Estimating returns to Education and Experience in the South African Agricultural Industry

by

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Declaration

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Summary

Education is an important tool for economic growth and eradicating poverty. As the topic of returns to education has been researched extensively in South Africa, this study followed a slightly different direction. Literature determining the returns to education and experience in specific industries is scarce in South Africa. An increase in capital investments or supply of factor inputs creates an increase in the demand for skilled workers over time as an economy develops (Bhorat and Hodge, 1999). The primary objective of this study was to determine the returns to education and experience for the agricultural labour force using Mincer's earnings functions. The objective of Mincer's equation is to quantify returns to education and experience received by an individual for each additional year of education and experience in the workforce completed. The Mincer equations also have the capacity to include additional background and individual characteristics into the model, determining the influence these may have on earnings.

The returns to education and experience for workers employed in the agricultural industry were analysed and compared to those in the mining and manufacturing sectors. To this end the level of education and experience of individuals, together with other factors that influence the monthly earnings, were considered. This study made use of the data provided by the Post-Apartheid Labour Market Series between the years of 2010 and 2017. If compared to other studies on the returns to education and experience in South Africa, this study is novel, since it both distinguishes between the industries in which individuals are employed and the skill levels at which they are employed.

The main analysis in this study is based on the Ordinary Least Squares regression of the adjusted Mincer equation. Besides the standard regressors in the equation – education and experience – other dummy variables were included such as gender, union membership, marital status, and area type. Fixed effects were also included in the model for the period analysed in the study – 2010 to 2017 – and provincial fixed effects, to determine the impact of an individual's location on wages.

The findings are, firstly, that entry-level workers in the agricultural industry receive the lowest returns to education. A possible reason for this observation is that agricultural workers do not require more than basic education to complete simple and frequent tasks. Secondly, professional agricultural workers gain the highest returns to education compared to their peers in mining and manufacturing. Thus, higher levels of education lead to higher returns. Thirdly, female workers in

the agricultural sector earn considerably lower monthly wages compared to males, regardless of their level of skill. The estimates of the additional variables included are in line with other studies analysing returns to education.

Positive returns on education in the agricultural industry prove that there are gains to be had if there is an increase in educational attainment. These results provide policy makers with insight into where to invest, while pertinently considering that female education is more profitable and that more educational opportunities be provided for workers in the rural areas.

Opsomming

Opvoeding is ʼn belangrike instrument vir ekonomiese groei en die uitwissing van armoede. Aangesien die onderwerp van voordeele aan onderwys breedvoerig in Suid-Afrika nagevors is, is die fokus van hierdie studie effens anders. Literatuur wat die voordeele aan onderwys en ervaring in spesifieke bedrywe bepaal, is skaars in Suid-Afrika. 'n Toename in kapitaalbeleggings van die aanbod van faktor-insette lei mettertyd tot 'n toename in die vraag na geskoolde werkers namate 'n ekonomie ontwikkel (Bhorat en Hodge, 1999). Die primêre doel van hierdie studie was om die voordeele aan onderwys sowel as ervaring in die landbou-arbeidsmag te bepaal met behulp van Mincer se verdienste-funksies. Die doel van Mincer se verdienste-funksies is om die voordeel wat individue uit onderwys en ervaring trek, te kwantifiseer vir elke addisionele jaar van onderwys en ervaring wat in die werksmag voltooi is. Die Mincer verdienste-funksies het ook die vermoë om addisionele agtergrond en individuele eienskappe in die model in te sluit, om sodoende die invloed wat dit op verdienste mag hê, bepaal.

Die voordeele aan opleiding en ervaring van werkers in die landboubedryf is ontleed en vergelyk met dié in die mynbou- en vervaardigingsektor. Vir hierdie doel is die opvoedings- en ervaringsvlak van individue in ag geneem, tesame met ander faktore wat maandelikse verdienste beïnvloed. Hierdie studie het gebruik gemaak van die data voorsien deur die Post Apartheid Arbeidsmark Reeks tussen 2010 en 2017. Wanneer dit vergelyk word met ander studies oor die voordeel van onderwys en ervaring in Suid-Afrika, is hierdie studie nuut, omdat dit beide onderskei tussen die bedryf waarin individue in diens is, en die vaardigheidsvlakke waarop hulle werksaam was.

Die hoof-ontleding in hierdie studie is gebaseer op die Ordinary Least Squares regressie van die aangepaste Mincer vergelyking. Afgesien van die standaard-regressors in die vergelyking – opvoeding en ervaring – is ander *dummy*-veranderlikes ingesluit, soos geslag, vakbond-lidmaatskap, huwelikstatus, en gebiedstipe. Vaste effekte vir provinsies is ook ingesluit in die model in die tydperk wat in die studie ontleed is (2010 tot 2017), om die impak wat 'n individu se ligging op lone het, te bepaal.

Die bevindings is, eerstens, dat intreevlak-werkers in die landboubedryf die laagste lone vir hul opleiding ontvang, dus die laagste voordeele aan opleiding. 'n Moontlike rede vir hierdie

waarneming, is dat landbouwerkers nie meer as basiese opleiding benodig om eenvoudige en gereelde take te voltooi nie. Tweedens, professionele landbouwerkers ontvang die hoogste voordeele aan opleiding in vergelyking met hul eweknieë in mynbou en vervaardiging. Hoër onderwysvlakke lei dus tot hoër opbrengste. Derdens, vroulike werkers in die landbousektor verdien aansienlik laer maandelikse lone vergeleke met mans, ongeag hul vaardigheid. Die beramings van die addisionele veranderlikes wat hierby ingesluit is, stem ooreen met ander studies wat die voordeele aan opleiding ontleed.

Positiewe voordeele aan onderwys in die landboubedryf bewys dat 'n toename in opvoedkundige prestasies kan lei tot ’n toename in wins. Hierdie bevindinge bied beleidmakers insig oor waar hulle moet belê, terwyl pertinent in ag geneem moet word dat vroulike opleiding meer winsgewend is en dat meer opvoedkundige geleenthede vir werkers in landelike gebiede voorsien moet word.

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Dedication

I would like to dedicate this thesis to my parents as an act of gratitude for everything they have done for me.

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GDP	Gross Domestic Product
IT	Information Technology
LFS	Labour Force Surveys
NIDS	National Income Dynamics Surveys
OHS	October Household Surveys
OLS	Ordinary Least Squares
PALMS	Post-Apartheid Labour Market Series
PSLSD	Project for Statistics on Living Standards and Development

QLFS	Quarterly Labour Force Surveys
SALDRU	South Africa Labour and Development Research Unit
SASCO	South African Standard Classification of Occupations
SSA	Sub Saharan Africa
SSA	Statistics South Africa
UCT	University of Cape Town

1. Introduction

1.1. Background

Education is an important tool for economic growth and eradicating poverty. Many African countries have improved and capitalised on education with the hopes of reducing poverty since colonial times (Depken, Chiseni and Ita, 2019). Yet studies show that increased investments in education have led to a decline in returns to schooling[1] in several African countries (Söderbom et al., 2006). Quality education systems produce the economy's workers and broadens knowledge. Years of education equip students with the ability to learn skills that will improve individual labour productivity in the long run. Schooling also improves on a list of social benefits such as child well-being and health status (Montenegro and Patrinos, 2014). Psacharopoulos (1994) found that investment in primary education remains a priority in developing countries and that returns to education from lower levels of education are higher compared to higher levels of education. Therefore, many African countries have increased investments in primary education (Depken, Chiseni and Ita, 2019).

The current South African education system is failing the youth and has been problematic since the transition to democracy (Engelbrecht and Harding, 2008). This is because students do not have equal educational opportunities due to various reasons such as location or province; people in urban areas may have better access to education compared to residents in rural areas. Other reasons include language, level of wealth of the household, infrastructure, and even safety. Trends recording the transition from school to university and work show that poor quality schooling at primary and secondary levels restrict individuals in future training opportunities. For several years South Africa has maintained a relatively high unemployment rate. The proportion of young adults not in education or training, or working, has increased by almost 15 percent since 1995. Though unemployment rates for the youth increased since 2008, the unemployment rate for young adults with a tertiary education is much lower than for those with secondary education qualifications or less (Engelbrecht and Harding, 2008).

Labour shifts in South Africa are the result of changes in production procedures used in specific sectors, and changes in the overall structure of the economy. Economic growth and development

[1] Returns to education and schooling are used interchangeably throughout the study.

affected labour in each sector differently, with the proportions of skilled to unskilled labour in the respective sectors changing drastically (Bhorat and Hodge, 1999). Economic growth is the product of one of two things: when the supply of factor inputs is increased, or when technological change takes place. This process influences the level of labour demands required within a sector. A change in technology or increase in capital will cause production methods to change, changing the mix of skills for production (Bhorat and Hodge, 1999).

An increase in capital investments or supply of factor inputs over time creates an increase in the demand for skilled workers as an economy develops (Bhorat and Hodge, 1999). Hamermesh (1993) proved that an increase in the capital requirement for production will cause the demand for unskilled or lower-skilled workers to decline over time; more skilled workers will be needed to run operations and work with new equipment. He found that skill and physical capital are a more profitable combination than capital and unskilled labour. Mining, agriculture, and manufacturing are some of the sectors that have experienced the most capital expansion since 1970; the capital-labour ratios for these sectors all increased significantly. In terms of the changes in technology, South Africa experienced a rapid rate of adoption in information technology (IT). Compared to the primary sectors, the adoption rate in service industries were much higher, meaning these industries are more compatible with the changes in IT. The proportion of skilled employment to unskilled employment increased due to capital expansions in the primary and secondary sectors. The same trend was observed for the services industries due to the increased use of IT (Bhorat and Hodge, 1999). Therefore, determining the effects education will have on wages in the different sectors is relevant for the current debate on high unemployment levels in South Africa.

Researchers have been studying returns to education for decades, reporting on the trends in the estimated returns to education observed globally, in countries, with some studies further differentiating between sectors within a country. Research by Psacharopoulos from 1994 to 2018 concludes that there is a positive correlation between wages and education, and globally investing in female education is more profitable, as males tend to leave school and start working earlier than females. In 1994, wages were set to increase by 8 to 20 percent for every additional year of education (Psacharopoulos, 1994). In 2018, the average estimated returns to an additional year of education were 9 percent. The trend for female education remained the same in the latter study, returns to schooling for females are higher than for males (Psacharopoulos and Patrinos, 2018).

Abbas and Foreman targeted the agricultural sector specifically in Pakistan and found that returns to schooling for males are higher than for females, as a small sample of females form part of the working population in Pakistan and an even smaller sample are in agriculture (Abbas and Foreman-Peck, 2008).

Studies by Mwabu and Schultz (1996) and Depken, Chiseni and Ita (2019) estimated returns to schooling in South Africa. South African males, separated by race, formed the sample used by Mwabu and Schultz in 1996 and recorded that private returns for white males were double the returns to schooling for blacks. According to the more recent study by Depken, Chiseni and Ita (2019), the average returns to education in South Africa was 18.4 percent and females gained higher returns to schooling than males. The average estimated returns to schooling in South Africa seem high when considering other African countries, which indicates considerable gains if the education systems were to be improved (Abbas and Foreman-Peck, 2008). Both studies also found that returns to schooling are higher with higher levels of education.

Considering this brief overview of returns to education, most studies show similar results; there are higher returns with higher levels of education, and females' returns are higher than males' (with the exception of the study in Pakistan regarding the agricultural sector's returns). Studies estimating returns often look at gender, race, and possibly location within a country (urban vs rural) but few have disaggregated their analysis between sectors. Therefore, this thesis will contribute to the literature by estimating the returns to education specifically for the agricultural, mining, and manufacturing sectors in South Africa.

The Mincerian earnings functions also have the capacity to determine individuals' returns to experience by estimating how increased years in the labour force affect earnings. Like returns to education, experience also forms part of the earnings function as a standard regressor. An explicit experience variable is not always included in surveys or data samples and is therefore calculated. In many cases, age is used as a proxy to calculate experience (see for example Keswell and Poswell, 2004; Salisbury, 2016); thus, experience is the product of individuals' age minus the number of years of their education minus six.

Studies found that earnings and experience are positively correlated (Montenegro and Patrinos, 2014). Therefore, individuals with more working experience receive higher wages. Returns to experience are considerably lower compared to returns to education, as some individuals may start working at a later stage. The experience squared variable indicates the rate of change in the experience variable. It is expected that the coefficient of experience squared will be negative, however, this may not always be the case, depending on the data analysis. If the coefficient does result in a negative estimate, estimates are usually small and thus indicate a small change in earnings. The same applies to positive estimates.

1.2. Problem statement

The topic of returns to education has been widely studied in the South African context. However, literature is lacking on returns to education in agriculture. Therefore, this study aims to compare the returns to education and experience in agriculture to these returns in mining and manufacturing.

1.3. Hypotheses

The following hypotheses will guide the data analysis for this thesis. First, it is hypothesised that returns to education for entry-level workers in agriculture are relatively lower compared to those in the mining and manufacturing industries. Secondly, it is hypothesised that returns to education for professionals are the highest in agriculture compared to mining and manufacturing, as individuals who have completed more years of schooling, tend to earn the highest returns. Thirdly, returns to education are expected to display a convex trend in potential earnings, meaning that a positive rate of change is expected. Lastly, females in agriculture are expected to earn higher returns to education than males, although a gender gap might be prominent in agriculture.

1.4. Research aims and objectives

The primary objective of this study is to determine the returns to education in the agricultural, mining, and manufacturing sectors in South Africa at various skill levels. These results will be compared and used to test the hypotheses discussed in the previous section. The second objective is to provide a comprehensive review of literature focused on the returns to education in agriculture and the findings thereof. The aim is to review literature on a global scale to observe the general trends in returns in other countries and then compare these to the studies done in South Africa. Thirdly, this study will provide an analysis of the wage gap between genders in agriculture and determine how it affects wages. Lastly, it will look at several demographic factors, like gender, marital status, union membership, and the type of areas in which workers reside (rural or urban), that may influence individuals' wages.

1.5. Proposed method

The main form of analysis for this study will be the Ordinary Least Squares regression. This comprehensive study will make use of the Mincer equation to analyse South African household data from the latest version of the Post-Apartheid Labour Market Series (PALMS) to determine returns to education for the agricultural, mining, and manufacturing sectors. The monthly real earnings for individuals in the respective industries will be analysed from 2010 to 2017.

1.6. Outline of the study

Chapter 2 starts with a brief discussion of the South African economy and education system. This discussion is followed by the introduction of the Mincer (1974) model, explaining the theoretical foundations of the model. Global studies using the study are then discussed, followed by relevant studies done in South Africa and the agricultural industry. In Chapter 3, the Mincer model is explained in detail, focusing on how the model works to determine earnings as a function of education and experience. The advantages and disadvantages of using this model are also discussed in this chapter. The dataset used in this study is then introduced, followed by the sample used in the analysis and the summary of statistics for agricultural workers. The data description of the earnings functions used in the analysis of the data is identified. The results of each model in the respective industries are reported in Chapter 4. The final chapter starts with a summary of the findings, followed by a discussion of these results. The conclusion and policy recommendations are also discussed in Chapter 5, followed by a detailed discussion of limitations of this study.

2. Literature review

2.1. Introduction

The purpose of this chapter is to provide a selective review of the literature on the Mincer equation (1974) and returns to education. The first section will briefly discuss the background of the South African economy, followed by a brief discussion of education in South Africa. The theory of the Mincer equation (1974) and the theoretical foundations of the framework will then be described. The last section of this review will provide evidence of the Mincer equation (1974) applied in studies on a global scale and a national scale. Returns to education and experience in South Africa are reviewed. Finally, studies that have investigated returns in agriculture specifically will be discussed, followed by a conclusion to the chapter.

2.2. Background on the South African economy

The political transition of South Africa is known to be one of the most impressive political achievements of the past century. Significant strides have been made in South Africa toward developing the wellbeing of citizens since the shift to democracy, but the process is slowing down. The South African economy maintains a dual structure with one of the highest inequality rates in the world (Rodrik, 2008). High inequality rates have been and continue to be experienced in the country, with a skewed distribution of wealth over the country's population.

A high unemployment rate has plagued the country for years – the unemployment rate was 30.1 percent in 2020; the rate among younger people remains higher. High unemployment rates mean that a large part of the population lives below the food poverty line (Stats S.A., 2019). Unemployment in South Africa is high, because individuals do not have access to the same educational opportunities for various demographic reasons. Rodrik (2008) explains that the proximate cause of high unemployment is that current South African wages are too high compared to real wage levels that would clear labour markets at lower levels of unemployment. The inability of the South African economy to generate strong economic growth also plays a role in unemployment.

The agricultural industry plays a vital role in the process of economic development and was ranked as a priority until the end of apartheid, but only in the commercial sector (Binswanger-Mkhize, 2014). The percentage of contribution to the country's Gross Domestic Product (GDP) is relatively small and continues to decline as the economy develops and becomes more diverse. The agricultural industry is an important contributor, as it provides employment to many individuals. The industry also has forward and backward linkages with other industries in the economy, as factors such as natural disasters could cause changes in production (Van Zyl, Nel & Groenewald, 1988). Having discussed the background of the South African economy briefly, the following section will focus on education in South Africa and the quality thereof.

2.3. Education in South Africa

It is believed that increasing education will decrease the high unemployment rate and help reduce poverty in South Africa (Biyase and Zwane, 2015). The poor quality of the South African education system is apparent in that many pupils cannot read, write, and compute at grade-appropriate levels. Compared to other middle-income countries participating in cross-national assessments of educational achievement, South Africa has the worst education system in terms of educational outcomes (Spaull, 2013).

There are two prominent and very different public-school systems in the country, according to an analysis by Spaull (2013). Wealthier students, who also achieve much higher results, are accommodated in smaller, better performing schools. Students who are less privileged, end up in larger schools which cater to these communities; the performance in these schools is usually very poor as a result of the poor quality of education they receive. Poor quality primary and secondary education can severely limit students' capacity to exploit further training opportunities. The sub-par quality of education provided has severe economic consequences for those affected. The number of individuals between the ages of 18 and 24 years who are not currently studying, employed, or in training increased to 45 percent in 2011. The unemployment rate for the youth aged 15 to 24 years increased to 55.2 percent in 2019. The unemployment rate among graduates was 31 percent in the first quarter of 2019 (Stats S.A., 2019). The number of young people enrolled in education has decreased drastically; thus, there has been a shift away from participation in education towards economic inactivity of unemployment. The severe inequalities of educational outcomes can clearly be seen along numerous correlated dimensions such as wealth, school location, language, and province. To conclude, a poor-quality education system does not improve capabilities or expand economic opportunities of students; instead, they are denied proper employment. Poor school performance in South Africa thus reinforces social inequality and results in an outcome where children inherit the social station of their parents, regardless of their motivation or ability (Spaull, 2013). Given the brief background to education in South Africa, the following section discusses the theoretical foundation of the Mincer framework (1974).

2.4. The theory of the Mincer equation

The Mincer equation (1974) is widely used in empirical economics to estimate returns to schooling and to measure the impact of work experience on male-female wage gaps. It is the foundation for economic studies of education in developing countries and has been estimated using different datasets from different countries covering various time periods. Mincer's equation was also used in more recent studies to assess the economic growth and average education levels in various countries (Heckman, Lochner and Todd, 2003). The Mincer equation can be used to explain a wide variety of economic phenomena. One such application, and the reason for its use in this specific study, is that this model can explain and estimate employment earnings as a function of education and labour experience. Mincer's equation provides estimates of the average monetary returns of one additional year of education (Patrinos, 2016).

Based on theoretical and empirical arguments, Mincer's equation models the natural logarithm of earnings as a function of workers' education and total working experience. Many studies use the Mincer equation, as it provides a parsimonious specification that fits data unusually well in most contexts (Lemieux, 2006).

Private rates of return are often used to describe individual behaviour when it comes to the choices workers make regarding education; it is also used to indicate productivity (Oreopoulos, 2013). Returns to education using Mincer's equation can be employed to determine where investment in education should be made based on the distribution of returns. Depken, Chiseni and Ita (2019) have applied this in a South African context. Results can also be used to determine the potential returns and benefits of tertiary education (Patrinos, 2016).

Economists use Mincer's equation because it provides estimations necessary for evaluating returns to education in monetary terms, and the results generated can be directly compared. Estimates on the returns to investment in education provide individuals with the information they need to decide how to invest in their own human capital (Patrinos, 2016).

The degree of discrimination within a labour market can be determined by estimating Mincer equations for males, females, and even different racial groups. Returns to education can be used to motivate further investment in the schooling system, especially for females (Patrinos, 2016).

A limitation of the Mincer equation is the assumption that returns to experience are the same at all levels of education. The relationship between education and earnings does not necessarily mean that they are proportional to one another. The earnings functions provide private returns to education and not social returns; government costs are needed for that calculation (Patrinos, 2016). Given the discussion on the theory of the Mincer model and how it works, the following discussion will focus on the two different models specified by Jacob Mincer.

2.4.1. Theoretical foundations of Mincer's earnings regressions

The Mincer model (1958, 1974) is underpinned by two conceptually different theoretical frameworks; the assumptions for the two versions differ slightly (Heckman, Lochner and Todd, 2003). The first theoretical model is underpinned by the principle of differences in compensation. The Mincer equation (1958) makes use of the principle of compensating differences to explain why people with different levels of education are compensated differently over their lifetimes (Heckman, Lochner and Todd, 2003). This model assumes that all individuals have equal opportunities and abilities to enter the labour market. Secondly, the type of occupation differs according to the amount of training required – training takes time, and with each additional year of training, individuals' potential earnings are postponed, which ultimately reduces their lifetime earnings. Lastly, it is assumed that the flow of income is constant during the earnings life cycle. This makes it possible to determine the degree of compensatory differences resulting from the differences in the cost of training (Mincer, 1958).

The second model, Mincer's accounting-identity model (1974), is underpinned by completely different assumptions but yields similar results to the first one. It builds on an accounting identity model developed by Becker (1964) and Becker and Chiswick (1966). This model focuses on the earnings individuals would receive throughout their working lives and the relationship between observed earnings, potential earnings, and human capital investment (Heckman, Lochner and Todd, 2003). The aim of Mincer's innovation was to prove that individuals' choices would produce income streams that can easily be evaluated by capital theory. This is done by using education and occupation as investment opportunities to model the result of an individual's investment decision.

A fundamental assumption made, is that individuals continue to invest in their education until the investment costs are equal to the present value of the schooling gains. This is the foundation of the popular log-linear earnings function. This formulation is used to measure private rates of return to education as well as returns to experience after completing school or on the job training. This work shows that workers' returns increase over time at a decreasing rate throughout their earnings life cycle, yielding a concave earnings profile for most workers (Polachek, 2008).

2.5. Studies applying the Mincer equation

2.5.1. Existing literature on worldwide returns to education

Studies measuring the returns to education stretch back to 1958, the year Mincer developed his first model of compensating differences. The Mincer equation has become a cornerstone of empirical economics and has made studies to returns easier. Mincer's equation provides researchers with the necessary framework to do basic estimations. The vast amount of available literature on the topic also helps; studies have been done on global and national scales with ease. This section will review a few studies using Mincer's equation (1974), first on a global scale to review global trends and then on a national scale to review South African trends to returns.

In 1994, Psacharopoulos estimated the returns to investment in education globally to provide a worldwide perspective on the profitability of investment in education. He found that primary education remains a priority investment as it shows the highest returns compared to that of secondary and higher education. However, primary, and secondary returns show an overall declining trend over a 15-year period but returns to higher education experience a slight increase. For an additional year of education completed, returns increase by 8 to 20 percent in Sub-Saharan Africa (SSA). He also found that low-income countries receive higher returns to education relative to high- and middle-income countries. In SSA investments in female education yield a greater return relative to male education; the earnings potential of the former increases with 12.4 percent relative to 11.1 percent for the latter (Psacharopoulos, 1994). Therefore, investing in the education of females has proven to be more profitable.

In a more recent revisit of his earlier study, Psacharopoulos (2018) reviews the most recent trends in the returns to investment in education. It compliments a study by Montenegro and Patrinos (2014) with the same objective of estimating worldwide returns to education. The findings of both studies are consistent with those of Psacharopoulos (1994); the findings only differ in terms of the private average rate of return to an additional year of education. For the private average rate of return to an additional year of education, Montenegro and Patrinos (2014) recorded a 10 percent increase in returns and Psacharopoulos (2018) recorded a 9 percent increase in returns. The returns to education decline gradually over time as the supply of education increases in a country (Patrinos, 2016). Tinbergen (1975) describes this as a “race between education and technology”, as the price of education fails to decline proportionately in the face of rapid supply increases, indicating that the demand for skilled workers is outpacing the growth in supply of skills (Psacharopoulos and Patrinos, 2018). Psacharopoulos (1994) found that developing countries invest more in primary education whereas Psacharopoulos (2018) found that returns to higher education have increased since 2000. Increased returns to higher education indicate that the cost of education is increasing while the supply of education is simultaneously increasing. These higher returns also create financing issues, as private returns are subsidised (Montenegro and Patrinos, 2014).

Both Psacharopoulos (2018) and Montenegro and Patrinos (2014) found that the private returns to education for females exceed that of males. For males, the rate of return to an additional year of education is 9.6 percent, compared to 11.7 percent for females (Montenegro and Patrinos, 2014). These results are similar to several other studies where returns to education for females are higher than for males (see for example Psacharopoulos, 1989; Psacharopoulos, 2004; Harmon, Oosterbeek and Walker, 2003; Mwabu and Schultz, 2000). Comparing world regions, the private returns to another year of education are highest in SSA and Latin America and lowest in the Middle East and North Africa. As expected, they also found that tertiary education yields the highest returns and secondary education the lowest (Montenegro and Patrinos, 2014).

2.5.2. Returns to education in South Africa

Studies estimating returns to education in South Africa date back to the late 1960s (Moll, 1992, 1996, 1998). Towards the end of apartheid, returns to education were lower than 5 percent on average and around 10 percent for black males in South Africa. The returns to primary education for coloured South Africans showed a slight decline but remained between 8 and 9 percent. According to Moll, the increase in returns to higher education is the result of improvements in the quality of education rather than the decrease in discrimination in the labour market.

Keswell and Poswell (2004) estimated returns to education in South Africa with data from the Project for Statistics Living Standards and Development 1993, together with the 1995 and 1997

October Household Surveys and the September 2000 Labour Force Survey. They found that the data for South Africa differs from the findings of Psacharopoulos (1994); the structure of the rate of returns for South Africa displays a convex and not a concave pattern. Several studies determining returns to education in South Africa also found that returns to education generally display a convex trend (Mwabu and Schultz, 2000; Rospabe, 2001; Bhorat, 2000). The marginal rate of returns for tertiary education is significantly higher than the returns for lower levels of education in South Africa. The findings indicate a strong convex relationship between education and earnings in South Africa. The returns to education therefore increase at an increasing rate with every additional year of education attained.

Mwabu and Schultz (1996) conducted a study using data from the post-apartheid era to address the challenging issue of expanding and developing the educational opportunities of the South African population. They identified important differences in the returns to education for white and black people. There are several reasons why workers are compensated differently across race in South Africa, such as the quality of education offered and the access to education, which may have implications for how returns are likely to change in the future. Mwabu and Schultz (1996) estimated returns to education using data from the 1993 Project for Statistics on Living Standards and Development. They found that in 1993 private wage returns to education were twice as high for black people as for white people in South Africa. Returns to secondary schooling were 16 percent for blacks but only 8 percent for whites. At tertiary level, returns were 27 percent for blacks but only 15 percent for whites. Overall, the returns to education for both races were higher with higher levels of education (Mwabu and Schultz, 1996).

Salisbury (2016) made use of data from the National Income Dynamics Study (NIDS) to construct a new dataset which was used to estimate both the private and social returns to education in South Africa. The purpose of his study was to determine whether returns for black and coloured South Africans have improved since apartheid. Like Mwabu and Schultz (1996), he focused on different races. However, Mwabu and Schultz (1996) did not include coloured South Africans in their study. Overall returns to education for the full sample increased by 18.7 percent for every additional year of education. For whites returns increased by 23 percent for each additional year while black people’s returns increased by 16 percent and coloureds by 19 percent (Salisbury, 2016). Although black and coloured people experience smaller increases in returns compared to white people, there has been a large improvement in returns compared to the apartheid period.

These findings contradict those of Mwabu and Schultz (1996). This can be ascribed to racial discrimination in the labour market in South Africa, which values the productive characteristics of black and coloured people differently to those of whites. Like the previously discussed studies, Salisbury (2016) also found that returns to primary and secondary education are much lower than those to tertiary education.

Depken, Chiseni and Ita (2019) estimated the returns to education using two waves of the National Income Dynamics Study (NIDS) of 2010 and 2012 in South Africa. They estimated the returns to education at 11.3 percent in South Africa. However, there is a possibility that education can be endogenous, due to the work ethic or self-motivation of some individuals, which influences their wages and chosen level of education. To overcome this, Depken, Chiseni and Ita (2019) included a further set of models – the education level of the person's mother and father respectively as instrumental variables. Controlling for this increases the estimated return to education from 11.3 to 18.4 percent. Considering other African countries, this estimate seems high, indicating that there are substantial gains to be had if South Africans increase their levels of education and more people become educated. During 2010 and 2012 the returns to education for females (21.2 percent) were higher than for males (15 percent). A reason contributing to this outcome is that more male students drop out of school and start working, while female students remain at school. The returns to education in urban areas are higher than in rural areas, 21.4 percent and 13.8 percent respectively (Depken, Chiseni and Ita, 2019).

2.5.3. Returns to experience

The basic Mincer equation is widely used and popular for its ability to fit numerous datasets in most contexts because it includes "potential experience" as a standard regressor in the earnings function (Lemieux, 2006). Mincer (1958) states that the age-earnings profile follows a concave pattern and becomes steeper for more educated workers; in other words, this trend will diverge with age across education levels. In his later work, *Schooling, Experience and Earnings*, he states that the experience-earnings profiles are relatively parallel for different education levels. These sentiments are confirmed in the study by Heckman, Lochner and Todd (2003) in the United States of America (USA) for black and white males. They used data from the 1940 to 1990 Decennial

Censuses in the USA to extend Mincer's (1974) analysis to include both white and black males. The general trend in estimated profiles for white males supports Mincer's expectations for experience-earnings profiles from 1940 to 1970 – earnings were parallel for different education levels. The trends for black American males, however, was less clear, possibly because of the smaller sample size used for black males, which narrowed the number of precise estimates. From 1960 to 1970 sample sizes for black males were larger compared to earlier years; the experience-earnings profile for these years indicates a convergence across education levels over time. From 1980 to 1990 the experience-earnings profiles for both races show that returns converge over time. Therefore, this trend in the more recent data does not support Mincer's statement, while the older data from 1940 does (Heckman et al., 2003).

The estimated agricultural earnings profiles for white males fully support the expected trends stated by Mincer – earnings generally fan out as workers get older. For black males, unclear trends are again displayed for age-earnings profiles, and only with the more recent data in 1980 did a fanning-out trend occur (Heckman et al., 2003).

Montenegro and Patrinos (2014) provide more recent estimates of the returns to potential experience alongside the returns to education, to provide a worldwide perspective. Estimates of the returns to potential experience can be used to indicate an individual's productivity. Most studies define experience as the potential years of experience in the labour market, calculating it as age minus the years of schooling minus six (the typical age at which one starts attending school). In this study they found that there is a positive correlation between returns to education and returns to experience. Therefore, as the years of education attained increase and the years of experience increase, the returns of workers increase accordingly.

Although Montenegro and Patrinos (2014) provide a clear global trend for returns to experience, the following studies provide evidence for returns to experience in South Africa. As commonly found in literature on returns to education, Keswell and Poswell (2004), Depken, Chiseni and Ita (2019), Biyase and Zwane (2015) and Salisbury (2016) all made use of age as a proxy for "potential experience". Keswell and Poswell (2004) explain that the use of a proxy prevents overestimations of potential experience, which can be caused by factors such as grade repetition, low educational attainment, and low job insecurity. Including experience can cause challenges in the model, which ultimately influence the estimates for returns to education. Estimates displayed a sharp convex relationship between education and expected returns with the inclusion of potential experience, an expected outcome. However, a downward trend can be observed for the earlier years of education, mostly primary. This trend is partly attributed to reporting errors in the data because, if individuals with limited years of education are adults, the possibility arises that the apparently higher expected returns of individuals with less than three years of education may have to do with age or experience, rather than education. Following the recommendations of Hertz (2003), Keswell and Poswell (2004) controlled for experience, to eliminate the apparent trade-off between experience and education. Controlling for experience reverses the negative slope; thus, the second set of estimations show a constant rate of returns until around 12 years of education, after which returns increase significantly.

Depken, Chiseni and Ita (2019) and Biyase and Zwane (2015) both include age into the control variables for their respective models. Both studies conclude that the estimates for age are as expected; age is positive and statistically significant. These findings indicate that returns increase with the age of workers. However, Depken, Chiseni and Ita (2019) highlight that these returns increase at a decreasing rate.

Salisbury (2016) interprets age earnings according to workers' educational attainment and race. Earnings for people who did not complete lower grades of high school, remain relatively flat throughout their working life cycle. Earnings for these individuals reach a maximum of only twice as much as their initial earnings during the first few years in the labour market. For those who completed high school and obtained some form of higher-grade education, initial earnings are higher and increase gradually for each year of experience in the labour market. Earnings for these individuals increase up to three to five times their initial earnings. Maximum earnings are shown to be attained earlier for individuals who obtain additional levels of education. This is partly because workers in the public sector with higher levels of education retire earlier. In terms of race, the returns to education for every additional year in the white labour force significantly exceed the returns to education of black and coloured people.

2.5.4. Evidence on returns in agriculture

According to Bhorat and Hodge (1999), the structural change in South Africa influenced the demand for skilled workers in the primary and secondary sectors the most. These structural changes occurred in the form of technological improvements and capital deepening, requiring a change in production methods that affected the level of skills required in production. The change in production methods resulted in a change in terms of the demand for workers; more skilled workers are needed to operate new equipment and machinery that may be acquired with the increase in capital. As a higher level of skill is required, this section will discuss the effects of education on agricultural productivity. Numerous studies estimating returns to education using Mincer's equation (1974) in South Africa exist, however, studies reviewing the impact of education on agricultural productivity in South Africa using this framework are limited. Therefore, this study reviews the returns to education in agriculture from the African perspective.

A survey was conducted with evidence regarding the education and productivity of farmers in low-income countries (Lockheed et al., 1980). Results from 18 studies across 13 countries were reviewed; Kenya represented Africa in this study. The overall trend emerging from these results is that farming productivity increases by 7.4 percent with four years of education compared to no education at all. Lockheed et al. (1980) reasoned that four years of education is the minimum cycle for individuals to attain literacy. They also found that increased levels of education favour farmers who use modern technologies more. For the use of modern technology, higher levels of education are prioritised over more years of working experience. In countries with modern agricultural practices, the effect of four years of education increased productivity by 9.5 percent compared to countries that make use of more traditional farming practices, where productivity only increased by 1.3 percent (Lockheed at al., 1980).

A study in Uganda used production functions to estimate the returns to education for farmers and recorded positive results (Appleton and Balihuta, 1996). Using data from a 1992 to 1993 Integrated Household Survey, Appleton and Balihuta (1996) found that finishing primary school yields significantly higher returns than finishing years of high school. They controlled for age in this study, as it lowers the estimates of the effect of education; estimates for age were positive and statistically significant. Productivity for workers with four years of schooling, compared to those with no schooling, increased by 7 percent, which is in line with the Lockheed study. For workers who completed primary school, productivity was 13 percent higher (Appleton and Balihuta, 1996). This means that less educated workers with more experience are more productive. For returns to education, secondary education returns are much higher than primary school; however, in the agricultural sector, the opposite occurs. Years of secondary schooling have little to no effect on the returns to agriculture.

In Ethiopia evidence proved that education positively affects the production of cereal. However, productivity only increased with four years of basic education completed (Weir, 1999). Production increased by more than 10 percent when an individual completed four or more years of education compared to no education.

Alene and Manyong (2007) assessed the influence farmer education has on traditional and improved cowpea production in northern Nigeria. They found that farmer education has significant positive effects, but only when farmers use improved technologies; it has no effect when farmers use traditional technologies. They used a switching regression to model a two-stage process. In the first stage, farmers could choose to adopt improved cowpea varieties or not. In the second stage the cowpea production was modelled based on whether farmers chose to adopt improved practices or not. A household head with four or more years of schooling had positive effects. Farmer education positively affected cowpea production if they adopted new technologies. Cowpea production increased by 25.6 percent for farmers with four years of education using improved cowpea varieties. The proportion of other household members who completed primary schooling had no significant relationship with adoption of better varieties or production (Alene and Manyong, 2007).

2.6. Conclusion

This chapter has provided an overview of the Mincer framework used to estimate returns to education and experience, and the application thereof in South Africa. The first section provides a brief background of the South African economy, highlighting the high unemployment rate among the youth. This section is followed by a brief discussion of education in South Africa. Higher levels of education are believed to decrease the high unemployment rate and reduce poverty in the country. This section also highlights the quality of education in South Africa and the difference in education systems for students with different social backgrounds.

The review was followed by a theoretical background motivating the use of the Mincer equation as well as highlighting the weak points of the model. Mincer's method is widely used in economic studies and provides estimated returns which can help policy makers make investment decisions. This section continues to describe both of Mincer’s models (1958, 1974) with their respective assumptions. Mincer’s first model (1958) assumes a level playing field for all individuals, where everyone has the same abilities, the same opportunities, and can enter any occupation. However, occupations vary with the amount of required training and can ultimately reduce one's earnings life cycle for every year spent in training. The second model focuses more on decisions made by individuals; the focus is on how much they decide to spend on their education. The Mincer equation (1974) can estimate the returns to education with every additional year of education completed as well as estimate returns to every additional year an individual spends in the labour market. This thesis will continue to use Mincer's equation (1974) as it explains potential employment earnings as a function of education and labour market experience.

An overview of the application of Mincer's equation (1974) with a worldwide perspective as well as a national perspective was then provided. Psacharopoulos (1994) recorded that developing countries prioritise investments to primary education. Later studies proved that higher levels of education are more profitable as estimated returns are higher compared to primary schooling. Global trends show that female education is more profitable than male education and low-income countries yield higher returns to education than middle- and high-income countries. The studies also observed that returns to education decrease slightly over time as the supply of education increases.

Returns to education in South Africa was then reviewed and discussed. From the literature one can conclude that returns to education for females are typically higher than for males. The expected returns for males and females are in the range of 11 to 15 percent and 12 to 20 percent, respectively. Most studies apply the Mincer equation (1974), but it seems that better results are obtained by including instrumental variables to control for biases such as parents' education. Studies reviewing the returns to education according to race found that black males have higher returns than white males in the post-apartheid era. However, Salisbury (2016) found that an additional year of education increases returns for white people the most, then coloured people, and lastly black people. This is the result of racial discrimination in the South Africa labour market, which values the productive characteristics of black and coloured people differently than it values those of whites. Keswell and Poswell (2004) provide evidence of a convex relationship between education and earnings, meaning that the rate of change in education is positive throughout the study. In South Africa higher levels of schooling are more beneficial compared to only completing primary school. Tertiary education yields the highest overall returns to education for all individuals in South Africa.

The third section reviewed the effect of experience on earnings. As Mincer states, returns to experience converge and age-earnings fan out over time, which is motivated by Heckman, Lochner and Todd (2003). Montenegro and Patrinos (2014) discovered that returns to education and experience are strongly and positively correlated, meaning individuals with more experience and higher qualifications will receive higher wages. In South Africa, age was used as a proxy for experience by most; they found that with age returns increased at a decreasing rate, thus displaying a concave relationship. Salisbury (2016) found that earnings for white people increase significantly as they age, as opposed to earnings for coloured and African individuals.

The last section reviewed the effect of education on agriculture in Africa. Studies found that workers with a basic four-year education are considerably more productive, especially on farms that make use of improved technologies. Higher levels of education favour farmers who make use of more modern technology. In traditional farming practices, education makes little to no difference in productivity, as more value is placed on experience.

3. Data and methods

In this chapter, the Mincer model and the data used in this study are introduced and discussed. The Mincer model used to analyse the data is discussed as well as the identification of the variables used from the dataset to answer the research questions. This section initially describes the model, followed by a detailed description of the data, motivating why this dataset is the most appropriate one. A summary of statistics of the sample analysed is then provided. The section ends with a discussion on the regression equations, the expected results, and potential issues that affect the analysis.

3.1. Model

The main objective of this study is to determine the returns to education and experience in the agricultural sector in South Africa. In line with other studies, the Mincer earnings function (1974) is used as the framework to make these estimations. In South African literature, the Mincerian wage regressions have mostly been used to determine returns to education on a national scale (Keswell and Poswell, 2004; Biyase and Zwane, 2015; Mwabu and Schultz, 1996), rather than for specific sectors.

This study applies the most common specification of the earnings function and follows the same method as Dougherty and Jimenez (1991). Mincer's model specifies the natural logarithm of earnings as a function of schooling and years of potential experience in the labour market. In this popular specification of the earnings function, the log earnings are specified as the sum of a linear function of years of schooling and a quadratic function of years of potential experience.

$$Ln(Yi) = \beta_0 + \beta_1 ED_i + \beta_2 EXP_i + \beta_3 EXP_i^2 + \mu \qquad (1)$$

This specification of the earnings function (Yi) is quadratic and includes education (ED), years of potential labour market experience (EXP), and experience squared (EXP^2) as explanatory variables. Experience is controlled by squaring the experience variable, to reduce the chance of inaccurate results. Keswell and Poswell (2004) explain that the inclusion of experience causes results to show inaccurate trends in returns to education and, after controlling for this variable, the estimates show a more consistent trend. The parameter β_0 represents the intercept of the regression as the level of earnings of an individual with no labour market experience and no education.

The diminishing marginal return to experience is shown in the Mincer equation by making the experience variable a quadratic term. However, a few problems can arise because of this specification. Shyshkina (2001) explains that the variable for education is simply determined by the number of years spent on education, but it is important that the different levels of education be distinguished. This is because the quality of education offered at a tertiary institution such as a university is likely to be higher than that offered by primary or secondary level schooling and even colleges, because of better facilities (computer labs, libraries, and better qualified teaching staff). Another reason is the "certification effect", as employers perceive workers with tertiary qualifications to be of more value to them than workers without such qualifications (Dougherty and Jimenez, 1991).

Across various studies, Mincer's specification (1974) has proven to be the best model to determine returns to education and experience, as it explains employment earnings as a function of education and labour market experience (Patrinos, 2016). This study ran an Ordinary Least Squares (OLS) regression to estimate the returns to education and experience. This regression was completed with the use of the coding software R studio applied to the sample selected for this study. Various extensions of the Mincer equation were run to test different hypotheses, which will be discussed in detail in the next section.

3.2. Data

3.2.1 Data description

This research makes use of the 2019 version of the Post-Apartheid Labour Market Series (PALMS) dataset as a pooled dataset, it contains a combination of time series and cross-section data, created by DataFirst at the University of Cape Town (UCT) (Kerr and Wittenberg, 2019). The main advantage of PALMS version 3.3 is that it includes the microdata from 69 household surveys conducted by Statistics South Africa (SSA) between 1994 and 2019. It also contains the 1993 Project for Statistics on Living Standards and Development (PSLDS) conducted by the South Africa Labour and Development Research Unit (SALDRU) at UCT. The SSA surveys include the October Household Surveys (OHS) from 1994 to 1999, the bi-annual Labour Force

Surveys (LFS)from 2000 to 2007, as well as the smaller LFS pilot survey from February 2000, and Quarterly Labour Force Surveys (QLFS) from 2008 to 2019 (Kerr and Wittenberg, 2019). Each set of surveyswere prepared separately then appended together by the institution. This study analyses labour market data from 2010 to 2017. Different versions of PALMS are available; the updated versions include new variables and improvements that other researchers may have suggested.

Most of the variables included in PALMS are associated with the labour market. Some household variables are included, as well as the dwelling type and access to services. However, not all variables from all the surveys are included in PALMS. These surveys are considered one of the more reliable sources of labour market data, including labour income data, in South Africa (Kerr and Wittenberg, 2019).

A disadvantage of PALMS is that it contains limited general information on non-labour income. More comprehensive data on other forms of income was collected by the PSLSD and OHSs, however, this information is not included in PALMS. Kerr and Wittenberg (2019) warn researchers to be cautious when working with the earnings data from the QLFS, because the data displays some worrying and unbelievable trends in earnings inequality. A few issues were picked up in the earnings data in this survey, so it is necessary to be careful when comparing data from the QLFS to the LFS or OHS. To minimise problems that may be caused by missing data in OHS and QLFS,the years for which information is missing – 2008 to 2009 and 2018 to 2019 – are omitted from the sample.

The PALMS dataset includes demographic data, including age, sex, marital status, real monthly earnings, location of residence, area type, occupation, whether an individual belongs to a job union or not, years of education completed, employment status, and industry data. Data for each of these variables are included in the sample to analyse how these variables affect an individual's monthly labour earnings. Besides the agricultural industry, the mining and manufacturing industries are also included in the analysis so that returns can be compared across industries. This comparison allows for researchers to determine which industry receives the highest returns to education and experience, and to determine which of the two variables are valued more in a particular industry.

3.2.2 The dependent variable

The natural log of the real monthly earnings of individuals is the dependent variable in the regression. The aim of PALMS is to enable comparisons across different surveys and years. As the dependent variable in this study is monthly earnings, it is also the main variable used and corresponds with the "realearnings" variable in the dataset (Bassier and Woolard, 2020).

Bassier and Woolard (2020) mention that there are a few problems with the "realearnings" variable. Firstly, it is important to note that this variable is a measure of earnings and not income, and thus excludes income from other capital sources such as interest or shares. It is not clear how well the variable accounts for individuals' earnings outside of their usual income, such as bonuses received, or shares awarded. Secondly, there is no income data for the years 2008 to 2009 and 2018 to 2019 on the QLFS (Kerr and Wittenberg, 2019). Therefore, this study analyses labour market data from 2010 to 2017 to avoid results being affected by this missing data. Thirdly, many respondents did not provide information regarding their income, and there is no way in which to identify who refused to provide this information.

3.2.3 Explanatory variables

For the sake of this study, the sample is divided into the following sectors: agriculture, mining, and manufacturing. Only individuals reported as employed in these respective industries are included in the sample. Individuals in the sample are segmented into three skill levels: entry-level[1], skilled[2], and professional[3], using the South African Standard Classification of Occupations (SASCO) codes as a guide. The entry-level category includes individuals employed in elementary occupations and typically involves the performance of simple and routine manual and physical tasks. These tasks require limited training and no more than basic skills in numeracy. Workers classified as skilled generally include skilled agricultural, forestry and fishery workers, craft and related trade workers, and plant and machine operators and assemblers. Broad tasks performed by skilled agricultural workers usually include preparing soil, storing, basic processing of produce, and more. Lastly, workers classified as professionals have the highest SASCO skill level; these workers have higher levels of education such as a degree and possibly a postgraduate qualification (Stats S.A., 2012).

[1] Codes included: occupations with codes higher than 9000.
[2] Codes included: occupations with codes higher than and equal to 6000 and less than 9000.
[3] Codes included: occupations with codes less than 3000.

Age is used as proxy for determining the amount of potential work experience of individuals. This is calculated as age minus the years of education, subtracting an additional six years to allow for infancy. The use of age as a proxy for experience is a common practice across literature when years of working experience is not provided in the dataset (see for example Keswell and Poswell, 2004; Biyase and Zwane, 2015; Depken, Chiseni and Ita, 2019).

Various other dummy variables are included by other researchers in the earnings function to observe the impact these dummies have on real wages (see for example Fryer and Vencatachellum, 2003). Gender is included as a dummy variable in this study to determine the wage gap between males and females in each industry at each level of skill.

Individuals belonging to a job union are assumed to receive higher earnings and have access to better working opportunities. The type of area in which an individual resides, can greatly affect monthly earnings, hence area type (urban vs rural) is the final dummy included in the earnings function.

The province and year (2010-2017) variables are included in each of the respective models to controlfor spatial and temporal variation in the sample as fixed effects. The estimates, therefore, contain a collective average that can be used to explain results throughout the country and the period.

The education squared variable is included in the model to determine whether returns to education point towards convexity or concavity. The coefficient of the education squared variable indicates the rate of change in returns to education. A positive estimate of education squared would indicate a positive rate of change in potential earnings; earnings would then increase at an increasing rate. A positive education squared variable also indicates a convex trend in returns to education. A negative estimate of education squared would indicate a concave trend in returns to education; potential earnings would then increase at a decreasing rate. The negative education squared variable thus indicates a negative rate of change in returns to education. The same period and same pooled dataset are used for this analysis to allow for direct comparison between models. Any observations missing information regarding the identified variables are excluded from the sample to avoid inconclusive results.

3.3. Summary statistics

A summary of the data sample used in this study is provided; summary statistics are only provided for the agricultural labour force, as it is the focus of the study. The statistical variables for this sample are reported for real wages, years of education, experience, and other variables in Table 3.1. As the statistics are reported separately for each skill level within the agricultural labour force, it is interesting to see that the number of observations vary. More individuals are employed at entry-level positions compared to skilled and professional individuals. The variation in real monthly earnings is also significant across skill levels, especially when focusing on the years of education between skilled and entry-level workers. Summary statistics tables for workers in mining and manufacturing are included in Appendix A.

Given the summary of statistics reported in Table 3.1, real monthly earnings show a maximum of R 123 million for skilled workers. This obvious error in the data is the reason for omitting results on skilled labour in the data analysis, as this could severely distort the rest of the results.

In Table 3.1, the proportion of entry-level workers who are female is quite high based on the mean of the gender variable, which is 67 percent. This value decreases significantly when looking at females at the skilled and professional levels in agriculture. The proportion of professional females decreases to 14 percent in agriculture. Considering married couples and individuals who live together as married couples, the opposite occurs. As the rank in agricultural employment increases, the proportion of married individuals increases in the sample.

Table 3.1: Descriptive statistics of all workers in the agricultural industry

Statistic	N	Mean	St Dev	Min	Percentile (25%)	Percentile (75%)	Max
Entry- level workers							
Real earnings	81,596	2,119	5,423	0.000	1,086	2,491	585,559
Education (yrs)	83,036	7.3	3.7	0.0	5.0	10.0	17.0
Experience	83,036	28.1	13.3	-2.0	17.0	38.0	83.0
Fmale (=1)	84,405	0.67	0.47	0	0	1	1
Union member (=1)	77,087	0.02	0.13	0.00	0.00	0.00	1.00
Married (=1)	84,405	0.42	0.49	0	0	1	1
Rural (=1)	79,099	0.39	0.49	0.00	0.00	1.00	1.00
Skilled workers							
Real earnings	6,962	31,506	1,501,501	0.000	1,780	5,117	123,600,832
Education (yrs)	7,285	8.0	4.2	0.0	5.0	12.0	17.0
Experience	7,285	29.8	13.9	0.0	19.0	40.0	82.0
Female (=1)	7,338	0.15	0.36	0	0	0	1
Union member (=1)	4,565	0.08	0.27	0.00	0.00	0.00	1.00
Married (=1)	7,338	0.64	0.48	0	0	1	1
Rural (=1)	6,172	0.66	0.47	0.00	0.00	1.00	1.00
Professional workers							
Real earnings	1,399	28,175	64,698	0.000	7,063	26,788	700,570
Education (yrs)	1,609	12.3	2.5	0.0	12.0	14.0	17.0
Experience	1,609	26.64	13.56	0.0	16.0	36.0	67.0
Female (=1)	1,617	0.143	0.350	0	0	0	1
Union member (=1)	811	0.10	0.30	0.00	0.00	0.00	1.00
Married (=1)	1,617	0.76	0.43	0	1	1	1
Rural (=1)	1,303	0.59	0.49	0.00	0.00	1.00	1.00

3.4. Implemented regression equations and expected results

The basic earnings function used to test the hypothesis that returns to education are the lowest in agriculture, is the following:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 EXP_i + \beta_3 EXP_i^2 + YearFE + ProvinceFE + \mu \qquad (2)$$

This extension of Mincer's earnings function contains the same regressors with two additional variables. $Ln(Yi)$ represents the log of real monthly earnings as the dependent variable and is calculated by the addition of the standard education (ED_i), experience (EXP_i), and experience squared(EXP^2) regressors. Fixed effects for the period analysed ($YearFE$), 2010 to 2017, as well a provincial fixed effect ($ProvinceFE$) are included in the model. These fixed effects remain the same throughput the analysis.

Equation 2 is used to analyse returns to education and experience for entry-level and professional workers in agriculture, mining, and manufacturing. The sample used in the analysis divides individuals into the industries they are employed in. Using the SASCO codes, workers are divided into their respective skill levels based on their years of completed education. Year fixed effects and province fixed effects are also included in the model to control for the average differences over the period 2010 to 2017 and across provinces. This equation is then used to run the model nine times for all combinations of education and industries. The coefficient for education is expected to be positive, indicating an increase in earnings with every additional year of education completed, as discussed in the theory (Keswell and Poswell, 2004).

The experience variable is also expected to show a positive sign, because work experience in the labour market is likely to contribute to the development of a worker's human capital. For the variable experience squared, a negative sign is expected as marginal returns to experience decline over the working lifespan of an individual, indicative of concavity with regard to returns to experience.

Although the skilled labour sub-sample is identified in the data, it is not analysed in detail throughout the rest of thestudy. An obvious error occurred, seen in Table 3.1, in the real monthly earnings of skilled labour in agriculture. The earnings record an unrealistically high monthly wage for skilled workers in agriculture and is thus omitted to avoid distorting the rest of the estimates in the study.

The following equation is used to determine convexity in returns to education:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 ED_i^2 + \beta_3 EXP_i + \beta_4 EXP_i^2 + YearFE + ProvinceFE + \mu \quad (3)$$

Equation 3 is an extension of Equation 2 and includes the same variables. The only difference between these models is the addition of an education squared variable (ED_i^2) in Equation 3. The addition of this variable is to determine if there is a concave or convex trend in potential earnings from 2010 to 2017 based on the years of education an individual completed.

The sign of the coefficient of returns to education will determine a concave or convex pattern as education represents the rate of change in returns to education. Returns to education are expected to display a convex trend in returns to education (Keswell and Poswell, 2004), thus positive signs are expected for both the education variable and the education squared variable, indicating rates of returns that increase at an increasing rate. This equation is applied to each industry for workers with various levels of skill, notably entry-level and professional workers. Skilled workers are not included in this analysis because of the obvious error in real monthly earnings data, to prevent distortions in results.

The results from this model can then be directly compared to the results obtained using Equation 2. The only difference between these two equations is the addition of the education squared variable in Equation 3. These results will thus aid in determining if the hypothesis made earlier for convex trends in potential earnings, is true or false.

The following equation is used to determine the gender gap in agriculture:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 EXP_i + \beta_3 EXP_i^2 + \beta_4 GEN_i + YearFE + ProvinceFE + \mu \quad (4)$$

This equation controls for gender in the sample, a dummy with a value of 1 representing female (GEN_i) within the agricultural industry only. This equation determines the magnitude of the wage gap between males and females at the entry-level, skilled, and professional level of skill.

The following equation is used to determine how much more individuals earn based on their skills and gender:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 EXP_i + \beta_3 EXP_i^2 + \beta_4 GEN_i + \beta_5 ED\ GEN_i + YearFE + ProvinceFE + \mu \quad (5)$$

Equation 5 is an extension of Equation 4; aside from the gender dummy variable, an interaction term is also added. Females are expected to earn lower wages than males, a general finding in such studies (Patrinos 2016). Returns to education are also expected to be higher for females than males(Psacharopolous, 2018; Biyase and Zwane, 2015). This equation will determine how much more individuals earn based on their level of qualification and gender in agriculture. The result is determined by the interaction term ($ED\ GEN_i$) between the education and gender variables in the above equation.

The equation used to determine if potential earnings experience show a convex or concave trend, is:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 ED_i^2 + \beta_3 EXP_i + \beta_4 EXP_i^2 + \beta_5 GEN_i + \beta_6 ED\ GEN_i + YearFE + ProvinceFE + \mu \quad (6)$$

Using the same agricultural sample as in Equation 5, Equation 6 includes an education squared variable (ED_i^2). The inclusion of this variable will aid in determining concavity or convexity in potential earnings for entry-level, skilled, and professional workers in agriculture. Results from this model can be directly compared to the previous model as the same period is analysed. The addition of the education squared variable may also affect the gender gap as well as the interaction term.

The rest of the analysis in this study includes various dummies; the following equation is estimated:

$$Ln(Yi) = \beta 0 + \beta_1 ED_i + \beta_2 EXP_i + \beta_3 EXP_i^2 + \beta_4 GEN_i + \beta_5 UNION_i + \beta_6 MARSTAT_i + \beta_7 RURAL_i + YearFE + ProvinceFE + \mu \quad (7)$$

Based on the standard Mincer earnings function, Equation 7 extends on the model and includes a list of additional dummy variables. Equation 7 is used in the final analysis to determine returns and is modelled for all workers in agriculture from 2010 to 2017. Various demographic variables are included in the model to determine the effect of each one on potential earnings. The gender gap is determined again, but gender is included as a dummy variable (GEN_i) for the whole agricultural sample in this model, female = 1. The union dummy variable ($UNION_i$) (union = 1 for unionised workers) is included to determine if earnings are affected by this variable. The marital status ($MARSTAT_i$) of individuals is included like in various studies as discussed in the literature (Biyase and Zwane, 2015; Keswell and Poswell, 2004). This model includes a marital status variable to determine if being married does indeed influence potential earnings. Married workers and individuals living together as a married couple are identified as married, thus = 1. Lastly, the model includes a dummy variable for the area type ($RURAL_i$) in which an individual resides (rural =1). It is expected that returns to education will be higher for individuals in urban areasthan those in rural areas, but this may differ for agricultural workers and will be determined in the following chapter.

Additional models are analysed to determine the effect these dummy variables have on potential earnings when controlling for one or more dummy variable at a time.

3.5.Potential issues

Analysing the relationship between education and experience is not straightforward, because several socio-economic factors simultaneously correlate with education and experience. If these factors are not controlled for in the analysis, it cannot be concluded that the estimated association between education and experience is related (Biyase and Zwane, 2015). Therefore, these socio-economic factors must be accounted for so that changes in earnings are attributed to the relevant factors to prevent bias coefficients.

The skewed distribution of earnings in South African could also result in bias estimates for workers across the country. Therefore, to account for the uneven distribution in wages, a fixed provincial effect is included in all models analysed in this study. The purpose of this fixed effect is to obtain an average result that applies to all provinces. This is the same for the case of years analysed in the study, 2010 to 2017. A yearly fixed effect is included to attain an average result that applies to the period.

Gender earnings may also cause bias estimates, as more males tend to be employed than females (Polacheck, 2008). Especially in agriculture, more physical labour is associated with male employees. With PALMS it is difficult to determine if the gender distribution is even at different levels of skill. As seen in Table 3.1, the number of females decrease in the sample as the rank of employment increases. It is difficult to control for these estimates, thus they should be interpreted cautiously.

Omitted and mis-measured variables may also cause distortions in the results. In Table 3.1 a clearly mis-measured value for real monthly earnings of skilled workers has been highlighted. Therefore, to avoid distortions in the rest of the results in this study, this sub-sample has been omitted. Further limitations will be discussed toward the end of the study.

4. Results

The purpose of this study is to determine the returns to education and experience for agricultural workers. These estimates were compared to the estimates in the mining and manufacturing industries. The basic earnings functions of Mincer (1974) as well as extensions of Mincer's equation were applied to the latest version of PALMS, with the sample including monthly real earnings data from 2010 to 2017. The sample was analysed according to the level of skill and type of industry an individual is employed in; therefore, this chapter will discuss the results accordingly.

4.1. Outline of models

The models used in the OLS regression for this study include a range of dummy variables and fixed effects. The initial model specified the returns to education and experience for entry-level workers in agriculture, mining, and manufacturing. A model forskilled workers was not included in this analysis as an outlier for real monthly earnings is present in the data. The significant amount of R 123 million in monthly earnings is an obvious error and an unrealistic wage for skilled workers. Therefore, a detailed model of returns for this sub-sample of workers was omitted. The next set of models focused on professional workers in these respective industries followed by models that were analysed using Equation 3. This model would indicate ifthere is a positive or negative rate of change in the education variable. The last set of detailed models determined the wage gap between genders in agriculture. The following set of modelsintroduced an interaction term between gender and education, followed by a set of models determining concavity or convexity in potential earnings. Lastly, several models were analysed forall workers in the agricultural industry, specifically from 2010 to 2017, using dummy variables todetermine how potential earnings may be affected. These results will be discussed in detail later in the chapter.

In the last section of this chapter, Equation 3 was used to determine convexity or concavity in potential earnings for workers in all three industries and at all three levels of skill. These results were obtained using the earlier models in this section and allow for the graphical representation of potential earnings in agriculture, mining, and manufacturing.

4.2. Estimation results for entry-level workers across industries

Workers classified as entry-level have a skill level of one, defined by SASCO codes, meaning these workers do not have a higher form of education. It was hypothesised that entry-level workers in the agricultural industry would receive the lowest returns to education compared to workers in mining and manufacturing.

Returns to education is statistically significant and largely affect individuals' earnings in all three industries (see Table 4.1). Firstly, the sample for entry-level workers varies significantly as the number of observations for agricultural workers largely outweigh those for mining and manufacturing. This significant difference in sample sizes may also influence the results recorded in Table 4.1 – results for entry-level agricultural workers. These results also support the hypothesis that entry-level workers in agriculture do in fact receive the lowest returns to education. The positive returns to education across all three industries is in line with the theory that returns to education are positive.

For every additional year of education completed, entry-level workers receive 2 percent higher earnings on average. The low returns to education in agriculture may be the result of differing education requirements; workers at this level in agriculture may not require skills as specialised as in other industries. Although the increase in earnings is low for agricultural workers, it is still positive and significant. The trend of agricultural workers receiving the lowest returns is expected to change as the level of skill changes.

Regarding workers' returns to experience, coefficients are statistically significant for the mining and manufacturing industries, but not for agriculture. Although returns are low across all three industries, they are still positive, as expected, and have a positive effect on workers' earnings, with earnings rising slightly for every year of working experience completed. The negative sign for experience squared is as expected; the negative sign indicates that earnings start to increase at a decreasing rate once an individual reaches a certain age. This expected result indicates a concave trend in returns to experience, which is in line with the theory of returns increasing in smaller increments as individuals age.

Table 4. 1: Returns to education for entry-level workers in three South African industries

	Dependent variable: Log of real wages		
	Agriculture	Mining	Manufacturing
Intercept	7.51***	7.35***	7.33***
	(0.02)	(0.25)	(0.05)
Education	0.02***	0.04***	0.06***
	(0.001)	(0.01)	(0.003)
Experience	0.001	0.01**	0.01***
	(0.001)	(0.01)	(0.002)
Experience2	-3.321e-05***	-2.078e-05	-0.0001
	(0.0000)	(0.0001)	(0.0000)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	80,307	3,448	12,478
R^2	0.09	0.09	0.05
Adjusted R^2	0.09	0.09	0.05
Residual Std Error	0.67	0.85	0.87
F Statistic	445.77***	19.03***	36.22***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

Table 4.2 includes the education squared variable which indicates whether returns to education move toward a convex or concave trend. This model is applied to the same dataset used in Table 4.1 and runs from 2010 to 2017, making the comparison between tables straightforward.

The inclusion of the education squared variable results in the coefficient of education becoming negative. This result is unexpected, as returns to education are expected to remain positive; this goes against the assumptions of the model and the hypothesis. The rate of change in education is positive across all three industries in Table 4.2, as the coefficient of education squared is positive. Returns to education in the agriculture, mining, and manufacturing industries decrease significantly with theinclusion of the education squared variable. Despite the positive rate of change, this may not necessarily indicate a convex trend in earnings over the number of years of education, as the coefficients of returns to education are negative.

These results in Table 4.2 show that earnings are expected to decrease on average for every additional year of education completed, which contradicts the theory of Mincer’s equation about returns increasing with increased years of education completed.

The inclusion of education squared was expected to make the result of returns to education more robust, like in the case of including experience squared into the model. However, this is not the case for entry-level workers. Returns to experience continue to show a concave and expected trend due to a negative coefficient sign for experience squared.

Table 4.2: Returns to education squared for entry-level workers in three South African industries

	Dependent variable: Log of real wages		
	Agriculture	Mining	Manufacturing
Intercept	7.54***	7.52***	7.53***
	(0.02)	(0.25)	(0.06)
Education	-0.01***	-0.03*	-0.01
	(0.002)	(0.02)	(0.01)
Education2	0.002***	0.01***	0.004***
	(0.0002)	(0.001)	(0.001)
Experience	0.003***	0.02***	0.01***
	(0.001)	(0.01)	(0.002)
Experience2	-0.0001***	-0.0002	-0.0001***
	(0.0000)	(0.0001)	(0.0000)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	80,307	3,448	12,478
R^2	0.09	0.10	0.05
Adjusted R^2	0.09	0.09	0.05
Residual Std Error	0.67	0.85	0.87
F Statistic	430.66***	18.97***	36.64***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

Table 4.3 shows the returns to education and experience for professional workers in agriculture, mining, and manufacturing. Workers are classified as professionals in their respective fields using the SASCO codes. According to previous studies, individuals who have completed more years of education, are expected to receive the highest returns to education. The initial hypothesis for professional workers states that returns for agricultural workers are relatively high compared to returns for mining and manufacturing workers.

Professional workers in agriculture on average receive 17 percent higher earnings for every additional year of schooling completed, in line with findings from other studies reported earlier in the literature. Although returns to education for mining and manufacturing are slightly lower, they are still positive and statistically significant, meaning all professional workers in these industries benefit greatly for every additional year of education completed.

Besides the fact that professionals gain the highest returns to education in agriculture, according to the results, they also receive the highest returns to experience. Although returns to experience are positive across all industries, returns are only statistically significant in agriculture. For every additional year of working experience completed, professional workers receive 3 percent higher earnings on average. The result of experience squared is similar, as it is only statistically significant in agriculture. Earnings slowly start to increase at a decreasing rate. This result is as expected, as it represents the earnings life cycle of an individual.

Table 4.3: Returns to education for professionals in three South African industries

	Dependent variable: Log of real wages		
	Agriculture	Mining	Manufacturing
Intercept	7.22***	8.56***	7.64***
	(0.21)	(0.35)	(0.12)
Education	0.17***	0.09***	0.15***
	(0.01)	(0.02)	(0.01)
Experience	0.03***	0.01	0.01
	(0.01)	(0.01)	(0.005)
Experience2	-0.0004***	-0.0003	-5.134e-06
	(0.0001)	(0.0003)	(0.0001)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1,390	1,086	6,395
R^2	0.17	0.06	0.08
Adjusted R^2	0.16	0.05	0.08
Residual Std. Error	1.07	1.07	1.16
F Statistic	16.10***	4.00***	30.30***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

Table 4.4 again records the results for returns to education and experience for professional workers in the agriculture, mining, and manufacturing industries. However, the difference between these results and the results in Table 4.3 is that the education squared variable is introduced. The inclusion of this variable is to determine convexity or concavity in returns to education for professional workers in their respective industries. Results in Table 4.4 can be directly compared to the results in Table 4.3, as the model analyses the same dataset over the same period – 2010 to 2017.

Including the education squared variable has a significant impact on returns to education for professional workers across all three industries. Returns to education remain statistically significant for professionals in the agricultural and manufacturing industries. Returns for these workers also decrease slightly compared to the returns to education reported in Table 4.3, although professional agricultural workers continue to receive the highest returns to education for every additional year of education completed; earnings increase by an average of 13 percent each year. The returns to education for the agricultural and manufacturing industries displayed in Table 4.4, show that returns experience a convex yet insignificant trend as the coefficients of the education squared variables are positive. Returns to education for mining professionals show a negative rate of change in education as the coefficient of education squared is negative. Although the rate of change is negative, the rate is extremely small and may not necessarily result in a concave trend for earnings. These insignificant results for education squared indicate that earnings of individuals working in the respective industries only change slightly.

The inclusion of the education squared variable resulted in no value change in returns to experience for professionals in all three industries. In Table 4.4, the addition of education squared resulted in returns to experience becoming statistically significant for manufacturing professionals. Returns to experience for agricultural professionals remain statistically significant, while also remaining the highest returns to experience across all three industries.

The negative coefficients for experience squared in Table 4.4 across all three industries indicates that these results display a concave trend. Although these values remain low, like in Table 4.3, it results in professionals' earnings increasing at a decreasing rate by the respective increments. This trend in concavity for experience squared for professional workers is in line with the findings of the existing literature.

Table 4.4: Returns to education squared for professional workers in three South African industries

	Dependent variable: Log of real wages		
	Agriculture	Mining	Manufacturing
Intercept	7.38***	8.47***	7.88***
	(0.31)	(0.48)	(0.23)
Education	0.13***	0.11	0.11***
	(0.05)	(0.07)	(0.03)
Education2	0.002	-0.001	0.002
	(0.002)	(0.003)	(0.001)
Experience	0.03***	0.01	0.01*
	(0.01)	(0.01)	(0.005)
Experience2	-0.0004***	-0.0003	-1.356e-05
	(0.0001)	(0.0003)	(0.0001)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1,390	1,086	6,395
R^2	0.17	0.06	0.08
Adjusted R^2	0.16	0.05	0.08
Residual Std Error	1.07	1.07	1.16
F Statistic	15.28***	3.79***	28.78***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

4.3. Gender wage gaps in agriculture

Introducing a gender variable into the earnings function is common in this field of study and provides insight into how earnings differ between males and females. Considering the wage gap between males and females that is reported throughout the literature, this following section focuses on how females' earnings in agriculture are affected by their levels of education and years of experience. To compare earnings, females are divided into skill groups based on the levels of education attained in Table 4.5.

Although the observation for different levels of skill differs significantly, the results for each group display the same trend. Returns to experience and education are statistically significant and positive at all levels of skill, while experience squared also displays an expected result of low and negative estimates. This confirms a concave trend in returns to experience which is in line with the existing theory.

The results for including gender into the model, show a significant gap between female and male earnings, regardless of the level of skill. Females employed at entry-level earn an average of 16 percent[5] lower than males, which is a small discrepancy compared to females working at skilled and professional levels. Skilled and professional females earn an average wage of 34 percent and 30 percent lower than males in the agricultural industry. The wage gap between genders increases from entry-level to skilled workers, indicating that males benefit more from higher levels of education in this industry. Results for the mining and manufacturing industries (not presented here) indicate that the wage gap between males and females stretches across industries and females continue to earn lower wages. The smallest wage gap exists between professional females and males in the mining industry, with females earning an average of 5 percent lower wages than males.

[5] Dummy variable percentages are calculated using the antilog of the coefficients from the tables, minus one.

Table 4.5: Determining the gender wage gap in agriculture

	Dependent variable: Log of real wages		
	Entry-level	Skilled	Professional
Intercept	7.52^{***}	6.67^{***}	7.22^{***}
	(0.02)	(0.08)	(0.21)
Education	0.02^{***}	0.13^{***}	0.17^{***}
	(0.001)	(0.003)	(0.01)
Experience	0.004^{***}	0.03^{***}	0.03^{***}
	(0.001)	(0.003)	(0.01)
Experience2	-0.0001^{***}	-0.0001^{*}	-0.0004^{***}
	(0.0000)	(0.0001)	(0.0001)
Female (=1)	-0.18^{***}	-0.41^{***}	-0.36^{***}
	(0.01)	(0.04)	(0.09)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	80,307	6,910	1,390
R^2	0.10	0.24	0.18
Adjusted R^2	0.10	0.24	0.17
Residual Std Error	0.67	0.99	1.06
F Statistic	487.97^{***}	114.44^{***}	16.33^{***}
Significance levels	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$		

Note: Standard errors are reported in parenthesis.

Table 4.6 displays the model results for the same model used in Table 4.5, with the addition of an interaction term between gender and education. These results illustrate how earnings are affected based on an individual's level of skill and qualification, represented by the interaction term of gender (female) and education.

The interaction of gender and education determines the impact of education level on females' earnings as they move through the ranks of agricultural employment. Entry-level males earn an average of 15 percent higher wages than females, and professional males an average of 79 percent higher wages than females! The results in Table 4.6 show that the gender gap is not the same at all levels of skill and the interaction term provides more detail. Males at entry-level in agriculture earn slightly higher wages for every additional year of education completed compared to females. The same result can be observed for males and females at the skilled level in agriculture. From this observation, females tend to earn slightly lower returns to education at the entry-level; however, this difference in returns is not significant. A significant difference between wages for males and females at the skilled level does exist; females continue to earn lower wages and lower returns to education as indicated by the negative and statistically significant coefficient of the interaction term. Education thus favours males at the skilled level in agriculture. However, professional females in agriculture receive significantly higher returns to education for every additional year of schooling completed compared to males. As indicated by the positive and statistically significant coefficient for the interaction term in Table 4.6, education thus favours females more at the professional level in agriculture compared to other levels of skill.

According to the results in Table 4.6, more qualified individuals earn higher returns to education. Although the gender wage gap proves to be the biggest for professionals in agriculture, professional females benefit the most from higher levels of education. Females with higher levels of education will thus receive higher returns to education compared to males.

Table 4.6: Determining the gender wage gap in agriculture with an interaction term

	Dependent variable: Log of real wages		
	Entry-level	Skilled	Professional
Intercept	7.52***	6.65***	7.40***
	(0.02)	(0.08)	(0.22)
Education	0.02***	0.13***	0.15***
	(0.001)	(0.003)	(0.01)
Experience	0.004***	0.03***	0.03***
	(0.001)	(0.003)	(0.01)
Experience2	-0.0001***	-0.0001*	-0.0005***
	(0.0000)	(0.0001)	(0.0001)
Female (=1)	-0.17***	-0.26***	-1.55***
	(0.01)	(0.07)	(0.41)
Education x Female	-0.001	-0.02**	0.09***
	(0.001)	(0.01)	(0.03)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	80,307	6,910	1,390
R^2	0.10	0.24	0.19
Adjusted R^2	0.10	0.24	0.18
Residual Std Error	0.67	0.99	1.06
F Statistic	463.61***	109.09***	16.04***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

The results presented in Table 4.7 are based on the same model as in Table 4.6, with the addition of the education squared variable being the only difference. This model runs over the same period, 2010 to 2017, for the same dataset.

The addition of the education squared variable has a significant effect on the returns to education in Table 4.7. Returns to education for entry-level and skilled workers become negative and statistically significant, an unexpected result that is not in line with the theory discussed earlier, as returns to education are expected to remain positive. Returns to education for professional workers decrease slightly but remained positive and significant. Professional workers in agriculture continue to earnthe highest returns to education in agriculture. The positive education squared variable displayed in Table 4.7 indicates a convex trend in returns to education for all levels of skill.

Returns to experience are significantly impacted in Table 4.7 by the inclusion of education squared for entry-level workers; returns to experience increase. For skilled and professional workers, returns to experience remain unchanged. The negative and low coefficients of the experience squared variable is as expected and in line with the theory, indicating concavity in returns to experience for all workers in the agricultural industry.

Compared to the gender dummies in Table 4.6, the estimates for the gender wage do not change much for entry-level and professional workers with the addition of education squared. The gender gaps for both skill levels decrease by only 1 percent. In the case of skilled workers, the gender gap increases from 5 percent to 28 percent. The interaction term between gender and education in Table 4.7 remains negative for entry-level workers and becomes significant with the addition of the education squared variable. The coefficient of the interaction term for skilled workers remains negative as well, however, the change is not significant, and females continue to earn slightly lower returns to education compared to males. The estimate of the interaction term for professional workers remains the same as in Table 4.6; females receive higher returns to education compared to males in agriculture.

Table 4.7: Returns to education squared for the gender wage gap in agriculture

	Dependent variable: Log of real wages		
	Entry-level	Skilled	Professional
Intercept	7.54***	7.18***	7.56***
	(0.02)	(0.08)	(0.31)
Education	-0.01***	-0.05***	0.12**
	(0.002)	(0.01)	(0.05)
Education2	0.003***	0.01***	0.002
	(0.0002)	(0.001)	(0.002)
Experience	0.01***	0.03***	0.03***
	(0.001)	(0.003)	(0.01)
Experience2	-0.0001***	-0.0002***	-0.0005***
	(0.0000)	(0.0001)	(0.0001)
Female dummy	-0.16***	-0.33***	-1.53***
	(0.01)	(0.07)	(0.42)
Education x Female	-0.003**	-0.01	0.09***
	(0.001)	(0.01)	(0.03)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	80,307	6,910	1,390
R^2	0.11	0.28	0.19
Adjusted R^2	0.11	0.28	0.18
Residual Std Error	0.67	0.97	1.06
F Statistic	451.98***	126.30***	15.29***
Significance levels	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors are reported in parenthesis.

4.4. The effects of additional variables on agricultural earnings

Besides education and experience as the standard Mincer equation (1974) predictors, other dummy variables are added to the earnings function to determine their effect on wages. This section focuses on the magnitude of these effects on earnings in the agricultural industry only, regardless of individuals' skill levels.

The analysis consists of five main models, Model 1, 2, 3, 5 and 7, and covers the same period from 2010 to 2017. These models analyse the same pooled dataset as in the previous section – the data for the agricultural industry is analysed without separating workers into skill levels. Model 1 runs the basic Mincer equation, represented by Equation 2. Besides the standard Mincer regressors, a gender dummy is added to Model 2; the estimate in this model indicates the difference in earnings between genders. Model 3 includes a union membership dummy variable to indicate the effect on earnings if workers belong to a union; it is assumed that workers who belong to a union, receive higher earnings (Long, 2013). The effect of individuals' marital status on earnings is analysed in Model 5 – this also includes individuals in households who live together like a married couple. Model 7, the last of the main models, includes a dummy variable for the type of area individuals reside in, defined as rural and urban areas.

Besides the main models discussed, there are four additional models for controlling: Model 4, 6, 8, and 9. Models 8 and 9 are estimated using the same equation, Equation 7. However, the province fixed effect is not included in Model 8, which changes the estimates in Model 9. The estimates for all nine models are displayed in Table 4.8.

Table 4.8: Summary of the regression results for agriculture including all dummy variables

	Dependent variable: Log of real wages								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	7.15***	7.23***	7.45***	7.47***	7.12***	7.45***	7.09***	7.11***	7.42***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Education	0.06***	0.07***	0.03***	0.04***	0.06***	0.04***	0.06***	0.04***	0.04***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience	0.002***	0.01***	-0.0001	0.005***	-0.001	0.003***	0.004***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience2	0.0001***	-1.352e-05	6.701e-06	-3.890e-05**	0.0001***	-1.513e-05	4.735e-05***	-1.265e-05	-1.919e-05
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Female (=1)		-0.37***		-0.25***		-0.25***		-0.20***	-0.21***
		(0.01)		(0.01)		(0.01)		(0.01)	(0.01)
Union member (=1)			0.60***	0.53***		0.53***		0.55***	0.52***
			(0.02)	(0.02)		(0.02)		(0.02)	(0.02)
Married (=1)					0.17***	0.08***		0.10***	0.07***
					(0.01)	(0.01)		(0.01)	(0.01)
Rural (=1)							0.11***	-0.11***	-0.01
							(0.01)	(0.01)	(0.01)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	90,588	90,588	80,033	80,033	90,588	80,033	83,829	73,787	73,787
R^2	0.11	0.15	0.10	0.13	0.12	0.13	0.11	0.07	0.13
Adjusted R^2	0.11	0.15	0.10	0.13	0.12	0.13	0.11	0.07	0.13
Residual Std Error	0.79	0.77	0.72	0.71	0.79	0.71	0.78	0.73	0.71
F Statistic	593.97***	839.07***	493.79***	592.99***	621.85***	578.42***	552.22***	389.71***	498.20***
Significance levels	*p<0.1; **p<0.05; ***p<0.01								

Note: Standard errors are reported in parenthesis.

Most of the dummy variables included in the earnings functions for the agricultural industry are statistically significant at the 99 percent confidence interval. The year variable is applied to every model as a fixed effect; therefore, these estimates represent returns from 2010 to 2017. Like the year variable in PALMS, the province variable is also applied to all models except Model 8 as a fixed effect. The R-squared variable increases as more variables are added into the model. Adjusted R-squared determines how reliable the correlation is between the dependent and independent variable. In Table 4.8, the adjusted R-squared increases for Model 2, 5 and 7 compared to the base Model 1. This increase in adjusted R-squared indicates that relevant variables are included into the model.

4.4.1. Gender – Female

The results in Model 2 in Table 4.8 indicate that on average, for all levels of education obtained by female workers in agriculture, there is still a prominent wage gap between genders. This observation is in line with other studies in this field, as gender gaps are common across many industries. Females earn an average of 31 percent lower wages than males, yet their returns to education prove to be more profitable; including the gender dummy variable results in both returns to education and experience being the highest, compared to including other dummies.

As more dummies are included into the model (Model 4, 6, 8 and 9), the magnitude of the female variable decreases, which might indicate that the model with only the gender dummy suffers from omitted variable bias. Thus, the gender coefficient has an upward bias because it wrongly captures some of the effects that should be attributed to other dummies.

4.4.2. Union workers

Model 3 includes a dummy variable to determine the difference in wages between workers who belong to unions and those who are not union members. The results indicate the difference in wages for workers who belong to a union in the agricultural industry compared to those who do not. These results show that unionised workers earn an average of 82 percent higher wages compared to those who are not union members. Unionised workers are expected to earn higher wages as they have better access to employee-sponsored benefits and receive larger wage increases.

Although the estimates for unionised workers indicate much higher earnings, fewer than 6 percent of farm workers belong to trade unions in South Africa. Low levels of unionisation in the agricultural sector are due to South African trade unions being largely based in urban areas (Webb, 2017).

4.4.3. Marital status

The marital status of workers also has a significant impact on their potential earnings. Siphambe and Thokweng-Bawena (2001) suggest that employers may be more willing to invest in the human capital of married women by providing more training. Studies in the same field often include the marital status of individuals to control individual and household characteristics (see for example Biyase and Zwane, 2015; Depken, Chiseni and Ita, 2019). According to Model 5 in Table 4.8, agricultural workers defined as married, including individuals who live together as a married couple, earn an average of 19 percent higher wages compared to those who are not married. In Model 6 the gap between married and unmarried workers decreases by almost 10 percent when gender and union are controlled for.

Fryer and Vencatachellum (2003) report that married females would be rendered less mobile if employers provide on-the-job training and a lower probability of quitting the job. Therefore, especially females in rural areas benefit more if they are married, as they possibly receive more training and other employee benefits.

4.4.4. Urban-rural

Several studies found that workers receive higher wages in the urban areas than the rural areas. However, in the case of people working in the agricultural industry, results indicate that workers benefit more in the rural areas. Agricultural workers receive higher potential earnings in rural areas compared to urban areas. Regardless of qualifications, agricultural workers based in rural areas receive an average of 11 percent higher wages (Model 7).

When including the area type variable into a model with all the other dummy variables, the rural variable becomes negative. Another interesting finding for the rural area variable in Model 8 is that the estimate for rural areas is statistically significant when province is not controlled for via fixed effects in this specific model. This estimate changes significantly once province is controlled for and the rural area variable becomes insignificant. The rural coefficient in Model 8 is statistically significant with a value of negative 10 percent. This value increases significantly once province is controlled for as seen in Model 9 in Table 4.8. Thus, controlling for province leads to an insignificant estimate for rural and only has a slight negative impact on potential earnings for agricultural workers. Therefore, the province in which an individual resides may have a significant impact on potential earnings.

4.5. Potential earnings for entry-level and professional workers

Studies investigating returns to education in South Africa found that potential wages display a convex trend over the number of years of education (Keswell and Poswell, 2004). In this section, potential earnings are graphed over the number of years of education individuals have completed. These graphs illustrate whether potential earnings display a convex or concave trend to determine if the results in this study are consistent with existing studies. These graphs allow for comparison with other studies as well. The figures in this section are estimated using Equation 3; thus, these results provide the potential earnings for entry-level and professional workers in agriculture, mining, and manufacturing. The skilled sub-sample is omitted again for continuity, as it was omitted in the previous analysis to prevent distortions in the overall results. Potential earnings are calculated over the number of years of education, *cetris paribus*. The same pooled sample of workers is used in this analysis from 2010 to 2017 as in the earlier models.

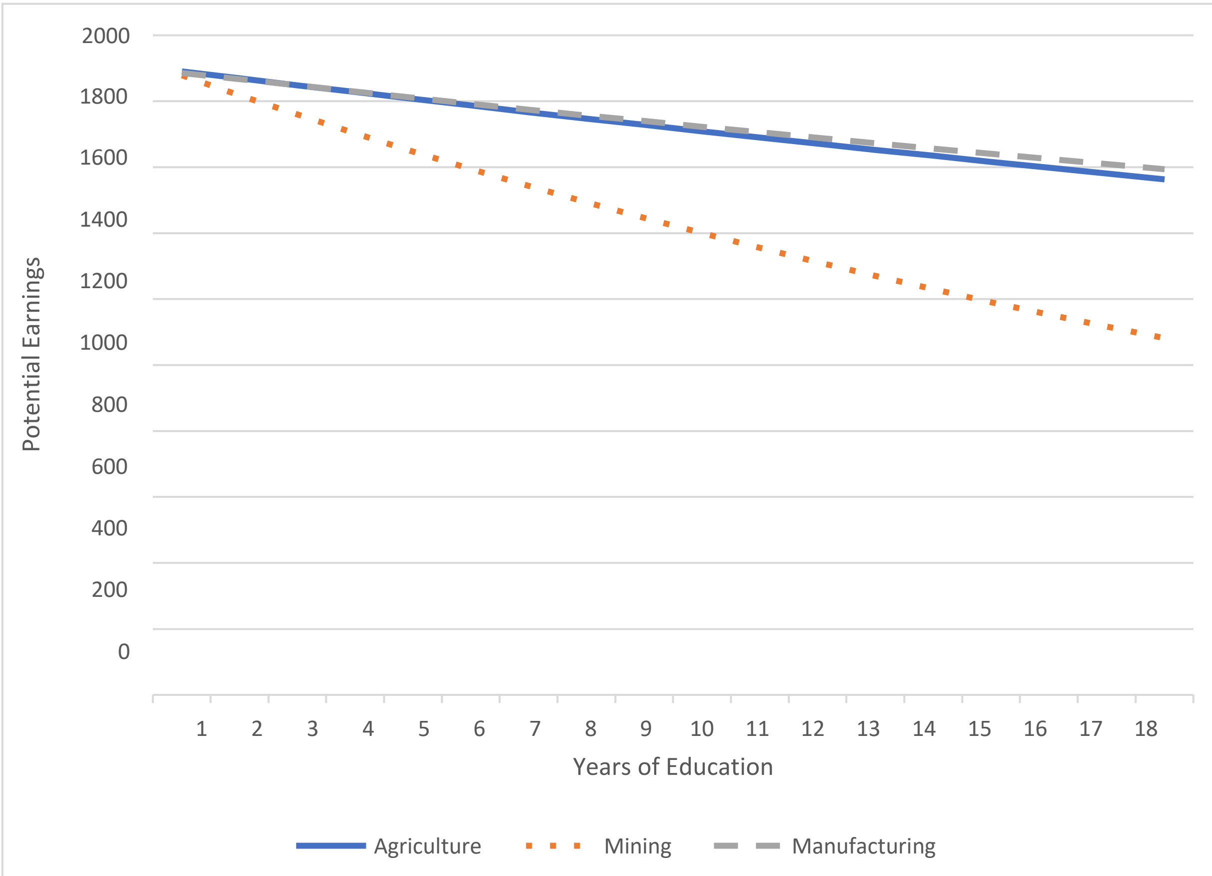
4.5.1 Determining the trend in potential earnings for entry-level workers

Figure 4.1 displays the trend in potential earnings for entry-level workers in agriculture, mining, and manufacturing against the corresponding years of education for this sample. To facilitate comparison with Keswell and Poswell (2004), the estimates in Table 4.2 are used to calculate potential earnings and graphed in Figure 4.1 as an alternative way of depicting these estimates. Potential earnings are expected to display a convex trend over the number of years of education. A convex trend thus indicates a positive rate of change in education. However, Figure 4.1 displays a contradicting trend in potential earnings. The potential earnings appear to decrease for entry-level workers in all three industries as the number of years of education increase. Although a positive rate of change for education is displayed earlier in Table 4.2, the negative coefficient has a significant impact on potential earnings. This positive coefficient of education squared suggests convexity in education. However, this unexpected result of negative returns to education results in a decreasing trend for potential earnings, because the positive rate of change represented by the education squared variable is significant but not big enough to change the direction of earnings. Thus, these results contradict the findings in Keswell and Poswell (2004) as well as other previous studies (Patrinos, 2016; Psacharopolous, 2018), as returns to education recorded for this sub-sample are negative across all three industries.

The trend in Figure 4.1 suggests that potential earnings decrease at a decreasing rate for entry-level workers in all three industries. The trend for entry-level workers in mining appears to be more severe, despite the rate of change for mining being the highest compared to agriculture and manufacturing. The trend in potential earnings for agriculture and manufacturing workers are very close to each other, as the rate of change in education for these industries is similar (see Table 4.2). The estimates for both industries do not vary much except for experience (see Table 4.2).

This decreasing trend also suggests that entry-level workers do not benefit from increased levels of education, as the positive rate of change is not big enough to increase earnings significantly. These results in potential earnings for entry-level workers in agriculture also do not support the initial hypothesis that entry-level agricultural workers earn lower wages compared to those in mining and manufacturing. Figure 4.1 shows that entry-level workers in the mining industry earn the lowest wages, with agricultural workers earning slightly lower wages than workers in manufacturing.

Figure 4.1: Potential earnings for entry-level workers in three South African industries



4.5.2 Determining the trend in potential earnings for professional workers

The trend in potential earnings for professional agricultural, mining, and manufacturing workers and the corresponding years of education for this sample of individuals are displayed in Figure 4.2. To compare potential earnings of professional workers with Keswell and Poswell (2004), earnings were estimated using the results in Table 4.3. The estimates in Table 4.3 were then inserted into Equation 3 with the corresponding years of education to calculate potential earnings. A convex trend in potential earnings is expected for professional workers (Keswell and Poswell, 2004). A convex trend would mean that a positive rate of change in education is expected to increase potential earnings as additional years of education are completed.

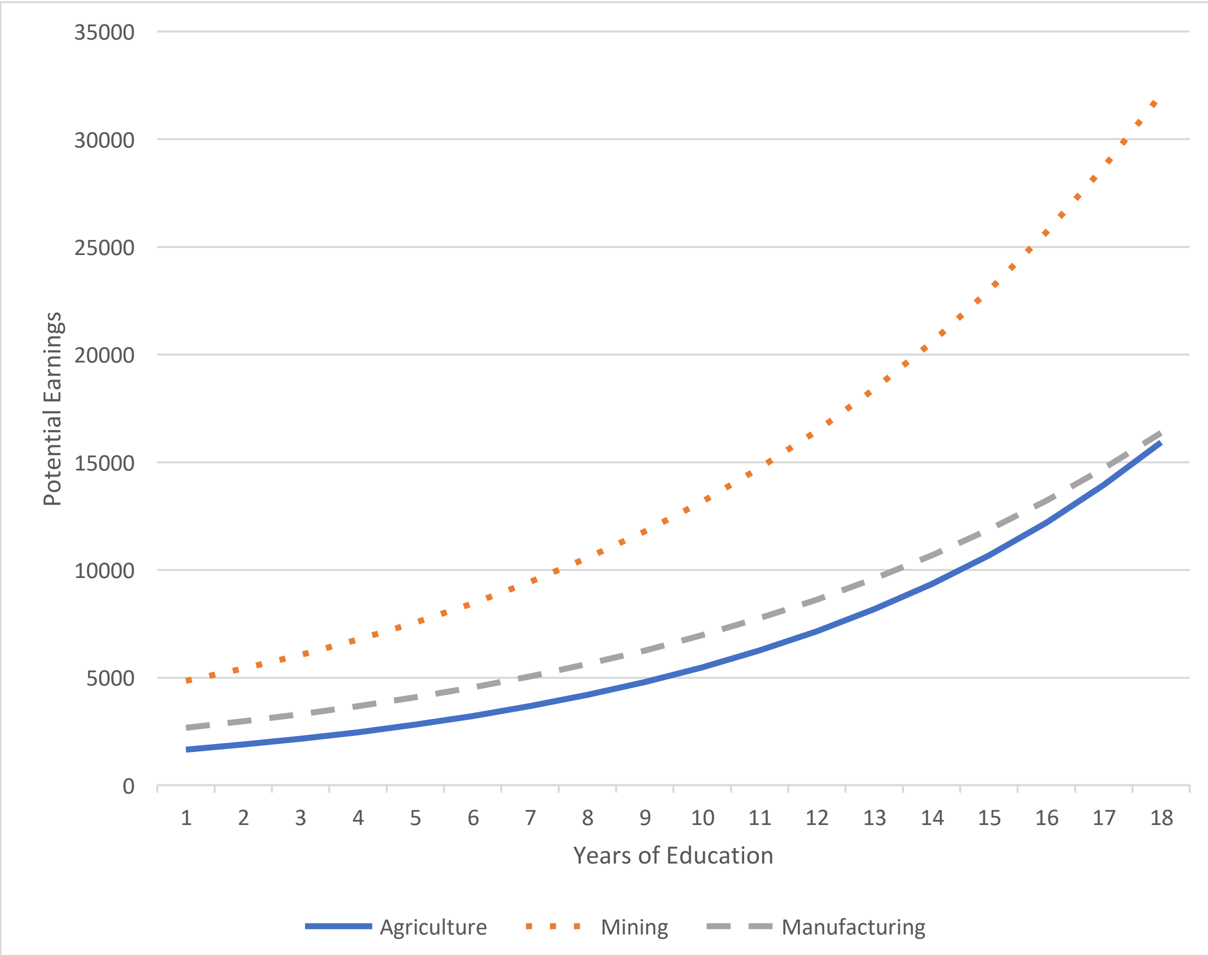
Potential earnings for professional workers in agriculture, mining, and manufacturing display a convex trend in Figure 4.2. This convex trend in potential earnings for workers in all three industries is in line with the findings of Keswell and Poswell (2004).

In Table 4.4, the rate of change (education squared coefficient) recorded for agricultural and manufacturing professionals is positive. Although a negative rate of change is recorded for mining professionals, the insignificant value does not have a big impact on earnings. Professional workers in mining appear to earn the highest earnings, despite a negative rate of change, as their returns to education are quite high.

Returns to education for professional agricultural workers are the highest compared to mining and manufacturing (see Table 4.4). Despite these high returns to education, professionals in agriculture appear to have the lowest potential earnings. This could be attributed to the small rate of change in education for professionals; the negative rate of change for experience is also the biggest in agriculture. The negative rate of change in experience for agricultural workers may, therefore, result in diminishing returns being more severe in this sub-sample compared to the others.

Although agricultural professional workers earn the lowest potential wages, this convex trend in Figure 4.2 indicates that workers benefit from additional years of education. All professional workers in these three industries gain higher earnings for every additional year of education they complete. These results are, therefore, in line with studies that have found convex trends in potential earnings over years of education, as the expected trends are displayed in Figure 4.2.

Figure 4.2: Potential earnings for profession workers in three South African industries



Most of the results in this study are in line with and support the findings recorded in other existing literature (see for example Psacharopoulus and Patrinos, 2018; Depken, Chiseni and Ita, 2019; Keswell and Poswell, 2004) researching the returns to education. It extends the research by highlighting the benefits of increased education for agricultural workers in South Africa, which have not been researched in the South African context before.

The earnings functions applied reveal that education has a significant impact on earnings of all workers, regardless of the industry in which they are employed. The returns to experience also indicate how valuable years of working in the labour force benefit various individuals.

5. Summary of findings, conclusion, and recommendations

This chapter provides a summary and interpretation of the findings, conclusions, and recommendations based on the data analysed in the previous chapter. The returns to education for workers with different levels of skill were determined at industry level using the Mincer framework. In this chapter a summary of the findings is provided first, followed by a discussion of these findings to provide context and explain the importance of these results. A conclusion to the study is then drawn with policy recommendations. This study concludes by discussing the limitations that are common in this type of study and future research recommendations based on these limitations.

5.1. Summary

As the topic of returns to education has been extensively researched in South Africa, this study followed a slightly different direction. Literature determining the returns to education and experience in specific industries is scarce in South Africa. Therefore, the primary objective of this study was to determine the returns to education and experience for the agricultural labour force using Mincer's earnings functions. The objective of Mincer's equation is to quantify returns to education and experience gained by an individual for each additional year of education and experience in the workforce. Mincer's equation also has the capacity to include additional background and individual characteristics into the model, determining the influence these may have on earnings.

The returns to education and experience for workers employed in the agricultural industry were analysed and compared to those in the mining and manufacturing sectors. To this end, the level of education and experience of individuals, as well as other factors that influence their monthly earnings, were considered. This study made use of the monthly data provided by PALMS between the years 2010 and 2017. If compared to other studies on the returns to education and experience in South Africa, this study is novel in that it both distinguishes between the industries in which individuals are employed and the skill levels at which they are employed.

The main analysis in this study is based on the OLS regression of the adjusted Mincer equation. Variables for education were classified using the SASCO codes to represent the levels of education of individuals and utilising the years of education variables in PALMS. Different models were run for each of the identified skill levels. Other dummy variables as well as fixed effects were inserted to determine the impact of individuals' provinces of residence on wages.

Table 4.1 displays the returns to education and experience for entry-level workers in agriculture, mining, and manufacturing. Results in this table for entry-level agricultural workers indicate that potential earnings increase by 2 percent on average for every additional year of education completed. Agricultural workers receive the lowest returns to education compared to workers in the mining and manufacturing industries. Therefore, entry-level workers in agriculture benefit the least from additional years of schooling, as workers in mining and manufacturing receive an average of 4 and 6 percent higher wages, respectively.

Professional workers in agriculture gain 17 percent higher earnings on average for every additional year of education completed (see Table 4.3). Professional agricultural workers also receive the highest returns to experience compared to mining and manufacturing – 3 percent for every additional year of working in the labour force. The estimate for experience squared indicates a negative rate of change in experience as the coefficient for experience squared is negative for all three industries. In agriculture, professionals' wages increase at a decreasing rate of 0.04 percent. This concave result for age-earnings is consistent with the theory.

Tables 4.2 and 4.4 include an education squared variable which determines the rate of change in education. The theory suggests that a convex pattern is expected for earnings; therefore, a positive rate of change is expected to increase earnings as additional years of education are completed. The results for entry-level workers differ significantly from the theory, as returns to education result in negative coefficients with the inclusion of education squared. Positive coefficients for education squared are recorded for entry-level workers in Table 4.2, indicating a positive rate of change in education. This result suggests convexity in earnings for these workers based on this positive rate of change. The results for professional workers in Table 4.4 are in line with the theory. Agricultural professionals continue to receive the highest returns to education with the addition of the education squared variable. The education variables for agricultural and manufacturing workers are positive, indicating a positive rate of change in education, indicating convexity. The rate of change for mining professionals is negative and very low; this negative rate of change suggests that earnings increase at a decreasing rate.

The regression results indicate that a significant wage gap exists between genders, regardless of their levels of skill – males earn much more than females in agriculture, mining, and manufacturing. Females employed in the agricultural industry at an entry-level position earn approximately 16 percent lower wages than males (see Table 4.5), while females classified as skilled or professional earn around 34 percent and 30 percent lower wages respectively than males working in the same positions.

A further extension of the gender analysis is the inclusion of an interaction term between gender and education. This provides an estimate on the returns to education according to gender and years of education. The results show that women working in agriculture at entry-level and skilled positions receive slightly lower returns to education for every additional year of schooling compared to males, while the result for professional females is the opposite – these females earn higher returns to education compared to males (see Table 4.6).

Returns to experience throughout the study remain low and positive, indicating that additional years of working experience positively impact individuals' earnings. Returns to experience square are as expected – low and negative – to show that returns increase at a decreasing rate, which indicates concavity.

The results show that including gender, marital status, union membership, and area type variables greatly influence the monthly real wages of individuals. The inclusion of each additional variable into the model also slightly improves the adjusted R-squared, improving the fit of the model.

When modelling for all individuals employed in the agricultural industry (see Table 4.8), regardless of skill levels, females earn on average 31 percent less than males. The research shows that workers who belong to a union, receive significantly higher earnings compared to those who are not unionised; unionised workers earn 82 percent higher wages on average. The same observation applies to individuals who are married; these individuals earn an average of 19 percent higher wages. The final model determines the difference in wages between individuals in the rural and urban areas. The result shows that agricultural workers in rural areas earn on average 11 percent higher wages compared to workers in urban areas.

Lastly, the estimates recorded in Tables 4.2 and 4.4 are used to calculate potential earnings for entry-level and professional workers to determine convexity or concavity in earnings. Figure 4.1

displays the potential earnings for entry-level workers in agriculture, mining, and manufacturing. Despite the positive rate of change that is recorded for entry-level workers in all three industries, it shows a decreasing trend in potential earnings. This decrease in earnings could be the result of the negative and unexpected returns to education for workers in all three industries. These results are inconsistent with the findings in other studies, as returns to education are expected to be positive and increase earnings with every additional year of education completed. Although the rate of change – education squared – is positive, the insignificant size of these changes may not be big enough to increase earnings given the number of years of education. From this graph it is also clear that entry-level agricultural workers do not earn the lowest wages as estimated by Equation 3; mining workers earn the least. This declining trend in earnings suggests that entry-level workers do not benefit from additional years of education, which is inconsistent with the theory.

Figure 4.2 displays the potential earnings for professional workers in agriculture, mining, and manufacturing. The trend of potential earnings for professional workers displays an obvious convex trend over the number of years of education. Despite a negative rate of change recorded for mining professionals in Table 4.4, potential earnings display a convex trend. Mining professionals appear to earn the highest potential earnings; their earnings appear to increase at a faster rate for every additional year of education completed. Despite agricultural professionals having the highest returns to education, they have the lowest potential earnings, as seen in Figure 4.2. Although agricultural professionals earn the lowest potential earnings, they still benefit from additional years of education. After nine years of education, potential earnings increase at a faster rate.

5.2. Discussion

The returns to education for entry-level workers are generally lower in agriculture compared to the other industries but once individuals obtain a higher level of skill, their returns to education improve significantly. Therefore, education has a significant effect on the monthly earnings of all workers. The findings in this study also provide further insight into factors influencing earnings. Various kinds of potential biases can have an impact on the estimates for returns to education. Common examples of biases in this field of study include the omission of ability, race, family background, school quality, and the error stemming from the mismeasurement of the education variable itself (Keswell and Poswell, 2004). This discussion will focus on reasons as to why returns to education and experience are lower in the agricultural industry. This will then be followed by a discussion of why and how the identified factors in the data analysis influence earnings.

Ferreira (2018) reports that, in Malawi, the overall trend in returns to education in agriculture is low. Considering the other studies reviewed in Africa, the significance of returns to education depends on the nature of the farming practices used. On farms using traditional practices, education does not have much of an impact on the productivity of farm workers, whereas education is greatly valued on farms using improved technologies and improved farming practices and workers with additional years of education prove to be more productive. The results of this study show that education can significantly impact the earnings of workers in this industry.

5.1.1 Differences in industry returns to education

It was hypothesised in the beginning of this study that returns to education would be the lowest for entry-level workers in agriculture. The results from the analyses uphold this prediction – entry-level workers in the agricultural industry receive the lowest returns to education compared to other industries. Comparing the returns across industries, entry-level workers receive the lowest returns to education as their field of study may not be as specialised compared to other industries. An additional year of schooling completed increases an entry-level worker’s earnings on average by 2 percent (refer to Table 4.1). As returns to education increase with higher levels of education, entry-level workers are at a significant economic disadvantage. Entry-level workers are classified as only having a skill level equal to one. In South Africa, this level entails those individuals who received primary education, generally starting between the ages of 5 to 7 years old and includes a standard six years of full-time schooling. Individuals without any formal primary schooling also form part of this group (Stats S.A., 2012).

Although an in-depth analysis of skilled agricultural workers was not conducted, estimates for returns to education and experience for this group are recorded in Table 4.5. Compared to entry-level returns, skilled workers in agriculture receive approximately 13 percent more in monthly earnings for every additional year of schooling. Skilled workers receive higher returns, as they are required to obtain knowledge and skills necessary for competent performance, generally achieved through the completion of secondary schooling. A period of on-the-job training and experience in the form of apprenticeships or learnerships may be required and may supplement or partly replace formal training in some cases (Stats S.A., 2012).

Professionals in agriculture receive approximately 17 percent more earnings for every additional year of schooling completed (see Table 4.3). Considering that professionals are classified as having achieved higher levels of schooling in the form of a degree or higher qualification, these individuals are expected to earn the most. In some extensive cases, experience may replace formal education, or may be required in addition to formal education (Stats S.A., 2012). In this study, results for returns to experience for professionals are recorded as the highest – 3 percent for every additional year of working in the labour market. Although returns to experience remain low throughout the industries in this study, agricultural workers prove to receive the highest returns to experience, increasing with the level of skill. This result can be ascribed to the fact that workers in this industry are required to do more manual labour and farm workers usually start at entry-level positions at a very young age and gain more experience.

The difference in returns to education across industries is partly attributed to education being used as a screening tool in the formal sector. This statement is supported by the fact that earnings in the agricultural industry, which are a more accurate measure of productivity than wages, is low. Another reason for differing returns to education across industries is that the education syllabus in schools provides students with skills that are more useful in the formal sector than in agriculture (Ferreira, 2018).

Although entry-level returns to education are the lowest in agriculture, returns for skilled and professional workers are the highest compared to the other industries. In support of the hypothesis made earlier in the study, professional workers in agriculture receive the highest returns to education. These results are consistent with those of the existing studies done in South Africa – individuals with higher levels of education, receive higher earnings. In the case of agriculture, increased knowledge is desired, as the industry continues to become modernised and workers are required to work with capital intensive machinery. As discussed earlier in the literature, modernised practices are becoming more common and education is valued more in a modernising environment.

To facilitate comparison between this study and existing studies in this field, returns to education were graphed in section 4.5, using the estimates recorded in Table 4.2 and Table 4.4. The purpose of these graphs is to graphically illustrate whether returns to education display a convex or concave trend based on the rate of change reported in the previously mentioned tables. The theory and findings in Keswell and Poswell (2004) suggest that returns to education display a convex pattern. In the case of entry-level workers (see Figure 4.1), negative returns to education are recorded, resulting in a decreasing trend in returns to potential earnings based on education. With the rate of change recorded for entry-level workers across all three industries, the negative and unexpected returns to education result in a trend that decreases potential earnings with additional years of education, thus suggesting that entry-level workers do not benefit from additional years of studying. These results do not support the hypothesis of this study, as returns to education are expected to be positive. The estimates used to determine potential earnings for professional workers (Table 4.3), record different trends. In Figure 4.2, there is a clear convex pattern in potential earnings for all professional workers. Therefore, the relationship between education and earnings is positive and consistent with the findings of Keswell and Poswell (2004). Potential earnings for agricultural professionals appear to be the lowest compared to potential earnings for workers in mining and manufacturing. Potential earnings for agricultural workers increase at a faster rate after nine years of education. Thus, workers with higher levels of education, benefit more and receive higher earnings.

5.1.2 Returns to experience

The working experience of an individual, regardless of the industry they are employed in, positively affects the earnings of the individual. Returns to experience for all industries are significantly lower than returns to education.

The highest and lowest returns to experience are both recorded in the agricultural industry, with professionals receiving 3 percent higher earnings for every additional year of working experience completed. Returns to experience are statistically significant for all skill levels in agriculture; although the size of the coefficients is small, they still influence earnings positively. Considering professionals in other industries, returns to experience are not statistically significant and do not have much of an impact on earnings. These results indicate that experience is valued higher in the agricultural industry; workers with years of experience and on-the-job training have more of an advantage as they have more knowledge of certain farming practices to optimise production. Skilled and professional workers in the mining and manufacturing industries gain more from every additional year of education completed than working experience.

The purpose of including the experience squared variable is to capture the concavity of the earnings function of experience. Including this variable shows how returns to working experience start to diminish after a worker reaches a certain age; returns start to increase at a decreasing rate (Havlin, 2016). In most cases, the coefficient of the experience squared variable is negative and very small, indicating that the marginal effect of experience on earnings diminishes with more experience gained (Shyshkina, 2001). This negative coefficient is expected and indicates that, with an additional year of age, earnings start to increase at a decreasing rate, indicating concavity for the experience vs earnings relationship.

Low returns to experience indicate that careers in agriculture are not largely affected by years of experience; perhaps years of experience favour a different industry. An explanation for this could be that workers are paid by the government or that the government sponsors subsidies, and wages do not increase much in their lifetime (Havlin, 2016).

5.1.3 The effects of different factors on earnings

The marginal effect of gender suggests that males receive on average between 16 and 34 percent higher earnings than females in agriculture taking into consideration their respective positions within the industry. This result is fully consistent with global studies as well as other studies done in South Africa (refer to Keswell and Poswell, 2004; Salisbury, 2016; Psacharopoulos and Patrinos, 2018; Depken, Chiseni and Ita, 2019). Although females earn considerably lower earnings compared to males, females with higher qualifications receive higher returns to education. In agriculture, returns to education for females are higher at the professional level.

This result of returns to female education is also consistent with numerous other studies considering the gender of workers. Female education has continuously proved to be the more profitable investment, as females tend to be more risk averse than males, and they choose to finish school rather than drop out. Females consider the long-term benefits of education more than males (Psacharopolous, 2018; Depken, Chiseni and Ita, 2019).

The unionisation of workers also has a considerable effect on the earnings of workers in the agricultural industry. Labour unions play an important economic and political role in South Africa, with the aim of decreasing the wage gap between workers. South Africa continues to have one of the largest wage gaps in the world; wages are distributed unevenly because of ongoing discrimination in the workplace, industry, and location (Schultz and Mwabu, 1998). Agricultural workers belonging to a union earn on average 82 percent higher earnings compared to non-union workers, which is unexpectedly high. Apart from union workers earning higher wages, Long (2013) explains that these workers also have greater access to employer-sponsored employee benefits and receive larger wage increases.

Many other studies have included the marital status of workers. Siphambe and Thokweng-Bawena (2001) discovered that employers may be more willing to invest in the human capital of married females. This study does not analyse an interaction between females and their marital status. However, it does indicate that individuals who are identified as married earn approximately 19 percent higher wages than unmarried ones. This variable was added to the model to determine the effect of marital status on workers' monthly earnings. It is common across the literature for married individuals to earn higher wages.

The location of an individual's residence can also have a significant impact on earnings. As the provinces are included into the model as fixed effects, it is difficult to identify specific provinces in which agricultural workers benefit most. However, the area type variable indicates which areas favour these workers more. Regardless of the level of education an individual has obtained, average earnings in rural areas were found to be 11 percent higher than wages in urban areas. This result is expected, as many farms are in rural areas and most agricultural workers are employed in these areas. This result differs from studies in this field, but this is not unexpected, as agricultural practices primarily take place in rural areas. Studies found that individuals working in other sectors receive higher earnings in urban areas as returns to education are expected to be higher in the bigger cities; higher returns in these regions may be the result of urbanisation. This is also to be expected due to the persistent effects of apartheid that still exist in South Africa (Depken, Chiseni and Ita, 2019).

5.3. Conclusion and policy recommendations

This study concentrated on estimating returns to education and experience in the South African agricultural industry from 2010 to 2017. Using the 2019 version of PALMS as a pooled dataset, this study identified the sample according to the following criteria: workers employed according to the narrow definition of employment were grouped according to the level of education obtained into "entry-level", "skilled", and "professional" labour, comparing workers employed in the agricultural, mining, and manufacturing industries. Knowledge of returns to experience and education across South Africa and for different skills groups gives policy makers some insight into where they should focus potential investments.

According to the findings, education remains a positive, significant, and profitable investment for individuals in the agricultural industry. An additional year of schooling will lead to individuals earning on average between 2 percent and 17 percent higher wages. Returns to experience for workers in the agricultural industry remain low but still positive, indicating a positive correlation between experience and earnings. An additional year in the working force leads to entry-level workers earning 0.04 percent higher wages on average. Returns to experience for skilled and professional workers is 3 percent for every additional year of work completed. When workers reach a certain age, earnings start to increase at a decreasing rate, which is implied by the negative estimates of experience squared. Workers' wages at the entry- and skilled levels decrease annually by 0.01 percent. Earnings for professional workers in agriculture increase at a decreasing rate of 0.04 percent.

Returns to education at the professional and managerial level remain the highest throughout the study at 17 percent for every additional year of schooling completed (see Table 4.3). As a result of this finding, the demand for tertiary education could increase and put pressure on policy makers to expand university education. Therefore, policy makers should increase the opportunities for individuals who are able to attend university and provide the necessary financial aid. Higher returns to higher education are in line with the global studies of Psacharopoulos and Patrinos (2018) and other studies in South Africa.

As returns to education in agriculture are higher in rural areas, it is important that the South African government create more opportunities in rural areas. Government should initiate more educational programmes in rural areas, with the aim of improving individuals' access to quality education.

Improving access to quality education in rural areas can also aid in reducing poverty in these areas, as the educational opportunities can help individuals find employment. In terms of improving the wage gap for farm workers, government should investigate creating short and accredited courses that will certify workers with various skills, improving their earnings.

The negative returns to education that are recorded for entry-level workers with the addition of the education squared variable, are unexpected results. Returns to education are expected to be positive and a convex trend is expected for potential earnings over the number of years of education. Figure 4.1 displays a decreasing trend in potential earnings for entry-level workers, which suggests earnings decrease with additional years of education. While entry-level results appear to be inconsistent with the theory, the results for professional workers are in line and consistent with other studies. Potential earnings for professional workers display an obvious convex trend in Figure 4.2, thus proving that individuals with higher levels of education receive higher returns to education.

The Mincer equation has helped to determine earnings in the agricultural field. However, this topic still requires more attention and research in the South African context. As South Africa still suffers from the discrimination effects of apartheid in the labour force, earnings in different areas of the country and in different industries will not easily move to an equal distribution. The difference in industry earnings is also largely attributed to the shifts in demand for labour, therefore, government should focus on increasing opportunities and aiding individuals to obtain higher levels of education so that they may receive higher earnings and reduce this wage gap.

5.4. Limitations and future research

A common methodical limitation that occurs when estimating returns to education, is the formation of potential biases. An example of a bias that often occurs in these studies, is the omission of "ability" in the earnings function. If the relationship between education and ability yields a positive result, higher earnings because of higher education may actually be a function of higher ability. This is because individuals with a greater ability are more inclined to remain in school longer. The omission of ability in the earnings function could result in biased estimates (Keswell and Poswell, 2004). Ashenfelter and Rouse (1998) attempted to quantify ability biases using instrumental variables. Individuals with a greater ability could also choose to register for a programme or degree at a university because they are more academically inclined. As these individuals complete more years of schooling, they benefit more from studying and are more likely to find a higher paying job. Universities are more likely to accept more able students and more likely to offer financial aid to them as they are more likely to succeed in the respective degrees. This is the result of individual self-selection and will lead to upward bias in estimates of returns to education (Patrinos, 2016).

Biased coefficients can also be the result of ignoring family background variables like parental education. This needs to be accounted for, as there is potential for genetic factors and ability to be positively correlated. There is also a possibility that wealthier parents could organise more education for their children, or even high-paying jobs (Keswell and Poswell, 2004). Not controlling for these factors will lead to an upward bias in estimates as well.

The omission of the quality of schooling variable in the earnings function may also lead to biased estimates of returns to education (Keswell and Poswell, 2004). If there is a positive relationship between the quality and quantity of education, it is important to include the quality variable to determine how much of the returns are attributed to the quality of schooling. This all depends significantly on how quality is measured. Schultz (1988) explains that estimates of the returns to education would not be significantly impacted if one were to measure the correlation between test scores and wage rates.

Instrumental variables could be introduced into the study to account for or quantify biases; refer to Depken, Chiseni and Ita (2019) as an example using parental education as an instrumental variable. However, due to the nature of the dataset used in this study, the use of instrumental variables is not possible, because PALMS does not include parental education or any kind of family background variable. In future studies researchers should account for family background, quality of education, and ability, to avoid such biases and make use of datasets that allow for this kind of analyses.

Using cross-sectional data may also cause biased estimates of returns to education. Firstly, cross-sectional data does not allow researchers to monitor major trends over time, like time series data. Secondly, as there are continuous improvements in technology and the demand in labour changes, cross-sectional data based on old observations from the past may also cause bias in the estimates (Patrinos, 2016). Researchers need to consider whether these older estimates can still be interpreted and used to project future earnings, as the cross-sectional data assumes that younger workers base their earnings expectations on the current experiences of older workers (Alqattan, 2013).

Using past trends and data for future or current investment decisions can be very difficult. Several assumptions need to be made, such as South Africa having a stable economy and labour market, and perfect certainty of future earnings (Keswell and Poswell, 2004; Alqattan, 2013). These assumptions cannot be upheld in a country like South Africa, as the demand for labour changes, and with a high unemployment rate, one cannot assume certainty in future earnings. The trend in earnings from 2010 to 2017 is not constant, which makes it challenging to use cross-sectional data to estimate lifecycle earnings. Keswell and Poswell (2004) suggest following individuals over their entire educational and employment lifecycles as a solution to determine their earnings pattern, and then estimate returns to education.

The quality of the PALMS dataset also poses a problem to the research. Although PALMS was identified as one of the more reliable sources of labour market data, the data is missing observations for the real earnings variable, which decreases the sample size.

Finally, there is limited research on returns to education and experience in South African agriculture. This is problematic, because previous literature helps to identify the scope of work that has been done, and, when discussing the findings of this study, there is not much of a foundation to compare it to. Therefore, further research on returns to education in the South African agricultural industry will significantly contribute to this field of study. It will allow for better comparisons of the literature and will assist researchers in determining how education, worker productivity, and earnings are correlated.

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Appendix A

Table A 1: Summary statistics of workers in mining

Statistic	**N**	**Mean**	**St. Dev.**	**Min**	**Percentile (25)**	**Percentile (75)**	**Max**
Entry-level workers							
Real earnings	3,564	7,706.64	7,156.14	0	4,018.32	10,060.34	237,610.40
Education (years)	3,822	9.577	3.099	0	8	12	16
Experience	3,822	22.788	11.806	0	13	32	62
Female (=1)	3,876	0.131	0.338	0	0	0	1
Union member (=1)	3,632	0.833	0.373	0	1	1	1
Married (=1)	3,876	0.568	0.495	0	0	1	1
Rural (=1)	3,847	0.6	0.49	0	0	1	1
Skilled workers							
Real earnings	9,471	10,621.14	13,687.44	0	4,453.28	13,056.09	498,324.00
Education (years)	10,187	10.209	3.056	0	9	12	17
Experience	10,187	23.452	11.483	-2	14	32	73
Female (=1)	10,271	0.079	0.27	0	0	0	1
Union member (=1)	9,433	0.839	0.367	0	1	1	1
Married (=1)	10,271	0.679	0.467	0	0	1	1
Rural (=1)	10,204	0.353	0.478	0	0	1	1
Professional workers							
Real earnings	1,110	31,932.37	55,602.80	0	10,586.02	32,575.80	588,112.20
Education (years)	1,236	13.538	2.246	0	12	15	17
Experience	1,236	21.801	10.585	0	13	30	58
Female (=1)	1,245	0.208	0.406	0	0	0	1
Union member (=1)	1,101	0.579	0.494	0	0	1	1
Married (=1)	1,245	0.765	0.424	0	1	1	1
Rural (=1)	1,238	0.189	0.392	0	0	0	1

Table A 2: Summary statistics of workers in manufacturing

Statistic	N	Mean	St. Dev.	Min	Percentile (25)	Percentile (75)	Max
Entry-level workers							
Real earnings	12,629	4,643.69	13,955.74	0	1,949.40	4,872.70	572,084.90
Education (years)	13,540	9.68	2.83	0	8	12	17
Experience	13,540	20.732	12.456	-3	11	29	78
Female (=1)	13,715	0.427	0.495	0	0	1	1
Union member (=1)	12,006	0.301	0.459	0	0	1	1
Married (=1)	13,715	0.401	0.49	0	0	1	1
Rural (=1)	13,528	0.166	0.372	0	0	0	1
Skilled workers							
Real earnings	34,978	10,072.16	525,560.40	0	2,110.92	7,054.28	97,579,600.00
Education (years)	37,707	9.964	2.881	0	9	12	17
Experience	37,707	23.619	12.558	-1	13	33	93
Female (=1)	38,264	0.294	0.456	0	0	1	1
Union member (=1)	28,540	0.407	0.491	0	0	1	1
Married (=1)	38,264	0.537	0.499	0	0	1	1
Rural (=1)	38,049	0.198	0.398	0	0	0	1
Professional workers							
Real earnings	6,477	35,123.30	145,606.50	0	8,869.31	31,145.25	6,700,207.00
Education (years)	7,310	13.095	2.208	0	12	15	17
Experience	7,310	24.366	11.927	0	15	33	77
Female (=1)	7,371	0.266	0.442	0	0	1	1
Union member (=1)	4,931	0.232	0.422	0	0	0	1
Married (=1)	7,371	0.775	0.417	0	1	1	1
Rural (=1)	7,330	0.037	0.189	0	0	0	1