagged income did not have any credible predictive power for current consumption if lagged consumption is included in the regression model. The result went along the reasoning that all vital information is used by consumers on income prospects when making decisions about consumption. However, although lagged income did not show any significant predictive power, Hall's results showed that stock prices had some ability to predict changes in consumption.

Extensive debates over the following years have been conducted over the random walk hypothesis. Some studies have found support for Hall's results, whilst others have found sensitive consumption to predictable changes income, pointing to the likelihood of precautionary savings or liquidity constraints which the random walk hypothesis does not

capture. Even though there remain questions about Hall's results, the hypothesis remains fundamental to research in consumption behaviour and continues to influence researchers to develop more empirical approaches that try to address the behaviour of consumers under uncertainty.

3.4 EMPIRICAL LITERATURE

Patton and Nelson (1991) were one of the early researchers on forensic economics to analyse the Bureau of Labour Statistics (BLS) Consumer Expenditure Survey 1986-87 and estimate personal consumption tables. These personal consumption tables have been widely used and referenced by lawyers and forensic economists in determining the economic loss of a deceased household member. Patton and Nelson (1991) wrote their article to provide forensic economists with a substantial methodology of estimating compensation in a wrongful death case or personal injury. The first personal consumption tables were published in 1991 (Patton & Nelson, 1991). Thereafter, from time-to-time, other consumption Tables have been published, taking into consideration changes in methodologies and updates from the BLS's database (M. Ruble et al., 2000, 2014, 2019a, 2019b; M. R. Ruble et al., 2002, 2009). The consumption tables are based on a natural logarithmic regression equation, estimated by gender and on the unit size of consumers. The tables produced consistent results, whereby an increase in income levels resulted in a decrease in personal consumption rates for both male and female members of households. For a three-member household with an income level of $20,000 USD, a male household's consumption rate was at 31.3% as compared to a female household member consumption rate which was 32.5% (Ruble, Patton & Nelson, 2014).

Gilbert (1991) compared existing methods in calculating personal consumption rates in the 1990's, in the USA. Mainly, Patton and Nelson (1991) approached with the Bureau of Labour Statistics (BLS) equivalence scales approach. The BLS equivalence scales approach was based on the concept that larger families would be assigned higher scales or higher values of consumption as compared to smaller family units. Gilbert (1991) provided a critique of both methods, highlighting that they excluded a number of expenditures in the calculation of family consumption. His paper suggested a method that differentiates expenditure in personal goods and public goods. Although Gilbert (1991)'s consumption rates were not too different from those calculated by the BLS equivalence method, the personal consumption rates were more stable at different family income brackets.

In contrast to Patton and Nelson (1991), and Gilbert (1991), who used the 1986-87 American Consumer Expenditure Survey (CES), Trout and Foster (1993) estimated personal consumption rates using the 1989-1990 American CES data. Trout and Foster (1993) used econometric regression analysis to estimate the consumption functions of three family types: a male as head of the household, a female as head of the household and a husband-and-wife household. An employed econometric analysis was employed to analyse the relationship between consumption expenditure and explanatory variables such as family size, disposable income, and family type. Using the consumption functions of three family types to estimate differences in savings for households with a decedent and those households without a decedent, they obtained consumption estimates for the decedent. The paper presented consumption ratios which were lower as compared to those presented by Patton and Nelson (1991) and Gilbert (1991). The authors highlighted some of the challenges they encountered in the estimation, which included the issue of truncation, especially for high-income-earning households.

Ajwa et al. (2000) utilised the 1997 BLS Consumer Expenditure Survey (CES) to estimate personal consumption of American households taking savings into consideration. The paper argued that previous studies, such as (Lierman et al., 1998; Patton & Nelson, 1991b) had underestimated consumption values since they did not include savings in their calculations. The authors characterised savings as delayed consumption and highlighted that higher-income families would save more than lower-income families. Furthermore, the authors used a lon-log regression technique to estimate the specific percentage of income that was used for consumption by household members. The paper estimated personal consumption rates that incorporated savings estimates and personal consumption rates that did not have savings estimates. In their estimates, personal consumption rates increased as income increased due to delayed consumption, which could be utilised by households in later periods. However, the paper provides assumptions on household's savings decisions on their income which can be challenging to determine since there is limited data. In addition, the authors mentioned that they did not consider indivisible consumption expenditure as it would overestimate their consumption rates. This consideration of indivisible consumption expenditure is important in estimating personal consumption rates.

Scoggins (2001) estimated personal consumption through the use of instrumental variables. The author argued that previous studies on estimating personal consumption did not highlight the difference between permanent and transitory income in calculating consumption rates. The

study used ungrouped data from the 2000 BLS CES and an econometric model derived from the Permanent Income Hypothesis (PIH), to conduct the analysis. The regression model had factors, such as household size, gender, race and age. The paper found that those household members who were unemployed had higher consumption rates as compared to household members who had worked for 2080 hours per year. Furthermore, the study revealed that an individual aged 46 years had a consumption percentage rate of about 16.7% as compared to an individual aged 63 years, who was estimated to have a consumption percentage of about 18.8%. However, Scoggin's (2001) paper provided complex estimations using instrumental variables, which could not be practical in reality if personal consumption rate estimates were needed with urgency to calculate compensation damages. Furthermore, the paper also faced the challenge of truncation, especially for higher-income household data.

Brown (2004) provided estimates for personal consumption rates in Canada, based on the 1997 Canadian Survey of Household Spending (SHS)—the first research of this nature outside of the USA. Brown (2004) used microdata to estimate personal consumption rates before and after the removal of tax in Canada. The study carried out the analysis, making use of log-log form regression, and differentiated the data by family size as well as income level. The study's expenditure allocation is similar to what Patton-Nelson (1991) used in their paper. The paper presented personal consumption rates for households with two to five family members over the household income range from 10,000 Canadian dollars to 100,000 Canadian dollars and over. In addition, Brown (2004) found that there was an inverse relationship between personal consumption rates for both before and after income levels, as well as family size. The study acknowledged that their Canadian dataset did not have sufficient household income data to provide more accurate personal consumption rate estimates.

Krueger (2007) used data from the American Consumer Expenditure Survey (CES) to estimate personal consumption rates for husbands and wives by using their work status. Unlike previous studies (Patton & Nelson, 1991; Ruble, Patton & Nelson 2000, 2004), which used the CES's tabulated and summarised data of household expenditure, the study used CES micro data to come up with more comprehensive estimates. Furthermore, the study used second-order polynomial regression analysis to come up with personal consumption rates for husbands and wives. The study found that as income increased, both personal consumption rates for husbands and wives decreased. In addition, the study highlighted that for both households which had

spouses employed and unemployed, women had slightly higher personal consumption rates as compared to their male counterparts.

Krueger (2014) utilised the microdata of the American CES dataset for the years 2011 to 2013 to estimate personal consumption rates by household income and family size. The study aimed to consider personal consumption rates using various family characteristics and types, which included families who were retirees, married couples with children and single parents with children. To provide more accurate estimations, the study calculated personal consumption rates with micro data, which had over 700 expenditure classifications. In addition, the study had expenditure allocation rules to separate divisible, indivisible and fixed expenditures of households. The paper showed variations in the personal consumption rate estimates which were categorised by different family sizes and by household income. The study found declining personal consumption rates for all family types as household income increased. However, the study acknowledged the limitation of the CES data, which may have under-reported some expenditures.

Rosenbaum and Ellis (2021) compared micro data and income strata-based models in estimating personal consumption rates in America, making use of the Consumer Expenditure dataset. The authors argued that studies which employed income strata in household expenditure calculations resulted in the distortion of the variation in spending amongst household members. Furthermore, the study highlighted that studies which employed micro data were able to allocate household expenditures of goods and services to the relevant household members. The study made use of logarithmic power functions for micro data analysis and quadratic equations for income strata analysis to come up with the personal consumption rates. The study found that households without children had higher consumption rates as compared to households which had children. Furthermore, the study indicated that for lower income levels, estimates for income strata data and micro data were similar, which means that forensic economists who decided to use one of the two types of estimates would produce the same results as the other.

3.5 METHODOLOGY

3.5.1 Expenditure Allocation Rules

Our paper follows the Krueger (2014) and Krueger (2007) expenditure allocation rules to estimate personal consumption rates (PCRs). The expenditure estimations are important in

deriving the percentage of expenditure, which is specific to a household member who has died wrongfully (Krueger, 2007). Expenditure in the dataset needs to be allocated using some rules because there are some expenditures, which are divisible and some, which are indivisible. Divisible expenditures are specific expenditures to the female parent and the child. So, such expenditures need to be separated and allocated accordingly. Indivisible expenditures are shared expenditures which will need to be allocated equally among the household members. Fixed expenditures, such as rent, are not added to the specific expenditure allocation of a household member because such expenditures will not change regardless of whether there are more or fewer household members. In addition, these expenditures do not directly relate to a particular household member's personal consumption.

The Krueger expenditure allocation methodology offers more robust results as compared to the Patton-Nelson method, as its foundation is rooted in microeconomic consumption theory, which recognises how the economies of scale of households vary across different categories of expenditure. Krueger's approach shows that consumption patterns differ based on the composition and size of a household, a feature important in diverse households in South Africa. In addition, Krueger's methodology allows for more accurate identification of household's specific personal consumption rates in South Africa as shared resources often follow distinct, unique patterns different from those observed in Western economies where the Patton-Nelson rates are originally based.

We use six expenditure allocation categories for our analysis. The six categories are (a) Female expenditure; (b) Family shared expenditure, (c) Food shared expenditure, (d) Utilities, (e) Semi-divisible expenditure, and (f) Medical insurance. In these categories, our paper follows different allocation rules, which are based on separating expenditures into divisible and indivisible, then allocating them to the parent and child. We follow the rules used by Krueger (2014) and Krueger (2007) in allocating expenditure. The rules will be explained in detail for each category. In addition, these six categories consist of the various products that are allocated to that category. These products are obtained from the NIDS dataset for wave 5.

a. Female expenditure

The expenditure allocation rule for this category is equal to the total expenditure for the female parent divided by one. In our paper, we only have one adult who is the single parent with either one or two children. Hence, the expenditure which falls into this category is peculiar only to

the female adult in the household. The products which form the expenditure of the female adult include cigarettes and tobacco; beer, wine and spirits; newspapers, stationery, envelopes, stamps, and books, excluding school books, jewellery and watches.

b. Family shared expenditure

The expenditure allocation rule for this category is equal to total family expenditure divided by the number of persons in the family. In our paper for a single parent with one child, there are in total two household members and for a single parent with two children, there are in total three household members. The products which form the expenditure of this category include products, such as personal care items, such as cosmetics, soap, shampoo and haircuts; entertainment, such as cinema, music, MNET and DSTV; sport including sporting equipment, gym and club membership; buses, taxis, trains and air tickets, including transport to school; homeopaths, physiotherapists, dieticians; traditional healer's fees; dentists, doctors or nurses; medical supplies, for example medicines and bandages; hospital fees.

c. Food shared expenditure

The expenditure allocation rule for this category is equal to total food expenditure divided by the number of persons in the family. The products in this category include all groceries stated in the NIDS dataset. There were 32 food expenditures in the NIDS dataset which are mealie meal; samp; flour and bread; rice; pasta; biscuits, cakes, rusks; red meat (beef, mutton, pork, etc.); canned red meat; chicken; fresh fish and shell fish; tinned fish; dried peas, lentils, beans; potatoes; other vegetables; fruits and nuts; oil for cooking; margarine, butter, ghee, other fats; peanut butter; milk, cheese, yoghurts and dried milk; eggs; sugar, jam, honey, chocolates and sweets; soft drinks and juices; tinned fruit and vegetables; breakfast cereal and porridge; salt and spices; soya products; coffee and tea; food hampers; ready-made meals brought into the household; meals prepared outside the home (including restaurants and takeaways); and other food expenditures. We excluded the food items of baby food and bay formula, since we are estimating expenditures and personal consumption rates for the adult single parent. This was consistent with Krueger (2007), who explained the advantage of his expenditure allocation rules method over the Patton and Nelson (1991) method, which used summary tables of expenditures calculated by the American Bureau of Labour Statistics. Krueger (2007) was able to remove the baby food as he was calculating expenditures and personal consumption rates for husband and wife only households.

d. Utilities

The expenditure allocation rule for this category is such that 25% of the utilities is allocated to single parents and children. The other 75% of utility expenditure are considered fixed and omitted from the calculations. Products which form expenditure for this category are cell phone accounts and/or airtime, the landline telephone account, internet, if not included in the telephone account.

e. Semi-divisible Expenditure

The expenditure allocation rule for this category is total expenditures divided by of household members, which was calculated as 1 (for the single parent) + (number of children / 2). This meant that 50% of expenditures were non-divisible and attributed to the single parent, while the remaining 50% were divisible and allocated equally among the single parent and the children, considering the reduced allocation for each child. This was consistent with Krueger (2014; 2007) allocation of semi-divisible expenditure rules. Products found in the NIDS dataset which form expenditure for this category include water, electricity, other energy sources, such as wood, paraffin, charcoal, coal, candles etc.; washing powder, dishwashing liquid, polish and all household cleaners.

f. Medical Insurance

The expenditure allocation rule for this category is equal to total expenditure divided by the quantity of one (single parent) plus the division of the number of children by two (i.e. the cost of child medical insurance is assumed at 50% of the cost of adult insurance). This allocation method is consistent with how Krueger (2014; 2007) allocated expenditure for this category. Products found in the NIDS dataset which form expenditure of this category are medical aid schemes/medical insurance, such as a hospital plan.

Our methodology for our paper is done in seven steps, which are the following:

Step 1: Expenditure Allocation

The paper produced six average expenditure allocation categories using the expenditure allocation rules mentioned above. The six average expenditure categories are female expenditure, family expenditure, food expenditure, utilities, semi-divisible expenditure and medical insurance.

Step 2: Calculation of the Mean Household Income

Based on the NIDS dataset for wave 5 (2017), we analyse household income figures reported by households who were interviewed. Based on the available household income figures reported, we generated five household income brackets which represent all the incomes which were reported in the dataset. The five income brackets are a) R60k-119.9k b) R120k-237.9k c) R238k-419.9k d) R420k-R719.9k e) R720k and over. Expenditures, which are estimated in step 1, are categorised and presented according to these five household income brackets. The five income brackets present the initial steps of showing expenditure and calculating personal consumption rates.

Step 3: Initial Calculation of Personal Consumption Rates (PCRs)

We calculate personal consumption rates for single female parents with one child and single female parents with two children by dividing allocated total average expenditures by mean income per income bracket. For example, for the income bracket of R60k-119.9k, all six average expenditures of this income bracket are added together after expenditure allocation rules are done and then divided by the mean household income of that income bracket. The formula is as follows:

$$Initial\ average\ PCRs = \frac{Total\ average\ expenditure\ after\ expenditure\ allocation\ rules\ are\ obtained\ per\ income\ bracket}{Mean\ household\ income\ per\ income\ bracket}$$

Step 4: Calculation of Smoothened Consumption Rates (PCRs)

We estimate Smoothened Personal Consumption Rates (PCRs) for single female parents with one child and single female parents with two children. The five mean household incomes and five initial PCRs estimated in step 3 are regressed in Stata using the linear log function of the form:

$$PCR_i^1 = \alpha^1 + \beta logHincome_i^1 + \varepsilon_i^1 \dots\dots (8)$$

$$PCR_i^1 = \alpha^2 + \beta logHincome_i^2 + \varepsilon_i^2 \dots\dots.. (9)$$

Equations 8 and 9 represent the linear log functions for single female parents with one child and single female parents with two children, respectively. This is consistent with the regression method used by Wright et al. (2024) in their paper "Patton-Nelson Personal Consumption

Tables 2018-2019". The linear log regression is used to regress the five average household incomes and five initial PCRs to smooth consumption. The results of the regression, which include coefficients of α and β are used to estimate PCRs at specific income levels from R100 000 to R3 500 000. The specific income levels are generated from the initial five income brackets, which are a) R60k-119.9k b) R120k-237.9k c) R238k-419.9k d) R420k-R719.9k e) R720k. To have well distributed income levels and eventually smoothed PCRs we randomly select 35 observations of specific household income levels from R 100 000 to R3 500 000. Any value within the initial five income brackets could be used to produce smooth PCRs, however we select 35 specific income levels, which we observe could provide evenly distributed PCR values for the whole range of income values. This random selection of specific income values is consistent with how Krueger (2014) and Krueger (2007) selected their specific income values. Equation 3 is the equation for single-female parents with one child, whilst equation 4 is for single-female parents with two children.

Step 5: Estimation of the Differences in PCRs

The difference between the PCRs for single-female parents and one child with the PCRs for single-female parents and two children are regressed in Stata using the log-log functional form to analyse the influence in household income on the differences in PCRs between these two types of family households. The log-log function form is used in this case because the smoothed PCRs at specific income levels show a non-linear relationship. This is shown in the graphs in Figure 1 and Figure 2 in the results section. The log-log functional form is the following:

$$lnPCR_diff_i^{12} = \alpha^{12} + \beta lnincome_i^{12} + \varepsilon_i^{12} \dots\dots (9)$$

Where $lnPCR_diff_i^{12}$ is the log of PCR differences between single female parents with one child and single female parents with two children, $lnincome_i^{12}$ is the log of the specific income levels from R100,000 to R3,500,000.

Step 6: Estimation of Cohen's d test

We estimate Cohen's d test, which is an effect measure of size that computes the scale of the difference between the means of the single female parent with one child PCR versus the single female parent with two children PCR. The Cohen's d test considers variability in the two single female parents' groups of PCRs. Cohen's d test standardises the difference of the means in PCRs between the two single female parents' groups by considering how variable or spread

out these PCRs are within the two single female parents' groups. The test provides a practical significance of the difference between the PCRs of the two types of single female parents. If the Cohen's d value is equal to 0.2 it is a small effect size, whilst a Cohen's d size of 0.5 is equal to a medium size effect. A Cohen's d value of 0.8 or above is a large effect size (Bobbitt, 2021). The functional form of Cohen's d test is as follows:

$$Cohen's\ d\ test = \frac{X_1 - X_2}{S}$$

Where:

X_1 is the mean personal consumption rate for the group of single-female parents with one child.
X_2 is the mean personal consumption rate for the group of single-female parents with two children.
S is the standard deviation of the two groups of single-female parents with one child and single female parents with two children. It can be expressed as follows:

$$S = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Where:

n_1 and n_2 are the sample sizes for single female parents with one child and single-female parents with two-children groups.
s_1 and s_2 are the standard deviations of the PCRs for single female parents with one child and single female parents with two-children groups

3.6 DEFINITION OF VARIABLES

a. Personal Consumption Rates (PCRs)

Personal Consumption Rates (PCRs) are a numerical measure which are estimated by dividing the total average household spending by the total average household income, indicating the rate of consumption relative to household income. This is the dependent variable of this study. In a wrongful death scenario, the estimated PCRs will be deducted from the income of the deceased to remain with compensation, which will be awarded to the surviving family members (Patton & Nelson, 1991). In our case, the income of the deceased is the household income. At first,

we estimate initial average personal consumption rates by dividing total average expenditure by household income per income bracket. We later use the linear log regression to smooth consumption and estimate PCRs at 35 specific income levels. Initial average PCRs is the dependent variable, and average household income is the independent variable for the linear log regression.

b. Household Income

Household income is monetary, goods and services receipts that household members receive at different time intervals, such as per month or annually (OECD, 2013a). This household income is used for consumption and other household activities. In our study, we use household income found in the NIDS dataset for Wave 5, which took place in 2017. In our paper, we use the income for female heads of the household who have either one or two children. The children are still minor or below the working age of at least 15 years, which means they were still dependent upon the salary of the mother. Children above 15 years may be allowed to work those minimal jobs which do not place them at risk (Visser, 2021).

We convert, monthly income to annual income. We then add all the household income and divide it by the number of female heads per income bracket to produce the average household income. The five income brackets are R60k-119.9k; R120k-237.9k; R238k-R419.9k; R420k-R719.9k; R720k and above. The five income brackets are created based on the data available in the dataset. Since we have five income brackets, we end up also having five average household incomes per income bracket. We also use average household income linear log regression as an independent variable, where the dependent variables are the initial average PCRs to generate coefficients which are used to estimate smoothened PCRs. The coefficients estimated in Stata are substituted into the linear log regression equation together with 35 specific income values to produce 35 smooth PCRs. We produce 35 specific income values based on the five income brackets. In other words, the specific income values selected need to be within the income range of the initial five income brackets.

3.7 DATA SOURCE

This paper estimates personal consumption rates in South Africa using the National Income Dynamics Survey (NIDS) dataset for wave 5 (2017), specifically for single female parents with one child and single female parents with two children. Data analysis and cleaning are done using the NIDS dataset, and we are left with 3,847 observations of single female parent

households with one or two children. Expenditures are extracted from the NIDS dataset and using the allocation expenditure rules, expenditures are allocated into five expenditure income groups. Five income brackets, as well as average household income are also estimated. The NIDS dataset, which started in 2008, includes information on a range of topics, including household income, education, employment, and health status of households.

3.8 ESTIMATED RESULTS

3.8.1 Consumption Expenditures for Single Female Parents

Table 3.3: Consumption expenditure for single female parents with one child

Table 3.3a

Household group income (1)	Mean household income (2)	Number of households (3)	Female expenditure (4)	Family shared expenditure (5)	Food shared expenditure (6)	Utilities (7)	Semi-divisible (8)	Medical insurance (9)	
R60k-R119.9k	R93948.67	226	R8262.406	R9437.965	R33146.55	R6626.956	R3855.08	R21614.18	
R120k-R237.9k	R178802.9	648	R15888.8	R18293.98	R46492.38	R13360.9	R7445.201	R44735.26	
R238k-R419.9k	R310772.7	578	R25309.99	R27526.82	R105265.5	R19161.01	R11095.37	R65103.5	
R420k-R719.9k	R534446.2	306	R32791.31	R38304.21	R139013.3	R24402.25	R14985.41	R86096.47	
R720k and over	R1436305	269	R40770.18	R47016.88	R172759.9	R31522.6	R17209.52	R103813.6	

Table 3.3b

Household group income (1)	Mean household income (2)	Female expenditure (3)	Family shared expenditure (4)	Food shared expenditure (5)	Utilities (6)	Semi-divisible (7)	Medical insurance (8)	Total expenditure (9)	Parent (PCE) (10)
R60k-R119.9k	R93948.67	R8262.406	R4718.983	R16573.28	R828.3695	R2891.31	R14409.45	R47683.8	50.76%
R120k-R237.9k	R178802.9	R15888.8	R9146.99	R23246.19	R1670.113	R5583.901	R29823.51	R85359.5	47.74%
R238k-R419.9k	R310772.7	R25309.99	R13763.41	R52632.75	R2395.126	R8321.528	R43402.33	R145825.1	46.92%
R420k-R719.9k	R534446.2	R32791.31	R19152.11	R69506.65	R3050.281	R11239.06	R57397.65	R193137.1	36.14%
R720k and over	R1436305	R40770.18	R23508.44	R86379.95	R3940.325	R12907.14	R69209.07	R236715.1	16.48%

Table 3.4: Consumption expenditure for single female parents with two children

Table 3.4a

Household group income (1)	Mean household income (2)	Number of households (3)	Female expenditure (4)	Family shared expenditure (5)	Food shared expenditure (6)	Utilities (7)	Semi-divisible (8)	Medical insurance (9)	
R60k-R119.9k	R94178.53	163	R8002.717	R9160.933	R34607.85	R6523.509	R3151.656	R23000.25	
R120k-R237.9k	R181171.1	494	R15178.76	R17571.81	R65336.36	R12376.28	R6694.834	R40485.57	
R238k-R419.9k	R313126.6	463	R23890.21	27388.25	R101633.8	R19122.79	10326.27	R61115.56	
R420k-R719.9k	R519525.4	202	R28633.39	R37786.69	R129186.5	R25056.63	R3855.08	R81947.41	
R720k and over	R1335701	183	R39285.2	R47858.58	R172185.6	R31184.15	R17847.21	R119830.2	

Table 3.4b

Household group income (1)	Mean household income (2)	Female expenditure (3)	Family shared expenditure (4)	Food shared expenditure (5)	Utilities (6)	Semi-divisible (7)	Medical insurance (8)	Total exp (9)	Parent (PCR) (10)
R60k-R119.9k	R94178.53	R8002.717	R3053.644	R11535.95	R543.6258	R2101.104	R11500.13	R36737.17	39.01%
R120k-R237.9k	R181171.1	R15178.76	R5857.27	R21778.79	R1031.357	R4463.223	R20242.79	R68552.18	37.84%
R238k-R419.9k	R313126.6	R23890.21	R9129.417	R33877.93	R1593.566	R6884.18	R30557.78	R105933.1	33.83%
R420k-R719.9k	R519525.4	R28633.39	R12595.56	R43062.17	R2088.053	R2570.053	R40973.71	R129922.9	25.01%
R720k and over	R1335701	R39285.2	R15952.86	R57395.2	R2598.679	R11898.14	R59915.1	R187045.2	14%

Tables 3.3a and 3.4a show consumption expenditure for single female parents with one child and single female parents with two children, respectively in South Africa. The first columns of Tables 3.3a and 3.4a labelled "Household group income" show five household income groups created as a result of the data available in the NIDS dataset. The household income is per annum and is diverse, as it starts from those single parents with full-time income levels of R60,000 per annum, which is R5,000 per month to income levels beyond R720,000 per annum, which is beyond R60,000 per month.

The second columns of Tables 3.3a and 3.4a labelled "Mean household income" show the mean of household income which are calculated in Stata by averaging household income according to the income brackets given in column 1. Furthermore, the third columns of Tables 3.3a and 3.4a labelled "Number of households" show the number of households, which are in each income bracket. In addition, the Tables 3.3a and 3.4a show the six household average expenditure groups, which are calculated by per each income bracket. The six-household expenditure groups contain specific expenditures, which are added and averaged. Each expenditure is data, which is extracted and added from the NIDS dataset for the fifth wave (2017). In the NIDS dataset, there are sections where the households were asked for the expenditures, which they carry out per month. We add the amounts of these expenditures according to each relevant category and per relevant income bracket into, which the household fits. There is also a question which asked for the household's income per month. The six-household expenditures shown in Tables 3.3a and 3.4a are female expenditure, family shared expenditure, food shared expenditure, utilities, semi-divisible expenditure and medical insurance.

Tables 3.3b and Table 3.4b show expenditures which are calculated based on the expenditure allocation rules mentioned earlier in the methodology section. After we have averaged the expenditures per income bracket in Table 3.3a and Table 3.4a, we apply the expenditure allocation rules to each of these six expenditure groups in Tables 3.3b and 3.4b. For example, in Table 3.3b for the income bracket of R60,000 to R1,199,999 the average female expenditure of R8,262.406 is divided by one since the single parent in the family is a female adult. This gives the figure of R8,262.406 in the third column written "Female expenditure" for Table 3.3b. The average "Family shared expenditure" of R9,437.965, which is in the fifth column of Table 3.3a is divided by the equal number of persons in the family, which are 2, since in this case there is one single-parent and one child. This gives the value of R4,718.983 for "Family

expenditure" fourth column for Table 3.3b. For food shared expenditure, the average expenditure of R33,146.55 found in column 6 of Table 3.3a is divided by the number of persons in the family which is 2 (the single parent and one child) to come the value of R16,573.28 which is in Table 3.3b column 5. For our illustration for tables 3.3a and 3.3b, we shall use the income bracket R60k-R119.9k.

For utilities, the divisible component is 25% of every utility. This means that we multiply 0.25 on the value of R6,626.956 in Table 3.3a and then divide by the number of persons in the family (two in this case) to generate R828.3695 in Table 3.3b. For semi-divisible expenditure, 50% of the expenditure is allocated to the single parent, whilst the other 50% is allocated to the single-parent and the number of children in the household. So, in terms of the calculations, 50% of the value of R3,855.08 in Table 3.3a column 8, (which is 3855.08/2= 1927.54) is added to the other 50% of that value which is divided by the number of persons in the household which are the single parents and the number of children (in this case the 50% is 1927.54 which is divided by 2 to get the value of 963.77). We then add 1927.54 from the first 50% and 963.77 to get a value of 2891.31 which is in column 7 of Table 3.3b.

For medical insurance, the value of R21,614.18 in Table 3.3a column 9 is divided by the single-parent plus the division of the number of children in that household, which is by 2. In this case, it will be R21,614.18 divided by (1 for single-parent plus (1/2) for one child). This gives the value of R14,409.45 which is in Table 3.3b column 8. The expenditure in Table 3.3b is added together per income bracket to come up with the total expenditure column (total exp), which is column 9 of Table 3.3b. The total expenditure per row or per income bracket is divided by the mean of household income per income bracket and multiplied by 100 to come up with five personal consumption rates. For example, for the income bracket of R60,000 to R 1,199 999 in Table 3.3b, the total average expenditure value of R47,683.8 is divided by the mean income for the same income bracket which is R93,948.67 and then multiplied by 100 to come up with a personal consumption rate of 50.76% which is the personal consumption rate for a single-parent with one child for the income bracket of R 60,000 to R 1,199 999.

For Table 3.4a and 3.4b, we illustrate how personal consumption rates were calculated using one scenario for the income bracket of R 60,000 to R 1,199 999. The female expenditure value of R 8002.717 found in the fourth column of Table 3.4a is divided by 1, since there is a single-female adult, which will result in a value of R 8,002.717, which is in column 3 of Table 3.4b. family shared expenditure value of R 9,160.933 is divided by the equal number of persons in

the family which is 3 since in this case there is one single parent and two children. This results in the value of R 3,053.644 which is found in the fourth column of Table 3.4b. The value of food shared expenditure, which is found in column 6 of Table 3.4a, R 34,607.85 is divided by the number of family members who are in the household. In this case, there are three which includes the single-parent and three children. This gives a value of R 11,535.95 which is found in the fifth column of Table 3.4b.

For utilities the divisible component is 25% of every utility. This means that 0.25 is multiplied on the value of R6,523.509 in Table 3.4a and then divided by the number of persons in the family (three in this case) to come up with R543.6258 in Table 3.4b. For semi-divisible expenditure, 50% of the expenditure is allocated to the single-parent whilst the other 50% is allocated to the single-parent and the number of children in the household. So, in terms of the calculations 50% of the value of R3,151.656 in Table 3.4a column 8 (which is 3151.656/2= 1575.828) is added to the other 50% of that value, which is divided by the number of persons in the household, which are the single parent and the number of children (in this case the 50% is 1575.828, which is divided by 3 to get the value of 525.276). We then add R1575.828 from the first 50% and R525.276 to get a value of R2101.104, which is in column 7 of Table 3.4b.

For medical insurance, the value of R23,000.25 in Table 3.4a column 9 is divided by the single-parent plus the division of the number of children in that household, which is by 3. In this case it will be R23,000.25 divided by (1 for single-parent plus (2/2) for one child). This gives the value of R11,500.13 which is in Table 3.4b column 8. The expenditure in Table 3.4b is added together per income bracket to produce the total expenditure column (total exp), which is column 9 of Table 3.4b. The total expenditure per row or per income bracket is divided by the mean of household income per income bracket and multiplied by 100 to generate five personal consumption rates. For example, for the income bracket of R60,000 to R 1,199,999 in Table 3.4b, the total average expenditure value of R36,737.17 is divided by the mean income for the same income bracket, which is R94,178.53 and then multiplied by 100 to produce a personal consumption rate of 39.01%, which is the personal consumption rate for a single-parent with two children for the income bracket of R 60,000 to R 1,199,999.

First step towards producing smoothened PCRs

Table 3.5: Results for the linear-log regression for single female parent with one child

	Coefficient	Standard error	P-value
In_income	-0.1266128	0.0266849	0.018
Constant	2.005522	0.3401205	0.010
Prob>F	0.0178		
R-squared	0.8824		
Adjusted squared	0.8432		

Table 3.6: Results for the linear-log regression for single female parent with two children

	Coefficient	Standard error	P-value
In_income	-0.1297939	0.0286725	0.020
Constant	2.04394	0.3649503	0.011
Prob>F	0.0202		
R-squared	0.8723		
Adjusted squared	0.8297		

We run linear log regressions to produce coefficients of household income, which are essential to generating smoothed PCRs. The coefficients in Tables 3.5 and 3.6 are statistically significant at 5% level. The P-value for the coefficient in Table 3.5 is 0.018, whilst the P-value for the coefficient in Table 3.6 is 0.020. The results reveal that as household income increases, personal consumption rates for single-female parents with one child and single- female parents with two children decreases. In Table 3.5, a 1% increase in household income will result in a decrease in personal consumption rate by 0.1266128. Table 3.5 has a Prob>F value of 0.0178, which means that the model is statistically significant and the independent variable In income is statistically significant and influential to the dependent variable, Personal Consumption Rates (PCR). The R-squared value is 0.8824, which shows that the model is a good fit to the data. In other words, this is an income make up about 88.3% variation in the dependent variable of PCR. Furthermore, in Table 3.6 a 1% increase in household income will result in a decrease in the personal consumption rate by 0.1297939. Furthermore, Table 3.6 has a Prob>F value of 0.0202, which highlights that the independent variable, which is income is statistically

significant and influential to the dependent variable. Furthermore, a Prob>F which is less than 5% shows that the model is statistically significant. Table 3.6 has an R-squared value of 0.8723, which implies that household income explains about 87.2% of the variation in PCR.

In our paper, we take the coefficients of the independent variable of household income and the constant and we substitute into the equations 1 and 2 (shown in step 4 of the methodology section) to produce smoothed PCRs. From the five income brackets, which are (R60k-R119.9k; R120k-R237.9k; R238k-R419.9k; R420k-R719.9k and R720k and over), we came up with specific income levels, which are spread across the five income brackets. Our construction of 35 specific income levels is upon the available household income data, which is in the NIDS dataset. We observed the household income data points in the NIDS dataset and from there we construct the 35 specific income levels from R100,000 to R3,500,000. These specific income levels are within the five household income brackets. We take the coefficients of household income and constant from the regressions together with the specific income levels to estimate the smoothed PCRs equations 1 and 2 in Stata. As an illustration, we show the calculation of the first PCR for a single-parent with one child.

$$display\ 2.005522\ +\ \left(-0.1266128\ *\ ln(100000)\right)$$

As shown in the above working "display" is the Stata command, 2.005522 is the coefficient for the constant and -0.1266128 is the coefficient for household income and 100,000 is the household income specific level for single-female parents with one child regression. This is equal to 0.54783827 which if multiplied by 100 it gives approximately 54.8%, which is the smoothed PCR at the household income level of R100,000. Table 3.7 below shows the smoothed PCRs and PCR difference over a range of specific household income levels from R100,000 to R3,500,000 for single- female parents with one child and single-female parents with two children.

3.8.2 Smoothed Personal Consumption Rates

Table 3.7: Smoothened personal consumption rates

Household income (per annum) (1)	Single female parent with one child (2)	Single female parent with two children (3)	PCR differences (4)
R100000	54.8%	55.0%	-0.2%

Household income (per annum) (1)	Single female parent with one child (2)	Single female parent with two children (3)	PCR differences (4)
R200000	46.0%	46.0%	0.0%
R300000	40.9%	40.7%	0.2%
R400000	37.2%	37.0%	0.3%
R500000	34.4%	34.1%	0.3%
R600000	32.1%	31.7%	0.4%
R700000	30.1%	29.7%	0.4%
R800000	28.5%	28.0%	0.5%
R900000	27.0%	26.4%	0.5%
R1000000	25.6%	25.1%	0.6%
R1100000	24.4%	23.8%	0.6%
R1200000	23.3%	22.7%	0.6%
R1300000	22.3%	21.7%	0.6%
R1400000	21.4%	20.7%	0.7%
R1500000	20.5%	19.8%	0.7%
R1600000	19.7%	19.0%	0.7%
R1700000	18.9%	18.2%	0.7%
R1800000	18.2%	17.4%	0.7%
R1900000	17.5%	16.7%	0.8%
R2000000	16.9%	16.1%	0.8%
R2100000	16.2%	15.4%	0.8%
R2200000	15.6%	14.8%	0.8%
R2300000	15.1%	14.3%	0.8%
R2400000	14.5%	13.7%	0.8%
R2500000	14.0%	13.2%	0.8%
R2600000	13.5%	12.7%	0.9%
R2700000	13.5%	12.2%	1.3%

Household income (per annum) (1)	Single female parent with one child (2)	Single female parent with two children (3)	PCR differences (4)
R2800000	12.6%	11.7%	0.9%
R2900000	12.1%	11.3%	0.9%
R3000000	11.7%	10.8%	0.9%
R3100000	11.3%	10.4%	0.9%
R3200000	10.9%	10.0%	0.9%
R3300000	10.5%	9.6%	0.9%
R3400000	10.1%	9.2%	0.9%
R3500000	9.8%	8.8%	1.0%

Table 3.7 shows the smoothed PCRs for single female parents with one child and single female parents with two children over the specific income levels from R100,000 to R3,500,000. All households' incomes and PCRs are relevant; however, we interpret the household incomes and PCRs shaded in yellow. The table also shows the PCR differences between PCRs for single-female parents with one child and single-female parents with two children. Table 3.7 shows that as household income increases the PCRs for both single-female parents with one child and single-female parents with two children decline. For instance, when household income is R 300,000 PCRs for single-female parents with one child and single-female parents with two children are 40.9% and 40.7% respectively. In addition, when the household income becomes R2 000 000 PCRs for single-female parents with one child and single-female parents with two children are 16.9% and 16.1% respectively. Except for the first income level of R100,000 and second of R200,000, PCRs for single-female parents with one child have been slightly higher as compared to PCRs for single-female parents with two children. For instance, for the household income level of R600,000 the PCR for single-female parents with one child is 32.1% whilst the PCR for single-female parents with two children is 31.7%. Furthermore, at the household income level of R2,500,000 the PCR for single-female parents with one child is 14.0% whilst the PCR for single-female parents with two children is 13.2%. In addition, column 4 shows that as household income increases, the difference in PCRs between single-female parents with one child and single-female parents with two children widens. PCR difference is the difference in PCRs between the PCR percentages of single-female parent with one child minus the PCR percentage of single-female parents with two children. For instance,

at a household income level of R400,000 the PCR difference between single-female parents with one child and single-female parents with two children is at 0.3%. When household income level is R3,400,000 the PCR difference between single-female parents with one child and single-female parents with two children widens to 0.9%.

3.8.3 Graphs for Single-female Parent PCRs

Figure 3.2: Single-female parents with one child PCRs

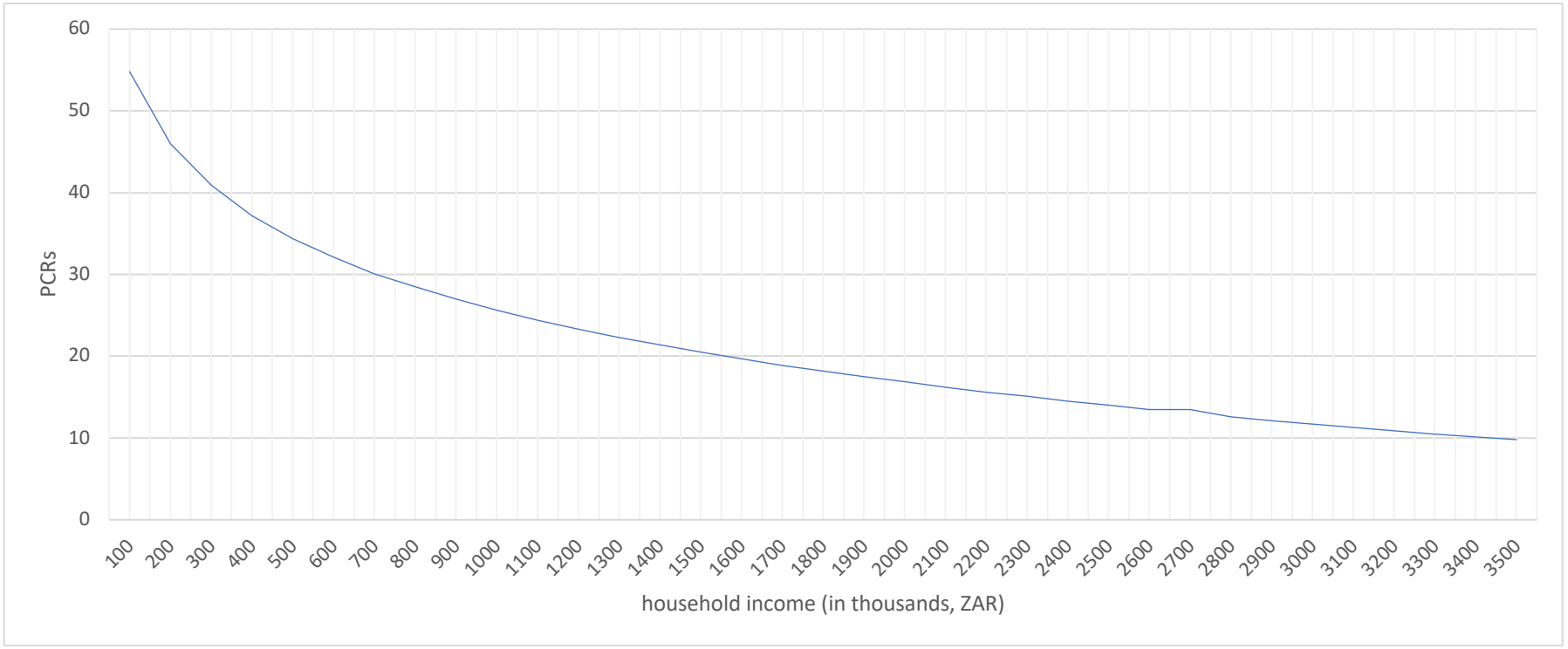


Figure 3.3: Single-female parents with two children PCRs

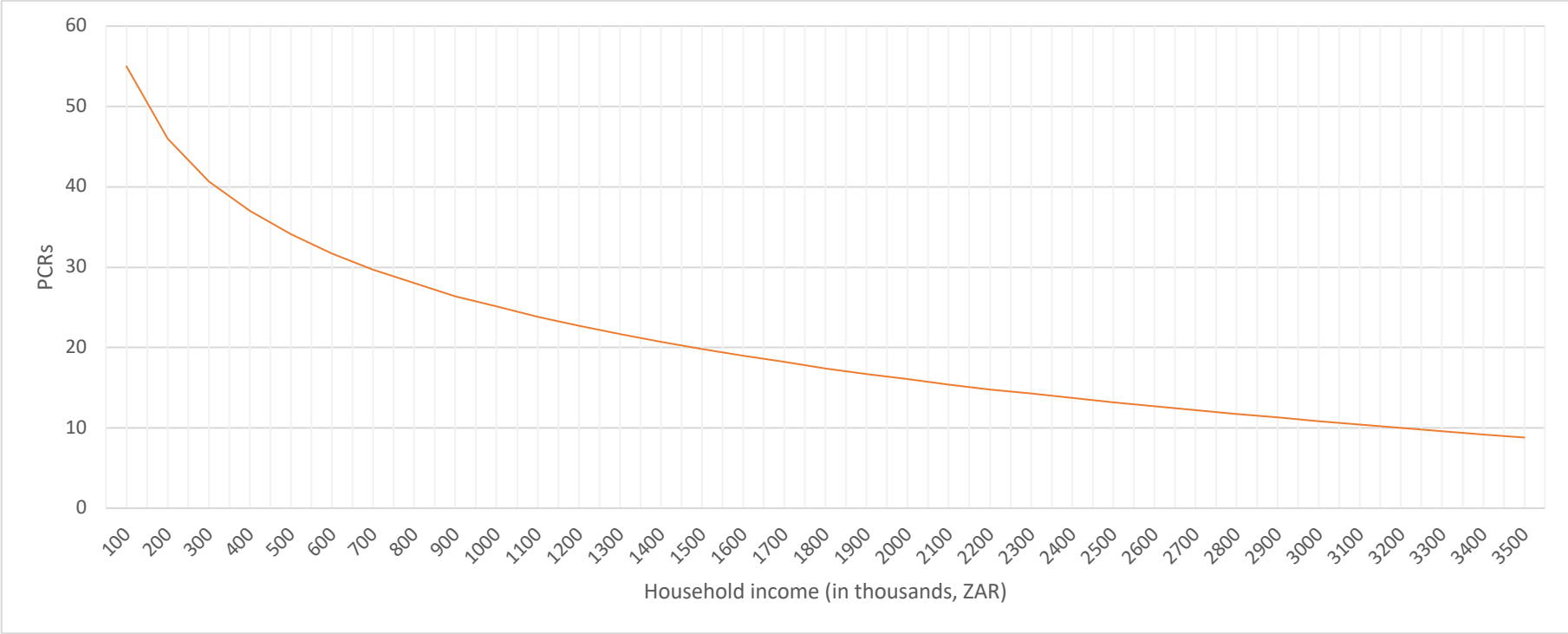


Figure 3.2 and 3.3 show the graphs for the PCRs of single-female parents with one child and two children for the income specific levels from R100,000 to R3,500,000. The graphs are sloping downwards from left to right showing that as income increases, PCRs decline. This is consistent with the results shown in Table 3.7. In other words, there is high consumption by single-female parents with one child and single-female parents with two children at lower income levels and lower consumption when the income levels are higher. As additional income is earned by the single-female parents with one child and single-female parents with two children there is a decline in consumption. The graphs are a bit steeper at lower household income levels and flatter as household income levels increase. This shows a non-linear relationship between household income and the PCRs.

3.8.4 Post-estimation Techniques

a. Estimation of the differences in PCRs

Table 3.8: Results of the personal consumption rates differences

	Coefficient	Standard error
ln_income	0.0033062***	0.000161
Prob>F	0	
R-squared	0.9271	
Adjusted R-squared	0.9249	
Number of observations	35	

*** *Significant at 1% level of significance.*

The positive and statistically significant coefficient on ln_income (0.0033062) indicates that as household income increases, the difference in personal consumption rates (PCR) between single-female parents with one child and those with two children also increases. In other words, the gap in spending between these two-family types widens as income rises. A 1% increase in income is associated with a 0.33% increase in the difference in PCR between single-female parents with one child and those with two children.

Table 3.9: Cohen's d test

Variable	Mean	Standard deviation	Effect Size
Pcr_diff	0.066857	0.029583	2.2599804

Table 3.9 shows the results of Cohen's d test for the differences in the two PCRs for single-female parents with one child and single-female parents with two children. The results show an effect size of 2.26. This shows the magnitude of the difference between the PCRs for single-female parents with one child and the PCRs for single-female parents with two children. This highlights that the mean difference in PCR values, which is 0.066857 is about 2.26 standard deviations away from zero. This highlights that the magnitude of the differences in PCRs between single-female parents with one child and single-female parents with two children is substantial. Single-female parents with one child have consistently higher personal consumption rate values as compared to single-female parents with two children.

b. Cohen's d test results for income groups

Table 3.10: Cohen's d test for low- and middle-income groups

Effect size	Estimate	95% confidence interval	Low vs Middle
Cohen's d test	2.280444	1.54074 3.005002	24 observations each

Table 3.11: Cohen's d test for low versus high income groups

Effect size	Estimate	95% confidence interval	Low vs high
Cohen's d test	3.196664	2.306479 4.070493	24 obs low; 22 obs high

Table 3.12: Cohen's d test for middle versus high income groups

Effect size	Estimate	95% confidence interval	Middle vs High
Cohen's d test	3.010047	2.148796 3.854921	24 obs middle, 22 obs for high

Table 3.10, 3.11 and 3.12 show the magnitude of the differences in PCRs with three levels of household income. Table 3.10 shows that the Cohen's d test value between the low-income group versus the middle-income group is 2.28 which is a large effect size. This indicates a large difference in PCRs between the low versus middle income groups. Furthermore, there is 95% confidence that the difference in PCRs between these two groups is between 1.54 and 3.01 standard deviations.

Furthermore, Table 3.11 shows that the magnitude size of the differences in PCRs between the low- and high-income groups is a value of 3.196664. This also shows that there is a large difference in PCRs between the low versus the high-income groups. In fact, this is the largest difference in PCRs as compared to other income group comparisons. There is a 95% confidence that the difference in PCRs between these two groups is between 2.31 and 4.07 standard deviations.

Table 3.12 shows the effect size of the differences in PCRs between the middle versus the high-income groups. The Cohen's d test value between the income groups is 3.010047 which is a large effect size. This shows that there is a large difference in PCRs between the middle- and high-income groups. There is a 95% confidence that the differences in PCRs between these two groups is between 2.15 and 3.86 standard deviations.

We compare our selected results of PCR for single parents with one child with the result found by Krueger (2014). In his 2014 paper "Personal Consumption by Family Type and Household Income", Krueger estimates PCRs for a husband and a wife in a nucleus family structure. He also estimates PCRs for a single parent who has one child. Hence, we compare our PCR, which we estimated for single parents, with one child with those found out by Krueger (2014). Krueger, like other forensic economists, estimated PCRs using American dataset. We utilised a different dataset, which is the South African NIDS dataset. To compare the PCRs, we use the exchange rate of 1 USD to 18 Rands and convert the household income in USD to Rands. In that way, we are able to compare like for like PCRs with a similar range of household income. For example, household income of US$ 15,000 for Krueger's (2014) paper is equal to R270, 000 when we use the exchange rate of 1 USD equal to 18 Rands. In our results, R 270,000 is between the household incomes we used of R 200,000 to R 300,000. Hence, we present PCRs, which are between these income household ranges, to compare directly with the PCRs of Krueger's (2014) paper. Exchange rates fluctuate from time to time, however, during the time we wrote our paper, the exchange rate between the US dollar and Rand was at 1 USD = 17.7112 as of September 2024 (South African Reserve Bank [SARB], 2024). We use a rounded up exchange rate of 1 USD = 18 rands.

Table 3.13: Comparisons of selected PCRs between Krueger's (2014) paper and this study

	Krueger (2014)	Our paper (in Rands)	Our paper (in US dollars)
Household income PCR	US$ 15000 52.0%	R 200 000 – R 300 000 46.0%-40.9%	US$ 11111 – US$ 16667 46.0%-40.9%
Household income PCR	US$ 60 000 32.0%	R 1 000 000 – R 1 100 000 25.6% - 24.4%	US$ 55556 – US$ 61111 25.6%-24.4%
Household income PCR	US$ 100 000 26.7%	R 1 700 000 – R1 800 000 18.9%-18.2%	US$ 94 444- US$ 100 000 18.9%- 18.2%
Household income PCR	US$ 140 000 23.7%	R 2 500 000 – R 2 600 000 14.5% - 14.0%	US$ 138 889- US$ 144444 14.0%-13.5%
Household income PCR	US$ 160 000 22.7%	R 2 800 000 – R 2 900 000 12.6%-12.1%	US$ 155 556 – US$ 161 111 12.6%-12.1%

Table 3.13 shows a comparison of selected PCRs found in Krueger's (2014) paper and our paper for single parents with one child. The results show that Krueger's (2014) paper has higher PCRs as compared to our paper for the same range of household incomes. For a household income of US$ 15,000 Krueger (2014) found a PCR of 52.0%. In our paper, US$ 15,000 is between R200,000 to R 300,000 when converted to Rands using the exchange rate of 1 US$ = 18 Rands. Furthermore, at a household income of US$100,000 Krueger (2014) found a PCR of 26.7% as compared to our PCR of between 18.9% to 18.2% for the household income value of between R1,700 000 to R ,800,000. Lastly, for the household income value of US$ 160 000 Krueger (2014) found a PCR of 22.7%. In comparison, we find a PCR of between 12.6% and 12.1% for the range of household income values of between R2,800,000 to R2,900,000. We also provide a third column which shows US dollar household income values. We converted the household income values in Rands to US dollars using the exchange rate of 1 USD = 18 Rands to easily compare our household income values with those established by Krueger (2014).

3.9 DISCUSSION OF RESULTS

Our results show that as household income increases, the personal consumption rates (PCRs) for both single-female parents with one child and single-female parents with two children decrease. Our results suggest the concept of average propensity to consume (APC). This is because, as income increases, the percentage of income, which is consumed by households,

declines. Some of the income will be saved or invested in other activities. In other words, if households become high-income earners over time, they will allocate a smaller percentage of their income towards consumption whilst a larger percentage goes toward savings. This is different from the absolute level of consumption well known in conventional economics, which may produce different results. Furthermore, our results are consistent with other studies, such as Krueger (2014), Krueger (2007), Ruble et al. (2019), Ruble et al. (2014), Wright et al. (2024) who found in their studies declining PCRs as household income increased.

In addition, our results found out that PCRs for single-female parents with one child are higher as compared to PCRs for single-female parents with two children. Furthermore, our Cohen's d results reveal that there is a large magnitude between the differences in PCRs of single-female parents with one child and single-female parents with two children. This may suggest budgetary constraints for single-female parents with two children as compared to single-female parents with one child. The single-female parents with two children may experience tighter budgets or an increase in expenses due to the additional child in the family. This will result in the single-female parents having to reduce their personal consumption. The number of children in different households influences the differences in consumption expenditure between different households (Madudova & Corejova, 2024).

Furthermore, our results show that as household income increases, the difference in personal consumption rates between single-female parents with one child and single-female parents with two children widens. This shows differences in consumption expenditures between the two-family structures. This may reveal more parental investment in the children's welfare as household income increases. Particularly for single-female parents with two children, additional investment in resources for children will be amplified. Households with a smaller number of children are more likely to consume a larger proportion of their income as compared to households with more children (Rosenbaum and Ellis, 2021). Personal consumption can also be redirected to other costs, such as costs of child care. Hence, the single-female parent with an additional child will be more likely to redirect more of her income and expenditure from personal consumption to child costs, such as child care. In addition, single-female parents with two children may save more to increase future investments for her children as compared to single-female parents with one child. Parents who are financially responsible and save more will be more likely have children who are financially independent in the future (Allsop et al., 2020).

We find out that there is a substantial difference in the PCRs of low versus middle versus high income groups. Our Cohen's d results found large effect size in PCRs of the three income groups. In addition, the low versus high income groups had the largest effect size as compared to other comparisons of income groups. This shows that this was the largest difference in PCRs between the two income groups. This suggests as well that as household income increases, the single-female parent saves more and buys assets and accumulates wealth. In turn, there will be less consumption, hence, lower PCRs for high income groups compared to lower income groups. This shows the effect of the marginal propensity to consume where an increase in income will result in an increase in consumption, but by a lesser proportion than the increase in income.

Our results show that the personal consumption rates in developed countries are higher as compared to the personal consumption rates in developing countries. This suggests that developed countries have more resources and stronger currencies than developing countries. As a result, households in developed countries have more purchasing power as compared to households in developing countries. In addition, households in developed countries earn higher income levels as compared to developing countries, which allows them to have higher discretionary spending beyond basic necessities. Furthermore, developed economies have better social security and healthcare systems. This results in the reduced need for precautionary savings by households in developed countries which will be channelled toward consuming a higher percentage of their household incomes.

3.10 LIMITATIONS OF THE STUDY

Studies on personal consumption rates assume stable family structures at periods of estimation. However, family compositions can change from time to time due to issues such as remarriage, adult child returning into the family, among other issues. This will likely alter the proportional allocation of household expenditures which will in turn most likely change the personal consumption rates which are established. Furthermore, the subject area assumes a coherent association between consumption adjustments and changes in income. However, consumers do not adjust the same way when their incomes fluctuate over time. In some instances, consumers may gradually increase their spending when income increases and not cut back spending by the same amount when income decrease. Hence, such unpredictable changes in spending in reality may make it challenging to have accurate personal consumption rates.

3.11 CONCLUSION

Our chapter aimed to estimate personal consumption rates that are crucial in the determination of compensation that may be due to surviving family members in cases of wrongful death in South Africa. These personal consumption rates are significant for use in wrongful death court cases because they are later removed from the total household income made by the deceased, with the remaining amount being given to the surviving family members as compensation.

Our paper shows that as household income increased, personal consumption rates decease, for single-female parent households. This shows the concept of marginal propensity to consume which would transpire as household income increases. Our results also show that personal consumption rates for single-female parents with one child are higher when compared to personal consumption rates for single-female parents with two children. In addition, our paper finds significant differences in personal consumption rates between different income groups. Our findings address the research questions of this paper, which include: estimating personal consumption rates in South Africa, if female household income influenced the differences in personal consumption rates between single-female parent households and determining the effect size of the difference in personal consumption rates within single-female parents' households. Overall, our chapter is vital in providing personal consumption rates which can be used in courts to determine lost earnings.

CHAPTER FOUR

EDUCATIONAL ATTAINMENT PROBABILITIES AND EXPECTED LIFETIME EARNINGS FOR SOUTH AFRICAN MINOR CHILDREN: THE CASE OF APPROPRIATE ESTIMATIONS

4.1 INTRODUCTION

Investment in education is a fundamental driver of equality, future productivity and future lifetime earnings for households. Inclusivity in education is required to provide equal opportunities to society (UNESCO, 2018). Access to quality education is important to create healthy, sustainable and peaceful societies (UN, 2023). Hence, as much as education is important for adults, access to education for all children, regardless of their race, gender or family background, has overarching benefits since they are the future employers or employees who will aim to build an equal and sustainable society.

In case there is a personal injury to or wrongful death of a minor child, such potential can be diminished or decimated, as that child may not be able to achieve certain educational attainment levels or expected future lifetime earnings, due to the disability or death. The estimation of expected future earnings for minor children can be challenging for forensic economists as compared to the estimations for adults, since children do not have any history of past earnings (Spizman, 2016). Nevertheless, to provide for compensation and equality in societies, such potential earning stream for the child who is a victim needs to be estimated.

Injuries are among the leading causes of death in children in the world (WHO, 2010). Furthermore, UNICEF (2024a) highlights that road traffic injuries are one of the prominent causes of disability and death for children between the ages of 5 to 19 years, with Southern Africa having the worst rates of child death as compared to other regions. In addition, although the number is declining, in 2022, about 4.9 million children under the age of 5 years died due to various factors, which include injuries (UNICEF, 2024). One way of attempting to control injuries is through the engagement of international institutions. International organisations, such as the United Nations Children's Fund (UNICEF) and the World Health Organisation (WHO), are scaling up their prevention mechanisms, such as medication, vaccinations, and education to the public to minimise preventable deaths in children. This shows how vulnerable children can be to diseases and injuries, which will lead to wrongful death.

Injuries and violence are a leading cause of child deaths in South Africa, with the injury death rate at about 38.9 per 100,000 for those children who are aged 0 to 19 years. (Van Niekerk & Mathews, 2019). Some of the specific injuries which have caused death in children in South Africa include injuries from road traffic accidents, burns and drowning (Van Niekerk & Mathews, 2019). During the period from October to December 2023, about 285 children were murdered and about 2, 707 experienced bodily harm or assaults (UNICEF, 2024). Furthermore, about 42% of children every year in South Africa face some form of violence, such as physical and sexual violence. Such violence can lead to mental health disorders in children, which may cause some of the disabilities in children (Tomlinson et al., 2022). Moreover, infanticide in South Africa is one of the highest globally, at a rate of 28.4 per 100,000 births (Shung-King et al., 2019b). School-going children, aged 6 to 12 years are at risk or vulnerable to road traffic accidents when travelling to school in South Africa, as some of them go to school with no adult supervision (Shung-King et al., 2019b). With these statistics, South African minor children are defenceless and exposed to personal injuries and wrongful death situations.

Such vulnerabilities can be exacerbated in the case of rampant educational inequalities, poor educational outcomes, and income inequality. With these three factors, estimation of the earning potentials of children and ultimate compensation for personal injury and wrongful death cases can be an enormous undertaking. South Africa faces inequality in educational outcomes, with only 20% of schools being functional and having adequate resources for learning (De Clereq, 2020). Furthermore, children in South Africa who are from poor backgrounds or informal settlements struggle to get access to quality education (Spreen & Vally, 2006). The poor quality of education, which children from disadvantaged backgrounds receive, intensifies for these children the vicious cycle of poverty (Spaull, 2015). Given their background and the educational inequalities which they may face, the potential and compensation of such children can be distorted if they are wrongfully injured or die.

South Africa is one of the most disproportionate countries in the world with rampant poverty and a stagnant economic growth (Francis & Webster, 2019). Although there have been some established legislative frameworks on inclusiveness in South Africa, the country still faces higher levels of poverty, inequality and unemployment (Plagerson & Mthembu, 2019). In the labour market, wages reflect racial and income inequality as Blacks earn the lowest earnings, whilst White South African have the highest (StatsSA, 2019a). Furthermore, the Palma ratio, which is a measure of income inequality attained by comparing income proportions, revealed

that the top 10% income earners in South Africa spend 7.9 times more than the bottom 40% of South African income earners (Stats SA, 2019). Children who come from backgrounds with parents who are disadvantaged or poor, are in a vulnerable state and may fail to realise their potential in terms of getting education, and they may not get adequate compensation if these children are involved in a wrongful injury or death.

At the same time, family structures or backgrounds may also have an impact on the resources, mainly income accessible to children, resulting in differences in the magnitude of potential and compensation which different children may receive. Traditional literature has indicated that children who live with both father and mother were likely to do well in life as compared to children who lived without both parents (Brown et al., 2015). In addition, Chavda and Nisarga (2023) highlight that children who live with single parents, were more likely to have mental health problems, which could also negatively affect their overall growth. Furthermore, female-headed households are regarded to be more vulnerable and at risk of being in poverty as compared to households headed by men. Chant (1997) describes female-headed households as family units that are the poorest among other poor households. Female-headed households are generally disadvantaged due to limited access to factors of production, such as labour, capital, and land (Klasen et al., 2011). Hence, children living with their mothers only may face challenges in reaching their full potential.

Our paper aims to estimate educational probabilities and expected lifetime earnings for minor children in South Africa. Specifically, we explore these estimates, in the context of South Africa, to serve as a guide for cases in which compensation may be required for the relatives of a child who has experienced wrongful death or personal injury. In addition, this paper checks for the gender and racial disparities concerning expected lifetime earnings for minor children in South Africa, given the educational and income inequalities which exist in the country. Thirdly, we estimate the differences in education probabilities and expected lifetime earnings for minor children in South Africa who live under different family structures.

A limited number of studies have estimated educational probabilities and expected lifetime earnings for minor children. Only Spizman and Kane (1992), Kane et al. (2010), and Spizman (2016) have estimated beyond educational probabilities to provide expected life-time earnings' estimates. Other studies, such as those done by Gill and Foley (1996); Bruce and Anderson (2005); Kane et al. (2013), just to mention a few, have estimated educational probabilities and

mentioned that these probabilities could be used to estimate expected lifetime earnings by economists and lawyers in the court cases.

Nevertheless, studies in the forensic economics area have given insights to economists in court cases on how to estimate compensation for minor children who do not have any earning history. Studies, such as those by Spizman and Kane (2020), Jepsen and Jespen (2001), Kane et al. (2010) etc. estimate educational probabilities, following Spizman and Kane's (1992), methodology. These studies provided improved estimations based on updated data which was available during the analysis. However, all previous studies on educational probabilities and expected lifetime earnings for minor children were based on datasets from developed economies, mostly from the United States and Canada (Bruce & Anderson, 2005).

Therefore, due to the use of the available longitudinal dataset, which was at their disposal, a few studies were able to show comprehensive estimates of educational probabilities and expected lifetime earnings, differentiated by gender and race, to reveal disparities which may exist. Although Spizman and Kane (1992), Spizman and Kane (2020), Gill and Foley (1996) and Spizman (2016), showed different racial variables of White, Hispanic and Black in their ordered probit regression analysis, these studies did not provide comprehensive educational probabilities and expected future earnings of minor children of these three races. Rather, the estimates for educational probabilities and lifetime earnings were specific for selected races and category.

Our paper contributes to the growing body of literature on estimating educational attainment probabilities and expected lifetime earnings for minor children in four ways. Firstly, our paper estimates educational probabilities and expected lifetime earnings using the ordered probit model with cluster robust standard errors. Previous studies have estimated educational probabilities using the ordered probit model introduced by Spizman and Kane (1992). Our paper considers that the use of longitudinal data contains repeated observations of homogeneous units over time, hence, introducing the problem of the clustering effect. Data which is in clusters is likely correlated and violates the independence assumption of the ordered probit model.

Secondly, we expand upon previous studies by providing comprehensive estimates of educational probabilities and expected future earnings for minor children by race and gender. Given the well-documented educational and income inequalities in South Africa, it is important

to provide comparisons of gender and racial disparities in educational probabilities and expected future lifetime earnings, which may exist in minor children in South Africa.

Thirdly, besides showing gender and racial estimates, we calculate educational probabilities and expected future lifetime earnings based on four family structures—children living with both parents, children living with mother only, children living with father only and children living without any parents. Previously, only Kane et al. (2010) estimated educational probabilities and lifetime earnings based on different family structures. Christensen (2020) estimates only educational probabilities, excluding the expected lifetime earnings, but based on different family structures. Although Christensen (2020) estimates educational probabilities for children living without both parents, our paper is the first to extend beyond estimating educational probabilities for children living without parents to estimating their expected lifetime earnings. In Sub-Saharan Africa, specifically in South Africa in this context, children living with extended families, such as a grandmother or grandfather, uncles and aunts, just to mention a few, are quite common and this is taken into account in our paper.

Fourthly, our paper estimates educational probabilities and expected lifetime earnings in a unique context of a developing country. Previous studies in this area have been undertaken in a developed country setup, specifically in the United States and Canada. Given the heterogeneity in demographics and economic environment as compared to developed countries, our study aims to provide unique estimates of educational probabilities and expected lifetime earnings for minor children which are specific to developing countries' context.

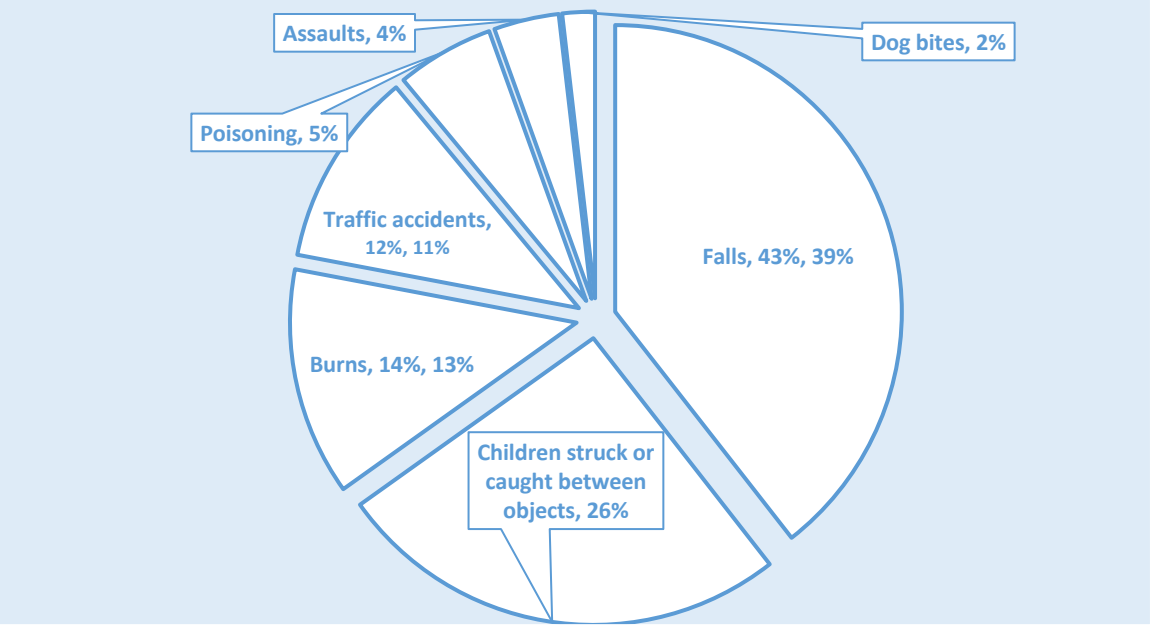
4.2 BACKGROUND

Annually, many children either die or become disabled due to intentional or unintentional injuries. 80 to 95% of global injuries of children take place in emerging and developing countries per year (Van Niekerk & Mathews, 2019). Intentional injuries are those which are deliberate upon children, whilst unintentional injuries are injuries, which prevail on the child without the aim to harm. Injuries can have negative impacts on the economy, including high costs of health care and even lost productivity (WHO, 2024).

Personal injury or wrongful death to children can often happen in various ways through actions, such as a child being involved in an accident, medical malpractice against the child, birth injuries as a result of pregnancy mismanagement, or even the consumption of defective products. Injury and violence on children as well as young people are the major causes of deaths

of over 950,000 children and young people each year (WHO, 2008). Jones et al. (2021) add that child injury was a major cause of child death as well as disability, highlighting that injuries, such as a traumatic injury had long-term negative impacts on children's social welfare. In addition, child abuse can cause long-term mental health injuries to children (Eben, 2022; Nyarko et al., 2014; Springer et al., 2003; WHO, 2022). Figure 4.1 shows the percentages of injuries which were experienced by children in South Africa in 2019.

Figure 4.1: Percentage of the causes of child injuries in South Africa in 2019



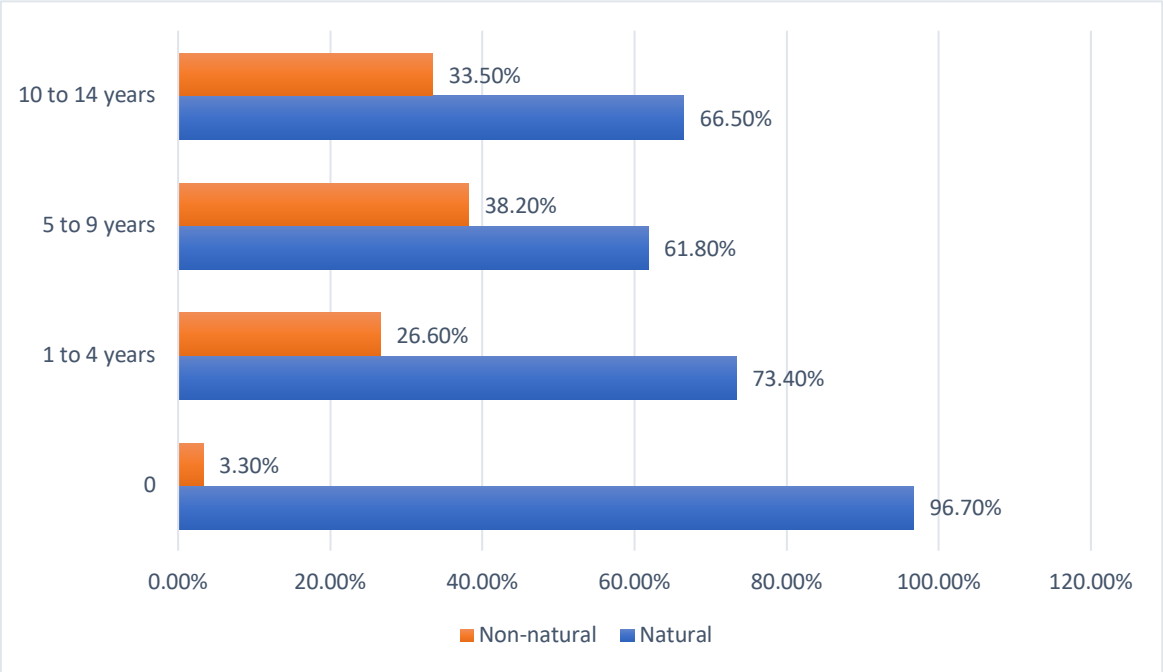
Source: StatsSA (2019)

Figure 4.1 shows the percentages of causes of children's injuries in South Africa for 2019. These injuries have the potential to lead to wrongful death or cause the child to have a disability. The figure shows that falls among children had the largest percentage (43%) of being the cause for injuries as compared to other causes. This is followed by 28% recorded for children struck or caught between objects. Burns had 14% of the causes of child injury, whilst traffic accidents had 12% of the causes of child injuries. Poisoning as a cause of child injury had 6%, whilst assaults had 4%, and dog bites at 2% was the lowest cause of injury.

Wrongful death cases can also be characterised as non-natural deaths. According to the StatsSA (2020a) document, "Mortality and causes of deaths in South Africa", non-natural causes of death in children include deaths through assault, transport accidents and complications in medical and surgical care. Natural causes of death in children include deaths from diseases such as COVID-19, Diabetes, Tuberculosis, Influenza and Pneumonia and Chronic Lower

Respiratory diseases (StatsSA, 2020). Figure 4.2 below shows the percentage of non-natural and natural causes of death in South Africa for ages 0 to 14 years:

Figure 4.2: Percentage of non-natural and natural deaths in South Africa in 2020

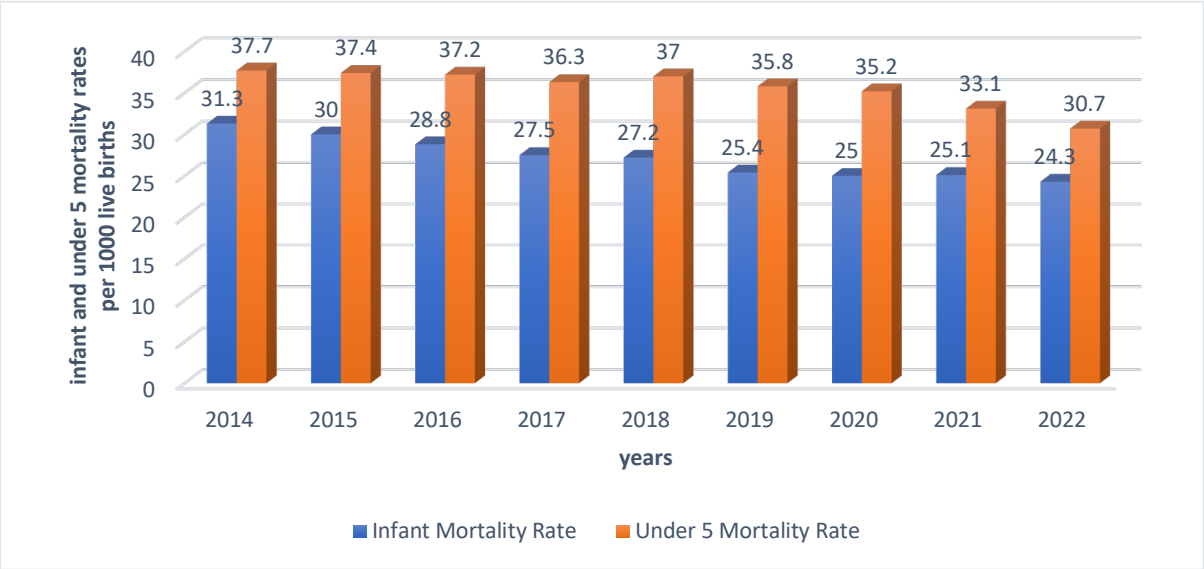


Source: StatsSA (2022)

Figure 4.2 shows that children aged 5 to 9 years had the largest percentage (38.20%) of non-natural causes of death as compared to non-natural causes of death of children in other age groups. Although natural causes of death for children had the largest percentages as compared to non-natural causes of death for all ages, the percentages of non-natural causes of death are significant and reflect the occurrence of wrongful deaths among children. Children aged 10 to 14 years had a non-natural cause of death percentage of 33.50%, whilst children aged 1 to 4 years had a non-natural cause of death percentage of 26.60%. Children less than 1 year old had the lowest non-natural causes of death percentage of 3.30%, as compared to other non-natural causes of death percentages of children in other age groups.

Furthermore, the wrongful death of a child or a young person deprives households and society at large of the potential of that child or young person. However, there have been fluctuating mortality cases of children in various countries as efforts are being made to minimise the deaths of these children. Figure 4.3 below shows infant mortality rates as well as under-5 mortality rates which occurred in South Africa during the period 2014 to 2022.

Figure 4.3: Infant and child under 5 mortality rates in South Africa for the period 2014 to 2022

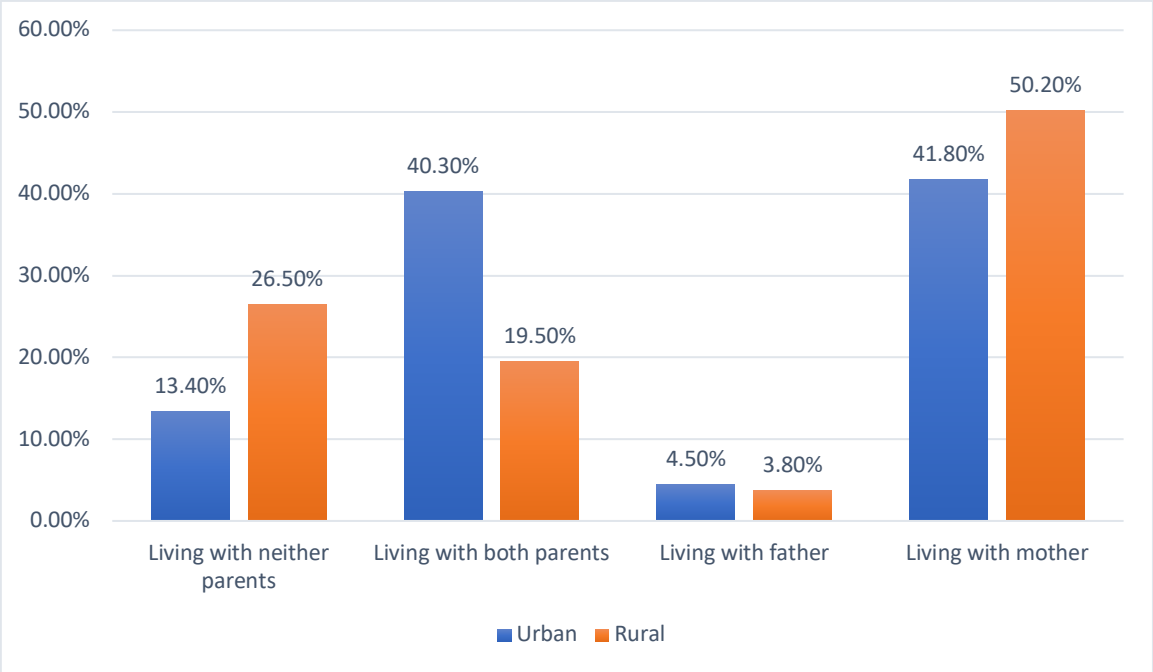


Source: StatsSA (2022)

Figure 4.3 above shows that the infant mortality rate between the periods 2014 to 2022 has been declining in South Africa, whilst the under 5 mortality rate in South Africa has been fluctuating over the same period. Infant mortality rate declined by 7 per 1000 live births from 31.3 per 1000 live births recorded in 2014 to 24.2 per 1000 live births which is an estimate recorded in 2022. Under-5 mortality rates increased to 37 per 1000 live births in 2018 from 36.3 per 1000 live births recorded in 2017. Furthermore, since 2018, the under-5 mortality rate has declined reaching an estimate of 24.3 per 1000 live births in 2022. Although the two indicators of infant mortality and under-5 mortality rates declined over the period 2014 to 2022, children's deaths are still occurring- which can be an indication of personal injuries and wrongful death cases occurring in minor children.

Hence, there is pain and suffering by parents, guardians and children themselves if there are personal injury or wrongful death cases in minor children. There can be a loss of potential future earnings in cases where the minor child wrongfully died or was disabled due to injuries. At the same time, even if income which could have been earned in the future by the minor child had he or she not been injured is estimated, estimates may vary due to the child's living arrangements. Living arrangements influence the child's potential in educational attainment and, therefore, future expected earnings. Figure 4.4 below shows the children's living arrangements in South Africa.

Figure 4.4: Children's living arrangements in South Africa in 2023



Source: StatSA (2023)

Figure 4.4 shows the composition of parents and guardians in 2023 who lived and took care of children in South Africa. The figure shows that 13.40% of children who live in urban areas live without parents, whilst 26.50% of children who live without parents live in rural areas. This is in contrast with children who live with both parents as 40.30% of them live in urban areas, whilst 19.50% of them live in urban areas. This may show that children who live with both parents may have access to resources provided by the parents, and that the parents may be motivated to work and find opportunities for their families. This may explain the larger percentage of children who live with both parents in urban areas. Furthermore, a larger percentage of children who live with their mother only (50.20%), live in rural areas, whilst also a large percentage of children who live with their mothers also live in urban areas (41.80%). Lastly, there are small percentages of children who live with their fathers only in rural and urban areas, as compared to other living arrangements. About 4.50% of children who live with their father only live in urban areas, whilst 3.80% of children who live with their fathers only live in rural areas.

4.2.1 Policies which affected educational attainment

The South African government has, over the years, implemented several important policies which were aimed at addressing the historical inequalities which existed in educational access

and quality. The South African Schools Act enacted, in 1996, a unified education system replacing the unequal and racially segregated education system of apartheid South Africa (Department of Basic Education, 1996). This Act provided the foundation for equal educational opportunities by standardising the governance of schools and removing the previously existing discriminatory admission practices. These discriminatory admission practices had previously favoured educational attainment for children of the white population at the expense of other population groups.

Furthermore, the government the 1994 National School Nutrition Programme and the 2007 No-Fee Schools Policy to increase enrolment of economically disadvantaged children. The No-Fee Schools Policy designated schools in lower income households as exempt from charging fees to increase basic education access for children from lower income households. In addition, the Child support Grant, introduced in 1998, is empirically linked to improving educational outcomes. The government's child support grants have increased enrolment rates and better grade progression over the years among grant recipients (Southern Africa Labor & Development Research Unit, 2024).

In addition, the National Student Financial Aid Scheme (NSFAS) established in 1999 (Mabuse, 2023), has increased access to tertiary education for students from low-income households. However, over the years, the scheme has faced challenges such as corruption and delays in fee-payments by students. Furthermore, students experienced a shift in government funding in 2023 when NSFAS capped student accommodation to R45,000 per annum. (Mabuse, 2023). Although such challenges exist, the scheme remains an important tool in bridging the gap in educational inequality between children from low-income households with the rest of the population.

4.3 THEORETICAL LITERATURE REVIEW

4.3.1 Human Capital Theory

The Human Capital Theory is essential in explaining the concepts of education and earnings. The early contributors to the theory were Mincer (1958) and Schultz (1960). In the late 1950s and early 1960s, Mincer and Schultz highlighted that the cost of education was a form of investment, as individuals would earn a higher return in the form of wages in the future. In their findings, college graduates were more likely to earn higher earnings in the workplace as compared to high school graduates due to increased human capital. However, the theory is

mostly attributed to Becker (1964), who formalised the theory by examining additional factors that spur investments in human capital, such as migration, health care, and at work place training. Becker (1964) highlighted that investment in humans formed the idea of human capital. Hence, the theory highlights the need for investment in humans through education and employment training which would drive productivity and, therefore increase wages. According to the theory, education would cause the marginal productivity of labour to increase, which would in turn cause the income of workers to increase.

The human capital variable is introduced as an extension to physical capital and labour variables in the neo-classical growth model by Robert Lucas in his 1988 paper on economic development. Analysing from a macro perspective, investment in human capital would also lead to an increase in economic growth (Marginson, 2019). Schultz (1962) argued that countries, such as Germany and Japan, were able to recover swiftly after the Second World War due to high levels of human capital. In addition, Becker (1992) highlighted that European countries' economic growth and development were rapidly beginning in the 1960's onwards due to investment in human capital.

The Human Capital Theory is important in the realm of economics as it has assisted policymakers in understanding the importance of education as a form of investment. In that sense, education has been a crucial sector in the economy, which has benefited from public and private funding. Public education investment is important in the labour force to develop knowledge and skills, and also to reduce social inequality (Voss et al., 2017).

Governments in developed and developing countries have invested huge sums of money towards education to facilitate future economic growth. In addition, investment in private education has also been important to supplement government efforts on education as well as expand the educational opportunities available to individuals (World Bank, 1999). Governments have also invested in education as a means of poverty reduction and to equip workers with the skills needed in the labour market (Liu, 2018).

There has been some criticism of the Human Capital Theory as more economists have studied the field of educational economics. In his 1964 model, Becker distinguished between general and specific human capital. General human capital is the skills and knowledge acquired by a worker which is useful for current and future employers. At the same time, specific human capital has a positive bearing on the productivity of the employee in his or her current job.

However, it is challenging to differentiate general and specific human capital at a particular time for a worker (Fleischhauer, 2017).

There can be many other factors besides education which may affect an individual's lifetime earnings after school. The theory does not explicitly acknowledge the presence of these other factors. The lifetime earnings of an individual can be affected by factors such as the family's income and aspects of social networking (Marginson, 2019). Hence, although researchers try to analyse education on earnings in their research work, there are many other factors which are not accounted for which affect earnings.

Nevertheless, the Human Capital Theory provided a basis on which other researchers used to develop their educational models. Cunha and Heckman (2007) developed a model which explained how children develop skills over time, which will contribute to their future human capital. This paper provided an alternative approach to Becker and Tomes' (1986) paper which emphasised that parental earnings had an impact on children's human capital. Cunha and Heckman's (2007) paper highlighted the importance of parental investment in a child's educational attainment and development. The paper also acknowledged that the educational levels and skills of parents can also have an effect on the child's educational attainment. Parents with higher levels of education may likely be able to provide resources and knowledge to their children which will assist in their educational development. The paper acknowledged the need for interventions in cognitive and non-cognitive abilities for children at an early age for the development of their skills, which will have a positive impact on their educational attainment, productivity and future lifetime earnings.

4.4 EMPIRICAL LITERATURE

Literature on the study of educational attainment probabilities and expected future earnings is still limited but growing in line with the developing field in forensic economics. Spizman and Kane (1992), were the first to develop a model for estimating educational attainment for a minor child. Their study was based on the background that it was challenging to know the level of compensation for a minor child in case there was a wrongful death or wrongful injury, since he or she would not have any work history. Consequently, compensation estimates for minor children through the use of educational attainment, family and demographic variables became important. The authors developed an ordered probit model which classified different educational attainment levels according to an ordinal ranking.

Spizman and Kane (1992) estimated educational attainment levels using various demographic variables, such as if the child lived in an urban or rural area and if the child was Black, Asian or Hispanic. Furthermore, the authors also came up with a methodology, which combined educational probabilities with lifetime earnings for five educational levels which resulted in the expected lifetime earnings for a minor child. Spizman and Kane's (1992) ordered probit model did not have other important variables, such as religion and language, which have the potential to affect a child's educational attainment. Spizman and Kane (1992) used the 1972 American National Longitudinal Study of the High School Class dataset for their analysis. However, preceding studies used a different dataset, namely, the American National Longitudinal Survey of Youth dataset to capture recent trends and expansion in labour market participation rates (Kane et al., 2013). Given a scenario of a 4-year-old black boy who had parents with degrees and lived in an urban area, the study found that there was a 35.3% likelihood that the boy would get a college degree. Furthermore, the study found out that a four-year-old White boy with parents without high school education and living in a rural area would have a 66.3% educational probability of achieving a high school education, whilst only 13.5% educational probability of achieving a 4-year college degree.

Gill and Foley (1996) were the first to utilise the 1979 National Longitudinal Survey of the Youth (NLSY) dataset in their analysis. Their sample was made up of individuals who were aged 14 to 21 years. Spizman and Kane (1992) had a truncation challenge because in their study, they acknowledged that the individuals surveyed had already finished high school education. For this reason, in their dataset, they could not estimate educational probabilities for those individuals who would achieve less than high school education (Gill & Foley, 1996). Gill and Foley's (1996) study expanded the model to include other variables, such as religion, family composition and the occupation of parents (Spizman, 2016). The study estimated an ordered probit model with the coefficients and thresholds used to estimate educational probabilities under different family background scenarios. Their expanded model found that a White boy who had parents with less than a high school and lived in the rural areas had a 64% likelihood of reaching a less than high school education and a 0.76% likelihood of reaching a college degree. The study also estimated other educational probabilities for other different scenarios. For example, a female White child with parents who had a high school education and lived in an urban area had an 18.6% likelihood of achieving a degree whilst having a 2.6% of achieving a master's degree. In addition, their study highlighted that a black male child with parents who had completed a high school education and lived in an urban area had a 48.4%

likelihood of achieving a high school degree, 21.3% chance of achieving a college degree and a 1.6% likelihood of reaching a Master's degree.

Similar to Gill and Foley (1996), five years later, Kane and Spizman (2001), provided an update to Spizman and Kane's (1992) study by utilising the 1979 NLSY as compared to the National Longitudinal Survey of the high school class of 1972. Kane and Spizman (2001) went a step further as compared to Gill and Foley (1996), in estimation, as they used an additional 6 years of data, which were introduced in the 1979 NLSY dataset. Data with more years was necessary to reflect completed educational attainment, which would prevent the problem of truncation (Kane & Spizman, 2001). The study estimated educational probabilities based on the assumptions that a minor White boy had parents with some college education, lived in rural areas, with one parent at least being employed. Their study found that the minor child had a 64.45% probability of achieving a high school education, whilst also having a 16.64% likelihood of achieving a Bachelor's degree. This is in contrast to Gill and Foley (1996) who found a 51.29% likelihood of the minor child achieving a high school education and a 10.89% chance of achieving a Bachelor's degree under the same assumptions.

Jespen and Jespen (2001) estimated educational probabilities of the minor child with the use of the National Longitudinal Survey of the Youth, as was done by previous studies by Gill and Foley (1996) and Spizman and Kane (2001). The study estimated three models: the first two had the same demographic and family characteristics as Gill and Foley (1996) and Spizman and Kane (2001), for comparison purposes. However, their third model added private schooling and household income as additional variables in their ordered probit model. In the third model with additional characteristics, the study estimated predicted educational probabilities after an ordered probit regression. Furthermore, in their third model, the study found out that a male White child who lived in the rural areas whose parents had some college education and at least one parent was working, had a 34.7% likelihood of achieving a high school education and a 25.2% likelihood of achieving a bachelor's degree. Although their ordered probit regression included races, such as Blacks, Hispanics and Whites, the study failed, however, to show various educational probabilities at different educational levels for the different races.

Thirteen years after Spizman and Kane's initial theory, Bruce and Anderson (2005) used the General Social Survey for 2001 to estimate educational probabilities for the minor children in Canada. The study's main aim was to provide new estimates of educational probabilities for minor children with the use of a different dataset, other than the National Longitudinal Survey

of the Youth used in the USA. Our study is the second after Bruce and Anderson (2005) to use a dataset other than the NLSY, which was based on the American population. Bruce and Anderson's (2005) study also used the ordered probit model in their analysis with the thresholds used to estimate the predicted educational probabilities. The study had five educational levels, with a university degree being the highest educational level for the dependent variable. Their ordered probit regression results found that parents' educational levels were the main predictor of a child's educational attainment. Furthermore, after estimating educational probabilities, the study found that a White male raised in the rural area with parents who had a college degree had a 45% likelihood of achieving some college education, whilst the study found a 36% likelihood of that child achieving a university degree. The study, however, does not provide estimates for other diverse groups in society, such as female children for other races.

Kane et al. (2010) estimated expected future earnings for a minor child in the absence of one parent in the household. The study analysed the effects on expected future earnings for a minor child for situations where one of the parents has died or was not in the household due to other reasons, like divorce, etc. The study used the NLSY of 1979, as they followed the same framework as presented by Spizman and Kane (1992) for estimating educational probabilities and expected future earnings for a minor child. In their ordered probit regression, the study included additional variables, such as the presence of a biological father only, or a biological mother only, if the mother was deceased and if the father was deceased, which had significant coefficients when estimated, except for when a father was deceased. The study also calculated educational probabilities and expected future earnings under four different family structures. The family structures used in the study were when a minor child lived with the biological mother only when the father was absent; lived with biological mother present when father had died; lived with biological father when biological mother was absent and lived with biological father when biological mother had died. The study found out that a minor child had a greater loss in life time earnings of 3 to 12% if either one of the parents was absent in the household due to divorce or separation as compared to an expected lifetime loss in earnings of only 2 to 4% for the minor child if one of the parents had died.

Kane et al. (2013) used a different dataset to estimate educational attainment and expected lifetime earnings for minor children. The study used the 1997 National Longitudinal Survey of the Youth (NLSY) dataset as compared to the 1979 NLSY used by previous studies. Kane et

al., (2013), argued that the NLSY for 1997 was more reflective of the characteristics which were current during that time as compared to the 1979 NLSY. Furthermore, the study highlighted that the 1997 NLSY had other variables which were not found or reliable in the previous NLSY dataset. In their analysis, they introduced the income to poverty ratio as one of the independent variables in the ordered probit regression model. Assuming that the child was White and lived in an urban area with both parents, with a father who had 16 years of schooling and 14 years of schooling for the mother, the study found out that female children had higher educational probabilities of achieving higher educational levels, such as a Bachelor's degree as compared to male children. Kane et al. (2013) did not estimate future expected lifetime earnings of the minor children but acknowledged the process of using the educational probabilities estimated with lifetime earnings found in the expectancy dataset in the USA.

Spizman (2016) explained the history and methodology behind the estimation of expected lifetime earnings for a minor child. The study highlighted that compensation for a minor child can be challenging, especially since the child does not have any work history and if the child is born with a medical problem, such as a brain injury. However, the study emphasised the importance of parental education, stating that this could be used by the jury to determine the level of educational attainment the minor child could have reached. The study estimated educational probabilities and expected future earnings for a hypothetical Black male minor child with a brain injury who lived with both parents and lived in an urban area. The father was a high school graduate and the mother was a college degree graduate. The study found out that the minor child had a 48% likelihood of achieving a high school education whilst having a 27% likelihood of achieving a Bachelor's degree. Furthermore, the study showed that the minor child would acquire the highest expected lifetime earnings for achieving a Bachelor's degree as compared to other educational levels.

Spizman and Kane (2020) provided an update on the educational attainment model for a minor child from Kane et al.'s (2013) paper, which used the NLSY of 1997. Spizman and Kane (2020) used round 18 of the 1997 NLSY in their analysis. Kane et al., (2013) study was based on round 14 of the same dataset. Spizman and Kane (2020), used the same variables and parameters as in Kane et al. (2013). The study's estimated coefficients of the ordered probit model predicted a higher educational attainment for children who had parents with higher levels of education, and the children lived with both parents. The results of educational probabilities for the study were consistent with the Kane et al. (2013) study, with slight differences. Spizman and Kane

(2020) found an educational probability of 19.5% of a minor child achieving a Bachelor's degree, whilst in Kane et al. (2013) the educational probability for the same educational level was 20.6%.

Christensen (2020) also provided an update of Kane et al. (2013) study with emphasis on providing two educational attainment models for minor children living with both parents and those living without both parents. Christensen (2020) mentioned that the child's educational attainment may differ if the minor children lived with both parents as compared to those who lived with single parents. The study used the 1997 NLSY dataset, which was also used by Kane et al. (2013), with an additional five-year dataset on educational attainment variables. The results of the study showed that for given assumptions where the minor child is a non-Hispanic of Black/mixed race with parents who have a high school education and are non-religious, a minor male child had an educational attainment probability of 52.18% of achieving a high school education if both parents lived together. Furthermore, a female minor child had a lower educational attainment probability of 44.95% of achieving high school education. The study predicted that a male minor child had an educational probability of 46.80% of achieving a high school education, if living without both parents. A female minor child had a lower educational probability of 44.36% of achieving the same educational level if living without both parents.

During a 2020 meeting of allied social science, Spizman and Kane (2020) conducted a presentation on the impact of race on educational attainment probabilities and expected lifetime earnings of minor children. The study compared estimates, which considered race and those estimates which were race-neutral. The paper also used the 1997 NSLY data as was used by Kane et al. (2013). In America, there were particular jurisdictions which emphasised economists and lawyers to use race-neutral data. The study found out that Black and Hispanic female children were likely to incur lower expected lifetime earnings if race-neutral data was used as compared to when race-based data was used.

4.5 METHODOLOGY

Spizman and Kane (1992), introduced the ordered probit model in analysing educational probabilities and future lost earnings for minor children. The model has become the standard methodology in literature (e.g., see Christensen, 2020; Spizman & Kane, 2020; Kane et al., 2013; Kane et al., 2010; Jepsen & Jepsen, 2001; Kane & Spizman, 2001). This paper uses the ordered probit model with cluster-robust standard errors. The use of longitudinal data, as in

this paper, creates a clustering effect in the analysis since the data has repeated observations of the same units over time. Observations of the same units are likely to be correlated over time. This results in dependency within structures. The use of the standard ordered probit model may result in the under-estimation of standard errors since observations may not be independent. Hence, the ordered probit model with cluster robust standard errors corrects dependency and provides more robust standard errors.

Our paper also uses the educational probability-weighted lifetime earnings model in estimating expected lifetime earnings for minor children in South Africa. This model combined the predicted educational probabilities estimated with expected income streams based on earnings by educational level, thus yielding an estimated lifetime earnings for each child. The model's probabilistic approach accurately captures uncertainty which is in educational attainment levels. This is particularly important in the South African context where factors such as household income volatility and expanded educational policies create variation in outcomes even among children with similar backgrounds. The combined use of the ordered probit model with cluster-robust standard errors together with the educational probability weighted lifetime earnings model provide a robust approach that balances theoretical coherence and empirical tractability in estimating educational probabilities and expected lifetime earnings for minor children.

The specification of the ordered probit model with cluster standard errors is as follows:

$$Z_{it} = \beta X_{it} + \varepsilon_{it}$$

Where:

Z_{it} is the categorical dependent variable, X_{it} are independent variables of family and demographic characteristics which influence the dependent variable, β is the coefficient of the independent vector of variables and ε_{it} is the error term.

As shown in other papers, the dependent variable Z_{it} is unobservable, hence, an indicator variable is used to show the educational attainment level of individuals in the data (Kane et al., 2013). To account for gender differences of independent variables on educational attainment, this paper estimates the ordered probit model with cluster robust standard errors for males and females as follows:

For males:

$$Z_{it}^{m} = \beta^{m} X_{it}^{m} + \varepsilon_{it}^{m}$$

For Females:

$$Z_{it}^{f} = \beta^{f} X_{it}^{f} + \varepsilon_{it}^{f}$$

This paper categorises education into 5 categories, which are (1) Less than a high school education (2) High school education (3) Certificate and diploma (4) Bachelor's degree (5) Honour's degree. Our paper matches data of children who were between 6 to 13 years in 2008, wave 1 NIDS dataset started and they were between 15 to 22 years in 2017, wave 5 of the dataset. For the analysis to hold, we needed to make sure the children were not employed which were checked under data cleaning. We also established that there were a few of them who had attained a master's degree or higher educational level. Hence, we modelled our ordered probit with cluster robust standard error regression to only include educational levels from less than high school education to honour's degree.

An individual *i* at time *t* is assumed to have the following educational attainments:

Less than high school if $Z_{it} \leq \theta_1$

High school if $\theta_1 < Z_{it} \leq \theta_2$

Certificate and diploma if $\theta_2 < Z_{it} \leq \theta_3$

Bachelor's degree if $\theta_3 < Z_{it} \leq \theta_4$

Honour's degree if $Z_{it} > \theta_4$

The gender specific estimated model coefficients of the model together with the gender specific model thresholds ($\theta_1;\ \theta_2;\ \theta_3;\ \theta_4$) are used to estimate educational probabilities of the minor child under the five educational levels. The thresholds are cut-off points which are generated when the ordered probit model is estimated in Stata. The coefficients of the gender specific independent variables and thresholds are the output after the gender specific ordered probit

with cluster robust standard errors regression. The educational probabilities of reaching different educational levels are shown in Table 4.1 below:

Table 4.1: Educational probabilities estimations at different educational levels

Outcome	Probability
Less than high school	$\Phi(\hat{\theta}_1 - \hat{Z}_{it})$
High school	$\Phi(\hat{\theta}_2 - \hat{Z}_{it}) - \Phi(\hat{\theta}_1 - \hat{Z}_{it})$
Certificates and diploma	$\Phi(\hat{\theta}_3 - \hat{Z}_{it}) - \Phi(\hat{\theta}_2 - \hat{Z}_{it})$
Bachelor's degree	$\Phi(\hat{\theta}_4 - \hat{Z}_{it}) - \Phi(\hat{\theta}_3 - \hat{Z}_{it})$
Honour's degree	$1 - \Phi(\hat{\theta}_4 - \hat{Z}_{it})$

$\hat{Z}_{it}$ are the estimated values of the coefficients of the independent variables multiplied by a dummy variable of the child's educational category. The cumulative density function $\Phi(.)$ together with the "normadist function" are applied on the difference between the cut-off points and coefficients of the independent variables (Z-scores) to estimate the educational probabilities in Excel. The educational probabilities for each educational level from less than high school to an Honour's degree summed up, equal to 1. The educational probabilities are estimated separately according to race and gender (Male Black, Female Black, Male White, Female White, Male Coloured, Female Coloured, Male Asian/Indian and Female Asian/Indian) as well as the four living structures (Living with both parents, living with mother, living with father, living without parents. This is consistent with Kane et al. (2010) methodology on how they estimated educational probabilities according to different family structures.

4.5.1 Expected Lifetime Earnings

To estimate expected future lifetime earnings, we multiply the gender and race-specific educational probabilities per educational level found earlier with the average earnings an individual is expected to earn when reaching a certain educational level. The paper has five educational levels (Less than high school, high school, certificates and diploma, Bachelor's degree and Honours degree) and the summation of the outcome of multiplying educational probabilities per educational level with average earnings given the educational level for all five educational levels is considered expected future lifetime earnings. The formula was adopted from Spizman and Kane (1992).

The technique for estimating expected future lifetime earnings adopted builds on the estimated educational probabilities described in the preceding section and aligns closely with earlier researchers (e.g., see Kane et al. 2010). The Expected future lifetime earnings formula is as follows:

$$\sum_{i=1}^{5}[Prob(education\ level\ i) * E(median\ earnings\ |education\ level\ i)]$$

Where: $Prob(education\ level\ i)$ stands for the gender and race specific educational probabilities for each educational level *i* and $E(median\ earnings\ |education\ level\ i)$ is the expected value of gender and race specific average earnings which an individual is expected to earn if he or she reaches a certain educational level *i*.

The outcomes of the expected lifetime earnings are categorised by race, gender and living structure. Before the median earnings are applied to the equation they are adjusted to a selected real growth rate, work-life expectancy per educational level and fringe benefits value. Adjusting median earnings to real growth rate is important so that these earnings reflect the increase or decrease of an individual's earnings over time. In addition, median earnings are adjusted according to the anticipated work-life expectancy for the individual according to educational level. This is important because these median earning reflects the number of years the individual is anticipated to work and will need to be compensated for. The higher the educational level attained the higher would be the work-life expectancy. Furthermore, adjusting median earnings with fringe benefits is important in determining a more accurate picture of the total compensation an individual can acquire over time.

a. Steps of the Methodology and Analysis

We present the steps for the estimation of educational probabilities and expected lifetime earnings. These steps are consistent with Kane et al., (2010). We have numbered our steps from step 1 up to step 7 to cover all the relevant categories:

Step 1

We estimated descriptive statistics of male and female minor children in the Stata software using the National Income Dynamics (NIDS) dataset of 2008 to 2017. After analysis of the

data, we were left with 1962 observations for male minor children and 2154 observations for female minor children. The results of the descriptive statistics are shown in Table 4.2.

Step 2

We run the ordered probit model with cluster robust standard errors regression. We run two regressions in Stata for male and female minor children. The dependent variable is the child's educational attainment. The independent variables are Race, Mother's education, Father's education, Province, Language, and Religion. A description of these variables is given under the definition of the variables section. The results of the ordered probit with cluster robust standard errors regression are shown in Table 4.3.

Step 3

We estimate the educational probabilities for the four major races (Black, White, Coloured and Asian/Indian) and two major genders (Male and Female) in South Africa. We follow papers, such as Spizman and Kane (1992), Kane et al. (2010) and Spizman (2016), who made assumptions before the educational probabilities were estimated. For us to be able to calculate educational probabilities, there are certain reference conditions which we came up with for the minor children. Forensic economists make assumptions of these reference conditions, which portray the family background of where the child is coming from to be able to calculate the educational probabilities this child could acquire. The reference conditions for this paper relevant to calculating the educational probabilities were as follows:

b. For a Male Black Child

"The child is a Black male, living in the province of Gauteng, parents have high school education, parents and child speak English and are all Christians and the child lives with both parents."

It is important to note that these are reference categories which are given for this paper, but the data could also contain information of other categories which are also to be considered. For example, for the above Black male reference category, there could be children who lived with their mother only, children who lived with their father only or children who also lived without parents. All these family conditions are considered. In the excel document of calculations, a dummy value of one is recorded for our reference criteria where a Black male child lived with both parents and a zero is recorded for children who live with mother only, father only or

without parents. This method in Excel was also applicable to other conditions like "living in the province of Gauteng", "parents have high school education", "parents and child speak English" and for "all are Christians". We take these dummy values for these categories and multiply with the coefficients of the results of the ordered probit model with cluster robust standard errors to come up with the estimated value of $\hat{Z}_{it}$. These estimated values of ($\hat{Z}_{it}$) together with the thresholds ($\widehat{\theta}_{it}$) which come out as output of the ordered probit model with cluster robust standard errors, are substituted into the formulas in Table 4.1 to produce educational probabilities based on different educational levels, race and gender. Other reference conditions for other genders and races were as follows:

c. For a Female Black Child

"The child is a Black female, living in the province of Gauteng, parents have high school education, parents and child speak English and are all Christians and the child lives with both parents."

d. For a Male White Child

"The child is a White male, living in the province of Gauteng, parents have a high school education, parents and child spoke English and were all Christians and the child lived with both parents."

e. For a Female White Child

"The child is a White female, living in the province of Gauteng, parents have a high school education, parents and child speak English and are all Christians and the child lives with both parents."

f. For a Male Coloured Child

"The child is a Coloured male, living in the province of Gauteng, parents have a high school education, parents and child speak English and are all Christians and the child lives with both parents."

g. For a Female Coloured Child

"The child is a Coloured female, living in the province of Gauteng, parents have a high school education, parents and child speak English and are all Christians and the child lives with both parents."

h. For a Male Asian/Indian Child

"The child is an Asian/Indian male, living in the province of Gauteng, parents havea high school education, parents and child speak English and are all Christians and child lives with both parents."

i. For a Female Asian/Indian Child

"The child is an Asian/Indian female, living in the province of Gauteng, parents have high school education, parents and child speak English and are all Christians and the child lives with both parents."

The results of the educational probabilities for the minor child are shown in Tables 4.4 to 4.21 according to race and gender.

Step 4

Step 4 calculates the work-life expectancies for males and females which are later used to estimate expected life time earnings. The work-life expectancies are calculated using the NIDS dataset (2008-2017). In this instance, work-life expectancies are actually calculated with two states which are "being active in the labour force" and "being inactive". The results of these work-life expectancies are be shown in appendix A (page 249) of the paper. Earlier papers in this in this subject area used work-life expectancies already computed by other researchers in calculating life time earnings. This was possible because the work-life expectancies were derived based on the dynamics of the American population and the studies were also conducted in either the USA or Canada. Hence, the off-the-shelf estimates could easily be used to generate expected lifetime earnings since their studies were also based on the American population. However, in this paper, we had to start from the very first step of calculating work-life expectancies due to a lack of previous work-life expectancies calculated in the South African context. The results are shown in tables 4.22 to 4.23.

Step 5

Lifetime earnings are calculated, firstly, using median earnings. The median earnings are derived from the General Household Survey dataset of 2022. This is the most recent dataset available for public use, which has incomes for different individuals in different households. This paper follows what other papers in this subject area have done when calculating life time earnings, which is to use other datasets besides the dataset used for regression of the ordered

probit model. Kane et al. (2010) took the most recent data during that time, of the expectancy dataset (2007) to produce median earnings. For this paper, the median earnings are multiplied by a real growth rate of 0.97724503, which is the South African value found in the International Labour Organisation (ILO) global wage report of 2022-2023. The revised lifetime earnings are later multiplied by work-life expectancies per educational level provided. Lastly, the lifetime earnings are multiplied by a fringe benefit percentage of 1.05278442. The value is calculated using the NIDS dataset of 2008-2017, since it was the dataset which provided enough parameters to calculate the fringe benefit percentage. The results are shown in tables 4.24 to 4.31.

Step 6

The lifetime earnings estimate in Step 5 are multiplied by educational probabilities to generate the expected lifetime earnings for minor children by different categories (living with both parents, living with mother, living with father and living without both parents). The results are shown in tables 4.32 to 4.41.

Step 7

The expected lifetime earnings for children living with their mother, living with their father and living without parents are compared with the expected lifetime earnings of minor children living with both parents to formulate percentage penalties of not living with either of the parents. The results are shown in tables 4.42 to 4.49.

4.6 DEFINITION OF VARIABLES

4.6.1 Variables of the Ordered Probit Model with Cluster Robust Standard Errors

a. Child's Educational Attainment

This is the dependent variable of the ordered probit model with cluster robust standard errors. The dependent variable is categorised into five educational levels, which are less than high school, high school, certificates and diploma, bachelor's degree and honours degrees. This is a categorical dummy variable and takes the value of (1) for less than high school education (2) for high school education (3) for certificates and diplomas (4) for bachelor's degrees (5) for honour's degree. In other words, the categories have a natural order. The independent variables show their effects on children's educational attainment. Previous forensic economics studies

such as (Spizman & Kane, 1992; Kane & Spizman, 2001; Gill & Foley, 1996, Kane et al., 2010; Jepsen & Jepsen, 2001; Christensen, 2020) have utilised the same dependent variable. However, categories of the dependent variables differ slightly according to the context of the study. In this study, we analyse education data for South Africa and find out that many children acquired education up to honour's degree. A few children reached Master's degree and above. Hence, our categories are from less than high school education up to an honour's degree.

b. Race

Race is an independent variable in the ordered probit model with cluster robust standard errors. The variable is categorised into different races in South Africa, which are Black, White, Coloured and Asian/Indian. Race is a social concept which divides people into certain groups which are associated with factors such as culture, physical appearance and ethnicity (Williams et al., 1997). Race is a dummy variable representing 1 if it is that category and 0 otherwise. The reference category for the ordered probit regression is White. Educational probabilities and expected future income categorised by race is important in the study to reveal if there existed any racial disparities among different population groups in the economy.

c. Mother's education

Mother's education is another independent variable in the ordered probit model with cluster robust standard errors. The variable is divided into different education levels for the mother, which are less than high school, high school, certificates and diploma, bachelor's degree and honours degree. This is a categorical dummy variable, and the reference category is less than high school. The mother's education can provide a better platform for children to develop and have various academic achievements (Hernandez & Napierala, 2014). A mother's educational level plays an important role in the development of the child's cognitive ability (Yu & Yan, 2023). In this paper, the variable of a mother's education is important in determining a child's future educational attainment level. We expect a positive relationship between higher levels of the mother's educational attainment with the child's educational attainment compared to the reference category of less than high school education. This is based on the notion that a mother with higher education is likely to contribute resources towards a child's education, which would increase the likelihood of that child also achieving higher levels of education.

d. Father's education

Father's education is another explanatory variable for this paper. The variable is categorised into less than high school, high school, certificates and diplomas, bachelor's degree and honour's degree. This is a categorical dummy variable, and the reference category is less than high school. Parental education level can influence children's behaviours and progress in society (Chevalier et al., 2010). Therefore, a father's education is also important in the educational development of the child. We expect a positive relationship between a father's higher educational levels with a child's educational attainment compared to the reference category of less than a high school education. This is because fathers are also an important unit together with the mothers in parental development and guidance of the child.

e. Province

Province is another independent variable of the paper. The variable is divided into the nine provinces of South Africa and other regions. The nine provinces of South Africa are Gauteng, Western Cape, Eastern Cape, Northern Cape, Free State, KwaZulu-Natal, North West, Mpumalanga and Limpopo (GCIS, 2011). "Other regions" which is also in this paper, represent all areas which are outside the nine provinces of South Africa. For example, if an individual is from a province in Botswana, that is categorised under "other regions". The independent variable is a categorical dummy variable which takes the value of 1 if it is for a particular province and zero otherwise if it is for other areas. The reference category is Gauteng province. We expect the province variable to have an impact on the child's educational attainment as compared to the reference category of Gauteng. Provinces with higher economic development are likely to have higher educational attainment amongst children since the provinces are assumed to have the educational infrastructure necessary for children to achieve higher educational attainment levels.

f. Language

Language is another explanatory variable in the paper. The variable is categorised into English, Ndebele, Xhosa, Zulu, Sepedi, Sesotho, Setswana, Siswati, Tshivenda, Isitsonga, and Afrikaans. This is a categorical dummy variable which takes the value of 1 for a particular language and zero otherwise for other languages. The reference category is English. Language is a means by which humans communicate and interact in ways which are understandable to each other (Hall, 1968; Lyons, 1981). Language is an important variable in this study in trying

to understand if it affects children's educational attainment. We anticipate the main language spoken by the child to have the most influence on the child's educational attainment, with English being the reference category. Since English is one of the major languages in the country, we expected that children who speak English would likely have higher educational attainment levels as compared to other children who may know only the indigenous languages.

g. Religion

Religion is another independent variable of the ordered probit model with cluster robust standard errors. Religion in South Africa is categorised into Christianity, Judaism, Islam, Hinduism, Black tradition and no religion. This is a categorical dummy variable which takes the value of 1 if it is a particular category of religion and zero otherwise. Furthermore, the reference category is no religion. No religion category refers to those children who do not have any belief system. Religion consists of the beliefs and rituals which people undertake to God (Agbiji & Swart, 2015). Religion is an important variable which affects a child's educational attainment. Certain religious values, which are paramount to a particular religion, can influence a child's ability to reach higher educational levels or not. Hence, we expect religion to have an impact on a child's educational attainment with no religion being the reference category. Some religious organisations may have more resources and have programmes which promote children to attain higher levels of education, as compared to other religions, which may not have much influence.

4.6.2 Variables for Calculating Expected Lifetime Earnings

a. Median Earnings

Median earnings in this paper are the middle-income value which is earned by individuals with particular educational attainment levels. Hence, the median earnings for individuals with less than a high school education are different from the median earnings for individuals with a bachelor's degree. Median earnings in this paper are categorised by educational level, gender and race. Median earnings are stable and can show the distribution of earnings for individuals and households (StatsSA, 2022a). Mean or average earnings may not consider outliers, which may distort the earnings value. Median earnings have been used by Kane et al. (2010) and Spizman (2016) in their analysis of estimating expected lifetime earnings for the minor child.

b. Real Wage Growth Rate

Real wage growth rate is the increase of wages or incomes over time after being adjusted for inflation. The real wage growth rate is multiplied with the median earnings to adjust earnings to inflation and to account for any increases in productivity over time. The real wage growth rate considers the growth of wages over time in the economy. Individuals' incomes have been adversely affected over the past few years by the COVID-19 pandemic and high inflation rates, which have occurred upon recovery from lockdown (ILO, 2022a). Hence, adjusting earnings by the real wage growth rate is important to capture such economic changes. This paper uses the real wage growth rate of 0.97724503, which is reflective of the growth in South African wages for the period 2022 to 2023. The data is taken from the International Labour Organisation (ILO) global wage data from 2022 to 2023.

c. Fringe Benefits

These are non-monetary benefits given to employees besides their regular salaries. Fringe benefits can assist in increasing employees' total compensation and help in improving job satisfaction. In some instances, salaries may only account for a certain proportion of the total compensation for workers, therefore, the accounting of fringe benefits is also important (Leibowitz, 1983). This paper uses a fringe benefit percentage of 1.05278442, which is calculated using wave 5 (2017) of the NIDS dataset. The fringe benefit percentage is equal to total fringe benefit costs divided by total salary or wage costs, all multiplied by 100 (Stephenson, 2013). We identify in the NIDS dataset, total fringe benefit costs, such as unemployment insurance, pension, worker compensation, private retirement annuity and retirement gratuity package for individuals, which are divided by incomes for individuals and bonuses and multiplied by 100 to produce a fringe benefit percentage of 1.05278442.

4.7 DATA SOURCE

This paper uses the National Income Dynamics Survey (NIDS) data of South Africa as the main dataset for analysis. This is a longitudinal dataset which began in 2008 and was conducted till 2017, categorised into five waves. The survey started in 2008 with about 28,000 individuals and over 7,000 households (NIDS, 2018). Wave 1 was the initial survey year followed by Wave 2 which was conducted from 2010 to 2011. Wave 3 was conducted in 2012 whilst Wave 4 was conducted in 2015 with the last wave, Wave 5 was conducted in 2017. The survey was

implemented by the Southern Africa Labour and Development Research Unit (SALDRU), a research institution which is based in Cape Town, South Africa

The survey asked individuals and households various questions on economic and social factors which affected their livelihood. Some of the issues asked pertain to labour market activities, education, health, income, demographics and other issues. Households that continued to be interviewed across the surveys were known as Continuous Sample Members (CSM), whilst household members who were surveyed and not asked in other preceding surveys were known as Temporary Sample Members (TSM). About 2,775 CSMs were added to the survey in 2017 due to attrition within the dataset (NIDS, 2018).

Our data is restricted to male and female children who were aged between 15 to 22 years. When the NIDS survey began in 2008, these children were 6 to 13 years. We ended up having 4,116 observations which is 1,962 observations for male children and 2,154 observations for female children who were not working. Other studies such as Kane et al. (2010) restricted their data for children aged 14 to 22 years initially when the National Longitudinal Survey of the Youth (NLSY) started in 1979. Gill and Foley (1996) restricted their data for children 14 years to 21 years using the same NLSY data. Bruce and Anderson (2005) were the only study of this analysis done in Canada using the Canadian data of the 2001 General Social Survey. They restricted their data to children who were 8-17 years.

4.8 ESTIMATED RESULTS

4.8.1 Descriptive Statistics

Table 4.2: Descriptive statistics for male and female minor children

Variables	**Male**		**Female**	
Educational attainment	Mean	Std deviation	Mean	Std deviation
Less than high school	0.583	0.467	0.545	0.487
High school	0.162	0.467	0.177	0.487
Certificates and diploma	0.165	0.437	0.186	0.435
Bachelor’s degree	0.066	0.337	0.074	0.339
Honour's degree	0.024	0.328	0.019	0.324
Race				

Variables	Male		Female	
Black	0.546	0.361	0.531	0.374
Asian/Indian	0.113	0.112	0.115	0.123
Coloured	0.209	0.311	0.226	0.332
White	0.130	0.171	0.126	0.159
Mother's education				
Less than high school	0.487	0.438	0.516	0.417
High school education	0.076	0.321	0.065	0.297
Certificates and diplomas	0.278	0.494	0.274	0.492
Bachelor’s degree	0.134	0.403	0.118	0.382
Honour's degree	0.024	0.188	0.027	0.198
Father's education				
Less than high school	0.472	0.488	0.485	0.490
High school education	0.091	0.323	0.087	0.311
Certificates and diplomas	0.169	0.413	0.170	0.408
Bachelor’s degree	0.125	0.368	0.108	0.341
Honour's degree	0.143	0.388	0.149	0.388
Province				
Gauteng	0.103	0.304	0.107	0.309
Western Cape	0.111	0.314	0.110	0.314
Eastern Cape	0.135	0.341	0.144	0.352
Northern Cape	0.115	0.319	0.098	0.297
Free State	0.120	0.325	0.104	0.305
Kwazulu-Natal	0.098	0.298	0.101	0.302
North West	0.081	0.273	0.075	0.264
Mpumulanga	0.087	0.282	0.087	0.282
Limpopo	0.084	0.278	0.104	0.305
Other regions	0.066	0.249	0.069	0.253
Language				

Variables	Male		Female	
English	0.091	0.218	0.089	0.222
Ndebele	0.021	0.151	0.028	0.175
Xhosa	0.166	0.385	0.157	0.383
Zulu	0.311	0.474	0.286	0.468
Sepedi	0.038	0.472	0.068	0.742
Sesotho	0.046	0.299	0.044	0.302
Setswana	0.097	0.307	0.095	0.310
Siswati	0.036	0.194	0.036	0.199
Tshivenda	0.028	0.172	0.026	0.170
Isitsonga	0.036	0.195	0.032	0.188
Afrikaans	0.131	0.350	0.136	0.362
Religion				
Christianity	0.316	0.446	0.347	0.360
Jewish	0.051	0.103	0.059	0.094
Muslim	0.107	0.084	0.110	0.098
Hindu	0.105	0.084	0.106	0.077
Black Tradition	0.204	0.182	0.133	0.180
No religion	0.215	0.411	0.254	0.294
Family structure				
Lived with both parents	0.335	0.472	0.349	0.477
Lived with mother	0.245	0.430	0.247	0.432
Lived with father	0.063	0.242	0.069	0.253
Lived with no parents	0.357	0.479	0.335	0.472
	n=1962		n=2154	

Table 4.2 shows the descriptive statistics of this research for male and female children. Consistent with other studies, we present the sample means of the variables. Bruce and Anderson (2005) present the sample means and relative standard deviations. However, for interpretation purposes, the sample means are more important in presenting the proportions of

the sample. As shown in Table 4.2, our sample reveals that on average, 58.3% of male children have less than a high school education as compared to 54.5% for female children. For race, 54.5% of male children are Black as compared to Black females who are 53.1%. For the variable of mother's education, 48.7% of mothers of male children have less than high school education, whilst 51.6% of mothers of female children have less than a high school education. Furthermore, 16.9% of the fathers of male children have a certificate and diploma, whilst 17% of the fathers of female children have a certificate and diploma. In terms of province, about 10.3% of male children live in the Gauteng Province, whilst about 10.7% of female children live in the same province. In terms of language, on average 31.1% of male children speak Zulu, whilst 28.6% of female children speak Zulu as well. In terms of religion, on average, about 31.6% of male children are Christians, whilst about 34.7% of female children are also Christians. Lastly, about 33.5% of male children live with both parents, whilst 34.9% of female children also live with both parents.

4.8.2 Ordered Probit with Cluster-Robust Standard Error Model Results for Male and Female

Table 4.3: Ordered probit cluster -robust standard error model results for male and female children

Variables	**Male**		**Female**	
	coefficient	**t-statistic**	**coefficient**	**t-statistic**
Race (Ref: White)				
Black	-0.665***	-3.168	-0.528***	-2.569
Asian/Indian	-0.232	-0.584	0.495	1.425
Coloured	-0.301	-1.581	-0.279	-1.478
Mother's education (Ref: Less than high school)				
High school education	0.221**	2.226	0.153	1.463
Certificates and diplomas	0.197**	2.529	0.059	0.775
Bachelor's degree	0.381***	2.892	0.486***	3.850
Honour's degree	0.027	0.140	0.112	0.793
Father's education (Ref: Less than high school)				
High school education	0.222**	2.295	0.044	0.426

Variables	Male		Female	
	coefficient	t-statistic	coefficient	t-statistic
Certificates and diplomas	0.156*	1.867	0.260***	3.204
Bachelor's degree	0.290**	2.074	0.275**	2.040
Honour's degree	0.065	0.851	0.102	1.466
Province (Ref: Gauteng)				
Western Cape	0.117	0.844	0.110	0.914
Eastern Cape	0.351***	2.586	0.126	1.109
Northern Cape	0.041	0.306	-0.234*	-1.795
Free State	0.026	0.183	-0.056	-0.445
Kwazulu-Natal	-0.025	-0.185	-0.217*	-1.890
North West	-0.266*	-1.864	-0.312**	-2.400
Mpumulanga	-0.203	-1.441	-0.333***	-2.656
Limpopo	0.065	0.471	-0.346***	-2.841
Other regions	0.511***	3.656	0.157	1.321
Language (Ref: English)				
Isindebele	-0.329	-1.321	0.358**	1.978
Isixhosa	-0.079	-0.594	0.044	0.556
Isizulu	0.043	0.348	0.043	0.581
Sepedi	-0.169	-0.951	-0.017	-0.491
Sesotho	0.091	0.653	-0.265***	-2.628
Setswana	0.100	0.743	0.009	0.093
Siswati	0.010	0.060	-0.055	-0.346
Tshivenda	-0.183	-0.949	-0.156	-0.711
Isitsonga	-0.287	-1.604	-0.290*	-1.649
Afrikaans	-0.301*	-1.922	0.018	0.118
Religion (Ref: No religion)				
Christianity	0.258***	3.673	0.077	0.834
Jewish	-0.552	-1.624	0.054	0.216

Variables	Male		Female	
	coefficient	t-statistic	coefficient	t-statistic
Muslim	-0.018	-0.060	-1.408***	-2.916
Hindu	-0.162	-0.354	-0.955**	-2.354
Black Tradition	0.236*	1.648	0.061	0.412
Family Structure				
Living with mother	0.086	1.071	0.162**	2.185
Living with father	0.116	0.944	0.140	1.203
Living with no parents	0.362***	4.369	0.326***	3.907
Theta1	0.279		-0.013	
Theta2	0.758		0.492	
Theta3	1.523		1.313	
Theta4	2.262		2.218	
chi squared (38)	223.63		241.54	

**** represents 1% significance level; ** represents 5% significance level and * represents 10% significance level. The values are rounded up to three decimal places.*

Table 4.3 shows the results after an ordered probit regression with cluster robust standard errors. The variable for Black males and females is statistically significant at 1% level. The coefficients for Black male (-0.665) and Black female (-0.528) highlight that being a Black male and Black female is associated with a lower likelihood of achieving higher levels of educational attainment as compared to White males and White females respectively, which are the reference categories.

Male children who have a mother or father with a high school education are associated with a higher probability of achieving higher educational attainment as compared to male children who have a mother or father with less than a high school education, respectively. High school education for mother and father is both statistically significant at 5% level and the coefficients are 0.221 for mother with high school education and 0.222 for father with high school education.

Furthermore, a male child with a mother with a certificate and diploma or with a father with a certificate and diploma is affiliated with a higher likelihood of achieving higher education as compared to a male child with a mother or father with less than a high school education. Mother with certificate and diploma and father with certificate and diploma variables are significant at 5% and 10 % respectively. The coefficient for a mother with certificate and diploma variable is 0.197 as compared to the coefficient for a father with certificate and diploma variable which is 0.156.

A male child with a mother with a Bachelor's degree or a father with a Bachelor's degree is associated with a higher probability of achieving higher academic achievements as compared to a male child with a mother with less than high school education or a father with less than high school education. The independent variables of a mother with a Bachelor's degree and a father with a Bachelor's degree are statistically significant at 10% and 5% levels, respectively. The coefficient for a mother with a Bachelor's degree is 0.381 as compared to the coefficient for a father with a Bachelor's degree, which is 0.290.

A female child with a mother with a Bachelor's degree or with a father with a Bachelor's degree is affiliated with a higher likelihood of higher academic achievements as compared to a female child with a mother or father with less than a high school education. A father with a Bachelor's degree and mother with a Bachelor's degree variables have coefficients of 0.275 and 0.486, respectively and are statistically significant at 5% and 1%, respectively. A female child with a father with certificate and diploma is associated with a higher probability of achieving higher educational attainment as compared to a father with less than a high school education. Father with a certificate and diploma variable is significant at 1% level and has a coefficient of 0.260.

Male children who come from the Eastern Cape Province and other regions have a higher probability of achieving higher educational attainment as compared to male children in the Gauteng Province. The Eastern Cape Province and other regions are significant at 1% level and have the coefficients of 0.351 and 0.511, respectively. Furthermore, male children who are from the North West Province have a higher probability of achieving less educational attainment as compared to male children from the Gauteng Province. North West Province is significant at 10% level and has a coefficient of -0.266.

Female children who come from Northern Cape, KwaZulu-Natal, North West, Mpumalanga and Limpopo have a higher probability of achieving lower educational levels compared to

female children who are in the Gauteng Province. The five provinces are significant at 10% level for Northern Cape and KwaZulu-Natal, 5% level for North West and 1% level for Mpumalanga and Limpopo. Furthermore, the provinces have the following coefficients: -0.234 for Northern Cape: -0.217 for Kwazulu-Natal: -0.312 for North West: -0.333 for Mpumalanga and -0.346 for Limpopo.

Male children who speak Afrikaans have a higher likelihood of achieving lower educational attainment as compared to male children who speak English. The Afrikaans language is significant at 10% level and has a coefficient of -0.301. In contrast, female children who speak isiNdebele have a higher likelihood of achieving higher educational attainment as compared to female children who speak English. Isindebele is statistically significant at 5% level with a coefficient of 0.358. Furthermore, female children who speak Sesotho and Isitsonga have a lower likelihood of achieving higher educational levels as compared to female children who speak English. Sesotho and Isitsonga variables are significant at 1% and 10%, respectively and have coefficients of -0.265 and -0.290 respectively.

In terms of religion, male children who are Christians and Black traditionalists have a higher probability of achieving higher educational attainment as compared to male children who are non-religious. Christianity and Black tradition variables are significant at 1% and 10%, respectively and have coefficients of 0.258 and 0.236, respectively. In addition, female children who are Muslims and Hindu are less likely to achieve higher levels of education as compared to female children who are non-religious. The variables for Muslims and Hindu are significant at 1% and 5% respectively. The coefficient for the Muslim variable is -1.408 and for the Hindu variable is -0.955.

Male children who live with no parents are associated with a higher probability of achieving higher levels of education as compared to male children who live with both parents. The variable for living with no parents is statistically significant at 1% level and has a coefficient of 0.362. Furthermore, female children who live with their mother and live with no parents are associated with higher probability of achieving higher educational attainment as compared to female children who live with both parents. The variables of living with mother and living with no parent are statistically significant at 5% and 1% level, respectively. Furthermore, the coefficients for living with mother and living with no parents are 0.162 and 0.326, respectively.

Referring back to Step 3 of the methodology section, reference conditions are given in this paper to calculate educational probabilities. We provide one illustration where we calculate the *Z*-score value of a Black male child using the coefficient results of the ordered probit model with cluster robust standard errors. The reference condition which we provide in Step 3 for a Black male child is that: "The child is a Black male, living in the province of Gauteng, parents have high school education, parents and child speak English and are all Christians, and the child lives with both parents." With this reference condition, we substitute 0 or 1 into the coefficients of the ordered probit model with cluster robust standard errors, which we estimated in Table 4.3. We use values which are not rounded up to avoid cumulative rounding up errors. The value of the Z-score of 0.035652, together with the thresholds (theta 1; theta 2; theta 3 and theta 4) of the ordered probit model, are substituted into the formulas, which we write initially in Table 4.1.

For Male Black Child

$$\hat{Z}_{it} = -0.66496(1) - 0.23214(0) - 0.30051(0) + 0.220522(1) + 0.196464(0) + 0.38136(0) + 0.02691(0) + 0.221837(1) + 0.15586(0) + 0.290371(0) + 0.0664831(0) + 0.117248(0) + 0.351249(0) + 0.041337(0) + 0.025733(0) - 0.02468(0) - 0.26563(0) - 0.20333(0) + 0.065025(0) + 0.51118(0) - 0.32869(0) - 0.07891(0) + 0.043219(0) - 0.1691(0) + 0.090637(0) + 0.099855(0) + 0.010117(0) - 0.18255(0) - 0.28658(0) - 0.300089(0) + 0.258257(1) - 0.5523(0) - 0.01833(0) - 0.16178(0) + 0.23545(0) + 0.085888(0) + 0.116212(0) + 0.361448(0) = 0.035652$$

The *Z* score values are also calculated for every other gender and race, that is for female Black, male White, female White, male Coloured, female Coloured, male Asian/Indian and female Asian/Indian. These *Z* score values are then substituted into the formulas of Table 1 consisting of the thresholds of the ordered probit model with cluster robust standard errors. Table 4.4 illustrates the process and the resulting educational probabilities for a male Black child who lives with both parents.

Table 4.4: Estimated educational probabilities for male Black children who live with both parents

Outcome	Probability
Less than high school	$\phi(0.279257 - 0.035652) = \phi(0.243605) = 0.596231274$
High school	$\phi(0.757483 - 0.035652) - \phi(0.279257 - 0.035652) = 0.168569471$
Certificate and diploma	$\phi(1.522752 - 0.035652) - \phi(0.757483 - 0.035652) = 0.166705002$
Bachelor's degree	$\phi(2.261642 - 0.035652) - \phi(1.522752 - 0.035652) = 0.055486815$
Honour's degree	$1 - \phi(2.261642 - 0.035652) = 0.013007439$

The results shown in Table 4.4 are the educational probabilities for a Black male who is living with both parents. The process is repeated for all genders, races and all the four family structures. We estimate these educational probabilities in Excel using the function of "NORM.S.DIST". This function was highlighted by Spizman (2016) as amethod which could be used to generate the educational probabilities in Excel.

4.8.3 Educational Probabilities and Expected Lifetime Earnings

Table 4.5 to Table 4.12 show the educational probabilities for children according to different family structures. Across all races and family structures, children have a higher likelihood of achieving less than a high school education as compared to other educational levels. The proportions, however, differ by race and gender. Children across all races and genders are likely to achieve the least likelihood of educational attainment at the Honour's degree level. Male and female White children have the least likelihood of achieving less than a high school education as compared to other races across all family structures. A male White child living with both parents has a 33.67% chance of achieving less than a high school education, whilst a female White child living with no parents has a 33.89% chance of achieving less than a high school education. Furthermore, the results show that, on average, male children are more likely to have the highest educational probabilities for different educational levels when living with both parents as compared to other family structures. This is shown by the Table of Results below from Table 4.5 to Table 4.12 for male educational probabilities across all races. For instance, male Black educational probabilities in Table 4.5 are the highest for male children living with both parents from high school education level to an Honour's degree. In Table 4.7, White male children have the highest educational probabilities when living with both parents from certificate and diplomas to an Honour's degree. On the other hand, on average female children

are likely to achieve the highest educational probabilities for different educational levels when living without both parents as compared to other family structures. This is shown by the Table of results below from Table 4.5 to Table 4.12 for female educational probabilities across all races. For instance, in Table 4.10, female Coloured children have the highest educational probabilities when living without parents from high school education to an Honour's degree. In Table 4.12, female Asian/Indian children living without a parent have the highest educational probabilities from certificate and diploma to an Honour's degree.

As shown in Table 4.5, a Black male child living with both parents have a 16.67% chance of achieving a certificate and diploma as compared to a male Black child living with no parents (15.26% chance). Black males living with a father only have a 14.86% chance of achieving a certificate and diploma education whilst Black males living with a mother only have a 14.32% chance of achieving a certificate and diploma.

In Table 4.6, a Black female living with both parents has a 17.69% chance of achieving high school education. This is in contrast to a Black female living with a mother who only has a 18.60% chance of achieving high school education, whilst a Black female living with a father only has 17.57% and a Black female living with no parents has a 18.67% chance of achieving a high school education.

Furthermore, Table 4.7 reveals that a White male child living with both parents has a 14.62% chance of achieving a Bachelor's degree as compared to 12.42% chance of achieving a Bachelor's degree for a White male living with a mother only. Male White children living with a father only have a 12.92% chance of achieving a Bachelor's degree, whilst a male White child living with no parents has a 13.29% chance of achieving a Bachelor's degree.

Table 4.8 shows that a White female child who lives with both parents has a 12.33% chance of achieving a Bachelor's degree, whilst a female White child living with a mother only and a father only has a 14.45% and 12.10% chance, respectively of achieving a Bachelor's degree. A White female child living with no parents has the highest probability of 14.65% of achieving a Bachelor's degree as compared to other female White children living in the other family structures.

Table 4.9 reveals that a Coloured male child living with both parents, has a 22.96% chance of achieving a certificate and diploma as compared to a Coloured male child living with a mother only, who has a 20.68% likelihood of achieving the same educational level. Furthermore, a

Coloured male child living with a father only is likely to have a 21.22% chance of achieving a certificate and a diploma whilst a Coloured male child living without any parents may likely have a 21.62% chance of achieving the same educational level.

A Coloured female child has the highest probability of 23.91% chance of achieving a certificate and diploma when living without any parents as presented in Table 4.10. Furthermore, there is a 23.72% chance of a Coloured female child achieving a certificate and diploma when living with a mother only. In addition, a Coloured female child living with both parents has a 21.57% chance of achieving a certificate and diploma whilst a Coloured female child living with father only has a 21.32% chance of achieving the same educational level.

Table 4.11 shows that an Asian/Indian male child has the highest likelihood of achieving a bachelor's degree of 10.94% if living with both parents. The lowest chance of achieving a bachelor's degree for an Asian/Indian male child (9.01%) is when living with a mother. An Asian/Indian male child living without parents has a 9.77% chance of achieving a Bachelor's degree, whilst an Asian/Indian male child living with a father only has a 9.44% chance of achieving the same educational level.

Table 4.12 reveals that an Asian/Indian female child living without parents has the highest chance of 9.34% of achieving an honour's degree certificate. Furthermore, an Asian/Indian female living with a father only has the lowest chance of 7.17% for achieving an honours degree. An Asian/Indian female living with a mother only has a 9.16% chance of achieving an honour's degree, whilst an Asian/Indian female who is living with both parents has a 7.36% chance of achieving the same educational level.

Tables 4.13 to 4.22 show educational probabilities by educational level, race and gender for all family structures. Table 4.13 reveals that for all family structures, Black males are expected to have the highest likelihood of achieving less than a high school education as compared to other races. For instance, a Black male child who lives with both parents has a 59.62% chance of achieving less than a high school education. On the other hand, a White male child living with both parents has a 33.67% chance of achieving a high school education. Furthermore, Coloured male children have a 45.19 % chance of achieving less than a high school education whilst Asian/Indian male children have a 42.50% chance of achieving the same educational level.

By contrast, Table 4.14 shows that Black male children have the lowest chance of achieving a high school education as compared to other races for all family structures. For instance, for

children living without parents, a Black male child has an educational probability of 16.17%, whilst a White male child has an educational probability of 18.80%, a Coloured male child 18.53% and an Asian/Indian male child 18.74%. Furthermore, a White male child has the highest chance of achieving a high school education as compared to other races for the three family structures, for those living with a mother only, living with a father only and living without parents. For instance, a White male child living with a mother only has the highest chance of 18.88% of achieving a high school education, whilst a Coloured, Asian/Indian and Black male child have a 18.31%, 18.58 and 15.66% chance of achieving the same educational level.

Table 4.15 shows that White male children have the highest probability of achieving a certificate and diplomas as compared to other races for all family structures. Asian/Indian male children have the second highest likelihood of achieving a certificate and a diploma whilst Black male children have the least likelihood for all family structures. For instance, White male children have the highest educational probability of 27.18 % of achieving a certificate and diploma for those living with both parents. Asian/Indian male children have the second highest likelihood of 24.04%, whilst Coloured male children have a 22.96% chance and Blacks have a 16.67% chance of achieving a certificate and diploma for the same family structure.

Table 4.16 shows that White male children have the highest likelihood of achieving a bachelor's degree as compared to other races for all family structures. The educational probabilities for White male children are all-in double-digit percentages as compared to educational probabilities of other races. For instance, a White male child living with both parents has a 14.62% chance of attaining a bachelor's degree, whilst a Coloured male child has a 9.95% chance of attaining the same educational level. A Black male child has a 5.55% chance and an Asian/Indian male child has a 3.65% chance of achieving a bachelor's degree with the family structure of living with both parents. A White male child living with a mother only has an educational probability of 12.42%, whilst a Coloured, Black and an Asian/Indian male child living with a mother only has an educational probability of 8.12%, 4.32% and 2.69%, respectively.

White male children had the highest educational probabilities of achieving an honours degree for every family structure as compared to other races, as shown in Table 4.17. However, on average for all races, the educational probabilities were less than 7% across all family structures. Black male children have the least likelihood of less than 2% of achieving an

honours degree, for all family structures. A White male child living with a father only has a 4.79% chance of achieving an honours degree whilst a Black male child has a 0.99% likelihood of achieving an honour's degree for the same family structure. In addition, an Asian/Indian male child has a 2.89% probability, whilst a Coloured male child has a 2.47% probability of achieving an Honours degree for the same family structure.

Table 4.18 shows that Black female children have the highest likelihood of achieving less than a high school education as compared to children of other races for all family structures. Coloured female children are second in terms of having the highest likelihood of achieving less than a high school education as compared to other children of other races. For example, as shown in Table 4.18, a Black female child living with father only has a 60.07% chance of achieving less than a high school education as compared to a Coloured female, Asian/Indian female and White female child with 50.26%, 39.25% and 22.14% chances respectively, of achieving less than a high school education for the same family structure.

In Table 4.19, White female children have the highest educational probabilities of achieving a high school education when living with both parents and when living with father only, as compared to female children of other races. Furthermore, Coloured female children have the highest likelihood of achieving a high school education as compared to female children of other races when living with a mother only and living without any parents. A White female child living with both parents has the highest educational probability of 19.92% of achieving a high school education as compared to Coloured female, Black female and Asian/Indian female children of the same family structure with educational probabilities of 19.35%, 17.69% and 17.38%, respectively of achieving high school education. In addition, Coloured female children have the highest likelihood of 19.80% of achieving a high school education as compared to White female children, Black female children and Asian/Indian female children with educational probabilities of 19.67%, 18.67% and 16.13% respectively when living without any parents.

Although previously, Asian/Indian female children had the least likelihood of achieving less than a high school education, Table 4.20 reveals that Asian/Indian female children have the highest likelihood of achieving a certificate and diploma as compared to female children of other races for all family structures. For instance, an Asian/Indian female child living with a mother only has an educational probability of 31.86% as compared to White female, Coloured

female and Black female children, with educational probabilities of 28.16%, 23.72% and 19.13%, respectively for the same family structure.

Across all family structures, a White female child is likely to have the highest chances of achieving a bachelor's degree as compared to other female children of other races in Table 4.21. Furthermore, in Table 4.21, Black female children have the lowest chances of achieving a bachelor's degree as compared to other races for all family structures. For instance, a White female child who lives with both parents has a 12.33% probability of achieving a bachelor's degree as compared to an Asian/Indian female, Coloured female and Black female children with 10.94%, 8.05% and 5.18% chance of achieving a bachelor's degree for the same family structure.

In Table 4.22, Asian/Indian female children have the highest likelihood of achieving an honours degree as compared to other female children of other races, across all family structures. Black female children have the least chances of achieving an honours degree. An Asian/Indian female child living, with father only has an educational probability of 7.17% as compared to White female, Coloured female and Black female children, with educational probabilities of 2.51%, 1.26% and 0.65% respectively for the same family structure. All educational probabilities for all races are in single percentages with Black female children having the least likelihood of achieving an honours degree of less than 1% for all family structures.

Part of the calculations for estimating life time earnings involves estimating work-life expectancies by educational levels and age for the minor child. Following what was done by Spizman (2016) and Kane et al. (2010), this research paper presents selected male and female work-life expectancies categorised by educational levels and age as part of the calculations, as shown in Table 4.23 and Table 4.24. The work-life expectancies are calculated separately and then matched with the ages of the children. Work-life expectancies are calculated using Millimet et al. (2003) multinomial logit regression method. We show the detailed work-life expectancies by five educational levels (less than high school; high school; certificates and diploma; bachelor's degree and honours degree) in Appendix A, page 252. We select specific work-life expectancies by ages 18 to 23 for different educational levels and present them in Tables 4.23 and Table 4.24.

Table 4.23 shows that a male child born in 2009 would be 15 years in 2024. We estimate that the male child will enter the labour market in 2027, when he is 18 years. If the male child has

less than a high school education, then his work-life expectancy is estimated at 31.38 years. And at the age of 18 in 2027, if the male child has a high school education, then his work-life expectancy would increase to 34.98 years. If the male child achieves an honours degree by the age of 23 he is expected to have a work-life expectancy of 39.75 years.

Table 4.24 shows that a female child born in 2009 will enter the labour market at the age of 18 in 2027. If the female child has less than a high school education in 2027 then her work-life expectancy will be 32.52 years. Furthermore, if she has a high school education in 2027 her work-life expectancy will be slightly higher at 32.76 years. If the female child achieves an honour's degree by 2032 at the age of 23 then she will have a work-life expectancy of 36.05 years.

Table 4.25 to 4.32 show the lifetime earnings for South Africans at each educational level category and by gender and race. The second column of each table shows the median earnings, which are derived from the South African General Household Survey dataset of 2022. This is the most recent dataset available for public use, which has incomes for different individuals in different households. This paper follows what other papers in this subject area have done when calculating lifetime earnings, which is to use additional datasets besides the dataset used for regression of the ordered probit model. Kane et al. (2010) took the most recent data during the time of their study, which was the expectancy dataset (2007) produce median earnings. For this paper, we multiply the median earnings by a real growth rate of 0.97724503, which is a value found in the International Labour Organisation (ILO) global wage report of 2022-2023. We later multiply these revised life time earnings by work-life expectancies per educational level, provided in Table 4.23 and 4.24. Lastly the lifetime earnings are multiplied by a fringe benefit percentage of 1.05278442. The percentage for fringe benefits are calculated using the NIDS dataset of 2008-2017, since it is the dataset, which provides enough parameters to calculate the fringe benefit percentage. These lifetime earnings we estimate are for all individuals for all ages. These lifetime earnings are later used to estimate expected lifetime earnings for minor children presented in tables 4.33 to 4.40.

Table 4.25 and 4.26 show that Black male lifetime earnings are higher than Black female lifetime earnings for less than a high school education, high school education and certificate and diploma educational achievement levels. However, Black female lifetime earnings exceed Black male lifetime earnings for the higher educational levels of achieving a bachelors and honours degree. For example, we estimate life time earnings for Black male with less than a

high school education to be R 1,164,785 whilst the life time earnings estimate for Black female is R647,125 for the same educational level. However, we estimate Black female lifetime earnings, for those with an honours degree, to be R 2,772,348 which is slightly higher than Black male lifetime earnings, which we estimate to be R 2,600,981 for the same educational level.

Table 4.27 and 4.28 show the lifetime earnings for White male and female people in South Africa. These lifetime earnings in Tables 4.27 and Table 4.28 are the highest as compared to other lifetime earnings of other races and genders. We estimate White female lifetime earnings to be higher than White male lifetime earnings for less than a high school, high school and certificate and diploma educational attainment. White Male lifetime earnings estimates outpace female lifetime earnings for the Bachelors and Honour's degree educational attainment level. For instance, we estimate White male lifetime earnings at R 1,846,088 as compared to White female life-time earnings which we estimate to be R 2,814,184 for less than high school educational attainment. At an honour's degree educational attainment level, we compute White male lifetime earnings of R 21,886,723 as compared to R 9,605,970 life time earnings for White females at the same educational attainment level. This is a massive disparity of 128% between White male lifetime earnings, as compared to White female life time earnings for an honour's degree educational attainment.

Table 4.29 and 4.30 show the lifetime earnings for Coloured male and female people in South Africa. Coloured male lifetime earnings exceed Coloured female lifetime earnings from a high school education till achieving an honours degree. For instance, we compute the lifetime earnings for Coloured female to amount to R 1,496,476 as compared to a Coloured male's lifetime earnings estimated to be R 1,360,276 for less than a high school education educational attainment. However, for high school educational attainment level, we project Coloured male lifetime earnings at R 2,159,305 whilst Coloured female life, time earnings amount to R 1,907,077 for the same educational attainment level.

Table 4.31 and 4.32 show the lifetime earnings for male and female Asian/Indians male and female individuals in South Africa. Male Asian/Indian lifetime earnings outpace lifetime earnings for female Asian/Indian from high school education to other higher educational attainment levels. For instance, we predict Asian/Indian male lifetime earnings at R 1,748,926 as compared to Asian/Indian female lifetime earnings with an estimate of R1,812,691 for less than high school educational attainment. At high school educational attainment level, male

Asian/Indian lifetime earnings exceed female Asian/Indian lifetime earnings by R 331,677. Asian/Indian male lifetime earnings are estimated to be R 2,214,799 as compared to R 1,883,122 for Asian/Indian female lifetime earnings for high school education attainment.

Table 4.33 to Table 4.40 show the statistically predicted lifetime earnings for minor children for all family structures, race and gender considering the educational probabilities of acquiring the five educational levels. The second column of the tables are the estimated lifetime earnings totals calculated in tables 4.25 to 4.32. The third to the sixth columns has the educational probabilities calculated in tables 4.5 to 4.11. The product of the lifetime earnings for each educational level with the corresponding educational probabilities are added to produce the predicted lifetime earnings for the minor children for each family structure, race and gender. For instance, in Table 4.33, the educational probabilities for the family structure of living with both parents 59.62%, is multiplied with the lifetime total compensation value of R 1,164,785 to get lifetime earnings adjusted for probability (694444.817). This is done for every educational probability and lifetime earnings per every educational level and family structure from Table 4.33 to Table 4.40. For ease of presentation, the lifetime earnings adjusted for each educational probability are not presented in the paper. This is consistent with how Kane et al. (2010) presented their results as well. The lifetime earnings adjusted for each educational probability are then added per family structure to produce the total earning capacity per family structure. For instance, in table 4.33 we multiply the lifetime earnings in the second column with each probability in the third column for each educational level and then add the results generate the value of 1420208. [(1164785 x 59.62%) + (1696782 x 16.86%) + (1792164 x 16.67%) + (1930078 x 5.55%) + (2600981 x 1.30%) = 1420208.]. The same lifetime earnings values in column 2 are used to multiply the educational probabilities in column 4, 5 and 6 and this is done for all tables from table 4.33 to table 4.40.

Table 4.33 shows the Black male minor child's adjusted predicted lifetime earnings. The highest anticipated lifetime earnings are R1 420 208 for Black male minor children living with both parents. This is followed by expected lifetime earnings of R1,398,168 for Black male minor children living without parents. Black male minor children living with a father only have expected lifetime earnings of R 1,392,265, whilst Black male minor children living with a mother have the lowest expected lifetime earnings of R 1,384,066.

Furthermore, Table 4.34 shows the Black female minor children's expected lifetime earnings considering the probabilities of achieving the five educational levels. We estimate that Black

female children living without parents have an expected lifetime earnings of R 1,110, 828 as compared to the expected lifetime earnings of other family structures. This is followed by Black female children living with mothers only with projected lifetime earnings of R1,105,708. We estimate Black female children living with father only to have the least expected lifetime earnings of R 1,045,866 as compared to expected lifetime earnings of other family structures.

Comparing Table 4.33 and 4.34 by gender it can be seen that Black male children have the highest expected lifetime earnings as compared to the anticipated lifetime earnings for Black female children across all family structures. For instance, Black male children living with both parents have expected lifetime earnings of R1,420,208 as compared to Black female children living with both parents and have projected lifetime earnings of R1,051,728. Black male children expected lifetime earnings are 26% higher than female Black children expected lifetime earnings for those living without parents. Male Black children have expected lifetime earnings of R 1,398,168 as compared to female Black children's expected lifetime earnings of R1,110,828 for those living without parents.

Table 4.35 shows White male children's expected lifetime earnings for the four family structures considering the likelihood of achieving the different educational attainment levels. We calculate that White male children who live with both parents have the highest projected lifetime earnings of R6,700,267 as compared to the expected lifetime earnings in other family structures. White male children living with a mother only have the least expected lifetime earnings of R5,961,196 as compared to the anticipated lifetime earnings of other family structures.

Table 4.36 reveals the White female children's predicted lifetime earnings for the four family structures considering the probabilities of attaining different educational levels. We calculate that White female children living without parents have the highest expected lifetime earnings of R 4,079,630 as compared to other expected lifetime earnings of other family structures. Furthermore, White female children living with father only have the least expected lifetime earnings of R 3,909,835 as compared to other expected lifetimes earnings of the other family units.

Comparing Table 4.35 and 4.36 reveals that White male children have the highest predicted lifetime earnings across all of the four family units as compared to White female children's expected lifetime earnings. For instance, White male children living with mother only have

anticipated lifetime earnings of R5,961,196 as compared to expected lifetime earnings of R 4,065,482 for White female children living with mother only. This shows that White male children's expected lifetime earnings for those living with mother only is 47% higher as compared to the expected lifetime earnings for White female children living with their mother only.

Table 4.37 shows Coloured male children's expected lifetime earnings for the four family structures considering the probabilities of attaining the different educational levels. We project that Coloured male children living with both parents have the highest expected lifetime earnings of R2,735,798 as compared to the expected lifetime earnings of other family structures. This is followed by Coloured male children living without any parents with expected lifetime earnings of R2,626,859. Coloured male children living with father only have expected lifetime earnings of R2,596,878 as compared to Coloured male children living with their mother only who have expected lifetime earnings of R2,555,769. Anticipated lifetime earnings for Coloured male children living with their mother only is the least anticipated lifetime earnings as compared to other expected lifetime earnings of other family structures.

Table 4.38 shows the Coloured female children's predicted lifetime earnings considering the likelihood of achieving the five educational levels for the four family structures. We estimate that female Coloured children living without any parents have the highest anticipated lifetime earnings of R 1,845,004 as compared to the expected lifetime earnings of other family structures. This expected lifetime earning is slightly higher by R 3884 as compared to the expected lifetime earnings of Coloured female children living with their mother only. We predict that Coloured female children living with their father only have the least expected lifetime earnings of R 1,796,908 as compared to the anticipated lifetime earnings of other family structures.

Comparing Table 4.37 and 4.38 shows that Coloured male children's expected lifetime earnings are the highest as compared to Coloured female children's expected lifetime earnings for the four family structures. For instance, Coloured male children living with their father only have predicted lifetime earnings of R 2,596,878 as compared to expected lifetime earnings for Coloured female children of R1 796,908 for the same family structure. This shows that the predicted lifetime earnings for Coloured male children living with their father only are 45% higher as compared to the expected lifetime earnings for Coloured female children living with their father only.

Table 4.39 shows the Asian/Indian male children's expected lifetime earnings considering the likelihood of achieving the five educational levels for the four family structures. We compute that Asian/Indian male children living with both parents have the highest expected lifetime earnings of R 2,178,890 as compared to other expected lifetime earnings in other family structures. Asian/Indian male children living with their mother only have the lowest predicted lifetime earnings of R 2,127,211 as compared to other expected lifetime earnings of other family structures.

Table 4.40 shows the Asian/Indian female children's expected lifetime earnings considering the likelihood of achieving the five educational levels for the four family structures. Asian/Indian female children living without any parents have the highest expected lifetime earnings of R2,267,334 as compared to other expected lifetime earnings of other family structures. This is slightly higher by R3,301 as compared to the expected lifetime earnings for Asian/Indian female children living with their mother only. Asian/Indian female children living with their father only have the lowest anticipated lifetime earnings of R2,220,650 as compared to expected lifetime earnings of other family structures.

Comparing Table 4.39 and 4.40 shows that Asian/Indian female children have the highest expected lifetime earnings as compared to Asian/Indian male children for all family structures. For instance, Asian/Indian female children living without parents have expected lifetime earnings of R2,267,334 as compared to expected lifetime earnings of R2,147,846 for Asian/Indian male children living without parents. This shows that Asian/Indian female children's expected lifetime earnings are higher than Asian/Indian male children's expected lifetime earnings by 6% for those living without parents.

Table 4.41 shows the male child comparison of expected lifetime earnings considering the likelihood of achieving the five educational levels for the four family structures. We show that White male children have the highest expected lifetime earnings as compared to expected lifetime earnings of other races for all family structures. For instance, White male children have anticipated lifetime earnings of R6,700,267 as compared to Coloured male and Asian/Indian male children with expected lifetime earnings of R2,735,798 and R2,178,890 respectively for those living with both parents. Black male children living with both parents have the lowest expected lifetime earnings of R1,420,208 as compared to other children of other races. In addition, White male children living without parents have the highest expected lifetime earnings of R6,249,508 as compared to expected lifetime earnings of R2,626,859 and R2,

147,846 for Coloured male and Asian/Indian male children respectively for the same family structure. Black male children have the lowest predicted lifetime earnings of R1,398,168 as compared to expected lifetime earnings of other races for those living without parents.

Table 4.42 shows the female child comparison of expected lifetime earnings considering the likelihood of achieving the five educational levels for the four family structures. White female children have the highest expected lifetime earnings as compared to expected lifetime earnings of other races for all family structures. For instance, White female children living with their mother only have the highest expected lifetime earnings of R4,065,482 as compared to expected lifetime earnings of R2,264,033 and R1,841,120 for Asian/Indian female and Coloured female children of the same family structure. Black female children living with their mother only have the lowest expected lifetime earnings of R1,105,708 as compared to expected lifetime earnings of children of other races. Furthermore, White female children living with their father only have the highest anticipated lifetime earnings of R3,909,835 as compared to R2,220,650 and R 1,796 908 for Asian/Indian female and Coloured female children for the same family structure. Black female children living with their father only have the lowest expected lifetime earnings of R1,045,866 as compared to other expected lifetime earnings of children of other races.

We calculate percentage penalties for the absence of one parent for all minor children by race from tables 4.43 to 4.50. This means that the reference living structure is when children are "living with both parents". We calculate the percentage penalties for those children who live with their mother and father only and those who live without parents. Children who live with both parents are likely to have more opportunities and resources as compared to other children in other family units (Abuya et al, 2019). We calculate the percentage penalties as follows:

Black male percentage penalty when father is absent:

$$\frac{Life\ time\ earnings\ when\ living\ with\ both\ parents - life\ time\ earnings\ when\ living\ with\ mother}{life\ time\ earnings\ when\ living\ with\ both\ parents}$$

$$\frac{R\ 1\ 420\ 208 - R\ 1\ 384\ 066}{R\ 1\ 420\ 208} = 0.025448 * 100 = 2.55\%$$

We follow the same estimation for other races, gender and family structure where living with both parents is the reference family structure which mean that we subtract every lifetime earnings of other family structures from the lifetime earnings of child living with both parents.

Our computations follow Kane et al (2010) where the positive percentages estimated for instance 2.55% is a reduction in lifetime earnings in case one or all of the parents are absent in the household. Then a negative percentage, for example -2.55%, would be like a gain in expected lifetime earnings when one or all of the parents are absent.

In Table 4.43 we compute the percentage penalties in expected lifetime earnings to be incurred by a Black male child if one or all the parents are absent in their life. Table 4.43 shows that Black male expected lifetime earnings might be reduced by 2.55% if the father is absent. If the mother is absent in the family setting, Black male children might incur a loss of 1.97% in expected lifetime earnings. In addition, in the case where no parents are present, the Black male minor child would likely incur an expected lifetime earnings loss of 1.55%. The highest percentage loss in expected lifetime earnings for Black male children is when the father is absent in the family.

In table 4.44 we estimate the percentage penalties in expected lifetime earnings which will be incurred by a Black female child if one parent is absent or all of them. The Table shows that Black female children's expected lifetime earnings could increase by 5.13% if the father is absent in the family. Furthermore, if the mother is absent in the family setting, a Black female child could incur a loss of 0.56% in expected lifetime earnings. If there are no parents in the family, the anticipated lifetime earnings for Black female children could increase by 5.62%. This is the highest percentage increase in expected lifetime earnings for Black female children.

Table 4.45 shows the percentage penalties in expected lifetime earnings that will be incurred by a White male child if there is an absence of one parent or all of them. If the father is absent in the family, a White male child might incur an 11.03% loss in expected lifetime earnings. This is the highest percentage loss in expected lifetime earnings incurred by the White male child. Furthermore, if the mother is absent in the family, the White male child could incur an 8.59% loss in expected lifetime earnings. There is a 6.75% reduction in White male child's predicted lifetime earnings if there are no parents present in the family.

In Table 4.46, we compute the percentage penalties in expected lifetime earnings that will be incurred by a White female child if there is an absence of one parent or all of them. White female children would experience a 3.58% increase in lifetime earnings if the father is absent. This is in contrast to when the mother is absent in the family, the White female children could

incur a 0.39% loss in predicted lifetime earnings. Furthermore, the White female children's expected lifetime earnings may increase by 3.94% if there are no parents present in the family.

We calculate the percentage penalties in expected lifetime earnings that will be incurred by a Coloured male child if one parent is absent or all of them in table 4.47. If the father is absent in the family setting, the expected lifetime earnings for the Coloured male child could be reduced by 6.58%. In contrast, the Coloured male child would incur a 5.08% loss in anticipated lifetime earnings if the mother is absent from the family. The Coloured male child's expected lifetime earnings could be reduced by 3.98% in cases where both parents are absent in the family.

Table 4.48 shows the percentage penalties in expected lifetime earnings that will be sustained by a female Coloured child if there is an absence of one parent or both. A Coloured female child will incur a 2.21% increase in expected lifetime earnings if the father is absent from the family. This is in contrast to a 0.25% loss in expected lifetime earnings which could be sustained by the Coloured female child if the mother is absent in the family. In addition, if there are no parents present in the family setting, the expected lifetime earnings for the Coloured female child could increase by 2.42%. This is the highest increase in predicted lifetime earnings for Coloured female children.

We predict the percentage penalties in expected lifetime earnings that will be sustained by an Asian/Indian male child if there is an absence of one parent or both of them in Table 4.49. If the father is absent in the family, Asian/Indian male children's anticipated lifetime earnings could fall by 2.37%. This is the highest percentage penalty loss in expected lifetime earnings for the Asian/Indian male child. In contrast, if the mother is absent in the family setting, Asian/Indian male children would incur a 1.84% loss in expected lifetime earnings. In addition, if both parents are absent in the family the Asian/Indian male child would incur a 1.43% loss in expected lifetime earnings.

Table 4.50 shows the percentage penalties in expected lifetime earnings that will be incurred by an Asian/Indian female child in the absence of one or both parents. An Asian/Indian female child could have a 1.74% increase in anticipated lifetime earnings if the father is absent in the family. In contrast, there would be a 0.21% reduction in expected lifetime earnings for an Asian/Indian female child if the mother is absent in the family. Furthermore, if both parents

are absent in the family setting, there couldd be a 1.89% increase in expected lifetime earnings for the Asian/Indian female child.

a. Educational Probabilities based on Race and Gender

Black

Table 4.5: Educational probabilities for male Black children

Educational probabilities under the family structure of an English-speaking Christian Black male, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	59.62%	64.79%	63.60%	62.72%
High school education	16.86%	15.66%	15.96%	16.17%
Certificates and diploma	16.67%	14.32%	14.86%	15.26%
Bachelor's degree	5.55%	4.32%	4.59%	4.79%
Honour's degree	1.30%	0.91%	0.99%	1.05%

Table 4.6: Educational probabilities for female Black children

Educational probabilities under the family structure of an English-speaking Christian Black female, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	59.55%	54.90%	60.07%	54.47%
High school education	17.69%	18.60%	17.57%	18.67%
Certificates and diploma	16.92%	19.13%	16.67%	19.34%
Bachelor's degree	5.18%	6.44%	5.05%	6.56%
Honour's degree	0.67%	0.93%	0.65%	0.96%

White

Table 4.7: Educational probabilities for male White children

Educational probabilities under the family structure of an English-speaking Christian White male, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	33.67%	38.77%	37.56%	36.68%
High school education	18.59%	18.88%	18.84%	18.80%
Certificates and diploma	27.18%	25.45%	25.89%	26.20%
Bachelor's degree	14.62%	12.42%	12.92%	13.29%
Honour's degree	5.93%	4.49%	4.79%	5.03%

Table 4.8: Educational probabilities for female White children

Educational probabilities under the family structure of an English-speaking Christian White female, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	38.74%	34.28%	39.25%	33.89%
High school education	19.92%	19.71%	19.93%	19.67%
Certificates and diploma	26.42%	28.16%	26.21%	28.31%
Bachelor's degree	12.33%	14.45%	12.10%	14.65%
Honour's degree	2.59%	3.39%	2.51%	3.48%

Table 4.9: Educational probabilities for male Coloured children

Educational probabilities under the family structure of an English-speaking Christian Coloured male, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	45.19%	50.60%	49.34%	48.41%
High school education	18.77%	18.31%	18.44%	18.53%
Certificates and diploma	22.96%	20.68%	21.22%	21.62%
Bachelor's degree	9.95%	8.12%	8.53%	8.83%
Honour's degree	3.13%	2.29%	2.47%	2.60%

Table 4.10: Educational probabilities for female Coloured children

Educational probabilities under the family structure of an English-speaking Christian Coloured female, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	49.72%	45.00%	50.26%	44.58%
High school education	19.35%	19.77%	19.29%	19.80%
Certificates and diploma	21.57%	23.72%	21.32%	23.91%
Bachelor's degree	8.05%	9.73%	7.87%	9.90%
Honour's degree	1.31%	1.77%	1.26%	1.81%

Table 4.11: Educational probabilities for male Asian/Indian children

Educational probabilities under the family structure of an English-speaking Christian Asian/Indian male, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	42.50%	47.88%	46.62%	45.69%
High school education	18.88%	18.58%	18.68%	18.74%
Certificates and diploma	24.04%	21.85%	22.37%	22.76%
Bachelor's degree	10.94%	9.01%	9.44%	9.77%
Honour's degree	3.65%	2.69%	2.89%	3.05%

Table 4.12: Educational probabilities for female Asian/Indian children

Educational probabilities under the family structure of an English-speaking Christian Asian/Indian female, mother and father with high school education and who lives in the Gauteng Province

	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school education	21.74%	18.42%	22.14%	18.13%
High school education	17.38%	16.24%	17.50%	16.13%
Certificates and diploma	31.59%	31.86%	31.53%	31.86%
Bachelor's degree	21.93%	24.33%	21.65%	24.54%
Honour's degree	7.36%	9.16%	7.17%	9.34%

Table 4.13: Educational probabilities for male children who are likely to achieve less than high school education

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	59.62%	64.79%	63.60%	62.72%
White	33.67%	38.77%	37.56%	36.68%
Coloured	45.19%	50.60%	49.34%	48.41%
Asian/Indian	42.50%	47.88%	46.62%	45.69%

Table 4.14: Educational probabilities for male children who are likely to achieve high school education

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	16.86%	15.66%	15.96%	16.17%
White	18.59%	18.88%	18.84%	18.80%
Coloured	18.77%	18.31%	18.44%	18.53%
Asian/Indian	18.88%	18.58%	18.68%	18.74%

Table 4.15: Educational probabilities for male children who are likely to achieve certificates and diploma

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	16.67%	14.32%	14.86%	15.26%
White	27.18%	25.45%	25.89%	26.20%
Coloured	22.96%	20.68%	21.22%	21.62%
Asian/Indian	24.04%	21.85%	22.37%	22.76%

Table 4.16: Educational probabilities for male children who are likely to achieve Bachelor's degree

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	5.55%	4.32%	4.59%	4.79%
White	14.62%	12.42%	12.92%	13.29%
Coloured	9.95%	8.12%	8.53%	8.83%
Asian/Indian	3.65%	2.69%	2.89%	3.05%

Table 4.17: Educational probabilities for male children who are likely to achieve an Honour's degree

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	1.30%	0.91%	0.99%	1.05%
White	5.93%	4.49%	4.79%	5.03%
Coloured	3.13%	2.29%	2.47%	2.60%
Asian/Indian	3.65%	2.69%	2.89%	3.05%

Table 4.18: Educational probabilities for female children who are likely to achieve less than high school education

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	59.55%	54.90%	60.07%	54.47%
White	38.74%	34.28%	39.25%	33.89%
Coloured	49.72%	45.00%	50.26%	44.58%
Asian/Indian	21.74%	18.42%	22.14%	18.13%

Table 4.19: Educational probabilities for female children who are likely to achieve high school education

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	17.69%	18.60%	17.57%	18.67%
White	19.92%	19.71%	19.93%	19.67%
Coloured	19.35%	19.77%	19.29%	19.80%
Asian/Indian	17.38%	16.24%	17.50%	16.13%

Table 4.20: Educational probabilities for female children who are likely to achieve certificates and diploma

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	16.92%	19.13%	16.67%	19.34%
White	26.42%	28.16%	26.21%	28.31%
Coloured	21.57%	23.72%	21.32%	23.91%
Asian/Indian	31.59%	31.86%	31.53%	31.86%

Table 4.21: Educational probabilities for female children who are likely to achieve a Bachelor's degree

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	5.18%	6.44%	5.05%	6.56%
White	12.33%	14.45%	12.10%	14.65%
Coloured	8.05%	9.73%	7.87%	9.90%
Asian/Indian	10.94%	9.01%	9.44%	9.77%

Table 4.22: Educational probabilities for female children who are likely to achieve an Honour's degree

	Living with both parents	Living with mother	Living with father	Living without any parents
Black	0.67%	0.93%	0.65%	0.96%
White	2.59%	3.39%	2.51%	3.48%
Coloured	1.31%	1.77%	1.26%	1.81%
Asian/Indian	7.36%	9.16%	7.17%	9.34%

b. Work-life expectancies for male and female

Table 4.23: Male work-life expectancies

	Date	Year	Number of years	Age
(a) Date of birth	1 January 2009	2009	0	0
(b) Child's assumed age	1 January 2024	2024	15	15

	Labour market entry date	Entry age	Work-life expectancies
Less than high school	2027	18	31.48
High school	2027	18	34.98
Certificates and diplomas	2029	20	36.11
Bachelor's degree	2031	22	38.13
Honour's degree	2032	23	39.75

Table 4.24: Female work-life expectancies

	Date	Year	Number of years	Age
(a) Date of birth	1 January 2009	2009	0	0
(b) Child's assumed age	1 January 2024	2024	15	15

	Labour market entry date	Entry age	Work-life expectancies
Less than high school	2027	18	32.52
High school	2027	18	32.76
Certificates and diplomas	2029	20	35.42
Bachelor's degree	2031	22	35.56
Honour's degree	2032	23	36.05

c. Lifetime earnings

Table 4.25: Male Black lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	R 35964	35145.64	1106384.755	1164785
High school	R 47148	46075.15	1611708.7	1696782
Certificates and diploma	R 48240	47142.3	1702308.462	1792164
Bachelor's degree	R 49200	48080.46	1833307.767	1930078
Honour's degree	R 63600	62152.78	2470573.16	2600981

Table 4.26: Female Black lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	R 19200	18763.1	614679.306	647125
High school	R 43200	42216.99	1372896.362	1445364
Certificates and diploma	R 45600	44562.37	1578399.265	1661714
Bachelor's degree	R 58542	57209.88	2034383.281	2141767
Honour's degree	R 74748	73047.11	2633348.37	2772348

Table 4.27: Male White lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	57000	55702.97	1753529.392	1846088
High school	96000	93815.52	3281666.99	3454888
Certificates and diploma	108000	105542.5	3811138.348	4012307
Bachelor's degree	531444	519351	19802853.92	20848136
Honour's degree	535181	523003	20789368.15	21886723

Table 4.28: Female White lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	83496	81596.05	2673086.631	2814184
High school	113700	111112.8	3613386.952	3804117
Certificates and diploma	114825	112212.2	3974554.727	4184349
Bachelor's degree	160224	156578.1	5567917.51	5861817
Honour's degree	258996	253102.6	9124347.064	9605970

Table 4.29: Male Coloured lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	42000	41044.29	1292074.289	1360276
High school	60000	58634.7	2051041.869	2159305
Certificates and diploma	120000	117269.4	4234598.164	4458119
Bachelor's degree	132647	129628.6	4942739.338	5203639
Honour's degree	136278	133177	5293785.678	5573215

Table 4.30: Female Coloured lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	44400	43389.68	1421445.895	1496476
High school	57000	55702.97	1811460.477	1907077
Certificates and diploma	55116	53861.84	1907786.269	2008488
Bachelor's degree	72368	70721.27	2514848.302	2647593
Honour's degree	86297	84333.31	3040215.982	3200692

Table 4.31: Male Asian/Indian lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	54000	52771.23	1661238.371	1748926
High school	61542	60141.61	2103753.645	2214799
Certificates and diploma	65783	64286.11	2321371.425	2443904
Bachelor's degree	73920	72237.95	2754433.133	2899824
Honour's degree	75492	73774.18	2932523.727	3087315

Table 4.32: Female Asian/Indian lifetime earnings

Level of educational attainment	Median earnings	Median earnings *0.97724503 real growth rate	Expected lifetime earnings * WLE	Lifetime earnings *(1.05278442) fringe benefits
Less than high school	53782	52558.19	1721806.377	1812691
High school	56284	55003.26	1788705.991	1883122
Certificates and diploma	61839	60431.86	2140496.319	2253481
Bachelor's degree	73219	71552.9	2544421.261	2678727
Honour's degree	74947	73241.58	2640359.077	2779729

d. Expected lifetime earnings by categories

Table 4.33: Expected lifetime earnings for male Black children by living structure

	Expected Lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1164785	59.62%	64.79%	63.60%	62.72%
High school	1696782	16.86%	15.66%	15.96%	16.17%
Certificates and diploma	1792164	16.67%	14.32%	14.86%	15.26%
Bachelor's degree	1930078	5.55%	4.32%	4.59%	4.79%
Honour’s degree	2600981	1.30%	0.91%	0.99%	1.05%
Expected lifetime earnings by living structure		1420208	1384066	1392265	1398168

Table 4.34: Expected lifetime earnings for female Black children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	647124.8	59.55%	54.90%	60.07%	54.47%
High school	1445364	17.69%	18.60%	17.57%	18.67%
Certificates and diploma	1661714	16.92%	19.13%	16.67%	19.34%
Bachelor's degree	2141767	5.18%	6.44%	5.05%	6.56%
Honour’s degree	2772348	0.67%	0.93%	0.65%	0.96%
Expected lifetime earnings by living structure		1051728	1105708	1045866	1110828

Table 4.35: Expected lifetime earnings for male White children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1846088	33.67%	38.77%	37.56%	36.68%
High school	3454888	18.59%	18.88%	18.84%	18.80%
Certificates and diploma	4012307	27.18%	25.45%	25.89%	26.20%
Bachelor's degree	20848136	14.62%	12.42%	12.92%	13.29%
Honour’s degree	21886723	5.93%	4.49%	4.79%	5.03%
Expected lifetime earnings by living structure		6700267	5961196	6125031	6249508

Table 4.36: Expected lifetime earnings for female White children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	2814184	38.74%	34.28%	39.25%	33.89%
High school	3804117	19.92%	19.71%	19.93%	19.67%
Certificates and diploma	4184349	26.42%	28.16%	26.21%	28.31%
Bachelor's degree	5861817	12.33%	14.45%	12.10%	14.65%
Honour’s degree	9605970	2.59%	3.39%	2.51%	3.48%
Expected lifetime earnings by living structure		3925057	4065482	3909835	4079630

Table 4.37: Expected lifetime earnings for male Coloured children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1360276	45.19%	50.60%	49.34%	48.41%
High school	2159305	18.77%	18.31%	18.44%	18.53%
Certificates and diploma	4458119	22.96%	20.68%	21.22%	21.62%
Bachelor's degree	5203639	9.95%	8.12%	8.53%	8.83%
Honour’s degree	5573215	3.13%	2.29%	2.47%	2.60%
Expected lifetime earnings by living structure		2735798	2555769	2596878	2626859

Table 4.38: Expected lifetime earnings for female Coloured children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1496476	49.72%	45.00%	50.26%	44.58%
High school	1907077	19.35%	19.77%	19.29%	19.80%
Certificates and diploma	2008488	21.57%	23.72%	21.32%	23.91%
Bachelor's degree	2647593	8.05%	9.73%	7.87%	9.90%
Honour’s degree	3200692	1.31%	1.77%	1.26%	1.81%
Expected lifetime earnings by living structure		1801358	1841120	1796908	1845004

Table 4.39: Expected lifetime earnings for male Asian/Indian children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1748926	42.50%	47.88%	46.62%	45.69%
High school	2214799	18.88%	18.58%	18.68%	18.74%
Certificates and diploma	2443904	24.04%	21.85%	22.37%	22.76%
Bachelor's degree	2899824	10.94%	9.01%	9.44%	9.77%
Honour’s degree	3087315	3.65%	2.69%	2.89%	3.05%
Expected lifetime earnings by living structure		2178890	2127211	2138742	2147846

Table 4.40: Expected lifetime earnings for female Asian/Indian children by living structure

	Expected lifetime earnings	Living with both parents	Living with mother	Living with father	Living without any parents
Less than high school	1812691	21.74%	18.42%	22.14%	18.13%
High school	1883122	17.38%	16.24%	17.50%	16.13%
Certificates and diploma	2253481	31.59%	31.86%	31.53%	31.86%
Bachelor's degree	2678727	21.93%	24.33%	21.65%	24.54%
Honour’s degree	2779729	7.36%	9.16%	7.17%	9.34%
Expected lifetime earnings by living structure		2225273	2264033	2220650	2267334

Table 4.41: Comparison of expected lifetime earnings for male children

	Living with both parents	Living with mother	Living with father	Living without parents
Male Black	R 1420208	R 1384066	R 1392265	R 1398168
Male White	R 6700267	R 5961196	R 6125031	R 6249508
Male Coloured	R 2735798	R 2555769	R 2596878	R 2626859
Male Asian/Indian	R 2178890	R 2127211	R 2138742	R 2147846

Table 4.42: Comparison of expected lifetime earnings for female children

	Living with both parents	Living with mother	Living with father	Living without parents
Female Black	R 1051728	R 1105708	R 1045866	R 1110828
Female White	R 3925057	R 4065482	R 3909835	R 4079630
Female Coloured	R 1801358	R 1841120	R 1796908	R 1845004
Female Asian/Indian	R 2225273	R 2264033	R 2220650	R 2267334

e. Percentage penalties

Table 4.43: Percentage penalties for male Black children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 1420208	R 1384066	2.55	R 1392265	1.97	R 1398168	1.55

Table 4.44: Percentage penalties for female Black children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 1051728	R 1105708	-5.13	R 1045866	0.56	R 1 110 828	-5.62

Table 4.45: Percentage penalties for male White children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 6700267	R 5961196	11.03	R 6125031	8.59	R 6249508	6.73

Table 4.46: Percentage penalties for female White children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 3925057	R 4065482	-3.58	R 3909835	0.39	R 4079630	-3.94

Table 4.47: Percentage penalties for male Coloured children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 2735798	R 2555769	6.58	R 2596878	5.08	R 2626859	3.98

Table 4.48: Percentage penalties for female Coloured children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 1801358	R1841120	-2.21	R 1796908	0.25	R 1845004	-2.42

Table 4.49: Percentage penalties for male Asian/Indian children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 2178890	R 2127211	2.37	R 2138742	1.84	R 2147846	1.43

Table 4.50: Percentage penalties for female Asian/Indian children

Living with both parents	Living with mother	Percentage penalty when father is absent	Living with father	Percentage penalty if mother is absent	Living without parents	Percentage penalty if mother and father are absent
R 2225273	R 2264033	-1.74	R 2220650	0.21	R 2267334	-1.89

4.9 DISCUSSION OF RESULTS

a. Discussion for the Ordered probit with cluster robust standard errors results

Our results reveal an association between parents' educational attainment with children's academic achievements in South Africa. Children are likely to achieve advanced academic achievements if parents have advanced education from high school to a bachelor's degree. This suggests a strong correlation between parents' educational attainment with children's future academic achievements. Our results are consistent with (Spizman & Kane 2020; Kane et al., 2010), who also found that children are likely to achieve higher levels of education if their parents also have higher educational attainment levels. Children in different family settings are likely to be inspired by expertise and expectations which surround them (Ceka & Murati, 2016). Hence, it is likely that parents who achieve higher education would also encourage their children to achieve higher education as well as provide a conducive environment and resources for their children to prosper (Ludeke et al., 2021).

Male children who are Christians and Black traditionalists had a higher probability of achieving higher educational attainment as compared to male children who are non-religious. This may be because some of the values and principles in some of these religious organisations encourage children to achieve higher academic qualifications. Students who are religious spend more time working hard, doing school work such as homework which results in them achieving higher academic results than those who are non-religious (Byfield, 2008; Fagan, 2010). However, the results show that female children who were Muslims and Hindu were less likely to achieve higher levels of education as compared to female children who were non-religious. This may suggest the impact of traditional gender roles, such as household work which may limit female children's opportunities to achieve higher levels of education. People who are Muslim and Hindu have the lowest years of formal education as compared to other religious groups and even those who were non-religious (Mitchell, 2016). However, Spizman and Kane (2020) found positive and significant coefficients for both males and females who enter religious organisations, such as Muslim, Hindu and Buddhist

b. Discussion for educational probabilities estimates

Children have a higher likelihood of achieving lower educational levels such as less than high school education as compared to achieving higher levels of education, such as an honours degree for all family structures. This may imply the lack of access to education and educational

resources for the children, which may limit their ability to reach higher educational levels. Our results were similar to Kane et al. (2010) who found higher educational probabilities for lower levels of education, such as less than high school diploma and high school diploma or GED. In 2023, about 62.7% of people living in South Africa were considered to be poor when using the upper-middle-income poverty line (World Bank, 2024). Hence, with such levels of poverty, households may have challenges in keeping up with the living standards in South Africa's upper middle-income society and providing enough educational resources for their children to reach higher levels of education. Our results were in contrast to studies, such as (Christensen, 2020; Spizman & Kane, 2020; Spizman, 2016; Kane et al., 2013) who found out that children were likely to achieve high school education as compared to other educational levels which were lower or higher. Looking at the context of their studies which were carried out in the USA, it was most likely that due to higher per capita incomes for USA households as compared to South African households, more children would likely achieve high school education.

On average, for all family structures, Black male and female children have the highest likelihood of achieving the lowest educational levels such as less than high school education, whilst having the least educational probabilities of achieving higher levels of education such as a bachelors and honours degree. On the other hand, White male and female children have the highest educational probabilities of achieving higher levels of education as compared to all other races, such as Blacks, Coloureds and Asian/Indians. This suggests that educational disparities continue to exist within the South African society. Although the South African government is trying to come up with inclusive policies in education, educational inequality is still rampant in the country (Gore & Botha, 2022). South African education is still influenced by the consequences of the apartheid era, where schools in the majority of White communities are well-resourced whilst other schools are under resourced (Amnesty International, 2020). Hence, the lack of access to quality education for other races, mainly Blacks, may result in the likelihood of achieving lower levels of education as compared to other races.

Furthermore, on average, male children are more likely to have the highest educational probabilities for different educational levels when living with both parents as compared to other family structures. This suggests the ability of the two-parent households to mobilise resources, to invest in the children's education. Kane et al. (2010) estimated that male children have the highest educational probability for high school or GED attainment when living with both parents. Parental ability in a nuclear family has the potential to provide motivation and

expertise to children, which will, in turn, assist in improving the children's educational attainment (Abuya et al., 2019). In addition, some of these South African households may still practice traditional gender roles such that more priority is given to the male child to pursue higher education since he will be considered as the future breadwinner.

Conversely, on average, female children are likely to achieve the highest educational probabilities for different educational levels when living without parents as compared to other family units. This may suggest that, due to the absence of traditional family expectations which may be anticipated in a two-parent household, female children may have the independence and freedom to pursue higher levels of education. Furthermore, of late, there has been considerable investment in girl child education through the provision of scholarships and conducive learning environments by the government and other international organisations to reduce gender inequality and extreme poverty. Through the World Bank education projects, over 150 million female children's educational outcomes are improving (World Bank, 2024). In addition, over the years, UNICEF, through the Girls Education Movement (GEM) in South Africa, assists female children with resources in both rural and urban areas to improve their educational outcomes (UNICEF, 2018).

c. Discussion for expected lifetime earnings estimates

Male children for all races living with both parents have the highest anticipated lifetime earnings as compared to other family structures, whilst male children for all races living with their mother have the lowest expected lifetime earnings as compared to other family structures. Families with both parents who live together have access to resources and can be financially stable as compared to other family structures. There are shared responsibilities by both parents in assisting children to achieve their full potential. Children have the advantage of continuous financial and moral support from both parents which could be important for their growth and development (Peterson & Rose, 2003). Parental care is an important determinant in the development of cognitive and non-cognitive abilities of children (Mao et al., 2020). On the other hand, male children who live with their mother only may face financial constraints which may limit their ability to acquire quality education, which is essential to have higher future earnings. Dorrit and Van der Stoep (2008) highlighted that due to a lack of resources mothers living only with children are less likely to enter the labour force. Some female-headed households are economically vulnerable as the female heads are more likely to earn low incomes and have less access to productive resources, such as capital and land (Julka & Das,

2015; Nwosu & Ndinda, 2018). Therefore, children in female-headed households may have less resources to achieve their full educational potential. In contrast, our results are different from what Kane et al. (2010) discovered. The paper found that male children have the highest expected lifetime earnings when a biological father is present, whilst the biological mother is deceased as compared to all other family structures.

The results of our research show that female children with the highest anticipated lifetime earnings are in contrast to the above results for male children. Female children for all races living without parents have the highest anticipated lifetime earnings as compared to other family structures whilst female children for all races living with their mother have the lowest expected lifetime earnings as compared to other family structures. Without parents, relatives take up the responsibility of the upkeep of the children. African societies put emphasis on the importance of communities (Amoateng et al., 2017). Hence, this may suggest important roles which extended relatives have toward the growth of female children in the absence of their parents. The absence of the mother as a female role model in the family negatively affects female children's potential for growth and ability to earn high expected lifetime earnings. In comparison, on average, Kane et al. (2010) found out that female children had the highest anticipated lifetime earnings when living with both parents.

White male and female children have the highest expected lifetime earnings as compared to the expected lifetime earnings of other children of other races for all family structures. At the same time, Black male and female children have the lowest predicted lifetime earnings as compared to other races for all family structures. This suggests the disparities which exist between racial groups in terms of their potential future earnings. The country's legacy of apartheid resulted in majority groups being marginalised in the access and ownership of resources which prompted high levels of social and economic inequality in South Africa (Chatterjee et al., 2020). Due to this aspect of the legacy of apartheid, it may take a long time before earnings and future earnings of different population groups are equalised. As shown in our results, children of other population groups were likely to have lower expected lifetime earnings as compared to children of White households.

d. Discussion for percentage penalty results

Our results show that if a father is absent in the family, male children of all races are likely to incur the largest loss in expected lifetime earnings as compared to the absence of the mother

and the absence of all parents. This shows the important role fathers have in raising their male children. Fathers who promote reading and other literacy habits in the family are likely to positively influence a child's ability to read (Clark, 2009). The lack of fatherhood with reading and literacy activities in the early years of male children can negatively affect their ability to reach higher educational attainment levels (Clark, 2009; Trent & Slade, 2001). Male children for all races are likely to have the lowest reduction in expected lifetime earnings when both parents were absent in the family. This suggests the importance of extended families in the development of male children, even in the absence of the parents. The role played by extended families, such as grandparents, is important as they canpass on their knowledge, cultural traits and skills to their grandchildren which could assist in their development (StatsSA, 2021a). Our results are in contrast to Kane et al. (2010), who found a higher percentage penalty loss in expected lifetime earnings if male children have an absent mother in the family.

On average, female children of all races are likely to sustain the largest loss in expected lifetime earnings if the mother was absent in the family as compared to other family structures. Female children of all races are likely to incur the largest percentage increase in expected lifetime earnings if both parents are absent in the family as compared to the absence of the mother or the father. Comparing male and female children in the absence of both parents, on average, female children will have a percentage increase in expected lifetime earnings, whilst for male children, they will incur percentage losses in their expected lifetime earnings. Resources from extended families can assist in the development of the child, especially if the child has a low socio-economic status background (Jaeger, 2012). In addition, female children will also likely incur a percentage increase in expected lifetime earnings if the father is absent in the family. This also suggests the important role of the mother towards the development of the female child. Mothers have a significant impact on the goals and self-perspectives of their female children (Rittenour et al., 2014). Our results are similar to Kane et al. (2010) who found a high percentage penalty loss in expected lifetime earnings if female children did not have or lived with their mother. However, the percentage losses in predicted lifetime earnings for female children in the absence of the mother, estimated by Kane et al (2010), are much higher than what we found in our paper.

4.10 LIMITATIONS OF THE STUDY

The study assumes stable historical relationships between educational outcomes and family background factors. However, factors such as changes in educational policies, shifts in returns

to education and accessibility of education can change this stable relationship. For instance, if education accessibility changes to policy changes or technological innovations in the delivery of education, then it means that our educational attainment probabilities may need adjustments to reflect such changes. Furthermore, our expected future lifetime earnings use historical education-earnings data, which may not be accurate in case there are major changes in the evolution of the labour market.

4.11 CONCLUSION

This chapter estimates educational attainment probabilities and expected lifetime earnings for minor children in South Africa. Our results show that, on average, children in South Africa were likely to achieve lower levels of education as compared to higher levels of education for all family structures. With that said, White male and female children have the highest educational probabilities and expected lifetime earnings as compared to other children who were Black, Coloured and Asian/Indian. In addition, male children living with both parents have the highest expected lifetime earnings as compared to other male children who lived in other family structures. On the other hand, female children living without parents have the highest expected lifetime earnings as compared to other female children who live in other family structures. Our results address our research questions of estimating compensation for minor children in South Africa, arising from if there were any racial and gender disparities in estimates for expected lifetime earnings, as well as revealing the differences in educational probabilities and expected lifetime earnings for minor children living in different family structures in South Africa. Overall, our paper provides an important dimension in providing estimates from a developing economy environment in modern-day South Africa. Furthermore, our paper contributes to the growing worldwide literature on predicting economic loss estimates for a minor child, to be used in court for cases where minor children are injured or have died due to the negligence of another individual.

CHAPTER FIVE

SUMMARY, POLICY RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

Analyses in forensic economics are vital in providing economic loss estimates if and/or when there is a personal injury or a wrongful death case to contend with. In addition, forensic economic estimates can prove to be very useful, especially to vulnerable groups in society who may require compensation when a personal injury or wrongful death of a relative or family member occurs. However, to date, studies that relate to and the use of estimates from forensic economic analyses are more common in developed countries as compared to developing countries. This reveals the need for the judicial systems in developing economies, such as South Africa, to embrace forensic economics and associated computation of economic loss estimates so that the courts could be viewed as also possessing the capacity to deliver fair and equitable judgments in litigations on personal injury and wrongful death.

5.2 SUMMARY OF FINDINGS

Our thesis is centred on estimating lost earnings from personal injury or wrongful death in South Africa. In this regard, our thesis achieved three major objectives:

- An exploratory estimation of work-life expectancies across labour market states and future lost earnings in formal and informal employment in South Africa (Chapter Two).
- Assessing and computing personal consumption rates, should there occur cases of wrongful death of single-female parents with one child and single-female parents with two children in South Africa (Chapter Three).
- Estimating educational attainment probabilities and expected lifetime earnings for South African minor children (Chapter Four).

In Chapter Two, we estimate work-life expectancies across labour states and future lost earnings in formal and informal employment in South Africa. Specifically, our paper employs a four-state model—formally employed, (FE), informally employed (IE), Unemployed (UE), and Economically inactive (ECONI)— to estimate work-life expectancies. The four labour states are, in the first instance, estimated using the multinomial probit model to generate sixteen

(16) transitional probabilities. A recursive process in Stata, using these transition probabilities, is then implemented backwards, from the terminal year or final year to the initial age of 16 to obtain the work-life expectancies' estimates, from the age of 16 to 65 years per labour state. Furthermore, estimates of the work-life expectancies, categorised by gender, race and education are presented. In the final stage, the estimated work-life expectancies are employed to estimate future lost earnings—males and females who were formally employed, males and females who are informally employed from the ages of 16 to 65—using the widely accepted formulae (Lewis et al., 2003).

Our results show that work-life expectancies for formally employed male workers are higher as compared to work-life expectancies for formally employed female workers, for all races and educational levels. These results show a disproportionate advantage in opportunities for males as compared to female workers in formal employment. By contrast, informal employment shows variations in work-life expectancies across gender, race and education. Our results show that, on average, females are more employed in informal employment as compared to their male counterparts, for all races and education levels. This suggests that more flexible job opportunities may be available for women in the informal sector as compared to the formal sector.

Furthermore, our results reveal that males and females with higher education have higher work-life expectancies as compared to males and females who had lower levels of education in formal employment. Our results reflect on the importance of education in influencing work-life expectancies in formal employment. In contrast, for informal employment, the results illustrate that there are lower work-life expectancies for male workers with a higher education in the informal economy as compared to male workers in the informal economy with less education. Female work-life expectancies for those aged 20 to 50 years are higher for those with college degrees and above as compared to those with a lower education of high school with some college.

Furthermore, in the case of formal employment, the White male and female population seem to exhibit higher work-life expectancies, on average, as compared to other population groups. The longer work-life duration for the White population may be due to higher wages, career opportunities and job satisfaction as compared to other population groups. On the other hand, for informal employment, our results show fluctuations in the population group with the highest work-life expectancies over different ages. On average, White male population who are

informally employed have the highest work-life expectancies as compared to other races for young adults (20-34), while Asian/Indians male have work-life expectancies which are the highest for the middle aged (35-49) and the Coloured male population have the highest work-life expectancies as compared to other population groups for those old aged workers (50-65). For informally employed female workers, White female work-life expectancies are the highest from the young adults to middle-aged workers, while Asian/Indian female work-life expectancies are the highest as compared to other population groups, for workers who are middle to old aged. On average, Black male and female populations have the lowest work-life expectancies for formal and informal employment as compared to other population groups.

Our estimates also reveal higher work-life expectancies for both males and females who were formally employed as compared to other labour states, such as those who are informally employed, unemployed and those who are economically inactive. This highlights the idea that formal jobs may be more stable and less precarious compared to other employment types. Formal employment has employment benefits which motivate employees to increase their work-life duration.

The analyses also show that male workers who were formally employed have the potential for higher future lost earnings, compared to female workers who are formally employed. Our results showed the gender wage gap which exists between male and female workers in formal employment. Of interest in the informal sector is that, although female workers have higher work-life expectancies as compared to male workers, female workers have lower future lost earnings as compared to male workers. This highlights generally that male workers earn higher incomes as compared to female workers in the informal sector.

Our results also reveal that male and female future lost earnings increase as age increases, reach a peak at a particular age, then starts to decline as workers attain retirement age. In addition, there are different peak levels of future lost earnings for male and female workers in formal and informal employment. Male and female workers in formal employment have peak future lost earnings at 43 years and 42 years respectively, whilst male and female workers in informal employment have a peak future lost earnings at 39 years and 37 years, respectively.

In Chapter Three, we estimate personal consumption rates which can be used to calculate future lost earnings in case there is a wrongful death case in South Africa. We use microdata of the National Income Dynamics Survey (NIDS) to allocate expenditure using the expenditure

allocation rules. Expenditures are allocated accordingly to a particular household member since there are divisible, indivisible and fixed expenditures. Six expenditure categories, which are female expenditure, family shared expenditure, food shared expenditure, utilities, semi-divisible expenditure and medical insurance, are obtained, using the expenditure allocation rule. Furthermore, using the NIDS dataset for wave 5 (2017), mean household income is computed to obtain five household income brackets, which are a) R60k-119.9k b) R120k-237.9k c) R238k-419.9k d) R420k-R719.9k e) R720k and over. Five average personal consumption rates are then computed for single-female parents with one child and single-female parents with two children, by dividing the total expenditure of the six expenditure categories by the mean household income, per income bracket. In addition, using the linear log regression model, we calculate smoothed personal consumption rates (PCRs) for 35 household income levels from R100,000 to R3,500,000. Any value within the initial five household income brackets could be used to produce smoothed PCRs, however, we select 35 specific household income levels which we observe could provide evenly distributed PCR values for the whole range of income values. This random selection of specific income values is consistent with how Krueger (2014) and Krueger (2007) selected their specific income values. To investigate the influence of household income on the difference of PCRs between single-female parents with one child and single-female parents with two children, we estimate the PCR differences of the two groups using the log-log regression model. Lastly, we estimate the effect size of the difference in PCRs within the single-female parent with one child and single-female parent with two children groups and between different income groups of the single-female parents' households.

Our results show that as household income rises, the PCRs for both single-female parents with one child and single-female parents with two children decrease. As household income increases, single parents would rather invest or save the additional income than consume it. Furthermore, we found that PCRs for single-female parents with one child are higher as compared to PCRs for single-female parents with two children. However, the magnitude or size of the differences between the PCRs of the two groups is large. Moreover, as household income increases the difference in personal consumption rates between single-female parents with one child and single-female parents with two children widens. In addition, we find a large difference in the PCRs of low versus middle versus high income groups since our Cohen's d results show a large effect size in PCRs of the three income groups. Lastly, we find that

personal consumption rates in developed countries are higher as compared to those personal consumption rates in developing countries.

In Chapter Four, using the ordered probit model with cluster robust standard errors regression technique, we estimate educational attainment probabilities and expected lifetime earnings for minor children in South Africa. The dependent variables are child educational attainment, and the independent variables are race, mother's education, father's education, province, language, and religion. We use the thresholds or cut-off points from the regressions together with the educational probabilities' formulae for five educational levels. The five educational levels in our paper are: (1) less than high school, (2) high school (3) certificates and diplomas (4) Bachelor's degree and (5) Honour's degree. Educational probability estimates are by gender (male and female) and by race (Black, White, Coloured and Asian/Indian) and per family structure (living with both parents; living with the mother; living with the father and living without parents). We calculate median earnings of the five educational levels from the General Household Survey of 2022 and multiply them with the real growth rate, work-life expectancies and fringe benefits percentage to generate lifetime earnings per educational level. We then multiply these lifetime earnings by educational probabilities per educational level, per gender, per race and per family structure, to produce the expected lifetime earnings for minor children.

Our results show an association between parents' educational attainment and a minor child's academic achievement. This is shown in the results of the ordered probit model with cluster robust standard errors regression where results reveal that a male or female minor child is likely to have a higher likelihood of achieving a higher level of education if they have a mother or father with any other higher educational level other than less than high school education which was the reference educational level. In addition, our ordered probit model with cluster robust standard errors regression shows that male minor children who are Christian and Black traditionalist, have a higher probability of achieving higher educational attainment as compared to male children who are non-religious, while female minor children who were Muslims and Hindu, are less likely to achieve higher levels of education as compared to children who are non-religious. Male minor children who were Christian and Black traditionalist had significant positive coefficients of 0.258257 and 0.23545 respectively whilst female minor children who were Muslim and Hindu had significant negative coefficients of -1.40828 and -0.95454 respectively.

Our results for educational probabilities show that, on average, male and female children are likely to achieve lower educational levels, such as less than high school education, as compared to achieving higher levels of education, such as an honour's degree for all family structures. Furthermore, on average for all family structures, Black male and female children have the highest likelihood of achieving the lowest educational levels, such as less than high school education whilst having the least educational probabilities of achieving higher levels of education, such as a bachelor and honours degree. White male and female children have the highest educational probabilities of achieving higher levels of education, as compared to all other races such as Black, Coloured and Asian/Indian.

In addition, on average, male children are more likely to have the highest educational probabilities for different educational levels when living with both parents as compared to other family structures. In contrast, on average, female children are likely to achieve the highest educational probabilities for different educational levels when living without parents, as compared to other family units. Without a traditional family structure, female children may be provided with the leeway (by extended families) to achieve higher levels of education. In contrast, male children who live with both parents are more likely to thrive and achieve higher levels of education due to the presence of support and resources.

Moreover, we find that White male and female children have the highest expected lifetime earnings as compared to the expected lifetime earnings of other children of other races for all family structures. Black male and female children have the lowest predicted lifetime earnings as compared to other races for all family structures. This reveals disparities which exist between racial groups in terms of their potential future earnings. Furthermore, male children of all races are likely to incur the largest loss in expected lifetime earnings if the father is absent in the family, as compared to the absence of the mother and absence of all parents. On the other hand, female children of all races are likely to incur the largest increase in expected lifetime earnings if both parents are absent in the family as compared to the absence of the mother or father.

5.3 IMPLICATIONS AND POLICY RECOMMENDATIONS

a. Chapter Two

Our findings that for all races, work-life expectancies for male workers are higher as compared to female work-life expectancies for those who are formally employed, reveal persistent gender inequalities which exist in the South African labour market. As discussed in earlier sections,

men have more opportunities as compared to women, and women have more household and social responsibilities. Hence, the gender imbalances in formal employment. Gender inequality results in the under-utilisation of human capital and a low labour force participation rate for women in formal employment. Hence, policy makers need to promote policies that create a sustainable work-life balance, such as subsidising child care activities or programmes and allowing more options of working from home. This allows more inclusion and integration of women into formal employment, thereby increasing their work-life duration.

By contrast, we find that, on average, female workers have higher work-life expectancies in informal employment as compared to male workers. This may imply that, due to social expectations, women are more flexible and adaptable in informal employment as compared to their male counterparts. Although female workers have a longer work-life duration, informal employment has fewer social protection programmes which provide medical insurance, retirement packages or compensation against injuries at work. Hence, this provides a risk to their work safety and health in the informal sector. We recommend that policy makers need to expand the compensation fund to include informally employed workers to cater for a large pool of workers who are contributing to economic development. In this way it would assist and limit the risks associated with female workers who have longer work-life durations in informal employment but no protection. In addition, there is a need for policymakers to fast-track regulating the informal sector to provide occupational and safety laws as well as labour laws, which promote fair employment compensation for those who work in informal employment.

However, it is important to note, as well, that the fast track regulating of the informal sector can also have unintended consequences. Formalising the informal sector may lead to the vanishing of some informal jobs which were doing well in the absence of labour regulations. In this regard, in the short term, the introduction of labour regulations could result in employment losses, especially for vulnerable groups who may have relied on informal work for survival. Hence, any strategy to regulate the informal sector needs to be carefully weighed against the potential risks of displacing informal workers. A step-by-step gradual approach could help mitigate these risks by having labour protections while also spearheading the transition of informal businesses to the formal sector. Furthermore, complementary policies such as the provision of access to credit and simplifying business registration procedures could also help reduce disruptions in employment.

Our result that male and female workers with higher education have higher work-life expectancies as compared to those male and female workers with lower education in formal employment, reveals the significance of education in labour market dynamics. Education is correlated to productivity; hence, employees are likely to be remunerated with higher wages by their employers if they have higher education (Chevalier et al., 2004). With higher wages and compensation, workers are likely to work for longer durations in formal employment. We recommend policy-makers to have policies which expand access to quality and affordable higher education to individuals in South Africa. Although South Africa has a large public spending on education, its educational outcomes are poor with one of the reasons being discrimination and inequality in educational access (Mlachila & Moeletsi, 2019).

In addition, one of our findings is that older male workers above 60 years who have the higher education of a college degree and above, and are in formal employment, have lower work-life expectancies as compared to older male workers above 60 years who have the lesser education of only high school and some college education. This implies that male workers who are highly educated may gain financial security earlier in their careers, such that a few of them would remain employed at an older age. This is in contrast to male workers with lower levels of education who might continue working in old age due to lower wages and opportunities over their lifetime careers. There is a need for the government to provide education and training programmes to workers at every level of their productive years in employment, to create more skilled workers who, in turn, will have create financial stability early before they retire. In South Africa, low educational attainment due to challenging learning conditions has resulted in unequal outcomes in labour (Reddy & Mncwango, 2021).

Another result of our paper shows that, on average, highly educated male workers have lower work-life expectancies as compared to male workers with less education in the informal sector. On the other hand, on average highly educated female workers have higher work-life expectancies in the informal sector as compared to the less educated female workers. This implies that there is a mismatch between the skills of the highly educated male workers and the opportunities which are available in the informal sector. Furthermore, the informal sector may not provide enough job satisfaction to male workers, who are highly educated, such that they end up looking for opportunities elsewhere. Since women are more prominent than men in the informal sector, highly educated women can utilise their skills and knowledge to increase productivity and growth, such that they could work longer in the informal sector. We

recommend that the government access innovative finance, which will attract highly educated workers to embark on entrepreneurial initiatives. Formal employment may be saturated with many highly educated people being unemployed. Hence, access to innovative finance can attract these highly educated workers to the informal sector and contribute towards the development of the informal sector. In the first quarter of 2023, about one in every three graduates in South Africa between the ages of 15 to 34 were unemployed (Khumalo, 2024). Furthermore, access to innovative finance will also assist female workers who are highly educated to capacitate their skills for growth and development in the informal sector.

Our result that the White male and female population has higher work-life expectancies on average as compared to other population groups implies that there are continuous racial disparities in the South African labour market. There is a persistent relation to the issue of race to poverty in South Africa, with the White population earning higher earnings as compared to other races (Burger & Jafta, 2006). Furthermore, such racial disparities result in long-term adverse economic consequences, such as widening wealth gaps between the White population and other population groups. There is a need for the government and the private sector to provide skills development programmes which are targeted to the minority groups to reduce skills gaps, increase their earnings and longevity in the workplace. It is also important for the government and the private sector to enforce anti-discriminatory practices and policies in the workplace. Discriminatory practices may exist in salary grades and payments and even in hiring workers and there is need for transparency in human resource processes.

We find that population groups with the highest work-life expectancies in informal employment vary for both male and female at different age levels with Blacks having the lowest work-life expectancies for both male and female. This reveals the economic disadvantages which the Black population group has in the informal market as compared to other population groups. Blacks have less capacity in terms of resources and capital to be productive entrepreneurs or to be productive employees in the informal sector as compared to other population groups. Blacks face high levels of poverty and lack of financial resources as a result of systemic policies implemented during the apartheid era (McGhie & Keim, 2017). Furthermore, this could have future intergenerational implications for the Black population as lower work-life expectancies reflect lack of resources, hence low future incomes and growth. We recommend that the government and the private sector provide financial and technical support to Black workers in the informal sector so that they can become incentivised to be

productive and to work longer in the informal sector since they have support from the relevant stakeholders.

We find that work-life expectancies for both males and females who were formally employed are higher, as compared to other labour market states, such as informal employment, unemployment and economically inactive. This implies that the formal sector in the economy has better social security and health insurance, which enables workers to have longer work-life durations. In formal employment, there are formalised work safety regulations which prevent workers from sustaining life-threatening workplace injuries. Moreover, if they are injured, there is health insurance that will cover treatment at the hospital for such injuries. Hence, the work-life span for formal employees is longer as compared to informal workers. The absence of regulations of workplace safety in the informal sector place most informal workers at the risk of occupational hazards (Bamu-Chipunza, 2018). We recommend policymakers to speed up the process of formalising the informal sector and safety regulations that protect informal employees from the risk of occupational injuries.

Another important result of our paper shows that future lost earnings for male workers who are formally and informally employed are higher as compared to future lost earnings for female workers who are formally and informally employed. This implies that there will most likely be continuous economic inequality in the labour market based on gender shortly due to differences in future lost earnings. The gender wage gap continues to widen in South Africa as women occupy positions which have low salaries in highly skilled sectors (Pleace et al., 2023). In addition, although a man and a woman may incur the same personal injury or wrongful death, there is likely to be systemic bias in terms of the calculation for compensation due to the gender wage gap which exists in the labour market. There is a need for the government and the court system to come up with guidelines which are standardised and consider the disparities in gender wages. In addition, there is need for accuracy and transparency in how compensation damages are estimated by forensic economists in court cases removing the aspect of gender bias in incomes as well.

To buttress the above paragraph, our paper finds that men have higher peak years of future lost earnings as compared to women. Men's peak age of future lost earnings in formal and informal employment is 43 years and 39 years, respectively. On the other hand, women's peak age of future lost earnings in formal and informal employment is 42 years and 37 years respectively. Men and women's future lost earnings start to fall after the peak age of earnings. This reflects

that women are likely to be poorer in the future as compared to men due to lower future lost earnings and lower peak years of future lost earnings. Hence, even when it comes to compensation for personal injury or wrongful death, women and their relatives are likely to be at an economic disadvantage since they are estimated to have lower future lost earnings, which also decline more than men's future lost earnings as age increases after the peak ages. We recommend the government and court systems implement effective checks and balances in the justice system to remove income inequality in compensation as a result of gender biasness.

b. Chapter Three

Here, we find that as household income rises, personal consumption rates (PCRs) for single-female parents with one child and single-female parents with two children decrease. Our findings imply high compensation (future lost earnings) for the survivors of high-income earners as compared to low-income earners. This is because the percentage of income consumed by the deceased (in this case, the single-female parent) is deducted from total income, such that the smaller the percentage of income consumed, the larger the compensation to survivors (in this case, the children) of a wrongful death of the parent. However, civil court judgements in South Africa take many years to complete due to reasons such as lack of adequate resources and the complexities involved in court proceedings (Rensburg & Clasquin-Johnson, 2023). Hence, we recommend that the government assist the judicial systems to capacitate through training and the recruitment of relevant professionals, such as forensic economists, who can provide compensation estimates in civil cases.

Another important finding is that PCRs for single-female parents with one child seem higher as compared to PCRs for single-female parents with two children. Furthermore, our Cohen's d results reveal that there is a large magnitude between the differences in PCRs of single parents with one child and single parents with two children. This shows that there is more consumption of income by the single-female parent with one child as compared to the single-female parent with two children. It could be the case that the single-female parent may face budgetary limits or constraints of spending a significant portion of income on consumption because of more responsibilities to take care of the two children. At the same time, this prompts the single-female parent with two children to find more income generation activities, such as savings, employment in multiple jobs, to sustain the larger family. In addition, more savings mean less current consumption, but the parent may smoothen their consumption over time. Furthermore, since the effect size is large, it implies that, in absolute terms, more compensation may be

available to survivors (two children) of the deceased single-female parent, as compared to the survivor (one child) of the other deceased single-female parent in case there is a wrongful death case.

We recommend for the government to increase family support programmes which assist single-female parents, in particular with financial support and subsidised services to sustain their households. In this way, single-female parent households will have more income for their household development, with more future lost earnings being available to the children in case their single-female parent is involved in a wrongful death.

Moreover, we find that as household income increases, the difference in personal consumption rates between single parents with one child and single parents with two children widens. For both groups, as revealed in our previous results, as household income increases, both single-female parents will likely save more. However, there are differences in savings rates, with the differences in personal consumption rates widening between the two groups as income increases. This implies differences in investment priorities between the two household groups. More investments may be channelled towards her children by the single-female parent with two children as household income increases, whilst for the female parent with one child, some investment will go towards the upkeep of the child, with some investments going towards other activities. We recommend for the government to continue expanding their tax incentives on retirement accounts in both the formal and informal sectors to specifically assist the single-female parent households to save more. In this way, single-female parents who are in formal and informal employment are able to invest in the current and future development of their children. The South African government has, over the years, carried out tax incentives to promote pension savings for retirement (Redonda et al., 2021). However, such reforms or programmes are not inclusive to the majority of people in the economy (Nhabinde & Schoeman, 2008).

A further result of our paper is that we find that there are substantial differences in the PCRs of low versus middle versus high income groups. We find that the largest difference in PCRs are for the low versus high income groups. This implies that there are disparities in wealth accumulation between the two income groups in South Africa. This can have a ripple effect in terms of intergenerational wealth, whereby households of low-income groups may fail to pass on sustainable wealth and resources to their children. Wealth inequality is persistent in South Africa with about 1% of the population having ownership of 50% of the wealth in the country

(Fortuin et al., 2022). Moreover, children from low-income households are likely to receive less compensation for the wrongful death loss of their parent as compared to children from high-income households. Hence, we recommend that policymakers continue carrying out labour market reforms that are aimed at higher the minimum wage over time to provide more substantial incomes for low-income groups. Furthermore, there is a need for the government and banks to provide micro-financing initiatives to low-income households who have small businesses, and are entrepreneurs both in the formal and informal sectors, to facilitate productivity and income growth.

c. Chapter Four

We find that children are likely to achieve advanced academic achievements if their parents have higher education from high school to a bachelor's degree. This implies that educational investment in a household can have a multiplier effect where parents with knowledge invest more in their children's education, resulting in the children earning higher future earnings over time. School and parental inputs are important in shaping a child's educational outcomes (Rabe, 2019). Hence, we recommend government to encourage education not only to children but to their adults through creating programmes such as the parent or adult educational programmes which equips adults with knowledge. In this way, parents who have the knowledge are likely to be able to invest in their children's growth and education as well as benefiting the society in the long run with highly skilled workers who earn high salaries.

In addition, we find that male children who are Christians and Black traditionalists have a higher likelihood of achieving higher educational attainment as compared to male children who are non-religious. In contrast, female children who are Muslims and Hindu are less likely to achieve higher levels of education as compared to female children who are non-religious. This implies there is likely to be disparities in future living standards of children of different religious groups due to differences in educational attainment. Educational attainment increases efficiency in human capital, productivity of communities and the reduction of poverty in families (Alali, 2011). We recommend that the government officials to carry out outreach programmes which are targeted to religious groups to educate them on the importance of children going to school. Furthermore, the government and private sector needs to provide suitable learning environments for children of different religious groups to continue motivating and attracting them to achieve educational attainment.

Furthermore, we find that children in South Africa are likely to achieve lower educational levels of education such as higher school education as compared to achieving higher levels of education such as an honours degree or above. This implies that we are likely to have a society with workers who have low skills and are unable to be employed in high-paying jobs. This translates to households living with low levels of income and high levels of poverty. Although South Africa has a large expenditure budget on education, the country has poor educational outcomes as compared to other middle- and lower-income countries (CDE, 2023). We recommend the government should subsidise education and increase easily accessible scholarships up to college level to encourage children from low-income families to further their education.

Our results reveal that, on average, for all family structures, Blacks have the highest likelihood of achieving the lowest level of educational attainment, with the least likelihood of achieving high educational attainment. Whites have the highest likelihood of achieving higher levels of education as compared to other races. This implies that differences in education may lead to persistent disparities in income between population groups in South Africa. In addition, if the necessary policies measure are not put in place, the country will continue having job segregation in the labour market, with over-representation of population groups, which have low educational attainment in low-level jobs. South Africa's economic benefits are only concentrated to a small percentage of people (McKeever, 2023). We recommend that the government expands early childhood programmes, mainly to disadvantaged population groups to sensitise children of all backgrounds early, on the importance of education. Furthermore, there is need for the government, private sector and donors to equip all under resourced schools in the country with standard educational materials and other resources to allow all children to have equal opportunities to learn and develop.

The results of our paper indicate that male children are likely to have the highest educational probability for different educational levels when living with both parents, whilst female children are likely to have the highest educational probabilityies for different educational levels when living without parents. This implies that in South Africa family structure which a child lives in, is an important indicator in determining educational attainment with male children more likely to benefit in traditional families as compared to female children. A family's composition together with economic, social and behavioural factors have an impact towards the life outcomes of children (Hampden-Thompson, 2013). There is need for schools,

government and the private sector to invest educational resources and mentoring programmes in schools and households targeting all children to encourage learning despite the family background of the children.

We find that male children living with both parents have the highest lifetime earnings as compared to other family structures, whilst female children living without parents have the highest lifetime earnings as compared to other family structures. One common aspect is that male and female children living with their mother only have the lowest expected lifetime earnings as compared to other family structures. Hence, this implies that it is likely that children from female-headed households will continue to be economically vulnerable as compared to children of other family structures. Gender inequality, which exists in labour markets, is a major determinant of women's vulnerability to poverty (Boudet et al., 2018). Furthermore, in case of a wrongful death or personal injury, children will likely get the lowest compensation if the mother dies. This implies that such households will continue experiencing intergenerational poverty and inequality as compared to other family structures. We recommend that the government and donor organisations embark on family support programmes which target especially female-headed households, since they are the most vulnerable. These family support programmes need to be concentrated on capacitating both the children and mother, such as providing easy access to educational infrastructure and resources to children as well as providing financial and technical support to women to develop sustainable businesses. Besides women who are informally employed, women who are formally employed can also be vulnerable, hence, having entrepreneurial skills and sustainable businesses of their own are important for the growth and development of female headed households.

We find that White male and female children have the highest expected lifetime earnings as compared to the expected lifetime earnings of other children of other races for all family structures. This implies that there is systemic and intergenerational income inequality in the country, which affects even minor children who are not yet economically active. Years after apartheid ended in South Africa, the country ranks as one of the most unequal countries compared to other countries in the world (Makgetla, 2020). We recommend that the government embark on social and economic programmes which will reduce the systemic and intergenerational income inequality in the country. There is a need for the government to implement labour policies which will promote racial diversity in high- earning positions in companies, such as managerial posts. There is a need for the government to conduct educational

reforms, which will provide quality education to children. Quality education enables children to be more competitive in the labour market. These measures among others can assist in improving the quality of life for both Black minor children and parents, which will also improve expected lifetime earnings, as well as in cases where there is a wrongful death or personal injury to the minor children. Furthermore, it is also important for the court systems to address racial disparities when dealing with civil litigation cases which need to provide compensation for minor children and family.

We find that male children are likely to incur the largest loss in expected lifetime earnings if the father is absent in the familym whilst female children are likely to have a loss in expected lifetime earnings if the mother is absent in the family. This implies the importance of gender specific roles from parents in the development of their children's education and careers. When looking at the nature of several Black societies which are traditional and conservative, fathers and mothers have important roles in shaping the skills and knowledge of their male and female children respectively. Parents play an important role in the development and education of their children (Ceka & Murati, 2016). Hence, we recommend the government and court systems to facilitate and implement co-parenting support and mentorship programmes, which will assist in the development and growth of the children, especially for households which have single parents.

We find that male children of all races are likely to have the lowest reduction in expected lifetime earnings when both parents are absent in the family. In addition, female children experience their highest increase in expected lifetime earnings if both parents are absent in the household. Extended families have an important role towards the growth and development of both male and female children. Extended families can be very important in terms of human capital accumulation for children in their early lives (LaFave & Thomas, 2014). We recommend government to strengthen social safety nets, such as expanding on existing social grant programmes to provide resources to households, especially extended families who are raising up their relatives' children.

5.4 LIMITATIONS OF THE STUDY

Although in our three papers we managed to have sample sizes which are suitable for regression and analysis, our study has data limitations due to the nature of the NIDS dataset. For instance, in Chapter Two, due to attrition in the NIDS dataset, our estimations of transitioning workers

moving from one state of employment to another were affected. For example, when an individual was not available in the next wave of the NIDS dataset, we had to drop that individual. Hence, due to this issue, our dataset was reduced in size. However, the sample sizes of the three papers were sufficient to address our research questions and produce statistically meaningful estimates.

Furthermore, our thesis uses the NIDS dataset from the period of 2008 to 2017. The limitation is that certain economic, social factors may change over time, such that recent data would provide more information for forensic economic estimations. However, the NIDS dataset from 2008 to 2017 is the sufficient longitudinal dataset available to carry out our study in forensic economics. It provides the essential variables for use to estimate economic losses. The other NIDS dataset ,which was conducted by StatsSA during the COVID-19 period of 2019 to 2021, does not have sufficient labour market and household variables to conduct our study. The issue of data constraints has been a major problem which researchers who are studying the economies of developing countries have faced.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

Future research on forensic economic estimates in South Africa could be done using a more recent longitudinal dataset if it becomes available. StatsSA is one of the main research institutes in South Africa which conducts surveys on the economic well-being of South Africans. A future longitudinal dataset can provide more information, which may be relevant in estimating economic loss estimates for personal injury and wrongful death scenarios. Furthermore, further research can be done in terms of estimating economic losses for other employment types. Studies can be done in estimating work-life expectancies and future income loss for full-time vs part-time employment. Although this study was only done once in the United States by Krueger (2006), it would provide interesting dynamics and results if such an analysis was done using the South African labour data to reveal some of the nuanced differences in work-life expectancies and economic loss estimates which may exist.

In addition, we hope that our study provides a starting point for more research to be done on other economic loss estimates in the developing country context. Besides economic loss estimates on lost earnings, which were the centre of our thesis, there are other estimates, such as lost earnings capacity, medical expenses, lost household services and lost enjoyment of life, which have not yet been done. Research on these economic loss estimates are important, as

they reveal a different spectrum of compensation, which needs to be awarded to individuals who are victims of personal injury or wrongful death. Hence, we recommend studies into other economic loss estimates to unpack important estimates, which can later be used in court systems for compensation.

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Appendix A

a. Male work-life expectancies used in chapter four.

The work-life expectancies highlighted in yellow are used in chapter 4 to determine labour market entry in tables 4.23 and 4.24. WLEa- stands for "being active in the labour force"; WLEia-stands for "being inactive".

	less than high school		High school		certificate and diploma		Bachelor's degree		Honours	
age	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia
16	34.48975	33.24348	38.64807	38.065676	42.22599	41.657198	46.96404	45.305717	49.05899	43.84948
17	32.97052	31.72425	36.30275	35.720356	40.85258	40.283788	44.13343	42.475107	48.14912	39.54192
18	31.48201	30.23574	34.97864	34.396246	39.41068	38.841888	42.49883	40.840507	47.47921	36.09502
19	30.06762	28.82135	34.76284	34.180446	38.76089	38.192098	40.89865	39.240327	47.39948	33.19924
20	28.59372	27.34745	34.38341	33.801016	36.10882	35.540028	40.11956	38.461237	45.40875	30.30431
21	26.9636	25.71733	33.48346	32.901066	35.121751	34.552959	39.64948	37.991157	43.52341	26.18318
22	25.36235	24.11608	32.38943	31.807036	33.027721	32.458929	38.13069	36.472367	41.37063	26.6143
23	24.17637	22.9301	30.6168	30.034406	31.255091	30.686299	32.11317	30.454847	39.74822	24.75527
24	22.70274	21.45647	28.69151	28.109116	29.329801	28.761009	31.46678	29.808457	38.0652	23.64738
25	21.17782	19.93155	26.87972	26.297326	27.518011	26.949219	30.76557	29.107247	36.94609	20.63918
26	19.90081	18.65454	25.17149	24.589096	25.809781	25.240989	30.10089	28.442567	35.60533	19.18003
27	18.72879	17.48252	23.70091	23.118516	24.339201	23.770409	29.5741	27.915777	34.24776	18.02804
28	17.56805	16.32178	22.25961	21.677216	22.897901	22.329109	29.25405	27.595727	33.18521	17.6275
29	16.54657	15.3003	21.03483	20.452436	21.673121	21.104329	28.77357	27.115247	31.96228	16.9418
30	15.47524	14.22897	20.02428	19.441886	20.662571	20.093779	28.15813	26.499807	30.57277	15.67202
31	14.50046	13.25419	18.88817	18.305776	19.526461	18.957669	27.73595	26.077627	29.54348	13.58238
32	13.36751	12.12124	18.0551	17.472706	18.693391	18.124599	27.15212	25.493797	28.16904	12.53263
33	12.64055	11.39428	17.50251	16.920116	18.140801	17.572009	26.59668	24.938357	27.09874	10.63548
34	12.10122	10.85495	16.9791	16.396706	17.617391	17.048599	26.02345	24.365127	25.98167	9.916761
35	11.35669	10.11042	16.2735	15.691106	16.911791	16.342999	25.47221	23.813887	24.9008	9.276741

36	10.61821	9.37194	15.51877	14.936376	16.157061	15.588269	25.08411	23.425787	24.12022	8.585341
37	10.09002	8.84375	14.86224	14.279846	15.500531	14.931739	24.96	23.301677	23.24219	7.477237
38	9.528925	8.282655	14.00853	13.426136	14.646821	14.078029	24.93189	23.273567	22.31643	6.941734
39	8.913431	7.667161	13.05861	12.476216	13.696901	13.128109	25.22514	23.566817	21.49144	6.421817
40	8.422375	7.176105	12.20823	11.625836	12.846521	12.277729	24.47968	22.821357	20.6333	5.568844
41	7.879022	6.632752	11.25241	10.670016	11.890701	11.321909	23.8833	22.224977	19.79839	5.560615
42	7.287935	6.041665	10.36425	9.781856	11.002541	10.433749	23.16551	21.507187	19.29538	5.097754
43	6.704611	5.458341	9.478078	8.895684	10.116369	9.547577	22.37554	20.717217	18.41916	4.940538
44	6.273925	5.027655	8.753971	8.171577	9.392262	8.82347	21.41933	19.761007	17.56489	4.618168
45	5.867223	4.620953	8.036025	7.453631	8.674316	8.105524	20.49938	18.841057	16.5573	4.31315
46	5.377763	4.131493	7.27442	6.692026	7.912711	7.343919	19.70405	18.045727	15.49328	4.010059
47	4.924454	3.678184	6.590211	6.007817	7.228502	6.65971	18.29184	16.633517	14.61381	3.565936
48	4.485669	3.239399	6.187967	5.605573	6.826258	6.257466	16.81294	15.154617	13.81541	3.348034
49	4.043669	2.797399	5.892677	5.310283	6.530968	5.962176	16.29037	14.632047	13.16255	3.146085
50	3.694836	2.448566	5.372406	4.790012	6.010697	5.441905	15.54263	13.884307	12.36428	2.707685
51	3.402585	2.156315	4.877323	4.294929	5.515614	4.946822	14.58765	12.929327	11.37617	2.544666
52	3.054821	1.808551	4.283708	3.701314	4.921999	4.353207	13.61463	11.956307	10.51458	2.229334
53	2.760759	1.514489	3.819097	3.236703	4.457388	3.888596	12.90679	11.248467	9.779884	2.100195
54	2.45092	1.20465	3.460291	2.877897	4.098582	3.52979	11.72769	10.069367	8.953127	1.961157
55	2.198225	0.951955	3.077371	2.494977	3.715662	3.14687	10.33317	8.674847	8.157736	1.863766
56	1.927727	0.681457	2.765647	2.183253	3.403938	2.835146	9.424159	7.765836	7.299014	1.660077
57	1.723268	0.476998	2.409062	1.826668	3.047353	2.478561	8.402634	6.744311	6.525262	1.514475
58	1.493519	0.247249	1.947903	1.365509	2.586194	2.017402	7.119531	5.461208	5.732619	1.429865
59	1.265146	0.213452	1.606891	1.024497	2.245182	1.67639	5.991883	4.33356	5.004197	1.30937
60	1.035757	0.210513	1.330383	0.747989	1.968674	1.399882	5.013675	3.355352	4.287015	1.199499
61	0.867103	0.209166	1.120041	0.537647	1.758332	1.18954	4.068599	2.410276	3.57029	1.100676
62	0.674086	0.191837	0.8854355	0.3030415	1.5237265	0.9549345	3.091289	1.432966	2.778691	0.8948773
63	0.495054	0.183465	0.6357012	0.29762	1.2739922	0.352002	2.187945	0.529622	1.989943	0.6812663
64	0.303753	0.179823	0.4024212	0.294323	1.0407122	0.3419202	1.264542	0.429832	1.158233	0.4378376
65	0.285168	0.156536	0.3768741	0.284628	0.4251651	0.3363731	0.4392108	0.413742	0.4698329	0.4276943

b. Female work-life expectancies used in chapter four.

The work-life expectancies highlighted in yellow are used in chapter 4 to determine labour market entry in tables 4.23 and 4.24. WLEa- stands for "being active in the labour force"; WLEia-stands for "being inactive".

	less than high school		High school		certificate and diploma		Bachelor's degree		Honour's degree	
age	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia	WLEa	WLEia
16	33.57857	33.141289	35.35766	35.037839	37.82117	37.417441	38.53344	37.67094	42.25919	41.149979
17	33.29409	32.856809	33.86271	33.542889	36.21708	35.813351	38.4463	35.13171	41.46783	40.358619
18	32.52428	32.087999	32.76356	32.443739	36.05139	35.647661	37.55948	33.03934	40.05362	38.944409
19	31.2672	30.829919	31.30163	30.981809	35.56949	35.165761	37.430127	31.16477	39.026609	37.917398
20	30.39939	29.962109	29.92583	29.606009	35.42335	35.019621	37.313987	29.40589	38.040469	36.931258
21	29.85258	29.415299	28.31905	27.999229	31.03095	30.627221	36.231587	27.33384	37.958069	36.848858
22	26.51124	26.073959	26.7706	26.450779	30.36571	29.961981	35.563471	25.43603	37.292829	36.183618
23	23.20167	22.764389	25.20067	24.880849	29.44082	29.037091	30.641457	23.6271	36.047939	34.938728
24	18.02097	17.583689	23.87431	23.554489	28.60542	28.201691	29.806057	21.86765	30.532539	29.423328
25	16.88722	16.449939	22.50719	22.187369	27.79047	27.386741	28.991107	19.31215	29.717589	28.608378
26	15.8644	15.427119	21.29925	20.979429	26.90448	26.500751	28.105117	17.95576	28.831599	27.722388
27	14.8775	14.440219	20.11656	19.796739	24.30294	23.899211	25.503577	16.6718	26.230059	25.120848
28	13.98464	13.547359	18.94308	18.623259	22.84843	22.444701	24.049067	15.35157	24.775549	23.666338
29	13.13726	12.699979	17.91685	17.597029	20.47871	20.074981	21.679347	14.1888	22.405829	21.296618
30	12.30846	11.871179	16.90214	16.582319	18.9775	18.573771	20.178137	13.14668	20.904619	19.795408
31	11.49055	11.053269	15.86585	15.546029	18.44364	18.039911	19.644277	12.25187	20.370759	19.261548
32	10.79409	10.356809	14.98816	14.668339	17.97539	17.571661	19.176027	11.28042	19.902509	18.793298
33	10.12594	9.688659	14.03591	13.716089	16.54436	16.140631	17.744997	10.28726	18.471479	17.362268
34	9.460601	9.02332	13.38639	13.066569	16.12254	15.718811	17.323177	9.544736	18.049659	16.940448

35	8.846513	8.409232	12.70236	12.382539	15.90629	15.502561	17.106927	8.891609	17.833409	16.724198
36	8.262977	7.825696	11.98274	11.662919	14.60356	14.199831	15.804197	8.372845	16.530679	15.421468
37	7.686405	7.249124	11.20938	10.889559	13.31547	12.911741	14.516107	7.964919	15.242589	14.133378
38	7.198767	6.761486	10.72478	10.404959	13.01881	12.615081	14.219447	7.46968	14.945929	13.836718
39	6.711364	6.274083	9.997807	9.677986	12.90878	12.505051	14.109417	7.042692	14.835899	13.726688
40	6.235372	5.798091	9.341735	9.021914	12.79378	12.390051	13.994417	6.573061	14.720899	13.611688
41	5.774973	5.337692	8.750488	8.430667	9.951125	9.547396	11.151762	6.144087	11.878244	10.769033
42	5.353071	4.91579	8.215975	7.896154	9.416612	9.012883	10.617249	5.791798	11.343731	10.23452
43	4.996036	4.558755	7.631988	7.312167	8.832625	8.428896	10.033262	5.487339	10.759744	9.650533
44	4.612546	4.175265	7.014278	6.694457	8.214915	7.811186	9.415552	5.274116	10.142034	9.032823
45	4.287448	3.850167	6.511352	6.191531	7.711989	7.30826	8.912626	5.092506	9.639108	8.529897
46	3.955149	3.517868	6.074873	5.755052	7.27551	6.871781	8.476147	4.768526	9.202629	8.093418
47	3.649561	3.21228	5.487421	5.1676	6.688058	6.284329	7.888695	4.451878	8.615177	7.505966
48	3.368656	2.931375	5.178618	4.858797	6.379255	5.975526	7.579892	4.195798	8.306374	7.197163
49	3.080802	2.643521	4.763677	4.443856	5.964314	5.560585	7.164951	3.963768	7.891433	6.782222
50	2.816351	2.37907	4.327956	4.008135	5.528593	5.124864	6.72923	3.766477	7.455712	6.346501
51	2.556034	2.118753	3.975325	3.655504	5.175962	4.772233	6.376599	3.531001	7.103081	5.99387
52	2.320857	1.883576	3.634138	3.314317	4.834775	4.431046	6.035412	3.28523	6.761894	5.652683
53	2.098224	1.660943	3.336724	3.016903	4.537361	4.133632	5.737998	3.038512	6.46448	5.355269
54	1.885319	1.448038	3.057516	2.737695	4.258153	3.854424	5.45879	2.796812	6.185272	5.076061
55	1.678118	1.240837	2.739037	2.419216	3.939674	3.535945	5.140311	2.689583	5.866793	4.757582
56	1.477313	1.040032	2.455978	2.136157	3.656615	3.252886	4.857252	2.571107	5.583734	4.474523
57	1.28306	0.845779	2.106954	1.787133	3.307591	2.903862	4.508228	2.410399	5.23471	4.125499
58	1.11374	0.676459	1.870758	1.550937	3.071395	2.667666	4.272032	2.182869	4.998514	3.889303
59	0.943499	0.5062181	1.650069	1.330248	2.850706	2.446977	4.051343	2.00153	4.777825	3.668614
60	0.783446	0.3461648	1.334275	1.014454	2.534912	2.131183	3.735549	1.778354	4.462031	3.35282
61	0.625638	0.1883572	1.036652	0.716831	2.237289	1.83356	3.437926	1.5528	4.164408	3.055197
62	0.49077	0.053489	0.7910073	0.4711863	1.9916443	1.5879153	3.1922813	1.253119	3.9187633	2.8095523
63	0.35683	0.043573	0.5350624	0.2152414	1.7356994	1.3319704	2.9363364	0.9130423	3.6628184	2.5536074
64	0.229703	0.033738	0.299111	0.206473	1.499748	1.096019	2.700385	0.5407356	3.426867	2.317656

65	0.0925	0.028394	0.2807241	0.197364	1.2613611	0.8576321	2.4619981	0.1788025	3.1884801	2.0792691