TECHNICAL REPORT

Ten Year Forecast

Modelling Future Demand and Supply of Skills in South Africa

March 2017

higher education & training
Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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Applied Development Research Solutions

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10 Year Skills Demand and Supply Forecast

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Final Report

March 2017

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Adelzadeh, Asghar (2017). *Modelling Future Demand and Supply of Skills in South Africa: Technical Report and Ten Year Forecast*. Report prepared for the Department of Higher Education and Training, Pretoria.

ISBN: 978-1-77018-825-9 (web edition)

This report is available on the DHET and ADRS websites:

www.dhet.gov.za

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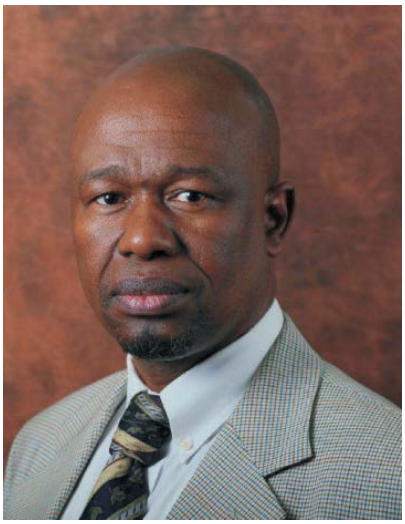
TABLE OF CONTENTS

DIAGRAMS

TABLES

FIGURES

FORWARD



It is my pleasure to present to you the report on Modelling Future Demand and Supply of Skills in South Africa. The Department of Higher Education and Training has identified the provision of credible information, analysis and signals on the demand and supply of skills as an important contribution to the establishment of the institutional mechanism for skills planning in South Africa.

This report is a product of theme 2 of the Labour Market Intelligence Partnership Project (LMIP), implemented through a partnership between the Department of Higher Education and Training and the University of Witwatersrand that is led by Wits Centre for Researching Education and Labour.

The major objective of the report is to support strategic thinking and policymaking and to build government's capacity to anticipate trends in the demand for and supply of skills. Regular, coherent and systematic forecasts of demand for and supply of skills is an important resource to inform and improve the responsiveness of the post-school education and training system to the needs of the economy and society more broadly, by supporting decision-making on matters pertaining to skills planning. The report is expected to be used as a strategic resource to inform supply-side planning in post-school education and training, particularly in relation to the allocation of funds, development of strategies and prioritisation, development of qualifications and programmes that are relevant to the needs of the labour market and to assist individuals to make appropriate career and educational choices.

It is hoped that planners, funders, policy makers, education and training institutions, skills development providers, employers as well as the media will use this report to guide them on matters pertaining to skills planning and the provision of education and training.

The Department will strive to improve the accuracy of this report and be more responsive to stakeholders' needs. Your feedback, including suggestions for improvement, can be emailed to Khuluvhe.m@dhet.gov.za.

Mr. GF Qonde

Director-General: Department of Higher Education and Training

Pretoria, South Africa

ACKNOWLEDGEMENTS

The driving force behind this project has been the need for an economic model that efficiently provides regular, comprehensive, systematic and consistent projections of demand and supply of skills and occupations to help policymakers plan and execute the transformation of the country's education and labour market systems. Throughout the four year project, the modelling work was supported, helped, encouraged, and stimulated by a large number of colleagues in South Africa and the United States. Both modelling work and this Technical Report have benefited from inputs from many individuals and organisations. I am grateful to all of them, and especially to the following:

- The Honourable Minister of Higher Education and Training, Dr. Blade Nzimande, Director General, Mr. Gwebinkundla Qonde, Deputy Directors General, Mr. Firoz Patel and Dr. Nkosinathi Sishi, and other senior officials at the Department who provided vision, leadership and support and remained engaged with the project as it progressed.
- A DHET core team of individuals whose effort, commitment and energy was invaluable to the completion of the project, including Dr. Hersheela Narsee, Ms. Mamphokhu Khuluvhe, and Ms. Mmaphake Ramasodi who each provided essential project and administrative support.
- Members of various departments and committees who participated in meetings and workshops and made useful comments and suggestions on the project as it progressed. I especially thank the Economic Cluster, the economic modelling teams at the Reserve Bank and the Treasury, and the research teams from Statistics South Africa and the South African Revenue Services.
- All those individuals and organisations who participated in a number of training workshops that were organised by the DHET and the REAL Centre. They participated in the workshops with high levels of enthusiasm and interest. Special thanks to representatives of SETAs who remained consistent in their support for the project and earnestly found ways that the modelling tools make their work more efficient and effective.
- Adrienne Bird from the DHET, Dr. Geeva Pillay, and Leon Pretorius from the DPSA who enthusiastically supported the project and provided valuable comments and suggestions throughout the project.
- Peter Buwembo, Diego Iturralde, and Ndivhuwo Gangazhe from Statistics South Africa who provided support by preparing and providing the research team with a significant amount of data for the project.
- At ADRS, Cynthia Alvillar who supported the project since its inception and provided adept legal counsel. Emma Dunn, who provided invaluable support in preparing tables

and graphs and stellar proofreading. Sebastian Bautista, Madhu Kanji, Jain Zeng and Q. Wang, who provided research and data analysis support for the project.

- At the REAL Centre, Dr. Peliwe Lolwana and Prof. Stephanie Allais, who lead the research and administration teams that worked on various background research inputs and facilitated the training workshops. Pundy Pillay, Helen Perry, and Phumzile Ncube, who conducted research for the project. I especially thank Siphelo Ngcwangu who provided invaluable and wide-ranging support throughout the project.
- Dr. Seeraj Mohammed, Dr. Pundy Pillay, and Dr. Andre Kraak who supported the original concept for the project and helped the project's core idea reach fruition.

While thankful for the support I have received, as author of this Technical Report, I assume full responsibility for its contents.

Asghar Adelzadeh
ADRS

CHAPTER 1

INTRODUCTION

Establishing a credible institutional mechanism for skills planning is a key goal of the third National Skills Development Strategy (NSDS III). The Strategy notes that "[t]here is currently no institutional mechanism that provides credible information and analysis with regard to the supply and demand for skills. While there are a number of disparate information databases and research initiatives, there is no standardised framework for determining skills supply, shortages and vacancies, and there is no integrated information system for skills supply and demand across government." In his March 2010 budget speech, Minister of Higher Education and Training, Dr. Nzimande, stressed the need for "better information and integration of the holistic needs of the economy in planning the university, vocational college and skills sub-systems". He went further to state "[w]hat is needed is knowledge and planning instruments for the system and research-based intelligence for strategic decision-making for the post school system".

Clearly, policy-makers need to devise strategies and pursue related investments which can influence the future path of the economy. Such choices need to be guided by robust information and intelligence, including a forward-looking element. In the context of education policy, the role of information and intelligence is twofold: to assess existing skill needs and to provide a longer-term perspective, so that policymakers not only anticipate future requirements but can also actively shape them. Regular and systematic early warning systems using forecasting, scenario development and other approaches are essential. Skills are a key part of the economy's infrastructure, and right choices made by policymakers, enterprises and individuals on investment in education and skills can help drive economic development. The rationale for regular, coherent and systematic forecasts of demand and supply for skills from the education sector follows policy initiatives that have given high priority to anticipate changing skill needs due to globalisation, economic restructuring,

technological and organizational change, and demographic developments (including HIV/AIDS, ageing populations and migration). Moreover, the need for regular forward-looking assessments has received further impetus following the setting of employment targets in the New Growth Path, the National Development Plan and the Industrial Policy Action Plan. Finally, as the NSDS III notes, since the integration of SETAs into the DHET, there is the possibility for a holistic approach, which draws on and builds the SETAs' understanding of labour market issues in their respective industrial and economic sectors, and enables development of plans for the education system.

The Linked Macro-Education Model (LM-EM) that has been built for South Africa is a forecasting tool to fulfil the above strategic decision-making needs of the government. Specifically, LM-EM enables policymakers to design economic and education policy scenarios, quantify their impact, and project future trends in economic indicators and the demand for and supply of educational qualifications. Through its comprehensive and consistent forecasts, LM-EM's aim is to provide credible foresight about the skill needs of future jobs that supports skills planning and systematic decision making.

There are several caveats related to the use of economic modelling techniques in general and to the specific approach used in the LM-EM to assess the demand and supply of skills. These have been discussed throughout the Report. The first caveat, however, is to acknowledge that the range of information that is normally used for planning education and training in South Africa and other countries is much wider and diverse than the information that is produced using economic modelling techniques. At best, models such as LM-EM uniquely complement other inputs to labour market intelligence and decision making by providing quantitative projections of some important factors in a consistent and methodologically sound and transparent manner. At the same time, the importance of the intelligence that is provided by the model for decision making is not automatic and depends on specific circumstances. Models such as LM-EM are most useful to provide tactical and strategic intelligence at the macro level to policy makers and they are least useful to directly guide the decision making of individuals and other labour market actors at a micro level. The project's terms of reference emphasised the former as the aim of the project. It stated the major objective of the project "to support strategic thinking and policymaking at the Department of Higher Education and Training (DHET) and to build the Department's

capacity as well as that of the Sectoral Education and Training Authorities (SETAs) to anticipate trends in the demand for and supply of skills from the education and training sector." The LM-EM is built to meet that terms of reference.

The aim of this report is to provide a full technical presentation of the modelling techniques used to build the LM-EM. The Report is broken down into thirteen chapters. Chapter 2 provides a summary of the Report. Chapter 3 is dedicated to the structure, features and operation of the LM-EM. A relatively detailed presentation of the macroeconomic model that underlies the LM-EM is provided in Chapter 4. This is followed by a brief overview of the statistical method that was used for the empirical analysis of educational modules of the LM-EM. Chapters 6 to 9 are dedicated to the presentation of the demand modules of the LM-EM, namely, occupational demand, qualification demand, replacement demand, and job openings. Chapters 10 and 11 present specifics of how the labour supply module of LM-EM has been constructed, and the model's job seekers module. The specifics of the labour market imbalances module of the LM-EM are presented in Chapter 12. Chapter 13 concludes the Report.

CHAPTER 2

EXECUTIVE SUMMARY

2.1. Background

In South Africa, the rationale for regular, coherent and systematic forecasts of demand and supply for skills follows policy initiatives that have given high priority to anticipate changing skill needs due to globalisation, economic restructuring, technological and organizational change, and demographic developments (including HIV/AIDS, ageing populations and migration). An important pre-requisite for skills planning is access to quantitative foresight about the possible future paths of the economy that includes projections of the labour force, job openings, employment and unemployment by qualification under alternative 'what if' scenarios. Until last year, South Africa did not have such a comprehensive system to perform consistent skills projections. Through the economic modelling programme of the LMIP, a firm foundation has been established for undertaking such forecasts regularly. The economic model that has been built for skills planning in South Africa (the Linked Macro-Education Model, LM-EM) consists of a multi-sectoral macroeconomic module that is linked to seven inter-related demand and supply modules for occupations and skills. The model also has a user-friendly web-platform that makes it accessible to policymakers, policy analysts, academics and students. The model's full Technical Report provides a detailed presentation of the modelling techniques used to build the LM-EM.

The main objective of this project has been to support strategic thinking and policymaking at the Department of Higher Education and Training (DHET) by building the Department's capacity as well as that of the Sector Education and Training Authorities (SETAs) to anticipate trends in the demand for and supply of skills from the education and training sector. More specific objectives included (a) Building a holistic and sustainable linked macro-

education model with which to regularly generate credible projections of supply and demand of skills in the economy under alternative 'what if' scenarios related to the evolution of the economy, the labour market, key external drivers, and key policy changes and prospective reforms; and (b) building capacity at the Department, as well as SETAs, to effectively use the model for their planning purposes.

The planned approach involves six steps:

1. Producing projections of future demand for labour for the economy and its sectors using the ADRS forecasting multi-sector macroeconomic model of South Africa;
2. Using historical data and statistical methods to analyse occupational, qualification and replacement demand and supply of educational qualifications.
3. Constructing computer modules that properly link the macro model's annual projections of future sector demand for labour into corresponding demand for occupation and educational skills;
4. Researching the supply of skills from the education and training sector as a whole and building new computer modules for projecting the supply of skills from the education and training sector;
5. Building a computer module for comparing the model's skills demand and supply projections in order to provide predictions and estimates of possible labour market imbalances and skill mismatches;
6. Establishing a fully tested and validated linked macro-education model that captures the dynamic interaction between its detailed macroeconomic model and its education components to produce current and future projections of demand and supply for occupations and educational skills.

The implementation of the project was envisaged in three phases and was implemented through a partnership between the ADRS and the Real Centre at the University of Witwatersrand.

2.2. Overview of LM-EM

The LM-EM system has a modular architecture. It is composed of separate components (sub-models) that fit together as a system. The LM-EM's module design makes it relatively easier to work with because modules can be easily understood in isolation, and changes or extensions to functionality can be easily localised. It also makes the upgrading of the system easier. The LM-EM has a total of 8 modules with the ADRS macroeconomic model as its first and core model.

Macroeconomic Module (LMEM-MAC): ADRS Macroeconomic Model of South Africa (MEMSA) was used as the core model whose expansion incorporates education modules to establish the final Linked Macro-Education Model (LM-EM) of this project. MEMSA is an economy-wide macro-econometric model of South Africa built by ADRS for forecasting and impact analysis. It is comprised of over 3200 equations, including 400 estimated equations that allow it to properly capture the determinants of key variables in the economy. This includes seven estimated variables (i.e., employment, output, investment, export, import, price, wage rate) for 45 sectors of the economy. These capabilities also allow the model to reflect the inter-linkages and dynamic relations that exist between industrial sectors of the economy, macroeconomic variables, policy variables, and income and expenditure of government, household, and business. MEMSA is most suitable for forecasting and simulating the impact of domestic and international shocks, macroeconomic and industrial policy changes, major public expenditure projects, as well as policies that affect private businesses, government and household income and expenditure. MEMSA is hosted at the ADRS website (www.adrs-global.com) and is accessible through its user-friendly platform.

Occupation Module (LMEM-OCC): The aim of this module is to capture the occupational structure within economic sectors in order to translate changes in employment demand within sectors of the economy, which are provided by the LMEM-MAC module, to demand for occupations. Multinomial logistic regression techniques[1] were used to quantify the links and, after fully testing the results, the final set of estimated equations were used to write

[1] For an introduction to multinomial logit models, see Greene (2012, 763–766), Hosmer, Lemeshow, and Sturdivant (2013, 269–289), Long (1997, chap. 6), Long and Freese (2014, chap. 8), and Treiman (2009, 336–341). For a description emphasizing the difference in assumptions and data requirements for conditional and multinomial logit, see Davidson and MacKinnon (1993).

the computer codes for the occupational module. With links to the ADRS macroeconomic model, the occupational module of the LM-EM generates a range of forecasts that relate to demand for occupations. This includes projections of annual demand for nine occupations for the economy and for the 21 SETAs; projections of demand for occupations with 4-digit Standard Industry Classifications; and projections of occupational composition of new job opportunities due to the expansion of the economy (i.e., expansion demand).

Qualification Module (LMEM-QUAL): The aims of the qualification demand module of LM-EM are (a) to transform the statistical analysis of factors that determines demand for educational qualifications to a dynamic system of forecasting demand for qualifications; and (b) to capture the interactions between the qualification module and other modules of the LM-EM. Multinomial logistic regression techniques were used to establish the link between occupations and demographic factors and educational qualifications of employed in the labour market. The computer codes of the LMEM-QUAL module establish the necessary channels for the flow of inputs from the rest of the LM-EM into the qualification module and from the module to other parts of the model. The LMEM-QUAL generates a range of annual forecasts related to the qualification demand. This includes projections of demand for 7 educational qualifications based on the multinomial regression model, 27 educational qualifications based on transition-probability matrix, and 7 educational qualifications for each of 21 SETA. Outputs of the qualification module feed into at least two other modules of the LM-EM, namely the job openings and skills gap modules.

A caveat to the qualification module is how we have referred to and used the term skills in this Report. Even though it is understood that skill is a complex concept that embodies tangible and intangible attributes, we have assumed that skills significantly reflect and positively correlate with formal educational qualifications and thus we have used the highest educational qualifications of individuals within national surveys as close proxies for their skill levels. Despite its limitations (e.g., its shortcomings to measure various generic skills and competences), this is an internationally established practice in modelling the education sector that relates to the availability of data and relative ease of measurement.

Replacement Demand Module (LMEM-RPL): This module provides projections of the number of employees in each occupation that will be replaced due to labour turnover related to retirement, migration, mortality or through career changes, which together make up replacement demand. The empirical methodology that was used for the estimation of replacement demand involved using multiple surveys that include an individual's information on sector and occupation of employment, demographics and other information. The LMEM-RPLD module generates projections of the number of vacancies, i.e., replacement demand, that are expected under a given economic scenario by occupation and qualification.

Job Opening Module (LMEM-JO): The purpose of this module is simply to provide an aggregate view of total job openings in the economy, which is the combination of job openings due to economic growth (i.e., the expansion demand) and job openings due to vacancies that result from retirement, migration, mobility and mortality (i.e., the replacement demand). The module thus produces annual projections of total job openings by occupation and qualification. The module's outputs also facilitate identification of occupations and qualifications that are in high and/or low demand in the future.

Labour Supply Module (LMEM-LS): The aims of the labour supply module of LM-EM are (a) to produce annual projections of the stock of skills, measured by the highest level of education, in the labour force aged 15-64, and (b)to produce annual projections of the size of the labour force by the occupation of employed and the occupational preference of unemployed. The multinomial logistic regression techniques were used, coupled with the 10 percent Census data for 2011 (Statistics South Africa, 2012) to conduct statistical analysis of factors that influence adults' participation in the labour force. The LMEM-LS's computer programme fuses demographic and education inputs with the estimated equations of the multinomial logistic regression to produce annual projection of the labour force for ten educational qualifications. The LMEM-LS also uses the annually estimated probability matrix for qualification and occupation from the qualification module (LMEM-QUAL) to approximate estimates of labour force by occupation.

Job Seekers Module (LMEM-JS): Job seekers refer to the portion of the labour force that is not employed and seeks employment, using the broad definition of unemployment. The aim of the job seekers module (LMEM-JS) is to produce annual projections of the size of job seekers in the economy and its breakdown by qualification of unemployed and their occupational preference. For each forecast period, the module simply takes annual projections of the labour force from LMEM-LS for that period and subtracts from it last period's employment from the macro module (LMEM-MAC) and adds the projection of replacement demand for the current period, all expressed by occupation and qualification. The module's projections of job seekers by occupation and qualification are consistent with the results from other modules of the LM-EM.

Labour Market Imbalances Module (LMEM-LMI): The skills gap module of LM-EM uses the model's annual projections of job openings and job seekers to estimate the extent of labour market imbalances, skills gap, and unemployment over time. At the aggregate level, the module produces an annual estimate of the labour market imbalance as the difference between the model's estimates of job seekers and job openings, i.e., unemployment or excess supply of labour. Skills gaps are estimated for all educational qualification categories by calculating the difference between the model's projection of job seekers and job openings for the qualification categories. Finally, the module estimates skills gap by occupation by calculating the difference between the number of job seekers with different occupational preference and the number of job openings by occupation. Overall unemployment and unemployment within segments of the labour force in terms of qualification and occupation are represented by corresponding excess supply estimates.

2.3. Key Model Results

LM-EM produces forecasts in six principle categories: macroeconomic and industry indicators, employment, demand/supply of educational qualifications, demand/supply for occupations, skills (im)balances by educational qualifications and by occupations, and (im)balances in the labour market. The Report provides examples of LM-EM projections from each category for three future economic and education scenarios.

2.4. Three Hypothetical Future Scenarios

In order to demonstrate how LM-EM works and how it produces projections of macroeconomic and sector indicators as well as demand and supply of skills, the model was used to forecast the impact of three future economic and education scenarios for the next 10 years. The formulation of scenarios has taken into consideration various perspectives of global and national outlook. The global outlook informed the range of possible values for external factors that affect the South African economy through trade and financial markets. The national outlook is used to define scenarios within the context of recent South African economic performance and policy discussion. The scenarios have been designed as probable scenarios for the South African economy since their assumptions regarding domestic policies and external factors are within the realms of possibility. At the same time, our expectation is not that the economy will follow exactly one of the three model generated growth paths, but that there is a good chance that the actual future path of the economy's key indicators will fall within the upper and lower bounds of the three scenarios. Also, the three future scenarios represent distinct low, moderate, and high employment generation growth paths for the economy so that they can be compared and contrasted in terms of their impact on the demand and supply of skills.

Low Scenario (the Baseline or Benchmark Scenario): In the context of the LM-EM, the purpose of the Baseline Scenario is to examine 'what if' the economic performance over the next 10 years is relatively weak in terms of growth and employment creation. What are the implications of this path for the demand and supply of occupations and skills, at aggregate and sector levels? This scenario envisions the future South African economy as an extension of the recent economic path where the average real growth rate and the unemployment rate have oscillated around 2 percent and 24 percent, respectively.

Moderate Scenario: What if the economy follows a path that results in 'moderate' rates of economic growth and reductions in the unemployment rate over the next 10 years? What will be the implication of such a growth path for the size of job openings and job seekers, and what will be its effect on the skills gap and demand for occupations? The scenario is expected to generate a moderate growth path for the economy through a combination of external and domestic demand and supply measures. Together the scenario's measures are

to help the economy break away from the vicious cycle of the Baseline Scenario's low growth path. The details of the scenario are provided in the Report.

High Scenario: The purpose of this scenario is to demonstrate the implications for job openings, job seekers as well as skills demand and supply if the economy follows a path of high growth and employment. A scenario whose simulation produces such a growth path encompasses macroeconomic, pubic investment, industrial, trade, and international assumptions that are included in the Report.

2.5. Key Findings

LM-EM results from the above three scenarios provide insight into the interactions between the economy and the education sector and foresight about the economy and the demand and supply of occupations and skills. The report presents the details of the model results for each scenario. Following are a few of the report's findings.

Over the next 10 years, from 2015 to 2025, if the performance of the economy falls within the Low and High scenarios of this Report, the model's projections suggest that:

- The **labour force** is expected to gradually grow to 28.3 million in the next 10 years.
- For four out of six **qualification** categories, namely, No Schooling, Incomplete Primary, Complete Primary, and Secondary Incomplete, their combined share of the total labour force will gradually decline by 7.4 percent from 51 percent in 2015 to 43.6 percent in 2025.
- The shares of those in the labour force with Secondary Complete and Tertiary as their highest educational attainment are expected to grow from 32.7 percent to 33.4 percent in the case of Secondary Complete and from 15.7 percent to 22.3 percent in the case of Tertiary. Overall, the share of these two categories of qualifications in the labour force is expected to grow from 48.4 percent in 2015 to 55.8 percent in 2025.
- **Total employment** will increase between 2.38 million and 7.24 million. The implication is that by 2025, between 17.75 million to 22.61 million will be employed,

depending on whether the pace of employment creation is closer to the Low or the High scenario.

- High skill workers will capture between 26 to 28 percent of total employment by 2025.
- The **replacement demand** will range from 5.5 million to 6.1 million, or 500,000 to 550,000 persons per year, on average.
- The average unemployment rate (expanded definition) will be the lowest within the combined Managers and Professional occupations. The occupational cohort with the highest unemployment rate will be the combined Clerks and Service Workers occupations. Across the remaining occupations, the unemployment rate will remain relatively uniform within a given economic path. In the case of the Moderate Scenario, for example, the unemployment rates are expected to fall between 30 and 35 percent, and between 28 and 33 percent for the High scenario, and in the case of the Low scenario between 33 to 42 percent.
- If the pace of employment creation is more closely aligned to the Low scenario, the overall **replacement demand** for the period will be at least twice the number of jobs that will be created through economic growth, i.e., the expansion demand. In contrast, if the economy performs close to the High scenario, the size of replacement demand will be significantly lower and close to the scenario's expansion demand.
- If the economy follows a low job creation path, similar to the Low scenario of this Report, only about one third of **job openings** will be due to the expansion of the economy, the remaining two third of job openings will be from the replacement demand. If the economy's job creation path gets closer to the High scenario of this Report, 55 percent of job opportunities will be due to economic expansion and 45 percent will be from the replacement demand.
- If the future economic performance is similar to the Low scenario of this Report, the number of **job seekers** is projected to increase from 7.54 million in 2015 to 8.98 million by 2025. However, if the economy generates levels of employment that are close to the Moderate or High scenarios, the size of job seekers will decline between 1 and 2.5 million over the next 10 years.

- If the economy pursues the High scenario path, for all except those with no schooling as their highest educational qualifications, the model projects that the percentage of **job openings** relative to **job seekers** will double to triple over the next 10 years.

2.6. Reflections and a Way Forward

Until recently, South Africa did not have a comprehensive system to perform consistent skills projections. Through the economic modelling programme of the LMIP, a firm foundation has been put in place to regularly undertake such forecasts using the Linked Macro-Education Model. Moreover, the new tool for skills planning includes a user-friendly web-platform that is internationally unique by allowing policymakers, analysts, researchers, students, and others to have direct access to the model to design and simulate their own economic and education policy scenarios. Regular training workshops over the last two years, organised by the Department of Higher Education, have begun the task of building the necessary capacity within public and private sector, including SETAs, to effectively use the tool.

Among the areas that future additions and improvements to the annual projections would be welcome are projections of demand and supply of skills by province, gender and age group. In addition, data improvement and research focused on retirement, job mobility, emigration and mortality by occupation, qualification, age, and gender would help generate better forecasts for each category, which in turn will improve the LM-EM's annual projections of job openings, job seekers, and skills gap by educational qualification. Finally, in order to attain a more holistic view of future trends in demand and supply of skills, the model's forecasts, that capture the demand for and supply of formal qualifications, should be complemented by analysis of skills that individuals need to carry out particular jobs. Analyses should also include the outcomes of all other types of learning, such as informal and non-formal learning.

The establishment of the Skills Planning Unit within the Department of Higher Education and Training will provide the necessary institutional anchor within the government to use the LM-EM for forecasting, impact analysis and capacity building in skills planning. At the

same time, the unit will be in a position to facilitate integration of modelling work into broader research on skills planning. In delivering its expected outputs, the Skills Planning Unit will be supported by the flexible architecture of the LM-EM, its user-friendly web-platform and ADRS' commitment to regularly update and upgrade the model.

CHAPTER 3

LM-EM STRUCTURE, FEATURES AND OPERATION

There has been a recent upsurge of international interest in skills forecasting and South Africa is no exception.[2] While skills forecasting is necessary for skills planning, it has not been without its critics.[3] The challenges notwithstanding, forecasting provides useful insights, which can be incorporated into forward looking planning for an economy. Numerous studies aimed at forecasting skills needs have been conducted throughout the world, particularly in Europe. The most comprehensive European study has been conducted by the European Centre for the Development of Vocational Training ("CEDEFOP").[4] The studies that have been conducted by CEDEFOP have utilised economic modelling techniques that are similar to the techniques we have used to build the LM-EM. Similar to the CEDEFOP model for the countries in European Union, the Linked Macro-Education Model (LM-EM) of South Africa is a forecasting tool for strategic decision-making. Specifically, LM-EM enables users to design economic and education policy scenarios, quantify their impact, and to generate projections of future trends in economic indicators and the demand for and supply of occupations and educational qualifications.

To capture the interactions between macroeconomics and the education sector, LM-EM was created by linking the Applied Development Research Solutions (ADRS) multi-sector Macro-Economic Model of South Africa (MEMSA) to models of supply and demand for occupations and educational qualifications. This chapter provides an overview of the LM-EM's structure, features and operational properties.

[2]See for example Boswell *et al.*, 2004; Livanos and Wilson, 2009; Achkar, 2010, Van Aardt, 2001; Woolard*et al.*, 2003; Wilson *et al.*, 2004.
[3]For example, it has been argued that the complexity and dynamism of modern economies makes understanding the economy, let alone forecasting certain elements of it, a difficult exercise. It has also been suggested that while the model may be accurate, its level of disaggregation may not be high enough to render the model useful to its users. See for example, Richardson and Tan (2009).
[4]See website for publications: http://www.cedefop.europa.eu/en/publications-and-resources.

3.1. Structure and Features of LM-EM

LM-EM harnesses economic modelling techniques to forecast future demand and supply of skills. The approach combines statistical analysis of time series and survey data with computer programming to construct a model that captures the structure and dynamics of the economy and its interaction with the education sector. The structure and features of LM-EM are summarised here.

3.1.1. Module Approach

LM-EM uses modular design, which is a programming technique that allows breaking a system into smaller manageable units. The overall LM-EM system is subdivided into smaller parts (modules) characterised by functional partitioning of the model. Each module is designed to carry out a particular set of functions within the larger system, using inputs from other modules and feeding its outputs into the rest of the system. The approach has enabled ADRS to use its core model, the multi-sectoral macroeconomic model of South Africa (MEMSA) to build specialised models such as the LM-EM, the Multi-Sectoral Economy-Energy-Emissions (MS3E), Linked National Provincial Model (LN-PM) and the Dynamically Integrated Macro-Micro Simulation Model (DIMMSIM).

LM-EM's modular system has the following advantages:

- It allows easy updating of particular module codes and/or input data.
- It is most appropriate for augmenting the system with new modules in the future.
- It is relatively less involved and costly to make changes that adapt the system to user requests.
- It makes the overall programme easier to read and understand.
- It makes it easier to understand how the programme operates.
- It makes the model programme easier to debug and reduces the likelihood of bugs.

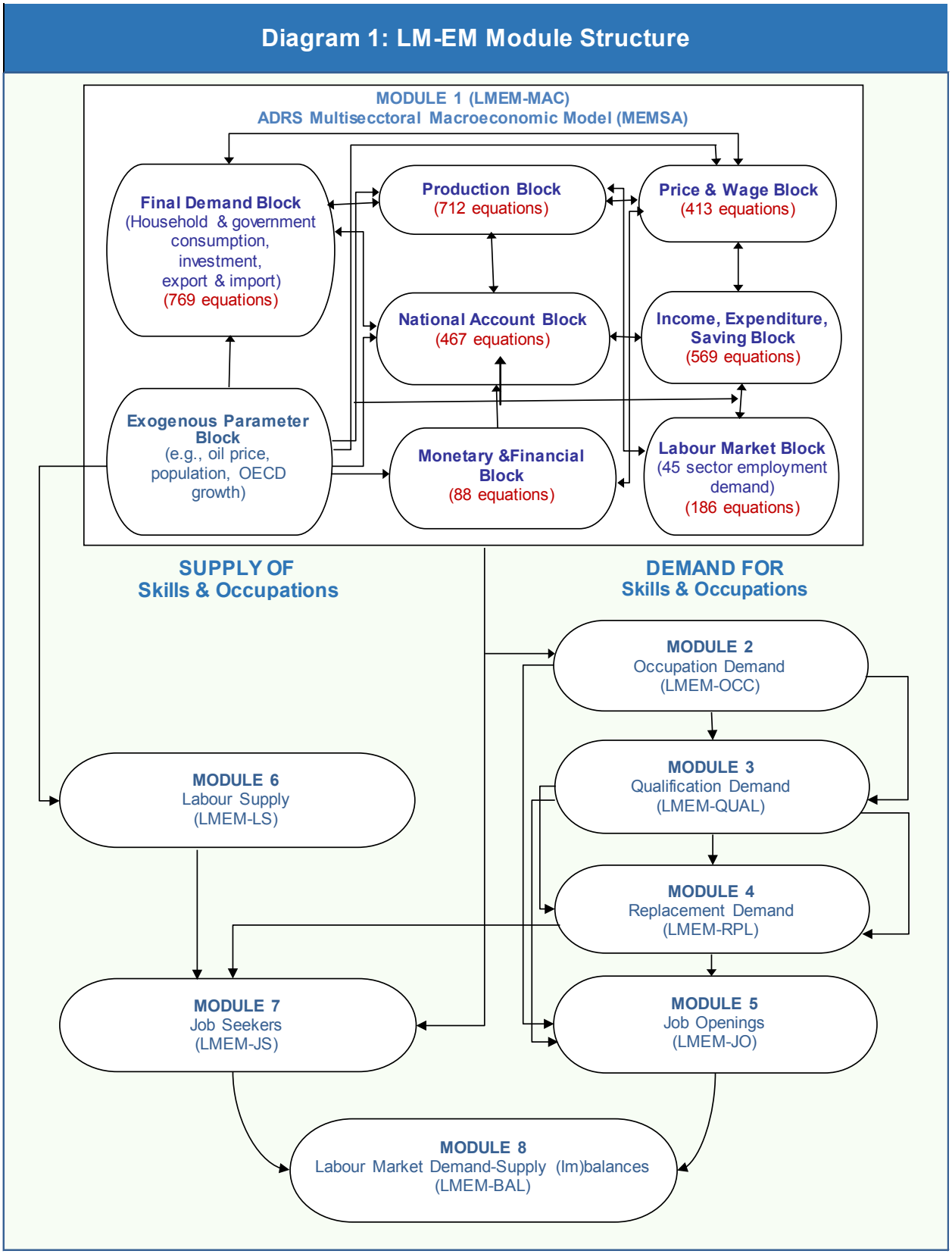
3.1.2. LM-EM Modules

The LM-EM is made up of eight modules:

- LMEM-MAC: Multi-Sectoral Macroeconomic Model of South Africa
- LMEM-OCC: Occupational demand module
- LMEM-QUAL: Qualification demand module
- LMEM-RPL: Replacement demand module
- LMEM-JO: Job openings module
- LMEM-LS: Labour Supply module
- LMEM-JS: Job seekers module
- LMEM: BAL: Balance and imbalance module

Diagram 1 presents a simple flowchart of the LM-EM.

Diagram 1: LM-EM Module Structure



3.1.3. Module 1: Macroeconomic Model of South Africa (LMEM-MAC)

ADRS' Macroeconomic Model of South Africa (MEMSA) has been used as the first and core module of the LM-EM. MEMSA was extended to incorporate education modules into it, and thereby establish LM-EM. Similarly, MEMSA constitutes the core macroeconomic model for other specialized ADRS models of South Africa.

MEMSA is a non-linear macro-econometric model that captures the structure of the South African economy. It allows design and analyses of macroeconomics and industrial policies and produces projections of the paths of key indicators related to the economy and its economic sectors under various domestic and international contexts and policy options.

MEMSA is relatively large with more than 3200 equations, including more than 400 estimated equations. It is a bottom-up model that captures the structure of the National Income and Product Account (NIPA) in a disaggregated fashion. MEMSA uses time series estimations of seven sector level variables and an input-output table of flows between economic sectors to capture and account for interactions between sectors of the economy. The input-output table is used to translate sector and/or aggregate expenditure shocks among MEMSA's 41 economic sectors in each period. The sector specific estimated equations capture the key underlying behaviour of economic sectors that determine the model's final macroeconomic and sector results. The model solution for each period is consistent with various identities required by the national account at real and nominal levels. The basic structure of the model is presented in Diagram 2.The key underlying behaviour of the economy is captured through the model's econometric estimations of determinants of short and long term dynamics of a large number of variables related to components of aggregate demand, production, labour market, prices and wages, and monetary and financial variables. For example, the model captures behaviour of the private sector through the sector level econometric estimation of investment, output, employment, export, import, real wage rate, and prices. Moreover, it uses historical data on household expenditure on various consumption goods and services to estimate equations that capture the dynamics of consumer prices and household consumption expenditure behaviour.

The model's list of exogenous variables includes a number of domestic and international variables. Among exogenous inputs to the model are:

- General government and public corporation investment
- Monetary and fiscal policy rules
- Government current spending
- Tax and subsidy rates
- Population
- Oil prices
- OECD annual growth rate
- Sub-Saharan annual growth rate
- U.S. interest and inflation rates

The LMEM-MAC module takes a user's specification of domestic and/or international shocks in order to simulate their combined impacts on

- aggregate economic variables (e.g., growth, employment, inflation, exports, etc.)
- economic sector variables (e.g., investment, employment, output, exports, imports, prices, wage rates)
- government, business, and household incomes and expenditures
- key indicators related to sustainability of macroeconomic and sector performances (e.g., BOP, budget balance, labour and capital productivity, etc.)

The macroeconomic module of LM-EM generates annual forecasts of a relatively large number of aggregate, sector level, nominal, and real variables and indictors. It includes indicators related to production, labour market, prices, wages, financial variables, and incomes and expenditures of households, business and government. The model projections are consistent across aggregation levels both in nominal and real terms. Key model's outputs include:

- Projection of key macroeconomic indicators
- Projection of demand for employment (expansion demand) for 45 sectors of the economy
- Projection of output, investment, exports, imports, wages, and prices for 45 economic sectors
- Financial indicators such as the interest rate, credit extensions, and money supply
- Current and capital account indicators
- Income and expenditure indicators
- Sustainability indicators
- Labour market indicators
- Production indicators
- Demand (expenditure) indicators

When a run is initiated with LM-EM, the macroeconomic module is the first to simulate the impact of the user defined scenario and generates projections of macroeconomic and industry indicators. Subsequently, a sub-module of LMEM-MAC translates LM-EM's 41 sector employment projections to employment and output for 21 SETAs.

3.1.4. Module 2: Occupational Demand (LMEM-OCC)

The aims of the occupational module of LM-EM are (a) to properly capture the links between LM-EM's macro module, that produces projections of sector employment, and the occupational structure of economic sectors in order to translate the model's projections of employment to projections of demand for occupations; and (b) to provide projections of occupation related indicators that allow monitoring the country's progress in the medium and long terms.[5]

[5]We have followed the tradition of referring to the occupational composition of employment as 'occupational demand' and the qualification of employment as 'qualification demand.' However, it should be noted that in the economy and in the model, employment levels, as captured by historical data or generated by the model as projections, are the outcome of a combination of both demand and supply factors. Similarly, the Report refers to the projected changes in the levels of employment between any two years as 'expansion demand' even though in some years the change may be negative.

The multinomial logistic regression techniques were used along with the Quarterly Labour Force Survey from 2008 to 2011 to conduct the statistical analysis of factors that influence the demand for various occupations. Chapter6 of the report provides details of the process of building LM-EM's occupational module.

The computer codes of the occupational module transform the estimated log-odds of the multinomial logistic model for occupations to dynamic probabilities related to demand for 10 occupations whose values adjust each period to changes in sector employment and demographic explanatory variables. The module's computer codes build the bridge between the LMEM-MAC annual projections of sector employment and demographic factors to produce annual forecasts of occupational composition of sector employment and net additions to employment (expansion demand). Moreover, two transition-probability matrices translate LM-EM's projections of employment by the main occupational categories to demand for about 400 lower occupational categories and employment by occupation for 21 SETAs.

3.1.5. Module 3: Qualification Demand (LMEM-QUAL)

Qualification demand refers to the educational qualification shares within occupations, and across industries.[6]Even though it is understood that skill is a complex concept that embodies tangible and intangible attributes, we have assumed that skills significantly reflect and positively correlate with formal educational qualifications and thus we have used the highest educational qualifications of individuals within national surveys as close proxies for their skill levels. Despite its limitations (e.g., its shortcomings to measure various generic skills and competences), this is an internationally established practice in modelling the education sector that relates to the availability of data and relative ease of measurement.

The aims of the qualification demand module of LM-EM are:

- To transform the statistical analysis of factors that determines demand for educational qualifications to a dynamic system of forecasting demand for qualifications.

[6] CEDEFOP, 2009, p.118. Also see footnote 5.

- To capture the interactions between the qualification module and other modules of LM-EM.
- To produce detailed annual projections of demand for qualifications for the economy as a whole and for the SETAs.

Chapter 7 of the Report provides a detailed presentation of the process of building LMEM-QUAL. The computer codes of the LMEM-QUAL module establish the necessary channels for the flow of inputs from the rest of LM-EM into the qualification module and from the module to other parts of the model. For example, since projections of qualification demand in each period requires, as inputs, estimates of the occupational demand for that period, the computer codes facilitate the channelling of outputs from the occupational module into the qualification module.

Within the module, for every year of the forecast period, the module combines LM-EM's projections of variables used as explanatory variables in the multinomial logistic regression for qualifications with the transformed log-odds ratios of parameters of the estimated equation to produce period specific sets of probabilities related to the range of skills composition (educational qualifications) within each occupational group. The calculated occupation-qualification probability matrix for each period and the vector of demand projections for 10 occupations for the same period, provide projections of demands for specific and all educational qualifications.

The LMEM-QUAL generates a range of annual forecasts related to the qualification demand. This includes projections of demand for 7 educational qualifications based on the multinomial regression model, 27 educational qualifications based on the transition-probability matrix, and 7 educational qualifications for each of the 21 SETAs. Outputs of the qualification module feed into at least two other modules of LM-EM, namely the job openings and skills gap modules.

3.1.6. Module 4: Replacement Demand (LMEM-RPL)

Replacement demand refers to job openings that result from the departure of workers that need to be filled by new workers.[7] The LMEM-RPLD provides projections of the number of employees in each occupation that will be replaced due to labour turnover related to retirement, migration, mortality or through career changes, which together make up replacement demand. Therefore, the aims of the replacement demand module of LM-EM are:

- To capture interactions between, on the one hand, LM-EM's occupation and qualification demand modules and the replacement demand module, and the replacement demand module and the job openings and imbalances modules, on the other.
- To estimate replacement demand arising from retirement, migration, occupational mobility, mortality, and emigration within each occupation for the forecast period.
- To provide estimates of replacement demand by educational qualification.

Estimates of future job turnover in an occupation provide important additions to the overall level of job openings in that occupation. For the design and delivery of skills policy, projections of the size of replacement demand are as important as the estimation of the expansion demand.[8] Modules 1 to 3 of LM-EM generate annual projections of employment by economic sectors, occupations, and educational qualifications. The LMEM-RPL module is designed to produce annual projections of replacement demand by occupation and educational qualification, which are then added to the model's estimations of expansion demand in order to produce the model's annual projections of total job openings by occupation and qualification.

The methodology that was used for the estimation of replacement demand is based on the pioneering work of Willems and de Grip (1993). It involves using multiple surveys that include an individual's information on sectors and occupations of employment, demographic and other information. Chapter 8 of the Report provides the details of how the

[7]Willems and de Grip, 1993, p. 173.
[8]CEDEFOP (2009a), p.21.

replacement demand module of LM-EM works. Briefly, the model uses exogenously given rates for retirement, mobility, mortality and migration by occupation to produce projections of the annual flow of replacement demand by occupation and qualification. Therefore, the LMEM-RPLD module generates projections of the scale of vacancies, i.e., replacement demand, that are expected under a given economic scenario by occupation and qualification.

3.1.7. Module 5: Job Openings (LMEM-JO)

The purpose of this module is simply to provide an aggregate view of total job openings in the economy, which is the combination of job openings due to economic growth (i.e., the expansion demand) and job openings due to the vacancies that result from retirement, migration, mobility and mortality (i.e., the replacement demand). The module thus produces annual projections of total job openings by occupation and qualification. The module's outputs also facilitate identification of occupations and qualifications that are in high and/or low demand in the future.

3.1.8. Module 6: Labour Supply (LMEM-LS)

The labour supply module of LM-EM is designed to produce annual projections of the labour force and its breakdown by educational qualification (i.e., skills supply). The output of this module also feeds into the model's generation of forecasts of job seekers. Therefore, the aims of the labour supply module of LM-EM are:

- to produce annual projections of the available skills, measured by the highest level of education, in the labour force, using the expanded definition of unemployment.
- To produce annual projection of the available skills in the labour force by the occupation of employed and the occupational preference of unemployed.

In order for the LMEM-LS to produce projections of the labour supply (labour force), the module requires a number of inputs. Therefore, current and future values of three

categories of inputs are fed into the module as part of producing projections of the labour force: (a) annual projections of population by gender, race, age groups and provinces; (b) current and future values for the labour market participation rate (LFPRs) by gender, race, province and age group; and (c) current and future values for the Average Matric Rate and the Higher Education Graduation Rate by race.

The multinomial logistic regression techniques were used along with the 10 percent Census data for 2011 to conduct statistical analysis of factors that influence adults' participation in the labour force. Chapter10 of the report provides the details of the process of building the LM-EM's labour supply module. The LMEM-LS uses the above three categories of inputs and the estimated equations of the multinomial logistic regression to produce annual projection of the labour force for ten educational qualifications. The annual projections of the total labour force are calculated as the sum of projections of the labour force for ten educational qualifications. The LMEM-LS also uses the estimated relationships between qualification and occupation from the qualification module (LMEM-QUAL) to approximate estimates of the labour force by occupation.

3.1.9. Module 7: Job Seekers (LMEM-JS)

Job seekers refer to the portion of the labour force that is not employed and seeks employment, using the broad definition of unemployment. The aim of the job seekers module (LMEM-JS) is to produce annual projections of the size of job seekers in the economy and its breakdown by qualification of unemployed and their occupational preference.

For each forecast period, the module simply calculates the size of job seekers by using the mathematical relationship between the labour force, employment, and the replacement demand, all expressed by occupation and qualification. The module's projection of job seekers by occupation and qualification are consistent with the results from other modules of the LM-EM.

3.1.10. Module 8: Labour Balance/Imbalance Skills Gap (LMEM-BAL)

The skills gap module of LM-EM uses the model's annual projections of job openings and job seekers to estimate the extent of labour market imbalances, skills gap, and unemployment over time. At the aggregate level, the module produces an annual estimate of the labour market imbalance (i.e., unemployment or excess supply of labour) as the difference between the model's estimates of job seekers and job openings. Skills gaps are estimated for all educational qualification categories by calculating the difference between the model's projection of job seekers and job openings for the qualification categories. Finally, the module estimates skills gap by occupation by calculating the difference between the number of job seekers with different occupational preference and the number of job openings by occupation. Overall unemployment and unemployment by qualification and occupation are represented by corresponding excess supply estimates.

Positive (negative) overall excess supply of labour in a given year implies that the projected number of job seekers is more (less) than the number of job openings in that year. Similarly, excess supply of (excess demand for) labour by qualification shows the number of job seekers segmented by educational qualification with the number of job openings that requires those qualifications. Negative excess supply or positive excess demand expressed by qualification implies the extent to which demand outpaces supply (job openings are greater than the number of job seekers) in various skill (educational qualification) categories. Finally, the overall unemployment rate for the economy is calculated as the share of the labour force that is unemployed, and moreover, unemployment rates for various qualifications (skills) and occupations are calculated as the unemployment shares of corresponding segments of the labour force.

Overall, the module utilises results related to sector employment, occupations, qualifications, replacement demand, labour supply, job openings and job seekers to present the effect of a given scenario on labour market balances and imbalances over time and by educational qualification and occupation. The module also estimates future unemployment rates by qualification and occupation.

A caveat to note is that despite the various advantages and utility of LM-EM to assess labour market imbalances and skills gaps using projections of both demand and supply for occupations and skills, in reality analysis of skills imbalances involves issues that are not always quantifiable and often demand much richer data than is currently available.

3.1.11. Data Sources

LM-EM as a multi-sectoral macro-education model uses extensive amount of data as input. The model's main sources of data for its endogenous variables include the Reserve Bank's electronic historical National Income and Product Account dataset and Quantec's industry database, which is based on Statistics South Africa data. The model's macroeconomic datasets start from 1970.

The model's database of exogenous variables includes domestic and international economic and policy indicators whose values are not determined within the model but they are either necessary part of the national accounting of the South African open economy or found to have statistically significant impact on particular endogenous variable(s) of the economy. This includes, for example, the growth rates of OECD countries and the Sub-Saharan countries, oil price, metal prices, U.S. interest rate, foreign investment, population growth, etc. For these and other similar data, the model uses various international databases, such as the electronic databases and publications of the International Monetary Fund, the World Bank, the OECD, the European Union, the African and Asian Development Banks, OPEC, and other similar sources.

A number of additional datasets have been used specially for the construction of the education modules of the LM-EM. Following is a short list of additional data sources that have been used:

- 10 percent Census 2011
- Population data
- Pooled Quarterly Labour Force Surveys from 2009-2011
- Various issues of Quarterly Labour Force Surveys from 2008-2015
- Various sources of education data

- OECD dataset on international migration

It is important to note that data limitations and data availability played a significant role in choosing the Quarterly Labour Force Survey and the 10% Census 2011 from Statistics South Africa to build the education modules of the LM-EM. More specifically, the statistical methodologies that we identified as most suitable to build the skills demand and supply modules of the model required micro level survey data that (a) represents the population of the country, (b) includes micro level information related to demographic, labour market and education information, (c) is collected with some regularity using consistent methodologies, and (d) is electronically accessible. The Quarterly Labour Force Survey and the Census 2011 data have the above desirable features, even though each has its own imperfections, as we acknowledge.

3.2. Operational Features of LM-EM

Five important and distinguishing operational features of LM-EM are described in this chapter.

3.2.1. Link to a Multi-Sectoral Macroeconomic Model

An important pre-requisite for skills planning is access to quantitative foresight about the possible future paths of the economy that includes sector level projections of employment under alternative 'what if' scenarios. The quality of sectoral employment information is especially important since statistical analysis of demand for skills relies heavily on the estimation of demand for occupations that are derived from sector employment projections. In effect, therefore, skills planning needs and stands to benefit from access to a multi-sectoral macroeconomic model.

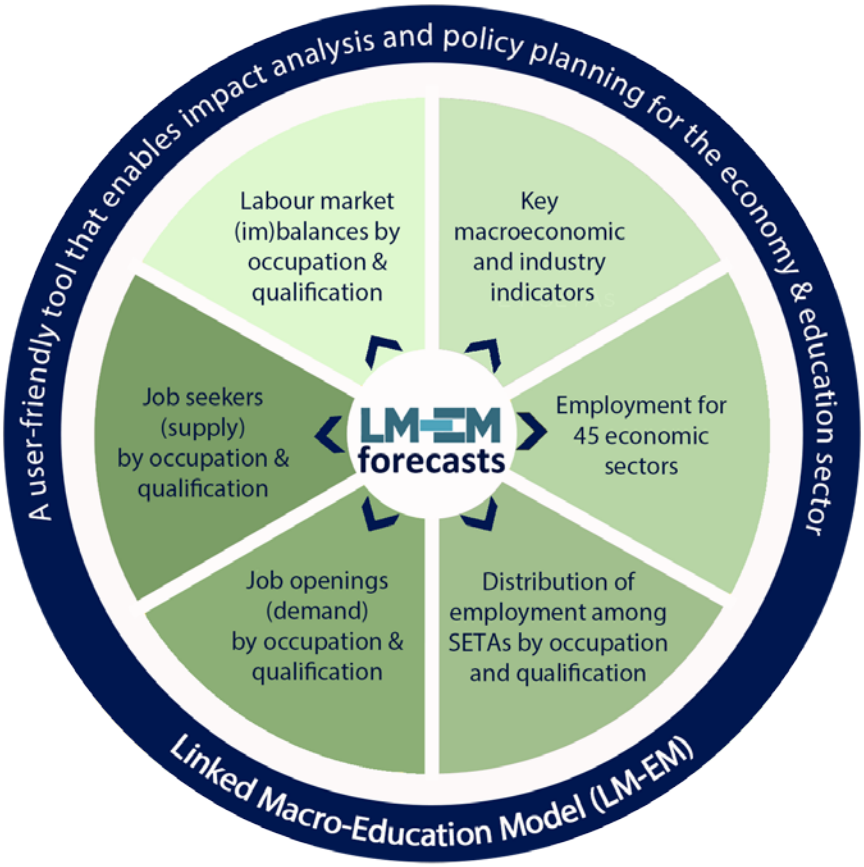
The LM-EM fulfils this pre-requisite, and its link to ADRS' disaggregated Macroeconomic Model of South Africa (MEMSA) is an important feature of the model, especially since it benefits from 15 years of work that underlie the construction and use of MEMSA in South

Africa.

3.2.2. LM-EM Scope

An important feature of LM-EM is the wide scope of its outputs, as shown in Diagram 2. LM-EM produces forecasts in six principle categories. The graphic below illustrates these categories which include: macroeconomic and industry indicators, employment, demand/supply of educational qualifications, demand/supply for occupations, skills (im)balances by educational qualifications and by occupations, and (im)balances in the labour market. In this report we provide examples of LM-EM projections from each category for three future economic and education scenarios.

Diagram 2: LM-EM Range of Forecasts



3.2.3. LM-EM Is Consistent

LM-EM has the capacity to regularly forecast economic and education sector indicators that are comprehensive, systematic and consistent. It predicts trends in the economy, the educational sector and the future demand and supply of occupations and educational qualifications. The range and consistency of results across the economy, sectors, and SETAs, by occupations and educational qualifications are key features of LM-EM that offer intelligent insight and powerful foresight for informed decision-making.

An important property of LM-EM is the consistency of measuring total employment from various angles. This means that LM-EM's projections of total employment in each period is equal to the sum of 41 economic sector employment projections, is equal to total employment estimated for 21 SETAs, is equal to the total of sector level occupations and qualifications, and finally, is equal to total occupation and qualification demands projected for 21 SETAs.

3.2.4. Easy Public Access to LM-EM

LM-EM has a user-friendly web-platform that is internationally unique. It allows the DHET and the public to have direct access to the model to design and simulate their own scenarios. This feature is possible because ADRS' macroeconomic model of South Africa (MEMSA) has had a web platform since 2006. The LM-EM utilises MEMSA and its web infrastructure for its user-friendly interface. This facility extensively enhances the LM-EM's accessibility to policymakers, analysts, researchers, students and others. DHET, SETAs, education policy teaching and research institutions are expected to gain foresight with LM-EM's ability to answer 'what if' questions about alternative economic and education policy scenarios.

Moreover, LM-EM's website has the potential to expand the institutional capability, especially within the DHET and SETAs, since economic and education policy scenarios can easily be designed and instantly tested for the impact of the scenarios on the economy, with results of the policies provided on demand and supply of occupations and educational

qualifications. LM-EM is always available via internet access. Since users are not required to buy data or software, and ADRS provides regular updates and upkeep, LM-EM users are quickly and easily empowered to do more. The principal goal of building LM-EM is to have users engage more on policy questions, and specifically to generate answers to 'what if' questions that inform the policy processes. Scenario testing of trends in the economy, the educational sector and the future demand and supply of occupations and educational qualifications can ultimately assist decision-makers with the foresight to see and understand the potential outcomes of alternative policies. Projections of important economic, education, skills and occupation demand and supply indicators, provide users with evidence-based intelligence for detailed and systematic decision making.

3.2.5. Sustainability of LM-EM

Building in-house modelling capability within and outside government is fraught with the type of challenges and uncertainties that undermine the long-term sustainability of such an endeavour.

Operationally, despite the complex nature of the LM-EM, its web-based platform not only makes policy design, impact analysis and forecasting relatively simple and widely accessible to users, it also frees institutions such as DHET and SETAs from spending valuable resources on gathering, validating, testing or updating the underlying data. Time and effort required to design, build, administer, manage and maintain models is more efficiently spent by users to create scenarios, run simulations, and forecast results. By accessing LM-EM, the tool not only increases the analytical and forecasting capability of its users but also significantly boosts the productivity, effectiveness and value-chain contributions of its users.

CHAPTER 4

LM-EM MACROECONOMIC MODULE (LMEM-MAC)

This chapter briefly describes the ADRS' multi-sectoral macroeconomic model of South Africa (MEMSA) that has been used as the core model whose extension to incorporate education modules has established the Linked Macro-Education Model (LM-EM). Similarly, MEMSA constitutes the core macroeconomic model for other specialized ADRS models of South Africa, such as, ADRS' carbon tax model, linked macro-micro model, and linked national-provincial macroeconomic models. Following is a brief description of MEMSA.

4.1. Background

MEMSA is ADRS' main multi-sectoral macro-econometric model of South Africa. The first desktop version of the model was completed in 2005 and was primarily used for ADRS research projects. In 2006, ADRS released to the public the first web-based user-friendly version of MEMSA along with its three other South African models.[9] Since 2006, ADRS has regularly updated and maintained the live public version of MEMSA. The model has also been regularly upgraded over the last 10 years. The latest version of the model (Version 7.0) includes a complete re-estimation of MEMSA's more than 400 estimated equations.

[9]Along with MEMSA, ADRS released its three other South African models, namely a full micro-simulation model of taxes and transfers (SATTSIM) and two linked macro-micro models (SATTSIM-Plus and DIMMSIM). Since 2006, ADRS suite of South African models has expanded to include provincial macroeconomic models; social security models; direct and indirect tax models; poverty-inequality models; public employment models; and an economy-energy-emissions model. In addition to above South African models, ADRS has built OCEANS that includes economic models for 52 countries with its user-friendly web platform.

4.1.1. Theoretical Background to MEMSA

MEMSA is a non-linear econometric model that captures the structure of the South African economy. It allows for the design and analyses of macroeconomic and industrial policies and produces projections of the paths of key indicators related to the economy and its economic sectors under various domestic and international contexts and policy options.

Several features of the model give it an edge for analyses of the economy and the education sector. For example, it is a multi-sectoral bottom-up model that represents the working of the labour market through 86 estimated equations for sector employment and the real wage rate. In LM-EM, this facilitates analysis of demand for occupations and educational qualifications at macro and industry levels. The model captures the necessary inter-temporal consistency between the production, income, and expenditure sides of the economy in nominal and real terms and at aggregate and sector level. It captures the working of the economy by adopting a broad theoretical perspective, in the tradition of scientific pluralism, and utilising modern time series analysis to estimate and build the model's system of behavioural equations. As an econometric model, it is inter-temporal and dynamic by nature and provides for short term and long term policy simulation exercises. The model's forecasts for each period reflect the influence of changing macro and micro economic conditions, policy parameters, external factors, the dynamic properties of the model, and long term tendencies within a sector and the economy as a whole.

4.1.2. Basic Model Structure

MEMSA is a relatively large model with more than 3200 equations, including more than 400 estimated equations. It is a bottom-up model that captures the structure of the National Income and Product Account (NIPA) in a disaggregated fashion using 7 estimated variables for 41 economic sectors. The model solution for each period is consistent with various identities required by the national account at real and nominal levels. MEMSA's flowchart and economic sectors are presented in Diagrams 3 and 4 below.

Diagram 3: Macro-Econometric Model of South Africa (MEMSA)

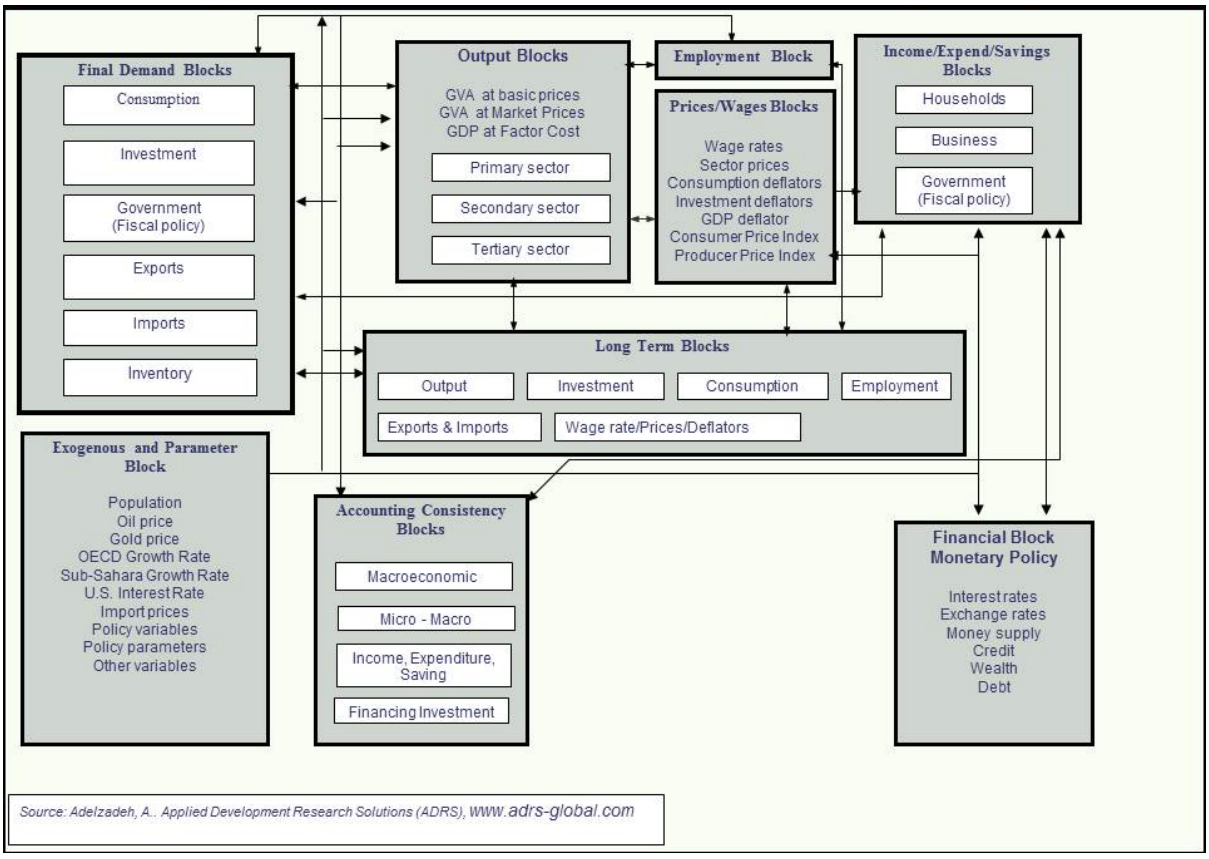
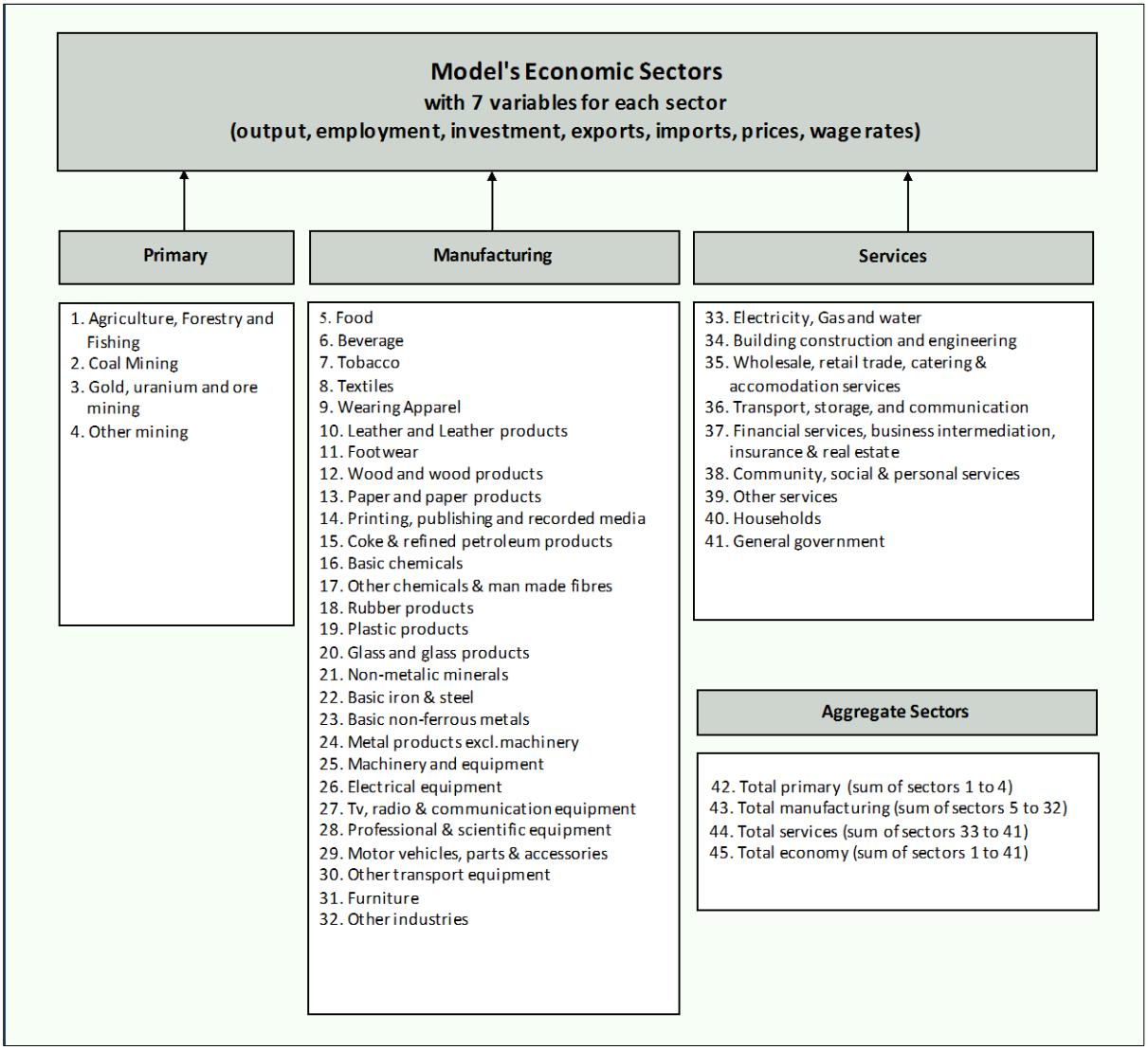


Diagram 4: MEMSA's Economic Sectors



MEMSA's equation blocks include:

- **Final Demand Block**: This block encompasses 769 equations. It includes sets of equations that capture the behaviours of the private sector as they relate to sector level investment, exports, and imports, households in terms of expenditure on 27 categories of consumption goods and services, and the public sector in terms of final consumption expenditure and investment. Variables from the rest of the equation blocks feed into the determination of the values of the expenditure block of equations and the values of the demand variables form the expenditure block feed back into the determination of values of variables from the rest of the economy. The expenditure block of equations that ultimately produces projections of various components of the aggregate demand in the economy generates the model's

projection of the GDP from the expenditure side.

- **The Production Block** includes 712 questions that allow the model to generate consistent projections of nominal and real values for sector and aggregate outputs, i.e., value added at basic prices. An important output of this block of equations is the calculation of the GDP from the production, i.e., value added, side.

- **The Price and Wage Block** is comprised of 413 equations that include a large number of estimated price equations for the outputs of economic sectors, consumer prices, investment prices, import, and export. It also includes 45 estimated equations for the sector level real average remuneration rates and 45 calculated nominal values for sector wage rates.

- **The Income, Expenditure, and Saving block** includes 569 equations that capture a detailed breakdown of income, expenditure, and savings of households, incorporated business and government, in nominal and real terms.

- **The Labour Market Block** is comprised of 186 equations that include estimated equations for sector level employment, labour productivity, and other labour market indicators.

- **The Financial Block** of equations embodies 88 equations for indicators related to the financial and monetary side of the economy, such as the interest rate, exchange rates, money supply, credit extensions, households financial assets and liabilities, and foreign direct and portfolio investments.

- **The National Account Block** incorporates 467 equations. This block of equations is responsible for ensuring consistency and enforcing national income and product account relationships within the economic system captured by the model. It, for example, ensures that in the model, the calculation of GDP, both real and nominal, from income, production and expenditure sides are made up of relevant NIPA

components and are consistent with each other at aggregate and sector levels, in nominal and real terms.

4.1.3. Model Specification

Specification refers to the selection of a model's functional form, that is, specifying the perceived nature of relations between variables in the economy. In the case of macroeconomic models, model specification generally is based on a good theoretical and empirical knowledge of how an economy functions and evolves over time. A model's specification therefore must include sufficient structural detail to approximate the system and its multiple interactions and establish conformity between economic theory and econometric test criteria. Finally, model specification should provide sufficient detail to generate forecasts of interest and include relevant policy variables and their transmission channels.

The Specification of MEMSA can be described in terms of the specification of its estimated behavioural equations and a large number of real and nominal accounting and other relationships that together constitute the overall model.

Specification of MEMSA's Behavioural Equations: The latest version of MEMSA includes more than 400 estimated behavioural equations. It is composed of industry level specification of output, employment, investment, wage rate, export and import, investment prices, sector prices, and export and import prices. The rest of the model's estimated equations include detailed real private household consumption expenditure, consumption prices, credit extension, money supply, and exchange rates.

Given the diversity among sectors of the economy, for the specification of each industry level variable (e.g., employment, investment), we considered the broad theoretical and empirical literature on the subject. Therefore, the specification of the model's behavioural equations avoids *a priori* imposition of one theoretical stand on the determination of a given sector level variable. The adapted broad specification approach is especially appropriate since the focus of the MEMSA is not to test or assert the validity of a particular

theoretical proposition, but to capture the potential differences in the law of motion (i.e., behavioural differences) among sectors of the economy, using a combination of econometric test criteria and economic theory.[10]

The model therefore has used the theoretical and empirical literature to identify a range of sector and economy-wide variables that are found to be significant in explaining the long-term trend and short-term fluctuations of the model's behavioural equations. In general form, the specification of the model's behavioural variables includes demand-side (*d*), supply-side (*s*), price and expectation variables:

$$Y_v^t = f_v(s_h, d_j, p_k, e_q, x_u) \qquad [4.1]$$

Where:

Y_v^t represents estimated variables in MEMSA with *v=1,2,...,V*;

s_h represents supply side variables with *h* = 0,1,2,...,H;

d_j represents demand side variables with *j* = 1,2,...,J;

p_k represents various aggregate and sector level prices with *k*=0,1,…,K;

e_q represents various expressions of expectations with *e*=0,1,…, E; and

x_u represents other variables with *u*=0,1,…,U.

Space limitation does not allow presentation of specification of MEMSA's large number of estimated equations. Table 4.1 provides a summary list of variables used in the specification and estimation process and their classification as demand side, supply side, prices, expectation, and other variables. It is important to note that the classification of variables is for ease of presentation.

Table 4.1: Classification of Sample of Variables Used in Specification of MEMSA

Supply Side	Demand Side	Prices	Expectations	Others
Productivity	Exports	Consumption prices	Price expectations	Employment
Capital labour ratio	Imports	Sector prices	Profit expectations	Output
Tax rates	Consumption	Investment prices	Output expectations	Deficit/GDP
	Income	Exchange rates		Debt/GDP
	Investment	Export prices		
	Government Expenditure	Import prices		

[10] The adopted approach reduces the risk of working with mis-specified regression models.

To provide an example of the procedure that was followed to specify and estimate particular blocks of economic variables, section 4.7 describes the processes for the model's 41 sector employments.

Specification of MEMSA's Non-behavioural Equations: A significant number of MEMSA equations are designed to capture a wide range of nominal-real conversions and accounting relationships at sector and aggregate levels and to ensure inter-temporal consistency. The specification of this considerable part of the model is concerned with enforcing the necessary accounting relationships at aggregate and sector levels to ensure model results are consistent, meaningful and reliable. MEMSA's iterative process of generating each period's forecast ensures that the accepted simulation results for each period satisfies all the specified accounting relationships.

4.2. MEMSA Data Sources and Preparation

The specification of the model equations informed the range and the details of its data requirements. MEMSA as a multi-sectoral macro-econometric model uses extensive amount of data as input. The model's main sources of data for its endogenous variables include the Reserve Bank's electronic historical National Income and Product Account dataset and Quantec's industry database, which is based on Statistics South Africa data. The model's datasets start from 1970. As part of building the model's database, the process included cross checking of industry time series data with the Reserve Bank time series data in order to ensure data consistency. The Standard Industrial Classification (SIC) for agriculture, mining (comprising three sectors) and services (comprising seven sectors) is aggregated at the 2-digit SIC level. Manufacturing (comprising 28 sectors) is aggregated at the 3-digit level. The data for the model's aggregate sectors, primary, manufacturing, services and total economy, are the sum of data from relevant sectors.

The model's database of exogenous variables includes domestic and international economic and policy indicators whose values are not determined within the model but they are either a necessary part of the national accounting of the South African open economy or found to have statistically significant impact on particular endogenous variable(s) of the economy.

This includes, for example, the growth rates of OECD countries and the Sub-Saharan countries, oil price, metal prices, U.S. interest rate, foreign investment, population growth, etc. For these and other similar data, MEMSA uses various international databases, such as the electronic databases and publications of the International Monetary Fund, the World Bank, the OECD, the European Union, the African and Asian Development Banks, OPEC, and other similar sources.

4.3. Parameter Estimation Method

The parameter estimation process refers to the utilisation of historical data and suitable econometric techniques to establish the specific forms of the model's behavioural equations. The process is expected to yield theoretically acceptable and statistically significant values for the parameters of the model equations.

The range of available regression techniques has expanded with the evolution of econometrics and availability of more and more data. Empirical literature has also expanded the choices that are available for estimating parameters of an economic model. For the specific functional form of its estimated equations, MEMSA uses the cointegration technique, in which dynamic relationships among a set of economic variables are specified in terms of error correction models (ECM) that allow dynamic convergence to a long-term outcome.The independent variables of the final estimated equation act as the 'long run forcing' variables for the explanation of the dependent variable.[11] The co-integration technique has been the preferred method used globally to build national, regional, and global macro-econometric models.[12]

Among the several such techniques available, MEMSA uses the Auto-Regressive-Distributed Lag (ARDL) estimation procedure, developed by Pesaran (1997) and Pesaran, Shin and Smith (1996). The advantages of this technique are that it offers explicit tests for the existence of a unique co-integrating vector, and since the existence of a long-run relationship is independent of whether the explanatory variables are integrated of order I(1) or of order

[11] Pesaran and Pesaran (1997), p.306.
[12] Recent examples of using cointegration techniques in the construction of regional and global macroeconomic models are Pesaran *et al.* (2004), Dees *et al.* (2007), Di Mauro *et al.* (2013), Chudik and Pesaran (2014), and Garrett *et al.* (2006).

I(0), the ARDL remains valid irrespective of the order of integration of the explanatory variables.[13]

The ARDL approach hinges on the existence of a co-integrating vector among the chosen variables, selected on the basis of economic theory and a priori reasoning. If a co-integrating relationship exists, then the second stage regression is known as the error-correction representation and involves a dynamic, first-difference, regression of all the variables from the first stage, along with the lagged difference in the dependent variable, and the error-correction term (the lagged residual from the first stage regression).[14]

The following equation represents the relevant ARDL formula used for the estimation of the model's behavioural equations such as y_t with a range of explanatory variables $x_{i,t-j}$. It includes the computation of the long-run coefficients and the associated error correction model (ECM).

$$\Delta \ln y_t = \beta_0 + \sum_{j=1}^{l_1} \eta_j \Delta \ln y_{t-j} + \sum_{i=1}^{n} \sum_{j=0}^{l_2} \gamma_{i,j} \Delta \ln x_{i,t-j} + \rho(\ln y_{t-1} + \sum_{i=1}^{n} \beta_n \ln x_{i,t-1}) + \varepsilon_t \qquad [4.2]$$

The model's ARDL equations have been estimated using *Microfit 5.0* software.

A successful single equation estimation process reflects an acceptable theoretical relationship among the estimated variables and produces values for parameters $\beta_0, \eta_j, \gamma_{i,j} \beta_n, \rho$ which are statistically significant and thus can be used to write into the model the specific functional form of y_t.

[13] Another advantage of the technique is that the endogenous variables are valid explanatory variables.

[14] The existence of a cointegrating vector (CV) is tested by the variable addition test, a technique that utilises the F tests developed by Perron. Where a CV existed, both short and long run estimates of the regression model are computed. It is an established fact that wherever there is a long-run relationship, there must exist a valid error correction mechanism that depicts the adjustment process towards this long run relationship. The critical test for the validity test of this adjustment process is that the coefficient of adjustment must be negative, between 0 and 1, and statistically significant.

In order to provide a more concrete presentation of the procedures that were followed to specify and estimate each behavioural equation of the model, the next section presents the process of estimating the model's 41 employment equations.[15]

4.4. Application of Empirical Method: Employment

In MEMSA, the block of behavioural equations that capture the working of the labour market includes 41 sector level estimated equations for employment and 45 estimated equations for the real wage rates.[16]The sector employment time series data used in the model includes employment in both the formal and informal economy in South Africa.[17]Since industry level employment is the main channel that links the LM-EM's macroeconomic module to the education modules, this section focuses on specifications and estimations of the employment equations of MEMSA.

First, in MEMSA, employment in the total economy is broken down into three aggregate categories (i.e., Primary, Manufacturing and Services) that have been further disaggregated into 41 sectors composed of 4 primary, 28 manufacturing, and 9 services sectors. There is significant diversity within the 41 economic sectors in terms of economic activity (e.g., agriculture versus banking sectors), size, production techniques (i.e., their utilisation of different mix of factors of production), links and dependency to other sectors, the rest of the economy, and the rest of the world.

As was explained earlier, given the diversity of economic sectors, at the specification stage, MEMSA uses a broad theoretical perspective to define, compile and process a number of variables which have been proposed to explain long-term trend and short-term fluctuations in employment. This allows the estimation process, which is the next step, to capture the differences in factors that determine employment of various sectors. The list of explanatory

[15] We have chosen to present a detailed discussion of estimation of sectoral employment since the project committee has been specially interested in employment wage elasticities. In the main part of the report, these elasticities are presented for all the sectors we used for the estimation purpose.
[16] The model includes 45 employment equations, 41 of which are estimated equations consisting of 4 primary, 28 manufacturing and 9 services. Four employment equations are for total primary, total manufacturing, total services, and total economy. Each aggregate variable is the sum of employment of its subsectors.
[17]The employment data that is reported by the Statistics South AfricaLabour Force Survey includes those that work in the informal part of the economy.

variables of the estimation of sector employment includes sector specific and macroeconomic data. The hypothesised relationships are consistent with a variety of theoretical views on demand, supply and institutional factors that influence employment.

On the supply side, the specification of employment equations include: the real average remuneration rate, the technique of production represented by a sector's capital labour ratio, a sector's labour productivity represented by the real output per unit of labour. On the demand side, we have included: sectoral real output, imports, exports, and the real gross domestic expenditure. Finally, the specification of this group of endogenous variables includes economy-wide price levels represented by the GDP deflator.

Overall, the following equation presents the specification of the sector employment equations in MEMSA in a general form.

$$L_i = f_i(\overset{-}{rw_i}, \overset{-}{rw_{tot}}, \overset{-}{cl_i}, \overset{-}{lp_i}, \overset{+}{ex_i}, \overset{+/-}{im_i}, \overset{-}{I_i}, \overset{+}{GDE}, \overset{+}{GDP}, \overset{+}{REER}, \overset{+}{q_i^e}, \overset{-}{P}) \qquad [4.3]$$

Where L_i represents employment in sector i where i=1,2,…,41, and the signs above the independent variables reflect the hypothesised relationship between the variables and the sector employment. The variables are:

rw_i represents real wage rate in sector i

rw_{tot} represents the economy-wide real wage rate

cl_i represents capital-labour ratio in sector *i*

lp_i represents labour productivity in sector *i*

ex_i represents real export (in 2010 prices) of sector *i*

im_i represents real import (in 2010 prices) of sector *i*

I_i represents real investment (in 2010 prices) of sector *i*

GDE_i represents real gross domestic expenditure (in 2010 prices)

GDP_i represents real gross domestic product (in 2010 prices)

$REER$ represents the real effective exchange rate

q_i^e represents one period ahead expectation of the real output of sector *i*

P represents economy-wide general price index

At the next stage, each of the above variables was tested to determine whether it should be used in logarithmic or level form at the estimation stage. Each variable was then tested for stationarity and its order of integration.

After visual inspection of the plots of each data set to assess whether the data should be run in logs or levels, two separate regressions were run, one in log form and one in level form. Using the Schwartz-Bayesian Criterion, it was possible to draw a final conclusion about each variable's level of transformation. The results highlighted the fact that almost all variables used in the regressions should be run in log form.

Next, a combination of Augmented Dickey Fuller tests, auto-correlation functions and Box-Pierce statistics were used to test for the existence of unit roots (i.e. the stationarity of data) and the order of integration of each variable. The results indicate that the majority of the variables were integrated of order one, implying that the data series had to be differenced once, in order to render them stationary. Very few data series were integrated of order zero. Similarly, very few data series were integrated of order two, implying that such variables had to be differenced twice. Since one of the major advantages of the ARDL technique is that the exact order of integration is not important when running co-integration tests (see Pesaran et. la. 1996, 2000), the above information was used specifically to ensure the careful choice of variables for the application of the OLS technique where co-integrating vectors did not exist. Needless to say, the employment data (the dependent variable in all our estimations) was found to be integrated of order one at all levels of aggregation.

The ADRS team followed the above procedure for the estimation of the rest of the MEMSA equations associated with production, labour market, expenditure, prices, and financial market. The sectoral estimations were conducted for 41 sectors of the economy.[18]

4.5. Model Solution

MEMSA uses the Gauss-Seidel's iterative method (Vrahatis *et. al.* 2003) to solve the model's

[18]Adelzadeh and Alvillar (2016) provide a more detailed presentation of the specification, estimation and validation procedures used in estimating MEMSA's behavioural equations.

system of non-linear equations for each year of the forecast period. The procedure is designed to find solution for systems of equations within each period by a series of iterations. For each period, the iteration process starts with the last period's values of endogenous variables and current values of the exogenous variables and policy parameters. For the second iteration, the procedure uses the estimated values for the endogenous variables from the first iteration to re-estimate new values for the endogenous variables. This process will continue until two consecutive results for all endogenous variables satisfy the specified strict convergence criterion. The method is simple to programme, robust and efficient in terms of the execution time. The model solution in each period is consistent with the output, expenditure and income sides of the National Income and Product Accounts in real and nominal terms. Needless to say, the model generates time-based results that reflect the actual process of policymaking and evaluation.

One caveat that needs to be mentioned is that even though the macroeconomic module of LM-EM is highly dynamic, designed to capture, as much as possible, feedback interactions with the economy and its sectors, the model is limited in terms of capturing the interactions between its macroeconomic module and the skills supply and demand modules. In principle, the availability of a good supply of skills in the labour force and their successful employment might be expected to have a positive feedback effect on productivity and economic performance in the sectors in which they are employed. In practice, however, this has rarely (if ever) been built in skills forecasting systems. ADRS' macroeconomic modelling team has examined the challenge of extending the LM-EM to include endogenous two-way interactions between the macroeconomic module and the skills supply and demand modules with the intention of adding this feature to a later version of the model.

4.6. Model Outputs

MEMSA generates annual forecasts of a relatively large number of aggregate, sector level, nominal and real variables and indictors. It includes indicators related to production, labour market, prices, wages, financial variables, and incomes and expenditures of households, business and government. The model projections are consistent across aggregation levels both in nominal and real terms. Key model outputs include:

- Projection of key macroeconomic indicators
- Projection of demand for employment for 45 sectors of the economy
- Projection of output, investment, exports, imports, wages, and prices for 45 economic sectors
- Financial indicators such as the interest rate, credit extensions, and money supply
- Trade indicators such as trade-deficit GDP ratio
- Income and expenditure indicators
- Sustainability indicators
- Labour market indicators
- Production indicators
- Demand (expenditure) indicators

A transition-probability matrix was developed to translate MEMSA's 41 sector employment projections to 21 SETAs' employment. The SETA Transition Matrix (STM) therefore has 41 rows (i=41) and 21 columns (j=21) such that s_{ij} represents the probability of employment in sector *i* to belong to SETA *j*. Sum of each row of STM is unity, reflecting total distribution of sector employment among SETAs that share the sector. Each period, the LM-EM calculates a vector of employment for all SETAs (ES_t) using the STM and the model's projections of employment for 41 economic sectors (E_t), that is:

$$ES_t = E_t^{'} \bullet STM \qquad [4.4]$$

The model also estimates the sector composition of employment in each SETA using the following operation:

$$\left[ES\right]_t = E_t \bullet\!* \; STM \qquad [4.4']$$

Where $\left[ES\right]_t$ represents 41 by 21 employment matrix and $\bullet\!*$ represents element-by-element matrix multiplication.

4.7. Model Verification and Validation

Model verification and validation are essential parts of the model development process.

Verification concerns with whether the model's computer codes correctly represent the model's conceptual framework, and validation concerns whether the model represents and correctly reproduces the behaviour of the real world system. The two are iterative processes that are carried out throughout the model building process (Banks *et al.*, 2010, Sargent, 2011).

Verification, therefore, is concerned with building the model right. It refers to the comparison of the conceptual model to the computer representation that implements that conception and asks whether the model's computer codes correctly represent the model's conceptual framework. That is, has the model been constructed correctly? Are the input parameters and logical structure of the model correctly represented?

Verification is therefore the process of checking whether (a) the model is programmed correctly; (b) the algorithms have been implemented properly; and (c) the model does not contain errors, oversights, or bugs. The process ensures that mistakes have not been made in implementing the model's specification. However, since no computational model will ever be fully verified, guaranteeing 100 percent error-free implementation, model verification continues as more tests are performed, errors are identified, and corrections are made to the underlying model, often resulting in retesting requirements to ensure code integrity. Technically, the aim of the verification process is to have a model that has passed all the verification tests.

ADRS' multi-sector macro-econometric model, that is the foundation upon which LM-EM is built on, has gone through a rigorous verification process over the last twelve years. In addition, as an integrated model, the LM-EM has gone through its own verification process. Among measures used to verify the model are:

- the model outputs have been closely examined for reasonableness under a variety of settings of the input parameters. The model codes include a wide variety of output statistics that are used to verify the working of each module of the model and the model as a whole.
- The desktop version of the model was directed to print the input parameters at the end of the simulation, to make sure that these parameter values are not changed inadvertently during the simulation process.

- The model's computer codes are written as self-documenting as possible by giving a precise definition of every variable used, and a general description of the purpose of each major section of code.

The validation process concerns with building the right model. It concerns determining whether a model is an accurate representation of the real system. Validation is usually achieved through an iterative process of comparing the model to actual system behaviour and using the discrepancies between the two, and the insights gained, to improve the model. This process is repeated until model accuracy is judged to be acceptable. Therefore, the ultimate goal of model validation is to make the model useable through establishing that the model is able to address specific problems. Validation also provides accurate information about the real system that it represents. To validate the LM-EM, the model was subjected to a series of exercises that included:

- Using historical data on the exogenous variables to obtain predicted values of endogenous variables in the model. These predicted values were then compared with actual values of the variables to find whether the predicted and actual values are close.
- Testing the LM-EM on whether other properties of the models are consistent with the actual properties of the South African economy. For example, we mapped out the model's "response" functions for specific shocks and compare it to "stylized facts" from historical experience or from experience of comparable countries.
- Testing whether the model "explains" history by conducting controlled experiments, that is, by using the model to produce values for the endogenous variables for the latest year(s) for which actual values for some or all endogenous variables exist.
- Testing whether all model results are explainable, usually with simple economics.

The current version of the model has passed all the validation tests. Moreover, the validation process provided the modeling team with a good understanding of the model's capabilities, limitations, and appropriateness for addressing a range of important questions. We have therefore concluded that the current version of the model, that is reported here, performs well and can be used for policy evaluation exercises.

4.8. Economic Scenario and Other Assumptions

This section provides a basic description of three economic scenarios that were developed for the project as part of demonstrating how LM-EM works and produces projections of macroeconomic and sector indicators as well as demand and supply of skills. The section also includes description of assumptions made in terms of the future trajectory of the labour market related to parameters and outputs from the education sector.

4.8.1. Economic Scenarios

The formulation of economic scenarios has taken into consideration various perspectives on global and national outlooks. Perspectives on the future of the world economy have informed the range of possible values for external factors that affect South African economy through trade and financial market.[19]On the other hand, recent South African economic performance and policy discussions have been used to define domestic policy inputs that are used in the three future scenarios.[20]

The scenarios have been designed as probable scenarios for the South African economy since their assumptions regarding domestic policies and external factors are within the realms of possibility. At the same time, our expectation is not that the economy will follow exactly one of the three model generated growth paths, but that there is a good chance for the actual future path of the economy's key indicators to fall within the upper and lower bounds of the three scenarios.

The purpose is also to have three future scenarios that present distinct Low, Moderate, and High growth and employment paths for the economy that can be compared and contrasted in terms of their impact on demand and supply of skills. The model normally takes as inputs a scenario's current and future values for external factors and policy parameters, carries out

[19]The Conference Board (February 2015), OECD (2014 and 2015), IMF (April 2015), UN DESA (2015) and World Bank (January 2015).
[20]Among documents that have informed the scenarios are: Economic Development (2011), National Planning Commission (2012), Department of Trade and Industry (2014), National Treasury (2015, 2016), ANC (2015a, 2015b), Investec Bank (2015), AfDB (2015).

quantification of its impact on the economy using the dynamic feedbacks with MEMSA, and produces projections of growth, employment, inflation, and other endogenous variables. We used this process to develop and fine-tune specifics of three scenarios with distinct growth and employment paths. This made it possible to avoid forcing the model to produce 'expected' economic forecasts by imposing values on the model's endogenous variables and bypassing the model's dynamic feedback mechanism.[21]

4.8.1.1. *The Low Scenario*

'What if' the South African economic performance over the next 10 years remains relatively weak in terms of growth and employment creation? What are the implications of this path for demand and supply of occupations and skills, at aggregate and sector level?

This scenario envisions the future of the South African economy as the extension of the current low growth and employment path. It is a plausible scenario for at least two reasons. One, it reflects a substantial degree of economic policy inertia that diminishes chances for significant policy changes in the near future. On the other hand, it reflects the slow pace and high degree of uncertainty with regard to the global economic recovery, especially as it relates to Europe, Asia, and BRICS countries.[22] The scenario therefore assumes relatively low growth performance in the world economy and uses the latest Medium Term Expenditure Framework to establish the possible future paths of government current and capital expenditure. This scenario therefore reflects a combination of the status quo in domestic economic policy and relatively low growth path for the rest of the world, especially among the OECD countries. More specifically, the scenario includes the following:

- **Fiscal Policy**: The Low Scenario's stand on fiscal policy captures the Treasury's concern about the potential increase in the debt-GDP ratio over the next 6

[21] In some studies, CEDEFOP, 2009, p. 68, desired scenario results are specified as part of a scenario and all the equations of the model except employment are fixed in order to reproduce the baseline economic forecast. This approach overrides the dynamic feedbacks within the model and produces a partial solution.
[22] For example, even though the European Central Bank has launched more aggressive measures than the U.S. or Japan to stimulate the economy, the impact has been muted.

years.[23]The scenario therefore sets low annual targets for the deficit-GDP ratio as a mechanism to gradually bring down the debt-GDP ratio. In the model, as in practice, this implies closely aligning government expenditure with the government revenue. Therefore, the scenario strives for achieving a balanced or close to balanced annual budget.

- **Monetary Policy**: The scenario also adheres to the government's current inflation targeting policy and assumes that the policy will remain unchanged over the next 10 years. In the model, as in practice, this means the interest rate varies in order to keep the inflation rate within the 3 to 6 percentage target band over time.

- **Public Investment**: The nominal investments by the general government and public corporations are designed to increase by 6 percent annually during the projection period.

- **OECD Growth:** The scenario considers the possibility of continuing weak economic performance among OECD countries. Specifically, it assumes one percent average annual growth rate for the country group over the next 10 years.

- **Sub-Saharan Africa Growth:** The scenario assumes that the Sub-Saharan African growth prospect will be 5 percent annual over the next 10 years.

- **Oil Price:** The price of a barrel of crude oil is set to gradually increase to 70 US Dollars by 2025.

4.8.1.2. The Moderate Scenario

What if the economy follows a path that results in 'moderate' rates of economic growth and

[23] National Treasury, July 2015.

employment over the next 10 years? What will be the implication of this growth path for the size of job openings and job seekers by occupations?

The scenario is expected to generate a moderate growth path for the economy through a combination of external and domestic demand and supply measures. Overall, it presents a more optimistic view about the domestic and world economy. The main features of the Moderate Scenario are:

- **Fiscal Policy**: Under the Moderate Scenario, fiscal policy rule remains the same as in the Low Scenario. However, its implementation favours using fiscal policy to expand economic growth as the mechanism to ensure sustainably of the debt-GDP ratio. Therefore, the Moderate Scenario is designed to allow for larger government expenditure envelop to directly and indirectly stimulate growth through increased expenditure (aggregate demand). Specifically, the scenario tolerates annual deficit-GDP ratio of up to 5 percent to facilitate higher growth that helps raise tax revenue and sustain higher public expenditure and debt-GDP ratio.

- **Public Investment**: Relative to the Low Scenario, the Moderate Scenario includes a higher rate of public investment, both by the General Government and public corporations, over the period 2015-2025. Initially, it expands the Low Scenario's public investment for 2016 by 5 percent. After 2016, public investment is expected to grow beyond the Low Scenario's allocation by the initial 5 percent plus an additional 2.5 percent every year. That means that by the year 2025, under the Moderate Scenario, the total public investment will be 27.5 percent higher, in nominal terms, than the corresponding value under the Low Scenario.

- **Government Final Consumption Expenditure (GFCE)**. In line with the scenario's fiscal policy approach, the Moderate Scenario allows for relatively higher government final consumption expenditure using the same approach as the one used for specifying public investment.

- **OECD and Sub-Saharan Growth Rates**: The Moderate scenario includes a more positive outlook for growth in OECD and SSA countries over the next 10 years. It assumes that, relative to the Low Scenario, the indices of economic growth in both regions will grow by an addition one percent.

- **Terms of Trade Shock**: Consistent with the scenario's more optimistic thrust, the Moderate scenario includes the possibility for improvement in the South African terms of trade over the next decade. Specifically, it considers the possibility that relative to the Low Scenario, the terms of trade for South African primary, manufacturing and services will improve by 10 percentage points.

- **Production Technology**: In the macro module of the LM-EM, sectoral capital-labour ratios are considered proxies for sector production technologies since they represent the relative mix of capital goods (i.e., machinery and equipment) and labour used to produce sector outputs. It is commonly agreed that the production technologies in South Africa have gradually become more capital intensive over the years. Given the considerable interest in policy discussions and research regarding the need to make the South African economy more labour intensive,[24] the Moderate scenario assumes a relatively small slowdown (2 percent) in the pace at which the current trend in sector production technologies continue to become more capital intensive.

4.8.1.3. *The High Scenario*

The purpose of this scenario is to capture the implications for job openings, job seekers as well as skills demand and supply if the economy follows a path of high growth and employment over the next 10 years. The scenario reflects a positive outlook on the world economy and the South African economy. A scenario whose simulation produces such a growth path encompasses following features:

[24] Standing *et al.* (1996).

- **Fiscal Policy:** The High Scenario uses the same approach to fiscal policy as the Moderate Scenario. However, it builds on the successful outcomes of the Moderate Scenario and allows for a higher ceiling for the annual deficit-GDP ratio of 7 percent.

- **Monetary Policy**: The High scenario follows the current inflation targeting rule for monetary policy; however, the scenario takes account of possible trade-offs between inflation and economic growth and raises the upper bound of the current inflation target band from 6 percent to 8 percent in order to ensure there is coordination between monetary and fiscal policy to promote higher growth.

- **Public Investment**: This scenario includes the possibility of higher public investment than in the case of the Moderate Scenario. The scenario cumulatively increases the annual public investment trajectory of the Low Growth Scenario by 7 percent initially and an additional 3.5 every year after, starting with 2016. This means that by the year 2025, the total nominal public investment will be 38.5 % higher under the High Growth Scenario than the corresponding value for 2025 under the Low Scenario.

- **Government Final Consumption Expenditure (GFCE)**. Under this scenario the annual government final consumption expenditure remains the same as the Moderate Scenario.

- **OECD and Sub-Saharan Growth Rates**: Relative to the Moderate Scenario, the High Scenario envisions a more optimistic view of the future for the rest of the world and considers average annual growth rates of 3 and 7 percent for OECD and SAA countries, respectively.

- **Terms of Trade Shock**: Relative to the Moderate Scenario, the High Growth Scenario includes the possibility for greater improvement in the South African terms of trade over the next decade. It assumes that the terms of trade for South African primary, manufacturing and services will annually be 15 percent lower than the corresponding values under the Low path scenario.

- **Oil Price:** The price of a barrel of crude oil is set to gradually increase to 70 US Dollars by 2025.

- **Production Technology**: The High Scenario assumes that the current positive trends in capital labour ratios in agriculture, manufacturing, and services, included in the Low Scenario, will slow down by 2.5 percent.

4.8.2. Other Assumptions

LM-EM's projections of demand and supply of skills and occupations depend not only on future international and economic policy outlooks but also on the likely future trends related to a number of education and labour force indicators, which are described in this section:

- **Education Sector Output:** The model's education modules use, as exogenous parameters, two indicators from the education sector that are disaggregated by race, namely the annual matric graduation rate, defined as the share of 18 year olds in the country that receive a National Senior Certificate in a given year, and the higher education graduation rate, defined as the share of 25 year olds that annually graduate from higher education institutions. Assumption about the future rates for each racial group takes account of the trajectory for the population of the group and the recent trends in the number of matric and higher education graduates for the group. Therefore, it is assumed that the rates for the Africans and Coloured students will continue to gradually increase by about 6 percent and 4 percent over the next 10 years respectively. For Asian and White students, the corresponding rates are assumed to decline by about 3 percent and 1.7 percent over the next decade.

- **Labour Force Participation Rates:** The model uses as input the labour force participation rates for the working age populations of the four racial groups that are broken down further by gender, province and age. For each cohort, the model uses its estimated labour force participation rate for 2014 and assumes that it remains

unchanged over the next 10 years.

Replacement Demand: The replacement demand rates for retirements, mobility, mortality and emigration are kept at their estimated baseline values for all occupations. Table 8.1 of Section 8.2.3 provides the specific baseline values for the various categories of the replacement demand.

4.9. Scenario Results

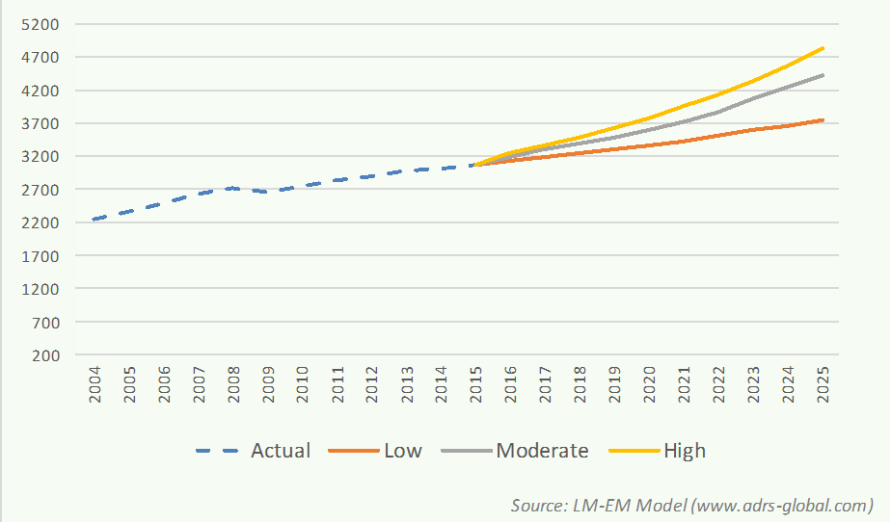
The LM-EM was used to simulate the growth paths of the above three policy scenarios for the period 2015 to 2025.[25] The model's macroeconomic module generates results for a wide range of indicators related to the macro economy and industrial sectors. Given space limitations, this section presents comparison of scenario results for only a selected number of indicators for the period 2015 to 2025. Since LM-EM's education modules utilise the macro module's projection of sector employment, only employment results have been presented in detail. Other sector and aggregate results for the three scenarios are available upon request.[26] In the later chapters of this report, the results of the model's educational modules will be presented.

Economic growth: The model projections show that the economy is expected to grow at average annual rates of 2 percent, 3.55 percent, and 4.38 percent between 2015 and 2025 under the Low, Moderate and High scenarios respectively. In terms of the size of the economy, it is projected to grow, in real terms (2010 prices), from R3,009 billion in 2014 to R3,743 billion in 2025 under the Low scenario, to R4,413 billion and R4,818 billion under the Moderate and High scenarios (Figure 4.1).

[25]The model takes as inputs a scenario's current and future values for external factors and policy parameters, carries out quantification of its impact on the economy using the dynamic feedbacks within MEMSA, and produces projections of growth, employment, inflation, and other endogenous variables. We used this process to develop and fine-tune specifics of three scenarios. This meant the model was not 'forced' to produce 'expected' economic forecasts by imposing values on the model's endogenous variables and bypassing the model's dynamic feedback mechanism. In some studies (e.g., CEDEFOP, 2009a, p. 68), desired scenario results are specified as part of a scenario and all the equations of the model except employment are fixed in order to reproduce the baseline economic forecast. This approach overrides the dynamic feedbacks within the model and produces a partial solution.

[26]Send your request to lm-em@adrs-global.com.

Figure 4.1: Real GDP Trends (2004-2025, R Bil)



Under the three scenarios, the share of the primary sector (agriculture plus mining) in total output is projected to gradually decline. By 2025, its share is projected to reduce from 10.6 percent in 2015 to between 7.5 and 8 percent, depending on the scenario. The output share of the manufacturing sector is projected to grow by about 2% under the Low scenario and 3% and 6.5% under the Moderate and High scenarios. The service sector will continue to maintain its high share of outputs. In 2015, its share of total output is estimated at 75.67%, which is estimated to remain relatively unchanged under the Low and Moderate scenarios but expected to decline to 72.2 percent under the High scenario.

Table 4.2 presents projections of sector outputs under the three scenarios. Since the model's econometric analysis of 45 sector outputs captures the differences in the determinants of sector productions, the differential impact of the scenarios on sector output is captured and reported in Table 4.2.

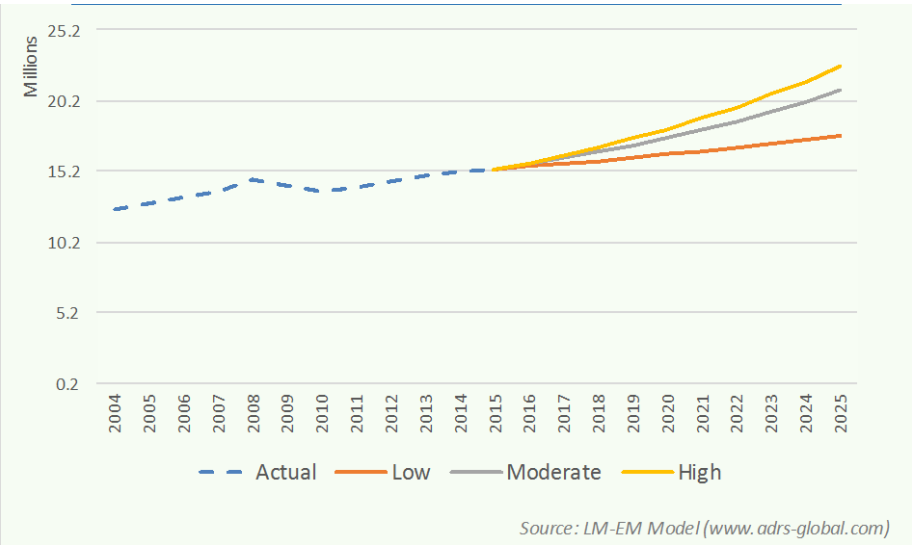
Table 4.2: Total Output by Sector (2015 & 2025, shares)

Sectors	Sectoral Shares of Output per year (%)			
	2015	2025		
	Actual	Low	Moderate	High
Index- Total Output (2010 Prices)	2,742,728	3,350,526	3,949,715	4,312,564
Agriculture, forestry and fishing	2.73	3.86	3.41	3.08
Coal mining	1.70	1.05	1.29	1.76
Gold, uranium and ore mining	0.87	0.33	0.32	0.41
Other mining	5.26	2.78	2.43	2.39
Food	1.95	2.15	2.20	2.15
Beverage	0.75	0.55	0.53	0.63
Tobacco	0.10	0.05	0.07	0.19
Textiles	0.11	0.12	0.15	0.32
Wearing apparel	0.23	0.41	0.46	0.69
Leather and leather products	0.05	0.03	0.10	0.04
Footwear	0.05	0.04	0.08	0.21
Wood and wood products	0.31	0.38	0.40	0.55
Paper and paper products	0.38	0.32	0.33	0.48
Printing, publishing and recorded media	0.48	0.40	0.36	0.35
Coke & refined petroleum products	1.39	1.84	1.63	1.69
Basic chemicals	0.58	0.71	0.78	1.17
Other chemicals & man made fibres	0.98	1.03	1.15	1.24
Rubber products	0.12	0.12	0.14	0.30
Plastic products	0.39	0.42	0.48	0.70
Glass and glass products	0.09	0.09	0.12	0.29
Non-metalic minerals	0.53	0.56	0.53	0.68
Basic iron & steel	0.79	1.07	1.17	1.40
Basic non-ferrous metals	0.39	0.40	0.44	0.65
Metal products excl.machinery	0.73	0.56	0.56	0.57
Machinery and equipment	0.72	0.80	0.74	0.82
Electrical equipment	0.35	0.61	0.60	0.74
Tv, radio & communication equipment	0.15	0.27	0.31	0.57
Professional & scientific equipment	0.05	0.02	0.05	0.18
Motor vehicles, parts & accessories	0.93	1.42	1.46	1.62
Other transport equipment	0.16	0.19	0.23	0.40
Furniture	0.14	0.13	0.15	0.30
Other industries	0.89	1.24	1.39	1.25
Electricity, gas and water	2.55	3.41	3.73	4.18
Building construction and engineering	3.61	3.90	4.86	4.69
Wholesale, retail trade, catering & acc.	14.41	13.21	14.40	13.25
Transport, storage, and communication	9.52	10.34	10.98	10.68
Financial & business services	21.99	22.28	19.81	18.37
Community, social & personal services	23.59	22.89	22.17	21.02
Other services	3.45	3.82	4.87	4.85
Households	2.60	2.59	3.32	3.36
General government	17.54	16.48	13.98	12.81
Total economy	100.00	100.00	100.00	100.00
Total primary	10.56	8.02	7.45	7.63
Total manufacturing	13.77	15.95	16.61	20.18
Total services	75.67	76.03	75.94	72.19

Source: LM-EM Model (www.adrs-global.com)

Employment: Figure 4.2 compares the trend in employment during the last 11 years with the model's projection of trends in employment under the three scenarios for the period 2015 to 2025. The three growth paths generate three corresponding employment paths that are significantly different. This is reflected in the outcome of the scenarios in terms of the unemployment rate which increases from 24.5 percent (36 percent with expanded definition of unemployment) to 25.4 percent (37 percent with expanded definition) under the Low scenario. Under the Moderate scenario the unemployment rate is projected to decrease by half over the next 11 years reaching 12% (20.3%) by 2025. Under the High scenario, it will become even lower, falling to 5% (14%).

Figure 4.2: Trends in Employment (2004-2024, levels)



Since policy differences between the three scenarios starts from 2016, the model's projection of employment for 2015 is the same across scenarios at 15.37 million. Afterward, the employment paths of the three scenarios part ways as the Low scenario adds 2.6 million jobs over the next 11 years compared to the increase in employment by 5.8 million and 7.5 million under the Moderate and High scenarios.

Under the three scenarios, the share of the primary sector (agriculture plus mining) in total output is projected to continue to gradually decline. By 2025, its share is projected to reduce from 8.3 percent in 2015 to between 4.5 and 4.7 percent, depending on the scenario. The output share of the manufacturing sector is projected to grow from 8.5 percent under the Low growth scenario to 9.0 and 10.3 percent under Moderate and High

scenarios, which is highly significant in terms of the relationship between growth and industrial transformation. The service sector's share of total employment adjusts downward under the Moderate and High scenarios to provide space for the higher share of the manufacturing sector (Figure 4.3).

Figure 4.3: Aggregate Sector Employment (2015 & 2025, levels)

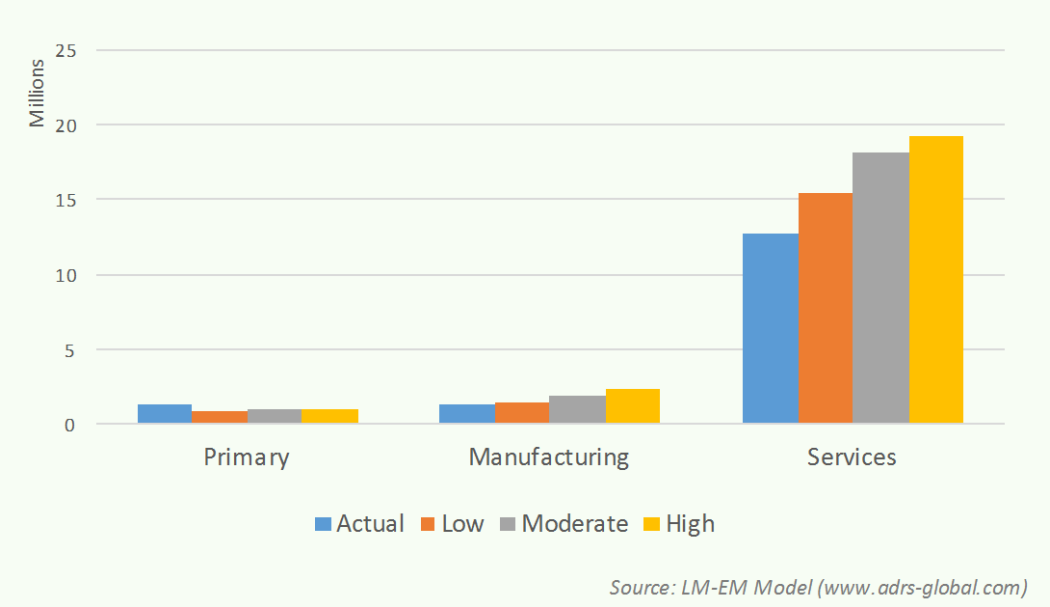


Table 4.3 presents LM-EM's employment projection for 45 economic sectors. Due to space limitations, the table only includes results for the first and the last year of the projection period.

Table 4.3: Total Employment by Sector (2015 & 2025, shares)

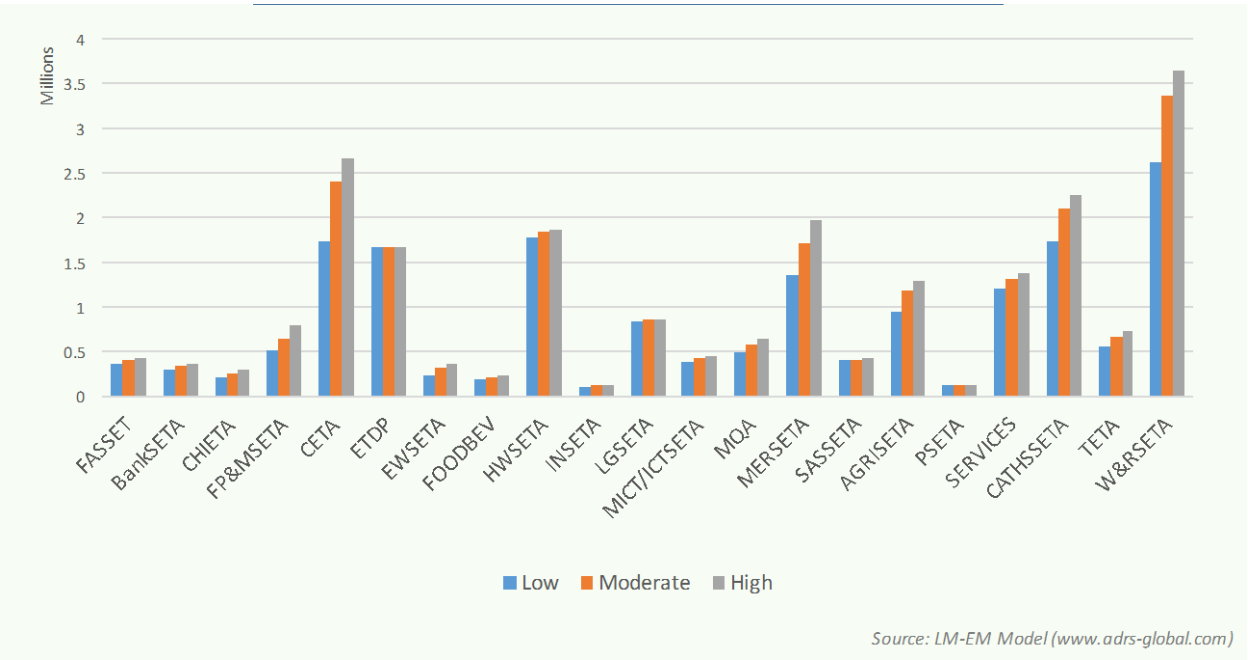
Sectors	Sectoral Shares of Employment per year (%)			
	2015	2025		
		Low	Moderate	High
Total Employment	15,370,261	17,748,991	20,932,626	22,607,461
Agriculture, forestry and fishing	5.10	2.38	2.42	2.46
Coal mining	0.57	0.47	0.54	0.66
Gold, uranium and ore mining	0.74	0.72	0.65	0.67
Other mining	1.87	0.92	0.88	0.88
Food	1.15	0.84	0.84	0.82
Beverage	0.45	0.50	0.45	0.46
Tobacco	0.02	0.02	0.02	0.03
Textiles	0.29	0.22	0.27	0.39
Wearing apparel	0.50	0.61	0.69	0.94
Leather and leather products	0.03	0.02	0.03	0.02
Footwear	0.07	0.05	0.09	0.16
Wood and wood products	0.37	0.32	0.35	0.47
Paper and paper products	0.25	0.12	0.10	0.12
Printing, publishing and recorded media	0.35	0.30	0.27	0.27
Coke & refined petroleum products	0.18	0.29	0.27	0.30
Basic chemicals	0.16	0.14	0.16	0.23
Other chemicals & man made fibres	0.36	0.48	0.52	0.57
Rubber products	0.07	0.05	0.06	0.10
Plastic products	0.26	0.14	0.16	0.20
Glass and glass products	0.06	0.05	0.05	0.05
Non-metalic minerals	0.39	0.31	0.37	0.39
Basic iron & steel	0.23	0.40	0.44	0.50
Basic non-ferrous metals	0.14	0.17	0.20	0.29
Metal products excl.machinery	0.94	0.44	0.45	0.46
Machinery and equipment	0.78	0.95	0.97	1.01
Electrical equipment	0.29	0.51	0.50	0.55
Tv, radio & communication equipment	0.04	0.06	0.07	0.11
Professional & scientific equipment	0.07	0.04	0.05	0.07
Motor vehicles, parts & accessories	0.58	0.70	0.70	0.73
Other transport equipment	0.09	0.07	0.08	0.11
Furniture	0.21	0.15	0.19	0.31
Other industries	0.40	0.58	0.62	0.63
Electricity, gas and water	0.42	0.37	0.43	0.47
Building construction and engineering	7.77	8.23	10.26	10.71
Wholesale, retail trade, catering & acc.	24.22	28.35	30.76	31.01
Transport, storage, and communication	5.40	5.65	5.73	5.72
Financial & business services	15.09	15.43	14.65	14.29
Community, social & personal services	30.07	28.95	24.67	22.84
Other services	2.80	2.89	2.58	2.38
Households	13.40	12.80	10.86	10.05
General government	13.87	13.25	11.24	10.40
Total economy	**100.00**	**100.00**	**100.00**	**100.00**
Total primary	8.28	4.50	4.48	4.67
Total manufacturing	8.74	8.52	9.01	10.30
Total services	82.98	86.98	86.51	85.03

Source: LM-EM Model (www.adrs-global.com)

Figures 4.4 and 4.5 present the model's projection of employment for 21 SETAs over the next 10 years. Some of the specific findings are:

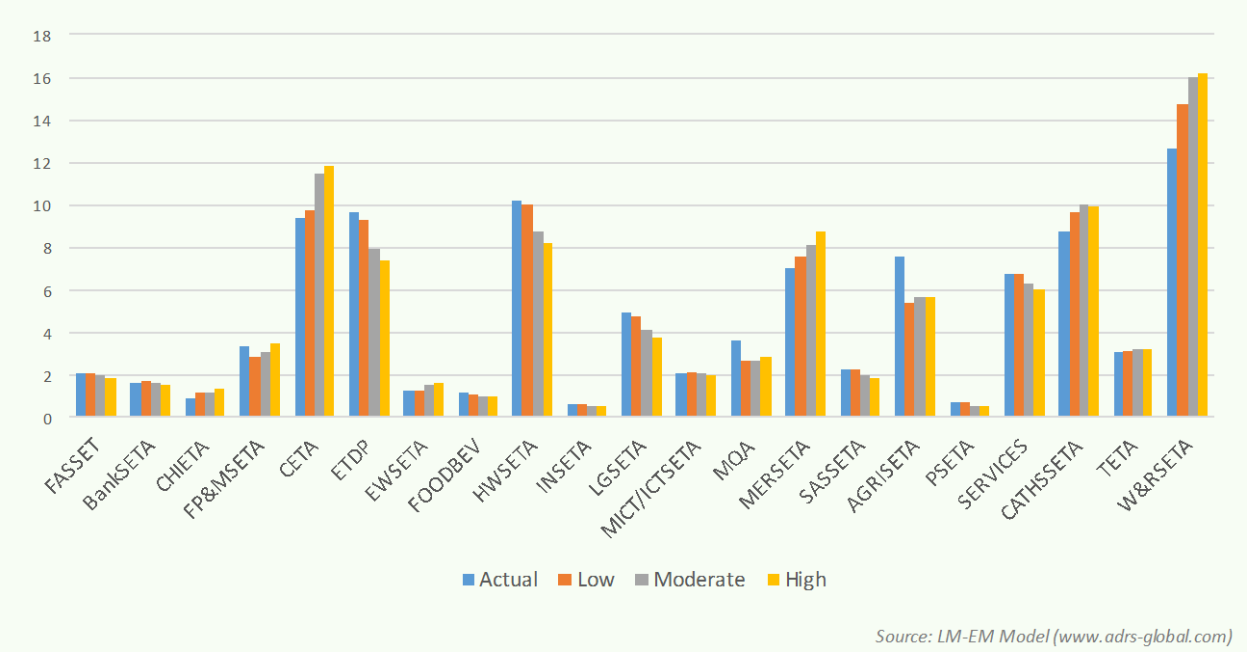
- Given the differential impact of the three scenarios on economic sectors, there are substantial variations among SETAs in terms of their evolution across scenarios over time. The growth paths that underlie the three scenarios are expected to raise the level of employment among all 21 SETAs. The only exceptions are MQA and AgriSETA, whose employment numbers are projected to decline under the Low scenario over the next 10 years.
- Employment in CHIETA is expected to grow at the fastest rate under all three scenarios. W&RSETA's share of total employment, which is currently the highest at 12.6 percent, is projected to remain the largest SETA under the three scenarios. Moreover, its share of employment is expected to grow to 14.78 percent (Low scenario), 16.04 percent (Moderate scenario), and 16.17 percent (High scenario).

Figure 4.4: Total Employment by SETAs (2025, levels)



Source: LM-EM Model (www.adrs-global.com)

Figure 4.5: Total Employment by SETAs (2015 & 2025, shares %)



Source: LM-EM Model (www.adrs-global.com)

Table 4.4 presents the model projections of distribution of annual employment among 21 SETAs for the Moderate Scenario, and Figures 4.6 and 4.7 present both the expected amount of change and the average growth rate of employment for the 21 SETAs under the three scenarios. Annexure D includes the LM-EM's results for the 21 SETAs.

Table 4.4: Projection of SETA Employment for Moderate Scenario (2015-2025, Thousand)

SETAs	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
FASSET	315	322	330	338	347	356	365	375	386	396	408
BankSETA	256	262	268	275	283	291	299	308	318	328	339
CHIETA	139	144	150	157	167	176	188	199	215	232	250
FP&MSETA	508	507	508	513	520	530	542	560	579	606	636
CETA	1,449	1,469	1,528	1,600	1,684	1,774	1,874	1,980	2,100	2,245	2,403
ETDP	1,491	1,531	1,565	1,594	1,619	1,640	1,656	1,666	1,673	1,673	1,667
EWSETA	196	201	209	218	229	240	253	266	280	298	317
FOODBEV	184	186	189	191	194	196	199	202	205	207	211
HWSETA	1,572	1,614	1,652	1,687	1,719	1,748	1,773	1,795	1,815	1,830	1,841
INSETA	91	93	95	98	100	103	106	109	113	116	120
LGSETA	759	779	797	813	826	838	848	855	860	862	862
MICT/ICTSETA	323	331	340	349	359	369	380	391	403	416	430
MQA	557	551	560	545	548	546	541	534	539	552	570
MERSETA	1,088	1,105	1,136	1,176	1,224	1,277	1,340	1,410	1,495	1,595	1,706
SASSETA	352	360	369	376	384	390	397	403	408	412	416
AGRISETA	1,170	1,164	1,153	1,145	1,138	1,134	1,133	1,135	1,150	1,165	1,184
PSETA	110	112	115	117	119	120	122	122	123	123	122
SERVICES	1,042	1,068	1,094	1,121	1,148	1,176	1,204	1,233	1,263	1,293	1,324
CATHSSETA	1,352	1,391	1,445	1,504	1,568	1,637	1,710	1,789	1,878	1,981	2,092
TETA	475	488	503	519	536	555	575	597	621	648	677
W&RSETA	1,941	2,002	2,098	2,206	2,325	2,454	2,595	2,748	2,922	3,130	3,357
Total	**15,370**	**15,681**	**16,103**	**16,542**	**17,037**	**17,550**	**18,098**	**18,678**	**19,344**	**20,109**	**20,933**

Source: LM-EM Model (www.adrs-global.com)

Figure 4.6: Compound Annual Growth Rate of Employment by SETAs (2015-2025)

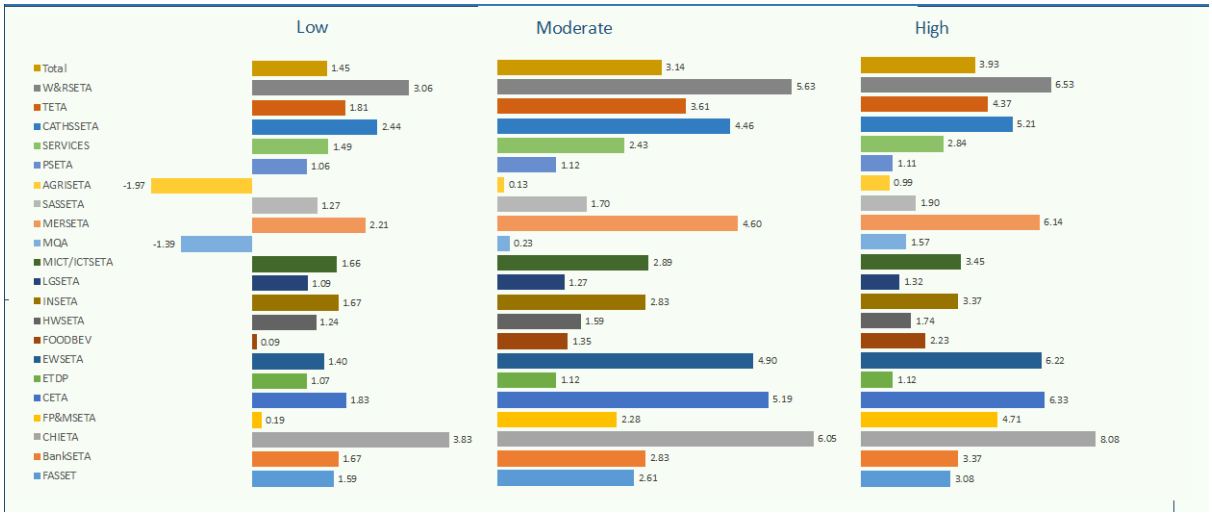
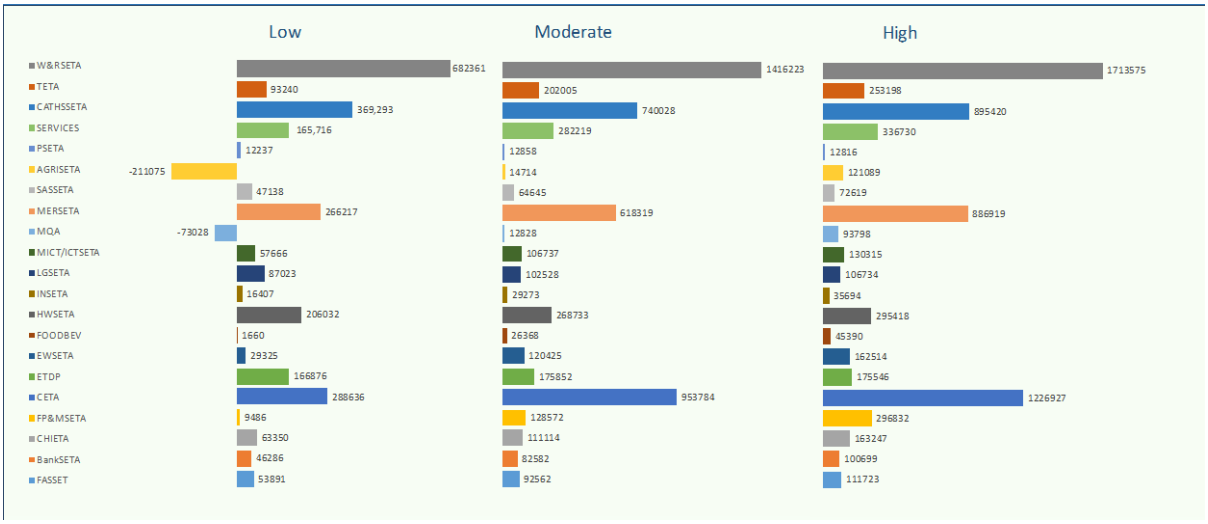


Figure 4.7: Change in Employment by SETA (2015-2025, levels)



4.10. Conclusions

LMEM's macroeconomic module is designed to capture the working of the South African economy at sector and aggregate levels. It is the core module of the LM-EM since at any point in time, the demand and supply of skills and occupations are intrinsically linked to the working of the economy, which the macro module of LM-EM replicates. The three scenarios for the likely evolution of the South African economy over the next 10 years produced three distinct trajectories for the sectors of the economy that the model's education modules will next utilise to produce corresponding projections of demand and supply of skills and occupations.

CHAPTER 5

LMEM EDUCATION MODULES – EMPIRICAL METHODOLOGY

LM-EM includes seven education modules. They are:

- LMEM-OCC: Occupational demand module
- LMEM-QUAL: Qualification demand module
- LMEM-RPL: Replacement demand module
- LMEM-JO: Job openings module
- LMEM-LS: Labour Supply module
- LMEM-JS: Job seekers module
- LMEM: BAL: Balance and imbalance module

The focus of the next seven chapters of this report is on the research and modelling work that was undertaken to build the education modules of LM-EM and on demonstrating the outputs of the modules using the simulation results for the three future scenarios for South Africa. Since three of the education modules, namely, occupation, qualification and labour supply modules, share a common empirical methodology to explain and to ultimately forecast skills demand and supply, the rest of this chapter is allocated to the explanation of their common methodology.

5.1. Multinomial Logistic Regression Techniques

For the LM-EM, the analyses of demand for occupations and qualifications and labour supply were carried out by means of the multinomial logistic (MNL) regression technique (Hosmer and Lemeshow, 2000; Long, 1997; Agresti, 2002). This approach allows estimating the probabilities of the different possible outcomes of a categorically distributed dependent variable (e.g., seven educational qualifications), given a set of independent variables (e.g., age, gender, occupations). In the process, the approach attempts to explain the relative effect of different explanatory variables on the outcome. In the case of this project, the MNL regression technique allows establishing the economic and demographic factors that are associated with each person's occupation, highest level of education, and participation in the labour force.

The multinomial logistic model assumes that the log-odds of each response follow a linear function to predict the probability that observation i has outcome j :

$$\delta_{i,j} = \beta_{0,j} + \beta_{1,j}x_{1,i} + \beta_{2,j}x_{2,i} + \ldots + \beta_{R,j}x_{R,i} \qquad [1]$$

Where $\beta_{r,j}$ represent a regression coefficient related to the *r*th explanatory variable and the *j*th outcome. In equation 1, the regression coefficients and explanatory variables can be represented by vectors of size *R+1*, so that the multinomial logit model can be written in a simpler form:

$$\delta_{i,j} = \beta_j x_i \qquad [2]$$

where β_j are the model coefficients associated with outcome *j* that will be estimated, and x_i (a row vector) is the set of explanatory variables associated with observation *i*.

The MNL technique requires assigning one of the response categories as the reference category, estimating the log-odds for all other categories relative to the reference category, and allowing the log-odds to be a linear function of the predictors:

$$\eta_{i,J} = \ln\frac{\pi_{ij}}{\pi_{iJ}} = \beta_j x_i \qquad [3]$$

Where π_{ij} is the probability of observation i falling in category j. The model estimates $J-1$ multinomial logit equations that contrast each of categories $1,2,...,J-1$ with category J. It makes no difference which category is selected as the reference category, because one can convert one formulation into another.[27]

An important advantage of using regression analysis is that the approach not only helps explain the relationship between the explanatory variables and the outcome, it enables predicting the future outcome of the dependent variable for which information about the explanatory variables, but not the outcome, is available. In the case of the multinomial logistic regression technique, the practical use of the technique in building the LM-EM is made possible by the fact that multinomial logistic regression results in log-odds that can be written in terms of the original probabilities, π_{ij}, rather than the log-odds using:

$$\pi_{ij} = \frac{e^{\beta_j \cdot x_i}}{1 + \sum_{j=1}^{J-1} e^{\beta_j \cdot x_i}} \qquad [4]$$

For *j*=1,2,…,J-1. Equation 4 will automatically produce probabilities that add up to one for all J of the probabilities.

In LM-EM, for each forecast period (*t+1*), the MNL estimated probabilities adjust to the values of the explanatory variables that are provided for the period t+1, thus making the estimated probabilities dynamic. Therefore, the dynamic version of equation 4, used in the LM-EM, can be written as:

$$\pi_{ij}^{t} = \frac{e^{\beta_j \cdot x_i^t}}{1 + \sum_{j=1}^{J-1} e^{\beta_j \cdot x_i^t}} \qquad [5]$$

The following chapters explain the specifics of how multinomial regression techniques were implemented for statistical analyses of occupation demand, qualification demand and labour supply.

[27] For example, in an example with three categories (J=3), model results that contrast categories 1 against 3 and 2 against 3, can be easily rewritten as categories 1 against 2 and category 3 against 2 since: $\ln(\pi_{i1}/\pi_{i2}) = \ln(\pi_{i1}/\pi_{i3}) - \ln(\pi_{i2}/\pi_{i3})$ and $\ln(\pi_{i3}/\pi_{i2}) = -\ln(\pi_{i2}/\pi_{i3})$.

CHAPTER 6

OCCUPATIONAL DEMAND MODULE (LMEM-OCC)

This chapter provides a brief presentation of the occupation module of LM-EM. The modelling work on the module was supported by background empirical research that was undertaken on occupational demand at the REAL Centre and ADRS.[28] This chapter's focus is on the modelling work that was undertaken to build the LMEM-OCC module as part of the overall LM-EM. It also presents the LM-EM occupational demand results for the three hypothetical future scenarios.

6.1. Purpose

The aims of the occupational module of LM-EM are:

- To properly capture the links between LM-EM's macro module, that produces projections of sector employment, and the occupational structure of economic sectors in order to translate the model's projections of employment to projections of demand for occupations.[29]
- To provide projections of the occupational composition of the employment share of 21 SETAs.

[28]The REAL Centre at the University of Witwartersrand assembled a team of researchers to conduct research on occupation demand, qualification demand, replacement demand, and labour supply. The team included H. Perry, P. Ncube, and P. Pillay. P. Ncube was the lead researcher on the occupation demand. ADRS office in the United States used a team of five researchers to work on the empirical analysis of the overall project, including the occupational demand. They included A. Adelzadeh, S. Bautista, M. Kanji, Q. Wang, and J. Zeng.

[29]We have followed the tradition of referring to the occupational composition of employment as 'occupational demand.' However, it should be noted that in the economy and in the model, employment levels, as captured by historical data or generated by models as projections, are the outcome of a combination of both demand and supply factors.

6.2. Empirical Methodology and Data

Internationally, most occupational employment forecasts are based on simple extrapolation of past trends, mainly due to significant data limitations.[30] Where relevant data is available, it is possible to utilise a more sophisticated approach. In South Africa, the accessibility of Quarterly Labour Force Survey (QLFS) data made it possible to choose regression techniques to establish the statistical links between the occupational structure within economic sectors and economic and demographic factors. An important advantage of using regression analysis relative to simple extrapolation of past trends is that it is based on statistical techniques that are designed not only to identify and establish the relationship between the explanatory variables and the dependent variable, but also to facilitate predicting the future outcome of the dependent variable based on a sound statistical approach.

The empirical research on the demand for occupations included the specification of the multinomial logistic model to be used, preparation of data, running various versions of the regression model, and establishing the final version of the estimated model to use in LM-EM.

6.2.1. Stylised Facts

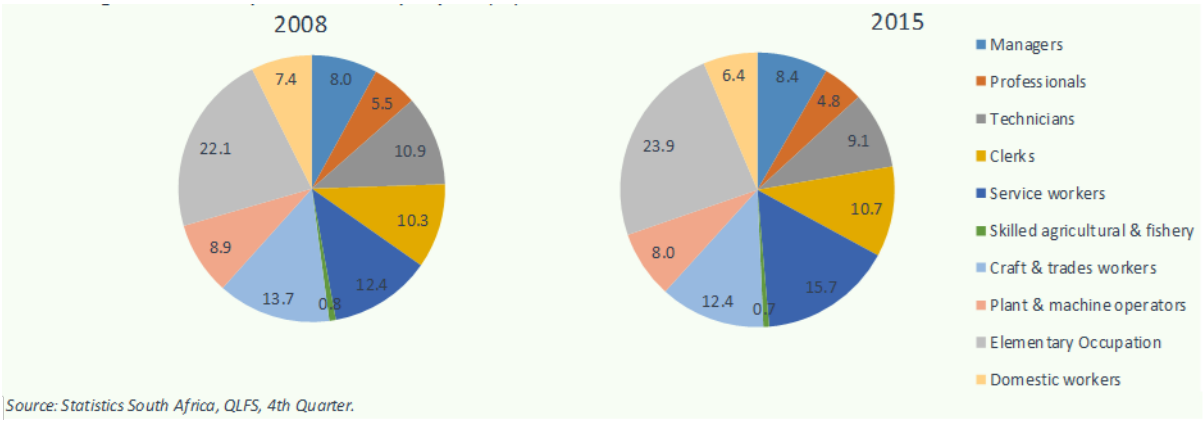
The Quarterly Labour Force Survey provides regular updates of South African employment structure that can be dissected from various economic and demographic angles. This section highlights current patterns related to the occupation structure of employment in South Africa as a precursor to the specification of the MNL regression models used for the estimation of the occupational demand.

Figure 6.1 shows the occupational distribution of all workers. Between 2008 and 2015, the occupational structure changed slightly, with the largest change in share (+4%) observed in Service workers (i.e., Service Workers and Shop and Market Sales Workers). All other shares changed less than 2 percent. The largest shares belong to Elementary workers, followed by Service workers. During the 8 year period, Service workers surpassed Craft and Related

[30] For a review see Wilson, R.A. (2001).

Trade workers as the second largest occupation by share of total workers. The overall level of employment between 2008 and 2015 rose about 1.3 million, with the largest increases observed within Service workers and Elementary workers, about 700,000 and 575,000 respectively.

Figure 6.1: Occupation of Employed (%) 2008& 2015



Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 6.2 shows the intersection between sector employment and main occupational categories for 2008 and 2015. It highlights historical patterns between sector employment and occupations. For example, the data for the two periods shows that about 50 percent of the total number of Managers in the country (1.2 million in 2008 and 1.35 million in 2015) is based in the Wholesale and Financial Services sectors; or more than 75 percent of Professionals and Technicians have been from the Financial Services and Community sectors historically. About 65 percent of Operators and Assemblers are employed in the Manufacturing and Transport sectors, and close to 60 percent of the between 3.3 million (2008) and 3.9 million (2015) Elementary occupations are concentrated in Agriculture, Wholesales, and Community Services sectors.

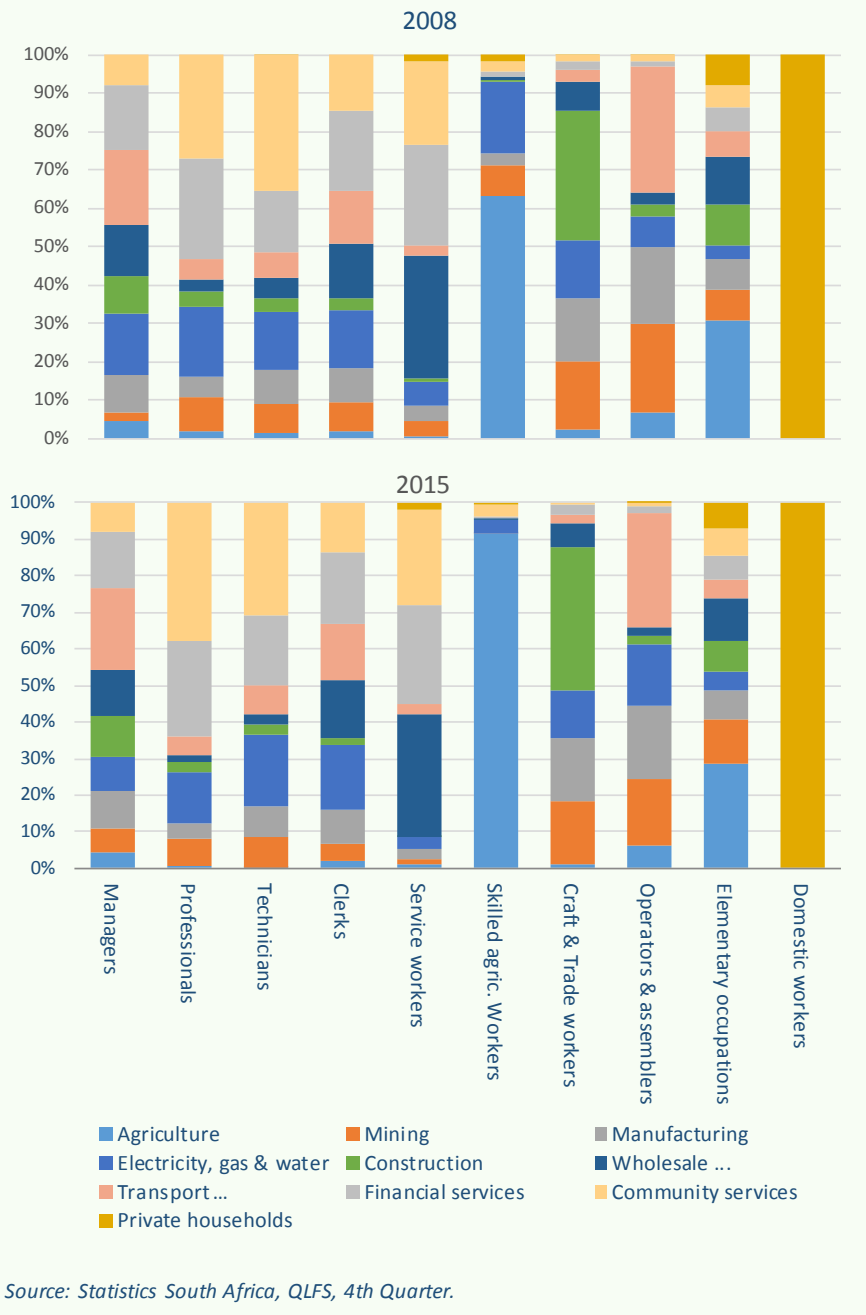
Comparison of data from 2008 and 2015 also shows that, over the eight year period, the occupational shares within the sectors have changed less than 5 percent with the exception of an 11 percent increase in the share of Elementary workers in Mining and Quarrying and a 12 percent increase in the share of Plant and Machine operators and Assemblers in the Electricity, Gas, and Water supply sector. There have also been increases of about 6 percent in the shares of Service workers and Elementary workers in the Community, Social and

Personal Services sector, accompanied by a 9 percent decrease in the share of Technical and Associate Professionals in the sector.[31]

Figure 6.3 compares the occupational distribution of workers among South African provinces over the period 2008 to 2015. It shows that between half and two third of all Mangers (legislators, senior officials and managers), and Professionals and Technicians (technical and associate professionals) in the country are in two provinces, Gauteng and Western Cape. Gauteng has the largest number of Managers and Professionals and the least number of Elementary Workers. In contrast, North West, Limpopo, and Northern Cape have a relatively high share of Elementary Workers and relatively few Managers and Professionals. Notably, since 2008, Service workers (i.e., Service Workers and Shop and Market Sales Workers) have grown as a percentage of total employment in every province, while the share of Technicians (i.e., technical and associate professionals) has declined in every province. The province with the highest number of employed people is Gauteng with 5.1 million workers, and the province with the lowest number of workers is Northern Cape, with 315,000 workers, which reflect their relative differences in population.

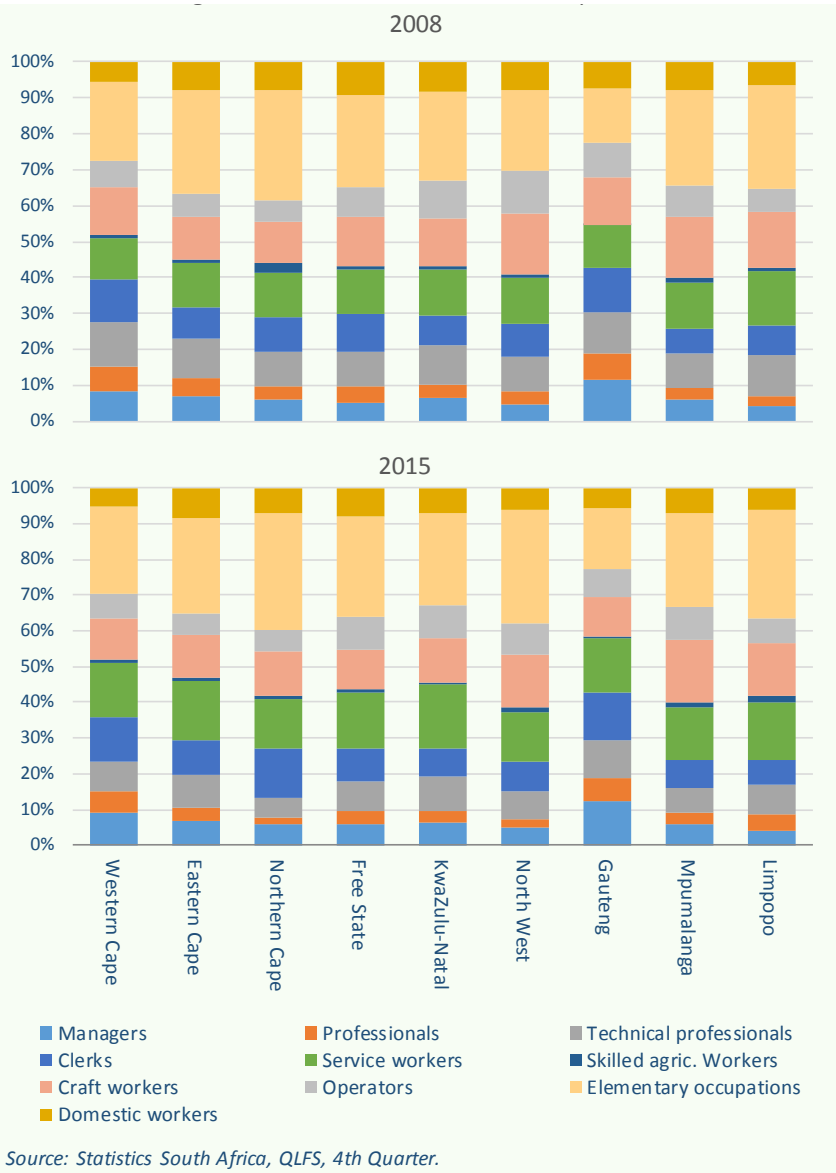
[31]The large swings in shares attributed to the "other" sector are mostly due to changes in classification – some legislators, senior officials, and managers, service workers, and elementary workers that were not included in the sector in 2008 were included in 2015, and clerks and plant and machine operators and assemblers that were included in 2008 were no longer included in 2015. Some of the changes in shares in other sectors during the time period may be attributable to these changes in classification.

Figure 6.2: Industry Structure of Occupations (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 6.3: Provincial Allocations of Occupations (2008 & 2015)

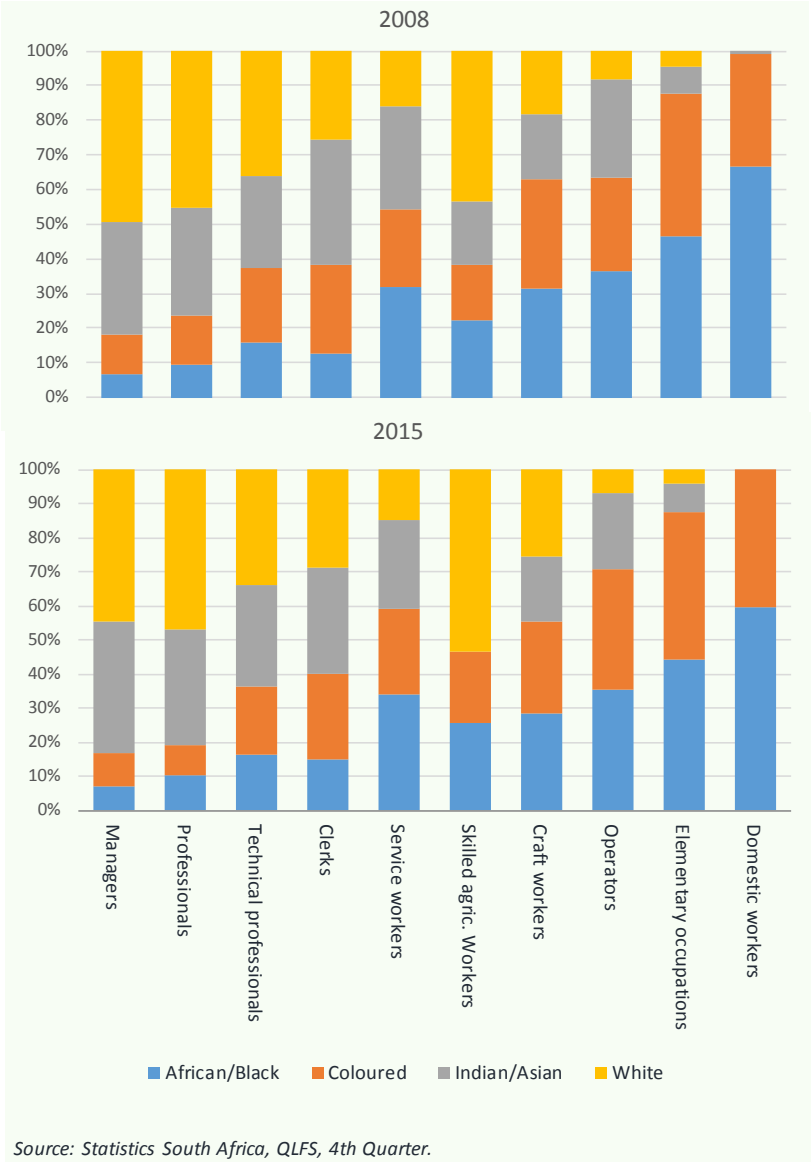


Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 6.4 contrasts the occupational distribution of workers among four racial groups for two periods. In terms of proportions, a large proportion of African/Black and Coloured workers are in Domestic and Elementary occupations while a large proportion of Indian/Asian and White workers make up most Managers and Professionals. Overall, comparison of 2008 and 2015 data indicates a clear pattern between occupation and race where the employment shares of African and Coloured workers increase as occupation becomes less skill intensive. The data shows the opposite for the occupational shares of White and Indian/Asian workers. At the same time, among African workers, the share of Service Workers has increased the most (by 3.7 percent) over the last 8 years. For the other

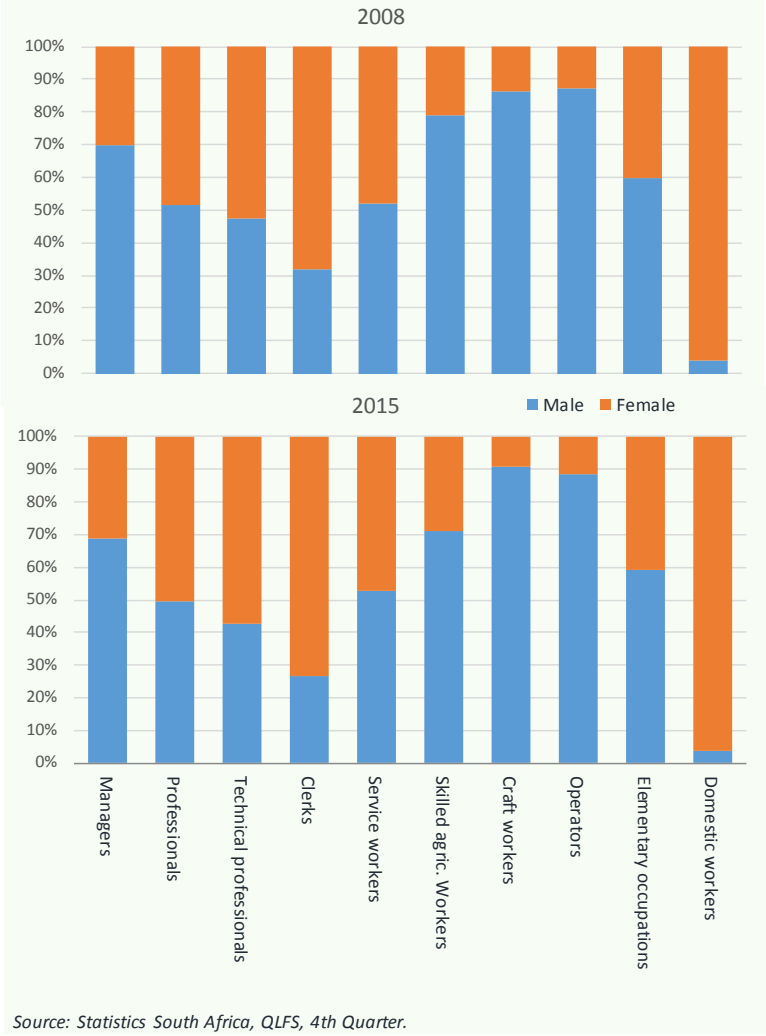
three racial groups, it is the shares of Elementary Occupations (Coloured, 3.4 percent), Managers (Indian/Asian, 6.5 percent), and Craft and Trade Workers (White, 2.8 percent) that have increased the most.

Figure 6.4: Racial Composition of Occupations (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 6.5: Gender Composition of Occupations (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

In terms of the distribution of employment by gender (Figure 6.5), the data points to a clear relationship between gender and occupation. Almost the entire workforce of Domestic Workers is women (96 percent in 2008 and 2015). Women also continue to make up a large proportion of Service Workers (48 percent in 2008 and 47 percent in 2015), Professionals (48 percent in 2008 and 50 percent in 2015), and more than half of total Technicians and Clerks. Men, on the other hand, are more represented, in both periods, in Elementary occupations and especially in occupations that fall under Managers, Skilled Agricultural and Fishery, Craft and Related Trade, and Plant and Machine Operators.

Overall, the labour force data for 2008 and 2015 indicate visible patterns between occupation of workers and their gender, race, province and sector of employment. These patterns have essentially remained the same between 2011 and 2013. The next section

outlines the process and results from the estimations of the multinomial logistic regressions and the calculation of occupation demand shares.

6.2.2. Data Preparation

A team from Statistics South Africa participated in the discussion on the suitable data for the project and subsequently provided the research team with a pooled dataset made up of three Quarterly Labour Force Survey data from 2009 to 2011.[32] This was followed by the use of basic statistical methods to prepare, review and test the statistical properties and suitability of identified variables for the inclusion in the estimation of the MNL model.

To realise the above objectives, three QLFS datasets were combined into one pooled dataset and multinomial logit methods were used to relate employment of 9 occupational categories to 40 sectoral employments and a number of demographic categories.[33]

6.2.3. Specification and Estimation of MNL Model

The theoretical and empirical literature on factors that influence the occupational choice of a person in the labour market provided the bases for the identification of factors that potentially explain occupational demand in South Africa.[34] This led to the initial specification of the multinomial logistic model for occupations in South Africa that included the following list of explanatory variables: sector employment, gender, age, province, race, average national real wage rate, export and import shares, investment-output ratio, and capital-labour ratio.

In total, twelve versions of the MNL model were estimated for the occupational demand; this included six estimations with and six estimations without the individual weights. After a thorough statistical analysis of the results, a model with economic sector, gender, race,

[32]The three QLFS data were from the third quarter of 2009, 2010 and 2011.

[33] In the LFS, the employed can be grouped in eleven main occupation categories: manager, professional, technician, clerk, sales and services, skilled agriculture, craft and related trade, plant and machine operator, elementary, domestic worker, and other.

[34]Additional literature on this topic includes Briscoe and Wilson (2003); Gregory *et al.* (2001); Machin (2001); Acemogly (2002); Autor *et al.*(2002); Wong *et al.* (2004), Woolard *et al.* (2003), Whiteford *et al.* (1999), and van Aardt (2001).

province, export share, and import share was selected as the final model. The fitted MNL model can be written using the estimated coefficients $\beta_{i,j}$ and the corresponding model matrix:

$$O_{j,i} = \beta_{0,j} + \beta_{1,j} Sec_i + \beta_{2,j} Race_i + \beta_{3,j} Gender_i + \beta_{5,j} Prov_i + \beta_{3,j} XSH + \beta_{3,j} MSH \qquad [6.1]$$

Where:

- O represents the dependent variable in the occupation demand equation and includes 9 categories, namely, Legislators, senior officials and managers (denoted as "Managers" in the results table); Professionals; Technical and associate professionals (denoted as "Technicians"); Clerks; Service workers and shop and market sales workers (denoted as "Service Workers"); Skilled agricultural and fishery workers; Craft and related trades workers; Plant and machine operators and assemblers; Elementary occupations and domestic workers. The category Service Workers was used as the reference category.
- $O_{j,i}$ represents individual *i*'s occupation *j*, where *j* represents the 9 occupation categories other than the reference category.
- Sec denotes 40 economic sectors in ADRS macroeconomic model (4 primary sector, 28 manufacturing sectors, and 8 service sectors). Sector General Government was used as the reference category.
- $Gender$ denotes gender and Male is the reference category.
- $Race$ denotes four category or racial groups in South Africa, namely, African, Coloured, Indian and Asian, and White. African is the reference category.
- $Province$ denotes nine provinces with Gauteng as the reference province.
- XSH, MSH denote export and import shares.

The MNL regression thus estimated the log-odds of being in occupation *j* relative to being in the Service Worker occupation. It therefore estimated 8 equations for the 9 occupation categories, not including the reference category. For each equation, the estimated

parameters represent the log ratio of the odds of being employed in *j* occupation versus being employed as a Service Worker. These log-odds are estimated on the basis of the working persons' sector of employment (sectors 1 to 41), province (1 to 9), gender (1 and 2), and race (1 to 4) plus the export and import shares. The transformation of estimated equations produces probabilities of the different possible occupational outcomes given a possible set of economic and demographic independent variables.

6.2.4. The MNL Results

The MNL regression results are made up of results for eight estimated equations. Table 6.1 presents the portion of the MNL regression results that capture the relationship between the demand for the Professional occupations and the MNL's economic and demographic explanatory variables. It shows, for example, that Professionals are less likely than Service Workers to be employed or demanded in all industries except Electricity, Gas and Water, Construction and Other Industries.[35] Exports increase the odds of Professional occupations by 35 percent. Females are 12 percent more likely than males to work in occupations that fall under Professionals. Workers of all other races are more likely than Africans to work in occupations under Professionals. Finally, workers are less likely to work as Professionals in all the other provinces other than Gauteng.

Results for the other occupations show that Agriculture is most likely to demand Skilled Agricultural workers and Elementary/Domestic workers compared to Service workers. Exports increase the likelihood of all the occupations being in demand for all occupations except Legislators, Senior Officials and Managers. Females are more likely than males to be in all occupations except for Managers. Females are especially likely to be Clerks as compared to males.

In terms of the relationship between occupation and race, Coloured workers are more likely than African workers to be in all occupations except for skilled agricultural workers. Indians are more likely than Africans to be in more skilled occupation whereas they are less likely

[35] It is important to note that the odds ratios are not probabilities as in certain instances they are greater than 1. The table above shows the odds ratios affecting the demand for professionals in different industries compared to being a service worker.

than African to be Craft workers, Operators and Elementary workers. Similarly, White workers are far more likely than African workers to be in high skill occupations, for example, Managers, Professionals and Skilled Agricultural workers, whereas they are far less likely than African workers to be Operators and Elementary workers.

Table6.1: Multinomial regression results for occupational demand

Occupation (Professional)*	Explanatory variable	Odds ratio
Industry (Mining)	Agriculture, forestry & fishery	0.16
	Manufacturing	0.48
	EGW	1.37
	Construction	1.65
	Wholesale and retail trade	0.03
	Transport and communication	0.86
	Finance and business services	0.34
	CSP	0.45
	Private households	5.49E-12
	Other industries	4
Trade	Export	1.35
Gender (Male)	Female	1.12
Race (Black)	Coloured	2.73
	Indian	8.24
	White	9.76
Province (Gauteng)	WC	0.64
	EC	0.56
	NC	0.24
	FS	0.51
	KZN	0.52
	NW	0.51
	MP	0.53
	LMP	0.53
	Intercept	1.04
**Text in brackets indicates the base category of the dummy variable.*		

6.3. LMEM-OCC Module

In order to build the occupational module of LM-EM, computer programming was used to transform the estimated log-odds of the MNL model for occupations to dynamic probabilities related to demand for 9 main occupations whose values adjust each period to changes in sector employment and demographic explanatory variables.

Computer codes were used to build the bridge between the LMEM-MAC annual projections of sector employment and demographic factors to produce annual forecasts of occupational composition of the new additions to employment and total employment.

Finally, we built two transition-probability matrices. The first was developed to translate LM-EM's 9 occupational demand projections to demand for 4-digit lower occupational categories. The occupational transition matrix (OTM) therefore has 398 rows (i=398) and 9 columns (j=9) such that t_{ij} represents the probability of employment in occupation category *j* to belong to *i* occupational subcategories. This transition matrix was originally built using the pooled QLFS data and will be regularly updated. The sum of each column of OTM is unity, reflecting the full allocation of each aggregate occupation among relevant occupations in a list of disaggregated occupations. Each period, the LM-EM calculates a vector of demand for disaggregated occupations (DO_t) using the occupational transition matrix (OTM) and the LMEM-OCC's projections of demand for 9 aggregate occupations (O_t), that is:

$$DO_t = OTM \bullet O_t \qquad [6.2]$$

$$\begin{bmatrix} do_1 \\ \vdots \\ do_{400} \end{bmatrix} = \begin{bmatrix} otm_{1,1} & \dots & otm_{1,10} \\ \vdots & \dots & \vdots \\ otm_{400,1} & \dots & otm_{400,10} \end{bmatrix} \bullet \begin{bmatrix} o_1 \\ \vdots \\ o_{10} \end{bmatrix} \qquad [6.2']$$

The second transition-probability matrix was developed to translate LM-EM's 41 sector employment projections to the 21 SETA employment projections. The SETA Transition Matrix (STM) therefore has 41 rows (i=41) and 21 columns (j=21) such that s_{ij} represents the probability of employment in sector *i* to belong to SETA *j*. The sum of each row of STM is unity, reflecting total distribution of sector employment among one or more SETAs. Each period, the LM-EM calculates a vector of employment for all SETAs (SE_t) using the STM and the model's projections of employment for 41 economic sectors (E_t), that is:

$$SE_t = E_t^{'} \bullet STM \qquad [6.3]$$

$$\begin{bmatrix} se_1 & \cdots & se_{21} \end{bmatrix} = \begin{bmatrix} e_1 & \cdots & e_{41} \end{bmatrix} \bullet \begin{bmatrix} s_{1,1} & \cdots & s_{1,21} \\ \vdots & \cdots & \vdots \\ s_{41,1} & \cdots & s_{41,21} \end{bmatrix} \quad [6.3']$$

The model also estimates the sectoral composition of employment in each SETA using the following operation:

$$[SE]_t = E_t \bullet\!* \; STM \quad [6.4]$$

$$\begin{bmatrix} se_{1,1} & \cdots & se_{1,21} \\ \vdots & \cdots & \vdots \\ se_{41,1} & \cdots & se_{41,21} \end{bmatrix} = \begin{bmatrix} e_1 \\ \vdots \\ e_{41} \end{bmatrix} \bullet\!* \begin{bmatrix} s_{1,1} & \cdots & s_{1,21} \\ \vdots & \cdots & \vdots \\ s_{41,1} & \cdots & s_{41,21} \end{bmatrix} \quad [6.4']$$

Where $\bullet*$ represents element-by-element matrix multiplication.

An important property of LM-EM is the consistency of measuring total employment from various angles. This means that the LM-EM's projection of total employment in each period (TE^t) is equal to the sum of 41 economic sector employment projections ($E_i^t, i = 1,2,...,41$), is equal to total employment estimated for 21 SETAs ($S_j^t, j = 1,2,...,21$), is equal to the total of sector level occupations $O_k^t, k = 1,2,...,9$), and finally, is equal to total occupation demand projected for 21 SETAs.

$$TE^t \equiv \sum_{i=1}^{41} E_i^t \equiv \sum_{j=1}^{21} S_j^t \equiv \sum_{k=1}^{9} O_k^t \quad [6.5]$$

6.4. MODULE OUTPUTS

The occupational module of the LM-EM generates a range of forecasts that relate to demand for occupations. This includes projections of the level of annual demand for nine occupations for the economy and for 21 SETAs. The model also produces projections of demand for occupations with 4-digit Standard Industry Classifications.

In section 4.10, the model's employment results for the proposed three scenarios were presented. In this section, the model's employment projections are presented by the occupation of employed.

6.4.1. Recent Employment by Occupation (2008-2014)

Table 6.1 presents an overview of recent distributions of employment by main occupational categories as used by Statistics South Africa. It shows that the largest occupation group among employees has been Elementary Occupations with more than one-fifth of total employment, followed by Service Workers with about 15 percent of total employment.

Table 6.1 also highlights the following trends in terms of occupations of employed. The shares of 3 of 9 occupational categories in total employment have clearly grown between October 2008 and October 2014; these are the employment shares of Managers (from 7.9 percent to 8.7 percent), Clerical workers (from 10.3 percent to 11.4 percent), and Sales and Services workers (from 12.4 percent to 16 percent). The shares for the remaining six occupations have either gradually declined over time (e.g., Technicians) or have moved around the average share for the sector (e.g., Plant and Machine Operators).

Table 6.2: Employment by Occupation (2008-2014)

Main occupation grouped	(Thousand)				(Shares, %)			
	2008	2010	2012	2014	2008	2010	2012	2014
Manager	1,166	1,184	1,152	1,337	7.9	8.5	7.9	8.7
Professional	807	802	861	654	5.5	5.8	5.9	4.3
Technician	1,615	1,559	1,609	1,467	10.9	11.2	11.1	9.6
Clerk	1,523	1,502	1,546	1,750	10.3	10.8	10.6	11.4
Sales and services	1,828	2,000	2,123	2,448	12.4	14.4	14.6	16.0
Skilled agriculture	115	74	63	94	0.8	0.5	0.4	0.6
Craft and related trade	2,034	1,659	1,773	1,957	13.8	11.9	12.2	12.8
Plant and machine operator	1,313	1,205	1,222	1,315	8.9	8.7	8.4	8.6
Elementary	3,269	2,964	3,216	3,356	22.1	21.3	22.1	21.9
Domestic worker	1,097	947	958	943	7.4	6.8	6.6	6.2
Total	**14,768**	**13,898**	**14,524**	**15,320**	**100**	**100**	**100**	**100**

Source: Statistics South Africa, Quarterly Labour Force Survey, Quarter 4 for all years.

6.4.2. Employed by Occupation (2015-2025)

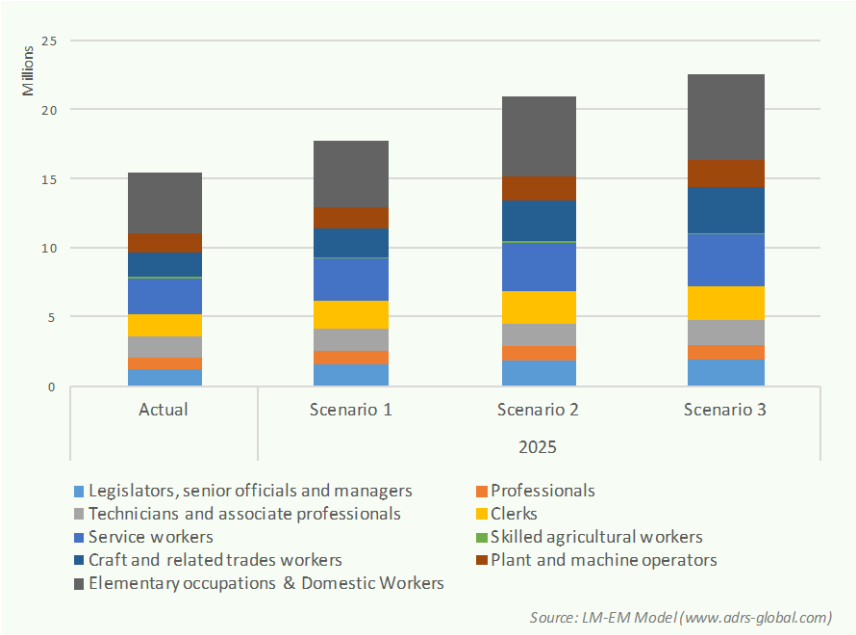
In Section 4.10, the LM-EM's employment projections for the three scenarios were presented. The LMEM-OCC produces annual projections of occupational composition of employment under alternative 'what if' scenarios. It therefore uses the LMEM-MAC projections of level and sector composition of employment and takes account of annual demographic changes. Figure 6.1 and Table 6.2 compare the model results for the three scenarios in terms of the model's projections of employment by the size and the share of various occupations over the next 10 years.

Table 6.3: Total Employment by Occupation (2015-2025)

Occupations	(Thousands)				Compound Average Growth Rate (			Shares (%)		
		2025			2015-2025			2025		
	2015	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Manager	1,263	1,536	1,827	1,972	3.32	6.35	7.72	8.65	8.73	8.72
Professional	813	936	995	1,027	2.39	3.43	3.97	5.28	4.75	4.54
Technician	1,456	1,655	1,731	1,770	2.15	2.92	3.31	9.32	8.27	7.83
Clerk	1,705	2,031	2,329	2,481	2.95	5.33	6.45	11.44	11.13	10.98
Sales and services	2,529	3,060	3,523	3,723	3.23	5.68	6.66	17.24	16.83	16.47
Skilled agriculture	86	57	67	73	-6.69	-4.19	-2.65	0.32	0.32	0.32
Craft and related trade	1,856	2,170	2,885	3,274	2.64	7.63	9.92	12.23	13.78	14.48
Plant and machine operator	1,312	1,461	1,774	2,018	1.80	5.15	7.43	8.23	8.47	8.93
Elementary and domestic worker	4,350	4,844	5,803	6,270	1.81	4.92	6.28	27.29	27.72	27.73
Total	15,370	17,749	20,933	22,607	2.43	5.28	6.64	100.00	100.00	100.00

Source: LM-EM (www.adrs-global.com)

Figure 6.6: Employment by Occupation (2015 & 2025, levels)



As explained earlier, one of the criteria that were used to select policy scenarios for this report was that the three scenarios had to generate significantly different levels of

employment in order to facilitate contemplating the implications that low, medium and high employment creation paths potentially have on the demand for occupations and educational qualifications. Given this background, under the three low, moderate and high growth path scenarios, total employment is projected to increase from 15.37 million in 2015 to 17.75 million under the Low Scenario, 20.93 million under the Moderate Scenario, and 22.61 million under the High Growth Scenario in 2025. In terms of the occupational demand, the results indicate the following:

- MANAGERS: The number of employed in the Managers category is projected to increase from 1.26 million in 2015 to 1.53 million or 21.6 percent (Low Scenario), 1.83 million or 44.7 percent (Moderate Scenario), and 1.97 million or 56.2 percent (High Scenario) over the next 10 years. The share of occupations classified as Managers is projected to increase from 8.2 percent to 8.7 percent in the three scenarios.
- PROFESSIONALS: The share of employed as Professionals will remain unchanged at 5.3 percent under the Low Scenario, but it is expected to decline under both the Moderate and High scenarios.
- TECHNICIANS AND ASSOCIATED PROFESSIONALS: In 2015, the number of employed under the category of Technicians is estimated at 1.46 million. This is expected to increase by between 123,000 (Low Scenario) and 214,000 (High Scenario) over the next 10 years. However, relative to total employment, the share of Technicians is expected to decline under the three scenarios (from 9.5 percent in 2015 to 9.3 percent (Low), 8.3 percent (Moderate) and 7.8 percent (High)).

  By 2025, across scenarios, the employment shares of occupations classified as Clerks will almost be the same at about 11 percent, even though under the High Scenario the number of employed as Technicians will be 660,000 more.

6.4.3. Occupation Demand by SETA (2015-2025)

As discussed earlier, the SETA module of the LM-EM generates projections of employment for 21 SETAs for the nine main occupational categories of the QLFS.

There are significant differences among SETAs in terms of the occupational distribution of their employment shares. At the same time, since the three scenarios have different impacts on the future growth of economic sectors and the magnitude and composition of sector employment and occupations, the evolution of occupational distribution of SETAs depend on the future scenario for the economy. Due to space limitations, Figures 6.2 and 6.3 illustrate the model results for the occupational composition of SETA employment for the Moderate scenario for the year 2025.

Figure 6.7: SETA Employment by Occupation (2025, Moderate scenario, levels)

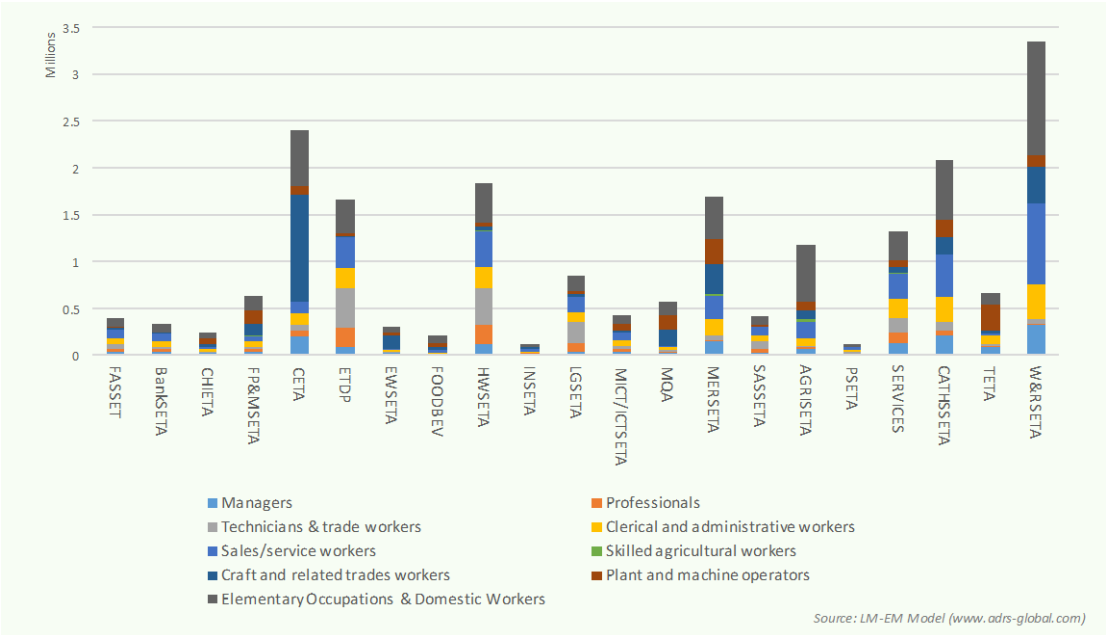
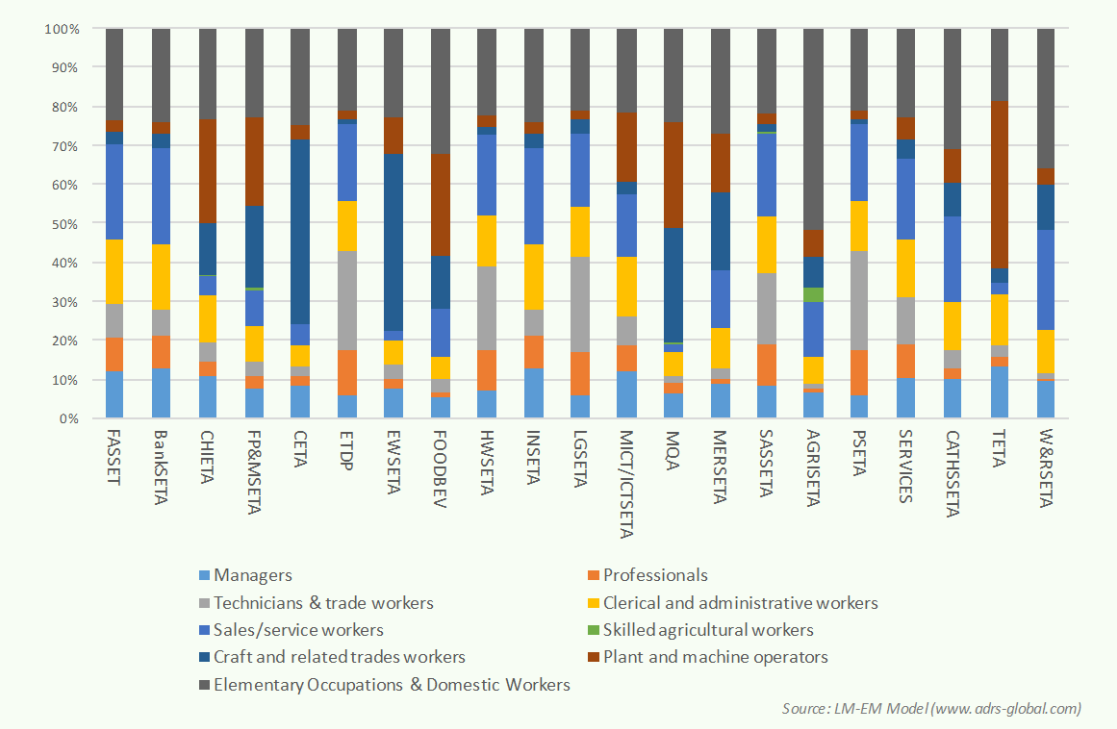


Figure 6.8: Occupational Shares of SETA Employment (2025, Moderate scenario)



In order to highlight the insight and foresight that LM-EM provides about the future evolution of SETAs, following are details of the model results for one SETA, i.e., MERSETA. Annexure D includes the LM-EM's results for all 21 SETAs.

Figure 6.4 depicts the three scenario's employment trends over the next 10 years for MERSETA. The results show that MERSETA's share of total employment is expected to gradually increase under each scenario from 7.08 percent in 2015 to 7.63 percent under the Low Scenario, 8.15 percent under the Moderate Scenario, and 8.73 percent under the High Scenario. On average, the number of workers that fall under MERSETA is expected to grow annually by 2.21 percent (Low), 4.6 percent (Moderate), and 6.14 percent (High Scenario). In terms of the actual number of employees, MERSETA's coverage is projected to expand by 266,000 (Low), 618,000 (Moderate), and 887,000 (High Scenario) by 2025.

Figure 6.9: MERSETA Employment Trends (2015-2025, levels)

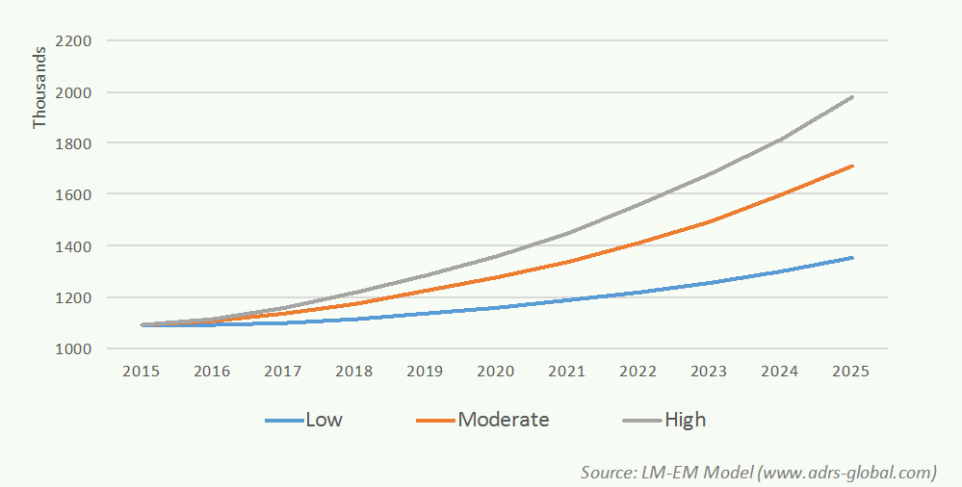


Figure 6.5 compares the occupational composition of employees under MERSETA in 2015 with the model's occupational results for the three scenarios for 2025. The size of various occupations is expected to grow under the three scenarios, but at different rates. This is demonstrated in Figure 6.6 which shows a comparison of scenarios in terms of their impact on occupational composition of the SETA over the next decade.

Figure 6.10: MERSETA Employment by Occupation (2015 & 2025, levels)

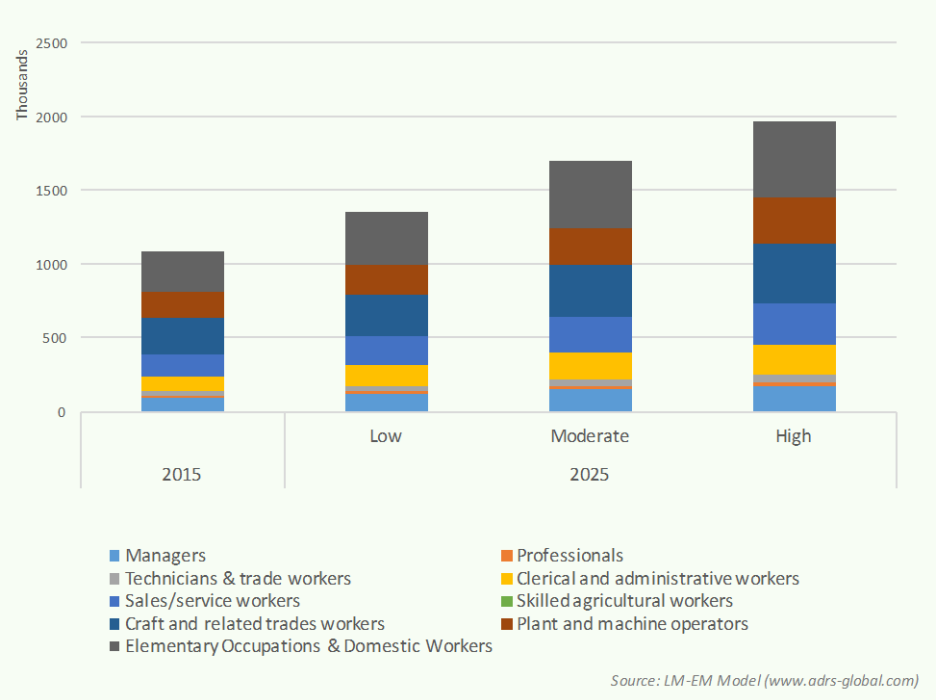
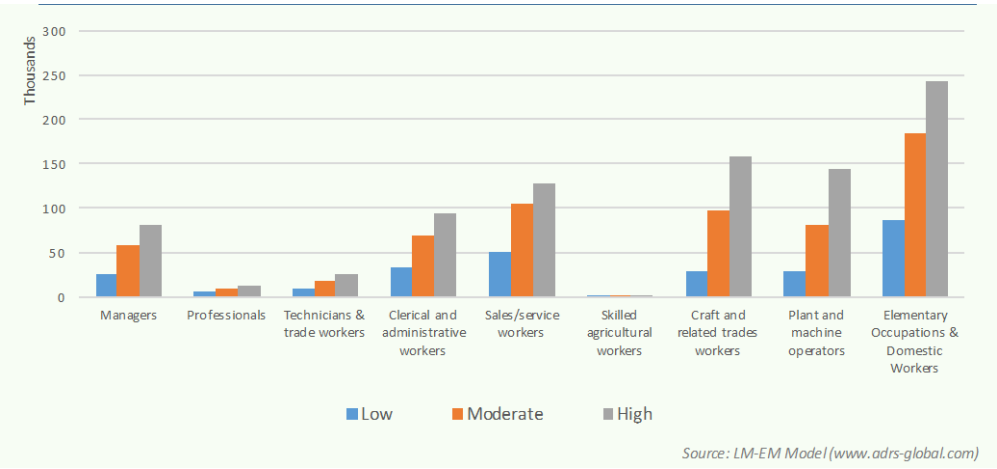


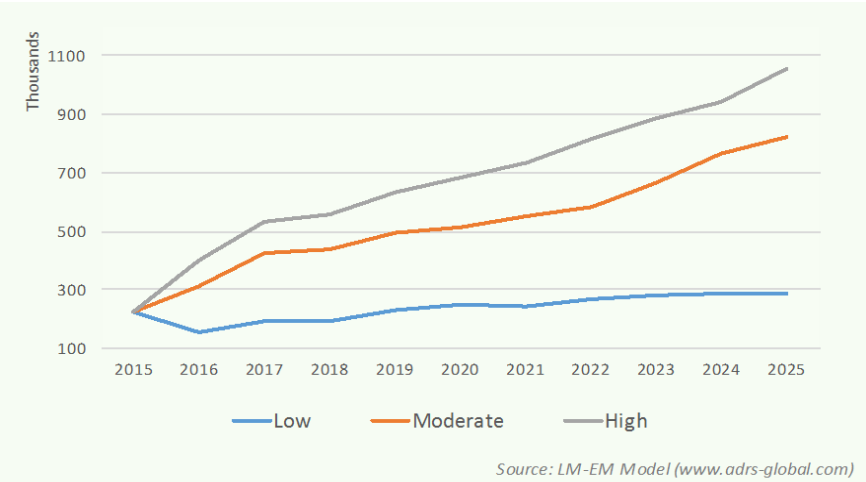
Figure 6.11: Change in MERSETA Employment by Occupation (2015 & 2025, levels)



6.4.4. Expansion Demand by Occupation (2015-2025)

Expansion demand refers to changes in demand for employment due to economic growth.[36] The aggregate expansion demand associated with the three growth paths are estimated at 2.6 million (Low Scenario), 5.8 million (Moderate Scenario), and 7.5 million (High Scenario) over the next 11 years. After 2015, the demands for employment, due to the growth paths of the three scenarios, are projected to grow at average annual rates of 2.47 percent (Low Scenario), 13.81 percent (Moderate Scenario), and 16.68 percent (High Scenario). What are the implications of these scenario results for the demand for various occupations in the next 10 years?

Figure 6.12: Trends in Total Expansion Demand (2015-2025)



[36]We have followed the tradition of referring to changes in the levels of employment between any two years as 'expansion demand' even though in some years the change may be negative.

Figure 6.13: Expansion Demand by Occupation (2015-2025)

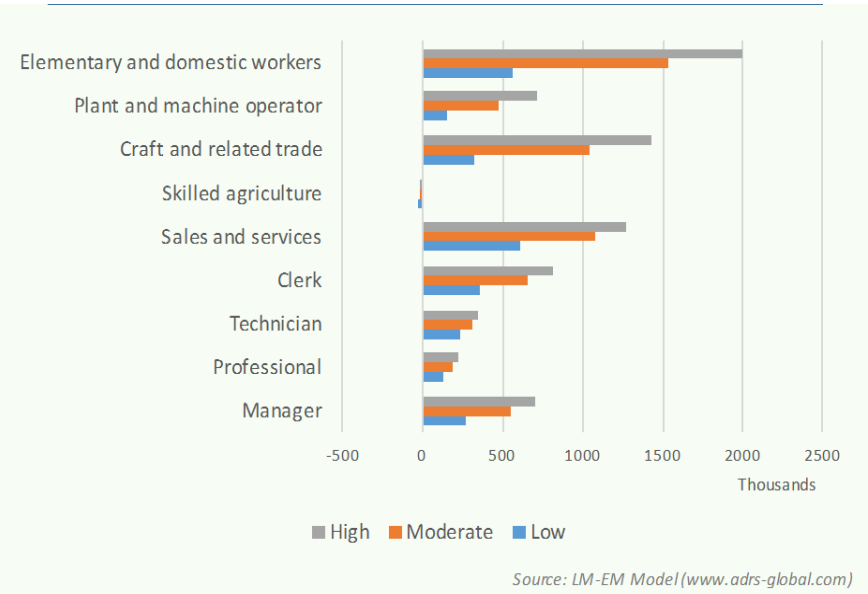


Table 6.4: Expansion Demand by Occupation (2015-2025, levels & shares)

Occupations	Total for 2015 to 2025			Share (%)		
	Low	Moderate	High	Low	Moderate	High
Manager	266,942	555,505	700,103	10.2	9.6	9.4
Professional	129,640	187,982	219,242	5.0	3.2	2.9
Technician	230,655	306,454	346,088	8.9	5.3	4.6
Clerk	358,008	656,127	808,471	13.7	11.3	10.8
Sales and services	606,878	1,071,373	1,271,330	23.3	18.5	17.0
Skilled agriculture	-34,202	-24,574	-17,976	-1.3	-0.4	-0.2
Craft and related trade	325,273	1,040,062	1,428,952	12.5	18.0	19.1
Plant and machine operator	154,690	467,338	711,188	5.9	8.1	9.5
Elementary and domestic workers	566,756	1,528,012	1,995,713	21.8	26.4	26.7
Total	2,604,640	5,788,279	7,463,111	100.0	100.0	100.0

Source: Linked Macro-Education Model (LM-EM) (www.adrs-global.com)

Figure 6.7 presents the trends for total expansion demand under the three scenarios for the period 2015 to 2025, and Figure 6.8 compares the three scenarios in terms of their implications for the main occupational categories. Finally, table 6.3 compares the three scenarios in terms of total employment that is expected from their underlying growth path over the next 10 years. Some key findings include:

- MANAGERS: The expansion demand for Managerial occupations is projected to increase but at a different pace under the three scenarios. Overall, over the next decade, demand for occupations that fall under this category is expected to grow by 29 percent, 151 percent and 200 percent under Scenarios 1 to 3, respectively.

- PROFESSIONALS: The expansion demand for Professionals is expected to decline over the next 10 years under the Low and Moderate scenarios by 36.8 percent and 12.4 percent, respectively. However, it is projected to grow slightly (by 0.2 percent) under the High Scenario.
- TECHNICIANS: Relative to 2015, the expansion demand for Technicians and Associate Professionals is expected to gradually decline under the three growth paths over the next 10 years. In 2025, demand for this category of occupation is projected to be lower than in 2015 by 44.5 percent (Low scenario), 27.1 percent (Moderate scenario) and 18.3 percent (High scenario).
- CLERKS: Occupations under the Clerks category will make up between 11 percent (High Scenario) and 13.75 percent (Low) of total additions to employment under the three scenarios over the next 10 years. Even though the employment share of Clerks is projected to decline under the High Scenario, their number is expected to increase from 90,000 in 2015 to 187,650 in 2025. Overall, the expansion demand for Clerks occupations is projected to grow by 14.4 percent (Low), 79.3 percent (Moderate Scenario) and 108.5 percent (High Scenario) over the next decade.
- SERVICE WORKERS: This occupational group is expected to cover between 17 (High Scenario) percent and 23.3 (Low) percent of the employment expansion associated with the three scenarios. The model's projections of demand for Service Workers follow a similar pattern as the demand for Clerks. It is expected to grow by 18.8 percent (Low), 84.9 percent (Moderate Scenario), and 106.7 percent (High Scenario) during the next 10 years.
- CRAFTS AND TRADE WORKERS: The growth pattern of demand for Crafts and Trade Workers differs from the growth patterns for Clerks and Service Workers occupations. Only 12.5 percent (325,000) of total employment over the next 10 years is expected to fall under Crafts and Trade workers under the Low Scenario. Employment in this occupational category is expected to grow both in shares and numbers under the Moderate (18 percent, 1.04 million) and High Scenarios (19.15 percent, 1.43 million).
- PLANT AND MACHINE OPERATORS: The growth path of the Low scenario is projected to need 155,000 additional Plant and Machine Operators, which constitute

5.9 percent of total additional jobs (2.6 million) that the Low Scenario's 2.0 percent average annual growth rate is expected to create. The shares and numbers of workers in Plant and Machine Operators are expected to be significantly higher under the Scenarios 2 (Moderate) and 3 (High). The shares are expected to reach 8.1 percent and 9.5 percent, and the employment numbers to 467,000 and 711,000 for the two scenarios respectively. Overall, the growth paths associated with the three scenarios will expand the size of employment in Plant and Machine Operators occupation from 43,000 in 2015 to 67,000 (55.8 percent), 128,000 (198 percent), and 176,800 (310 percent) over the next 10 years.

- ELEMENTARY AND DOMESTIC WORKERS: Over the next 10 years, across the three scenarios, between 21.8 percent and 26.7 percent of total projected additions to employment will be in occupations under the broad category of Elementary and Domestic Workers. Employment in this category of occupations is projected to grow by 27.5 percent (52,500), 125.7 percent (240,000), and 164.5 percent (313,800) respectively.

6.5. CONCLUSIONS

This chapter of the Report presented a summary of the modelling work that was undertaken to build the LMEM-OCC module as part of the overall LM-EM. The chapter explains how the module works and how it generates projections of annual demand for nine occupations in the economy and 21 SETAs; projections of demand for occupations with 4-digit Standard Industry Classifications; and projections of occupational composition of new job opportunities due to the expansion of the economy (i.e., expansion demand).

The chapter also provided a demonstration of the outputs of the module by presenting results for the three hypothetical future scenarios for South Africa.

The module approach that has been used to build the LM-EM enables us to regularly update the inputs into the module. The approach also allows us to make changes to the module in order to adapt the model to user requests or to expand the scope of the module outputs.

Some of the key findings from the three scenarios are summarised as follows.

Past trends:

- Between 2008 and 2014, the largest occupation group among employees with about one-fifth of total employment was Elementary occupations, followed by Sales and Services occupations with about 15 percent of total employment.
- Between 2008 and 2014, a little more than half a million people were added to total employment.
- The largest expansion of employees between 2008 and 2014 (620,000) was Sales and Services occupations, followed by Clerks (227,000) and Managers (170,000).
- Five out of nine occupations experienced declines between 2008 and 2014. The largest losses were in the Professionals (154,000) and Domestic Workers (154,000) categories, closely followed by Technicians (148,000).

Future trends: If the economy follows a growth path that falls within the Low and High scenarios:

- Employment in Managerial occupations, which grew on average 2.3 percent per annum between 2008 and 2014, will grow on average between 3.3 percent and 7.7 percent over the next 10 years. Overall, between 9 and 10 percent of additions to employment will be in Managerial occupations.
- The size of Professional occupations will expand between 124,000 and close to 215,000.
- On average, for every job created for Managers, Professionals, or Technicians, the economy is projected to create 3 to 5 jobs in the remaining six occupations combined.

CHAPTER 7

QUALIFICATION DEMAND MODULE OF LM-EM (LMEM-QUAL)

The main focus of the chapter is to explain the work on modelling the qualification module of the LM-EM. The chapter also includes a presentation of the LM-EM results for qualification demand related to the three future scenarios.[37] We have used the highest educational qualifications of individuals within national surveys as close proxies for their skill levels. Despite its limitations (e.g., its shortcomings to measure various generic skills and competences), this is an internationally established practice in modelling the education sector that relates to the availability of data and relative ease of measurement.

7.1. Purpose

The aims of the qualification demand module of LM-EM are:

- To transform the statistical analysis of factors that determine demand for educational qualifications to a dynamic system of forecasting demand for qualifications.
- To capture the interactions between the qualification module and other modules of the LM-EM.
- To produce detailed annual projections of demand for qualifications for the economy as a whole and for the SETAs.

[37] We have followed the tradition of referring to the educational qualification of employment as 'qualification demand.' However, it should be noted that in the economy and in the model, employment levels, as captured by historical data or generated by models as projections, are the outcome of a combination of both demand and supply factors.

- To provide foresight into the possible rise and decline in demand for particular educational qualifications over the medium and long term.

7.2. Empirical Methodology and Data

Domestic and international literature on demand for educational qualifications is extensive. In South Africa, the accessibility of the Quarterly Labour Force Survey (QLFS) data made it possible to choose regression techniques to establish the statistical links between educational qualifications of the employed with their occupations and demographic and economic factors. The steps that were undertaken included the specification of the multinomial logistic model to be used, preparation of data, running various versions of the regression model, and establishing the final version of the estimated model to use in the LM-EM.

7.2.1. Stylised Facts

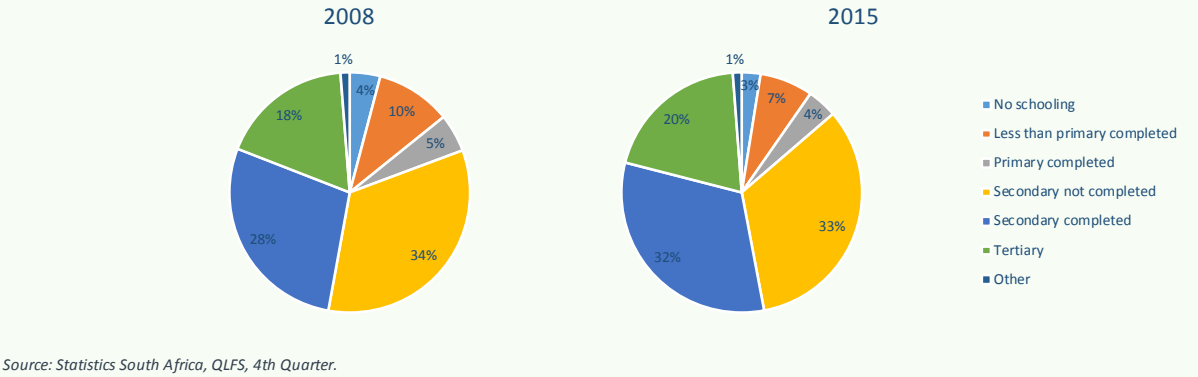
This section provides a descriptive analysis of data on the educational qualification structure of the employed in South Africa. It provides an initial insight into the potential relationship between skills, which is represented by the highest level of formal educational qualification of workers, and their economic and demographic characteristics.

Between 2008 and 2015, both the number and the share of workers with less than Secondary schooling (i.e., No Schooling, Less than Primary Completed and Primary Completed) significantly declined.[38]The opposite was the case for the number of workers with higher levels of education. In both periods, Secondary school was the most prevalent level of education among the employed. Between 2008 and 2015, the growth in the number of workers with Completed Secondary education increased much faster than the rate for the Secondary Not Completed (23.7 percent compared to 7.8 percent). The share of workers with Tertiary education, that is, post-Grade 12 certificates and diplomas and degrees, gradually increased to one-fifth of employed. It increased from 17.8 percent of

[38] The drops were -33.2 percent, -23.3 percent, and 14.6 percent for No Schooling, Less than Primary Completed, and Primary Completed.

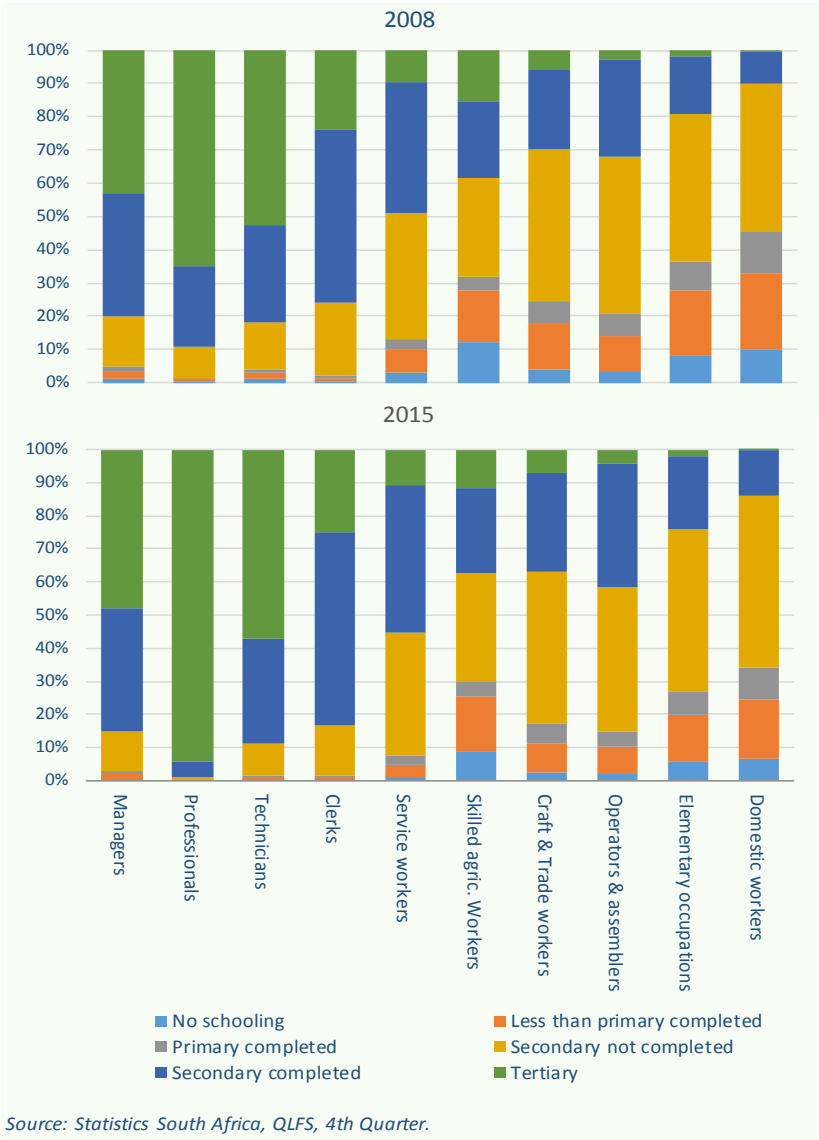
workers in the fourth quarter of 2008 (2.66 million) to 19.8 percent of employed in the same quarter of 2015 (3.2 million) (Figure 7.1).

Figure 7.1: Education Status of Employed (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 7.2: Skill Composition of Occupations (2008 & 2015)

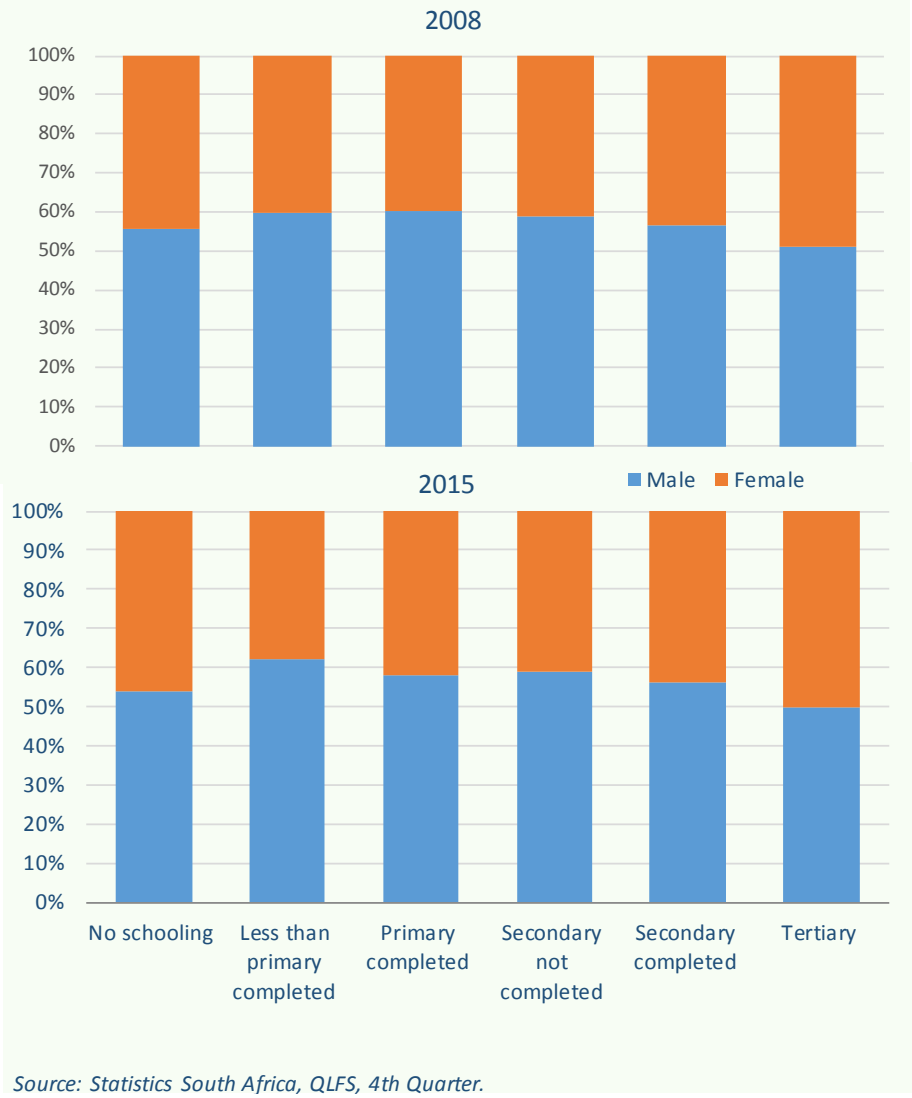


Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 7.2 shows the education status of workers in various occupations. The data for 2008 and 2015 highlights empirical regularity between occupations and educational qualifications of workers. Among all occupations, except Skilled Agricultural and Fishery Workers, the share of workers that had Less Than Primary school decreased over the last eight years, and the share of workers that had completed Tertiary school increased. Some of the largest changes between 2008 and 2015 occurred in the occupations that fall under Professionals. In 2008, workers with Tertiary education made up 65 percent of Professionals and 24% had Completed Secondary education, but in 2015, 94 percent of Professionals had Completed Tertiary education. Most workers fall within the category of Not Completed Secondary education, and the occupation with the highest share of this group is Domestic workers, followed closely by Elementary workers.

Among Managers, the highest level of education is Tertiary education followed by Secondary Completed. More than 50 percent of Technicians have Tertiary education and 30 percent have Secondary Completed as their highest level of education. Most clerks, more than 55%, have matric as their highest qualification followed by Tertiary at close to 25 percent. More than three-fourth of Service workers have either Secondary Not Completed or Secondary Completed. Most Craft and Trade workers – 75 percent in 2015 – and close to 80 percent of Operators and Assemblers have either completed or not completed secondary school education. Finally, more than 60 percent of Elementary and Domestic workers have secondary school education.

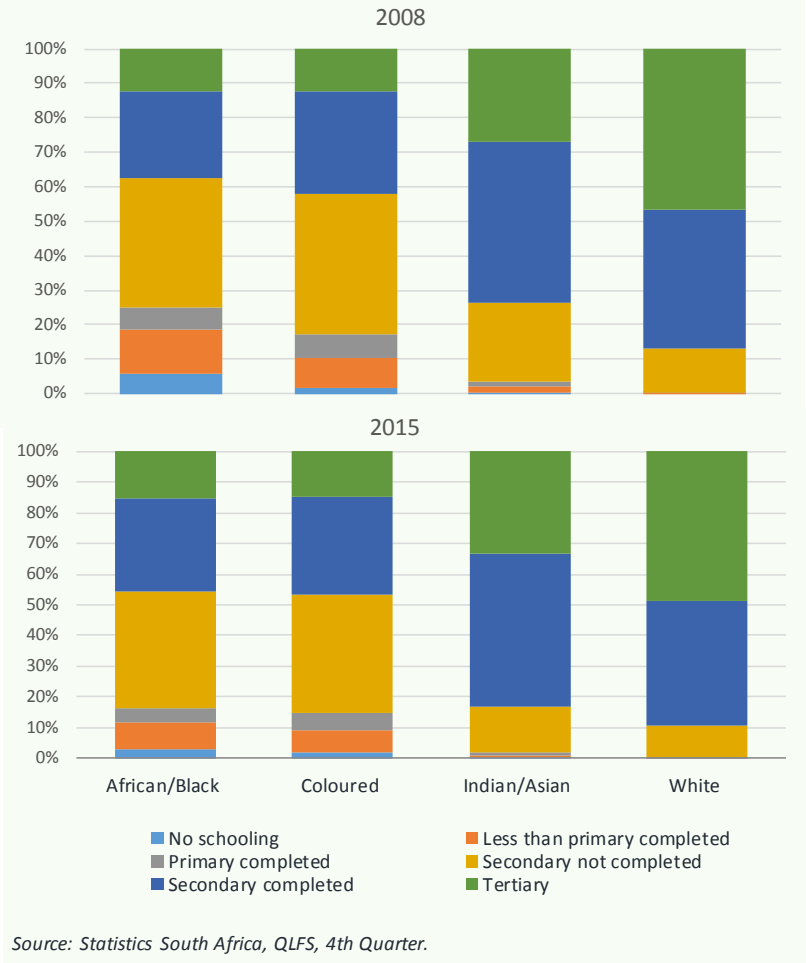
Figure 7.3: Gender Composition of Educational Qualifications (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

Employment data for 2008 and 2015 shows a relatively stable pattern of shares of male and female workers among various skills categories, represented by highest level of education (Figure 7.3). Over the last 8 years, the proportions of female workers in the No Schooling, Primary Completed, Secondary Completed, and Tertiary categories increased between 0.3 percent and 2 percent. The declines in the shares of female workers in the above educational categories imply that the corresponding shares have increased for male workers over the same period.

Figure 7.4: Skills and Race Composition of Employed (2008 & 2015)



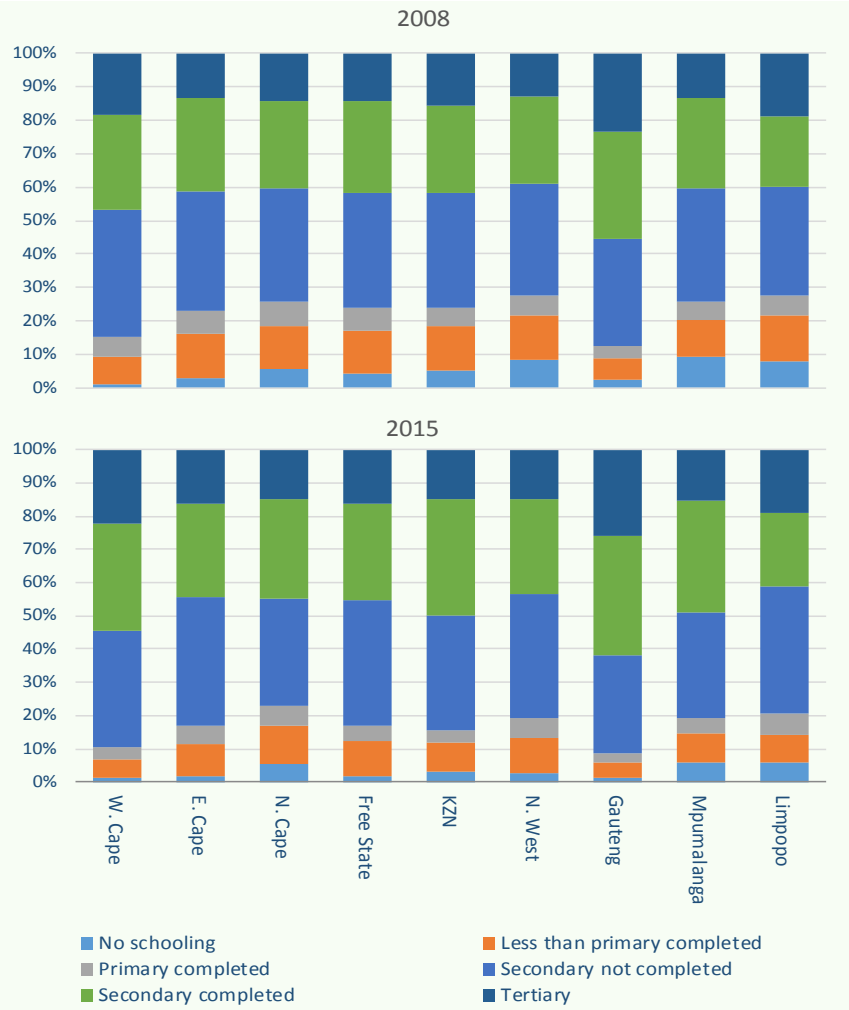
Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 7.4 highlights the range of skills (i.e., educational qualifications) among workers from four racial groups in South Africa. While for most races the number of people who have completed secondary school is higher than those who have post-secondary school education, for white people there are more people with post-secondary school qualification. In fact, while the highest single education level for black and coloured people is 'secondary not complete' for white and Indian/Asian people it is 'secondary complete'. Within white and Indian/Asian cohorts, workers are mostly distributed at higher levels of education while within African and coloured cohorts, workers are mostly distributed at lower levels of education.

In 2015, 37 percent of African/Black workers, 38 percent of Coloured, 14 percent of Indian/Asian, and 10% of White workers had not completed secondary schooling. Over the time period shown, the largest changes within each racial group were a 5.3 percent increase

in African/Black workers with completed secondary school, a 2.5 percent increase in Coloured workers with tertiary education, an 8.6 percent decrease in Indian/Asian workers that had not completed secondary school, as well as a 6.5 percent increase in the number of workers who had completed tertiary education, and a 2.4 percent decrease in White workers who had not completed secondary school. Employment among all racial groups experienced increases in the number of workers with completed secondary and tertiary education and decreases in number of workers that had not completed secondary education. As shown in the more general analysis of education in South Africa, all racial groups show an overall positive trend with respect to education level.

Figure 7.5: Provinces and Qualifications of Employed (2008 & 2015)



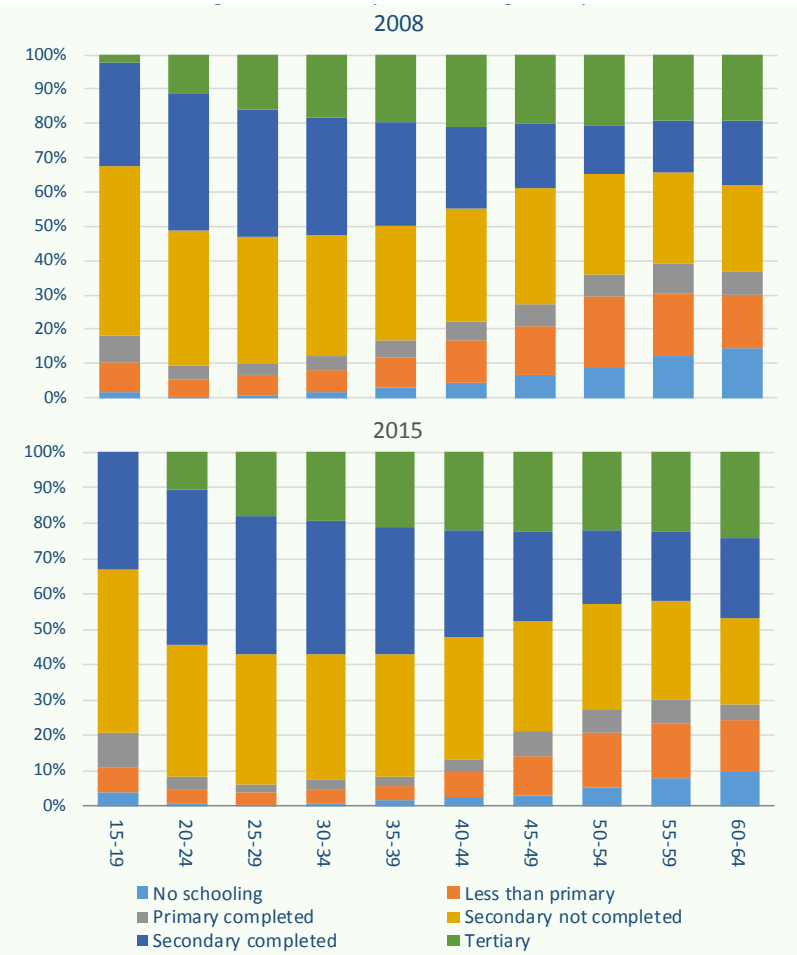
Source: Statistics South Africa, QLFS, 4th Quarter.

Comparison of education levels of workers across provinces over the last 8 years (Figure 7.5) shows positive growth in the number of workers in all provinces with Completed Secondary and Tertiary education. The largest changes in these categories between 2008 and 2015 were a 9 percent increase in secondary education in KwaZulu-Natal, a 6.5 percent increase in the same category in Mpumalanga, and a 4 percent increase in tertiary education in Western Cape. Data from all provinces show positive change in these two categories and negative growth in the other categories, with a few exceptions, namely a small dip (-0.5 percent) in workers with tertiary education in KwaZulu-Natal and moderate increases (around 3.6 percent) among workers that have not completed secondary education in Eastern Cape, Free State, and North West.

In spite of the observed general shift toward higher level of worker skills across provinces over the last 8 years, certain patterns of skills allocation across provinces have continued to persist. For example, between 40 and 55 percent of all workers with 5 out of 6 educational levels are concentrated in two provinces, namely Gauteng and KwaZulu-Natal.[39] The provincial shares of total workers with various skills levels have not drastically changed in the last 8 years. The median of differences in the shares of workers with Low, Medium and High skills across provinces between 2008 and 2015 is estimated at -0.04 percent.

[39]The exception is for workers with no schooling.

Figure 7.6: Skill Composition of Age Groups (2008 & 2015)



Source: Statistics South Africa, QLFS, 4th Quarter.

Figure 7.6 compares the education levels of workers across 10 working age groups for 2008 and 2015. It indicates possible relationship between age cohorts of workers and the six main categories of educational qualification. For example, notwithstanding small changes in various shares over the period between 2008 and 2015, more than 40 percent of workers within the 20-24 age group has continued to have Secondary Education Completed, and within the No Schooling cohort of workers, 50 percent are 50 years and older. Also, more than two-thirds of workers whose education levels fall within three educational cohorts, namely, Secondary Not Completed, Secondary Completed, and Tertiary, are between 25 and 45 years old.

7.2.2. Data Preparation

The pooled QLFS dataset that was used for the occupational demand analysis was also used for the qualification demand. Basic statistical methods were used to prepare, review and test the statistical properties and suitability of identified variables for the inclusion in the estimation of the MNL model.

7.2.3. Specification and Estimation of MNL Model

The theoretical and empirical literature on factors that determine demand for educational qualifications provided the bases for the identification of factors that potentially explain qualification demand in South Africa.[40] This led to the initial specification of the multinomial logistic model for qualifications that included the following list of explanatory variables: occupations, gender, age, race, province, import share, export share, and real wage rate.

In total, 10 versions of the MNL model were estimated for the qualification demand; this included five estimations with and five estimations without the individual weights. After a thorough statistical analysis of the results, a model with individual weights that included Occupation, Gender, Race, Age, and Province was selected as the final model, because the other interactions were found insignificant at the 5% level. The fitted MNL model can be written using the estimated coefficients $\beta_{i,j}$ and the corresponding model matrix as:

$$Q_{j,i} = \beta_{0,j} + \beta_{1,j} Occup_i + \beta_{2,j} Race_i + \beta_{3,j} Gender_i + \beta_{5,j} Prov_i + \beta_{3,j} Age_i \qquad [7.1]$$

Where:

- Q represents the dependent variable in the qualification demand equation and includes 10 categories, namely, No schooling; Incomplete Primary; Complete Primary; Secondary Incomplete; Secondary Complete; Certificate and Diploma

[40] The REAL Centre at the University of Witwartersrand assembled a team of researchers to conduct research on occupation demand, qualification demand, replacement demand, and labour supply. The team included H. Perry, P. Ncube, and P. Pillay. P. Ncube was the lead researcher on the qualification demand. ADRS office in the United States used a team of five researchers to work on the empirical analysis of the overall project, including the occupational demand. They included A. Adelzadeh, S. Bautista, M. Kanji, Q. Wang, and J. Zeng.

less than G12; Certificate with G12; Diploma with G12; Degree, and Unknown. The qualification 'Secondary Complete' was used as the reference category.

- $Q_{j,i}$ represents individual *i*'s educational qualification *j*, where *j* represents the 9 qualification categories other than the reference category.
- $Occup$ denotes 10 categories of aggregate occupations used in the QLFS, namely, Legislators, senior officials and managers (denoted as "Managers" in the results table); Professionals; Technical and associate professionals; Clerks; Service workers and shop and market sales workers (denoted as "Service Workers"); Skilled agricultural and fishery workers; Craft and related trades workers; Plant and machine operators and assemblers; Elementary occupations; and Domestic workers. The category Service Workers was used as the reference category.
- $Gender$ denotes gender, and Male is the reference category.
- $Race$ denotes four category or racial groups in South Africa, namely, African, Coloured, Indian and Asian, and White. African is the reference category.
- $Province$ denotes nine provinces with Gauteng as the reference province.
- Age denotes 10 age categories within working age population with the age group 20-24 as the reference category.

The MNL regression estimated the log-odds of having educational qualification *j* relative to having secondary complete as the educational qualification. It therefore estimated 9 equations for the 10 qualification categories, not including the reference category. For each equation, the estimated parameters represent the log ratio of the odds of being employed with *j* educational qualification versus being employed and having Secondary Complete as educational qualification. These log-odds are estimated on the basis of the working persons' occupation (1 to 10), province (1 to 9), gender (1 to 2), race (1 to 4), and Age (1 to 10).

For each forecast period, the module uses period specific values of the independent variables to estimate $Q^{t}_{j,i}$ and transform the estimated values for *j* educational categories to

probabilities, as discussed in Chapter 5.Therefore, the application of the multinomial logistic regression approach produces probabilities of the different possible educational qualification outcomes for each forecast period based on values for economic and demographic independent variables for that period.

7.2.4. The MNL Results

The final MNL regression for the qualification demand includes nine estimated equations for the 10 categories of educational qualifications. The final model estimates the likelihood of having various levels of education among workers given the determining factors. To explain the model results, the following analysis focuses on the results for the estimated equation for the No Schooling. Similar analyses apply to the model results for the remaining seven estimated equations.

Table 7.1 below shows the likelihood of having no formal education, i.e. No Schooling. Relative to the Service occupation, Elementary workers are far more likely than the other occupation groups to have No Schooling as their highest level of education. These are followed by skilled agricultural workers. Age has a positive effect on the likelihood of having no schooling. The higher the age group of a worker, the more likely it is that the person has gone to school. Females are 15% less likely than males to have No Schooling as their highest level of education. Coloured, Indian and White workers are all far less likely than African workers to have No Schooling as their highest level of education with White workers being the least likely, followed by Indian then coloured workers.

The Northern Cape and Mpumalanga are the provinces which are most likely, compared to Gauteng, to have workers with No Schooling. While all of the provinces are more likely than Gauteng to have workers with no formal education, the Western Cape has the lowest such likelihood at 40% more than Gauteng compared to the Northern Cape which is 8 times more likely as Gauteng.

Table 7.1: Multinomial Regression Results for Qualification Demand

*Qualification (No School)	Explanatory Variable	Odds ratios
Occupation (Service workers)	Manager	0.41
	Professional	0.11
	Technical workers	0.21
	Clerk	0.06
	Skilled agricultural worker	5.63
	Craft	2.51
	Operator	0.93
	Elementary/Domestic workers	6.02
Age	Age	1.16
Gender (Male)	Female	0.85
Race (Black)	Coloured	0.48
	Indian/Asian	0.19
	White	0.0005
Province (Gauteng)	Western Cape	1.39
	Eastern Cape	1.76
	Northern Cape	7.56
	Free State	1.74
	Kwazulu-Natal	2.83
	North West	3.66
	Mpumalanga	6.11
	Limpopo	4.59
*Text in brackets indicates the base category of the dummy variable.		

7.3. Qualification Module within the LM-EM

The computer codes of the LMEM-QUAL module establish the necessary channels for the flow of inputs from the rest of the LM-EM into the qualification module and from the module to other parts of the model. For example, since the projection of qualification demand in each period requires, as inputs, estimates of the occupational demand for that period, the computer codes facilitate the channelling of the outputs of the occupational module into the education module.

Within the module, for every year of the forecast period, the computer codes combine LM-EM's projections of variables used as explanatory variables in the MNL regression for qualifications with the transformed log-odds ratios of parameters of the estimated equation to produce a period specific set of probabilities related to the range of skills composition (educational qualifications) within each occupational group. The calculated occupation-qualification probability matrix (QM) for each period and the vector of demand projections

for 10 occupations for the same period, provide projections of demands for specific and for all educational qualifications:

Demand for a specific education qualification *e* with *e*=1,2,…,10:

$$QD_e^t = QM_e^t \bullet Occup^t \qquad [7.2]$$

Demands for all educational qualifications:

$$QDV^t = QM^t \bullet Occup^t \qquad [7.3]$$

Total economy-wide demand for education qualifications:

$$TQD^t = \sum_{e=1}^{10} QDV_e^t \qquad [7.4]$$

It is important to note that, in accounting terms, the LM-EM's total economy-wide demand for educational qualifications is equal to the total number of employed.

$$TQD^t \equiv TE^t \qquad [7.5]$$

In LM-EM, the link between the qualification demand module and the SETA module facilitates the model's projection of demand for educational qualifications by various SETAs:

$$QD_S^t = QMS_e^t \bullet Occup_S^t \qquad [7.6]$$

Where $QD_{e,s}^t$ represents demand for educational qualification e by the S SETA (*S*=1,2,…,21), QMS^t is the SETA equivalent of QM^t, and $Occup_S^t$ represents a vector that includes projections of 10 occupations within SETA S. Needless to say, the following accounting relationships hold for the demands for educational qualifications:

$$QD_e^t \equiv \sum_{S=1}^{21} QD_{e,S}^t \qquad [7.7]$$

Outputs of the qualification module feed into at least two other modules of the LM-EM, namely the job openings and skills gap modules, which will be discussed in Chapters 9 and 10.

The LMEM-QUAL generates a range of annual forecasts related to the qualification demand. This includes projections of demand for 10 educational qualifications based on the multinomial regression model, 27 educational qualifications based on transition-probability matrix, and 10 educational qualifications for each of the 21 SETAs. In section 4.10 and 6.4, the model's employment and occupational demand results for the proposed three scenarios were presented. In this section, the model's employment projections are presented in terms of the educational qualifications of workers.

7.3.1. Recent Employment Qualifications (2008-2014)

Table 7.2 shows that close to one-third of those employed during 2008 to 2014 had Secondary Incomplete as their highest level of education. About 30 percent had Secondary Complete as their highest qualification. Less than 1 percent (0.8 percent) had Tertiary education.

The shares of the bottom three educational qualification categories (No Schooling, Less than Primary, and Primary Completed) have gradually and consistently declined between 2008 and 2014. Together their share has dropped from 19.3 percent of employed in 2008 to 13.4 percent in 2014, which is a decline of about 31 percent. On the opposite side, the shares of employed with Secondary Complete and Tertiary have consistently increased over the same period. Their overall share increased from 45.9 percent of the employed to 51.9 percent, which is an increase of 13 percent. The share of Secondary Not Completed among the employed has remained relatively unchanged at around 33 percent.

Table 7.2: Employment by Educational Qualification (2008-2014)

	Main Education Groups	(Level)				(Shares, %)			
		2008	2010	2012	2014	2008	2010	2012	2014
1	No schooling	612,530	420,933	381,515	385,547	4.1	3.0	2.6	2.5
2	Less than primary completed	1,507,531	1,134,877	1,128,631	1,091,896	10.1	8.1	7.7	7.0
3	Primary completed	760,742	664,847	639,472	603,269	5.1	4.7	4.4	3.9
4	Secondary not completed	5,004,008	4,618,892	4,978,349	5,203,728	33.5	32.9	34.0	33.6
5	Secondary completed	4,187,134	4,261,004	4,525,270	4,887,306	28.1	30.4	30.9	31.5
6	Tertiary	2,661,815	2,747,602	2,856,645	3,164,433	17.8	19.6	19.5	20.4
7	Other	184,775	186,519	144,416	170,892	1.2	1.3	1.0	1.1
11	**Total**	**14,918,535**	**14,034,674**	**14,654,298**	**15,507,071**	**100**	**100**	**100**	**100**

Source: Statistics South Africa, Quarterly Labour Force Survey, Quarter 4 for all years.

7.3.2. Likely Trends in Employment Qualifications (2015-2025)

Table 7.3 and Figure 7.7 present model results for the educational qualifications of employed. Some of the important findings include:

- NO SCHOOLING AND INCOMPLETE PRIMARY: Over the next 10 years, the numbers and shares of employed with No Schooling and Incomplete Primary are projected to decline significantly under the three scenarios. For example, under the Low Scenario, the combined number of employed with No Schooling and Incomplete Primary as their highest education level is expected to decline from estimated 1.59 million (10.34 percent of employed) in 2015 to 941,000 (5.3 percent of employed) in 2025, which is equivalent to a 41 percent reduction.

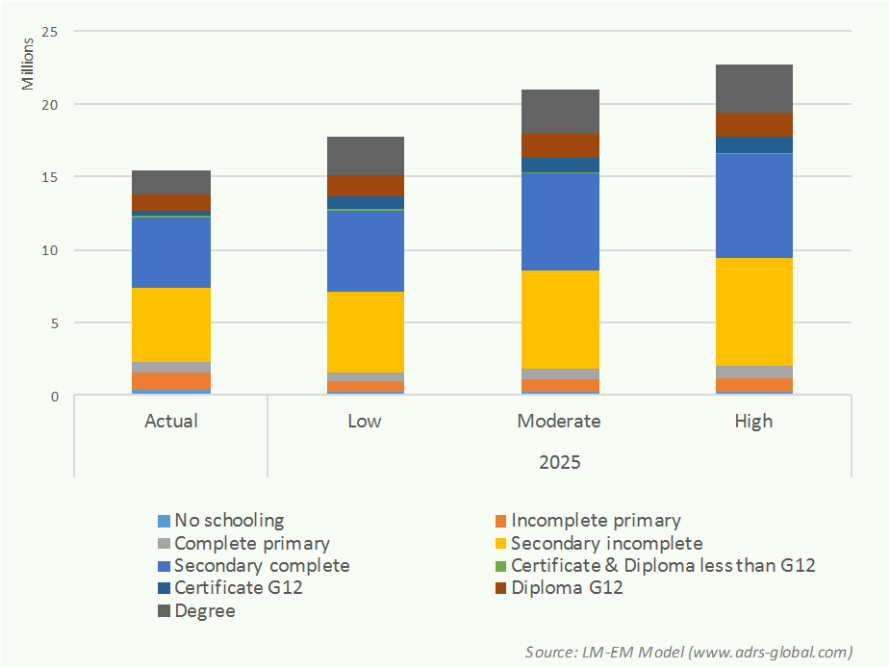
- COMPLETE PRIMARY: Over the next 10 years, the *number* of employed with Complete Primary as their highest level of education is projected to decline by 6.3 percent, from 646,000 to 606,000, under the Low growth scenario. On the other hand, if the economy follows the much higher employment creation paths of the Moderate and High scenarios, the number of employed with primary education is expected to increase by 12.9 percent and 23.5 percent respectively. However, across scenarios, the *share* of employed with Complete Primary education is expected to remain relatively unchanged at 3.41 percent (Low scenario), 3.48 percent (Moderate scenario) and 3.53 percent (High scenario).

Table 7.3: Total Employment by Qualification (2015-2025)

Qualifications	(Thousands)				Compound Average Growth Rate (%)			Shares (%)		
		2025			2015-2025			2025		
	2015	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
No schooling	408	206	244	265	-6.61	-5.00	-4.24	1.16	1.17	1.17
Incomplete primary	1,194	741	888	970	-4.65	-2.91	-2.05	4.18	4.24	4.29
Complete primary	646	606	729	798	-0.64	1.22	2.13	3.41	3.48	3.53
Secondary incomplete	5,148	5,539	6,690	7,315	0.73	2.65	3.58	31.21	31.96	32.36
Secondary complete	4,796	5,604	6,653	7,194	1.57	3.33	4.14	31.57	31.78	31.82
Certificate & Diploma less than G12	95	90	105	113	-0.55	1.02	1.75	0.50	0.50	0.50
Certificate G12	390	800	936	1,005	7.46	9.16	9.94	4.51	4.47	4.45
Diploma G12	1,039	1,466	1,666	1,766	3.50	4.84	5.44	8.26	7.96	7.81
Degree	1,654	2,697	3,021	3,182	5.01	6.21	6.76	15.19	14.43	14.07
Total	15,370	17,749	20,933	22,607	1.45	3.14	3.93	100.00	100.00	100.00

Source: LM-EM (www.adrs-global.com)

Figure 7.7: Employment by Qualification (2015 & 2025, levels)



- SECONDARY INCOMPLETE: The results of the three scenarios show that the past negative trend in the *share* of employed with Secondary Incomplete as the highest level of education is expected to continue over the next decade. The employment share of this group is expected to decline from 33.45 percent of employed in 2014 to 31.5 percent (Low Scenario), 32.2 percent (Moderate Scenario) and 32.6 percent (High Scenario). However, despite the decline in their share of employment, the *number* of employed with Secondary Incomplete as the highest education is projected to grow and is expected to grow more the higher the employment creation path of the economy. Therefore, under the High Scenario with the projected largest increase in total employment, the number of employed with Secondary Incomplete is projected to grow by 2.15 million over the next 10 years

compared to 393,000 under the low growth-low employment path of the Low Scenario.

- SECONDARY COMPLETE: Both the number and share of employed with Secondary Complete as their highest education level are expected to increase under the Low, Moderate and High growth scenarios over the next 10 years. The increase in the *share* of this group of employed is not as significantly different across scenarios as is the increase in the *number* of employed with a Secondary Complete level of education. In 2015, about 4.76 million workers are expected to have Secondary Completed education. The projections for 2025 are 5.57 million under the Low Scenario, 6.61 million under the Moderate Scenario, and 7.15 million under the High Scenario.

- TERTIARY: This educational classification is composed of Certificate with G12, Diploma with G12 and college Degree. The number of employed with Tertiary as their highest level of education is expected to significantly increase, especially under the Moderate and High growth paths. It is expected to increase from 3.06 million in 2015 to 4.94 million (Low), 5.60 (Moderate), and 5.95 million (High Scenario). The average annual increase in the number of employed with Tertiary is estimated at 5 percent (Low), 6.2 percent (Moderate), and 6.8 percent (High Scenario). The current 10.83 percent share of employed with Tertiary is projected to increase to 15.13 percent (Low), 14.37 percent (Moderate) and 14 percent (High Scenario).

Overall, for the next 10 years, the model projections indicate a gradual decrease in the share of employed with Secondary Incomplete and lower levels of education and an increase in the share of employed with Secondary Complete and beyond as their highest levels of education.

7.3.3. Qualification Demand by SETA (2015-2025)

The LMEM-QUAL produces projections of the distribution of educational qualifications of workers within each of the 21 SETAs. Given the diversity of SETAs, there are significant differences among them in terms of the concentration of skills, i.e., education qualifications

of employed. Figure 7.8 and 7.9 provide a comparative view of the allocation of skills within and across SETAs.

Figure 7.8: SETA Employment by Qualification (2025, Moderate scenario, levels)

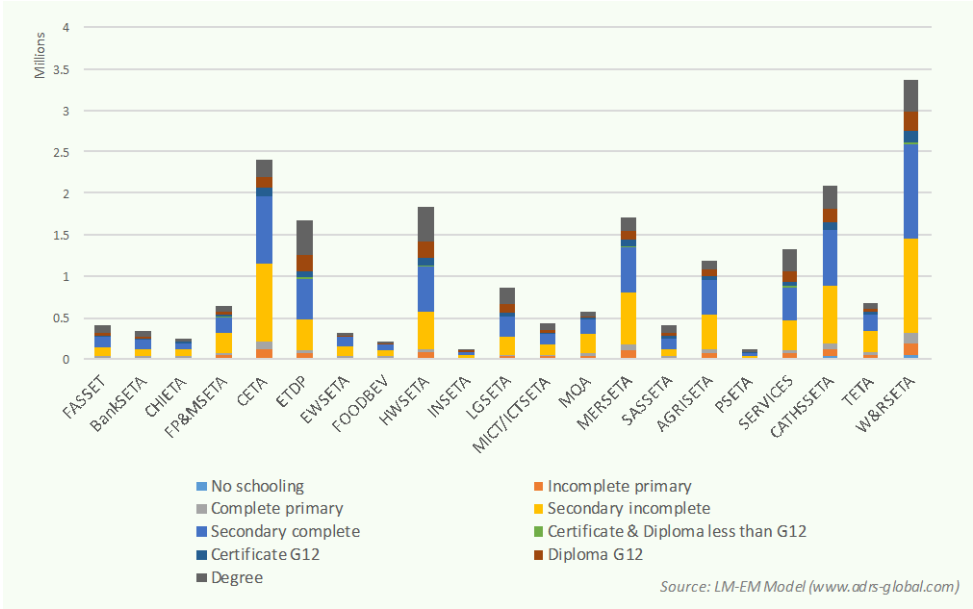
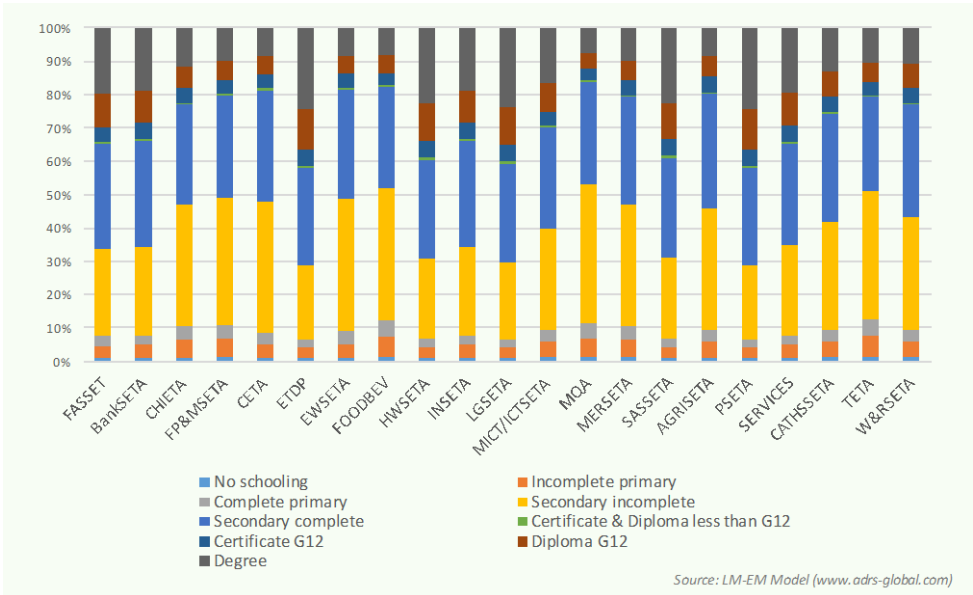


Figure 7.9: Qualification Shares of SETA Employment (2025, Moderate scenario)



Given space limitations, the model projections of qualification demand for 21 SETAs for the three scenarios are provided in Annexure D. As an example, the following are model results for MERSETA.

Figure 7.10 and 7.11 compare model results for the three scenarios for MERSETA employment by education qualification. The growth of the size of MERSETA over the next 10 years under the three scenarios uniformly raises the number of employees with different educational qualifications. As a result, under the Low Scenario, the growth rates of various groups of workers within MERSETA with different levels of education range from 22.3 percent for employees with Secondary Incomplete to 28.9 percent for employees in the category Degree over the next 10 years. The growth rates of the qualifications are higher under the Moderate Scenario (between 54 and 62 percent) and High Scenarios (between 80 and 85 percent).

Figure 7.10: Change in MERSETA Employment by Qualification (2015 & 2025, levels)

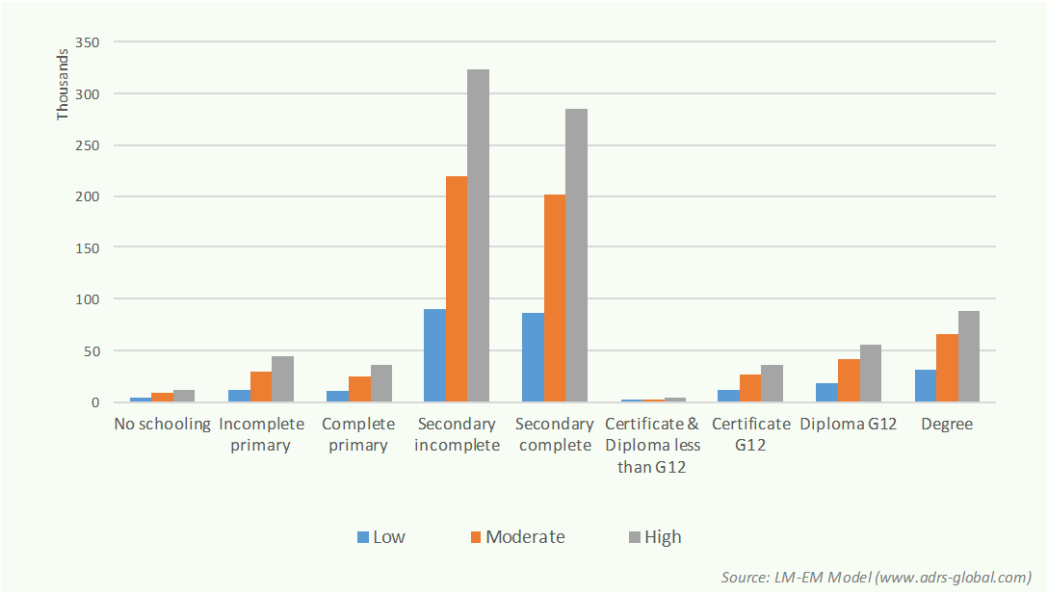
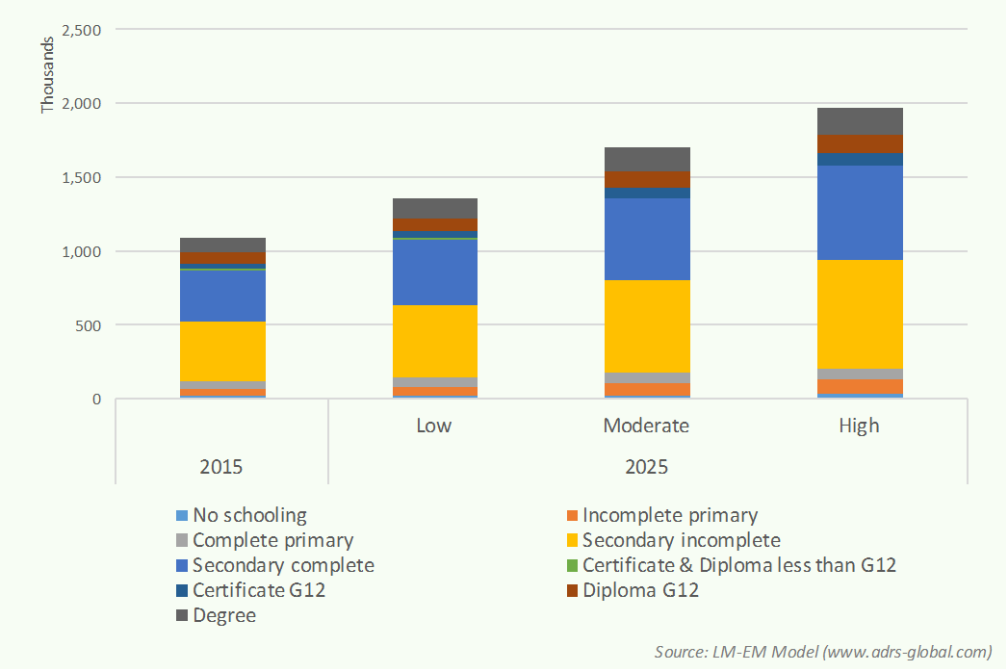


Figure 7.11: MERSETA Employment by Qualification (2015 & 2025, levels)



The share of workers under MERSETA with educational qualification levels of Secondary Incomplete and less is expected to gradually drop by about half a percent while the share of workers with Secondary Completed and more is expected to increase by about half a percent.

7.3.4. Expansion Demand by Qualification (2015-2025)

The expansion demand by qualification refers to the educational qualifications of annual additions to employment due to the growth of the economy.[41] Table 7.4 and Figure 7.12 present the details of expansion of employment by educational qualifications due to the growth of the economy under the three scenarios. It shows that differences among the three scenarios not only result in different overall growth rates for the economy but also shows different patterns of growth for the future demand for educational qualifications. For example, even though relative to the Low Scenario, the High Scenario is expected to generate more than twice the demand for employment for those with Degrees (Low: 626,000, High: 1.44 million), relative to the total number of jobs created by the scenario

[41] We have followed the tradition of referring of to changes in the levels of employment between any two years as 'expansion demand' even though in some years the change may be negative.

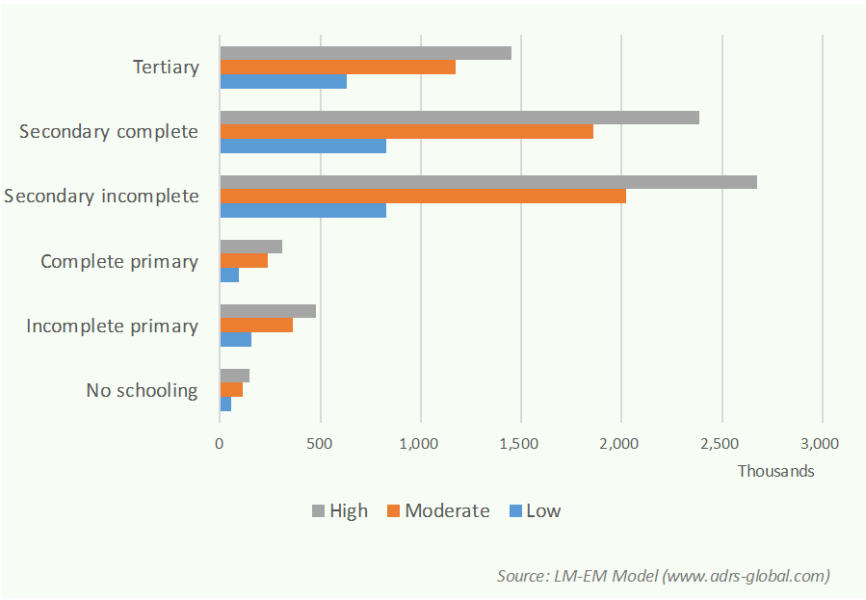
(Low: 2.59 million, High: 7.41 million), the share of workers with Degrees will be lower under the High Scenario (Low: 24.2 percent, High: 19.5 percent).

Table 7.4: Expansion Demand by Qualification (2015-2025, levels & shares)

Qualifications	Total for 2015 to 2025			Average Share (2015-2025, %)		
	Low	Moderate	High	Low	Moderate	High
No schooling	55,674	116,790	149,981	2.1	2.0	2.0
Incomplete primary	159,785	365,385	480,634	6.1	6.3	6.4
Complete primary	99,097	237,280	313,836	3.8	4.1	4.2
Secondary incomplete	813,201	1,997,303	2,638,666	31.2	34.5	35.4
Secondary complete	831,774	1,860,517	2,389,724	31.9	32.1	32.0
Certificate & Diploma less than G12	15,104	31,392	39,819	0.6	0.5	0.5
Certificate G12	85,202	187,530	238,550	3.3	3.2	3.2
Diploma G12	205,144	383,371	471,018	7.9	6.6	6.3
Degree	339,658	608,711	740,874	13.0	10.5	9.9
Total	2,604,640	5,788,279	7,463,111	100.0	100.0	100.0

Source: Linked Macro-Education Model (LM-EM) (www.adrs-global.com)

Figure 7.12: Expansion Demand by Qualification (2015-2025)



7.4. CONCLUSIONS

The outputs of the qualification module enable the final analysis of skills demand. This section of the report explains the work undertaken to model the qualification module of the LM-EM and how it generates a range of annual forecasts related to qualification demand. This includes projections of demand for 10 educational qualifications based on the

multinomial regression model, 27 educational qualifications based on the transition-probability matrix, and 10 educational qualifications for each of the 21 SETAs. Outputs of the qualification module feed into at least two other modules of the LM-EM, namely the job openings and skills gap modules.

The section also includes a presentation of the LM-EM results for qualification demand related to the three future scenarios.

Some of the key findings from the empirical section of the chapter are:

Past trends:

- Between 2008 and 2014, the share of total employed with Secondary Not Complete as their highest level of education was consistently the largest, followed by Secondary Complete and Tertiary. The overall share of the three categories increased by 6 percent from 79.5 percent (11.8 million) of total employed in 2008 to 85.5 percent (13.25 million) in 2014.
- The share of employed with no schooling as the highest level of education has gradually dropped from 612,000 in 2008 (4.1 percent of employed) to 385,000 in 2014 (2.5 percent of employed).
- Using three skill groups of low (Secondary Incomplete and less), medium (Secondary Complete) and high (beyond Secondary Complete), the share of low skill workers dropped by 5.9 percent from 52.9 percent in 2008 to 47 percent in 2014 (7.88 million to 7.28 million). The share of workers with medium skills increased by 3.4 percent (from 28.1 percent to 31.5) during the same period. Finally, the share of workers with high levels of education increased by 2.6 percent from 2.66 million (17.8 percent) in 2008 to 20.4 percent (3.16 million) in 2014.

Future trends: If the economy follows a growth path within the Low and High scenarios over the next 10 years:

- Regardless of the scenario, the skills (highest level of education) composition of employed is expected to gradually change with the share of workers with low skills

(secondary incomplete and less) declining and the share of high skilled workers (beyond secondary complete) increasing. For the group with medium skills (Secondary Complete), their share is expected to remain relatively unchanged across scenarios.

- The share of workers with low skills is projected to decline from current 48.7 percent to between 40.5 percent and 41.8 percent, and the share of workers with high skills is expected to increase from current 20.1 percent to between 28 percent and 26.3 percent by 2025. The lower share of high skill workers under the High scenario is due to the scenario's absorption of close to 5 million more job seekers into employment.

CHAPTER 8

REPLACEMENT DEMAND MODULE (LMEM-RPL)

Replacement demand refers to "the jobs resulting from the departures of workers that need to be filled by new workers."[42] In addition to the LMEM-OCC that provides projections of job openings in each occupation due to sector employment growth (i.e., expansion demand), the LMEM-RPLD provides projections of the number of employees in each occupation that need to be replaced due to migration, retirement or career change. The module is designed to use inputs from the rest of the model to produce projections of the extent to which future job openings in various occupations are due to retirement, mobility, migration, and mortality, which together make up replacement demand.

8.1. Purpose

The aims of the replacement demand module of LM-EM are:

- To capture interactions between LM-EM's occupation and qualification demand modules and the replacement demand module on the one hand, and the replacement demand module and job openings and imbalances modules on the other.
- To estimate replacement demand arising from retirement, migration, occupational mobility, mortality, and emigration within each occupation for the forecast period.
- To provide estimates of replacement demand by educational qualification.

[42]Willems and de Grip, 1993: 173.

8.2. Empirical Methodology

Estimates of annual job openings related to the expansion demand offer an incomplete picture of the number of job openings that are created in a given year. Estimates of future job turnover in each occupation provide important additions to the overall level of job openings in each occupation. For the design and delivery of human resource and skills policy, projections of the size of replacement demand are as necessary as the estimation of the expansion demand. Therefore, total job openings in the economy (JO) includes new employment opportunities due to the expansion of the economy (i.e., expansion demand, ED) and employment opportunities related to job turnover due to retirement, death, emigration and inter-occupation movement of employed (i.e., replacement demand, RD).

$$JO^t = ED^t + RD^t \qquad [8.1]$$

Chapters 4, 6 and 7 presented how LM-EM generates annual projections of sector employment and expansion demand by occupations and educational qualifications. Occupation specific job openings due to replacement demand make up, in many instances, significant portions of total job opportunities in those occupations. At the same time, the extent and composition of replacement demand by occupation have parallel implications for skills (educational qualification) demand in the economy. Therefore, the LMEM-RPL module is designed to produce annual projections of replacement demand by occupation and educational qualification, which are then added to the model's estimations of expansion demand by occupation and qualification in order to produce the model's annual projection of total job openings by occupation and qualification.

8.2.1. Empirical Methodology: Retirement, Mobility, and Mortality

The methodology used for the estimation of replacement demand is based on the pioneering work of Willems and de Grip (1993). It involves using multiple surveys that include detailed information on the demographic and labour market of individuals. The methodology has been used to calculate the net replacement demand in the Netherlands

(Willems and de Grip, 1993), Australia (Shah and Burke, 2001), Ireland (Sexton *et al.*, 2001), and the United States (Eck, 1991, and Bureau of Labour Statistics, 2006).

The cohort component approach uses the size of a population cohort at two different points in time to estimate the numbers of leavers from that cohort. If the size of the cohort has decreased, then there has been a net outflow. If the net flow is positive, then the method assumes that there has been no outflow and hence no replacement demand. The method therefore examines the net flows and is based on summing the net outflows over all cohorts where there is an outflow.

It is important to point out that this method uses pseudo cohorts, since it is not tracking the same individuals but drawing inferences from the relative numbers in two groups.[43] At the same time, in replacement demand, demographic information such as age and gender is usually required because many of the flows, especially retirements and mortality, are age and gender specific.[44] Furthermore, the age structure across the population also affects the estimates when people exit the labour market either due to retirement or mortality.

The above approach was applied to the South African data to calculate baseline values for the replacement demand rates that are used as exogenous parameters in the LM-EM. Following is a formal presentation of the application of the cohort component approach to estimate the replacement demand rates due to retirement, mobility, and mortality by gender and occupation using data for four years, 2008 to 2011. The formal presentation of the approach underlies the empirical calculation of the rates by Pillay and Ncube (2015):

Let:

- $RET^{t}_{i,a,g}, MOB^{t}_{i,a,g}, MOR^{t}_{i,a,g}$ represent the number of workers that retired (*RET*), changed occupation (*MOB*), or passed away (*MOR*) from *i* occupation (*i*=1,2,..10), of *g* gender (*g*=1,2), and *a* age group (*a*=1,2,…,10) in *t* period (i.,e., *t-1, t)* for*t*=2009 to 2011.[45]

[43]The outflow rates are estimated from pseudo cohorts created from the Quarterly Labour Force Survey data from 2008 to 2012.
[44]CEDEFOP (2009a).
[45]The Stats SA's Cause of Death surveys from the years 2006 to 2010 were used to calculate the mortality rate by occupation. These mortality numbers are the estimated numbers of people who used to work in each occupation who died in each year. In each year only roughly 10% of the occupations were reported for each of

- $R_{i,g}^{t} = \sum_{a}^{10} RET_{i,a,g}^{t}$ $B_{i,g}^{t} = \sum_{a}^{10} MOB_{i,a,g}^{t}$ $M_{i,g}^{t} = \sum_{a}^{10} MOR_{i,a,g}^{t}$ represent total number of workers that retired, changed occupation, or passed away by occupation (*i*) and gender (*g*) in *t* period.
- $E_{i,g}^{t}$ is the total number of workers employed by occupation and gender in *t* period.
- $E_{i}^{t} = \sum_{g=1}^{2} E_{i,g}^{t}$ is the total number of workers employed in *i* occupation in *t* period.
- n is the number of years for which three of four replacement demand components were calculated, i. e., *n*=3 reflecting 2009 to 2011.

The net outflows from each occupation (*i*) due to retirement, mobility and mortality by age category and gender are:

$$\begin{aligned} ORET_{i,a,g}^{t} &= \max\left\{0;\ RET_{i,a,g}^{t-1} - RET_{i,a+1,g}^{t}\right\} \\ OMOB_{i,a,g}^{t} &= \max\left\{0;\ MOB_{i,a,g}^{t-1} - MOB_{i,a+1,g}^{t}\right\} \\ OMOR_{i,a,g}^{t} &= \max\left\{0;\ MOR_{i,a,g}^{t-1} - MOR_{i,a+1,g}^{t}\right\} \end{aligned} \qquad [8.2]$$

The aggregation of net outflows (Eq. 8.2) by occupation (*i*) and gender (*g*) across five-year age groups (*a*) due to retirement, mobility, and mortality are calculated as:

$$\begin{aligned} ORET_{i,g}^{t} &= \sum_{a=1}^{10} ORET_{i,a,g}^{t} \\ OMOB_{i,g}^{t} &= \sum_{a=1}^{10} OMOB_{i,a,g}^{t} \\ OMOR_{i,g}^{t} &= \sum_{a=1}^{10} OMOR_{i,a,g}^{t} \end{aligned} \qquad [8.3]$$

The replacement demand is defined in relation to the expansion demand. When there is a positive expansion demand (i.e., a rise in employment), the replacement demand equals the number of workers who leave a certain job during the period (*t-1, t*). The job openings that

---

the deceased employees. Therefore, the rest of them had to be imputed. The first step in the imputation was to calculate the proportion of the employed in the working age population. The second step was to calculate the proportion of each reported occupation out of all the reported occupations. These proportions were then used to assign occupations, by gender, to the deceased whose occupations had not been assigned. Similarly the proportion of each age cohort was calculated and then assigned to the occupations which were assigned in the previous step. Finally, the imputed occupations and the occupations which were reported in the survey were added together for each age cohort and gender. The resultant tables were arranged by age cohort for each occupation and gender.

thus created need to be filled before there can be a rise in the total numbers employed. If, on the other hand, the expansion demand is negative, that is, there is a decline in employment, not all job openings associated with departing workers are filled. In this case, the replacement demand is *not* equal to the total of departures from a certain job, but rather to the number of vacancies that are actually refilled, that is, the total influx of labour to the job in question. Therefore, the total replacement demand for an occupational group with rising employment equals the total flow of workers out, and the replacement demand equals the total flow of workers in if the employment level is falling.[46] That means, for occupation-gender cohorts that one or more replacement demand categories grow between two periods $(R^t_{i,g} \geq R^{t-1}_{i,g};\ B^t_{i,g} \geq B^{t-1}_{i,g};\ M^t_{i,g} \geq B^{t-1}_{i,g})$, the corresponding replacement demands are determined according to Eq. 8.4:

$$\begin{aligned} RDRET^t_{i,g} &= ORET^t_{i,g} \\ RDMOB^t_{i,g} &= OMOB^t_{i,g} \\ RDMOR^t_{i,g} &= OMOR^t_{i,g} \end{aligned} \qquad [8.4]$$

On the other hand, the replacement demands for declining occupation-gender cohorts related to retirement, mobility, and mortality $(R^t_{i,g} < R^{t-1}_{i,g};\ B^t_{i,g} < B^{t-1}_{i,g};\ M^t_{i,g} < B^{t-1}_{i,g})$ are determined according to Eq. 8.5:

$$\begin{aligned} RDRET^t_{i,g} &= ORET^t_{i,g} + (R^t_{i,g} - R^{t-1}_{i,g}) \\ RDMOB^t_{i,g} &= OMOB^t_{i,g} + (B^t_{i,g} - B^{t-1}_{i,g}) \\ RDMOR^t_{i,g} &= OMOR^t_{i,g} + (M^t_{i,g} - M^{t-1}_{i,g}) \end{aligned} \qquad [8.5]$$

The annual replacement demand *rates,* for the three categories of the replacement demand, are calculated as the estimated replacement demand flows (Eqs. 8.4 and 8.5) relative to the total employment of the associate cohorts during t-1 period:

[46] Willems and de Grip(1993), p. 174 and p.177. If the concepts of inflow and outflow are interpreted as net inflow and outflow, replacement demand may be calculated as indicated in Eqs. 8.4 and 8.5.

$$rd\_ret_{i,g}^{t} = \frac{RDRET_{i,g}^{t}}{E_{i,g}^{t-1}}$$
$$rd\_mob_{i,g}^{t} = \frac{RDMOB_{i,g}^{t}}{E_{i,g}^{t-1}} \quad [8.6]$$
$$rd\_mor_{i,g}^{t} = \frac{RDMOR_{i,g}^{t}}{E_{i,g}^{t-1}}$$

Next, the retirement, mobility and mortality annual replacement demand rates by occupation are calculated as the replacement demand flows (Eq. 8.4 and 8.5) that are aggregated by gender, relative to the total employment during t-1 period by occupation:

$$rd\_ret_{i}^{t} = \sum_{g=1}^{2} RDRET_{i,g}^{t} \Big/ E_{i}^{t-1}$$
$$rd\_mob_{i}^{t} = \sum_{g=1}^{2} RDMOB_{i,g}^{t} \Big/ E_{i}^{t-1} \quad [8.7]$$
$$rd\_mor_{i}^{t} = \sum_{g=1}^{2} RDMOR_{i,g}^{t} \Big/ E_{i}^{t-1}$$

And, finally, the replacement demand rates related to retirement, mobility and mortality by occupation are calculated as the average for each rate over the period 2009 to 2011, i.e., n=3;

$$rd\_ret_{i} = \sum_{t=1}^{n} rd\_ret_{i}^{t} \Big/ n$$
$$rd\_mob_{i} = \sum_{t=1}^{n} rd\_mob_{i}^{t} \Big/ n \quad [8.8]$$
$$rd\_mor_{i} = \sum_{t=1}^{n} rd\_mor_{i}^{t} \Big/ n$$

8.2.2. Empirical Methodology: Emigration

Replacement demand due to emigration refers to job openings that are linked to employed workers in South Africa who emigrate from the country. Due to the unavailability of national

data on emigration, this component of the replacement demand was calculated using OECD 2005 and 2013 data.[47]

The OECD 2005 dataset provides detailed information about individuals who have emigrated from their countries of origin, including South Africa. The dataset has information about migrants' countries of origin, destinations, occupations, gender and age. The second available OECD dataset is for 2013 and only includes the stocks of South African migrants in the top five countries to which they emigrate, namely, Australia, Canada, Great Britain, New Zealand and the United States. Together, the five countries account for 46 percent of the South African migrants. Pillay and Ncube (2015) explain how above two OECD datasets were used to approximate the rate of outflow of South Africans by occupation.

For 2005, the age, gender, and occupation data for South Africa migrants to Australia, Canada and New Zealand were collected. Since the occupation data and the age and gender data could not be cross tabulated, the share of South African emigrants in each occupation for the three countries was calculated. These ratios were subsequently used to split the age and gender data into occupation data by gender and age cohort.

For 2013, the total migrant stock of South Africans in Australia, Canada and New Zealand was broken down by gender using the gender ratios of emigrants that prevailed in each country. Next, the data was broken down into age cohorts and then into occupations using the prevailing ratios in 2005.

Next, Pillay and Ncube used the difference between the total number of emigrants in 2013 and 2005 to estimate the emigration rate by occupation for South Africa.

8.2.3. Replacement Demand Baseline Results

The methodologies and data that were explained in sections 8.2.1 and 8.2.2 were used to calculate initial base line rates for the components of the replacement demand. Pillay and Ncube's (2015) results include:[48]

[47] The OECD immigration database is found at http://www.oecd.org/els/mig/dioc.htm.

- Across all the years, (i.e. from 2009 to 2011), and for both the male and female cohorts, the mobility component is the highest for each occupation. The rates for other components of replacement demand (i.e., mortality, retirement and emigration rates) are much lower than the mobility rates for both male and female. This suggests that there is a high turnover between occupations, which is supported by Samuel *et al.* (2009) and Robbins (2009).[49] The results across the years show that for males, the highest turnover rates are for high skill workers such as Technical Workers (i.e., Technical and Associate Professionals) and Skilled Agricultural Workers. The mobility rates are also high in the lower skill occupations such as Elementary Workers. This may be due to factors such as short-term contracts or loss of jobs.[50]
- For both males and females, the highest total replacement demand rate is found among Skilled Agricultural workers at 25 percent. For men the second highest is for Technical Workers at 23.2 percent, while for women it is for Managers at 20.3 percent. On the other hand, the lowest total replacement demand rate for men is among Professionals at 13 percent while for women it is among Craft Workers at 11.3 percent.
- While there are some gender differences in the replacement demand rates by occupation, there is no general pattern seen by gender. In some occupations, replacement demand rates are higher for males than females, while the opposite is true in other occupations.
- The replacement demand rates for the emigration component are generally higher for the higher skill occupations for both male and female workers, with the highest being found among Professionals. This is especially so for female Professionals.
- The retirement component is highest among male Skilled Agricultural workers in 2011, male Clerks in 2010 and female Managers in 2009.

[48]For the years 2009 and 2010, replacement demand rates are based on mobility, mortality and retirement. For the 2011 results, estimation of the emigration component of the replacement demand is also included as explained in section 8.2.1.
[49]Samuel and Chipunza (2009) suggest that the relatively highly-skilled employees in South Africa are constantly emigrating for better job opportunities or being "poached". Robbins (2009) also finds that average staff turnover in South Africa in 2006 was 12.3 percent compared to 36 percent in the United States.
[50]Since the data used for the development of base values of the replacement demand rates is from 2008 and after, a portion of the mobility is due to loss of work in the aftermath of the global financial crisis.

- The mortality component has affected Skilled Agricultural workers the most across the years, especially male Skilled Agricultural workers.

8.3. Replacement Demand Module within the LM-EM

The baseline values for the replacement demand rates by occupation, estimated using equations 8.8, are used to create the Replacement Demand Probability Matrix ($RDPM$) of the LMEM-RPL module. The *rates* that make up the $RDPM$ function as exogenous inputs for the model's endogenous estimation of annual *levels* of replacement demand by occupation and qualification.

For each year of forecast, the replacement demand module combines LM-EM's disaggregated occupational demand projection with the RDPM's probability rates to produce the LM-EM's Replacement Demand Matrix (RDM^t) that includes projections of retirement, mobility, emigration, and mortality by occupation:

$$RDM^t = RDPM \ \bullet\!* \ Occup^t \qquad [8.7]$$

The sum of columns in each row of RDM^t results in total replacement demand for an occupation:

$$RD_i^t = \sum_{j=1}^{4} RDM_{ij}^t \qquad (i=1,2,\ldots,10) \qquad [8.8]$$

The sum of rows in each column of RDM^t results in the total for each type of replacement demand, e.g., retirement, mobility:

$$RD_j^t = \sum_{i=1}^{10} RDM_{ij}^t \qquad (j=1,2,..,4) \qquad [8.9]$$

Total replacement demand in year t is calculated as the sum of replacement demand for 10 occupations or the sum of four types of replacement demands for that year:

$$RD^t \equiv \sum_{i=1}^{10} RD_i^t \equiv \sum_{j=1}^{4} RD_j^t \qquad [8.10]$$

Overall, the LMEM-RPL produces projections of future levels of job openings due to replacement demands by occupation and qualification.

8.4. Module Outputs

The LMEM-RPLD module generates projections of the scale of vacancies, i.e., replacement demand, that are expected under a given economic scenario by occupation and qualification. This section summarises the model's replacement demand projections for Low, Moderate and High Scenarios.

8.4.1. Replacement Demand by Occupation (2015-2025)

Figure 8.1 depicts the model's projections of future trends for total replacement demand for the Low, Modest and High scenarios. As expected, under the three scenarios, since the size of total employment is projected to grow over time, the size of the replacement demand associated with each scenario will also gradually increase. Moreover, the more job creating a scenario is, the higher the size of the replacement demand will be since, for example, a higher level of employment increases the number of retirement.

Over the eleven year period, replacement demand (RD) is projected to range from 5.5 million (Low Scenario) to 6.1 million (High Scenario) or 500,000 to 550,000 person per year, on average. In the case of the Low Scenario, the overall RD of 5.5 million for the period (2015 to 2025) is more than twice the number of jobs that are created through the scenario, i.e., the expansion demand. On the other hand, under the Moderate Scenario, the projected RD and ED numbers for the period are almost the same, 5.87 million and 5.79 million. The RD estimate for the High Scenario for 2015-2025 (6.1 million) is about half a million more than the Baseline Scenario, but it is significantly lower than the scenario's expansion demand estimate of 7.46 million.

Figure 8.1: Trends in Total Replacement Demand (2015-2025)

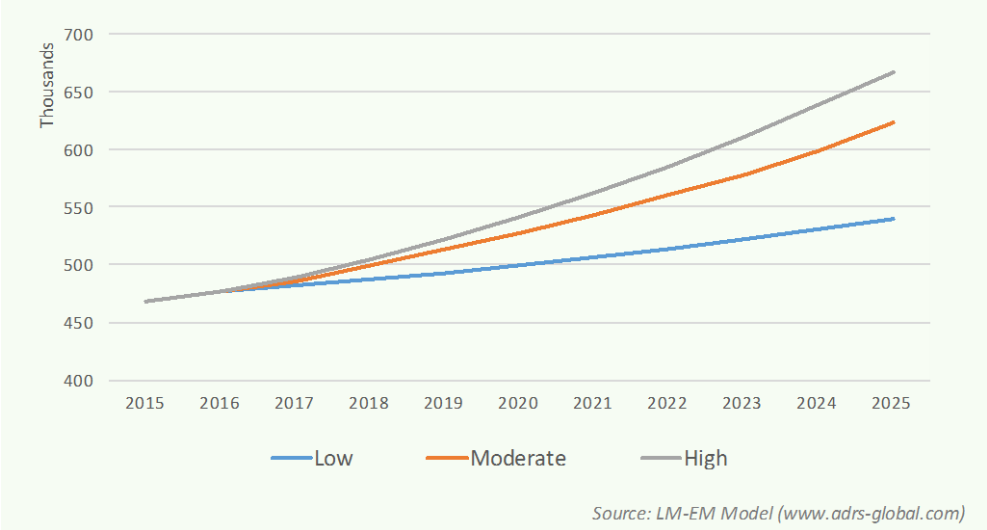


Table 8.1 and Figure 8.2 present LM-EM's projection of the replacement demand by occupation for the Low, Modest, and High scenarios for the period 2015 to 2025. Key findings include:

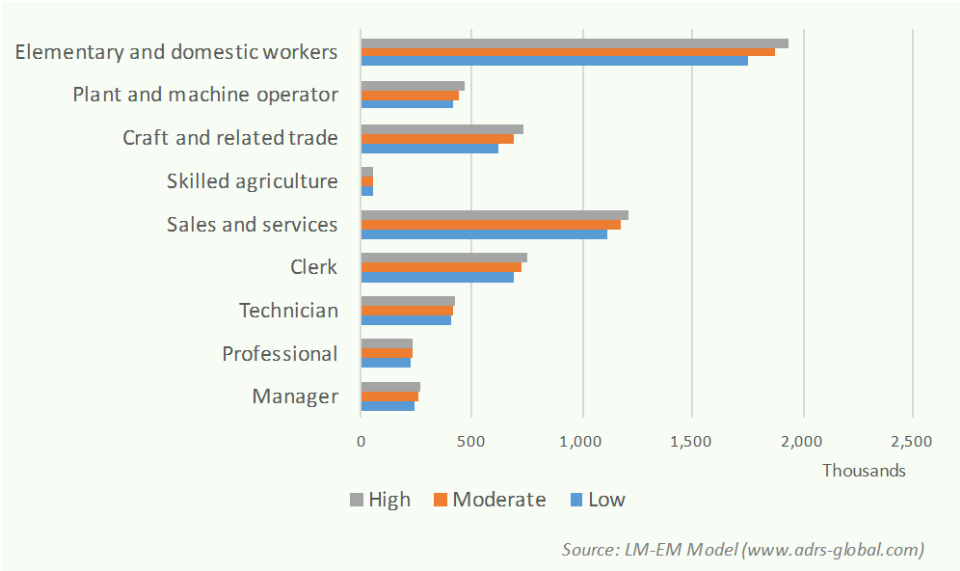
- Replacement demand outweighs expansion demand for the Low Scenario at aggregate level, and for 8 out of 9 occupational groups. The exception is the Managers group of occupations.
- The level of job openings due to replacement demand is almost similar to job openings due to the expansion of the economy under the Moderate Scenario. However, for 6 out of 9 occupational categories, their estimates of replacement demand for the period outweigh their job openings due to economic growth. The three exceptions are occupations in Managers, Crafts and Trade Workers, and Plant and Machine Operators.
- Under the High Scenario, job openings due to the expansion of the economy significantly outweigh the replacement demand engendered job openings. For three of the nine occupations, the estimate of replacement demand is greater than expansion demand, namely Professionals, Technicians, and Skilled Agriculture Workers.
- Under the three scenarios, a little more than 50 percent of their replacement demand over the next decade will be from occupation categories Elementary and Domestic Workers and Service Workers.

Table 8.1: Replacement Demand by Occupation (2015-2025, levels & shares)

Occupations	Total for 2015 to 2025			Share (%)		
	Low	Moderate	High	Low	Moderate	High
Manager	239,280	255,541	264,110	4.3	4.4	4.4
Professional	224,302	229,284	231,993	4.1	3.9	3.8
Technician	411,012	417,572	421,065	7.4	7.1	6.9
Clerk	692,799	729,159	748,568	12.6	12.4	12.3
Sales and services	1,117,194	1,177,916	1,206,814	20.2	20.1	19.9
Skilled agriculture	49,876	52,751	54,741	0.9	0.9	0.9
Craft and related trade	619,418	693,465	735,208	11.2	11.8	12.1
Plant and machine operator	415,462	445,865	468,619	7.5	7.6	7.7
Elementary and domestic workers	1,749,589	1,872,316	1,937,175	31.7	31.9	31.9
Total	5,518,932	5,873,869	6,068,293	100.0	100.0	100.0

Source: Linked Macro-Education Model (LM-EM) (www.adrs-global.com)

Figure 8.2: Replacement Demand by Occupation (2015-2025)



8.4.2. Replacement Demand by Qualifications

Figure 8.3 and Table 8.2 present the model's projections of replacement demand by educational qualifications of workers that annually vacate their jobs due to retirement, mobility, migration or mortality. Some key findings include:

- Across the three scenarios, annually, the largest share of the estimated RD is from workers with low skills, that is, workers with Secondary Incomplete or less as their highest level of education. However, their share of replacement demand is projected to gradually decline from 49.8 percent in 2015 to 42.1 percent (Low), 42.7 percent (Moderate), and 43.1 percent (High) by 2025. This is mainly a reflection of the

gradual decline in the share of low skill workers among employed in general and within job openings due to expansion of the economy, i.e., expansion demand, in particular.

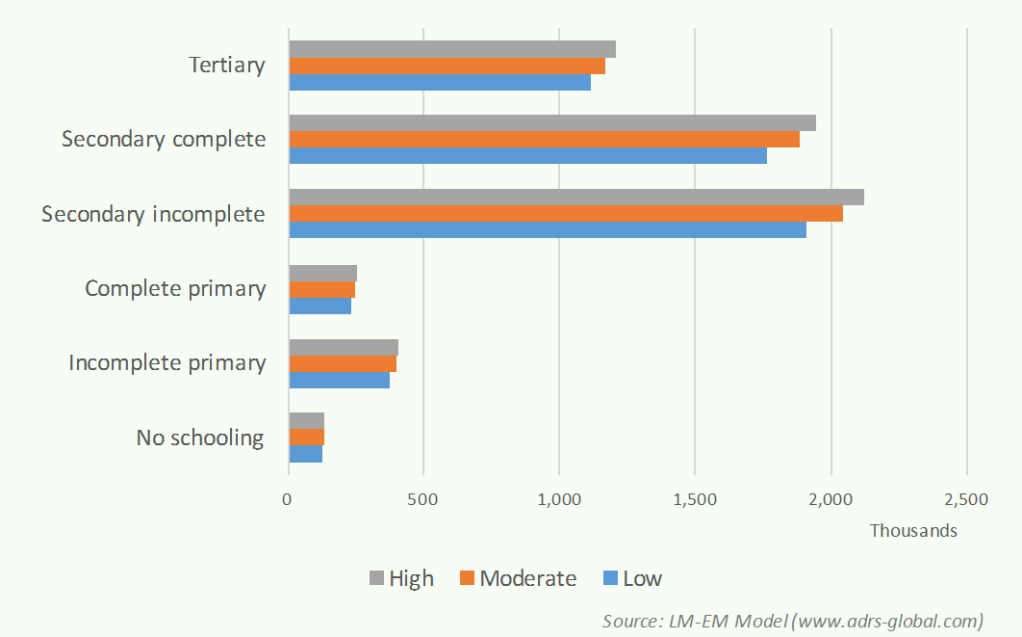
- Across the three scenarios, workers with medium skills, those with completed secondary school and those with certificates or diplomas with G12, are the second largest contributors to the estimates of RD during the next 10 years. Their share is expected to grow by less than one percent over the next 10 years, from 32.1 percent of total RD in 2015 to 33 percent (Low), 33.1 percent (Moderate) and 33.2 percent (High) in 2025 (Table 8.2).
- High skill workers are the lowest contributors to RD. However, their share of total RD is expected to gradually grow from 18.1 percent in 2015 to as high as 23.7 percent under the High Scenario in 2025.

Table 8.2: Replacement Demand by Qualification (2015-2025, levels & shares)

Qualifications	Total for 2015 to 2025			Average Share (2015-2025, %)		
	Low	Moderate	High	Low	Moderate	High
No schooling	124,341	130,799	134,312	2.3	2.2	2.2
Incomplete primary	372,488	394,275	406,509	6.7	6.7	6.7
Complete primary	230,649	246,136	254,859	4.2	4.2	4.2
Secondary incomplete	1,912,231	2,048,197	2,124,170	34.6	34.9	35.0
Secondary complete	1,765,400	1,882,724	1,946,233	32.0	32.1	32.1
Tertiary	1,113,816	1,171,729	1,202,220	20.2	19.9	19.8
Total	**5,518,925**	**5,873,860**	**6,068,303**	**100.0**	**100.0**	**100.0**
Qualifications	Total for 2015 to 2025			Average Share (2015-2025, %)		
	Low	Moderate	High	Low	Moderate	High
Low Skills	2,609,110	2,787,048	2,886,534	47.3	47.4	47.6
Medium Skills	1,795,999	1,915,083	1,979,549	32.5	32.6	32.6
High Skills	1,113,816	1,171,729	1,202,220	20.2	19.9	19.8
Total	**5,518,925**	**5,873,860**	**6,068,303**	**100.0**	**100.0**	**100.0**

Source: Linked Macro-Education Model (LM-EM) (www.adrs-global.com)

Figure 8.3: Replacement Demand by Qualification (2015-2025)



8.5. Conclusions

LM-EM's approach to the construction of the replacement demand module differs from the occupation and qualification modules. Given the nature of the existing data that underlie the four components of replacement demand, we applied an established technique to four years of the QLFS and to estimates of recent replacement rates for retirement, mobility, mortality and emigration for South Africa. These rates, which enter the model as exogenous parameters, can be changed by users of the model prior to running the model.

The replacement demand module of LM-EM generates projections of the number of vacancies that is expected under a given economic scenario by occupation and qualification.

The key findings from the three scenarios can be summarised as follows:

Past trends[51]:

- Over the period 2009 to 2011, the mobility component of replacement demand was the highest for each occupation. The second highest replacement demand rates were generally found in the mortality component, although this is not necessarily the case for some occupations, e.g. managers. In general, the rates for mortality, retirement and emigration were much lower than the replacement demand which suggests that high turnover exists between occupations.
- For both males and females, the highest total replacement demand rate was found among skilled agricultural workers at 25 percent. For men, the second highest was for technical workers at 23.2 percent while for women it was for managers at 20.3 percent.
- The lowest total replacement demand rate for men was among professionals at 13 percent while for women it was among craft workers at 11.3 percent.
- The replacement demand rates for the emigration component were generally higher for the higher skill occupations, with the highest being found among professionals. This was especially so for female professionals in 2013.
- The retirement component was highest among male skilled agricultural workers in 2011, male clerks in 2010 and female managers in 2009.
- The mortality component has affected skilled agricultural workers the most across the years, especially male skilled agricultural workers.

Future trends: If the economy follows a growth path within the Low and High scenarios, LM-EM provides the following foresight about the path of replacement demand and its breakdown by occupation and qualifications:

- Over the period 2015 to 2025, if the economy's job creation path falls within the Low and High scenarios, the replacement demand is projected to range from 5.5 million to 6.1 million, or 500,000 to 550,000 persons per year, on average.
- If the economy's future employment creation path is close to the Low scenario, the overall replacement demand for the period will be at least twice the number of jobs that will be created through economic growth, i.e., the expansion demand. On the

[51] See Pillary and Ncube (2015).

contrary, if the economy performs close to the High scenario, the size of the replacement demand will be significantly lower or close to the scenario's expansion demand.

- If the economy follows a low employment creation path that is close to the Low scenario, the replacement demand outweighs expansion demand for almost all 9 occupational groups. However, if the economy follows a path that is close to the High scenario, the opposite will happen, namely, expansion demand will outweigh replacement demand for the majority of occupations. Finally, as long as the economy's path falls within the Low and High scenarios, a little more than 50 percent of replacement demand will be from occupation categories Elementary and Domestic Workers and Service Workers over the next decade.
- If the economy's job creation path falls within the employment band suggested by the three scenarios, then annually the largest share of replacement demand will be from workers with low skills, that is workers with Secondary Incomplete or less as their highest level of education. However, their share is projected to gradually decline, due to the projected gradual decline in the share of low skill workers among employed, especially among new annual additions to employment.
- Similarly, workers with medium skills, i.e., those with completed secondary school and those with certificate or diploma with G12, are projected to be the second largest contributors to the estimates of replacement demand during the next 10 years.
- High skill workers that are projected to capture between 26 to 28 percent of total employment by 2025 will be the lowest but growing contributors to replacement demand. Their share of total replacement demand will gradually grow from 18.1 percent in 2015 to as high as 23.7 percent under the High Scenario in 2025.

CHAPTER 9

JOB OPENINGS MODULE OF LM-EM (LMEM-JO)

The purpose of this module is simply to provide annual projections of job openings in the economy (JO),which is the combination of job openings due to economic growth (i.e., the expansion demand, ED) and job openings due to vacancies due to labour turnover, resulting from retirement, migration, mobility and mortality (i.e., the replacement demand, RD). The module thus produces annual projection of total job openings by occupation and qualification:

$$
\begin{aligned}
JO^t &= ED^t + RD^t \\
JO_q^t &= ED_q^t + RD_q^t \\
JO_{oc}^t &= ED_{oc}^t + RD_{oc}^t \\
JO^t &\equiv \sum_{q=1}^{10} JO_q^t \equiv \sum_{oc=1}^{9} JO_{oc}^t
\end{aligned}
\qquad [9.1]
$$

9.1. Total Job Openings (2015-2025)

Table 9.1 presents the LM-EM projections of job openings, which reflect the above accounting relationships. The module's results are therefore consistent with the results from other modules of the LM-EM.

Figure 9.1 presents trends in total job openings under the three scenarios over the period 2015 to 2025. Over the next 10 years, the scenarios are expected to generate between 8.1 million (Low) and 13.5 million (High) job opportunities, which amounts to average annual job openings of between 738,000 and 1,230,000.

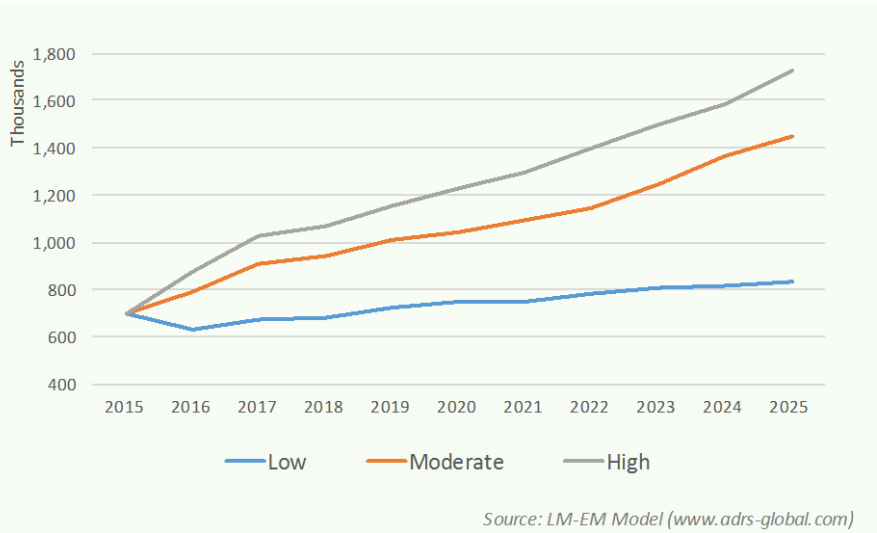
The three scenarios also differ significantly in terms of the pace at which the economy is expected to generate job opportunities. Under the Low scenario, job openings are expected to grow annually at an average rate of 1.78 percent, while under the Moderate and High scenarios, the rates elevate to 7.6 percent and 9.5 percent, respectively. Finally, the scenario differences in terms of the distribution of job openings between expansion demand and replacement demand is noteworthy. In the case of the Low scenario, only about one third of job openings are due to the expansion of the economy, the remaining two thirds are from replacement demand. In the case of the Moderate scenario, the total job openings over the next 10 years are equally generated by the scenario's growth path and labour turnover. Under the High scenario, more than 50 percent of job opportunities are due to economic expansion and 45 percent are from replacement demand.

Table 9.1: Components of Job Openings (Three Scenarios)

Job Openings		Total JO (2015-2025)	Average Annual	CAGR (%)	% of JO
Low	Expansion Demand	2,604,640	236,785	2.47	32.1
	Replacement Demand	5,518,932	501,721	1.43	67.9
	Total Job Openings	**8,123,572**	**738,506**	**1.78**	**100.0**
Moderate	Expansion Demand	5,788,279	526,207	13.81	49.6
	Replacement Demand	5,873,869	533,988	2.89	50.4
	Total Job Openings	**11,662,148**	**1,060,195**	**7.62**	**100.0**
High	Expansion Demand	7,463,111	678,464	16.68	55.2
	Replacement Demand	6,068,293	551,663	3.60	44.8
	Total Job Openings	**13,531,404**	**1,230,127**	**9.52**	**100.0**

Source: LM-EM (www.adrs-global.com)

Figure 9.1: Trends in Total Job Openings (2015-2025)



Source: LM-EM Model (www.adrs-global.com)

9.2. Job Openings by Occupation

Given the three outlooks for the economy, represented by the three hypothetical scenarios, what occupations are expected to be in high demand over the next 10 years? The set of charts in Figure 9.2 provides a comparative illustration of the impact of the three scenarios on each of the 9 occupational categories. Across the three scenarios, the top three occupations with highest growth over the next 10 years are projected to be Craft and Related Trade Workers, followed by Plant and Machine Operators and Mangers. The number of job openings in Craft and Related Trade Workers are projected to grow between 87 percent (Low) and 400 percent (High), or from about 65,000 workers in 2015 to 120,000 under the Low scenario and 323,000 workers under the High scenario.

In the case of Plant and Machine Operators, the number of workers is projected to grow between 56 percent (Low) and 310 percent (High), or from 43,000 in 2015 to 67,000 under the Low scenario and 177,000 under the High scenario.

The number of job openings that fall under the category Managers is projected to grow from 43,000 in 2015 to 55,000 (Low), about 108,000 (Moderate) and about 130,000 under the High scenario. These are equivalent to growth of 29 percent (Low), 151 percent (Moderate) and 202 percent (High).

Two occupations are projected to experience zero to negative growth under the three scenarios over the next 10 years. The number of job opportunities for Technicians are projected to drop significantly from about 77,000 in 2015 to 43,000 (Low), 56,000 (Moderate) and 63,000 (High). Occupations under the Professional category are expected to experience negative growth under the Low and Moderate scenarios and to be muted under the High scenario. Therefore, the number of job opportunities for Professionals are expected to gradually decline from job openings of 41,000 in 2015 to 26,000 new job opportunities (Low) and to 36,000 job openings under Moderate scenario. The number of job openings in the Professional category is expected to remain close to its value of 41,000.

Figure 9.3 allows analysis of job openings and its components across scenarios and occupations. With respect to occupations in high demand, what stands out is that under the Low scenario, for two of three occupations with highest growth over the next decade,

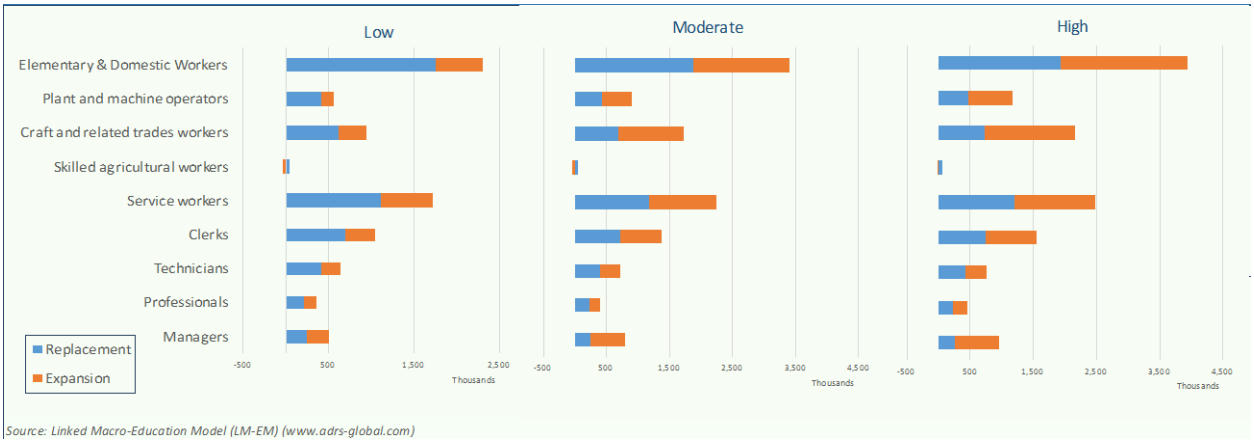
namely, Crafts and Related Trade Workers and Plant and Machine Operators, between 66 percent and 73 percent of their job openings are from job turnover, i.e., replacement demand. Economic expansion is expected to account for 27 percent and 34 percent of job openings in these occupations. However, economic growth supports 52 percent of the high level of job openings under the Manager category in the Low scenario.

The three fastest growing occupations under both the Moderate and High scenarios owe between 51 percent and 68 percent (Moderate) and 60 percent to 73 percent (High) of their job openings to growth of the economy, i.e., the expansion demand. In the case of job openings in the Manager category, less than 30 percent of these job openings are due to job turnover, the rest are generated from the underlying growth performance of the economy.

Figure 9.2: Job Openings by Occupations, 2015-2025

Source: Linked Macro-Education Model of South Africa (LM-EM). (www.adrs-global.com)

Figure 9.3: Composition of Job Openings: Expansion & Replacement Demand by Occupation (2015-2025)



Source: Linked Macro-Education Model (LM-EM) (www.adrs-global.com)

9.3. Likely Future Trends in Job Openings by Qualification (2015-2025)

To the extent that alternative growth paths for the economy impact economic sectors and the demand for occupations differently, the educational qualifications that would be in demand under each scenario will also be different and may change accordingly. Figures 9.4 and 9.5 provide comparative illustrations of the three scenarios in terms of demand for educational qualifications over the next 10 years.

Under the three scenarios, over the next 10 years, the number of job openings is projected to increase for all educational qualifications, but at a different rate. The Low Scenario is likely to generate a little more than 32,000 job opportunities for the Low qualifications compared to 259,000 and 349,000 job openings under the Moderate and High scenarios. However, relative to the total job openings under each scenario, the share of job openings for the low skill workers is expected to gradually decline over the next 10 years by -3.7 percent (Low), -2.3 percent (Moderate), and - 1.6 percent (High).

Relative to the Low Scenario, job openings for individuals with Medium level qualifications are also expected to increase at a faster pace under the Moderate and High Scenarios. Total job openings that require Medium level education qualification are expected to increase from a little more than 220,000 in 2015 to about 275,000 (Low), 480,000 (Moderate), and 570,000 (High) over the next 10 years. Across economic scenarios, the share of job openings in this skill category is projected to increase by about one percent over the entire 10 year period from 32.1 percent in 2015 to about 33. Therefore, one-third of all job openings are

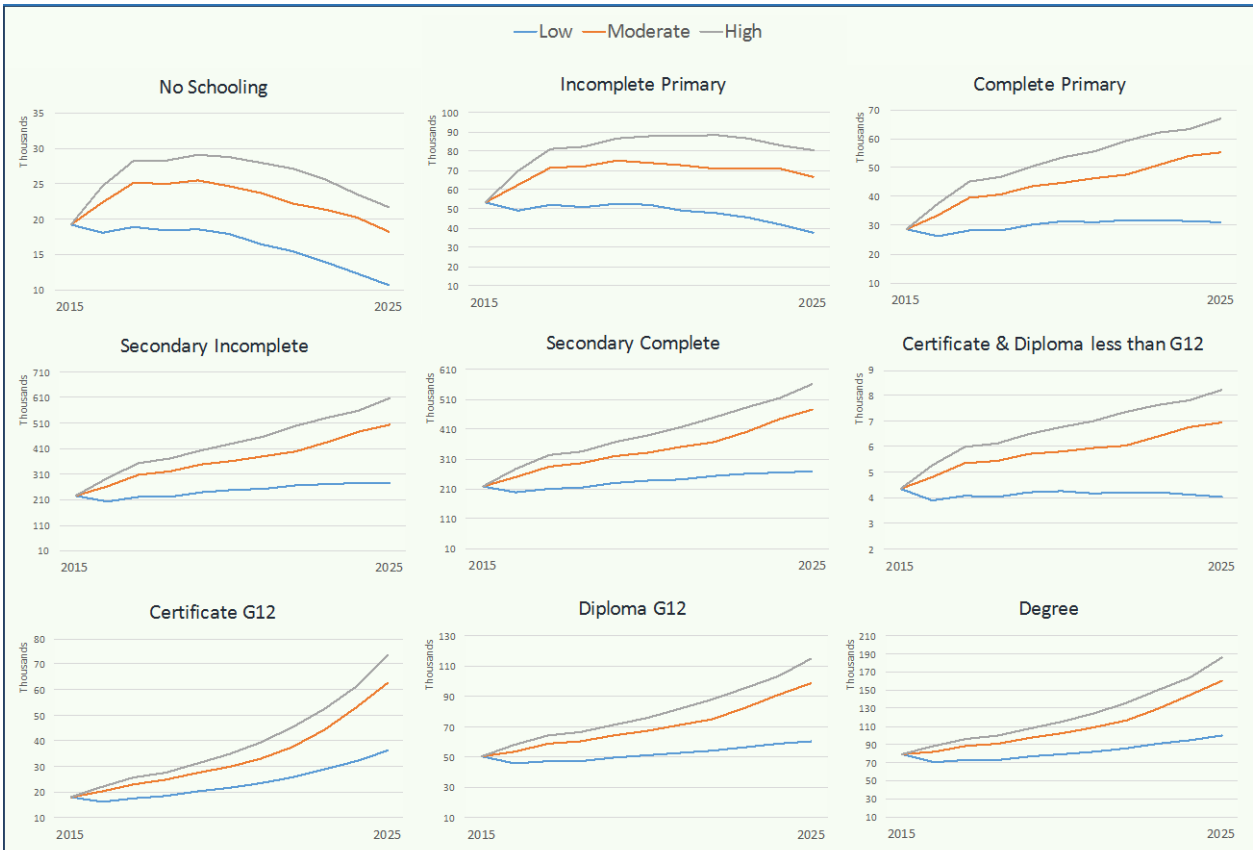
projected to require Moderate level of educational qualifications under each of the three scenarios.[52]

Over the next 10 years, if the job creation path of the economy falls within the Low and High Scenarios, about one out of every five job openings will require tertiary education. The remaining 80 percent of job openings (77.5 percent (Low) and 80.4 percent (High)) will require Low and Medium skills.

Since about 80 percent of those with jobs in 2015 (employed) have low to medium levels of education, that means a large percentage of future job openings that will be due to the replacement demand will require at least low to medium skills. That will ensure that there will be significant demand for low and medium skills workers in the future, if employers refill the job openings from replacement demand with individuals with similar level of educational background.

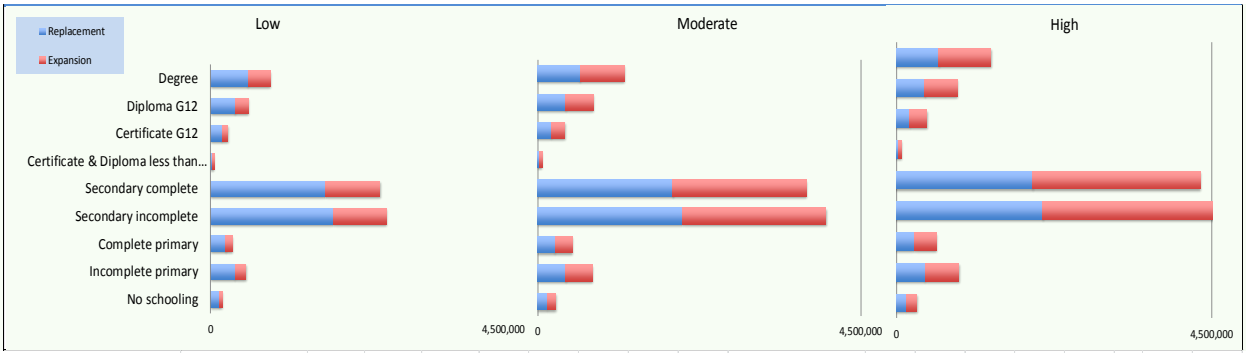
[52]The actual projected shares for the three scenarios are 33.1 percent (Low), 33.3 percent (Moderate), and 33.2 percent (High).

Figure 9.4: Job Openings by Qualification, 2015-2025



Source: Linked Macro-Education Model of South Africa (LM-EM). (www.adrs-global.com)

Figure 9.5: Composition of Job Openings: Expansion & Replacement Demand by Qualif. (2015-2025)



9.4. Conclusions

If the economy follows a growth path within the Low and High scenarios, some of the key findings of the model with regard to the future size and allocation of job openings over the next 10 years are:

- The economy will generate between 8.1 million and 13.5 million job opportunities, which amounts to average annual job openings of between 738,000 and 1,230,000.[53]
- If the economy follows a low job creation path, similar to the Low scenario, then only about one third of job openings will be due to the expansion of the economy; the remaining two thirds of job openings will be from replacement demand. If the economy's job creation path gets closer to the High scenario, more than 50 percent of job opportunities will be due to economic expansion and 45 percent will be from replacement demand.
- The top three occupations with highest growth over the next 10 years are projected to be Craft and Related Trade Workers, followed by Plant and Machine Operators and Managers. The number of job openings in Craft and Related Trade Workers will increase from about 65,000 workers in 2015 to between 120,000 and 323,000 workers in 2025, depending on whether the economy will perform close to the Low or High scenarios.
- The share of job openings for the low skill workers is expected to gradually decline over the next 10 years under the three scenarios.
- If the job creation path of the economy falls within the Low and High Scenarios, about one out of every five job openings will require tertiary education.
- A large percentage of future job openings that will be due to the replacement demand will require at least low to medium skills.

[53]Note that projections of job openings are the sum of job opportunities due to the growth of the economy and the replacement demand.

CHAPTER 10

LABOUR SUPPLY MODULE OF LM-EM (LMEM-LS)

The LM-EM's labour supply module (LMEM-LS) is developed to generate annual projections of the labour force and its breakdown by qualification and occupation. Related to the labour supply module is the job seekers module (LMEM-JS) that produces annual projections of the size of job seekers in the economy and its break down by qualification and occupation. Job seekers refer to the portion of the labour force that is not employed and seeks employment.

10.1. Purpose

The aim of the labour supply module of LM-EM is to produce annual projections of the labour supply and its breakdown by educational qualification (skills supply) and by occupation, using the extended definition of unemployment.

10.2. Empirical Methodology and Data

The background research on the estimation of the supply side of skills was undertaken by Perry (2015). ADRS also conducted additional statistical analysis of the supply of skills before building and testing the LMEM-LS. The empirical methodology utilised the current skills levels of the labour force, as captured by Census 2011, and estimated, by way of a multinomial logistical regression, the determinants of skills levels of the labour force. The

results of the regression analysis are utilised in the LMEM-LS to produce annual projections of the labour force.[54]

10.2.1. Data Preparation

Initially, in line with the skills demand modules, data from the third quarter of the 2009, 2010 and 2011 Quarterly Labour Force Surveys were combined and used for the analysis. Combining the three years of data yielded over 62 000 individual records, un-weighted. However, the estimation process based on the pooled QLFS data created insufficient statistical significance results. This was noted especially at the upper end of the highest qualifications – certificates, diplomas and degrees. After several attempts to improve the robustness of the regression model, it was decided to utilise the 10 percent sample of the Census 2011.

The Census 2011 (10% sample) includes over 495 000 individual records. Wherever possible the data coding that was used for the QLFS data was also used in the Census 2011 data set. The only variable that needed recoding was the variable related to the highest level of education attained. The detailed education level variable in the Census 2011 has 31 levels or types of qualification which is unworkable for the analysis. While in the Census 2011 there is a standard highest education level summary coding of 6 educational categories, we found that to be too aggregated for use in our analysis. In particular category 6, namely, tertiary, includes all post school qualifications and it was felt that this analysis needed to distinguish between a post school certificate, diploma and degree. Therefore an 11 level scale for highest education level was constructed.

Other data used for the analysis is the number of learners obtaining a National Senior Certificate in 2011 and the number of graduates from higher education and training

[54]This approach of projecting skills supply differs from the projection models generally developed in the education and training sector that utilise historical time series data on the input into and output from the education and training sector to project future expected supply of skills. These models are most commonly constructed to project the costs of education and training under different policy scenarios. They estimate the human, physical, and financial resources needed to implement the policies and strategies devised by public authorities. See Brey and Varghese (2011) for a review of international experiences and perspectives.

institutions in 2011. In terms of school output, a ratio of the number of learners by province, race and gender passing the SCE over the population of 18 year olds by province, race and gender was constructed. The table below shows the calculated ratios that were ultimately used as default values in the model. It will be noted that these ratios appear low and a number of caveats apply.

Firstly, the enrolment and thus output of the SCE is lower in 2011 than previous years due to the application of the Age Grade Policy in 2000. Secondly, the SCE results from the Independent examinations board are not included, but they only include approximately 8000 pupils, which are not disaggregated by race. This appears to affect white pupil graduation rates in Gauteng and KwaZulu Natal.

Table 10.1: Ratio of Learners Passing SCE to 18-year-old Population by Race, Gender, and Province

Prov	Gender	African	Coloured	Indian	White
EC	Male	0.228	0.222	0.328	0.698
	Female	0.273	0.297	0.339	0.742
FS	Male	0.323	0.312	0.384	0.871
	Female	0.344	0.392	0.590	0.922
GT	Male	0.307	0.348	0.413	0.575
	Female	0.341	0.445	0.433	0.605
KN	Male	0.360	0.324	0.463	0.523
	Female	0.376	0.379	0.502	0.528
LP	Male	0.363	0.321	0.188	0.631
	Female	0.384	0.333	0.242	0.799
MP	Male	0.340	0.263	1.269	0.563
	Female	0.361	0.345	1.561	0.603
NC	Male	0.257	0.300	0.241	0.797
	Female	0.287	0.390	0.164	0.861
NW	Male	0.276	0.219	0.469	0.661
	Female	0.305	0.295	0.417	0.749
WC	Male	0.247	0.258	0.409	0.766
	Female	0.308	0.317	0.391	0.756

In terms of degrees from higher education and training institutions, output data on post school certificates, diplomas and degrees was collected and tested in the regression model. Unfortunately, due to the inability to disaggregate all public and private certificates and diplomas by race and gender, these ratios were not statistically significant when run through the model.[55]

[55] It is hoped that as this data becomes more detailed it will be added to the regression model.

Data on output of degrees from public universities is disaggregated by race and gender and the ratio of graduates to the number of 22 year olds in the population in 2011 was calculated. The following table shows the calculated ratios that were also used as default values in the LM-EM.

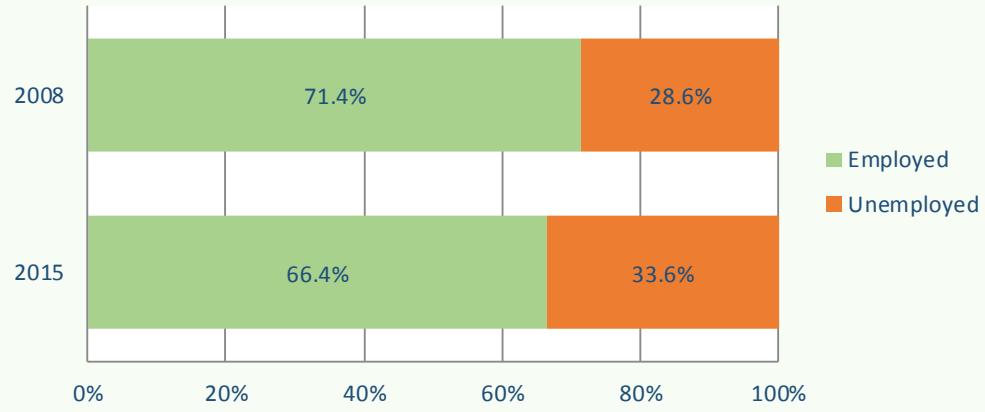
Table 10.2: Higher Education Graduation Rates (2011)

Race	Sex	Ratio of graduates to population of 22 year olds in 2011
African	Male	0.088
	Female	0.140
Coloured	Male	0.093
	Female	0.148
Indian	Male	0.290
	Female	0.513
White	Male	0.551
	Female	0.707

10.2.2. Stylised Facts

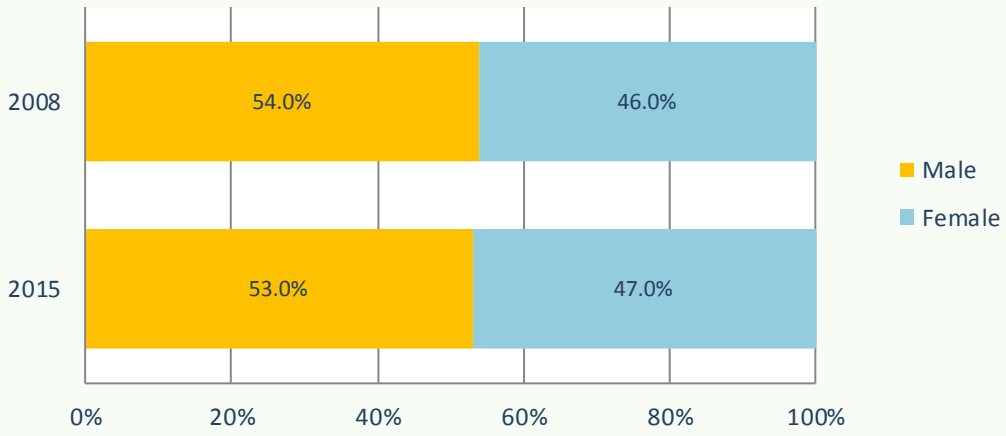
Between 2008 and 2015, the South African labour force, measured using the expanded definition of unemployment, grew from about 20.9 million to 24.4 million, or at a compound annual growth rate of 2.24 percent. In terms of the distribution of the labour force between employed and the unemployed, relative to 2008, the employment share of the labour force was 5 percent lower in 2015, which meant the unemployment rate was 5 percent higher in 2015, (Figure 10.1). The number of working age population that were classified as unemployed grew from about 6 million in 2008 to 8.2 million in 2015, while the number of employed in the labour force increased from 14.9 million to 16.2 million.

Figure 10.1: Labour Force by Labour Market Status



Source: Statistics South Africa, QLFS, 4th Quarter

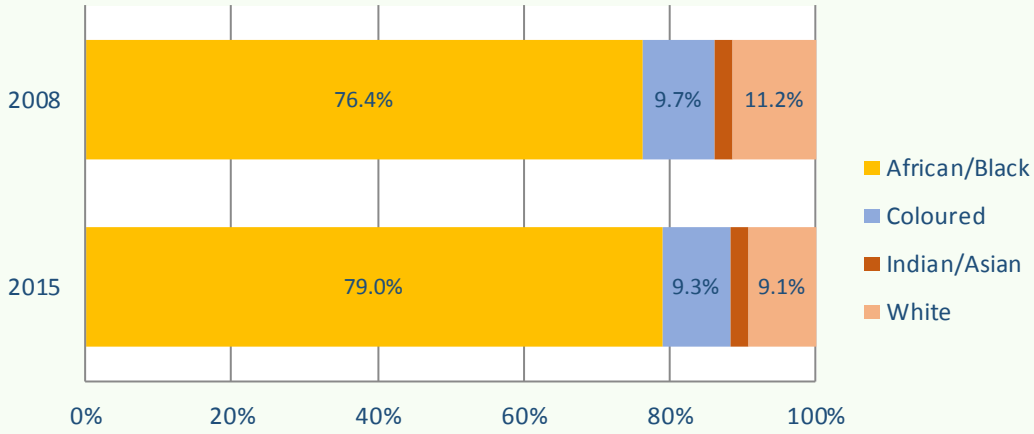
Figure 10.2: Labour Force by Gender



Source: Statistics South Africa, QLFS, 4th Quarter

The gender breakdown of the labour force has changed little over the last 8 years. In 2015, the labour force included about 100,000 more women than men, which meant a 1 percent increase in the proportion of women in the labour force (Figure 10.2).

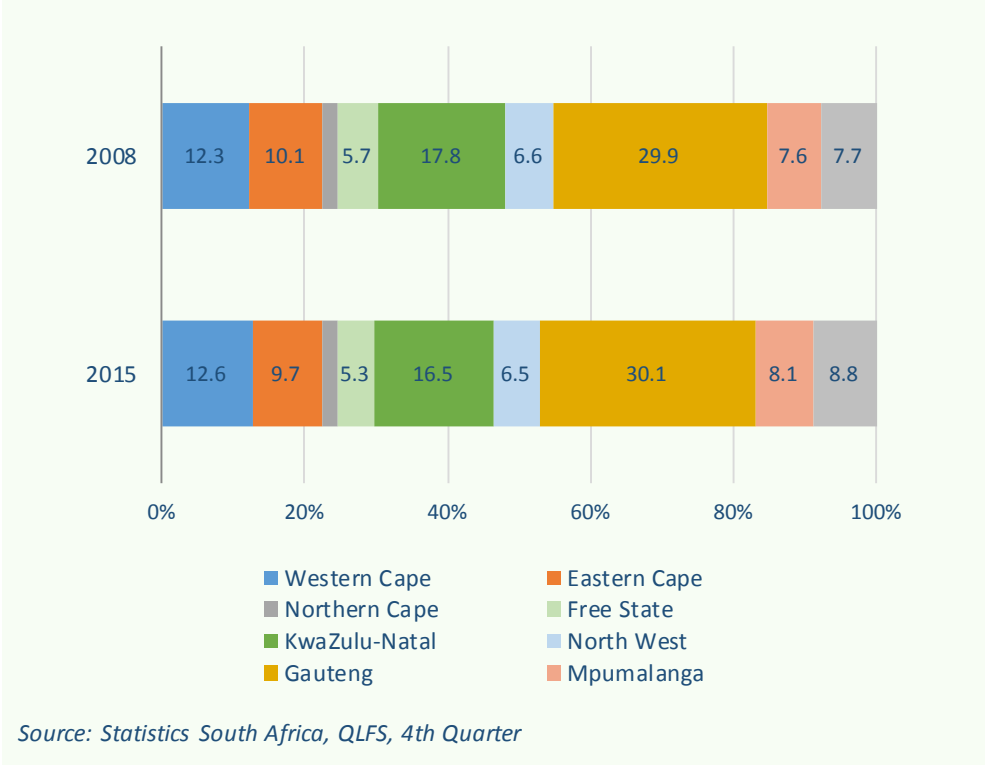
Figure 10.3: Labour Force by Race



Source: Statistics South Africa, QLFS, 4th Quarter

Figure 10.3 highlights the distribution pattern of the labour force between the four racial groups in South Africa. The largest growth was with regard to the size of Africans in the labour force, which experienced a 3 percent increase in share (equivalent to a 3.3 million increase in terms of levels). On the other hand, the number of Whites in the labour force dropped by about 120,000 persons between 2008 and 2015, while the number of Coloured and Indian/Asian in the labour force grew by 260,000 and 58,000 respectively. Notwithstanding above gradual changes in the racial composition of the labour force, each race's share of total labour force mainly reflects its population share in a given period.

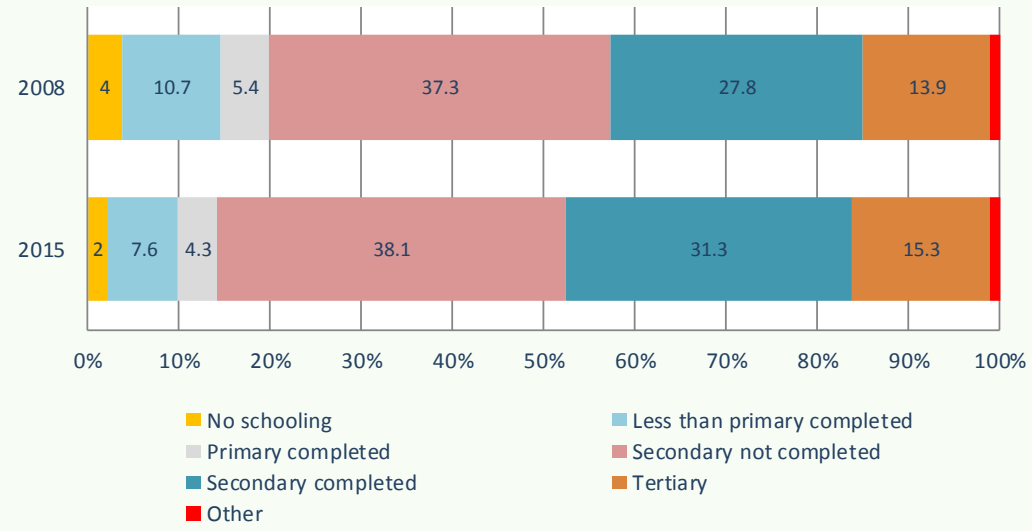
Figure 10.4: Labour Force by Province (2008, 2015)



Source: Statistics South Africa, QLFS, 4th Quarter

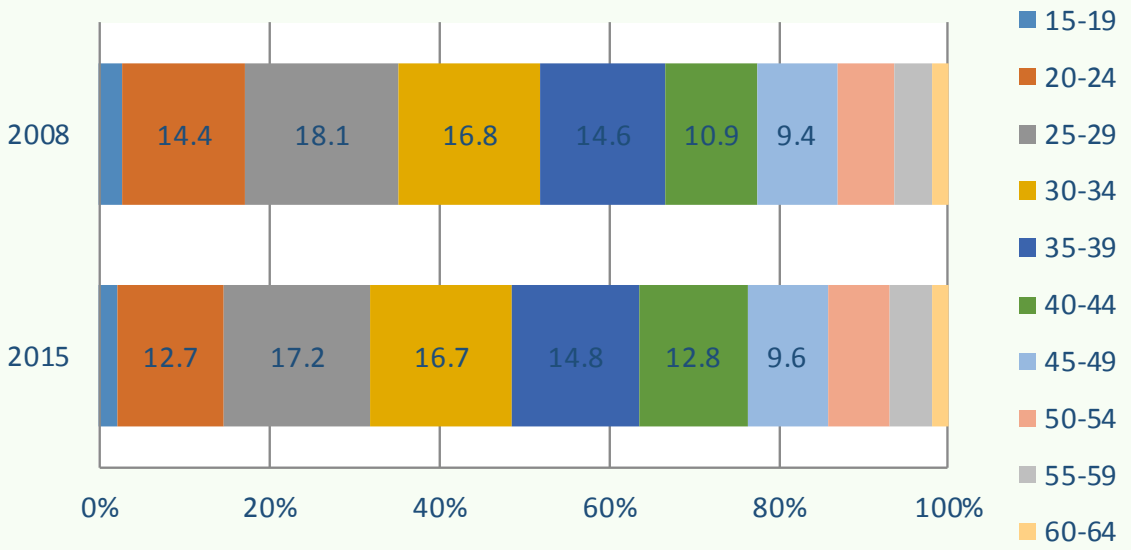
Figure 10.4 shows the relative stability of the provincial shares of the labour force over the last 8 years, which to a large extend reflect their shares of total population. On the other hand, as Figure 10.5 shows, the educational composition of the labour force has gradually changed, reflecting an increase in the overall level of education of the labour force, which is captured through positive growth in share of adults in the labour force with Secondary Not Completed and above levels of education and negative growth in the share of adults in the labour force with Primary Completed and below.

Figure 10.5: Labour Force by Skills



Source: Statistics South Africa, QLFS, 4th Quarter

Figure 10.6: Labour Force by Age



Source: Statistics South Africa, QLFS, 4th Quarter

Figure 10.6 reflects the distribution pattern of the labour force by age using 2008 and 2015 data. Overall, changes in shares of cohorts of age groups in the labour force have been small. The ages of about three-fourth of the labour force in 2008 and 2015 were between 20 and 44 years (74.6 percent, 2008, and 74.2 percent, 2015). The -1.6 percent decline in the

shares of 20-24 age group in the labour force over the last eight years and the 1.9 percent increase in the share of 40-44 age group stand out as largest changes in shares of various age groups in the labour force.

10.2.3. Specification and Estimation of MNL Models

The specifications of the multinomial logistical regression model took account of previous studies that have shown that the following demographic, socio-economic and education quality variables are significant in determining educational qualifications of members of the labour force: age, race, gender, province, urban/rural, type of dwelling, number of household dependents, relationship with head of household, access to social grants, quality of educational institution attended.[56]However, the specification of the MNL model was limited to factors whose future values could be generated endogenously by other modules of the LM-EM or could be provided from outside the model, as exogenous factors.[57]

Since at any point in time, the stock of skills within the labour force is affected by the current output from educational institutions, two indicators of output from the education sector were constructed and included in the specification of the MNL model. These were Matric and Higher Education graduation rates by race.

The initial set of estimations used the pooled three-year QLFS that was used for earlier modules. However, for the final run, a 10 percent sample of the Census 2011 was used. Overall, more than 10 versions of the MNL model were estimated for the skills supply; this included estimations using the pooled QLFS and the 10 percent Census with and without the individual weights. Various regression models were tested which included province, race, gender, age group, urban/rural and type of dwelling as well as the school output and higher education output ratios. The final multinomial logit regression model that was selected was:

[56]Simkins (2000), Crouch and Mabogoane (1998), van der Berg (2008), and Taylor and Yu (2009). See also CEDEFOP (2009b).
[57]Moreover, due to the data limitations, the significance of some factors could not be explored, most especially the quality of educational institution attended.

$$S_{j,i} = \beta_{0,j} + \beta_{1,j} Gender_i + \beta_{2,j} Race_i + \beta_{3,j} Prov_i + \beta_{5,k} Age_i + \beta_{3,j} Matric_i + \beta_{3,j} HED_i \quad [10.1]$$

Where:

- j represents the 10 educational qualification categories, not including the reference category, i.e., Secondary School Completed.
- i denotes the population of 15 – 64 year olds in the labour force, using expanded definition of unemployment, which includes disillusioned work seekers.
- $S_{j,i}$ is the highest level of education attained (j=1,2,…,11) by individual *i* in the labour force.
- $Prov$ Province is the province in which the individual resides.
- $Race$ is the race of the individual.
- $Gender$ is the gender of the individual.
- Age is the age group of the individual in the labour force, using 10 five-year intervals.
- $Matric$ is the number of learners attaining a National Senior Certificate in 2011 as a ratio of the total number of 18 year olds, disaggregated by race.
- HED is the number of graduates from higher education institutions in 2011 as a ratio of the total number of 25 year olds, disaggregated by race.

Omitted reference categories: Gender (Male), Race (African), Age (group 20-24 years old), Province (Eastern Cape), and Education level (Secondary Completed).[58] This regression model produced statistically significant results and no heteroscedasticity or collinearity was observed.

10.2.4. The MNL Results

The MNL model estimated 10 equations for 11 educational qualifications. For each equation, the estimated parameters represent the log ratio of the odds of being in the

[58] A number of models were run with various omitted variable and the omitted variables: male, African, age group 20 – 24 years old, Eastern Cape and education level of "secondary completed" yielded the most easily "understandable" outputs. Secondary completed, while not the most numerous category yields results relative to secondary completed which makes the interpretation of the post-secondary category more useful.

labour force with *j* level of education versus being in the labour force with Secondary Completed education level. These log-odds are estimated for each province (1 to 9), gender (1 and 2), race (1 to 4), age group (1 to 10), matric and higher education graduation status of members of the labour force, broadly defined. For example, the MNL regression provides the log-odds of being in the labour force with No Schooling compared to Secondary School Completed for female relative to male, given that the other variables in the model are held constant.

The results presented in this section are the relative risk ratio (RRR) or odds ratio. They are the odds of a certain level of education being attained in relation to the relevant reference category. In the interpretation of the results, it is important to note that the population analysed is the workforce and not the working age population. This is important since, for example, there are more women than men in the adult population with No Schooling but there are fewer women than men in the workforce with No Schooling.

For the category 'no schooling,' the results show, for example, that the odds of females in the workforce having "no schooling" as their highest level of education is less than men (as the RRR value is less than 0). Females are 0.895 times less likely than males to have no schooling. Coloured, Indians and whites in the workforce are less likely to have no schooling than their African counterparts. The workforce in the Northern Cape, KwaZulu Natal, North West, Mpumalanga and Limpopo are more likely to have no schooling than in the Eastern Cape. In terms of the age categories, the likelihood of having no schooling in comparison to the age group 20 – 24 years old, increases dramatically the older one is.

The above pattern is very similar for education categories up to "primary completed". For the category "secondary not completed", there are some interesting points to note. Females with secondary not completed are as likely to be in the workforce as males and coloureds as likely as Africans. The likelihood of being in the workforce is very similar across provinces except for KwaZulu Natal, Gauteng and Mpumalanga – these being much lower. The likelihood of being in the workforce with secondary incomplete is also fairly even across age groups.

The percentages of population holding certificates and diplomas without completing grade 12 and certificates completing grade 12 are extremely low. However, the results for these three categories are surprisingly similar with females and whites more likely than males and other race groups in the workforce to have these qualifications. In the case of females, this is somewhat understandable as many older teachers and nurses obtained professional certificates without necessarily completing Grade 12.

For diplomas and degrees categories, again females are 1.4 times more likely to have a diploma and 1.17 times more like to have a degree than males; whites 3.8 and 5.49 times more likely to have a diploma or degree than Africans; and the likely hood of having a degree or diploma increases with age.

10.3. Labour Supply Module within the LM-EM

The estimated system that captures the supply-side of skills was used to write the computer code for the module. The codes also established the necessary links between the module and the rest of LM-EM. More specifically, the parameter data files that include projections of various parameters related to demographic and education sector is designed to channel annual values of these parameters to the module.

Within the module, for every year of the forecast period, the computer codes combine exogenously provided annual values for the demographic and education variables, used in the MNL model, with corresponding transformed log-odds ratios of parameters of the estimated equation to produce period specific set of probabilities related to 11 categories of skills (educational qualifications) within each of the four racial groups. The calculated labour supply probability matrix (LSPM) for each period and the vector of population projections for 4 racial groups for the same period, provide projections of the size of the labour force for a specific and overall educational qualifications:

The size of the labour force for a specific education qualification q(q=1,2,…,11)

$$LS_q^t = LSPM_q^t \bullet Pop_{Race}^t \qquad [10.2]$$

Outputs of the labour supply module feed into at least two other modules of the LM-EM, namely the job seeker and skills gap modules, which will be discussed in Chapters 11 and 12.

The LMEM-LS produces annual projections of the size of the labour force and its composition by educational qualifications.

$$LS^t = \sum_{q=1}^{11} LS_q^t \qquad [10.3]$$

The LMEM-LS also uses the annually estimated probability matrix for qualification and occupation from the qualification module (LMEM-QUAL) to derive estimates of labour force by occupation LS_o^t, even though there is no actual data on the occupations of the unemployed part of the labour force.

$$LS^t = \sum_{o=1}^{10} LS_o^t \qquad [10.4]$$

10.4. Module Outputs

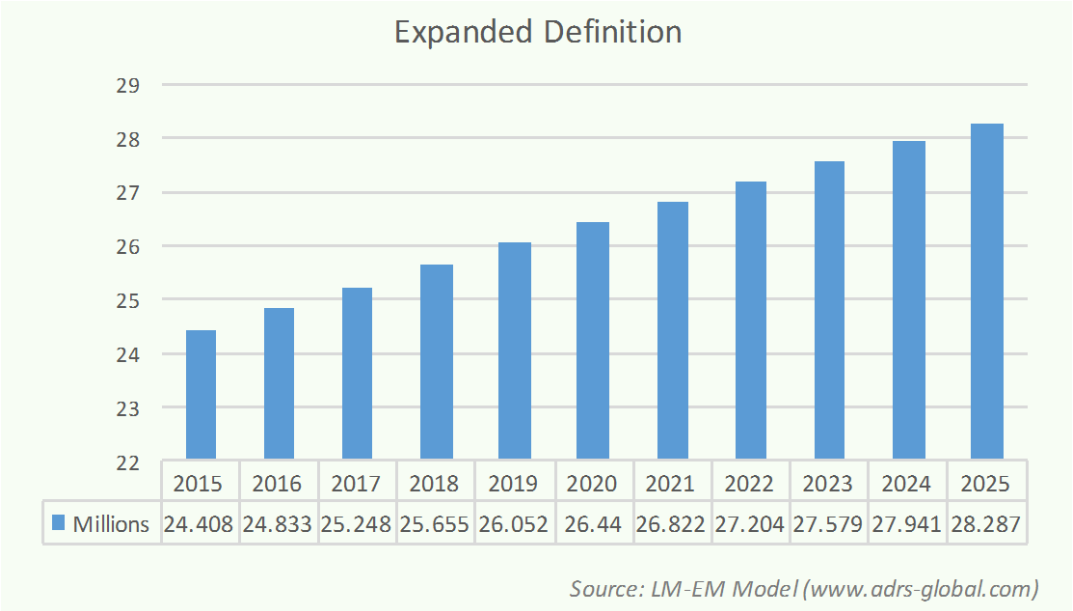
In order for the LMEM-LS to produce projections of the labour supply (labour force) over the next 10 years, the model requires a number of inputs, as explained in the sections on the specification and estimation of the labour supply equation. Therefore, current and future values of the inputs were prepared and fed into the model as part of producing projections of the labour force. Three categories of inputs were prepared. First, for the demographic inputs, the annual projections of population by gender, race, age groups and provinces were provided to the project by Statistics South Africa. Second, Quarterly Labour Force Surveys of the first quarter of 2015 were used to calculate current values for the 84 labour force participation rates (LFPRs) associated with various demographic categories cross tabulated by race. Since the model uses the LFPRs as input parameters, for the projection of the labour force, the 84 LFPRs used in the model are assumed to be fixed at base year levels over the forecast period.[59] Third, we used the current average matric rate and higher

[59]In principle, it is also possible to have endogenous determination of the labour force participate rate(s) within the model, which will allow for some modest variation in participation rates between economic scenarios, if labour market participation is positively related to the level of economic activity. In LM-EM, the LFPRs were not endogenised for two main reasons. First, it was not practically possible since the model

education graduation rate by race.The LMEM-LS used the above three categories of inputs to produce annual projections of the labour force for 11 educational qualifications. The annual projections of total labour force are derived as the sum of the LM-EM's projections of labour force for 11 educational qualifications.

According to Statistics South Africa's Quarterly Labour Force Survey, the labour force in South Africa, using the expanded definition of unemployment, grew 16.1 percent from 20.88 to 23.62 million between September 2008 and September 2015. Based on the LMEM-LS projections, the labour force is expected to gradually grow to 28.3 million in the next 10 years (Figure 10.7).[60]

Figure 10.7: Labour Force (2015-2025)



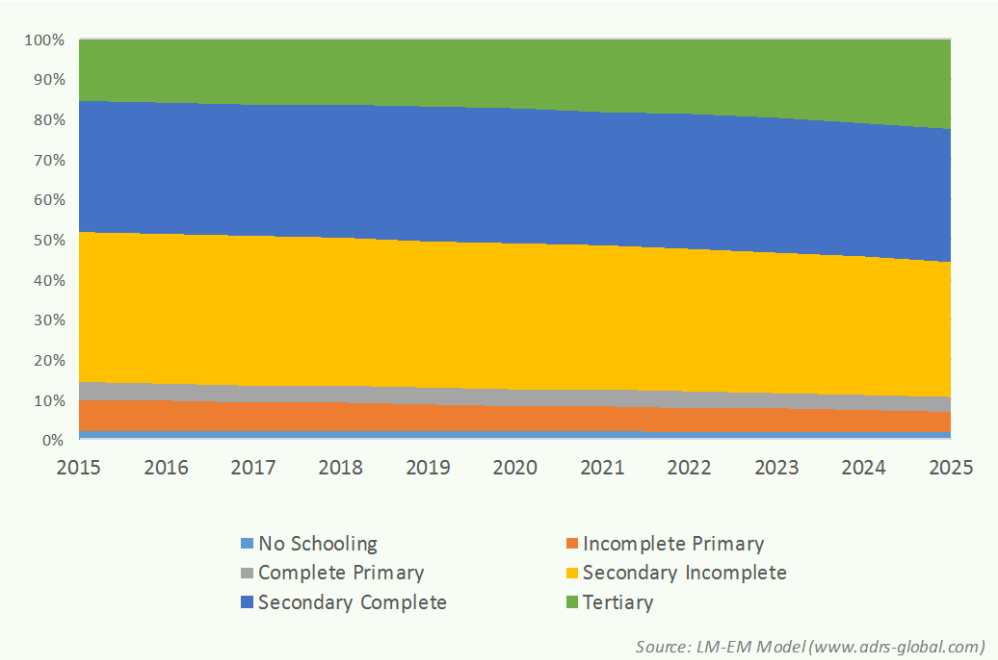
includes 84 LFPRs related to gender, province, and age categories, each broken down further by race. Second, and more importantly, allowing for the LFPRs to be exogenous, made it possible to present users of the web-platform of the LM-EM to design alternative 'what if' scenarios related to one or more the labour force participation rates and run the model based on the preferred values for the LFPRs.

[60]The model's projection of the labour force for the year 2015 is 24.4 million.

10.4.1. Labour Force Projection by Educational Qualification (2015-2025)

Table 10.1 presents LMEM-LS's projections of the labour force in terms of ten educational qualifications,[61] and Figure 10.8 illustrates trends in the qualification shares of the labour force. For four out of six qualification categories, namely, No Schooling, Incomplete Primary, Complete Primary, and Secondary Incomplete, their shares of the total labour force are projected to gradually decline over the next 10 years. The largest decline is in the share of those within the labour force with Secondary Incomplete as their highest level of education. Their share is expected to decline from the estimated 36.9 percent in 2015 to 33 percent in 2025. Together the share of these four qualification categories in the labour force is projected to decline by 7.4 percent from 51 percent in 2015 to 43.6 percent in 2025.

Figure 10.8: Trend in Qualification Shares of Labour Force (2015-2025)

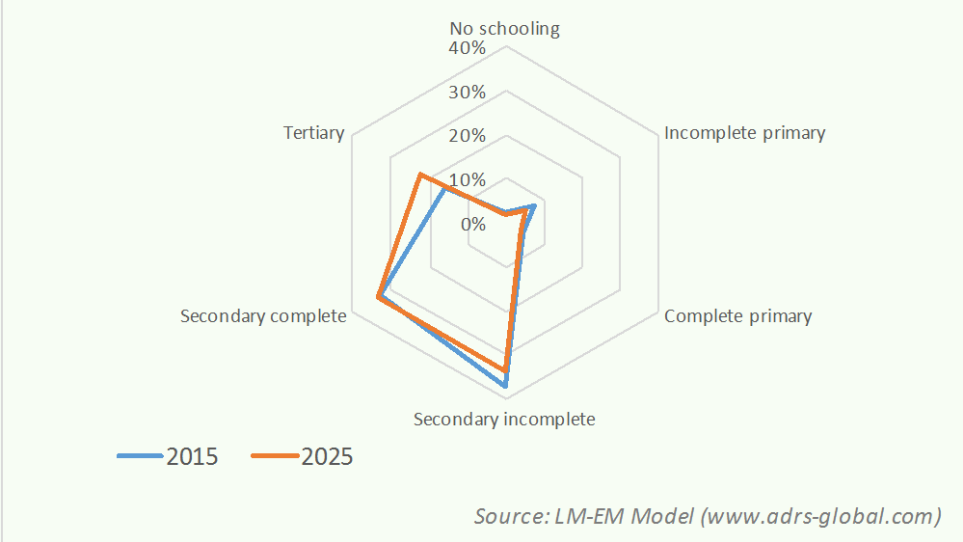


The shares of those in the labour force with Secondary Complete and Tertiary as their highest educational attainment are expected to grow from 32.7 percent in 2015 to 33.4 percent in 2025 in the case of Secondary Complete, and from 15.7 percent to 22.3 percent in the case of Tertiary. Overall, the share of these two categories of qualifications in the

[61] The LMEM-LS's projection of the labour force includes projections for the Unspecified category that captures the Quarterly Labour Force categories Unspecified and Other. The model's projection for this category has been distributed among the 10 educational categories using their shares as the weights.

labour force is expected to grow from 48.4 percent in 2015 to 55.8 percent in 2025. Figure 10.9 compares the education qualification structure of the labour force in 2015 with the model projection for 2025.

Figure 10.9: Labour Force Qualifications (2015 & 2025)



10.4.2. Labour Force Projection by Occupation

The LM-EM uses the ten multinomial logistic regression equations that were estimated to capture the relationship between demand for occupations and demand for qualifications to also transform the estimated supply of skills to estimates of occupations on the supply side.Table 10.3 and Figure 10.10 present LM-EM's projections of trends in the occupation composition of the labour force for the next 10 years, and Figure 10.11 compares the occupational structure of the labour force in 2015 with the model projection for 2025.

The number of workers in the labour force that are linked to the nine occupational categories is projected to increase between 2 percent (Plant and Machine Operators) and 47.7 percent (Professionals) over the next 10 years. At the same time, the shares of five out of nine occupations are projected to decline over the next 10 years; these are Service workers, Crafts and Trade Workers, Plant and Machine Operators, Elementary and Domestic Workers, and Skilled Agriculture and Forestry Workers. The shares of the remaining four

occupations (Managers, Professionals, Technicians, and Clerks) are projected to gradually increase. Out of the projected increase of 3.9 million (15.9 percent) in the labour force over the next 10 years, 44 percent (1.7 million) will be associated with three occupational categories of Managers, Professional and Technicians.

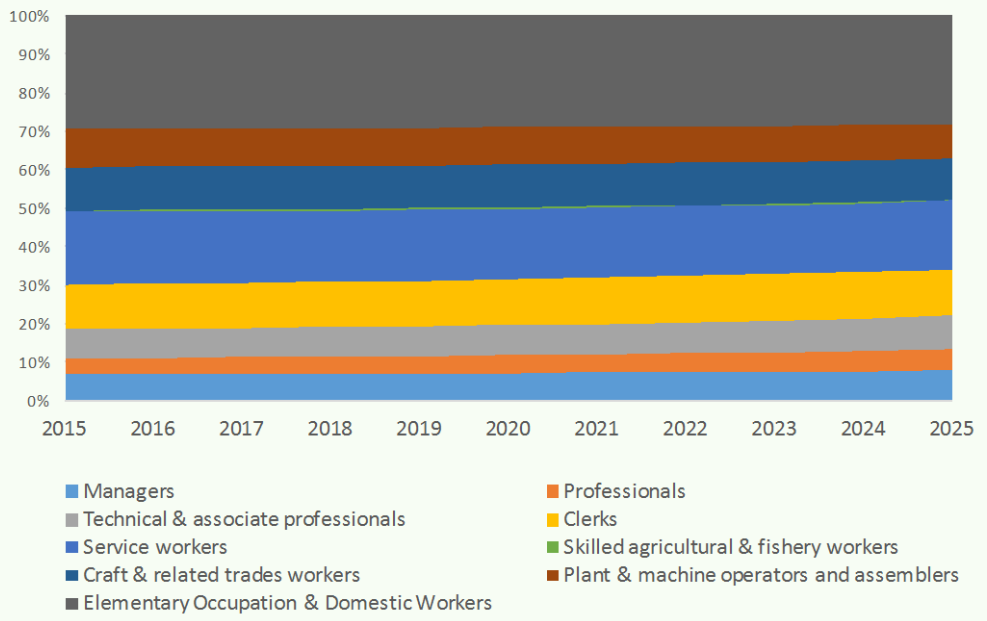
At a more aggregate level, when the above nine occupations are grouped into five, the occupational shares of the labour force remain relatively stable over time. The only significant changes are 2.2 percent increase in the share of the combined Managers and Professional group of occupations, and 1 percent decline in the share of the combined category of Elementary Occupations and Domestic Workers (Figure 10.12).

Table 10.3: Labour Force by Occupation 2015-2025 (Millions, Expanded Definition of Unemployed)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Managers	1.67	1.71	1.76	1.80	1.85	1.90	1.96	2.02	2.08	2.16	2.24
Professionals	1.03	1.06	1.09	1.13	1.17	1.21	1.26	1.31	1.37	1.44	1.52
Technicians	1.83	1.88	1.92	1.97	2.03	2.08	2.15	2.22	2.29	2.38	2.48
Clerks	2.85	2.90	2.96	3.02	3.08	3.13	3.19	3.25	3.31	3.37	3.43
Service workers	4.56	4.63	4.68	4.74	4.79	4.84	4.88	4.92	4.96	4.99	5.00
Skilled agricultural workers	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Craft & trades workers	2.76	2.80	2.84	2.87	2.91	2.93	2.96	2.98	2.99	2.99	2.99
Plant & machine operators	2.48	2.51	2.53	2.55	2.57	2.58	2.58	2.58	2.58	2.56	2.53
Elementary & domestic workers	7.13	7.25	7.36	7.47	7.57	7.66	7.75	7.83	7.90	7.95	7.99
Total	**24.41**	**24.83**	**25.25**	**25.66**	**26.05**	**26.44**	**26.82**	**27.20**	**27.58**	**27.94**	**28.29**

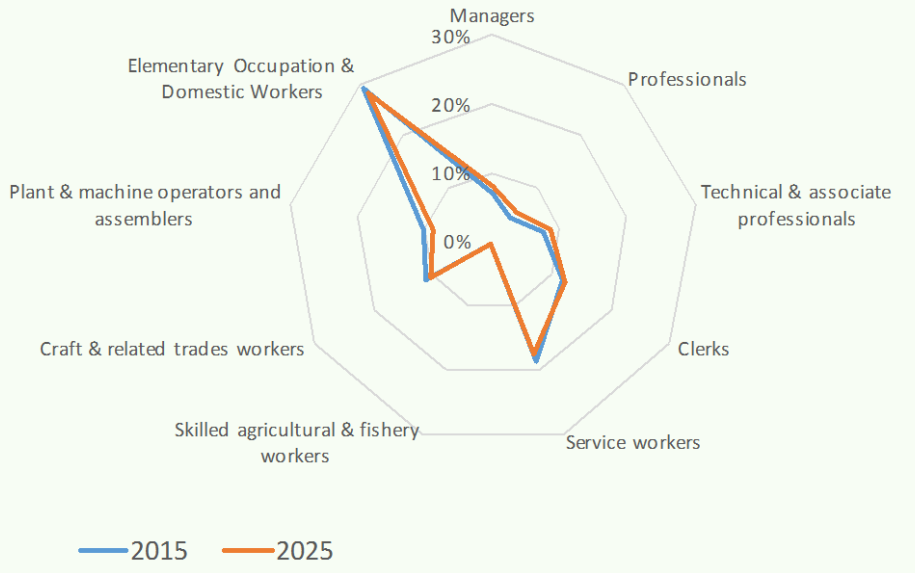
Source: LM-EM Model (www.adrs-global.com)

Figure 10.10: Trends in Occupation Shares of Labour Force (2015-2025)



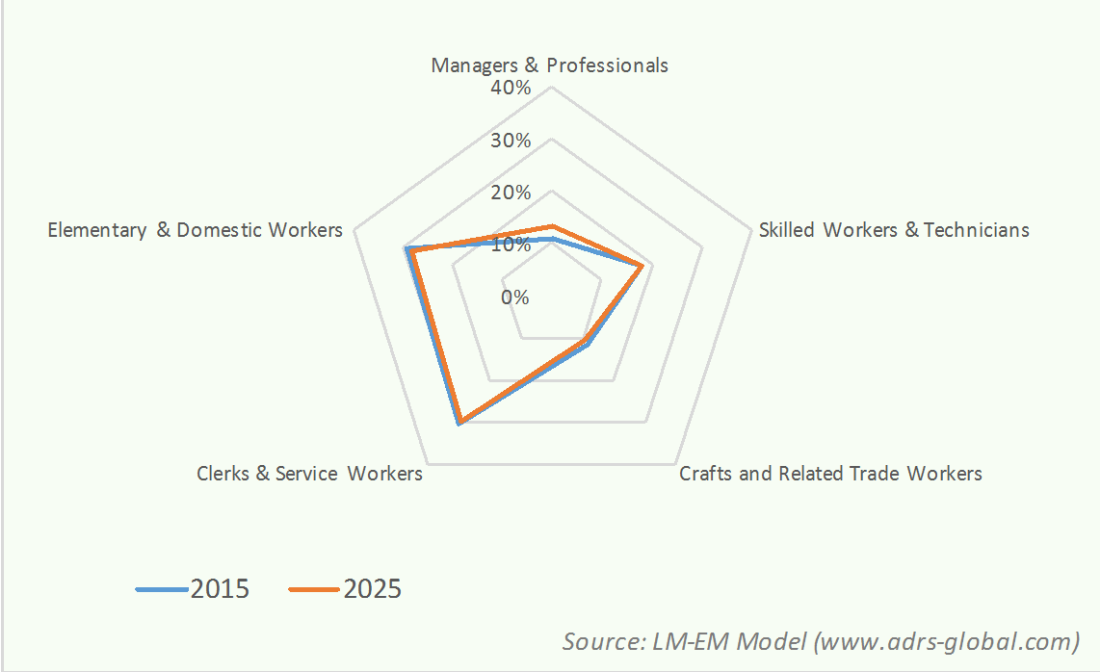
Source: LM-EM Model (www.adrs-global.com)

Figure 10.11: Labour Force Occupations (2015 & 2025)



Source: LM-EM Model (www.adrs-global.com)

Figure 10.12: Occupation Composition of Labour Force (2015 & 2025)



Source: LM-EM Model (www.adrs-global.com)

10.5. Conclusions

This chapter of the Report presented the labour supply module of the LM-EM. The module is designed to produce annual projections of the labour force by educational qualification (i.e., skills supply) and occupation and is defined by the expanded definition of unemployment. The quality of four inputs into the module, namely, working age population by race, gender and province, labour force participation rate for various cohorts of the labour force, matric graduation rate by race, and higher education graduation rates by race play important roles in the quality of the model's labour force projections.

The use of the model to produce projections of the labour force for the next 10 years yields the following insight:

Past trends:

- According to Statistics South Africa's Quarterly Labour Force Survey, the labour force in South Africa, using the expanded definition of unemployment, grew 13.1 percent from 20.88 to 23.6 million between September 2008 and September 2014.
- The number of workers in the labour force with No Schooling or Primary Incomplete and Primary Complete declined by 32 percent, 21 percent and 11 percent, respectively. On the other hand, the number of workers in the labour force with Secondary Incomplete, Secondary Complete, and Tertiary grew by 17.5 percent, 25.6 percent and 25.4 percent during the same period.
- Similarly, during the same period, the combined shares of workers in the labour force with the lowest three levels of education (Primary Completed and less) declined from 20 percent of the labour force to 14 percent. The combined shares of workers in the labour force with the highest three educational categories (Secondary Incomplete, Secondary Complete and Tertiary) increased from 78.9 percent to 85 percent.

Future trends:

Based on the projections of the adult population over the next 10 years, the current labour force participation rates for various cohorts of the labour force, and assumptions on the gradual increase in the matriculation rate among Africans and also gradual increase in the higher education graduation rates among all population groups, LM-EM's labour supply module produced projections of the size and composition of the labour force by educational qualifications and occupations. Among the findings are:

- Based on the LMEM-LS projections, the labour force is expected to gradually grow to 28.3 million in the next 10 years.
- For four out of six qualification categories, namely, No Schooling, Incomplete Primary, Complete Primary, and Secondary Incomplete, their share of the total labour force is projected to gradually decline over the next 10 years by 7.4 percent from 51 percent in 2015 to 43.6 percent in 2025.

- The shares of those in the labour force with Secondary Complete and Tertiary as their highest educational attainment are expected to grow from 32.7 percent to 33.4 percent in the case of Secondary Complete and from 15.7 percent to 22.3 percent in the case of Tertiary. Overall, the share of these two categories of qualification in the labour force is expected to grow from 48.4 percent in 2015 to 55.8 percent in 2025.
- The numbers of workers in the labour force that are linked to the nine occupations are projected to increase between 2 percent (Plant and Machine Operators) and 47.7 percent (Professionals) over the next 10 years. At the same time, the shares of five out of nine occupations are projected to decline over the next 10 years; these are Service Workers, Crafts and Trade Workers, Plant and Machine Operators, Elementary and Domestic Workers, and Skilled Agriculture and Forestry Workers. The shares of the remaining four occupations (Managers, Professionals, Technicians, and Clerks) are projected to gradually increase. Out of the projected 3.9 million (15.9 percent) increase in the labour force over the next 10 years, 44 percent (1.7 million) will be associated with three occupational categories of Managers, Professional and Technicians.
- At a more aggregate level, when the above nine occupations are grouped into five, the occupational shares of the labour force remain relatively stable over time. The only significant changes are a 2.2 percent increase in the share of combined Managers and Professional group of occupations, and a 1 percent decline in the share of combined category of Elementary Occupations and Domestic Workers.

CHAPTER 11

JOB SEEKERS MODULE (LMEM-JS)

Job seekers refer to the portion of the labour force that is not employed and seeks employment. The aim of the job seekers module (LMEM-JS) is to produce annual projections of the size of the job seekers pool in the economy and its breakdown by qualification of unemployed and their occupational preference.

11.1. Methodology

For each forecast period, the module simply takes annual projections of the labour force from LMEM-LS for that period, subtracts from it last period's employment from the macro module (LMEM-MAC), and adds the projection of replacement demand for the current period ,all expressed by occupation and qualification:

$$
\begin{aligned}
JS^t &= LF^t - Emp^{t-1} + RD^t \\
JS_q^t &= LF_q^t - Emp_q^{t-1} + RD_q^t \\
JS_{oc}^t &= LF_{oc}^t - Emp_{oc}^{t-1} + RD_{oc}^t \\
JS^t &\equiv \sum_{q=1}^{10} JS_q^t \equiv \sum_{oc=1}^{9} JS_{oc}^t
\end{aligned}
\qquad [11.1]
$$

Where

LF^t, LF_q^t, LF_{oc}^t represent projections of total Labour force and labour force by qualification and occupation for period *t.*

$Emp^{t-1}, Emp_q^{t-1}, Emp_{oc}^{t-1}$ represent last period's total employment and employment by qualification and occupation.

RD^t, RD_q^t, RD_{oc}^t denote model's projections of total replacement demand and replacement demand by qualification and occupation.

JS^t, JS_q^t, JS_{oc}^t represent projections of total job seekers and job seekers by qualification and occupation for period *t*.

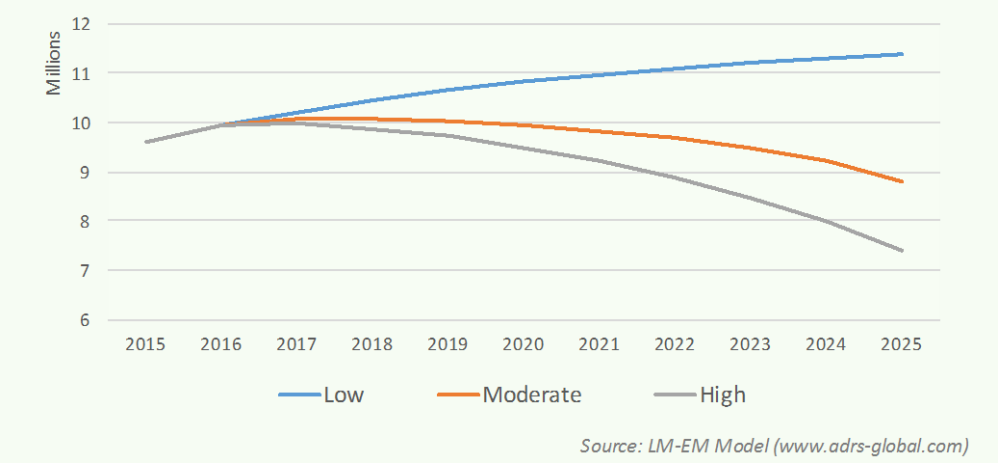
11.2. Module Outputs

Table 11.1 presents the LM-EM projections of job seekers, which reflect the above accounting relationships between modules of the model that produce projections of employment (LMEM-MAC, LMEM-OCC, LMEM-QUAL),replacement demand (LMEM-RPL) and labour force (LMEM-LS) both by qualification and occupation. The module's results are therefore consistent with the results from other modules of the LM-EM.

Figure 11.1 presents trends in total job seekers under the three scenarios over the period 2015 to 2025. It illustrates the significant difference between the three scenarios in terms of their gradual impact on the size of job seekers. Under the Low Scenario, the number of job seekers is expected to gradually grow from 9.59 million in 2015 to 11.36 million in 2025. The increase in the number of job seekers reflects the growth of the labour force due to the gradual increase in the working age population, and more importantly, the low employment creation path of the scenario. Under the Moderate Scenario, where total employment is expected to grow from 15.37 million in 2015 to 20.93 million by 2025, the size of job seekers is projected to gradually decline. By 2025, even with population growth, the number of job seekers is projected to decline by 788,000 relative to 2015.

The High growth scenario is expected to have even more significant impact on the size of job seekers. Under this scenario, and relative to 2015, the pool of job seekers is expected to decline by 2.2 million by 2025.

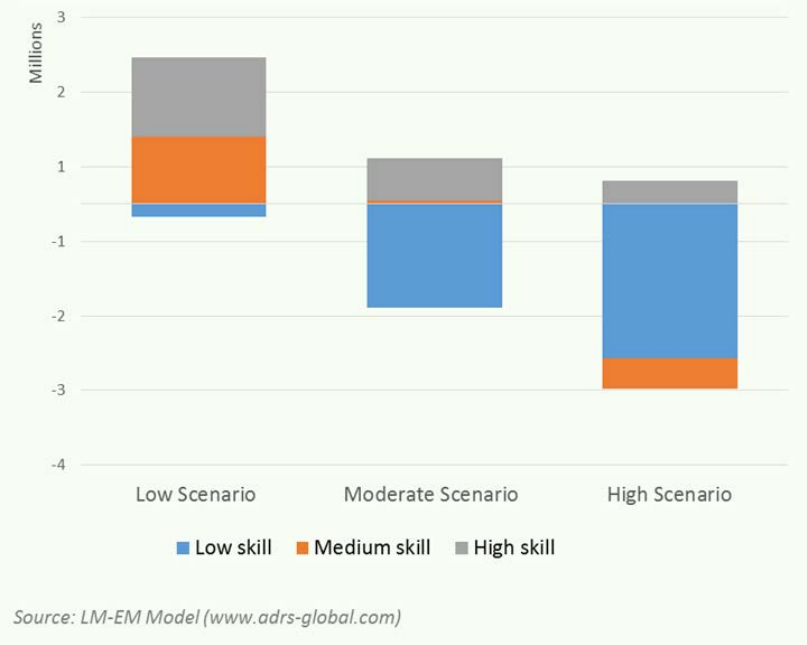
Figure 11.1: Trends in Job Seekers (2015-2025)



The classification of job seekers by qualification and their occupational preference provides important insight into the heterogeneities within the pool of job seekers and how the heterogeneities are impacted by the three growth paths. Figure 11.2 shows the extent to which the size of job seekers with low, medium and high qualifications (skills) change between 2015 and 2025 under the Low, Moderate, and High growth scenarios. For example, it shows that the low employment generation path of the Low scenario is expected to lead to high number of job seekers with high levels of education.

Under the Moderate and High scenarios, Figure 11.2 shows that the pool of job seekers with high skills significantly shrinks relative to the Low scenario. The largest decline among the job seekers is among the Low Skills which is projected to decline by 2 million, from 5.5 million in 2015 to 3.5 million in 2025 under the High Scenario.

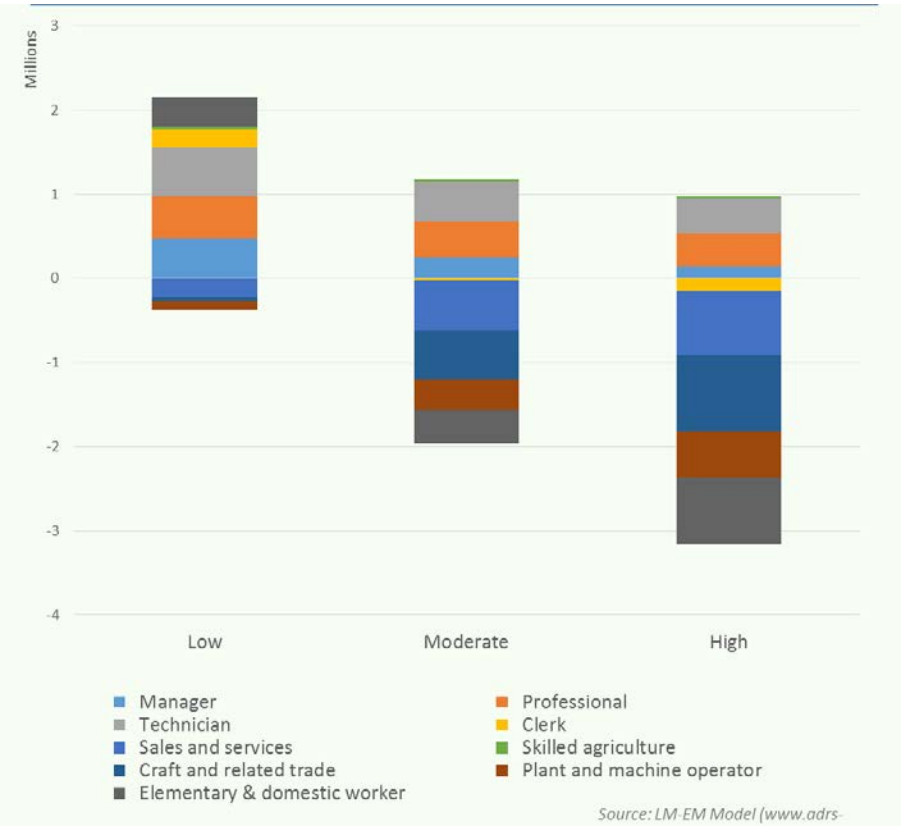
Figure 11.2: Change in Job Seekers by Qualification (2015-2025)



Source: LM-EM Model (www.adrs-global.com)

The classification of future estimates of job seekers by their occupational preferences provides additional insight into the potential impact of alternative growth paths on the evolution of the labour market in South Africa. Figure 11.3 illustrates changes in the composition of job seekers by their occupational preference between 2015 and 2025.

Figure 11.3: Change in Job Seekers by Occupational Preference (2015-2025)



Overall, under the three growth scenarios and relative to 2015, the specific pools of job seekers that seek employment aslant and Machine Operators and Crafts and Trade Workers and Service Workers are expected to *decline* over the forecast period. However, relative to the Low scenario, the declines in these groups of job seekers are expected to be more significant under the Moderate and specially the High scenario. Moreover, the Moderate and High growth scenarios are projected to lead to additional reductions in the pool of job seekers that seek employment in occupation categories Clerks and Elementary and Domestic Workers. The sizes of job seeker groups that are expected to seek employment in the remaining occupational categories (6 under the Low and 4 under the Moderate and High scenarios) are projected to *grow* over the next decade. Overall, under the Low scenario, the expansion or contraction of the job seeker groups, classified by their occupational preferences, are relatively less favourable than the relevant outcomes under Moderate and High scenarios.

11.3. Conclusions

This chapter presented the job seekers module of the LM-EM, which is designed to produce annual projections of the size of job seekers in the economy by skills and occupations using the model's annual projections of the labour force, employment and replacement demand. To demonstrate the module's operation, the chapter also presented a summary of the model's projections of job seekers for three alternative scenarios for the next 10 years. If the economy follows a growth path within the Low and High scenarios, some of key findings of the model with regard to the future size and allocation of job seekers over the next 10 years are:

- If the economy performs close to the Low scenario, the number of job seekers will gradually grow. In the case of the Low scenario, the number of job seekers is projected to increase from 9.59 million in 2015 to 11.36 million by 2025. However, if the economy generates levels of employment that are close to the Moderate or High scenarios, the size of job seekers will decline between 0.8 and 2.2 million over the next 10 years.
- If the economy follows a low employment path such as the Low scenario, it will lead to a high number of job seekers with High level of education. However, if the economy follows a growth path that generates employment comparable to the Moderate and High scenarios, the pool of job seekers with high skills will significantly shrink over the next decade.
- If the economy's future path follows the High scenario, the largest decline among the job seekers will be among the Low Skills workers, which is projected to decline by about 2 million by 2025.
- If the economy's future employment path falls within the employment outcomes of Low and High scenarios, the pools of job seekers that seek employment as 'Plant and Machine Operators', 'Crafts and Trade Workers' and 'Service Workers' are expected to decline over the next decade. If the employment path of the economy comes close to the Moderate or High scenarios, the pools of job seekers that seek employment in occupation categories 'Clerks' and 'Elementary and Domestic Workers' will also decline.
- Overall, as the economy's ability to generate more employment significantly grows, it begins to absorb the low skilled unemployed that seek employment in 'Elementary and

Domestic Workers' and 'Clerks' categories, which leads to gradual declines in the number of job seekers.

CHAPTER 12

LABOUR MARKET IMBALANCES MODULE (LMEM-IMB)

The labour market imbalances module of the LM-EM uses the model's annual projections of job openings and job seekers to estimate the extent of labour market imbalances, skills gap, and unemployment rates over time. At the aggregate level, the module produces an annual estimate of labour market imbalances as the difference between the model's estimates of job seekers and job openings, i.e., unemployment (*UE*) or excess supply of labour (*ES*). Skills gaps (ES_q), i.e., imbalances by qualification are estimated for all educational qualification categories by calculating the difference between the model's projection of job seekers and job openings for the qualification categories. Finally, the model estimates the imbalances by occupation by calculating the difference between the number of job seekers with different occupational preference and the number of job openings by occupation (ES_{oc}). Overall unemployment and unemployment within segments of the labour force in terms of qualification and occupation are represented by corresponding excess supply estimates:

$$
\begin{aligned}
ES^t &= UE^t = JS^t - JO^t \\
ES_q^t &= UE_q^t = JS_q^t - JO_q^t \\
ES_{oc}^t &= UE_{oc}^t = JS_{oc}^t - JO_{oc}^t \\
ES^t &\equiv UE^t \equiv \sum_{q=1}^{10} ES_q^t \equiv \sum_{oc=1}^{9} ES_{oc}^t
\end{aligned}
\qquad [12.1]
$$

Positive (negative) overall excess supply of labour in a given year implies that the projected number of job seekers is more (less) than the number of job openings in that year. Similarly, excess supply of labour by qualification captures the difference between the job seekers

segmented by educational qualification and the job openings that demand those qualifications. Negative excess supply expressed by qualification implies the extent to which demand outpaces supply (job openings are greater than job seekers) in various skills (educational qualification) categories.

Finally, the overall unemployment rate for the economy (UR^t) is calculated as the share of the labour force that is unemployed, and moreover, unemployment rates for various qualifications (skills) and occupations are calculated as the unemployment shares of corresponding segments of the labour force.

$$\begin{aligned} UR^t &= UE^t / LF^t = ES^t / LF^t \\ UR_q^t &= UE_q^t / LF_q^t = ES_q^t / LF_q^t \\ UR_{oc}^t &= UE_{oc}^t / LF_{oc}^t = ES_{oc}^t / LF_{oc}^t \end{aligned} \qquad [12.2]$$

Where $UR^t, UR_q^t, \ and \ UR_{oc}^t$ refer to the total unemployment rate and the unemployment rates by qualification and occupation.

12.1. Module Outputs

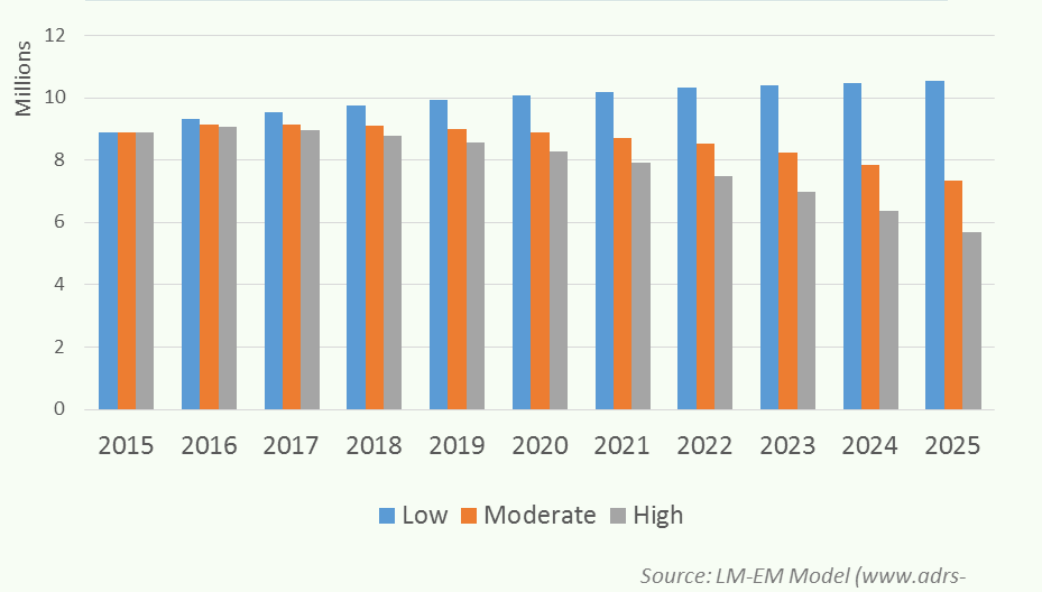
This chapter presents the output of the skills gap module (LMEM-SG) for the three scenarios. It utilises the model results related to sector employment, occupations, qualifications, replacement demand, labour supply, job openings and job seekers to present the effect of the scenario son the labour market balances and imbalances over time and by educational qualification and occupation. The next two chapters present comparative analyses of model results related to the different impact the three scenarios have on the labour market.

Figure 12.1 depicts the LM-EM projections of trends in the total number of unemployed (i.e., job seekers surplus) for the Low, Moderate and High scenarios over the next 10 years. The level of unemployment is expected to gradually increase under the Low scenario from 8.9 million to 10.5 million. The level of unemployment is projected to gradually decline

under both Moderate and High scenarios. Under the High scenario with the sharpest decline in unemployment over the next 10 years, the surplus in the number of job seekers is projected to decline by 36.2 percent from 8.9 million in 2015 to 5.7 million in 2025.

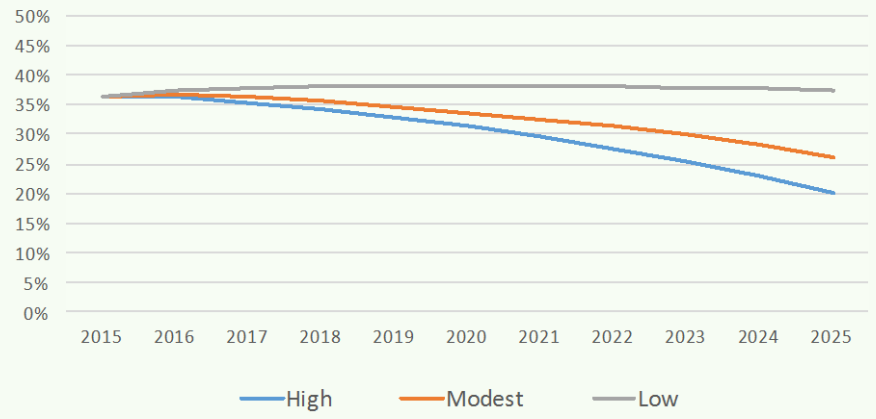
Figure 12.2 illustrates the model's projections of trends in total unemployment rates for the three scenarios. It is projected to remain relatively unchanged over the period under the Low scenario. By 2025, it is projected to be at 37 percent, which is actually one percent higher than the rate for 2015. However, the unemployment rate will significantly decline under the Moderate and High scenarios. It is projected to decline to 26 percent (Moderate scenario) and 20 percent (High scenario) by 2025.

Figure 12.1: Total Job Seeker Surplus (2015-2025, levels)



Source: LM-EM Model (www.adrs-

Figure 12.2: Unemployment Rates (Expanded definition, %)



Source: LM-EM Model (www.adrs-global.com)

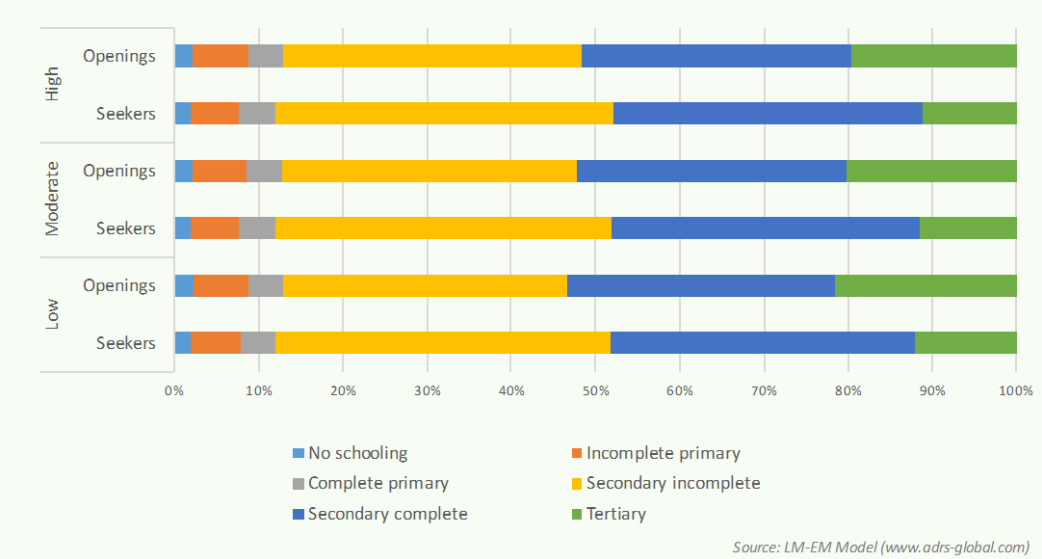
12.1.1. Labour Market Imbalances: Skills Gap (2015-2025)

Figure 12.3uses job seekers and job openings relative to the size of the labour force to illustrate the gaps between the two for each educational qualification over the next 10 years. It also allows for comparison of the skills gap, or qualification mismatch, across Low, Moderate, and High scenarios.

Comparison of scenarios shows that on average, the number of job openings is expected to be equivalent to 2.8 percent (Low scenario), 4.1 percent (Moderate scenario) and 4.7 percent (High scenario) of the labour force. On the other hand, the size of job seekers will be 40.5 percent (Low), 36.7 percent (Moderate) and 34.6 percent (High) of the labour force over the next 10 years. These results highlight a significant difference between the three scenarios. For example, the size of job seekers relative to the labour force is expected to be 14 times higher than the size of job openings relative to the labour force in the Low scenario, compared to 9 and 7 times under the Moderate and High scenarios, respectively.

Similarly, the model predicts major gaps between job openings and job seekers for various educational qualifications. As the scenarios generate larger job opportunities relative to the size of the labour force, the percentage of adults that are seeking employment relative to the labour force declines.

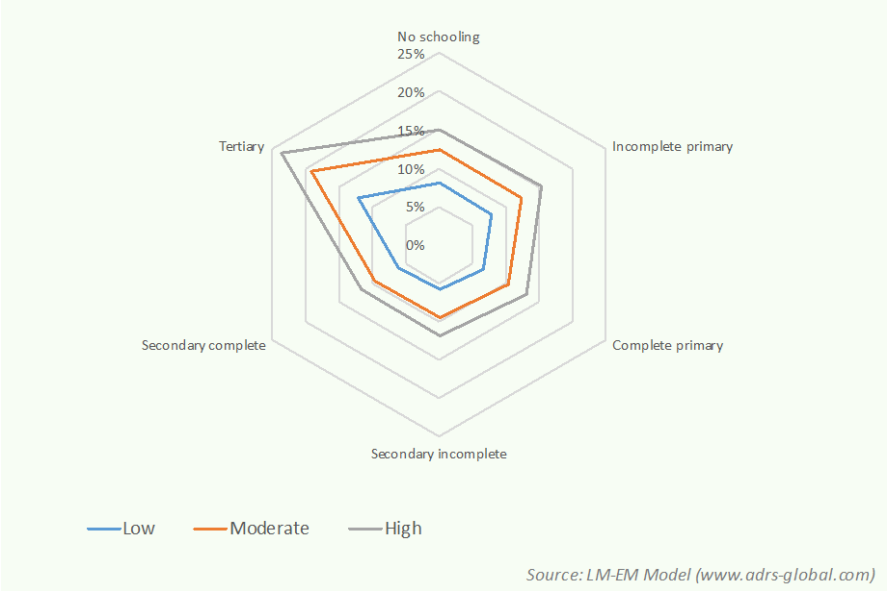
Figure 12.3: Qualification Shares of Job Seekers & Job Openings (Average, 2015-2025)



Job openings as a percentage of job seekers have been calculated as an indicator of the skills gap in the labour market that can also be used to compare model results across scenarios. If there is a perfect balance between the number of job openings in a particular educational qualification and the number of those seeking employment with similar qualification, the value of the indicator will be one (100%). For any qualification where the indicator value is greater than 1, it implies excess demand for that skill, that is, the size of job openings in that particular qualification is greater than the number of workers that seek employment with similar qualification. A value between zero and one reflects excess supply for a particular skill, that is, the number of job openings for a particular educational qualification is less than the number of job seekers with that qualification.

The spider diagram, Figure 12.4, allows comparison of the three scenarios on each of the six educational qualifications in terms of their implications for the skills gap over the next 10 years. The colour coding for each scenario helps to visually correlate and contrast the scenarios over different qualifications. At the same time, the combination of values on the six axes provides an overall view of the scenario's performance on multiple dimensions. In the diagram, the higher the scenario's percentage points on each qualification axis, the larger the scenario's percentage of job openings relative to job seekers for that qualification. From the diagram the following results stand out:

Figure 12.4: Job Openings as % of Job Seekers (Average, 2015-2025)



- Under the Moderate and High scenarios, the skill gaps improve for the labour market as a whole and for various education qualifications.
- The Low (High) scenario is expected to have the weakest (strongest) outcomes in terms of job openings relative to job seekers across all qualifications.
- For the three scenarios, the percentage of job openings relative to job seekers will be the highest for the tertiary education cohort of the labour force.
- The results also allow focus on specific scenario results to develop more comprehensive insight and foresight about the impact of the scenario. For example, the High scenario results show that the overall job openings as a percentage of job seekers is expected to more than double under this scenario, from 7.2 percent in 2015 to 16 percent in 2025. Moreover, with the exception of those with no schooling as their highest educational qualification, for the remaining qualification groups the model projects that the percentage of job openings relative to job seekers will double to triple over the next 10 years. For example, for the tertiary cohort, the percentage of job openings relative to job seekers is projected to almost double under the High scenario, from 18.5 percent in 2015 to 34 percent in 2025. For those in the labour market with Completed Secondary education, the percentage of job openings relative to job seekers is expected to grow from 6.7 percent in 2015 to 20 percent in 2025.

The future trends in unemployment rates under the three scenarios illustrate how each scenario is projected to unfold over time (Figure 12.2). Moreover, the model also provides annual projections of unemployment rates for each education cohort. Figure 12.5 compares the rates for the beginning year (2015) with the end year (2025) for various qualification categories across scenarios. It demonstrates the magnitudes and the differential impacts of the scenarios on segments of the labour market. Additionally, Figure 12.6 provides an overall view of the average rates of unemployment across scenarios for various qualification cohorts over the next 10 years. Across scenarios, the segment of the labour force with tertiary education is expected to experience the lowest average unemployment rate, which is projected at 24 percent (Low), 19 percent (Moderate), and 16 percent (High). For all other qualification cohorts of the labour market, in each of the three scenarios, the average unemployment rate is projected to be one-and-a-half to two times higher than the relevant unemployment rate for the tertiary cohort.

Figure 12.5: Unemployment Rate by Qualification (2015 & 2025)

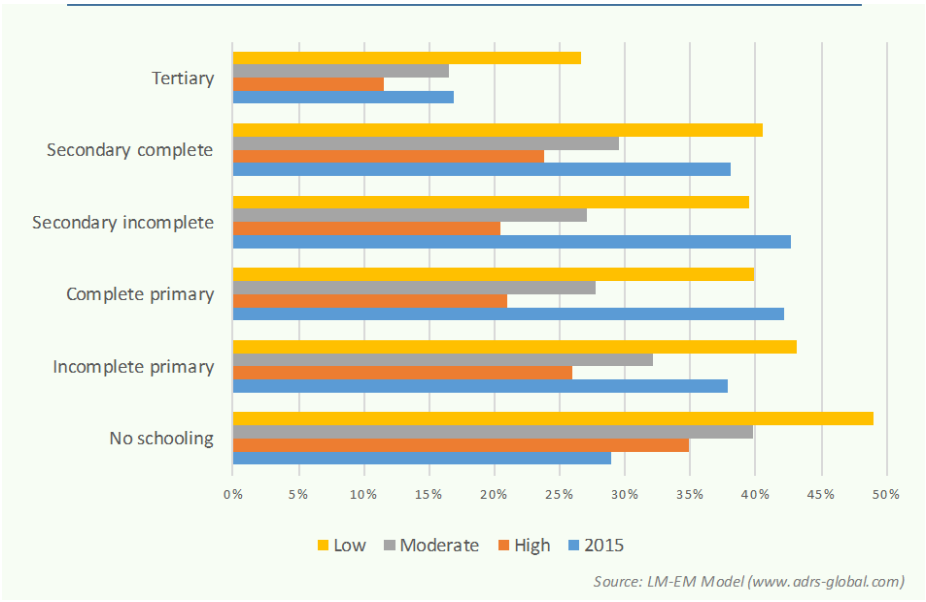
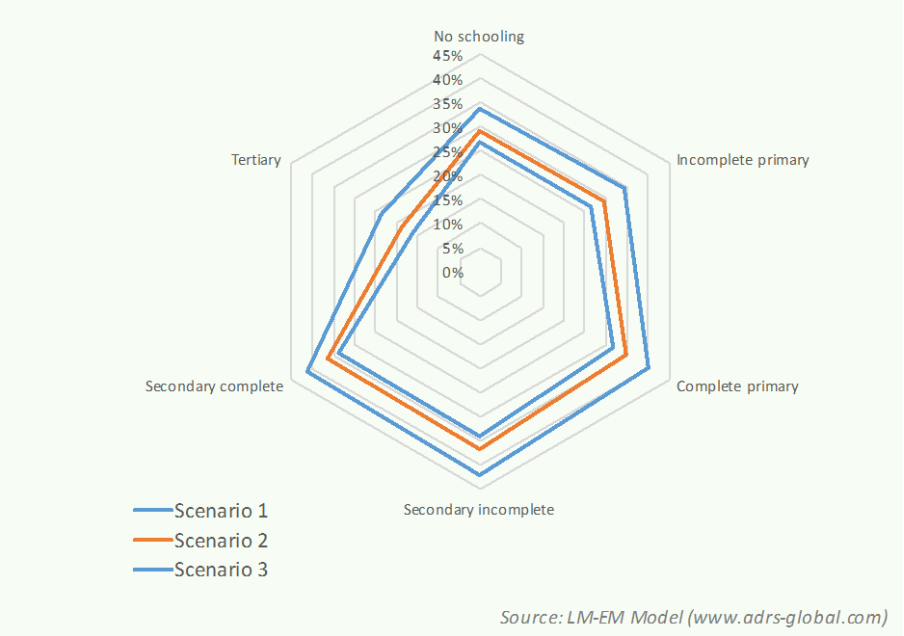


Figure 12.6: Rate of Unemployment by Qualification (%)



Source: LM-EM Model (www.adrs-global.com)

12.1.2. Labour Market Imbalances: Occupational Gap (2015-2025)

Section 12.1.1 presented the LM-EM results on skills gap. The model also generates an equivalent set of projections by occupation categories, which are referred to as occupational gap or preference mismatch. Key findings include:

First, 'occupational cohort' is used to refer to those workers within the labour force that are either employed or are seeking employment in one of the nine occupation categories. The gap between job seekers and job openings in various occupational cohorts, i.e., occupation gap or preference mismatch, is smallest for Skilled Agricultural Workers followed by Professionals, Technicians, and Managers and is the largest for Elementary Occupations and Domestic Workers. For the period 2015-2025, the average annual excess supply of combined Managers, Professionals, and Technicians is equivalent to 5.2 percent of the average annual labour force under the Low scenario, which falls to 3.9 percent under the Moderate scenario and 3.3 percent under the High scenario. In comparison, the excess supply of combined Elementary Occupations, Domestic Workers, and Service Workers is between a high of 19.4 percent of the labour force for the Low scenario and 15 percent for the High scenario. Table 12.1 illustrates projections of the extent of the excess supply for

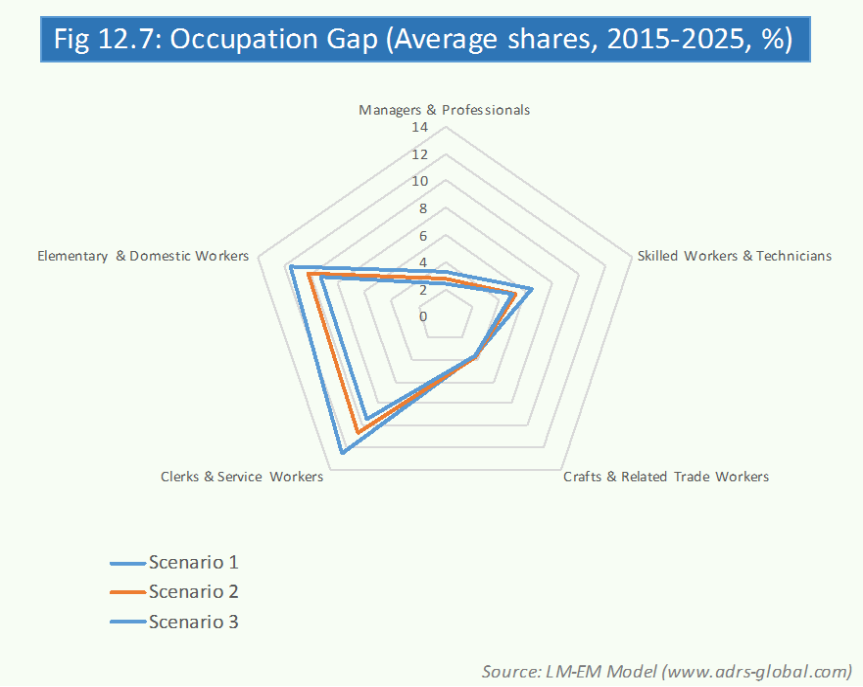
nine occupational categories through the differences between job seekers and job openings relative to the labour force by occupation, and Figure 12.7 highlights the expected occupation gaps both within and between scenarios.

Table 12.1: Occupation Gaps Relative to Labour Force

Occupations	Average 2015-2025, %		
	Low	Moderate	High
Managers	2.00	1.69	1.51
Professionals	1.28	1.04	0.93
Technicians	1.96	1.17	0.84
Clerks	4.83	4.15	3.81
Service workers	7.74	6.46	5.68
Skilled agricultural workers	0.10	0.07	0.07
Craft and related trades workers	3.61	3.71	3.61
Plant and machine operators	4.50	4.13	4.19
Elementary & domestic workers	11.64	10.24	9.31
Total	**37.66**	**32.66**	**29.94**

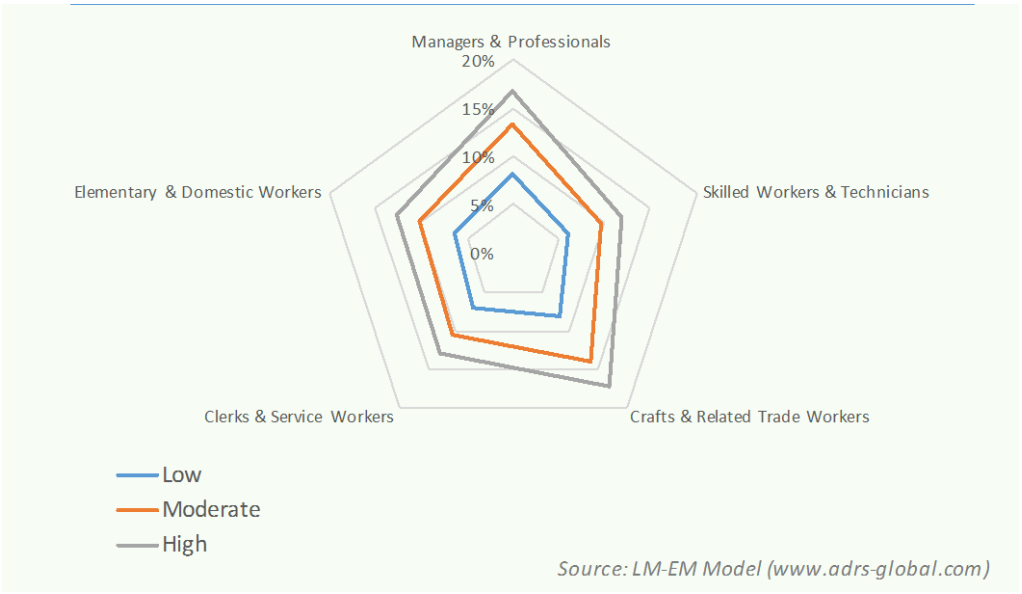
Note: Occupation gap is calculated as the difference between the number of job seekers and job openings in an occupation.
Source: LM-EM Model (www.adrs-global.com)

Figure 12.7: Occupation Gap (Average shares, 2015-2025, %)



Second, across scenarios and occupations, the average annual job openings as percentages of job seekers are expected to be between 6 percent for Elementary and Domestic Workers under the Low scenario compared to 17 percent for the combined Managers and Professionals occupations and for Crafts and Related Trade Workers (Figure 12.8).Within each scenario, the remaining occupational cohorts, aggregated in three, have almost similar job openings relative to job seekers (Figure 12.8).

Figure 12.8: Job Openings as % of Job Seekers by Occupation (Average, 2015-2025)



Third, the model's projections of annual unemployment rates for occupation cohorts enable analysis of the differential impact of policy scenarios. Figure 12.9 compares the impact of the three scenarios on the unemployment rate for each occupational group by showing the beginning year (2015) and the end year (2025) unemployment rates for various occupational categories for the three scenarios.

Figure 12.9: Unemployment Rate by Occupation (2015 & 2025)

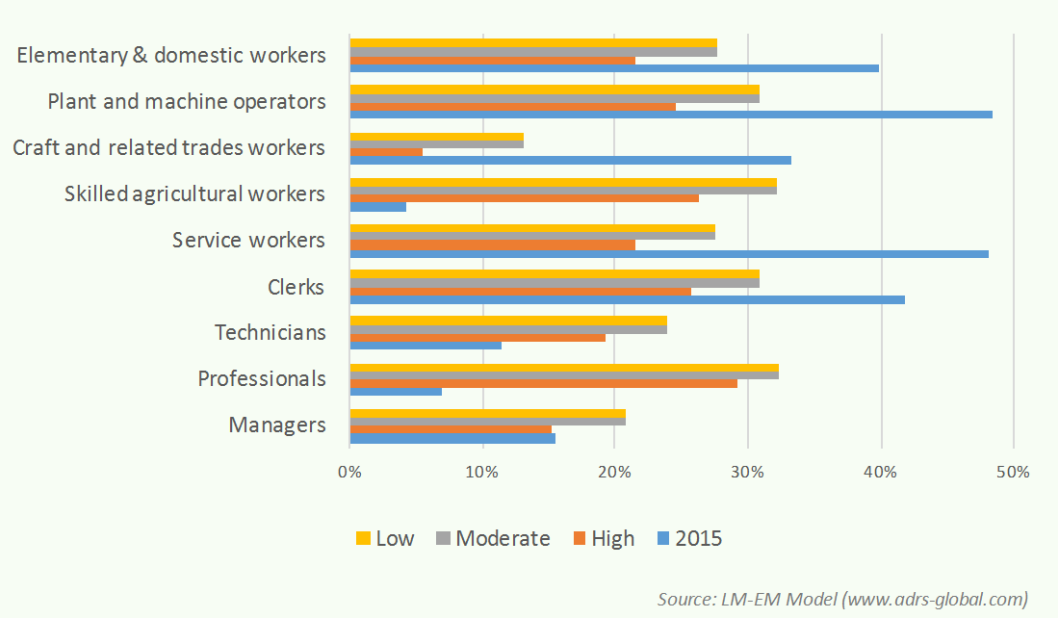
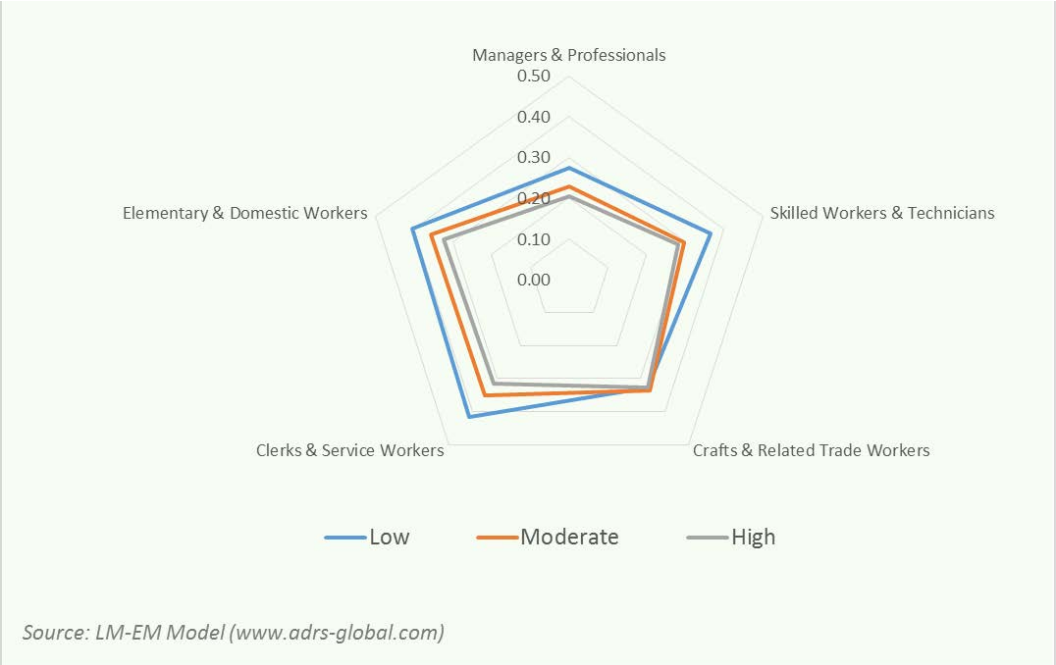


Figure 12.10: Unemployment Rate by Occupational Cohort



Across scenarios, over the next 10 years, the average expanded unemployment rate is expected to be the lowest within the combined Managers and Professional occupations (Figure 12.10). The occupational cohort with the highest unemployment rate will be the combined Clerks and Service Workers occupations. Notwithstanding the relatively low

unemployment rate for the Managers and Professionals cohort, and relative to the Low scenario results, both the Moderate and High scenarios are expected to generate relatively uniform unemployment rates across the remaining occupations, between 30 and 35 percent for the Moderate scenario and between 28 and 33 percent for the High scenario. In the case of the Low scenario the range will be from 33 to 42 percent.

12.2. Conclusions

This chapter presented the labour market imbalances module of LM-EM which uses the model's annual projections of job openings and job seekers to estimate the extent of labour market imbalances, skills gap, and unemployment over time. At the aggregate level, the module produces an annual estimate of labour market imbalances and the overall unemployment rate. Skills gaps are estimated for all educational qualification categories by calculating the difference between the model's projections of job seekers and job openings for qualification categories. The module produces projections of unemployment and unemployment rates for segments of the labour force by qualification and occupation. The module's results allow focus on specific scenario results to develop more comprehensive insight and foresight about the impact of the scenario.

The chapter also included results of the model from the three economic and education scenarios, which provide the following foresight regarding the evolution of labour market imbalances and skills gap for the next 10 years.

If the economy's labour market path is within the Low and High employment scenarios of this report, LM-EM projections lead to the following findings:

- If the economy's path is close to the Low scenario, the level of unemployment will still increase by more than half a million. However, if the economy follows a high employment creation path, such as the High scenario, the current large surplus in the number of job seekers will sharply decline. In the case of the High scenario, unemployment is projected to decline from 8.9 million in 2015 to 5.7 million in 2025.

- If the economy's performance is within the Low and High scenarios, the model's projections show that the percentage of job openings relative to job seekers will be the highest for the tertiary education cohort of the labour force.

- If the economy pursues the High scenario path, for all, except for those with no schooling as their highest educational qualifications, the model projects that the percentage of job openings relative to job seekers will double to triple over the next 10 years.

- If the economy's performance is within the Low and High scenarios, the segment of the labour force with tertiary education is expected to experience the lowest average unemployment rate. For all other qualification cohorts of the labour market, the average unemployment rate is projected to be one-and-a-half to two times higher than the relevant unemployment rate for the tertiary cohort.

- If the economy's performance is within the Low and High scenarios over the next 10 years, the average expanded unemployment rate is expected to be the lowest within the combined Managers and Professionals occupations. The occupational cohort with the highest unemployment rate will be the combined Clerks and Service Workers occupations. Across remaining occupations, the unemployment rate is expected to remain relatively uniform within a given economic path. In the case of the Moderate Scenario, for example, the rates are expected to fall between 30 and 35 percent, and between 28 and 33 percent for the High scenario, whereas in the case of the Low scenario, between33 to 42 percent.

CHAPTER 13

REFLECTIONS AND A WAY FORWARD

Until recently, South Africa did not have a comprehensive system to perform consistent skills projections. Through the economic modelling programme of the LMIP, a firm foundation has been put in place to regularly undertake such forecasts using the Linked Macro-Education Model. Moreover, the new tool for skills planning includes a user-friendly web-platform that is internationally unique by allowing policymakers, analysts, researchers, students, and others to have direct access to the model to design and simulate their own economic and education policy scenarios in real time. Regular training workshops over the last two years, organised by the Department of Higher Education, have begun the task of building the necessary capacity within public and private sector, including SETAs, to effectively use the tool.

The current scope of the LM-EM output goes far in efficiently providing regular, comprehensive, systematic and consistent projections of demand and supply of skills and occupations. There are, however, several caveats related to the use of economic modelling techniques in general and to the specific approach used in the LM-EM to project the demand and supply of skills.

The first is to acknowledge that the range of information that is normally used for planning education and training in South Africa and other countries is much wider and diverse than the information that is produced using economic modelling techniques. At best, models such as LM-EM uniquely complement other inputs to labour market intelligence and decision making by providing quantitative projections of some important factors in a consistent and methodologically sound and transparent manner. At the same time, the

importance of the intelligence that is provided by the model for decision making is not automatic and depends on specific circumstances. Models such as LM-EM are most useful to provide tactical and strategic intelligence at the macro level to policy makers and they are least useful to directly guide the decision making of individuals and other labour market actors at a micro level.

The second caveat relates to how we have referred to and used the term skills in this report. Even though it is understood that skill is a complex concept that embodies tangible and intangible attributes, we have assumed that skills significantly reflect and positively correlate with formal educational qualifications and thus we have used the highest educational qualifications of individuals within national surveys as close proxies for their skill levels. Despite its limitations (e.g., its shortcomings to measure various generic skills and competences), this is an internationally established practice in modelling the education sector that depends on the availability of data and relative ease of measurement.

Third, data limitations and data availability played a significant role in choosing the Quarterly Labour Force Survey and the 10 Percent Census 2011 from the Statistics South Africa to build the education modules of the LM-EM. More specifically, the statistical methodologies that we identified as most suitable to build the skills demand and supply modules of the model required micro level survey data that (a) represents the population of the country, (b) includes micro level information related to demographic, labour market and education information, (c) is collected with some regularity using consistent methodologies, and (d) is electronically accessible. The Quarterly Labour Force Survey and the Census 2011 data have the above desirable features, even though each has its own imperfections, as we acknowledge.

Fourth, despite the various advantages and utility of LM-EM to assess future labour market imbalances and skills gaps using projections of both demand and supply for occupations and skills, in reality analysis of skills imbalances involves issues that are not always quantifiable.

Fifth, the results of policy scenarios in this report should be utilised as benchmarks for debate and reflection to inform policy development and as indicative of general trends and orders of magnitude that might emerge.

Finally, the long term sustainability of the LM-EM depends to a large extent on whether the DHET and its entities, that supported the original project and participated in the training workshops, will use and financially support-EM's web-platform. In that context, some of the additions and improvements to the model's projections that will enhance the applicability domain of the model include:

Projections of Demand and Supply of Skills by Province: Efforts are underway to extend the LM-EM and its web-platform to include a provincial module (LMEM-Prov). The aim is to include, in a consistent manner, provincial level forecasts of demand and supply of skills. This extension of the model is expected to support skills demand and supply analysis at the provincial level, including the current initiative to roll out the 21 Step Process to identify scarce occupations for the Strategic Integrated Projects at the provincial level.

Projections of Demand and Supply of Skills by Gender: Similarly, a future extension of the model to include a gender module (LMEM-Gender) will be available to generate annual forecasts of skills demand and supply for males and females in the labour market. This extension will help answer gender-based questions such as whether the proportion of the labour force with high-level qualifications is expected to increase sharper for women than for men.

Projections of Demand and Supply of Skills by Age Group: Given the youth employment crisis in South Africa, LM-EM will be extended to include a module to produce projections of demand and supply of skills by age group (LMEM-Age). This extension will facilitate inquiry into the impact of economic and education policy scenarios on various age groups in a manner that is consistent with the analytical approach to demand and supply of skills that is used in this report.

In addition to investing in the expansion of the scope of the forecasts of demand and supply of skills, there is a need for an ongoing and systematic focus on monitoring and improving the quality of the model's forecasts, which can take various forms. For example, data improvement and research focused on retirement, job mobility, emigration and mortality by occupation, qualification, age, and gender will help generate better forecasts for each category, which in turn will improve the LM-EM's annual projections of job openings, job seekers, and skills gap by educational qualification. Close ongoing collaboration with the

Statistics South Africa's population unit will facilitate using latest population projections in the model which enhances the accuracy of population data used as input into all modules of the model and their outputs in terms of demand and supply of occupations and skills and the evaluation of labour market in South Africa. Moreover, studies that improve our understanding of the labour force participation rates among various population groups will provide better inputs into the model's projection of labour supply. Finally, improvements in the regularity, scope and consistency of data collection on various outputs of the education sector will help future versions of the model to integrate a wider range of education indicators.

Also, in order to attain a more holistic view of the future trends in demand and supply of skills, the model's forecasts that capture the demand for and supply of formal qualifications, should be complemented by analysis of the skills individuals need to carry out particular jobs. Analyses should also include the outcomes of all other types of learning, such as informal and non-formal learning. Such a comprehensive approach will require research and gathering and using data that captures the demand and supply of skills from broader perspectives.

Finally, each set of model forecasts, which is based on a particular scenario regarding the evolution of policy and internal and external factors, represents one of many possible future paths for the economy. Any steps to improve the process and quality of designing scenarios for the model that better reflect changes in the economy due to globalisation, economic policy, economic restructuring, technical and organisational change will enhance the accuracy, relevance, usefulness and applicability of the model forecasts. This includes, for example, an inter-departmental committee that meets twice a year to review the LM-EM's last forecasts, suggest improvements, propose a new set of consensus scenarios, and feed relevant model forecasts into the policy making process.

The establishment of the Skills Planning Unit within the Department of Higher Education and Training will provide the necessary institutional anchor within the government to use the LM-EM for forecasting, impact analysis and capacity building in skills planning. At the same time, the unit will potentially provide additional research support that can strengthen the quality of inputs into the LM-EM and its forecasts over time. The unit will likely be in a

position to facilitate the integration of modelling work into broader research on skills planning. In delivering its expected outputs, the Skills Planning Unit will be supported by the flexible architecture of the LM-EM, its user-friendly web-platform and ADRS' commitment to regularly update and upgrade the model.

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ANNEXURES

15.1. Annexure A: Glossary of Terms

Autoregressive Distributed Lags (ARDL): In statistics and econometrics, a distributed lag model is an approach for time series data in which a regression equation is used to predict current values of a dependent variable based on both the current values of an explanatory variable and the lagged (past period) values of this explanatory variable. In ARDL, the model is "autoregressive" in the sense that the dependent variable is explained (in part) by lagged values of itself and current and lagged values of one or more explanatory variables. ARDL model is an important approach for testing for the presence of long-run relationships between economic time-series.

Budget Deficit: The excess of central government's spending over its tax receipts.

Capital-Labour Ratio: The ratio of capital (i.e., already-produced durable goods or any non-financial asset that is used in production of goods or services) employed to labour employed. It is therefore the amount of capital used per unit of labour.

Debt-GDP Ratio: The ratio between a country's stock of government debt and its gross domestic product.

Deficit-GDP Ratio: Refers to a country's budget deficit as a percentage of its gross domestic product.

Econometrics: The methods of applying statistical techniques to economic data in order to identify and test economic relationships.

Economic Growth: An increase in the amount of goods and services produced over a period of time.

Economic Model: A model is a representation of an object, a system, or an idea in some form other than that of the entity itself (Shannon). An economic model is a construct representing economic processes by a set of variables and of logical and/or quantitative relationships between them.

Exchange Rate: The price at which one currency can be converted into another.

Expansion Demand: The job openings in the economy due to economic growth.

Fiscal Policy: The use of government spending and taxation to influence the economy.

Foreign Direct Investment: Cross-border investment by a resident entity in one economy with the objective of obtaining a lasting interest in an enterprise resident in another economy.

GDP (Gross Domestic Product): A measure of economic activity in a country. It is calculated by adding the total value of a country's annual output of goods and services.

Government Final Consumption Expenditure: All government current expenditures for purchases of goods and services (including compensation of employees).

Growth: see Economic Growth

Higher Education Graduation Ratio: In LM-EM, this ratio refers to the number of graduates from higher education institutions as a ratio of the total number of 25 year olds, disaggregated by race.

Import Price Index: An import price index measures changes in the prices of imports of particular goods and services into a country. The index numbers for each reference period relate to prices of imports landed into the country during the period.

Inflation Targeting: A monetary policy rule in which a central bank sets an explicit target inflation rate for the economy and uses monetary policy to achieve and uphold that target.

Job Openings: The total number of jobs available in the economy due to economic growth (expansion demand) and vacancies that result from retirement, migration, mobility and mortality (replacement demand).

Job Seekers: The portion of the labour force that is not employed and is seeking employment.

Labour Demand: see Job Openings.

Labour Force: Refers to currently active working age population comprised of all persons who fulfil the requirements for inclusion among the employed or the unemployed during a specified reference period.

Labour Force Participation Rate: The labour force as a percentage of the working age population.

Labour Market Imbalance: The difference between the number of job seekers and job openings in a given period, in total, by occupation, or by skills.

Labour Market Qualification Mismatch: Refers to when the qualifications of workers and the qualification needed to fill available vacancies do not match. It is also referred to as "skills mismatch" and "skills shortage."

Labour Market Preference Mismatch: Refers to a mismatch between occupations that the unemployed are willing to take on and the existing vacancies in those occupations.

Labour Supply: see Labour Force

Labour Shortage (Excess Labour Demand): Refers to when the labour demand, in total or for a particular occupation or qualification, is greater than the corresponding labour supply under existing market conditions.

Labour Surplus (Excess Labour Supply): Refers to when the supply of labour, in total or in particular skill or occupation, is greater than the corresponding labour demand under existing market conditions.

Matriculation Ratio: In LM-EM, Matriculation Ratio refers to the number of learners attaining a National Senior Certificate as a ratio of the total number of 18 year olds, disaggregated by race.

Monetary Policy: Refers to the measures taken by the monetary authorities to achieve certain macroeconomic objectives.

Money supply: The entire stock of currency and other liquid instruments in a country's economy as of a particular time.

Multinomial Logistic Regression: Refers to a regression approach in statistics that is designed to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables, which may be real valued, binary-valued, categorical-valued, etc.

Occupational Demand: Refers to the amount of demand for employment in the economy for various categories of occupations.

Odd Ratios: The odds than an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure.

Probability: is the measure of the likelihood (chance) that an event will occur.

Public Investment: Refers to the total investment by the general government and the public corporations.

Qualification Demand: Refers to the amount of demand for employment in the economy by the highest educational qualification of workers.

Real Effective Exchange Rate: A measure of the weighted average of a country's currency against an inflation-adjusted and trade-weighted index of other currencies.

Replacement Demand: Refers to job openings resulting from the departures of workers due to retirement, migration, mobility, and mortality.

SETA: Stands for Sector Education and Training Authority and refers to a vocational skills training organizations in South Africa. There are 21 different SETAs with jurisdiction in a specific industry.

Skills Gap or Skills Shortage: A divergence between the quantity of a given skill supplied by the workforce and the quantity demanded by employers under the existing market conditions (given the existing level of compensation and wage structure). A labour market situation in which there is a shortage of workers with the qualifications, skills or experience necessary to carry out the jobs in question. Sometimes it is referred to as "qualitative skills mismatch." See also Labour Shortage and Labour Surplus.

Social Transfers in Kind: Goods and services provided to individual households by government units (including social security funds) and non-profit institutions serving households (NPISHs), whether purchased on the market or produced as non-market output by government units or NPISHs. The items provided include: (a) social security benefits, reimbursements, (b) other social security benefits in kind, (c) social assistance benefits in kind, and (d) transfers of individual non-market goods or services.

Stabilisation Policy: Refers to a package or set of discretionary fiscal and monetary policy measures and programmes designed to stablise a country's economic cycle.

Stabilisation Parameter: Refers to specific fiscal and monetary policy measures and programmes used as part of a stabilisation policy.

Terms of Trade: The ratio of an index of a country's export prices to an index of its import prices.

Unemployment: The number of workers who are available to work (in the labour force) but who are not working. The Quarterly Labour Force Survey of the Statistics South Africa provides two measures of unemployment based on the expanded and strict definition of unemployment. According to the *strict definition* only those people who take active steps to find employment, but fail to do so, are regarded as unemployed. The *expanded definition*, on the other hand, includes everyone who desires employment, irrespective of whether or not they actively tried to obtain a job.

Unemployment Rate: The number of unemployed as a percentage of the labour force.

15.2. Annexure B: References on Domestic and Global Perspectives

Table 15.1: Long-term Global Perspectives

Source	Description	Details
The Conference Board- Global Economic Outlook 2015, February 2015 https://www.conference-board.org/data/globaloutlook/	The rapid decline in oil prices, quick adjustments in exchange rates (with the US dollar appreciating and weakening of most other currencies, notably the euro), and the new quantitative easing program of the ECB are some of the factors leading to the decreased projections for global economic growth. In addition, there is increased geopolitical uncertainty related to the Russia-Ukraine and Middle East conflicts, as well as increased concern about the economic and political future of the Euro Area and European Union.	**GDP Growth:** 2015-2019: 3.3% 2020-2025: 2.7% **Sub-Saharan Africa GDP Growth:** 2015-2019: 4.9% 2020-2025: 5.2%
OECD- Shifting Gear: Policy Challenges for the Next 50 Years, July 2014 http://www.oecd.org/eco/growth/Shifting%20gear.pdf	Global growth will slow from 3.6% in 2010-2020 to 2.4% in 2050-2060 -- due to ageing and gradual deceleration in emerging economies -- and will be increasingly driven by innovation and investment in skills. The global economic balance will continue to shift towards the current non-OECD area, which will have an economic structure and exports increasingly similar to those of the OECD. Climate change will curb global GDP by 1.5% on average and almost 6% in South and South-East Asia, unless increases in CO2 emissions are curbed.	**GDP Growth:** 2020: 3.6% 2030: 3.4%
IMF- World Economic Outlook, April 2015 https://www.imf.org/external/pubs/ft/weo/2015/01/index.htm	Global growth remains moderate, with uneven prospects across the main countries and regions. Potential output growth across advanced and emerging market economies has declined in recent years. In advanced economies, this decline started as far back as the early 2000s and worsened with the global financial crisis. In emerging market economies, in contrast, it began only after the crisis. This scenario suggests that potential output growth in advanced economies is likely to increase slightly from current rates as some crisis-related effects wear off, but to remain below pre-crisis rates in the medium term. The main reasons are aging populations and the gradual increase in capital growth from current rates as output and investment recover from the crisis. In contrast, in emerging market economies, potential output growth is expected to decline further, owing to aging populations, weaker investment, and lower total factor productivity growth as these economies catch up to the technological frontier.	**GDP Growth:** 2020: 4% **Crude oil price, 2020 (US$ per barrel):** $74.03 **Commodity Metals Price Index 2020 (index=100 in 2005):** 139.743 **Sub-Saharan Africa GDP Growth 2020:** 5.36%

Table 15.2: Medium-Term Global Perspectives

Source	Description	Details
UN DESA- World Economic Situation and Prospects 2015, January 2015 mid-year update http://www.un.org/en/development/desa/policy/wesp/wesp_archive/2015wesp_myu_en.pdf	The world economy continues to grow at a modest pace. Growth of world gross product is projected at 2.8 percent in 2015, accelerating to 3.1 percent in 2016. The growth divergence between various regions is widening in 2015, owing to differing impacts from the recent decline in the prices of oil and other commodities, as well as country-specific factors. The downward revision in global growth for 2015 reflects mainly a deteriorating outlook in the economies in transition and several large developing countries, especially in South America. Gross domestic product (GDP) in the economies in transition is projected to contract by 2 per cent this year, while average growth in developing countries is expected to remain at 4.4 per cent, about 3 percentage points below the pre-crisis pace. In the forecast period, the dollar is expected to stay relatively strong against most currencies as the growth and monetary policy divergences remain in place. Given uncertainties over the euro area outlook, the effects of a rise in US interest rates and the weakness in some emerging economies, foreign exchange volatility will likely remain elevated.	**GDP Growth**: 2015: 2.8% 2016: 3.1% **Crude oil price, 2015-2016 (US$ per barrel):** 2015: $60 2016: $70 **Sub-Saharan Africa GDP Growth:** 2015: 4% 2016: 4.8% **US$ Exchange Rate 2015-2016:** Expected to stay strong
World Bank- Global Economic Prospects, January 2015 http://www.worldbank.org/content/dam/Worldbank/GEP/GEP2015a/pdfs/GEP15a_web_full.pdf	Several major forces are driving the global outlook: soft commodity prices that are expected to persist; continued low interest rates but increasingly divergent monetary policies across major economies; and weak world trade. In particular, the sharp decline in oil prices since mid-2014 will support global activity and help offset some of the headwinds to growth in oil-importing developing economies. However, it will dampen growth prospects for oil-exporting countries, with significant regional repercussions. Overall, global growth is expected to rise moderately, to 3.0 percent in 2015, and average about 3.3 percent through 2017. High-income countries are likely to see growth of 2.2 percent in 2015-17, up from 1.8 percent in 2014, on the back of gradually recovering labour markets, ebbing fiscal consolidation, and still low financing costs. In developing countries, as the domestic headwinds that held back growth in 2014 ease and the recovery in high-income countries slowly strengthens, growth is projected to gradually accelerate, rising from 4.4 percent in 2014 to 4.8 percent in 2015 and 5.4 percent by 2017.	**GDP Growth:** 2015: 3% 2016: 3.3% 2017: 3.2% **Sub-Saharan Africa GDP Growth:** 2015: 4.6% 2016: 4.9% 2017: 5.1% **Commodity Metals Price Index (index=100 in 2010):** 2015: 87 2016: 88 2017: 89 **Crude oil price, 2015-2016 (US$ per barrel):** Prices will continue to be low for 2015 and rise marginally in 2016.

OECD- Economic Outlook and Interim Global Economic Assessment, March 2015 http://www.oecd.org/eco/economicoutlook.htm	Growth prospects in the major economies look slightly better than at the time of the OECD November 2014 Economic Outlook, but the near-term outlook is still one of moderate, rather than rapid, world GDP growth. Lower oil prices will boost global demand and have created conditions for many central banks to lower interest rates. Bold and open-ended action by the European Central Bank has boosted asset prices in the euro area and added to easier global financial conditions. The favourable tailwinds create an opportunity for the euro area and Japan to get back to somewhat stronger growth rates, and on balance the most recent indicators are encouraging. In the United States, a cyclical recovery continues. Over the next two years India is set to grow faster than China, where growth is slowing towards the official target of around 7%. Oil and commodity exporters are facing weaker growth prospects as the result of lower prices.	**GDP Growth:** 2015: 4.0% 2016: 4.3% **Crude oil price, 2015-2016 (US$ per barrel):** $85 **Exchange rates, US$/EUR, 2015-2016:** 1/0.80 **Commodity Metals Price Index, 2015-2016:** constant at 2014 prices

Table 15.3: Perspectives on South African Economic Outlook

Source	Description	Details
OECD- South Africa Economic forecast summary, November 2014 http://www.oecd.org/eco/outlook/south-africa-economic-forecast-summary.htm	In the first half of 2014, the economy slowed and inflation rose, before growth rebounded as widespread labour unrest came to an end. Growth is projected to pick up in 2015 and 2016 as exports recover on the back of a weak rand and firmer world trade growth. Private consumption will recover slowly in line with real incomes, while private investment will be held back by low capacity utilisation. The economic slack should contain inflation within the Reserve Bank's target range.	**GDP Growth:** 2015: 2.1% 2016: 2.9% **Inflation:** 2015: 5.8% 2016: 5.6%
The Conference Board- Global Economic Outlook 2015, February 2015 https://www.conference-board.org/data/globaloutlook/		**GDP Growth:** 2015-2019: 3.4% 2020-2025: 3.7%
AfDB, OECD, UN- African Economic Outlook: South Africa, 2015 http://www.africaneconomicoutlook.org/fileadmin/uploads/aeo/2015/CN_data/CN_Long_EN/South_Africa_GB_2015.pdf	Annual growth in GDP fell to 1.5% in 2014, but is expected to rebound to 2.0% in 2015, as the large rand depreciation may stimulate an export-led recovery and the global economy gradually improves. The country will also benefit from stronger demand from emerging partners and lower oil prices. However, tighter domestic fiscal conditions, concerns over security of electricity supply, weak consumption and the future of the United States Federal Reserve's tapering policy are likely to act as a constraint on growth.	**GDP Growth:** 2015: 2% 2016: 2.5% **CPI Inflation:** 2015: 4.9% 2016: 5.3%
Investec Bank- Economic Forecasts 2014-2019 https://www.investec.co.za/content/dam/investec/investec-international/documents/EconomicReportsPDFs/2014/Macro%20Economic%20Forecast%20%20Q2.15_final.pdf		**GDP Growth:** 2015: 2.1% 2016: 2.4% 2017: 2.8% 2018: 3.0% 2019: 3.4% **USD/ZAR:** 2015: 12.21 2016: 12.09 2017: 11.85 2018: 11.75 2019: 11.83

IMF- World Economic Outlook, April 2015 http://www.imf.org/external/pubs/ft/weo/2015/01/		**GDP Growth:** 2015: 2% 2016: 2.1% **Unemployment:** 2015: 25.1% 2016: 24.9%
RSA Treasury- National Budget Review, 2014 http://www.treasury.gov.za/documents/national%20budget/2014/review/chapter%202.pdf	GDP growth is projected to increase from 1.8per cent in 2013 to 3.5 percent in 2016.The medium-term outlook is supported by investment in electricity and transport that will lift output constraints, an expected pick-up in private investment and low real interest rates. The stronger global recovery presents new opportunities to increase exports, provided that the domestic economy can raise productivity and competitiveness. South Africa's improved medium-term growth prospects are tied to an improving global outlook, strong economic growth in sub-Saharan Africa, and the release of production and transport constraints as major infrastructure becomes operational. The weaker rand exchange rate is a risk to the inflation outlook, but sustained real depreciation can increase export competitiveness. This will require monetary and fiscal choices to ensure low and stable inflation. In line with the National Development Plan (NDP), government continues to invest in economic infrastructure, and supports a range of microeconomic reforms to boost potential growth. The commodity price outlook for South Africa is mixed. Platinum prices are likely to rise following the planned reduction in output in South Africa and higher industrial demand associated with tighter emission standards. Demand from India and China will support coal prices. Iron ore prices are projected to stabilise as a result of expansion by Australian and Brazilian companies, which will increase global supply. Expanded shale gas production should limit oil price increases.	**GDP Growth:** 2015: 3.2% 2016: 3.5% **CPI Inflation:** 2015: 5.9% 2016: 5.5% **Exports:** 2015: 6.3% 2016: 7% **Imports:** 2015: 6.1% 2016: 7%

15.3. Annexure C: Population Data to 2025

Table 15.4: Population Indicator Growth (2004-2005)

	Compound Annual Growth Rates (%)	
	2004-2014	2015-2025
Total Population	1.34	1.24
African	1.56	1.48
Coloured	1.21	0.83
Asian	1.37	0.95
White	-0.39	-0.66
Total Working Age Population	1.81	1.52
African	2.16	1.87
Coloured	1.69	0.85
Asian	1.62	0.86
White	-0.71	-1.20
Total Labour Force Participation Rates	62.81	
African	61.31	
Coloured	67.90	
Asian	62.30	
White	70.53	

Source: StatsSA Population Data, 2014

Table 15.5: South Africa Population by Race (2004-2025)

Race	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
African	36,806,908	37,367,254	37,939,022	38,522,474	39,117,880	39,725,515	40,345,664	40,978,616	41,624,670	42,284,132	42,957,316
Coloured	4,270,764	4,330,570	4,389,334	4,446,993	4,503,481	4,558,735	4,612,692	4,665,291	4,716,471	4,766,172	4,814,336
Asian	1,175,874	1,192,119	1,208,559	1,225,198	1,242,036	1,259,076	1,276,321	1,293,772	1,311,431	1,329,302	1,347,385
White	4,765,906	4,749,613	4,732,837	4,715,584	4,697,860	4,679,670	4,661,021	4,641,920	4,622,373	4,602,386	4,581,966
Total	**47,019,452**	**47,639,556**	**48,269,753**	**48,910,248**	**49,561,256**	**50,222,996**	**50,895,698**	**51,579,599**	**52,274,945**	**52,981,991**	**53,701,003**
Race	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
African	43,644,542	44,346,143	45,043,421	45,723,819	46,412,405	47,107,820	47,810,196	48,517,272	49,214,184	49,892,185	50,544,421
Coloured	4,860,906	4,905,827	4,951,273	4,995,811	5,039,414	5,082,030	5,123,678	5,164,315	5,203,849	5,242,170	5,279,170
Asian	1,365,684	1,384,200	1,399,146	1,414,455	1,429,008	1,442,893	1,455,993	1,468,297	1,479,897	1,490,700	1,500,807
White	4,561,121	4,539,857	4,515,372	4,489,332	4,461,734	4,432,614	4,402,092	4,370,269	4,337,205	4,302,964	4,267,605
Total	**54,432,253**	**55,176,026**	**55,909,212**	**56,623,417**	**57,342,561**	**58,065,357**	**58,791,959**	**59,520,153**	**60,235,135**	**60,928,019**	**61,592,003**

Source: StatsSA Population Data, 2014

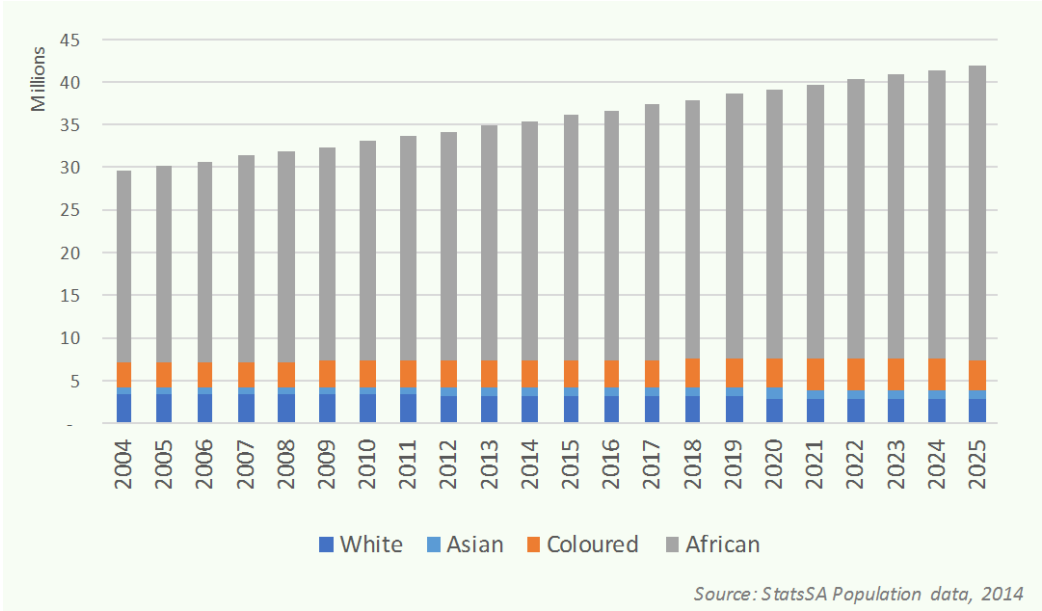
Table 15.6: South Africa Population by Age Group (2010-2025)

					CAGR (%)
Age Group	2010	2015	2020	2025	2010-2025
0-4	5,244,942	5,201,596	5,042,161	5,174,033	-0.23
5-9	5,081,091	5,196,705	5,191,505	5,025,180	-0.18
10-14	5,152,097	5,054,241	5,197,724	5,184,599	0.10
15-19	5,110,508	5,139,013	5,061,233	5,200,816	0.29
20-24	4,827,824	5,154,123	5,201,627	5,117,856	0.98
25-29	4,602,718	4,903,723	5,269,179	5,307,817	2.40
30-34	4,143,751	4,582,001	4,955,412	5,315,287	4.24
35-39	3,764,864	4,016,285	4,529,931	4,898,090	4.48
40-44	2,880,903	3,603,426	3,908,237	4,416,454	7.38
45-49	2,529,843	2,753,110	3,474,154	3,767,415	6.86
50-54	2,141,372	2,395,223	2,630,592	3,320,573	7.59
55-59	1,663,069	1,990,451	2,249,515	2,478,017	6.87
60-64	1,292,450	1,496,347	1,815,180	2,065,454	8.13
65-69	1,016,093	1,216,235	1,424,880	1,746,294	9.45
70-74	712,840	828,243	1,009,708	1,196,317	9.01
75-79	425,728	522,135	624,284	775,677	10.52
80+	305,604	379,396	480,035	602,124	11.97
Total	**50,895,698**	**54,432,253**	**58,065,357**	**61,592,003**	**3.23**

Table 15.7: South Africa Population by Gender (2010-2025)

Age Group					CAGR (%)
	2010	2015	2020	2025	2010-2025
Male	24,731,940	26,583,698	28,417,966	30,131,486	3.35
Female	26,163,758	27,848,554	29,647,391	31,460,517	3.12
Total	**50,895,698**	**54,432,253**	**58,065,357**	**61,592,003**	**3.23**

Figure 15.1: Working Age Population by Race (2004-2025)



Source: StatsSA Population data, 2014

Table 15.8: South Africa Working Age Population by Race (2004-2025)

Race	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
African	22,646,296	23,100,033	23,581,494	24,090,609	24,623,694	25,174,473	25,728,888	26,295,939	26,873,991	27,457,155	28,050,254
Coloured	2,780,456	2,830,743	2,882,082	2,934,333	2,987,141	3,040,021	3,092,528	3,143,987	3,193,777	3,241,693	3,287,506
Asian	820,627	836,572	852,316	867,754	882,768	897,387	911,528	925,368	938,654	951,356	963,630
White	3,337,861	3,323,255	3,307,275	3,289,653	3,270,176	3,248,391	3,224,359	3,197,951	3,169,498	3,139,624	3,109,088
Total	**29,585,240**	**30,090,604**	**30,623,167**	**31,182,350**	**31,763,778**	**32,360,272**	**32,957,303**	**33,563,245**	**34,175,920**	**34,789,829**	**35,410,478**
Race	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
African	28,648,953	29,265,087	29,875,104	30,475,650	31,066,660	31,648,910	32,226,468	32,808,174	33,381,539	33,937,474	34,470,291
Coloured	3,330,928	3,371,623	3,410,849	3,447,436	3,481,217	3,512,001	3,540,143	3,565,597	3,588,459	3,608,845	3,626,725
Asian	975,423	986,846	994,832	1,003,735	1,012,334	1,020,922	1,029,421	1,037,832	1,046,224	1,054,474	1,062,632
White	3,078,398	3,047,868	3,015,939	2,983,006	2,948,781	2,913,227	2,876,654	2,839,147	2,801,309	2,764,226	2,728,131
Total	**36,033,701**	**36,671,424**	**37,296,724**	**37,909,827**	**38,508,992**	**39,095,060**	**39,672,686**	**40,250,750**	**40,817,531**	**41,365,019**	**41,887,779**

Source: StatsSA Population Data, 2014

Table 15.9: South Africa Working Age Population by Province (2010-2025, levels)

Province	2010	2011	2012	2013	2014	2015	2016	2017
Eastern Cape	3,918,413	3,963,895	4,008,031	4,044,330	4,077,246	4,110,196	4,147,025	4,196,797
Free State	1,806,604	1,818,147	1,830,205	1,843,074	1,856,722	1,870,200	1,883,691	1,888,624
Gauteng	8,507,980	8,703,333	8,902,620	9,113,316	9,331,588	9,552,443	9,776,198	9,983,548
KwaZulu-Natal	6,225,254	6,323,386	6,420,742	6,514,190	6,607,541	6,702,204	6,801,585	6,907,456
Limpopo	3,239,459	3,310,246	3,377,901	3,442,284	3,505,087	3,566,180	3,627,041	3,685,269
Mpumalanga	2,492,761	2,543,164	2,595,595	2,648,960	2,703,016	2,756,227	2,809,029	2,859,607
Northern Cape	718,242	727,578	737,621	747,721	757,699	767,186	776,423	786,225
North West	2,215,720	2,255,436	2,297,190	2,339,893	2,383,603	2,427,855	2,473,455	2,517,632
Western Cape	3,832,871	3,918,059	4,006,015	4,096,061	4,187,976	4,281,209	4,376,977	4,471,566
Total	**32,957,303**	**33,563,245**	**34,175,920**	**34,789,829**	**35,410,478**	**36,033,701**	**36,671,424**	**37,296,724**
Province	2018	2019	2020	2021	2022	2023	2024	2025
Eastern Cape	4,246,684	4,295,336	4,342,451	4,388,272	4,447,711	4,504,890	4,559,756	4,611,703
Free State	1,898,789	1,907,014	1,914,083	1,920,633	1,928,197	1,934,718	1,939,903	1,943,523
Gauteng	10,185,068	10,384,976	10,582,208	10,777,499	10,951,832	11,126,278	11,296,361	11,460,329
KwaZulu-Natal	7,015,245	7,122,100	7,226,965	7,329,540	7,437,409	7,542,780	7,645,448	7,744,558
Limpopo	3,737,554	3,786,604	3,834,676	3,883,440	3,937,926	3,991,202	4,042,988	4,092,609
Mpumalanga	2,907,204	2,952,276	2,996,006	3,039,589	3,085,292	3,130,137	3,173,365	3,214,248
Northern Cape	795,189	803,352	810,923	818,216	826,149	833,608	840,465	846,783
North West	2,561,379	2,604,239	2,646,013	2,686,961	2,727,054	2,765,944	2,803,264	2,838,937
Western Cape	4,562,716	4,653,095	4,741,735	4,828,537	4,909,181	4,987,974	5,063,470	5,135,089
Total	**37,909,827**	**38,508,992**	**39,095,060**	**39,672,686**	**40,250,750**	**40,817,531**	**41,365,019**	**41,887,779**

Source: StatsSA Population Data, 2014

Table 15.10: Provincial Shares of South Africa Working Age Population (2010-2025, %)

Province	2010	2011	2012	2013	2014	2015	2016	2017
Eastern Cape	11.89	11.81	11.73	11.63	11.51	11.41	11.31	11.25
Free State	5.48	5.42	5.36	5.30	5.24	5.19	5.14	5.06
Gauteng	25.82	25.93	26.05	26.20	26.35	26.51	26.66	26.77
KwaZulu-Natal	18.89	18.84	18.79	18.72	18.66	18.60	18.55	18.52
Limpopo	9.83	9.86	9.88	9.89	9.90	9.90	9.89	9.88
Mpumalanga	7.56	7.58	7.59	7.61	7.63	7.65	7.66	7.67
Northern Cape	2.18	2.17	2.16	2.15	2.14	2.13	2.12	2.11
North West	6.72	6.72	6.72	6.73	6.73	6.74	6.74	6.75
Western Cape	11.63	11.67	11.72	11.77	11.83	11.88	11.94	11.99
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Province	2018	2019	2020	2021	2022	2023	2024	2025
Eastern Cape	11.20	11.15	11.11	11.06	11.05	11.04	11.02	11.01
Free State	5.01	4.95	4.90	4.84	4.79	4.74	4.69	4.64
Gauteng	26.87	26.97	27.07	27.17	27.21	27.26	27.31	27.36
KwaZulu-Natal	18.51	18.49	18.49	18.48	18.48	18.48	18.48	18.49
Limpopo	9.86	9.83	9.81	9.79	9.78	9.78	9.77	9.77
Mpumalanga	7.67	7.67	7.66	7.66	7.67	7.67	7.67	7.67
Northern Cape	2.10	2.09	2.07	2.06	2.05	2.04	2.03	2.02
North West	6.76	6.76	6.77	6.77	6.78	6.78	6.78	6.78
Western Cape	12.04	12.08	12.13	12.17	12.20	12.22	12.24	12.26
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: StatsSA Population Data, 2014

Table 15.11: Labour Force Participation Rates (2004 & 2014)

Race	2004	2014	Average
African	67.71	54.90	61.31
Coloured	70.30	65.50	67.90
Asian	65.30	59.30	62.30
White	73.86	67.20	70.53
Total	**68.53**	**57.10**	**62.81**

Source: StatsSA Population Data, 2014

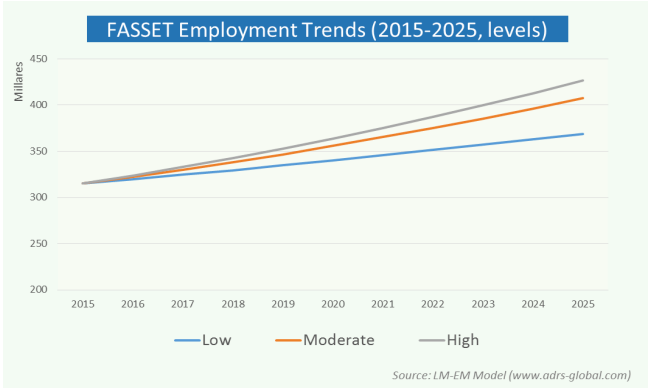
15.4. Annexure D: SETA Results

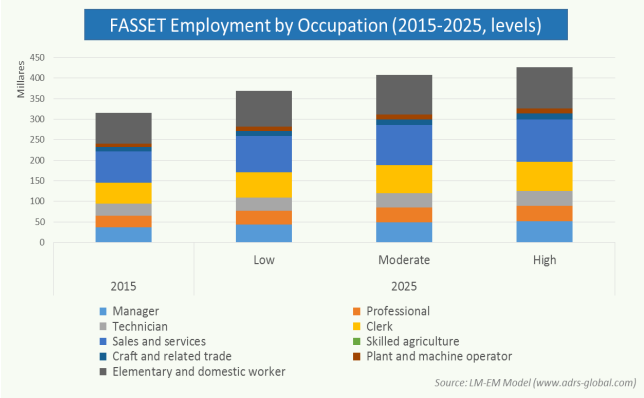
FINANCIAL AND ACCOUNTING SERVICES SETA (FASSET)

FASSET Employment (2015-2025)

Year	Low	Moderate	High
2015	315,042	315,042	315,042
2016	319,697	322,440	323,817
2017	324,567	330,075	332,968
2018	329,573	338,201	342,660
2019	334,785	346,767	352,963
2020	340,137	355,830	363,771
2021	345,722	365,262	375,142
2022	351,303	375,190	387,047
2023	357,044	385,578	399,650
2024	362,985	396,379	412,850
2025	368,933	407,604	426,765

Source: LM-EM (www.adrs-global.com)





FASSET Employment by Occupation

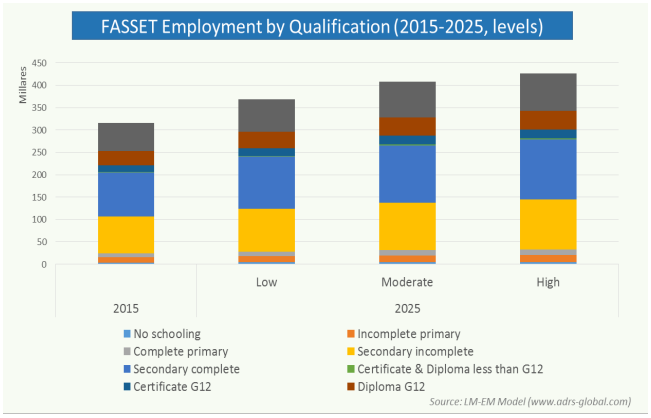
Occupations	2015	2025		
		Low	Moderate	High
Manager	37,185	43,721	48,632	51,075
Professional	28,340	33,111	36,439	38,083
Technician	28,458	32,835	35,358	36,582
Clerk	51,762	60,720	67,277	70,532
Sales and services	75,277	88,280	97,770	102,479
Skilled agriculture	388	454	501	524
Craft and related trade	10,499	12,359	13,775	14,481
Plant and machine operator	8,568	10,050	11,134	11,673
Elementary and domestic worker	74,566	87,403	96,717	101,337
Total	**315,042**	**368,933**	**407,604**	**426,765**

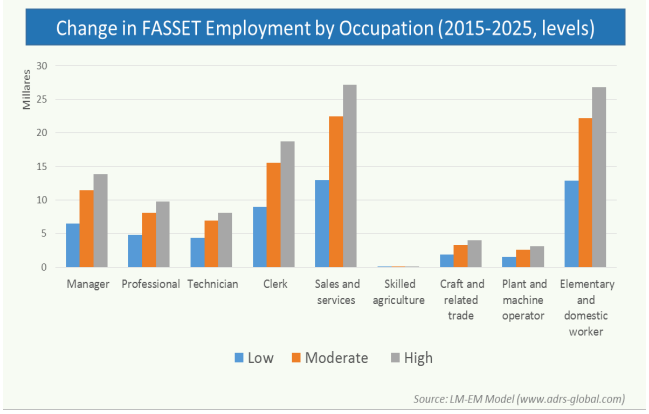
Source: LM-EM (www.adrs-global.com)

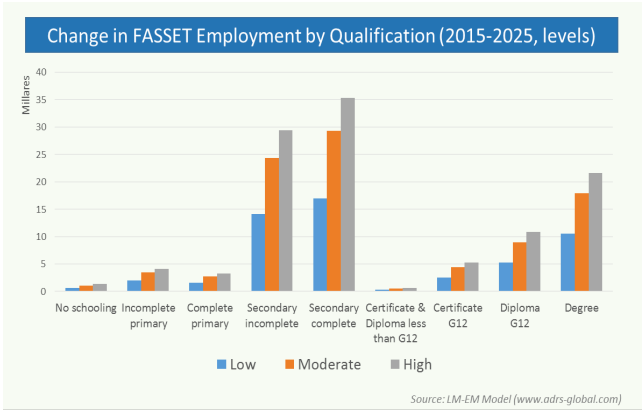
FASSET Employment by Qualification

Qualifications	2015	2025		
		Low	Moderate	High
No schooling	3,630	4,257	4,714	4,941
Incomplete primary	11,510	13,496	14,943	15,661
Complete primary	9,109	10,683	11,830	12,400
Secondary incomplete	81,804	95,901	106,147	111,231
Secondary complete	98,813	115,783	128,044	134,124
Certificate & Diploma less than G12	1,642	1,921	2,120	2,218
Certificate G12	15,004	17,564	19,393	20,299
Diploma G12	31,136	36,400	40,099	41,929
Degree	62,395	72,929	80,313	83,964
Total	**315,043**	**368,933**	**407,603**	**426,766**

Source: LM-EM (www.adrs-global.com)





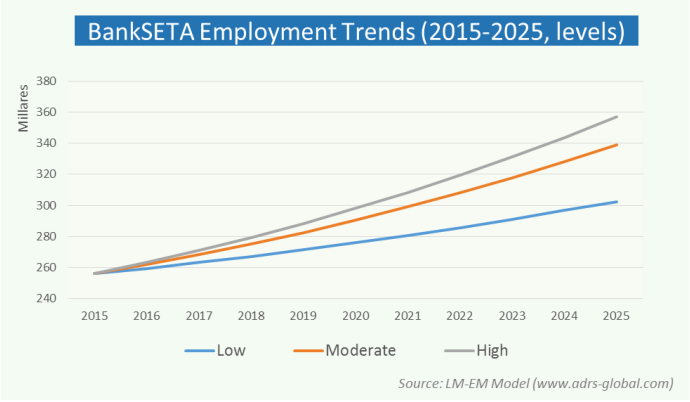


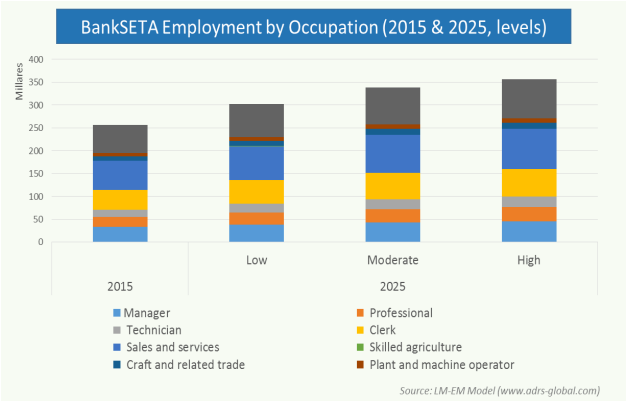
BANKING SECTOR EDUCATION AND TRAINING AUTHORITY (BANKSETA)

BankSETA Employment (2015-2025)

Year	Low	Moderate	High
2015	256,235	256,235	256,235
2016	259,582	262,121	263,404
2017	263,243	268,391	271,115
2018	267,170	275,252	279,456
2019	271,407	282,651	288,489
2020	275,913	290,645	298,126
2021	280,766	299,117	308,418
2022	285,762	308,197	319,366
2023	291,056	317,823	331,131
2024	296,708	328,040	343,610
2025	302,521	338,817	356,934

Source: LM-EM (www.adrs-global.com)





BankSETA Employment by Occupation

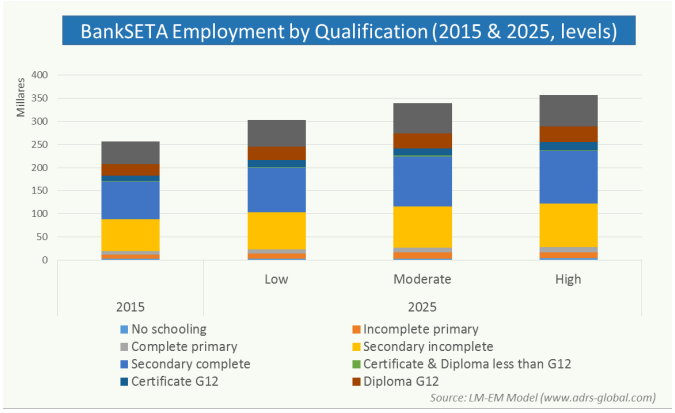
Occupations	2015	2025		
		Low	Moderate	High
Manager	32,650	38,548	43173	45481
Professional	21,997	25,971	29087	30642
Technician	16,406	19,370	21694	22854
Clerk	43,518	51,379	57543	60620
Sales and services	62,962	74,335	83254	87705
Skilled agriculture	310	366	409	431
Craft and related trade	9,426	11,128	12463	13130
Plant and machine operator	7,197	8,497	9516	10025
Elementary and domestic worker	61,770	72,928	81678	86045
Totals	**256,235**	**302,521**	**338817**	**356934**

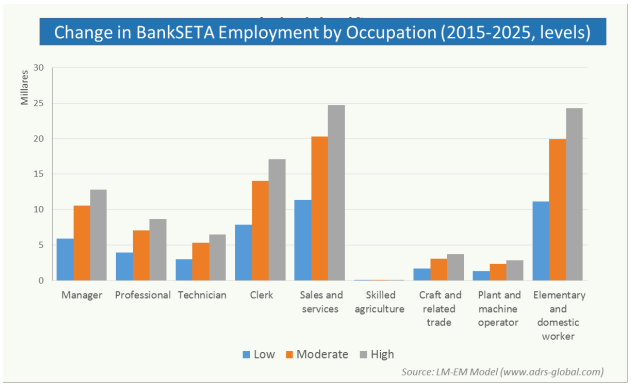
Source: LM-EM (www.adrs-global.com)

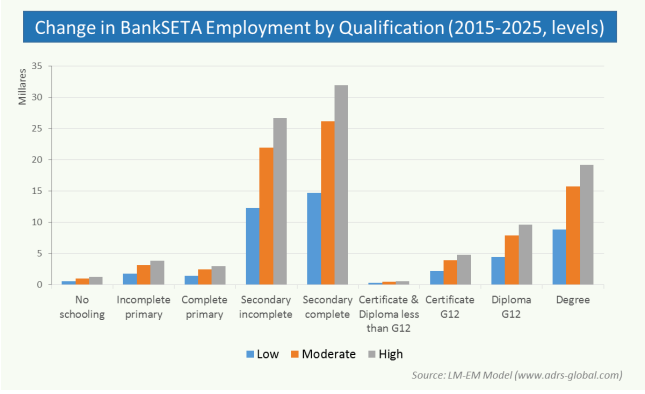
BankSETA Employment by Qualification

Qualifications	2015	2025		
		Low	Moderate	High
No schooling	3,032	3,580	4009	4224
Incomplete primary	9,601	11,335	12695	13374
Complete primary	7,615	8,991	10070	10608
Secondary incomplete	67,965	80,241	89868	94673
Secondary complete	81,289	95,973	107487	113235
Certificate & Diploma less than G12	1,314	1,551	1737	1830
Certificate G12	12,113	14,302	16017	16874
Diploma G12	24,473	28,894	32361	34091
Degree	48,833	57,655	64572	68025
Total	**256,236**	**302,522**	**338817**	**356933**

Source: LM-EM (www.adrs-global.com)



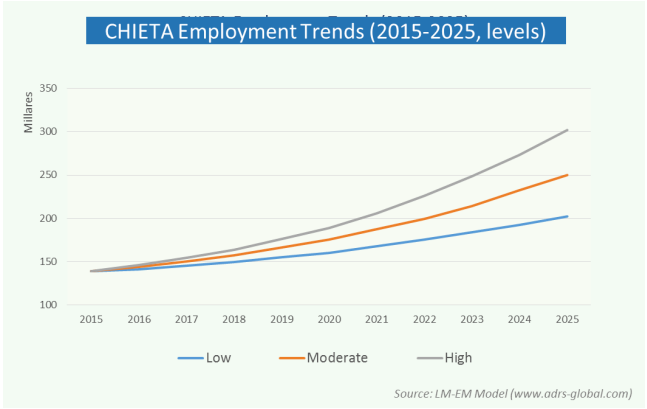


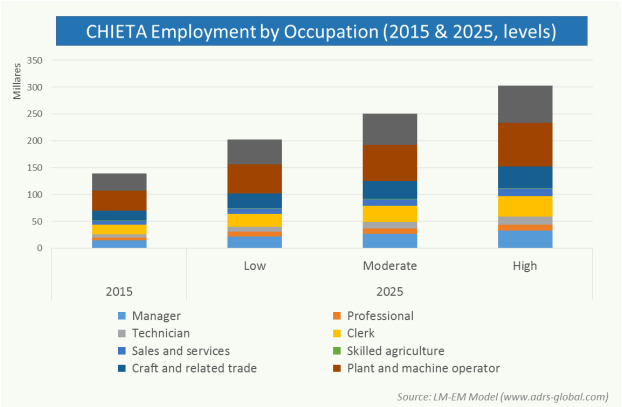


CHEMICAL INDUSTRIES EDUCATION AND TRAINING AUTHORITY (CHIETA)

CHIETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	139,029	139,029	139,029
2016	141,104	143,766	146,109
2017	145,227	150,444	154,438
2018	149,855	157,343	163,844
2019	155,140	166,588	176,127
2020	160,485	175,705	189,307
2021	167,631	187,595	205,922
2022	175,370	199,359	226,241
2023	184,330	214,561	248,583
2024	192,425	232,263	272,965
2025	202,379	250,143	302,276

Source: LM-EM (www.adrs-global.com)



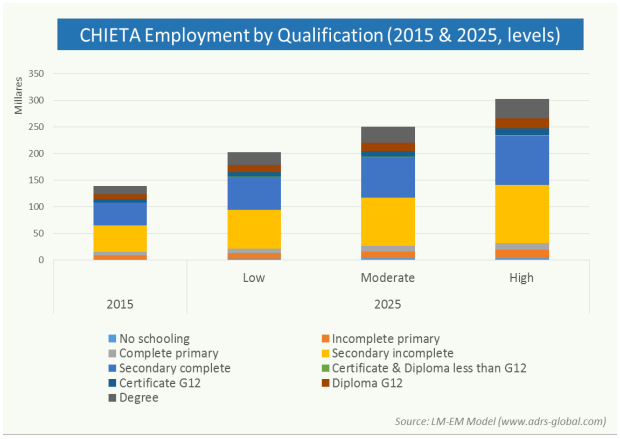


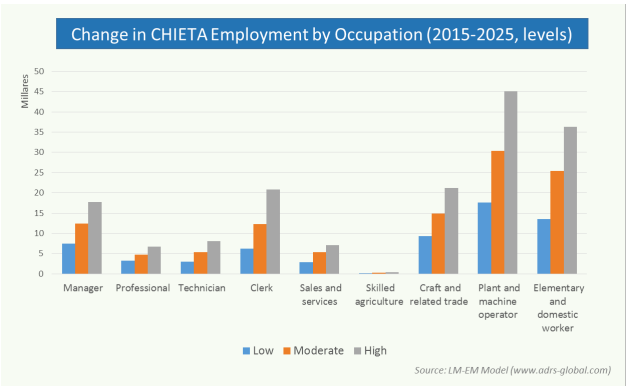
CHIETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	14,510	21,930	26928	32197
Professional	5,098	8,344	9811	11812
Technician	6,459	9,511	11849	14524
Clerk	17,893	24,102	30185	38668
Sales and services	7,164	10,018	12525	14186
Skilled agriculture	376	546	617	712
Craft and related trade	18,596	27,881	33479	39847
Plant and machine operator	36,379	53,999	66763	81474
Elementary and domestic worker	32,555	46,049	57985	68856
Total	**139,029**	**202,379**	**250143**	**302276**

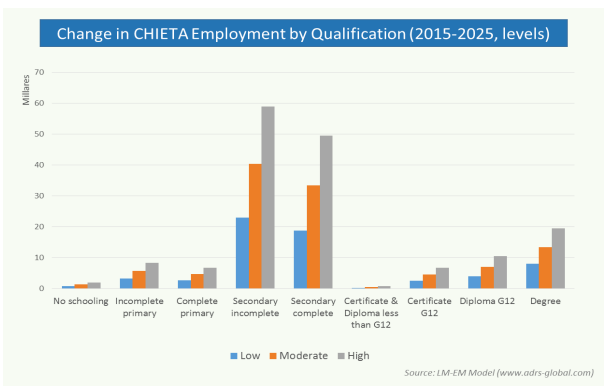
Source: LM-EM (www.adrs-global.com)

CHIETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	1,678	2,452	3038	3646
Incomplete primary	7,096	10,402	12860	15492
Complete primary	5,776	8,458	10454	12590
Secondary incomplete	50,336	73,347	90668	109326
Secondary complete	42,678	61,428	76130	92187
Certificate & Diploma less than G12	639	927	1145	1387
Certificate G12	5,849	8,389	10407	12664
Diploma G12	8,909	12,921	15984	19422
Degree	16,069	24,055	29456	35563
Total	**139,030**	**202,380**	**250142**	**302276**

Source: LM-EM (www.adrs-global.com)



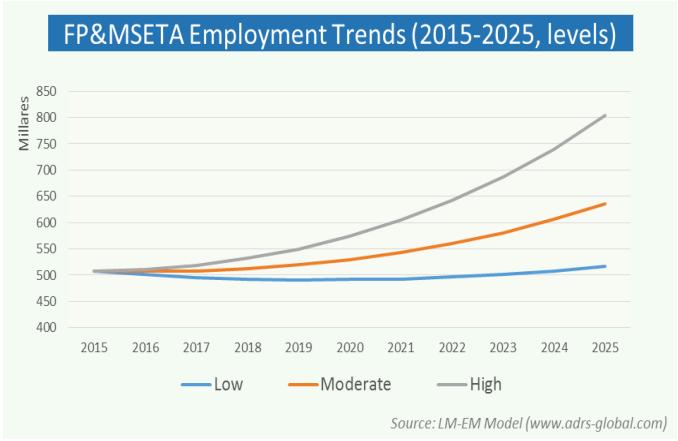


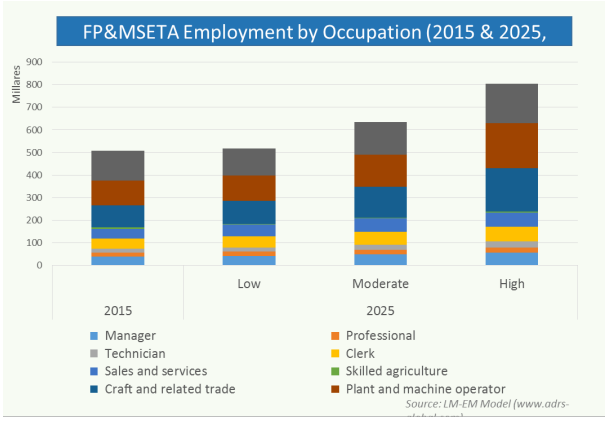


FIBRE PROCESSING AND MANUFACTURING (FP&M) SETA

FP&MSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	507,523	507,523	507,523
2016	500,761	507,280	511,183
2017	494,943	507,601	518,335
2018	492,519	512,781	532,346
2019	490,530	519,776	549,461
2020	491,856	529,738	574,145
2021	491,580	542,396	605,078
2022	496,528	559,766	641,590
2023	500,636	579,331	686,974
2024	508,073	605,515	739,643
2025	517,009	636,095	804,355

Source: LM-EM (www.adrs-global.com)



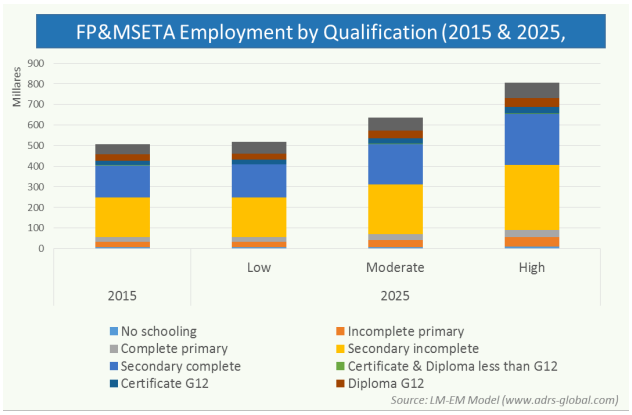


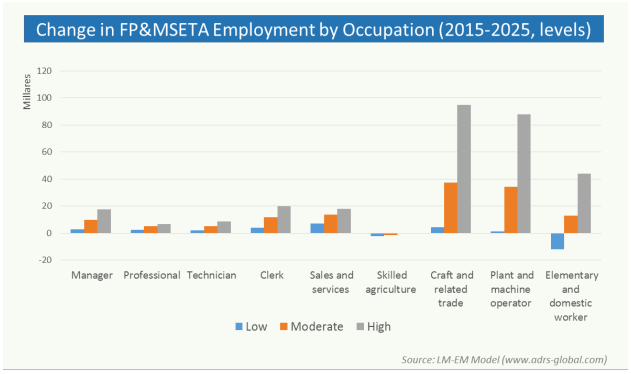
FP&MSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	38,518	41,320	48197	56098
Professional	17,014	19,549	21980	23550
Technician	17,297	19,226	22431	26066
Clerk	45,374	49,219	57037	65432
Sales and services	44,244	51,264	57820	62076
Skilled agriculture	6,079	3,877	4746	5681
Craft and related trade	97,928	102,267	135386	192759
Plant and machine operator	109,315	110,651	143776	197107
Elementary and domestic worker	131,754	119,635	144723	175586
Totals	**507,523**	**517,009**	**636095**	**804355**

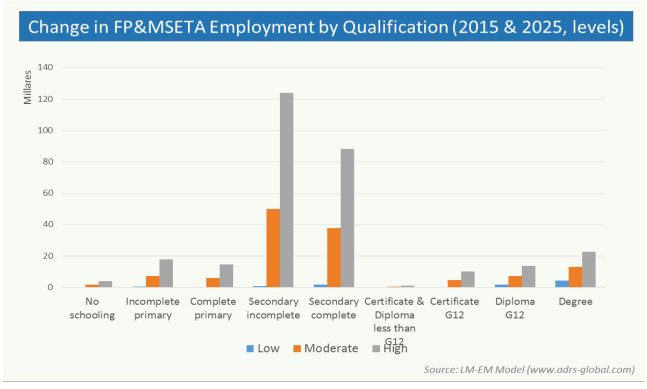
Source: LM-EM (www.adrs-global.com)

FP&MSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	6,438	6,616	8203	10473
Incomplete primary	26,578	27,032	33964	44329
Complete primary	21,909	22,163	27888	36489
Secondary incomplete	192,114	192,822	242208	316290
Secondary complete	157,303	159,009	195130	245705
Certificate & Diploma less than G12	2,329	2,375	2897	3615
Certificate G12	20,373	20,580	24912	30669
Diploma G12	29,409	31,074	36617	43077
Degree	51,069	55,336	64278	73709
Total	**507,523**	**517,008**	**636096**	**804355**

Source: LM-EM (www.adrs-global.com)



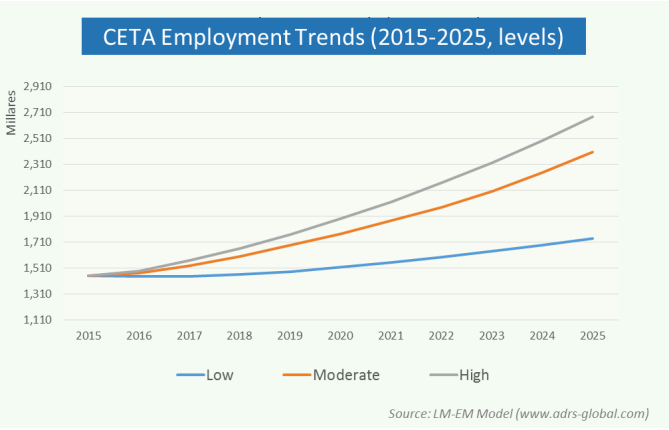


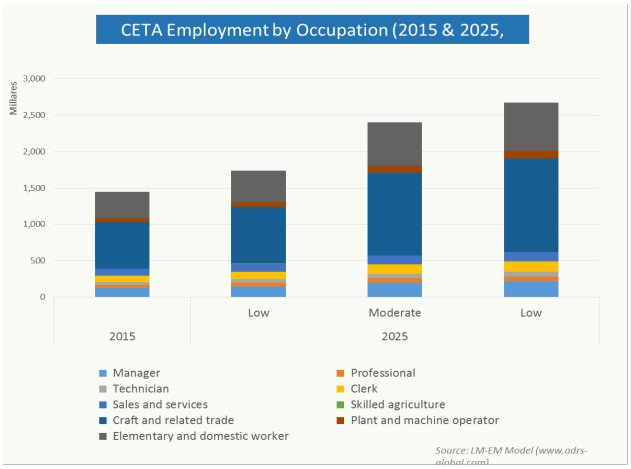


CONSTRUCTION EDUCATION AND TRAINING AUTHORITY (CETA)

CETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,449,291	1,449,291	1,449,291
2016	1,441,847	1,469,344	1,483,764
2017	1,442,785	1,527,680	1,564,914
2018	1,457,379	1,599,757	1,661,028
2019	1,482,303	1,683,967	1,769,231
2020	1,514,067	1,774,291	1,889,427
2021	1,551,803	1,873,848	2,021,721
2022	1,591,688	1,980,455	2,166,862
2023	1,638,865	2,100,146	2,323,682
2024	1,687,405	2,244,621	2,492,584
2025	1,737,927	2,403,075	2,676,218

Source: LM-EM (www.adrs-global.com)



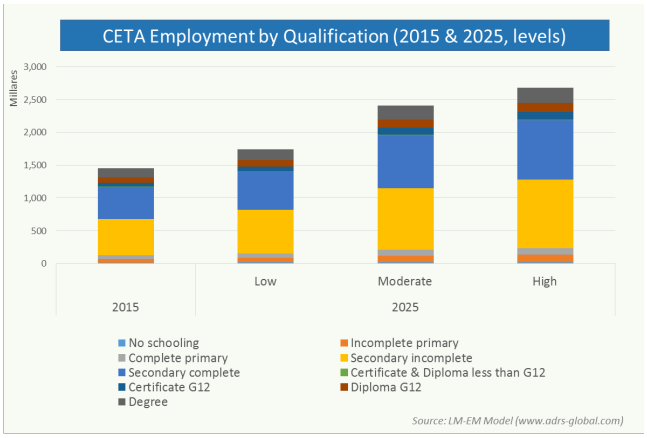


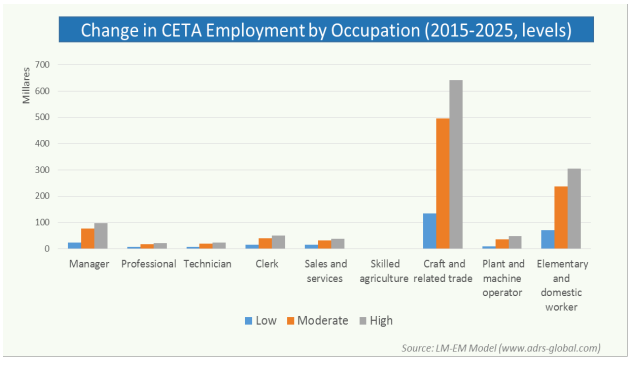
CETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	Low
Manager	124,091	148,866	200,760	222,149
Professional	41,096	48,442	57,848	61,982
Technician	43,166	50,807	62,029	66,794
Clerk	87,590	103,563	127,338	137,667
Sales and services	92,696	109,262	124,552	131,760
Skilled agriculture	1,017	1,185	1,530	1,751
Craft and related trade	642,680	778,335	1,138,385	1,283,856
Plant and machine operator	58,281	67,627	94,818	106,518
Elementary and domestic worker	358,674	429,839	595,815	663,741
Totals	**1,449,291**	**1,737,927**	**2,403,075**	**2,676,218**

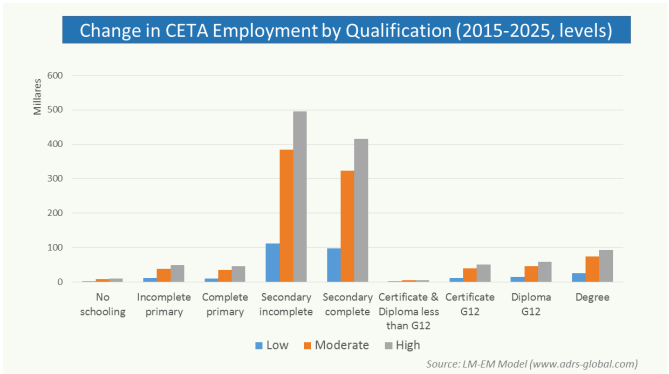
Source: LM-EM (www.adrs-global.com)

CETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	12,716	15,175	20,547	22,781
Incomplete primary	58,292	69,796	96,988	108,192
Complete primary	52,681	63,173	88,413	98,780
Secondary incomplete	553,823	665,487	938,360	1,049,937
Secondary complete	485,146	582,327	808,329	900,960
Certificate & Diploma less than G12	7,159	8,586	11,836	13,170
Certificate G12	61,418	73,616	101,024	112,286
Diploma G12	80,507	96,035	126,408	139,051
Degree	137,550	163,731	211,169	231,060
Total	**1,449,291**	**1,737,926**	**2,403,075**	**2,676,218**

Source: LM-EM (www.adrs-global.com)



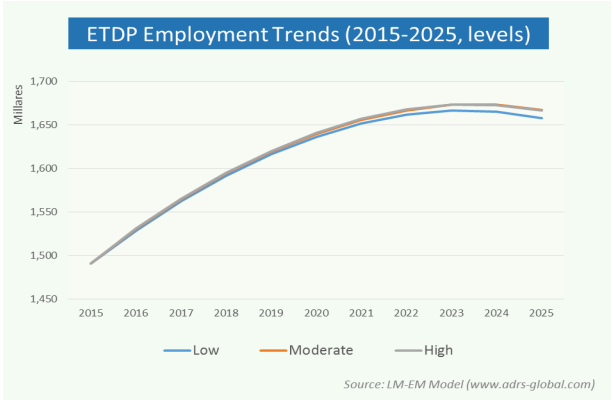


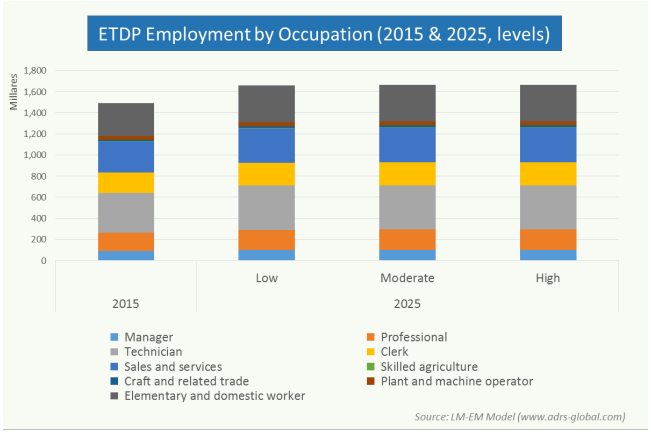


EDUCATION, TRAINING AND DEVELOPMENT PRACTICES (ETDP) SETA

ETDP Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,491,031	1,491,031	1,491,031
2016	1,528,825	1,530,732	1,531,388
2017	1,562,615	1,564,695	1,565,057
2018	1,591,520	1,594,095	1,594,488
2019	1,616,260	1,619,155	1,619,757
2020	1,636,101	1,639,672	1,640,511
2021	1,651,404	1,655,557	1,656,793
2022	1,661,396	1,666,413	1,667,706
2023	1,666,121	1,673,278	1,672,954
2024	1,664,774	1,672,930	1,672,792
2025	1,657,907	1,666,883	1,666,577

Source: LM-EM (www.adrs-global.com)



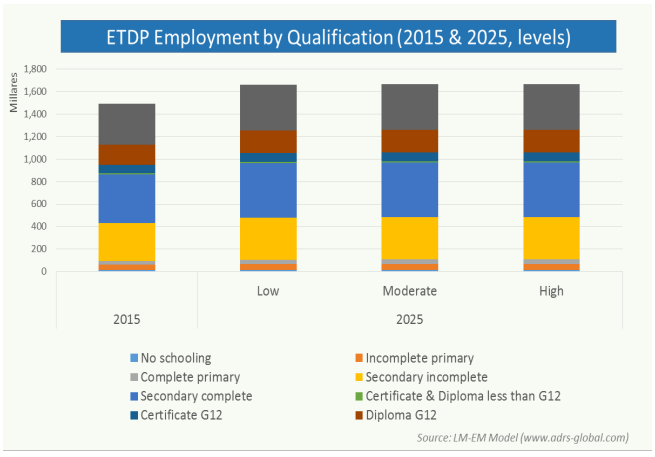


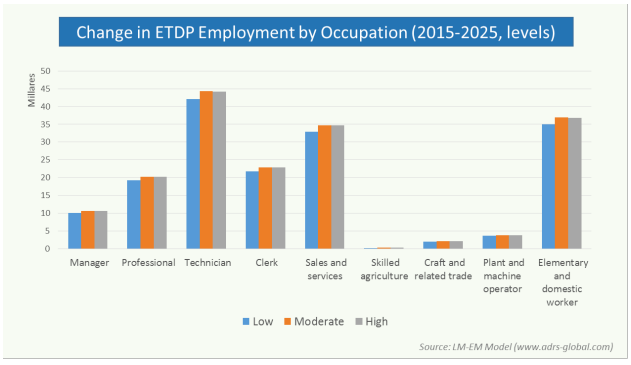
ETDP Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	89,543	99,582	100,156	100,156
Professional	171,962	191,201	192,221	192,178
Technician	376,827	418,952	421,123	420,995
Clerk	194,022	215,747	216,935	216,906
Sales and services	293,880	326,784	328,578	328,531
Skilled agriculture	2,061	2,292	2,304	2,304
Craft and related trade	17,828	19,830	19,950	19,953
Plant and machine operator	32,343	35,965	36,163	36,158
Elementary and domestic worker	312,565	347,555	349,453	349,397
Totals	**1,491,031**	**1,657,907**	**1,666,883**	**1,666,577**

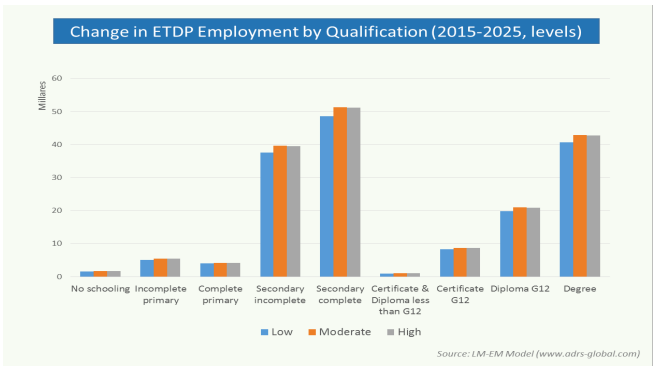
Source: LM-EM (www.adrs-global.com)

ETDP Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	14,323	15,926	16,014	16,011
Incomplete primary	45,851	50,985	51,264	51,256
Complete primary	35,701	39,698	39,916	39,910
Secondary incomplete	335,754	373,343	375,384	375,326
Secondary complete	434,571	483,215	485,844	485,762
Certificate & Diploma less than G12	8,552	9,509	9,560	9,558
Certificate G12	74,247	82,556	83,001	82,985
Diploma G12	177,923	197,829	198,888	198,845
Degree	364,110	404,848	407,012	406,923
Total	**1,491,031**	**1,657,908**	**1,666,883**	**1,666,578**

Source: LM-EM (www.adrs-global.com)



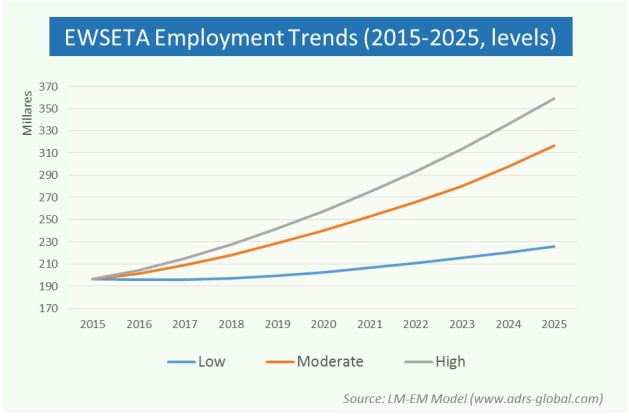


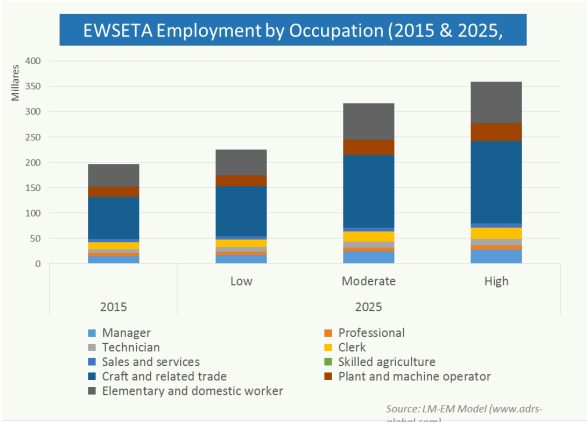


ENERGY & WATER SECTOR EDUCATION & TRAINING AUTHORITY (EWSETA)

EWSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	196,371	196,371	196,371
2016	195,647	201,241	203,894
2017	195,495	208,915	214,840
2018	196,773	218,112	227,537
2019	199,216	228,909	241,774
2020	202,439	240,159	257,486
2021	206,492	252,586	274,547
2022	210,403	265,709	293,384
2023	215,267	280,217	313,741
2024	220,442	297,656	335,420
2025	225,696	316,796	358,885

Source: LM-EM (www.adrs-global.com)



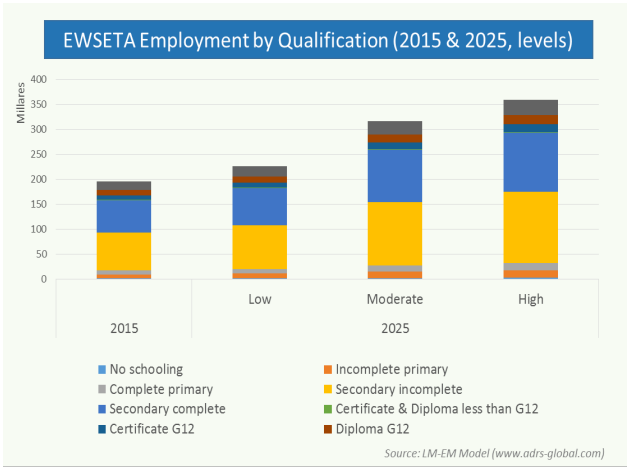


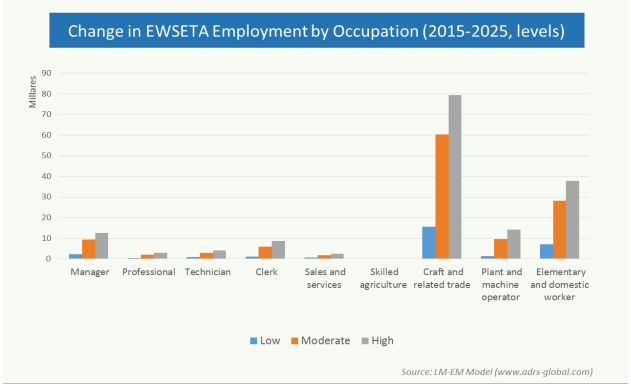
EWSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	15,248	17,458	24,536	27,850
Professional	5,467	5,956	7,563	8,452
Technician	8,449	9,277	11,420	12,571
Clerk	13,703	14,800	19,719	22,477
Sales and services	5,881	6,479	7,717	8,390
Skilled agriculture	187	202	273	312
Craft and related trade	83,047	98,646	143,351	162,434
Plant and machine operator	20,301	21,635	29,845	34,562
Elementary and domestic worker	44,088	51,243	72,372	81,838
Totals	**196,371**	**225,696**	**316,796**	**358,885**

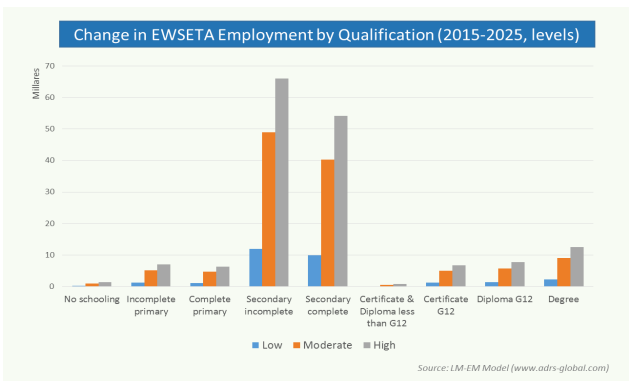
Source: LM-EM (www.adrs-global.com)

EWSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	1,762	1,997	2,779	3,155
Incomplete primary	8,430	9,622	13,542	15,393
Complete primary	7,491	8,595	12,149	13,803
Secondary incomplete	76,429	88,348	125,444	142,365
Secondary complete	64,298	74,198	104,569	118,455
Certificate & Diploma less than G1	958	1,102	1,542	1,745
Certificate G12	8,214	9,428	13,173	14,907
Diploma G12	10,674	12,070	16,380	18,457
Degree	18,114	20,337	27,218	30,606
Total	**196,371**	**225,696**	**316,796**	**358,886**

Source: LM-EM (www.adrs-global.com)



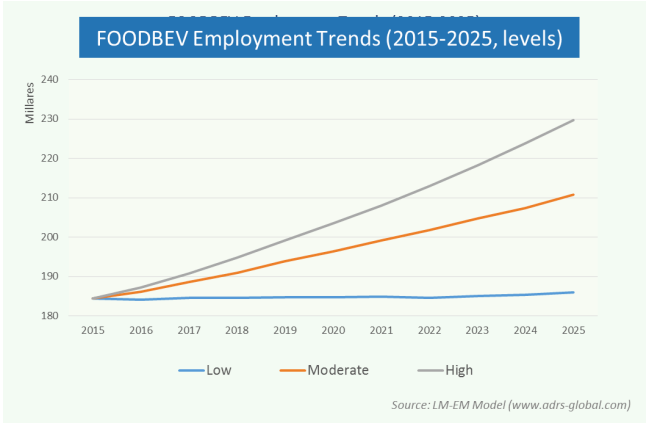


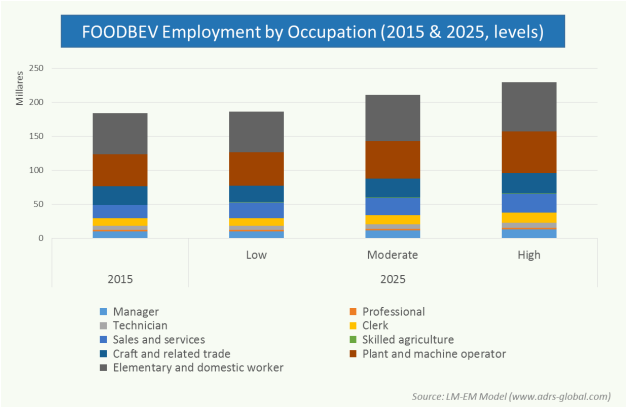


FOOD & BEVERAGES MANUFACTURING INDUSTRY (FOODBEV) SETA

FOODBEV Employment (2015-2025)			
Year	Low	Moderate	High
2015	184,370	184,370	184,370
2016	184,161	186,166	187,248
2017	184,590	188,591	190,794
2018	184,582	190,987	194,795
2019	184,766	193,902	199,105
2020	184,775	196,366	203,561
2021	184,936	199,169	208,046
2022	184,599	201,790	212,933
2023	185,024	204,699	218,210
2024	185,340	207,412	223,871
2025	186,030	210,738	229,760

Source: LM-EM (www.adrs-global.com)



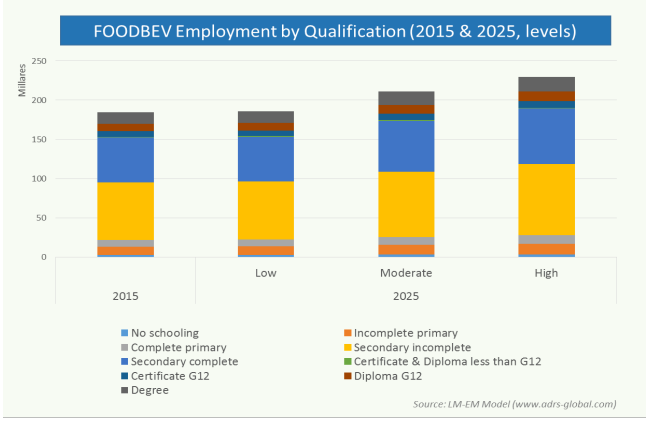


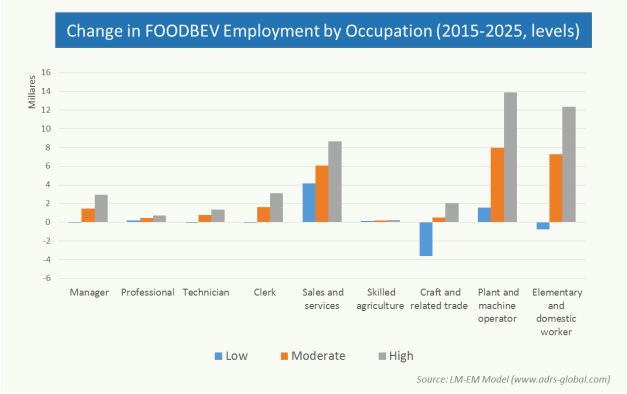
FOODBEV Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	9,987	9,979	11,469	12,931
Professional	2,032	2,222	2,474	2,739
Technician	5,981	5,958	6,765	7,342
Clerk	11,341	11,291	12,949	14,467
Sales and services	19,243	23,412	25,310	27,902
Skilled agriculture	586	709	768	846
Craft and related trade	27,564	23,976	28,102	29,628
Plant and machine operator	47,023	48,602	54,983	60,927
Elementary and domestic worker	60,613	59,880	67,919	72,977
Totals	**184,370**	**186,030**	**210,738**	**229,760**

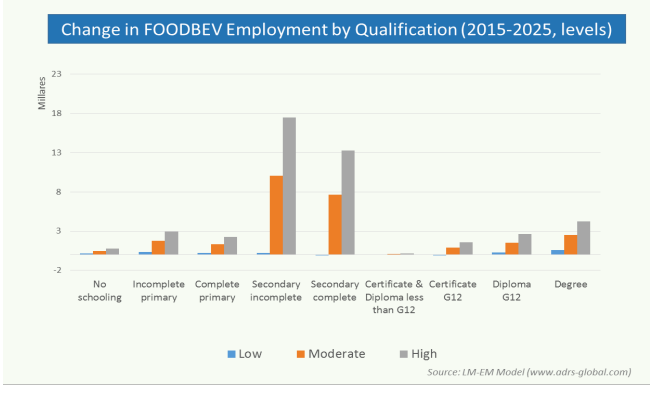
Source: LM-EM (www.adrs-global.com)

FOODBEV Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	2,656	2,807	3,145	3,450
Incomplete primary	10,616	10,977	12,368	13,549
Complete primary	8,655	8,870	10,013	10,947
Secondary incomplete	73,333	73,542	83,412	90,793
Secondary complete	57,164	57,096	64,808	70,456
Certificate & Diploma less than G12	799	800	908	988
Certificate G12	7,078	7,014	7,980	8,677
Diploma G12	9,588	9,861	11,129	12,194
Degree	14,483	15,062	16,976	18,704
Total	**184,370**	**186,029**	**210,739**	**229,759**

Source: LM-EM (www.adrs-global.com)



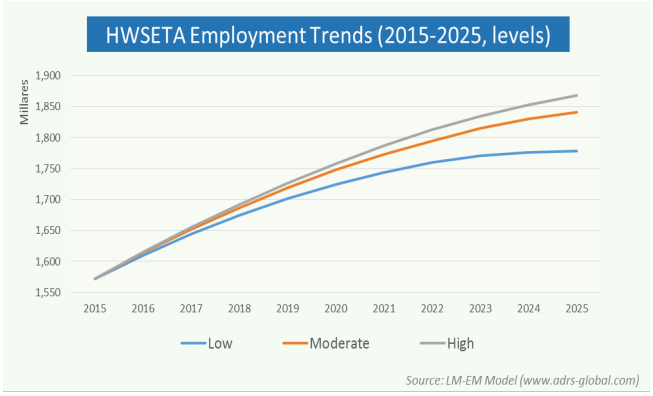


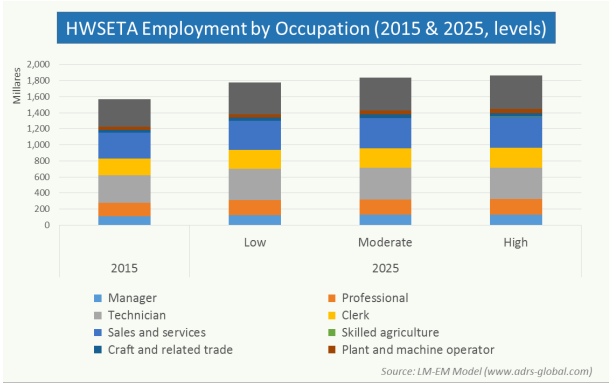


HEALTH & WELFARE (HWSETA) SETA

HWSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,572,016	1,572,016	1,572,016
2016	1,609,410	1,613,679	1,615,455
2017	1,643,752	1,651,660	1,655,077
2018	1,674,072	1,686,758	1,692,195
2019	1,701,375	1,718,847	1,726,613
2020	1,724,569	1,747,541	1,758,229
2021	1,744,168	1,772,895	1,787,060
2022	1,759,468	1,794,824	1,812,605
2023	1,770,448	1,814,524	1,834,309
2024	1,776,574	1,829,618	1,852,704
2025	1,778,048	1,840,749	1,867,434

Source: LM-EM (www.adrs-global.com)



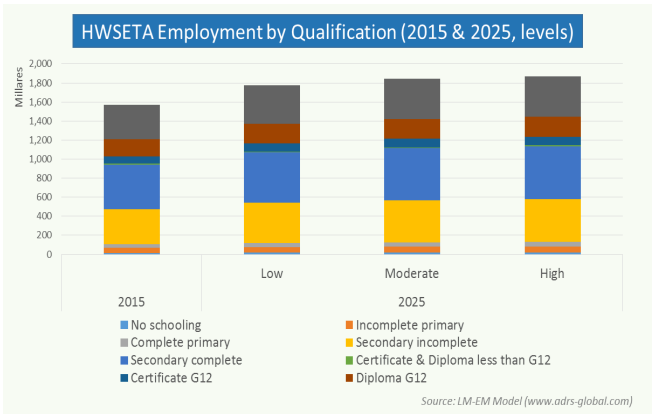


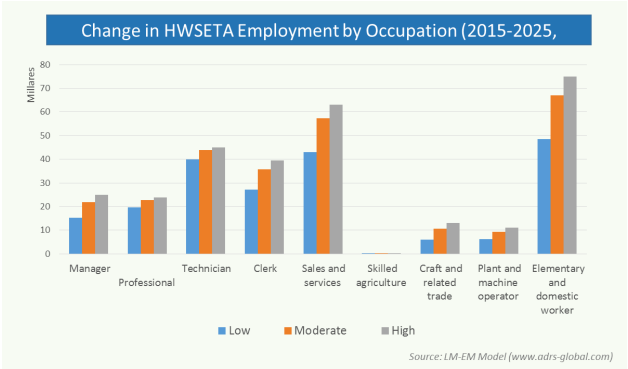
HWSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	108,084	123,353	129,920	133,031
Professional	167,658	187,339	190,413	191,574
Technician	348,482	388,435	392,401	393,405
Clerk	209,136	236,353	244,816	248,519
Sales and services	319,410	362,466	376,764	382,377
Skilled agriculture	2,081	2,319	2,373	2,405
Craft and related trade	31,718	37,656	42,363	44,695
Plant and machine operator	38,850	45,030	48,064	49,835
Elementary and domestic worker	346,598	395,098	413,634	421,594
Totals	**1,572,016**	**1,778,048**	**1,840,749**	**1,867,434**

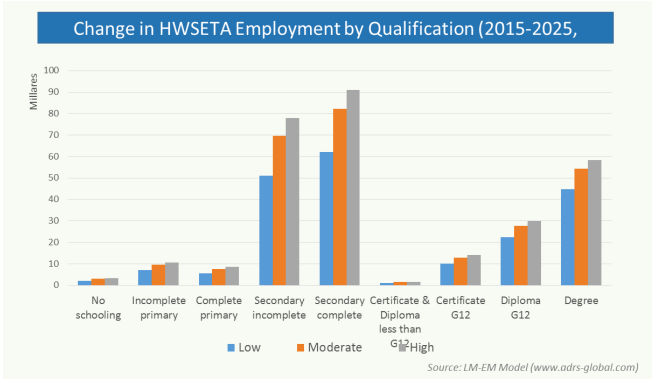
Source: LM-EM (www.adrs-global.com)

HWSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	15,766	17,936	18,715	19,047
Incomplete primary	50,672	57,688	60,273	61,405
Complete primary	39,703	45,232	47,320	48,239
Secondary incomplete	369,874	420,828	439,587	447,864
Secondary complete	465,893	527,921	548,203	556,909
Certificate & Diploma less than G12	8,840	9,975	10,288	10,419
Certificate G12	77,411	87,415	90,292	91,507
Diploma G12	179,748	202,205	207,545	209,681
Degree	364,110	408,849	418,525	422,365
Total	**1,572,017**	**1,778,049**	**1,840,748**	**1,867,435**

Source: LM-EM (www.adrs-global.com)



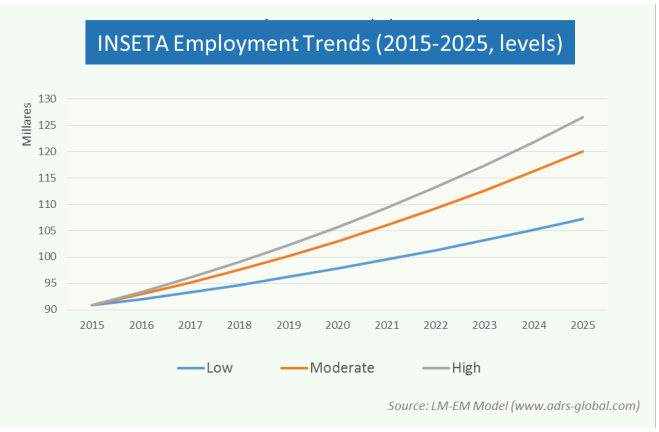


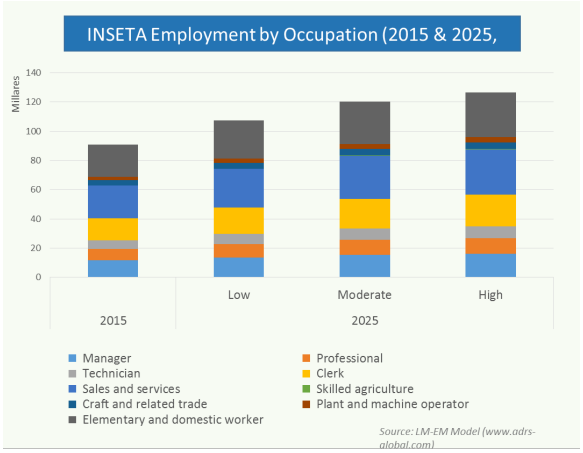


INSURANCE SECTOR EDUCATION AND TRAINING AUTHORITY (INSETA)

INSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	90,825	90,825	90,825
2016	92,012	92,912	93,366
2017	93,310	95,134	96,100
2018	94,702	97,566	99,056
2019	96,203	100,189	102,258
2020	97,800	103,022	105,674
2021	99,521	106,025	109,322
2022	101,291	109,244	113,203
2023	103,168	112,656	117,373
2024	105,172	116,278	121,796
2025	107,232	120,098	126,519

Source: LM-EM (www.adrs-global.com)



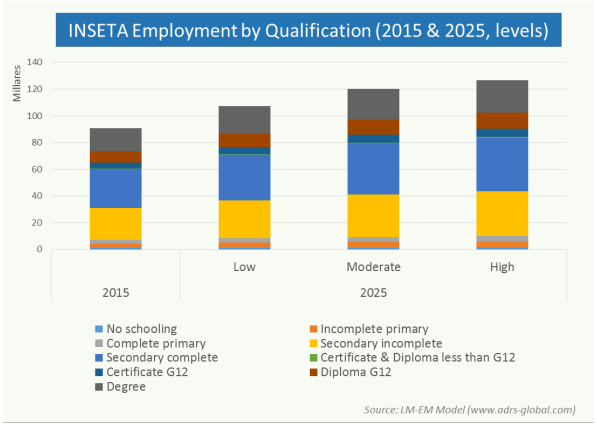


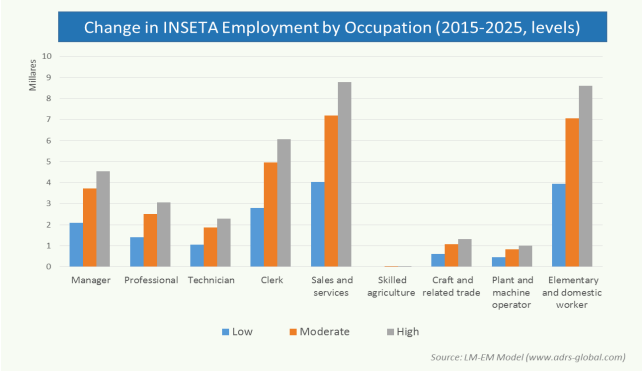
INSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	11,573	13,664	15,303	16,121
Professional	7,797	9,206	10,310	10,861
Technician	5,815	6,866	7,690	8,101
Clerk	15,425	18,212	20,397	21,488
Sales and services	22,317	26,349	29,510	31,088
Skilled agriculture	110	130	145	153
Craft and related trade	3,341	3,945	4,418	4,654
Plant and machine operator	2,551	3,012	3,373	3,553
Elementary and domestic worker	21,895	25,850	28,952	30,500
Totals	**90,825**	**107,232**	**120,098**	**126,519**

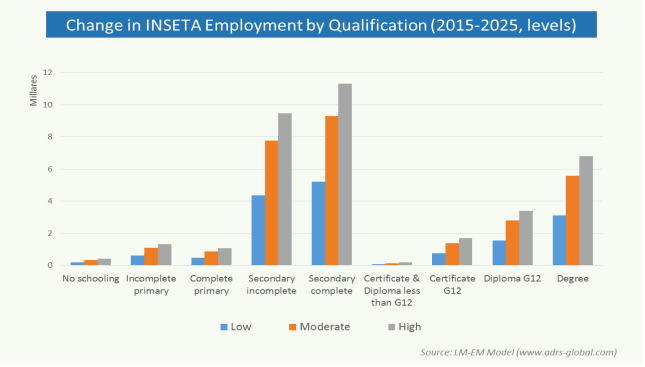
Source: LM-EM (www.adrs-global.com)

INSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	1,075	1,269	1,421	1,497
Incomplete primary	3,403	4,018	4,500	4,741
Complete primary	2,699	3,187	3,569	3,760
Secondary incomplete	24,090	28,443	31,855	33,558
Secondary complete	28,813	34,019	38,100	40,138
Certificate & Diploma less than G12	466	550	616	649
Certificate G12	4,294	5,069	5,678	5,981
Diploma G12	8,675	10,242	11,471	12,084
Degree	17,309	20,437	22,888	24,112
Total	**90,824**	**107,234**	**120,098**	**126,519**

Source: LM-EM (www.adrs-global.com)



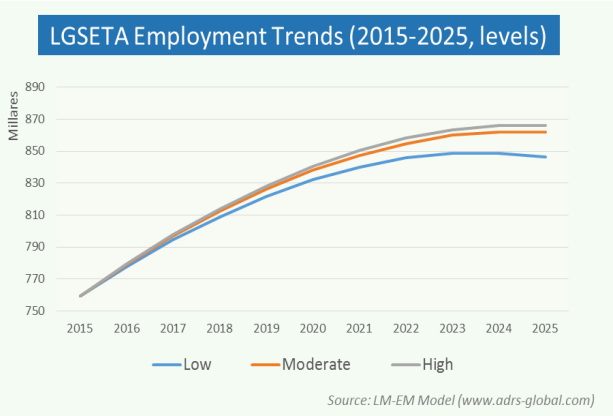


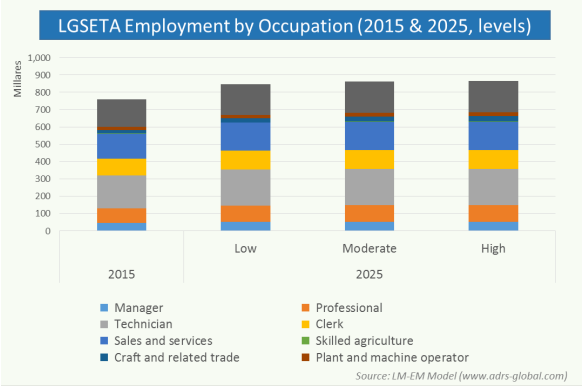


LOCAL GOVERNMENT SECTOR EDUCATION & TRAINING AUTHORITY (LGSETA)

LGSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	759,307	759,307	759,307
2016	777,847	779,175	779,701
2017	794,542	796,928	797,683
2018	809,065	812,666	813,830
2019	821,698	826,462	828,111
2020	832,027	838,096	840,345
2021	840,204	847,584	850,553
2022	845,777	854,689	858,323
2023	848,863	859,998	863,478
2024	848,955	862,208	866,142
2025	846,330	861,835	866,041

Source: LM-EM (www.adrs-global.com)



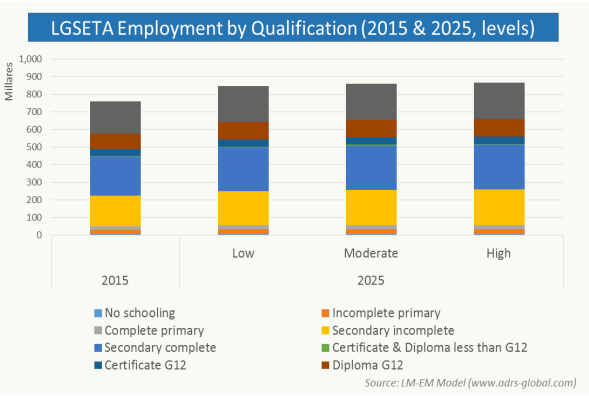


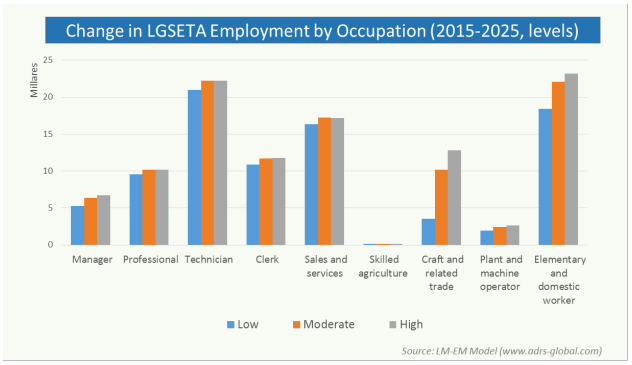
LGSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	45,769	51,047	52,147	52,468
Professional	85,532	95,108	95,690	95,696
Technician	187,553	208,539	209,753	209,741
Clerk	96,668	107,524	108,354	108,430
Sales and services	145,825	162,134	163,035	163,008
Skilled agriculture	1,031	1,147	1,157	1,158
Craft and related trade	20,286	23,825	30,490	33,114
Plant and machine operator	16,751	18,703	19,208	19,366
Elementary and domestic worker	159,893	178,303	182,001	183,061
Total	**759,307**	**846,330**	**861,835**	**866,041**

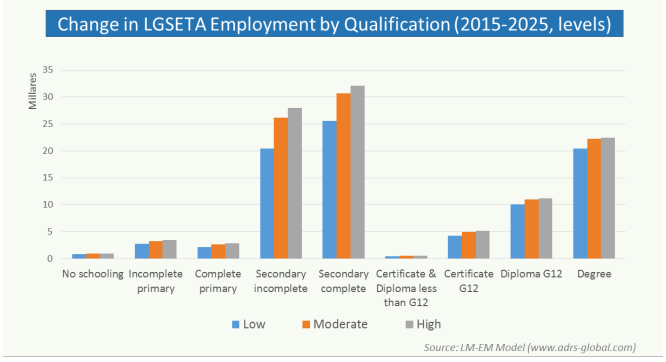
Source: LM-EM (www.adrs-global.com)

LGSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	7,252	8,079	8,207	8,238
Incomplete primary	23,534	26,253	26,843	27,017
Complete primary	18,453	20,598	21,132	21,298
Secondary incomplete	174,749	195,191	200,894	202,720
Secondary complete	222,251	247,830	252,921	254,374
Certificate & Diploma less than G12	4,339	4,835	4,914	4,934
Certificate G12	37,639	41,933	42,604	42,773
Diploma G12	89,134	99,185	100,161	100,316
Degree	181,957	202,426	204,159	204,370
Total	**759,308**	**846,330**	**861,835**	**866,042**

Source: LM-EM (www.adrs-global.com)

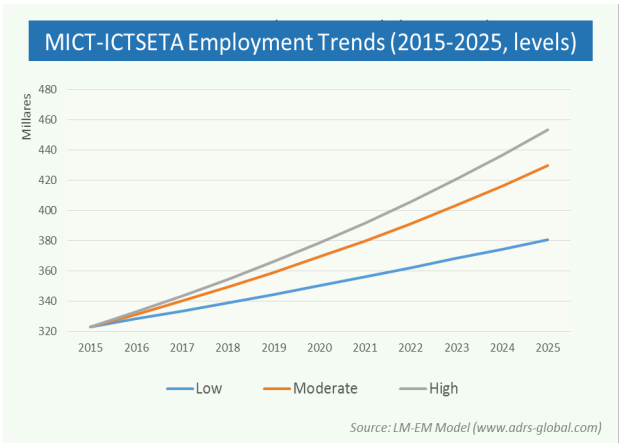


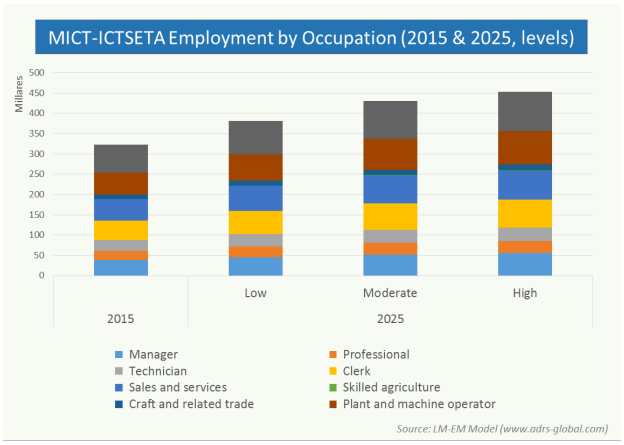




MEDIA, INFORMATION AND COMMUNICATION TECHNOLOGIES (MICT) SETA

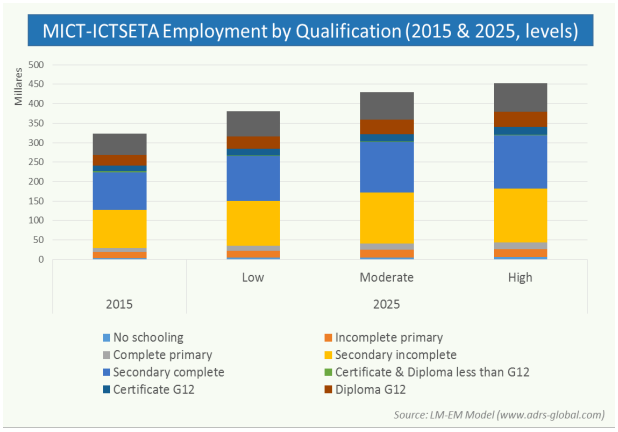
MICT-ICTSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	323,179	323,179	323,179
2016	328,318	331,424	332,888
2017	333,603	340,166	343,342
2018	339,030	349,358	354,323
2019	344,622	359,046	366,025
2020	350,348	369,252	378,448
2021	356,263	379,982	391,668
2022	362,213	391,319	405,750
2023	368,313	403,391	420,739
2024	374,577	416,357	436,588
2025	380,845	429,916	453,494
Source: LM-EM (www.adrs-global.com)			

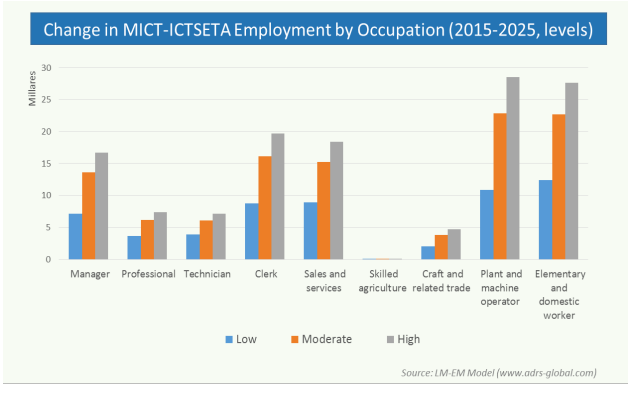


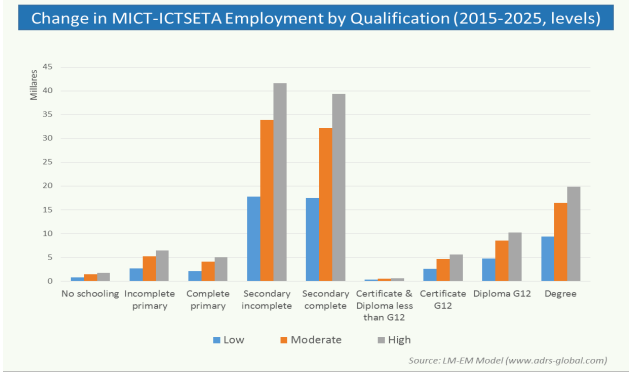


MICT-ICTSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	38,618	45,774	52,239	55,355
Professional	22,094	25,725	28,237	29,456
Technician	26,344	30,260	32,443	33,472
Clerk	48,873	57,620	65,010	68,577
Sales and services	52,886	61,802	68,154	71,273
Skilled agriculture	268	312	340	354
Craft and related trade	10,710	12,712	14,540	15,422
Plant and machine operator	53,533	64,400	76,411	82,075
Elementary and domestic worker	69,852	82,241	92,541	97,511
Total	**323,179**	**380,845**	**429,916**	**453,494**
Source: LM-EM (www.adrs-global.com)				

MICT-ICTSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	4,032	4,769	5,426	5,741
Incomplete primary	14,545	17,244	19,743	20,938
Complete primary	11,445	13,569	15,535	16,475
Secondary incomplete	96,686	114,456	130,563	138,278
Secondary complete	97,793	115,236	129,993	137,097
Certificate & Diploma less than G12	1,584	1,861	2,088	2,197
Certificate G12	14,375	16,901	18,975	19,974
Diploma G12	27,894	32,666	36,356	38,136
Degree	54,825	64,144	71,235	74,658
Total	**323,178**	**380,846**	**429,915**	**453,495**
Source: LM-EM (www.adrs-global.com)				



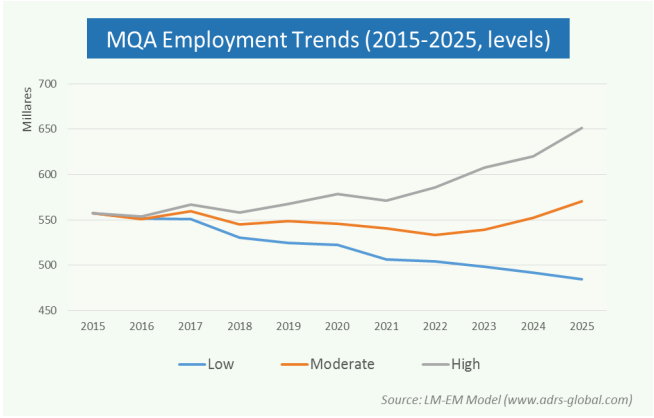


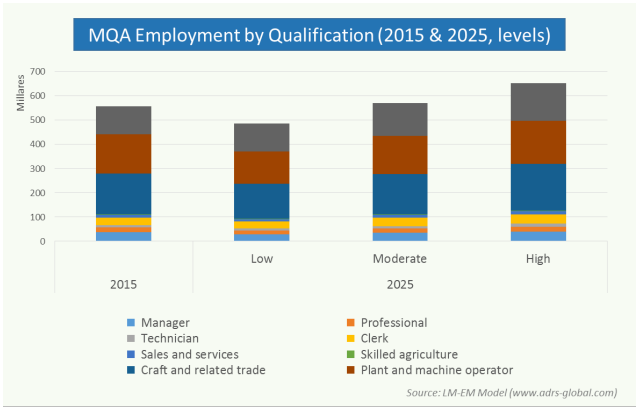


MINING QUALIFICATIONS AUTHORITY (MQA)

MQA Employment (2015-2025)			
Year	Low	Moderate	High
2015	557,466	557,466	557,466
2016	551,327	550,959	553,631
2017	551,231	559,691	567,240
2018	530,736	544,887	558,052
2019	524,366	548,447	567,662
2020	522,154	545,771	578,561
2021	506,291	540,599	571,114
2022	503,905	533,717	585,828
2023	498,265	539,466	607,830
2024	492,100	552,288	620,188
2025	484,438	570,294	651,264

Source: LM-EM (www.adrs-global.com)



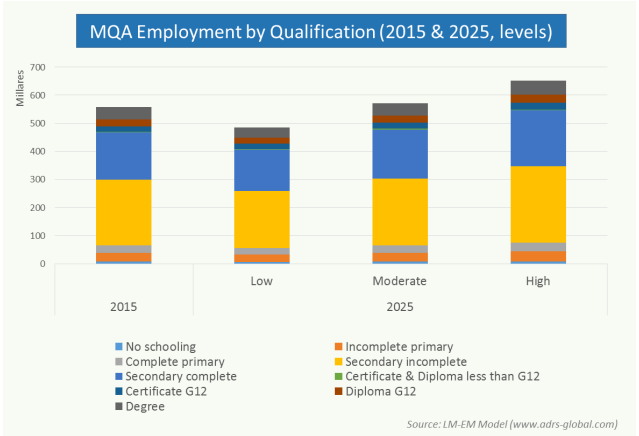


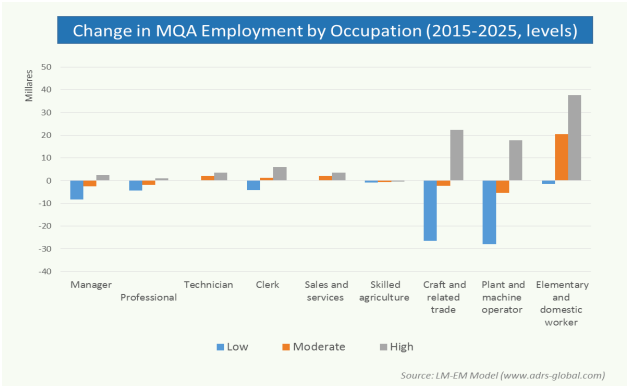
MQA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	38,063	29,740	35,486	40,521
Professional	19,265	14,926	17,429	20,276
Technician	7,993	8,237	10,008	11,575
Clerk	32,770	28,678	33,887	38,768
Sales and services	9,465	9,714	11,495	13,060
Skilled agriculture	2,698	1,785	1,974	2,162
Craft and related trade	169,798	143,218	167,592	192,065
Plant and machine operator	161,290	133,416	155,888	179,087
Elementary and domestic worker	116,124	114,722	136,536	153,750
Total	**557,466**	**484,438**	**570,294**	**651,264**

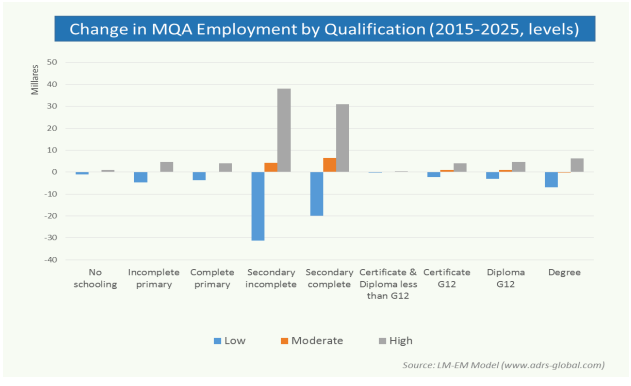
Source: LM-EM (www.adrs-global.com)

MQA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	6,964	5,996	7,035	8,045
Incomplete primary	31,859	27,237	31,937	36,540
Complete primary	26,580	22,805	26,750	30,590
Secondary incomplete	233,434	202,283	237,643	271,430
Secondary complete	168,054	148,084	174,561	199,014
Certificate & Diploma less than G12	2,408	2,100	2,476	2,826
Certificate G12	20,179	17,923	21,178	24,125
Diploma G12	24,295	21,312	25,254	28,843
Degree	43,694	36,696	43,460	49,851
Total	**557,466**	**484,436**	**570,295**	**651,264**

Source: LM-EM (www.adrs-global.com)



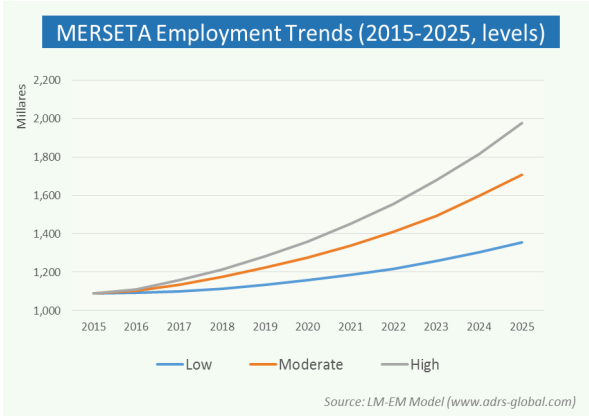


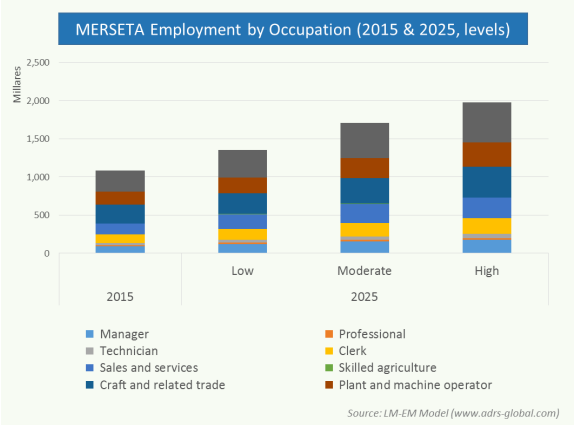


MANUFACTURING, ENGINEERING & RELATED SERVICES (MERSETA) SETA

MERSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,087,799	1,087,799	1,087,799
2016	1,091,355	1,104,771	1,111,569
2017	1,100,762	1,135,987	1,158,101
2018	1,114,823	1,175,752	1,214,748
2019	1,134,363	1,223,721	1,282,183
2020	1,157,870	1,277,462	1,359,818
2021	1,185,161	1,339,503	1,451,753
2022	1,217,700	1,409,657	1,556,834
2023	1,256,913	1,494,507	1,678,208
2024	1,302,900	1,595,468	1,814,911
2025	1,354,016	1,706,118	1,974,718

Source: LM-EM (www.adrs-global.com)



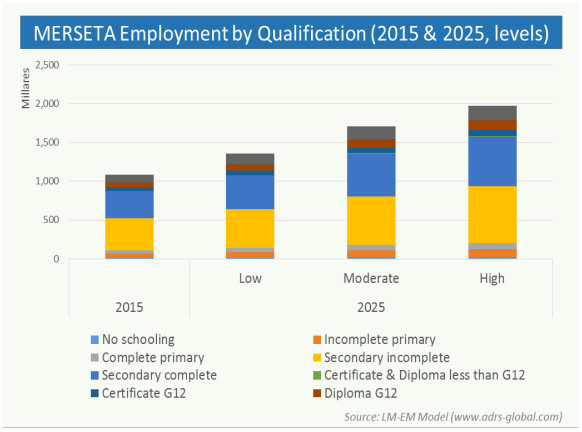


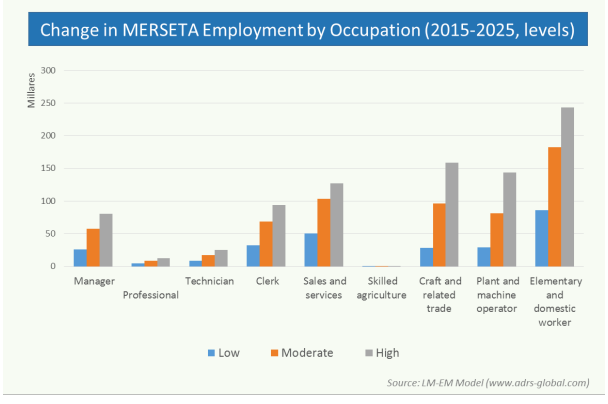
MERSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	94,936	121,023	152,356	175,349
Professional	13,205	17,791	21,867	25,567
Technician	28,216	37,159	45,892	53,766
Clerk	108,847	141,325	177,578	202,785
Sales and services	145,428	195,695	249,209	272,507
Skilled agriculture	1,365	1,675	2,080	2,611
Craft and related trade	242,680	271,061	339,403	401,697
Plant and machine operator	175,157	204,396	256,887	318,903
Elementary and domestic worker	277,964	363,891	460,846	521,533
Total	**1,087,799**	**1,354,016**	**1,706,118**	**1,974,718**

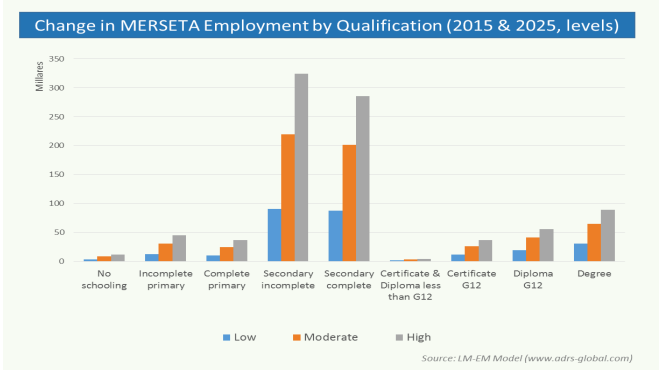
Source: LM-EM (www.adrs-global.com)

MERSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	13,979	17,478	22,096	25,574
Incomplete primary	55,087	67,554	85,237	99,751
Complete primary	45,554	55,717	70,278	82,225
Secondary incomplete	406,277	496,500	625,698	730,157
Secondary complete	349,741	437,074	550,914	634,750
Certificate & Diploma less than G12	5,048	6,314	7,950	9,165
Certificate G12	44,382	56,102	70,654	81,183
Diploma G12	65,193	84,146	105,957	120,793
Degree	102,538	133,131	167,333	191,121
Total	**1,087,798**	**1,354,016**	**1,706,118**	**1,974,718**

Source: LM-EM (www.adrs-global.com)



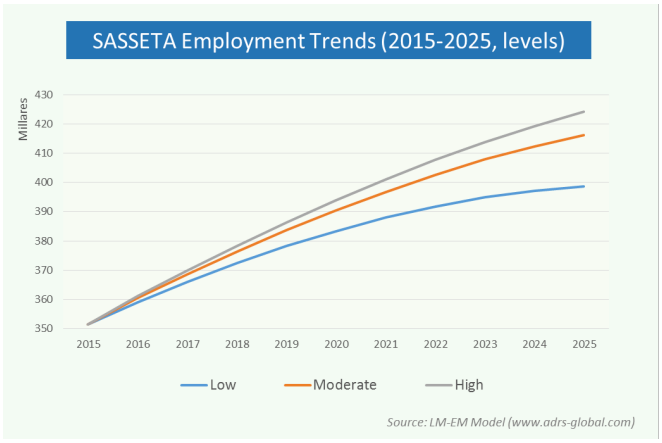


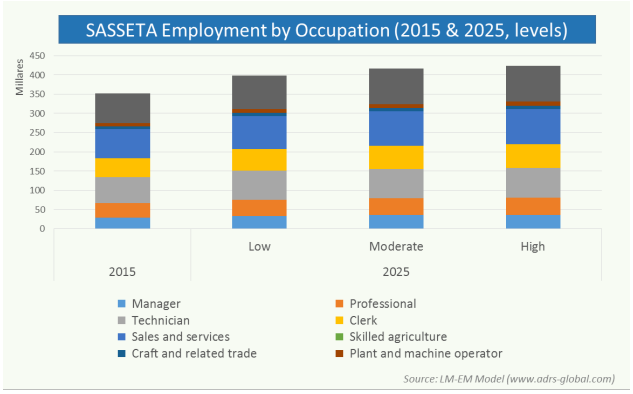


SAFETY & SECURITY SECTOR EDUCATION & TRAINING AUTH. (SASSETA)

SASSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	351,500	351,500	351,500
2016	359,016	360,445	361,118
2017	366,032	368,643	369,908
2018	372,385	376,375	378,300
2019	378,211	383,652	386,334
2020	383,374	390,468	393,915
2021	387,966	396,756	401,072
2022	391,773	402,509	407,662
2023	394,872	407,869	413,710
2024	397,160	412,338	419,210
2025	398,638	416,145	424,119

Source: LM-EM (www.adrs-global.com)



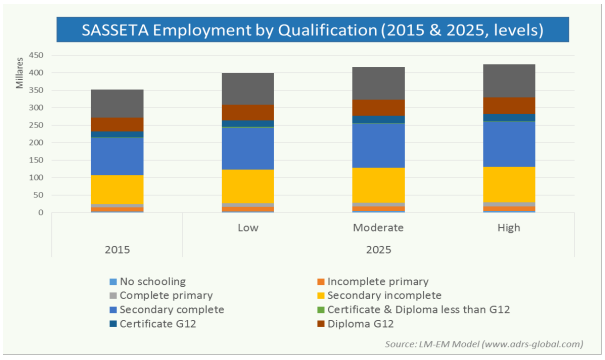


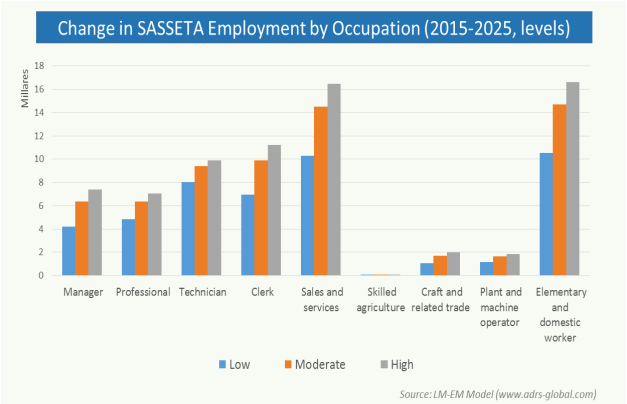
SASSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	28,754	32,968	35,108	36,130
Professional	37,193	42,024	43,567	44,249
Technician	67,422	75,459	76,835	77,328
Clerk	50,245	57,195	60,114	61,472
Sales and services	74,797	85,087	89,323	91,287
Skilled agriculture	466	528	549	559
Craft and related trade	7,020	8,094	8,704	9,000
Plant and machine operator	8,350	9,504	9,987	10,212
Elementary and domestic worker	77,252	87,779	91,957	93,882
Total	**351,500**	**398,638**	**416,145**	**424,119**

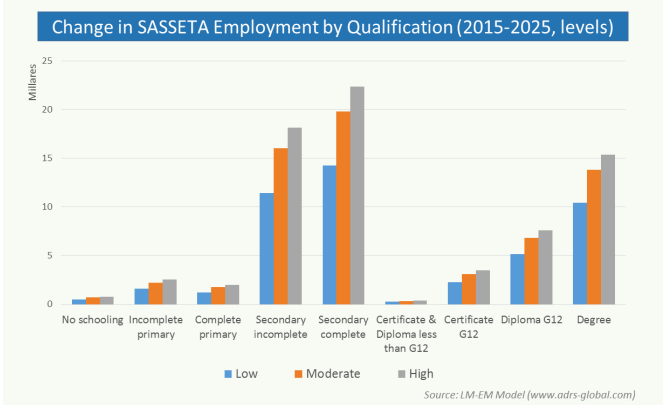
Source: LM-EM (www.adrs-global.com)

SASSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	3,629	4,128	4,332	4,426
Incomplete primary	11,571	13,159	13,806	14,105
Complete primary	9,072	10,319	10,831	11,069
Secondary incomplete	83,697	95,135	99,724	101,843
Secondary complete	105,373	119,641	125,160	127,692
Certificate & Diploma less than G12	1,947	2,205	2,295	2,336
Certificate G12	17,217	19,513	20,344	20,720
Diploma G12	39,241	44,377	46,081	46,841
Degree	79,752	90,162	93,571	95,086
Total	**351,499**	**398,638**	**416,144**	**424,119**

Source: LM-EM (www.adrs-global.com)



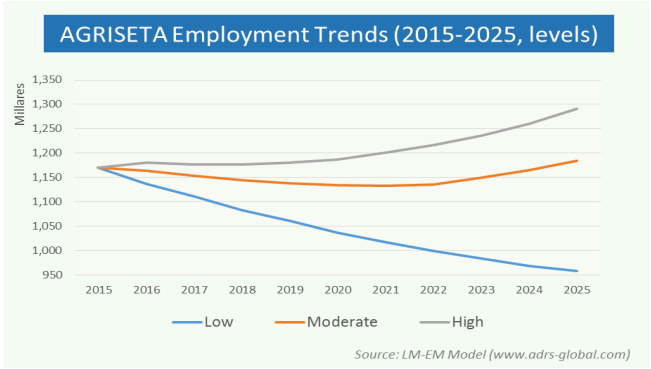


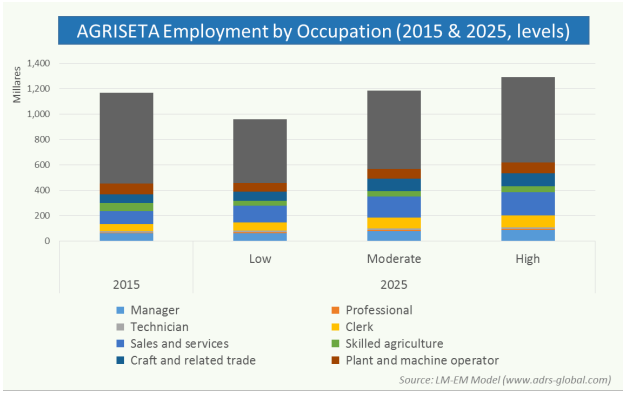


AGRICULTURAL SECTOR EDUCATION & TRAINING AUTHORITY (AGRISETA)

AGRISETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,169,620	1,169,620	1,169,620
2016	1,137,111	1,163,578	1,180,757
2017	1,110,707	1,153,056	1,177,005
2018	1,083,394	1,144,566	1,177,039
2019	1,060,640	1,138,109	1,180,102
2020	1,036,678	1,133,770	1,187,209
2021	1,017,329	1,133,121	1,200,518
2022	998,958	1,135,271	1,216,895
2023	984,292	1,149,830	1,235,285
2024	969,122	1,164,623	1,260,381
2025	958,545	1,184,334	1,290,709

Source: LM-EM (www.adrs-global.com)



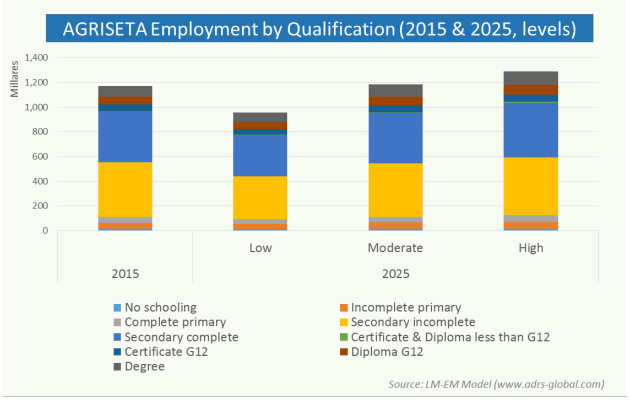


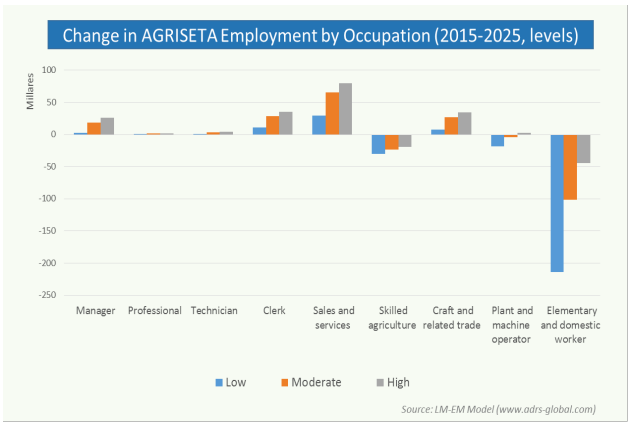
AGRISETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	61,737	64,065	80,347	87,390
Professional	5,217	5,616	6,743	7,221
Technician	11,840	12,645	15,203	16,256
Clerk	55,179	66,313	83,631	90,779
Sales and services	101,928	131,431	167,150	181,738
Skilled agriculture	66,191	35,838	42,864	47,127
Craft and related trade	68,308	75,595	94,916	102,805
Plant and machine operator	84,058	65,366	79,514	86,217
Elementary and domestic worker	715,161	501,675	613,967	671,176
Total	**1,169,620**	**958,545**	**1,184,334**	**1,290,709**

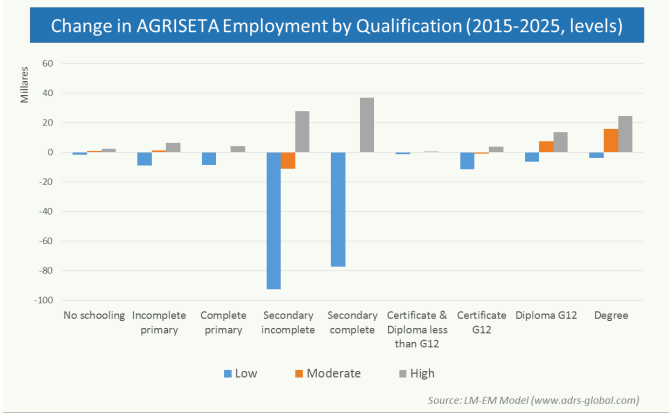
Source: LM-EM (www.adrs-global.com)

AGRISETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	13,397	11,697	14,522	15,818
Incomplete primary	51,799	43,127	53,336	58,105
Complete primary	45,246	36,845	45,506	49,591
Secondary incomplete	442,006	349,628	431,022	469,923
Secondary complete	406,732	329,383	406,895	443,619
Certificate & Diploma less than G12	5,691	4,627	5,714	6,228
Certificate G12	55,897	44,537	54,934	59,901
Diploma G12	63,614	57,340	71,214	77,514
Degree	85,239	81,361	101,193	110,010
Total	**1,169,619**	**958,544**	**1,184,335**	**1,290,709**

Source: LM-EM (www.adrs-global.com)



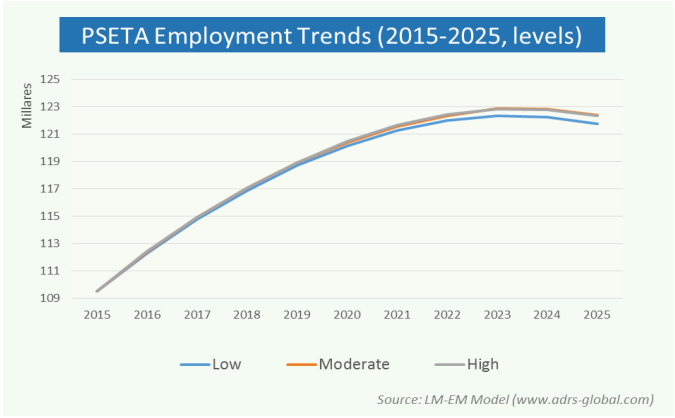


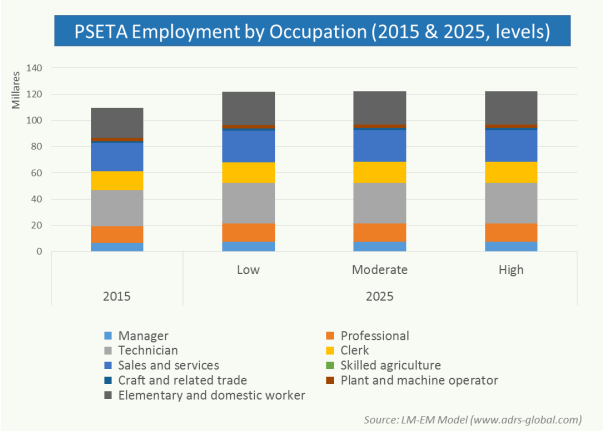


PUBLIC SERVICE SECTOR EDUCATION AND TRAINING AUTHORITY (PSETA)

PSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	109,506	109,506	109,506
2016	112,285	112,423	112,470
2017	114,769	114,917	114,941
2018	116,893	117,074	117,098
2019	118,710	118,911	118,949
2020	120,166	120,413	120,467
2021	121,288	121,574	121,654
2022	122,018	122,363	122,446
2023	122,360	122,858	122,820
2024	122,255	122,821	122,794
2025	121,743	122,364	122,322

Source: LM-EM (www.adrs-global.com)



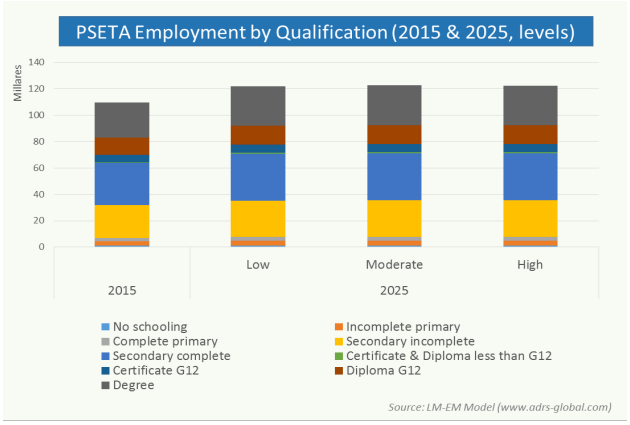


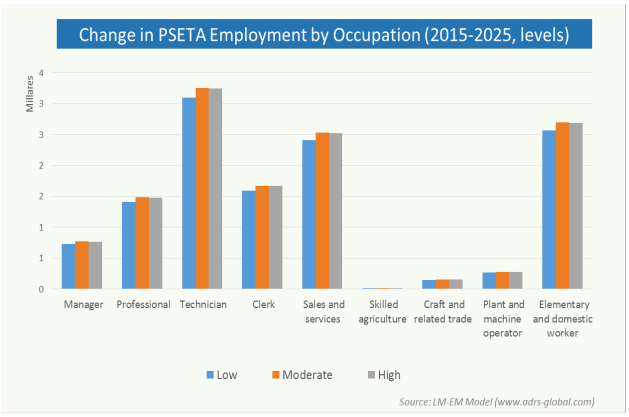
PSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	6,558	7,290	7,328	7,325
Professional	12,638	14,050	14,122	14,117
Technician	27,728	30,826	30,984	30,973
Clerk	14,238	15,830	15,910	15,905
Sales and services	21,570	23,980	24,103	24,094
Skilled agriculture	151	168	169	169
Craft and related trade	1,302	1,448	1,455	1,455
Plant and machine operator	2,374	2,639	2,652	2,651
Elementary and domestic worker	22,947	25,511	25,641	25,633
Total	**109,506**	**121,743**	**122,364**	**122,322**

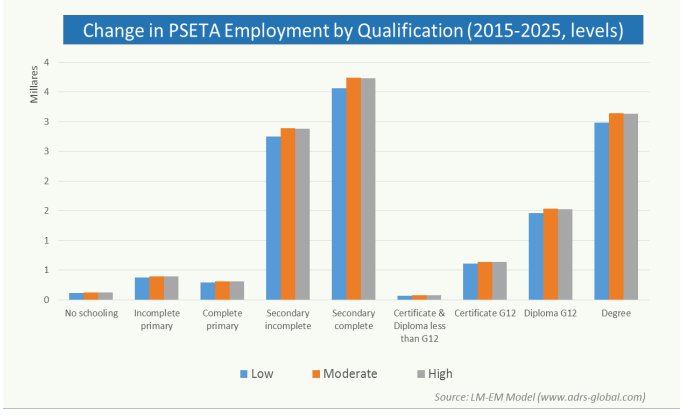
Source: LM-EM (www.adrs-global.com)

PSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	1,051	1,169	1,175	1,174
Incomplete primary	3,366	3,742	3,761	3,759
Complete primary	2,620	2,913	2,928	2,927
Secondary incomplete	24,647	27,402	27,541	27,532
Secondary complete	31,909	35,475	35,656	35,644
Certificate & Diploma less than G12	628	698	702	702
Certificate G12	5,454	6,063	6,094	6,092
Diploma G12	13,074	14,535	14,609	14,604
Degree	26,757	29,746	29,899	29,888
Total	**109,506**	**121,742**	**122,364**	**122,322**

Source: LM-EM (www.adrs-global.com)



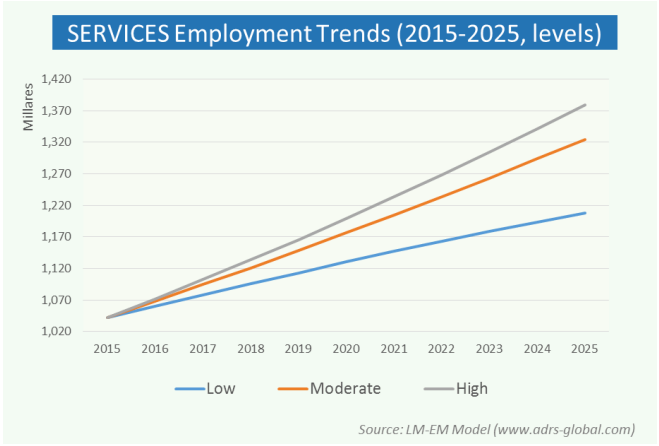


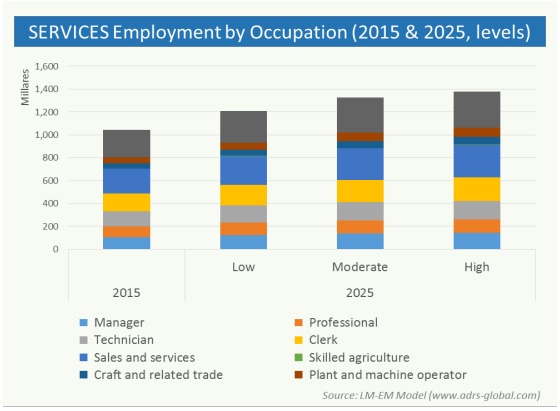


SERVICES SECTOR EDUCATION AND TRAINING AUTHORITY (SERVICES)

SERVICES Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,041,971	1,041,971	1,041,971
2016	1,059,919	1,067,828	1,071,706
2017	1,077,827	1,094,151	1,102,188
2018	1,095,432	1,120,996	1,133,413
2019	1,112,982	1,148,375	1,165,701
2020	1,130,076	1,176,243	1,198,803
2021	1,147,013	1,204,484	1,232,981
2022	1,163,043	1,233,214	1,267,902
2023	1,178,680	1,263,112	1,303,779
2024	1,193,630	1,293,450	1,340,643
2025	1,207,687	1,324,190	1,378,701

Source: LM-EM (www.adrs-global.com)



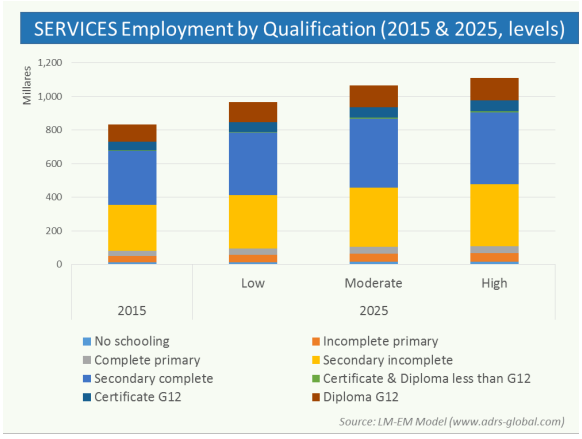


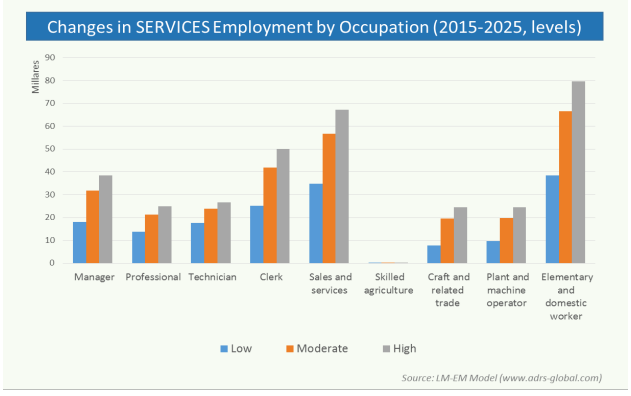
SERVICES Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	105,802	123,820	137,675	144,302
Professional	93,083	106,924	114,427	118,006
Technician	133,497	151,090	157,340	160,114
Clerk	155,042	180,146	196,991	205,075
Sales and services	217,393	252,303	274,198	284,718
Skilled agriculture	1,208	1,392	1,496	1,546
Craft and related trade	43,421	51,114	62,985	68,042
Plant and machine operator	54,543	64,369	74,454	79,158
Elementary and domestic worker	237,982	276,531	304,623	317,740
Total	**1,041,971**	**1,207,687**	**1,324,190**	**1,378,701**

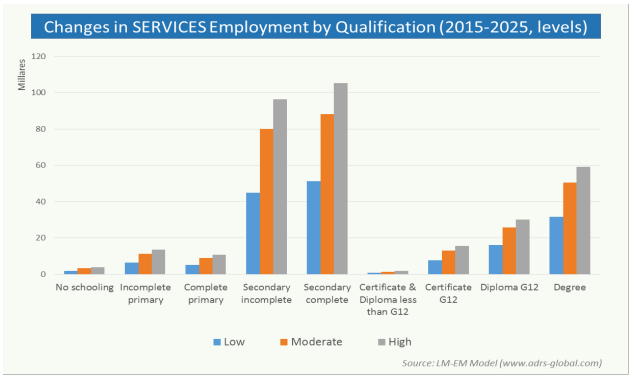
Source: LM-EM (www.adrs-global.com)

SERVICES Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	11,620	13,521	14,902	15,553
Incomplete primary	38,422	44,741	49,604	51,879
Complete primary	30,430	35,445	39,377	41,212
Secondary incomplete	274,154	318,993	354,247	370,615
Secondary complete	319,711	371,012	407,883	425,133
Certificate & Diploma less than G12	5,496	6,356	6,933	7,203
Certificate G12	49,374	57,148	62,403	64,867
Diploma G12	104,245	120,226	129,916	134,482
Degree	208,518	240,247	258,925	267,755
Total	**1,041,971**	**1,207,689**	**1,324,189**	**1,378,701**

Source: LM-EM (www.adrs-global.com)



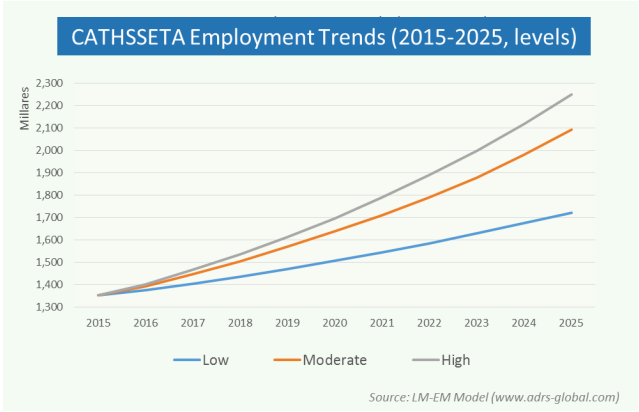


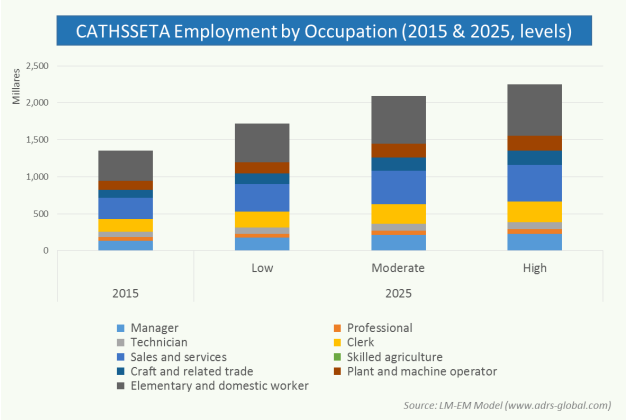


CULTURE ARTS TOURISM HOSPITALITY AND SPORT (CATHSETA) SETA

CATHSSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,352,381	1,352,381	1,352,381
2016	1,376,119	1,391,483	1,399,372
2017	1,403,881	1,445,379	1,464,930
2018	1,434,531	1,504,393	1,534,931
2019	1,468,491	1,568,104	1,612,115
2020	1,505,202	1,636,703	1,695,959
2021	1,543,520	1,710,203	1,789,368
2022	1,584,746	1,789,430	1,890,151
2023	1,628,667	1,877,653	1,999,087
2024	1,674,916	1,980,857	2,117,431
2025	1,721,674	2,092,409	2,247,801

Source: LM-EM (www.adrs-global.com)



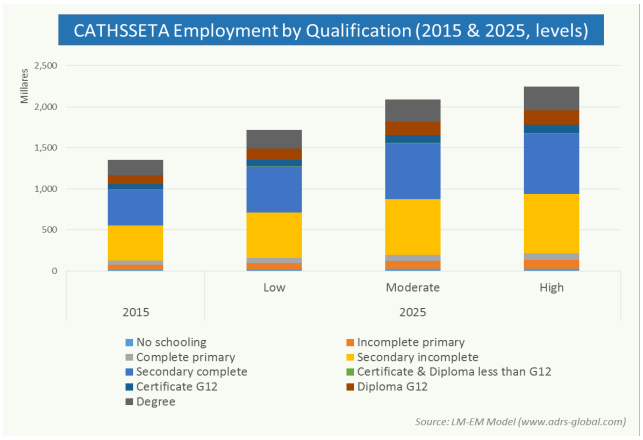


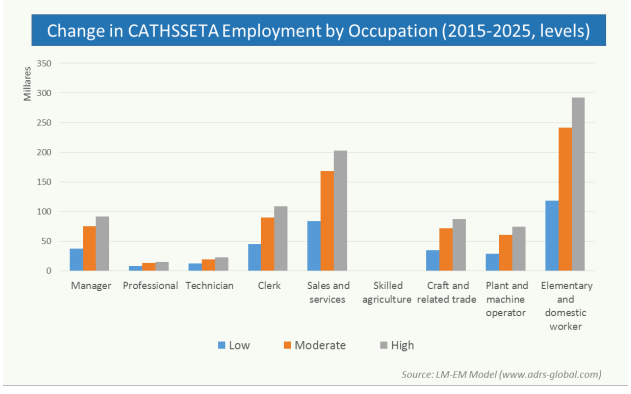
CATHSSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	136,991	174,459	212,614	228,785
Professional	46,223	54,094	59,372	61,744
Technician	73,132	85,244	92,548	95,632
Clerk	171,473	216,751	261,397	280,270
Sales and services	288,944	373,004	456,905	491,542
Skilled agriculture	953	982	1,124	1,190
Craft and related trade	107,367	142,275	179,316	194,529
Plant and machine operator	122,106	151,081	182,817	197,022
Elementary and domestic worker	405,194	523,785	646,315	697,086
Total	**1,352,381**	**1,721,674**	**2,092,409**	**2,247,801**

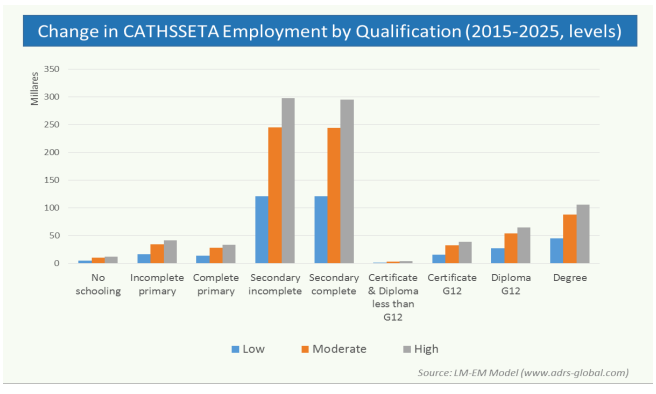
Source: LM-EM (www.adrs-global.com)

CATHSSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	17,708	22,695	27,795	29,933
Incomplete primary	60,760	77,722	95,189	102,538
Complete primary	48,937	62,677	76,854	82,813
Secondary incomplete	429,547	550,546	675,027	727,214
Secondary complete	435,825	557,214	679,883	731,153
Certificate & Diploma less than G12	6,584	8,355	10,109	10,843
Certificate G12	60,187	76,472	92,665	99,442
Diploma G12	107,015	134,653	161,181	172,298
Degree	185,820	231,341	273,705	291,567
Total	**1,352,383**	**1,721,675**	**2,092,408**	**2,247,800**

Source: LM-EM (www.adrs-global.com)



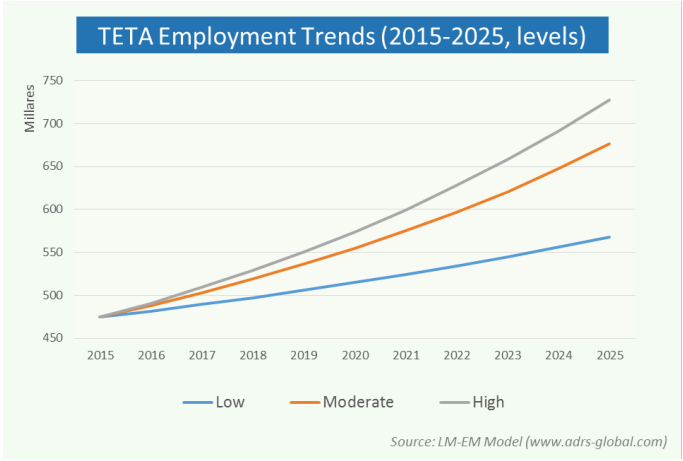


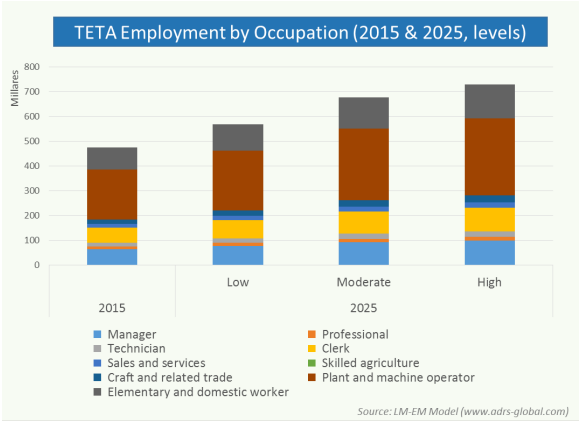


TRANSPORT EDUCATION AND TRAINING AUTHORITY (TETA)

TETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	474,679	474,679	474,679
2016	481,801	487,987	490,746
2017	489,289	503,070	509,235
2018	497,332	519,094	528,867
2019	505,845	536,382	550,271
2020	514,866	554,890	573,727
2021	524,421	574,981	599,415
2022	534,471	596,706	627,725
2023	545,109	620,681	658,444
2024	556,320	647,777	691,642
2025	567,919	676,684	727,877

Source: LM-EM (www.adrs-global.com)



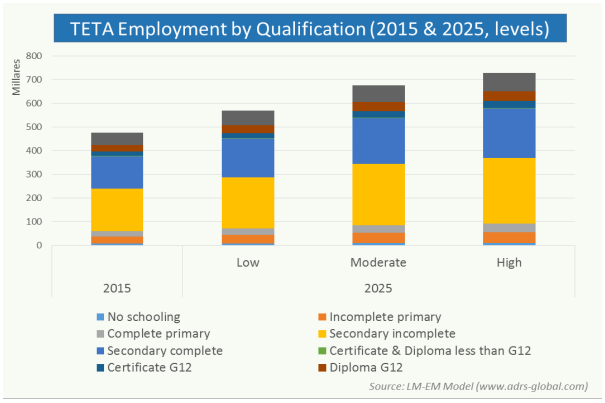


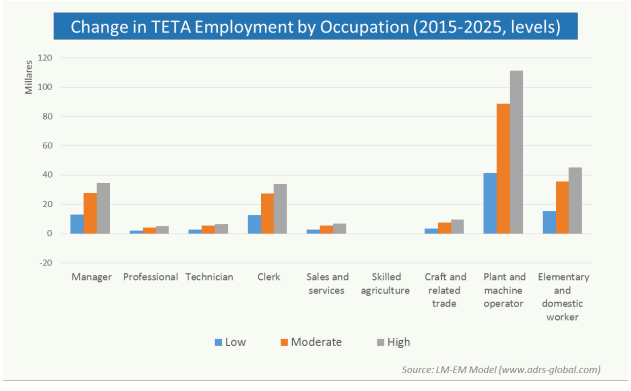
TETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	63,100	75,988	90,756	97,702
Professional	10,559	12,591	14,731	15,733
Technician	14,759	17,476	20,175	21,434
Clerk	62,736	75,533	90,008	96,811
Sales and services	14,386	17,079	19,863	21,165
Skilled agriculture	547	307	363	397
Craft and related trade	17,532	21,090	25,203	27,138
Plant and machine operator	200,767	242,092	289,637	312,002
Elementary and domestic worker	90,293	105,763	125,948	135,497
Total	**474,679**	**567,919**	**676,684**	**727,877**

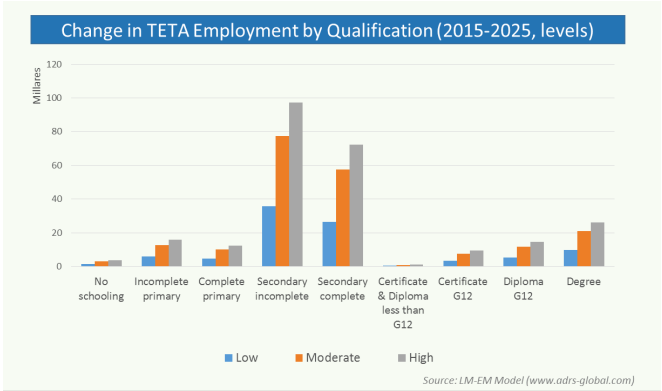
Source: LM-EM (www.adrs-global.com)

TETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	6,936	8,322	9,931	10,688
Incomplete primary	29,385	35,272	42,119	45,341
Complete primary	23,045	27,641	33,007	35,533
Secondary incomplete	180,783	216,430	258,335	278,066
Secondary complete	136,340	162,850	194,024	208,703
Certificate & Diploma less than G12	2,001	2,389	2,843	3,056
Certificate G12	18,160	21,666	25,781	27,719
Diploma G12	27,706	33,117	39,282	42,180
Degree	50,322	60,230	71,363	76,593
Total	**474,679**	**567,919**	**676,684**	**727,879**

Source: LM-EM (www.adrs-global.com)



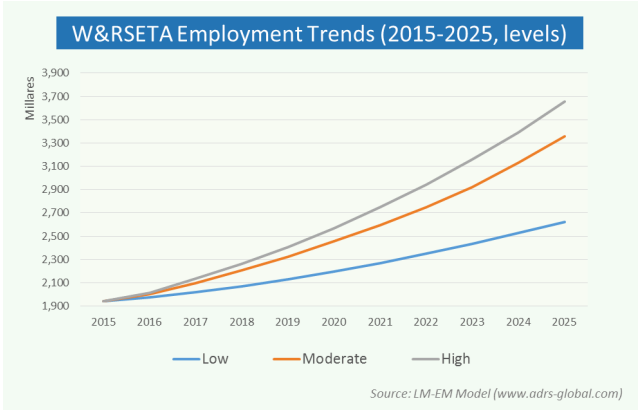


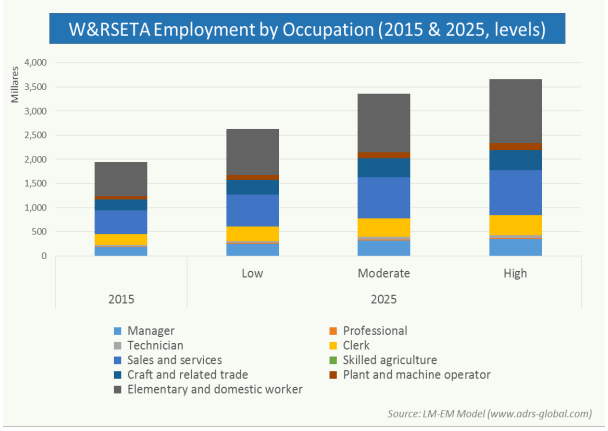


WHOLESALE & RETAIL (W&RSETA)

W&RSETA Employment (2015-2025)			
Year	Low	Moderate	High
2015	1,941,117	1,941,117	1,941,117
2016	1,975,422	2,001,647	2,015,666
2017	2,019,848	2,097,911	2,134,614
2018	2,071,731	2,206,037	2,263,376
2019	2,131,915	2,324,695	2,407,949
2020	2,199,267	2,454,348	2,567,036
2021	2,270,663	2,594,908	2,747,529
2022	2,349,989	2,748,224	2,943,855
2023	2,436,303	2,921,596	3,157,934
2024	2,528,835	3,129,785	3,392,933
2025	2,623,478	3,357,340	3,654,692

Source: LM-EM (www.adrs-global.com)





W&RSETA Employment by Occupation				
Occupations	2015	2025		
		Low	Moderate	High
Manager	185,813	251,132	321,381	349,845
Professional	11,999	16,217	20,753	22,591
Technician	26,966	36,445	46,640	50,770
Clerk	220,759	298,363	381,823	415,641
Sales and services	494,934	668,918	856,033	931,850
Skilled agriculture	524	708	906	986
Craft and related trade	224,603	303,557	388,471	422,877
Plant and machine operator	73,961	99,960	127,922	139,251
Elementary and domestic worker	701,559	948,178	1,213,411	1,320,880
Total	**1,941,117**	**2,623,478**	**3,357,340**	**3,654,692**

Source: LM-EM (www.adrs-global.com)

W&RSETA Employment by Qualification				
Qualifications	2015	2025		
		Low	Moderate	High
No schooling	26,791	36,208	46,337	50,441
Incomplete primary	88,705	119,888	153,424	167,012
Complete primary	72,653	98,193	125,660	136,790
Secondary incomplete	651,093	879,971	1,126,125	1,225,863
Secondary complete	658,091	889,429	1,138,228	1,239,039
Certificate & Diploma less than G12	9,270	12,528	16,033	17,453
Certificate G12	85,789	115,946	148,379	161,521
Diploma G12	138,497	187,183	239,543	260,759
Degree	210,229	284,131	363,611	395,815
Total	**1,941,118**	**2,623,478**	**3,357,340**	**3,654,691**

Source: LM-EM (www.adrs-global.com)