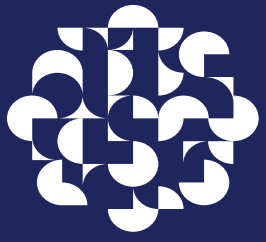
Expansion and Diversification in the MER Sector:

Results from an Enterprise Survey

By Caitlin Allen Whitehead, Haroon Bhorat, Robert Hill, Timothy Köhler and François Steenkamp

DPRU Working Paper 202203
November 2022



DPRU
DEVELOPMENT POLICY
RESEARCH UNIT

DPRU

DEVELOPMENT POLICY
RESEARCH UNIT

Expansion and Diversification in the MER Sector:

Results from an Enterprise Survey

DEVELOPMENT POLICY RESEARCH UNIT

CAITLIN ALLEN WHITEHEAD

HAROON BHORAT

ROBERT HILL

TIMOTHY KÖHLER

FRANÇOIS STEENKAMP

Working Paper 202203

ISBN 978-1-920633-95-0

November 2022

Abstract

This paper details the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities – as identified in Allen-Whitehead and Bhorat (2021) – in the Manufacturing, Engineering and Related Services (MER) sector (a core component of South Africa's broader manufacturing sector). Specific focus is placed on the extent to which the skills of the MER sector workforce constrain, and/or enable, the realisation of these industrial diversification opportunities. These research objectives are addressed by conducting statistical analysis on representative establishment-level data obtained from the 2021 MER Sector Enterprise Survey. The paper offers an analysis of the MER Sector Enterprise Survey dataset by describing the distribution and characteristics of MER sector establishments, the employment and skill structure of these establishments, and their productive structure. We examine the constraints these establishments face in realising frontier product growth and diversification, with specific focus on skills constraints, and the extent to which these establishments face skill shortages and skill mismatches. Drawing on these findings, the paper offers a policy discussion that provides critical input into industrial, innovation and education policy specific to the MER sector, and the manufacturing sector more broadly.

JEL codes:
O13; O14; O25

Keywords:
Economic complexity; manufacturing; industrial relatedness; product space; structural transformation; expansion; intensification; diversification; skills constraints

Acknowledgements:
We thank Dr Andrew Kerr (University of Cape Town) for providing input into the survey methodology applied to conduct the MER Sector Enterprise Survey. We thank Dr Ariane Neethling (University of the Free State) for input into sample design, post-survey adjustment and weight calculation.

Corresponding authors

François Steenkamp, Senior Research Officer
francois.steenkamp@uct.ac.za

Recommended citation

Allen Whitehead, C., Bhorat, H., Hill, R., Köhler, T. and Steenkamp, F. (2022). Expansion and Diversification in the MER Sector: Results from an Enterprise Survey. Development Policy Research Unit Working Paper 202203. DPRU, University of Cape Town.

Table of Contents

LIST OF FIGURES

List of Tables

List of Technical Boxes

1 INTRODUCTION

The premature deindustrialisation of the South African economy is one of the key factors behind the country being locked in a long-run economic growth trap.[1] Over the past two decades, GDP per capita growth has averaged 0.95 percent per year.[2] This lacklustre growth performance is put into perspective when considering that the corresponding average annual per capita growth rates for the global economy, as a whole, and for the sample of middle-income countries , was 1.71 and 4.26 percent, respectively. Over the corresponding period, the South African economy has been deindustrialising, although arguably, and as shown in Bhorat, Lilenstein, Oosthuizen & Steenkamp (2022), this process has been underway since the 1980s.[3] This pattern of structural change is troubling, as developing economies, mostly in Asia, have experienced rapid economic growth and graduated to higher levels of economic development, and achieved this through the industrialisation of their economies (Rodrik, 2016).

Allen Whitehead & Bhorat (2021) view this economic development challenge through the lens of economic complexity theory, and examine the role of the Manufacturing, Engineering and Related Services (MER) sector in driving the process of reindustrialisation, and thus growth-inducing structural change.[4] The authors map the manufacturing component of the MER sector to international trade data, and estimate the product complexity of MER sector products, and then develop an aggregate measure of the economic complexity of the MER sector, and its equivalent across countries. They find that MER sector products are, on average, more complex than other traded products, thus suggesting that diversification towards MER sector products is likely to build the economic complexity of the South African economy. In terms of the economic complexity of the MER sector, South Africa's MER sector is in line with that of other middle-income economies looking to industrialise.[5] Using network analytics and the concept of product relatedness, they develop a *MER sector product space*, akin to the *product space* network developed by Hidalgo et al. (2007). They show that the MER sector in South Africa has several automotive, plastic and rubber products positioned at the core of the *product space*, which suggests the presence of industrial capabilities from which to leverage future diversification efforts. Drawing on the notion of *smart specialisation*, and applying a method developed by Hausmann & Chauvin (2015), they identify a set of product-level industrial diversification opportunities – namely, MER sector *frontier products* – that provide a pathway to the reindustrialisation of the South African economy.

[1] The notion of the South African economy being stuck in a long-run growth trap, or middle-income growth trap, has been described in, amongst others, Bhorat, Cassim & Hirsch (2014) and in Andreoni & Tregenna (2021).

[2] Average GDP per capita growth rates are calculated for the period 2000 to 2021 using data from the World Bank's World Development Indicators (World Bank, 2022).

[3] In 1980, the manufacturing sector's share of employment was at its historical height of 16.5 percent (Timmer et al., 2015). The deindustrialisation pathway shows a consistent decline in the sector's share of employment, reducing to 13 percent in 2000, 11.4 percent in 2010, and 9.3 percent in 2018 (Timmer et al., 2015; De Vries et al., 2021).

[4] The MER sector comprises several key manufacturing sub-sectors within the South African economy – automotive manufactures, automotive component manufacturers, metal and machinery manufactures, plastic product manufactures and rubber product manufactures. The MER sector represents approximately half of the overall manufacturing sector in South Africa, with the manufacturing component of the MER sector accounting for 45.69 percent of manufacturing income (Statistics SA, 2019), and 50 percent of manufacturing exports in 2017 (The Growth Lab at Harvard University, 2019).

[5] The MER sector Economic Complexity Index developed by Allen Whitehead & Bhorat (2021) shows that South Africa's MER sector is ranked as the 54th most complex out of 121 countries and is at a similar level to other middle-income economies, such as Brazil, Russia and Tunisia.

This paper details the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities in the MER sector – as identified in Allen Whitehead & Bhorat (2021). The paper considers the constraints facing MER sector establishments looking to grow and diversify frontier product markets. Specific focus is placed on whether the skills of the MER sector workforce act as a constraint to the realisation of these industrial diversification opportunities. In doing so, we examine the importance of skills constraints in relation to a broader set of constraints facing the sector. We also examine the extent to which these constraints vary in incidence and intensity across establishment size. In particular, looking through the SMME lens, we identify the role and importance of skills in realising these frontier product industrialisation opportunities. We address these research objectives by conducting statistical analysis on data obtained from the MER Sector Enterprise Survey 2021.

As part of this research, we undertook to develop and implement an establishment level survey focused on establishments engaged in manufacturing activity in the automotive, automotive component, metals, plastics, and new tyre chambers (or sub-sectors) of the MER sector – The MER Sector Enterprise Survey. We developed a survey instrument that was designed to capture establishment level data on manufacturing and production, employment and skills, constraints to current production, opportunities and constraints to diversification, and financial information. Product-level information on products currently manufactured by establishments and the products that establishments aim to diversify toward in the future, allowed us to link establishment level information on constraints to frontier product industrialisation opportunities. Using administrative data from merSETA, we compiled a sample frame of manufacturing establishments in the MER sector, and from these data, drew a representative sample of establishments to interview. The survey was implemented, and interviews conducted by a survey company – Citizen Surveys. After implementing post-survey adjustment procedures, design weights for the survey were calculated to ensure a representative sample. These data are analysed in this paper.

This paper is structured as follows: In Section 2, drawing on Allen Whitehead & Bhorat (2021), we review the concepts of economic complexity and relatedness, and outline how these concepts are used to determine frontier product industrial diversification opportunities in the MER sector. We explain the conceptual framework behind how we link the survey data on products that establishments currently manufacture, and those that they aim to diversify toward in the future, with the MER sector frontier product list developed in Allen Whitehead & Bhorat (2021).

In Section 3, we detail the survey methodology applied to the MER Sector Enterprise Survey. We detail the various aspects behind the preparation and implementation of the survey. These include: the design of the survey instrument in relation to the objectives of the study, the sampling methodology used to draw a representative sample of MER sector manufacturing establishments, the implementation of the pilot and main phases of the survey, the challenges faced, and post-survey adjustment procedures.

In Section 4, we introduce the MER Sector Enterprise Survey dataset. We describe the sample of the 254 manufacturing establishments that completed the survey, and detail their

distribution across the sectoral, firm size and location strata. These data are then used in the analysis in Section 5.

In Section 5, we start by describing MER sector manufacturing establishments, with particular focus on the employment structure and productive structure of these establishments. We detail the constraints facing MER sector manufacturing establishments, and distinguish between establishments looking to intensify their production of frontier products, and those aiming to diversify into frontier products in the near future. On the other side of the constraints coin, we consider the capabilities that are required for these industrial diversification opportunities to be realized. The analysis places specific focus on skill constraints, where we detail the skill profile of MER sector manufacturing establishments, and identify skills gaps and skill shortages evident in the sector. We also identify the specific set of skills, at the frontier product-level, that are needed for MER sector manufacturing establishments to take advantage of the identified industrial diversification opportunities.

In Section 6, we provide a policy discussion, which draws from the findings in Section 5. The detailing of the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities, provides critical input into industrial, innovation and education policy specific to the MER sector, and the manufacturing sector more broadly. Section 7 concludes.

2 Building Economic Complexity in the MER Sector

In this section, drawing on Allen Whitehead & Bhorat (2021), we provide a brief outline of the conceptual underpinnings behind the identification of frontier product industrial diversification opportunities for the MER sector. We refer to the notions of economic complexity and industrial relatedness, and how the empirical measures behind these concepts are used to identify industrial diversification opportunities that are feasible given current industrial capabilities, and desirable given the economic complexity premium that will emerge from their production. We then detail the conceptual framework behind how we use data extracted from the MER Sector Enterprise Survey to examine the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities.

2.1 Economic Complexity: Building a Complex Growing Economy

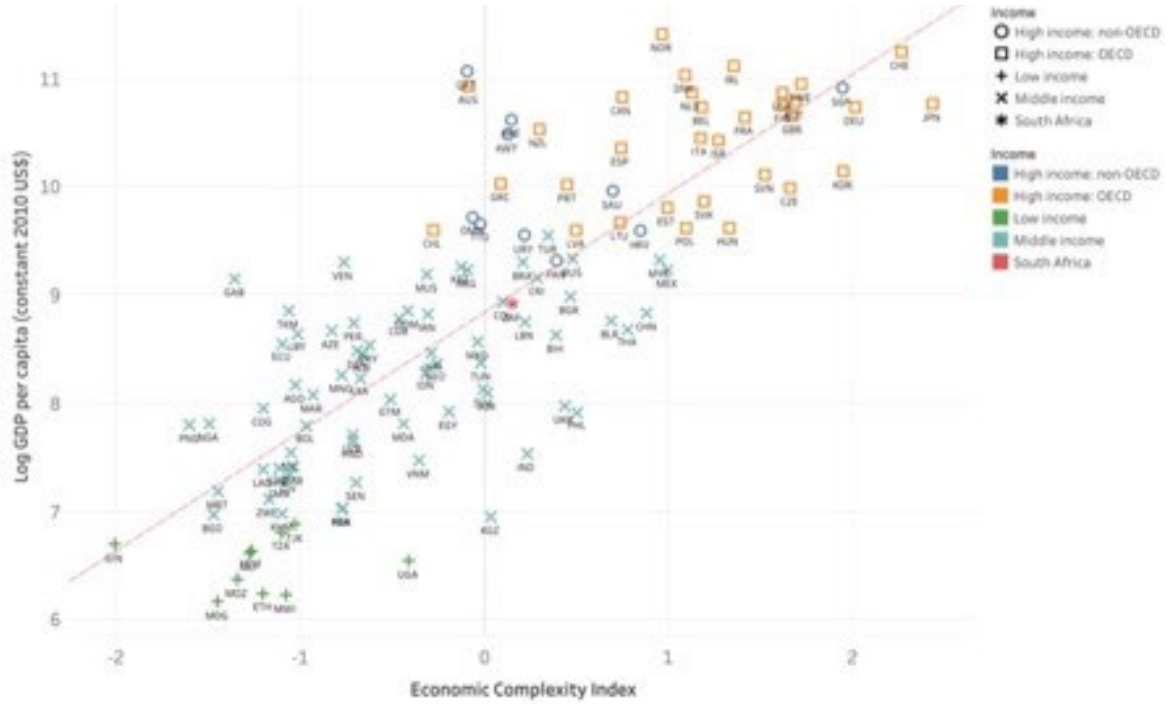
The concept of economic complexity is used to explain divergent patterns of economic development and growth across countries and regions. The central idea is that countries or regions that accumulate a greater range of capabilities and productive knowledge are able to productively engage in a widening array of increasingly complex economic activities. A direct measure of these capabilities does not exist, and thus dimensionality reduction techniques are applied to data on the geography of activities – such as product exports by country – to generate complexity metrics, including the economic complexity index (ECI) and product complexity index (PCI).[6]

[6] A detailed discussion on notion of economic complexity, how it is measured, and its applications can be found in Hidalgo (2021). A contextual discussion related to the MER sector on the topic can be found in Allen Whitehead & Bhorat (2021).

Building a country or region's economy complexity, and hence its capabilities and productive knowledge, is a desirable endeavour. This is substantiated by two stylized facts to emerge from the economic complexity literature: First, higher levels of economic complexity in countries or regions are associated with higher levels of economic development (Hausmann et al., 2014). Second, economic complexity is a significant predictor of future economic growth (Hidalgo & Hausmann, 2009).

Figure 1, which shows the relationship between economic complexity and economic development, provides a graphical depiction of these stylized facts. First, the positive relationship between the economic complexity index and the natural logarithm of GDP per capita, indicates that more complex economies tend to be more developed. Low-income economies (denoted by green cross), such as Ethiopia (ETH) and Malawi (MWI), are located in the low complexity south-west quadrant. High-income economies (denoted by orange squares), such as Germany (DEU) and Japan (JPN), are located in the high complexity north east quadrant. Middle-incomes economies (teal crosses), such as South Africa (ZAF), are located in the middle. Second, Hidalgo & Hausmann (2009) show that deviations from the regression line are predictive of future economic growth patterns. Countries with a low level of economic development for their given level of economic complexity, such as Vietnam (VNM), are predicted to experience accelerated economic growth in the future, and thus shift toward the regression line. Conversely, countries with a high level of economic development for their given level of economic complexity, such as Argentina (ARG), are predicted to experience slowing economic growth in the future.

Figure 1: Relationship between GDP per capita and ECI, 2016



Source: author's own calculations based on World Bank (2019) and The Growth Lab at Harvard University (2019).
Note: 1. Red dashed line is line of best fit (correlation=0.808, p-value=0.000). 2. The Syrian Arab Republic is excluded as no GDP per capita information was available for the period.

Thus, diversifying into more complex economic activities or products, builds economic complexity, and leads to the *desirable* outcome of higher levels of economic growth and

development. Key to this process is accumulating the requisite capabilities and productive knowledge.

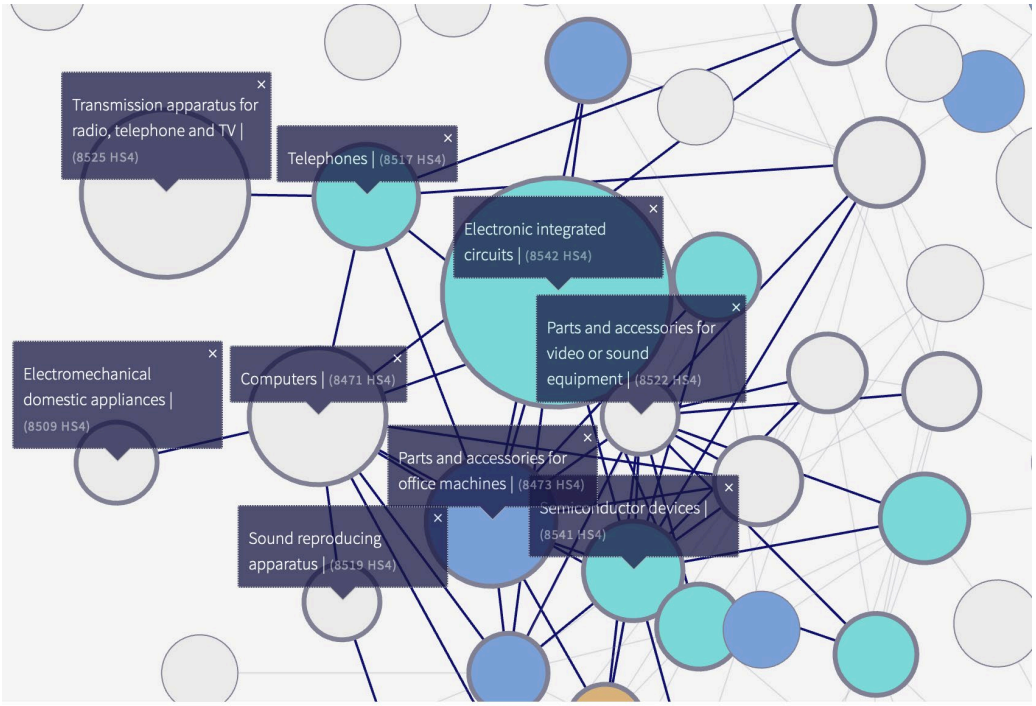
2.2 Industrial Relatedness: Feasible Paths to Diversification and Growth

The notion of industrial relatedness is the key idea behind how a country or region can diversify into new economic activities and thereby build economic complexity. Relatedness speaks to the idea that the success of a country or region in entering a new economic activity (product) depends, in part, on the relatedness (complementarity) between the new activity's required capabilities and productive knowledge, and the country or region's existing capabilities and productive knowledge. As is the case with measuring economic complexity, there is no direct measure of the relatedness of requisite capabilities and productive knowledge, between economic activities (products). Hidalgo et al. (2007) develop an indirect measure or relatedness – proximity – between two economic activities (products) based on the probability that the two activities (products) are both produced (exported) by a given region (country). This measure results in an activity-pair proximity matrix, which is in turn used to generate network diagrams such as the *product space*, the *industry space* and the *occupation space*.[7]

For example, in Figure 2 we show a magnified view of South Korea's product space, taken from the Atlas of Economic Complexity. We observe products that South Korea produces and exports competitively (the shaded nodes in blue and turquoise), such as electronic integrated circuits, telephones, parts and accessories for office machines, and semi-conductor devices. We also observe nearby products that South Korea does not produce and export competitively (unshaded nodes), such as computers, transmission apparatus for radio, telephone and TV, and parts and accessories for video or sound equipment. The notion of relatedness contends that a country is able to diversify from its current productive structure (shaded nodes) into new products (unshaded nodes) because the capabilities and productive knowledge required to diversify into these new products, is similar to those embedded in country's current productive structure – i.e. the nodes are connected. In the case of South Korea, it makes sense that it can diversify from telephones to transmission apparatus for radio, telephone and TV.

[7] Papers by Hidalgo, et al. (2007), Neffke, Henning & Boschma (2011), and Muneerpeerakul, et al. (2013), are useful introductions into describing the development of the *product space*, *industry space* and *occupation space*, respectively. Recent work by Allen Whitehead, Bhorat, Hill, Köhler & Steenkamp (2021) develops an *occupation space* for the MER sector, which allows them to examine the potential employment displacement effects of technologies related to the Fourth Industrial Revolution on the MER sector.

Figure 2: Magnified view of South Korea's product space, 2019



Source: the Atlas of Economic Complexity (Available at: https://atlas.cid.harvard.edu/)

A key stylized fact to emerge from this literature is the principle of relatedness, which states that relatedness predicts the probability that a location increases or decreases its specialisation in an economic activity (product) (Hidalgo, 2021). The premise behind the identification of frontier products exploits the principle of relatedness, in that if a country or region can identify products that are related to its current productive structure, in terms of the capability requirements, then one can use this information to identify *feasible* industrial diversification opportunities.

2.3 Frontier Product Industrial Diversification Opportunities: Feasible Complexity Building Paths to Diversification

The identification of frontier product industrial diversification opportunities for the MER sector involves the bringing together of the above two notions: Firstly, it is *desirable* to diversify into new increasingly complex economic activities (products) that thereby build economic complexity; and secondly, the successful diversification into these new activities involves the selection of related diversification opportunities that are thus feasible given current capabilities and productive knowledge. Looking at Figure 2, transmission apparatus for radio, telephone and TV, and computers, are related (connected) to South Korea's current productive structure, and are thus feasible. If these products are more complex than the South Korean economy on average, then they will be defined as frontier products. Allen Whitehead & Bhorat (2021) apply a method developed by Hausmann & Chauvin (2015), which drawing on these two ideas, identifies a set of product-level industrial diversification opportunities – namely, MER sector *frontier products* – that provide a pathway to the reindustrialisation of the South African economy. The details of the applied method used to identify frontier products for the MER

sector can be found in Allen Whitehead & Bhorat (2021), and a list of these products is reported in Appendix Table A 1.

The methodology used to identify these industrial diversification pathways acts as a useful tool to inform industrial policy interventions – as evidenced in its application in the EUs Smart Specialisation Strategy (S3). The method provides a data centric empirical approach to the identification of feasible, growth-inducing, product-level, industrial pathways.[8] While a number of research papers, aimed at either the research audience or the policy audience, use and adapt this approach to identifying industrial pathways, very few provide a robust quantitative assessment of the constraints and capabilities associated with these industrial pathways.

2.4 Identifying Constraints to Frontier Products: Using the MER Sector Enterprise Survey

This paper builds off the work by Allen Whitehead & Bhorat (2021), and identifies the constraints to overcome, and the capabilities required, to bring about the realisation of these frontier product industrial diversification opportunities in the MER sector. This is achieved through the collection and analysis of establishment level data from the MER Sector Enterprise Survey.

The MER Sector Enterprise Survey – the methodology for which is detailed in Section 3 – is designed to capture the following key groupings of information: Firstly, product-level information on an establishment's current productive structure and diversification opportunities that it foresees in the future. Secondly, information on constraints and capabilities that hinder and enable, respectively, the expansion of an establishment's current productive structure and future diversification into new product markets. This means that the survey captures information on establishments that are currently manufacturing MER sector frontier products, in which case we examine the constraints and capabilities that impact on the expansion or intensification of production of these products.[9] The survey also captures information on establishments looking to diversify into MER sector frontier products in the future, in which case we analyse the constraints and capabilities that impact on the ability if these establishments to diversify into these products. In Box 1, we explain the thinking behind the notion that frontier products can grow along these two margins – i.e. intensifying growth of frontier products and diversifying into frontier products.

Box 1: Understanding the margins of frontier product growth

The methodology applied by Allen Whitehead & Bhorat (2021) in identifying frontier products allows for the fact that frontier products, in reality, and hence in the data, can expand along two margins. Firstly, establishments in the MER sector that currently manufacture frontier products can overcome constraints and intensify their production of these products. Secondly,

[8] It is worth noting that taking this approach forward as an input into informing industrial policy warrants further research to validate the identified products.

[9] When identifying frontier products using international trade, as done by Allen Whitehead & Bhorat (2021), one excludes products that are already defined as revealed comparative advantage products – i.e. products that are exported competitively. Frontier products come from a subset of traded products that are either not exported at all, or are exported to some degree but not with a revealed comparative advantage – i.e. not exported competitively. The latter group corresponds with the fact that a number of MER sector establishments currently manufacture frontier products. As such, we are interested in what factors constrain their expansion or intensification.

establishments in the MER sector can diversify their product portfolios and shift production into these products.

Frontier products are defined as products that are not produced and exported competitively, but which meet the complexity and relatedness criteria defined in Allen Whitehead & Bhorat (2021). As such, you may have instances where a frontier product is not produced or exported at all in a country (i.e. exports are equal to zero), as well as instances where a frontier product is produced and exported by a country, but not competitively (i.e. exports are non-zero). The latter instance means that the MER Sector Enterprise Survey will, and does, pick up establishments that do currently manufacture frontier products. In such instances we speak to constraints to the intensification, or growth, of these products.

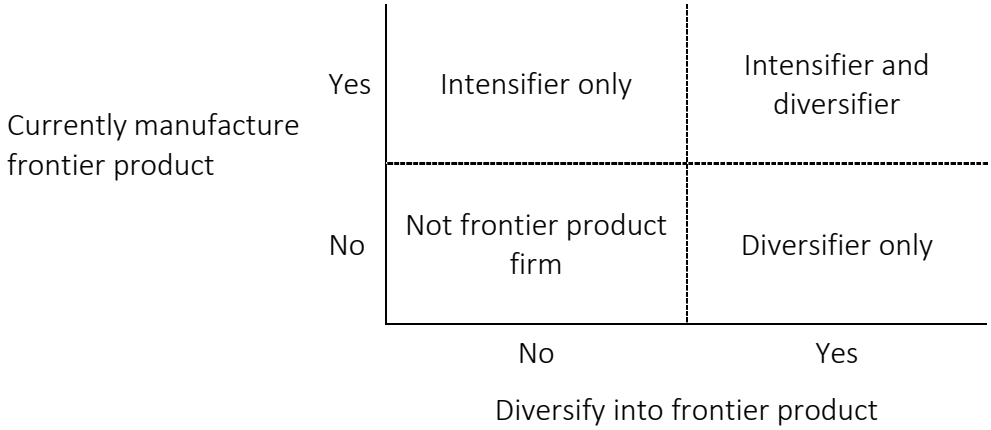
Motor vehicle parts provides a good example of how a frontier product can experience both these margins of growth. In the trade data, which is used to determine frontier products, we observe that the export value for motor vehicle parts is non-zero, and hence, there is a degree of production and export of this product. However, motor vehicle parts is not exported competitively, and given that it meets the complexity and relatedness criteria used to identify frontier products, it emerges as one of the 113 MER sector frontier products identified by Allen Whitehead & Bhorat (2021). Given that there is production of this product, we observe a number of establishments in the MER Sector Enterprise Survey that report manufacturing this product (or a version of it), and as such, we investigate what factors constrain these firms from intensifying the production of this product. We also identify a number of establishments in the survey data that aim to manufacture this product in the future, and as such, we investigate the factors that constrain this firm from diversifying into this product.

Given the fact that these two scenarios exist, we consider both constraints to intensification and constraints to diversification in this report.

We further depict these distinctions in frontier product growth in Figure 3, which provides a graphical representation of these types of establishments. The bottom left quadrant shows instances where there are establishments that do not currently manufacture MER sector frontier products and do not envision diversification into such products in the future. For example, an Auto chamber establishment that only assembles motor vehicles, which is not a frontier product, will fall into this quadrant.[10] We look at constraints facing MER sector establishments, in general, and these constraints apply to this type of establishment.

[10] Due to South Africa already manufacturing and exporting motor vehicles competitively (i.e. with a revealed comparative advantage) this product cannot be identified as a frontier product.

Figure 3: Conceptual framework structuring analysis of frontier products



The other three quadrants represent 'frontier product' establishments. The top left quadrant depicts establishments that are currently manufacturing frontier products, and do not plan to diversify into frontier products in the future. For example, we find a number of establishments that currently manufacture motor vehicle parts, and we thus consider the factors that constrain these establishments from intensifying, or growing, the production of this product. We refer to these establishments *intensifiers*. The bottom right quadrant refers to establishments that may only be positioned to diversify into frontier products in the future, in which case we're interested in understanding the constraints and capabilities associated with this diversification. We refer to these establishments as *diversifiers*. The top right quadrant points to establishments that currently manufacture a frontier product, such as motor vehicle components, and also aim to diversify into a frontier product in the future, such as vehicle bodies. These establishments fall into both the *intensifier* and *diversifier* group, and in the case of these establishments, the analysis below considers both the constraints and capabilities linked to intensification and diversification. Our analysis is thus structured to delineate between diversifiers and intensifiers, as we feel that the constraints and capabilities associated these products may vary across these groupings.

3 METHODOLOGY

In this section, we describe the process of obtaining the data that are analysed in the remainder of this report. These data are the result of an establishment-level quantitative survey that was designed and implemented as part of the research process. The survey's core purpose is to unpack the constraints and capabilities that hinder or enable MER sector firms in their attempts to diversify into new production opportunities that could grow economic complexity in the sector as a whole. Our discussion here describes the method undertaken to first design a survey instrument that adequately captures this information. Thereafter, we discuss the process of choosing an appropriate sample of MER sector firms to interview to ensure that the results presented in this report are as representative of the MER sector as possible. We also discuss the process of implementing the survey, and the challenges that arose as a result. Finally, we

discuss the post-survey adjustments that were undertaken to ensure the representativity of the sample for analysis.[11]

3.1 Design of the Survey Instrument

The development of the survey instrument was an iterative process that drew on the expertise of the core research team, a team from a survey company responsible for the implementation of the survey, and an academic expert in survey methods. In this section we discuss the development of the survey instrument. We start by providing a rationale for our choice of unit of analysis – manufacturing establishments in the MER sector. We then discuss the mode of survey and the structure of the survey instrument. The survey was targeted at establishments engaged in manufacturing activity within the MER sector, and as such we discuss the screening questionnaire that ensured that the appropriate unit of analysis was applied. This is followed by a detailing of the types of data collected, which enable the research team to address the objectives of the research study.

3.1.1 Unit of analysis

The survey uses, as its unit of analysis, establishments engaged in manufacturing activity. We omit establishments that are only engaged in service activities, even though they are present in the MER sector, since our research question focusses on manufacturing and production processes, not services. The choice of "establishment" as our unit of analysis is consistent with international surveys that aim to gather data on enterprises or establishments – for example, The World Bank's Enterprise Surveys.[12]

The establishment can be defined as a physical location where business operations are carried out, or in the case of this survey, where manufacturing activity is taking place. The establishment unit fits within the firm unit. Thus, it is possible to have firms made up of a single establishment (known as "single-establishment firms") or to have firms made up of multiple establishments (known as "multi-establishment firms"). We opt to collect establishment-level data rather than firm-level data since constraints and capabilities may be heterogenous within a firm, depending on the local environments and dynamics an establishment finds themselves operating within.[13]

3.1.2 Mode of Survey and Instrument Design

The MER Sector Enterprise Survey adopted a combination of survey modes that included telephonic and online interviews. The primary survey mode was to conduct computer assisted telephonic interviews (CATI).[14] However, the electronic survey instrument designed by Citizen

[11] In this section of the report, we present a summarized version of the method undertaken in each of these steps. Readers interested in a more detailed overview of the process should consult the accompanying technical report entitled "MER Sector Enterprise Survey: Survey Methods".

[12] Further such establishment-level surveys include: The various country-specific World Bank Enterprise Surveys; The UK Employer Skills Survey 2019; The eThekwini Large and Medium Manufacturing Firm Survey 2013-2014.

[13] Although collecting data at the establishment level is advantageous in some ways, it also raises challenges in that certain data – e.g. financial data – may not be available at a level more disaggregated than firm-level. On balance, however, we believe that the benefits of establishment-level data outweigh the disadvantages thereof for our particular research purpose.

[14] During the COVID-19 pandemic, the CATI survey mode was applied in other surveys conducted within South Africa, such as the National Income Dynamics Study – Coronavirus Rapid Mobile Survey (NIDS-CRAM), and the Quarterly Labour Force Survey (QLFS).

Surveys[15], as part of the iterative design process with the DPRU, was also distributed as an online survey to increase response rates.

The survey instrument was structured into two parts: First, a screening questionnaire, which aimed to ensure that the respondent was indeed an establishment engaged in manufacturing activities within the MER sector. Second, the main questionnaire, which was further divided into sections according to area of focus.[16] These include sections on basic firm characteristics; production characteristics; composition of employment and skills of workforce; constraints to current production; constraints to diversification; and financial information. To capture these different sets of information across an establishment, the survey questionnaire would need to be answered by a range of respondents across the establishment. With this in mind, each subsection of the main part of the survey questionnaire was designed so that they could be answered independently and sequentially by different respondents within an establishment.[17]

3.1.3 Ethics approval

After the survey instrument is designed, protocols at the University of Cape Town require that the proposed fieldwork and associated survey instrument undergo a process of ethical clearance before fieldwork can commence. The application for ethics clearance requires the DPRU to present the survey instrument, the data management and storage plans, and protocols to ensure anonymity of respondents. The DPRU team put together a package, which was deemed consistent with UCT best practice, and ethics approval was granted by the Commerce In Research Ethics Committee at UCT (Reference Number: REC 2021/05/010).

3.2 Sampling Methodology

One of the key outputs of this survey process is the production of a representative dataset for analysis of the MER sector. In order to ensure the production of such a representative dataset, it is key to ensure that the sample of establishments presented with the survey instrument is carefully and systematically constructed in order to ensure representativity of the population as a whole. We detail our processes for constructing an appropriate sample below.

3.2.1 Determining a Sample Frame

The sampling frame for this study was constructed by merging together three separate administrative data sources provided by the merSETA records office: First, a register dataset that captures the universe of firms who have ever registered their affiliation with merSETA; second, the dataset of all firms who are registered as paying levies to merSETA in 2021; and third, a dataset of firms who have submitted their Workplace Skills Plans (WSPs) to merSETA in 2021.[18] Firms were identified across datasets by using their unique Skills Development Levy

[15] Citizen Surveys is the company that was responsible for the implementation of the survey.

[16] It is worth noting that all respondent establishments could only proceed to the main questionnaire after completing the screening questionnaire and being classified as an establishment engaged in manufacturing activities within the MER sector.

[17] In certain cases – generally smaller establishments – a single respondent within an establishment may have been able to complete the questionnaire in its entirety. In this case, this single respondent could access all sections of the questionnaire themselves.

[18] The WSP is a plan that outlines a firm's intentions to train their staff in the upcoming 12-month period. Firms are incentivized to submit such a report through potential rebates on the levy paid to merSETA. As a result, firms in the WSP dataset are largely a subset of those firms in the levy-paying dataset.

(SDL) number. The merge was necessary due to important information for the sampling procedure being spread across all three datasets and not simply stored in one master data file.

After merging the three datasets together, the resultant file consisted of 89 102 observations. A rigorous, iterative and time-consuming cleaning procedure was undertaken to ensure that the sampling frame consisted only of the universe of manufacturing firms within the MER sector. In order to clean the list of firms, we employed a number of techniques: First, we employed string-matching techniques to filter out firms with names that were clearly not related to manufacturing, but clearly identified training or government institutions instead. Hereafter, we cleaned out firms who were classified as retail or services enterprises according to their Standard Industrial Code (SIC) provided in the data. Next, we cleaned out inactive firms by considering only those firms whose data had merged across the three datasets – this served as a proxy for firms who had been active during the 2021 reporting cycle. We also made use of desktop web searches and short telephonic screening procedures to ensure that our cleaning resulted in a sampling frame that, as accurately as possible, captured the universe of MER sector manufacturing firms.[19] After implementing these cleaning procedures, our sampling frame consisted of 9 560 firms that we believed captured the universe of manufacturing MER sector firms as accurately as possible, under the circumstances.[20]

3.2.2 Sampling

From the final sampling frame of 9 560 firms, we were able to construct a basic overview of the MER sector, particularly as regards firm size, firm location, and MER sector chamber. Notably, the distributions across these three variables were not uniform, with certain categories of firms being much more prevalent than others.[21] As a result of these non-uniform distributions, a simple random sample was inappropriate for our sampling procedure, and a more sophisticated method was required.

In order to account for at least some of the unevenness in distributions, we opted to implement a stratified survey design, with primary stratification across MER sector chamber, followed by secondary stratification across firm size[22], and finally implicit stratification across firm location as captured by South African province. Substantial amounts of missing data in the sampling frame meant that additional strata that accounted for "Unknown" chamber and province had to be created. This approach introduces concerns about the homogeneity of firms within the "Unknown" strata and thus whether a sampled firm can accurately be assumed to represent non-sampled firms. By violating this homogeneity assumption, we introduce slightly more instability into our weighted estimates and increase the possibility of potential bias. However, dropping firms in the "Unknown" chamber and province categories would, in all likelihood, introduce substantially more bias. Hence, we just draw the reader's attention to these potential

[19] Greater detail on the exact procedures summarized here is presented in the accompanying method report, "MER Sector Enterprise Survey: Survey Methods".

[20] At all times, our cleaning erred on the side of caution, and we only removed firms that we were sure were non-manufacturing or not part of the manufacturing MER sector. As a result, this final list of 9 560 firms could still include firms that are not part of our desired target population of interest. This is further justification for the inclusion of our screening questionnaire, which would filter out any firms that were not removed during this cleaning process.

[21] For example, there are many more small and medium-sized firms than large firms in the MER sector; or the fact that manufacturing firms are predominantly situated in agglomerated hubs in certain provinces rather than distributed across all provinces.

[22] Firm size was proxied for by using the amount of levy paid to merSETA, which is calculated as a proportion of payroll.

limitations in our method, but deem it the most desirable approach available to us given the data limitations we faced.

After determining appropriate stratification variables, we proceeded to compute how many observations would be required within each of our samples. We began with a target of 900 firms to be sampled, which we divided across our primary stratification variable (chamber) and then further subdivided by our secondary stratification variable (firm size). We used Neyman allocation according to the coefficient of variation (CV) to divide firms by chamber[23], whereafter cluster analysis was used in order to determine the appropriate cut-offs to create our firm size categories for stratification. Stratification occurred across 6 chamber categories, including one "Unknown" chamber category, and 4 firm size categories, resulting in 24 strata. Within each stratum, implicit stratification by province was implemented in order to achieve regional variation of firms. We applied different sampling probabilities to each stratum, with probability of selection being equal to 1 for firms in the "Very Large" size category, and this probability decreasing as firm size decreased. A summary of the strata and our chosen sample size for each stratum is presented in Table 1. In this table, the top number in each category is the number of firms to be sampled from each stratum while the number in parentheses represents the total number of observations available in the stratum. Unsampled firms in each stratum, if there were any, were then systematically numbered and listed as substitutes so that if a sampled observation was inappropriate or uncontactable, we could systematically substitute a different observation in to replace it and maintain our desired sample size to support subsequent analysis.

Table 1: Stratified sample design for MER Sector Enterprise Survey

	Size category 1 "Very Large"	Size category 2 "Large"	Size category 3 "Medium"	Size category 4 "Small"	Total
Chamber 1 AUTO	12 (12)	4 (20)	17 (34)	7 (55)	40 (121)
Chamber 2 METAL	46 (46)	197 (987)	188 (2063)	85 (3179)	516 (6275)
Chamber 3 AUTO COMP.	30 (30)	44 (219)	8 (333)	30 (480)	112 (1062)
Chamber 4 NEW TYRE	10 (10)	8 (21)	9 (39)	16 (35)	43 (105)
Chamber 5 PLASTICS	18 (18)	29 (324)	20 (460)	32 (520)	99 (1322)
Chamber 6 UNKNOWN	7 (7)	9 (71)	10 (147)	64 (450)	90 (675)
TOTAL	123 (123)	291 (1642)	252 (3076)	234 (4719)	900 (9560)

Note: Top number in each cell represents number of firms identified as part of our sample. Numbers in parentheses indicate total number of firms in each stratum. Selection probability in each stratum can be calculated as the top number divided by the bottom number in each cell.

[23] This method of dividing firms across chamber aims to increase sample sizes of smaller strata and decrease sample sizes of larger strata in a scientifically controlled way to ensure that the final sample has sufficient observations across all strata for meaningful analysis.

3.3 Implementation

3.3.1 Pre-fieldwork preparation

After the sample had been identified and the survey instrument design completed, we began preparation for implementation of the survey. However, in order to ensure that the survey ran as desired, it was necessary to engage in a number of pre-survey activities before the main tranche of fieldwork was carried out. This included the development of a training manual for enumerators who would ultimately be administering the survey – a 51-page document that provided enumerators with background on merSETA and the MER sector, as well as a detailed section-by-section breakdown of the survey's purpose, the type of data being collected, technical definitions that the enumerator may need to familiarise themselves with before administering a survey, and all skip logic or logical flow for the questionnaire.

After completing the training manual, we further had to market the survey to ensure that establishments would be aware of our research and be willing to participate in the study. This marketing took the form of stakeholder engagement at merSETA chamber meetings, electronic marketing on the merSETA website, as well as direct communication from merSETA to company stakeholders encouraging participation in the research. The marketing of the survey was further complicated by the enforcement of the Protection of Personal Information Act (POPIA) in August 2021. To ensure compliance with the law, merSETA communicated to firms that they could opt out of being contacted for this research if they were not comfortable with their information being used for this purpose. Firms who opted out of the study were then removed from the sampling frame and the sample, however, this only affected one firm from the sample and nine firms from the substitutes list.

3.3.2 Fieldwork

The survey fieldwork was carried out in two stages by Citizen Surveys, a survey enumeration company contracted to assist in implementing the survey: an initial pilot study[24] was run between 16 August 2021 and 27 October 2021, followed by the main study run between 17 November 2021 and 30 April 2022.[25] In both periods, firms would be sent an initial introductory letter via email, endorsed by merSETA and the University of Cape Town, detailing the purpose of the research project and the type of data to be collected. Thereafter, telephonic contact would be made with the establishment and an appointment to complete the screening questionnaire was set up. If the respondent qualified for the survey after being identified as an establishment engaged in manufacturing activities in the MER sector, then a unique web-based link would be forwarded to the respondent that could be completed independently, or with an enumerator, telephonically.

During the pilot study, 76 attempts to contact firms were made, of which only 13 successful interviews took place.[26] Learnings from the pilot study showed that the initial structure of the questions pertaining to firms' financial information was resulting in high refusal rates. As a

[24] Note that the pilot study comprised a subsample of firms who form part of the overall sample of this study. As a result, any data gathered during the pilot study was included in the final dataset for analysis.

[25] Due to many establishments slowing down operations during the December holiday period, Citizen Surveys suspended data collection on 22 December 2021 and recommenced on 12 January 2022.

[26] The remaining firms may have failed the screening questionnaire, been out of operation, or still been in the process of completing the questionnaire at the time the pilot study closed.

result, a significant restructuring of Section F of the questionnaire – which dealt with financial information – was undertaken. For the rest, the survey was answered relatively well, with an average completion time of between 20 and 25 minutes.[27] Some additional prompting and enumerator instruction was added to the questionnaire in response to feedback received, but for the most part, the survey instrument was deemed appropriate for the main study with major changes being made only to Section F.

During the main study, 1 443 attempts to contact firms were made, of which 254 establishments were successfully interviewed. Note, however, that of the 1 443 contacted firms, 481 were non-manufacturing firms. After accounting for the number of non-manufacturing firms in the sample, we estimate the response rate of our survey to be between 33.7 and 36.1 percent, which is not out of line with other surveys conducted during the pandemic period.[28] Throughout the fieldwork process, data quality management processes were put in place, and regular progress reports were generated. Data were also collected on reasons for non-response, so that post-survey adjustments could take into account whether firms should be part of the sampling frame or not. This is particularly important for the calculation of sampling weights, which will be discussed further in the next section of the report.

Throughout the fieldwork period, we encountered challenges with implementing the survey. We found that, in general, trying to run a survey during the COVID-19 pandemic raised challenges regarding remote work, particularly for high-ranking employees at respondent establishments. Since firm contact numbers generally route one through to a general helpdesk, we found that the so-called "gate-keepers" in the form of helpdesk operators or receptionists were reticent to provide contact details for the appropriate respondents within firms, making the gathering of data much more difficult. Furthermore, during this same period, a number of surveys to assess the impact of COVID-19 on operations were conducted, which resulted in survey fatigue on the part of respondent establishments, further decreasing total responses. The fact that the questionnaire potentially needed to be answered by multiple respondents raised challenges in ensuring that we received buy-in and responses from more than one respondent. Finally, the period of fieldwork was challenging in that it covered both the slow-down period over the December holidays, as well as the common financial year-end period of end-February. These challenges made obtaining data from respondents more difficult, and ultimately led to decisions to extend the survey from its initially planned end date of end-March 2022 to a new end date of end-April 2022.

3.4 Post-survey weighting adjustments

After the completion of the survey fieldwork, a period of data consolidation and post-survey adjustments was required. In particular, a process for computing appropriate sampling weights needed to be conducted to ensure that the data collected in the survey was representative of the broader population of MER sector firms. In calculating the sampling weights, we noted that there was a large proportion of firms who, when answering the screening questionnaire, had

[27] Note, however, that this figure is for active participation time. In cases where the survey instrument needed to be answered by multiple people, it could take longer than this due to delays in sending the survey between respondents.

[28] For example, the NIDS-CRAM, a labour-market survey conducted during the pandemic, achieved a response rate of approximately 40% (Kerr, Ardington & Burger, 2020).

been flagged as non-manufacturing firms. This suggests that the sampling frame consisting of 9 560 firms overstated the population of MER sector manufacturing firms. Using the relative proportion of respondents who identified as manufacturing versus non-manufacturing in the screening questionnaire, we adjusted our estimate of the population of MER sector firms downwards to 5 074 firms.

The calculation of weights for this survey was undertaken in two stages: first, the design weight was calculated as the inverse of the selection probability for firms in each stratum. Due to the low response rate, some strata had to be combined to ensure valid numerical weights. Second, since design weights generally assume a 100 percent response rate within strata, adjustments had to be made to account for non-response amongst establishments that were initially marked to be part of the sample. This two-stage process results in a set of sampling weights that can be used with the MER Sector Enterprise Survey in an attempt to make the sample representative of the MER sector as a whole.

Note, however, that the extent to which the weights truly make the results generalisable to the MER sector as a whole depend on a number of factors: First, the response rate. Weights assume that observed responses are representative of those respondents in the population, or the relevant stratum, that we do not observe. As a result, a lower response rate means more unobserved units and, as a result, the likelihood of observed respondents accurately representing the unobserved units decreases, making the weights less likely to accurately represent the full population. Given our relatively low response rate, there is a possibility that some of the weighted estimates may not be exactly representative of the population due to us potentially observing an idiosyncratic sample. Secondly, the weights will, in theory, make the captured sample representative of the sampling frame, and as a result, the extent to which the final sampling frame is an accurate reflection of the MER sector will be an important consideration in determining whether the results are generalisable to the MER sector as a whole. We believe that the sampling frame, following all adjustments and cleaning, is a relatively good representation of the MER sector, however, any inconsistencies that remain in the sampling frame will filter through to our results as well.

All this being said, we do believe that weighting the data in this report is the most appropriate way forward. We believe that the construction of weighted estimates is more desirable than unweighted estimates due to our complex survey design. Note, however, that our relatively small sample size and low response rate does mean that, to err on the side of caution, we opt not to report absolute numbers in most cases, but rather report results as shares and percentages of the total. In the following section, we give a brief overview of the MER Sector Enterprise Survey and the final sample used for analysis.

4 Data: MER Sector Enterprise Survey

In this section of the report, we provide a brief overview of the final sample of establishments sampled as part of our research. In total, our dataset contains responses from a total of 254 establishments, all of whom are manufacturing establishments operating within the MER sector. This sample of 254 establishments results from an initial sampling frame of 9 560 firms, from which a desired sample of 900 firms was identified. Due to the presence of non-manufacturing establishments present in our sampling frame, and a response rate of

approximately 35 percent, our final sample consists of 254 establishments drawn from an estimated population of 5 074 – meaning that our sample is approximately a 5 percent sample of the population of MER sector manufacturing establishments. While there are instances of establishments refusing to answer individual questions at times during the survey, this final sample of 254 establishments forms the basis of the sample used in all subsequent analysis.

In order to understand the distribution of establishments within the MER Sector Enterprise Survey, we present cross-tabulations of our sample across our main stratification variables. To begin, in Table 2, we present a cross-tabulation of our sample according to our two explicit stratification variables: chamber and establishment size. The establishment size category has been collapsed into two categories in this table that are consistent with the categories to be used in further analysis.

On the whole, the distribution of firms across chambers is not unexpected, with the majority of establishments located in the Metals chamber, followed by Plastics and Motor. The New Tyre chamber contains only 8 respondent establishments, which means that any analysis that considers New Tyre as a chamber in isolation should be particularly circumspect about the findings due to the small sample size. We also find that we have 18 respondent establishments in the Auto chamber. As far as we are aware, this overstates the number of establishments that are said to be operating in the MER sector Auto chamber.[29] However, given the information at our disposal and the details provided both by the register dataset and establishments self-reporting of their chamber, we are not able to refute this figure.

Table 2: Overview of analysis sample by chamber and firm size

		Firm size		
		SMME (<150 employees)	Large (150+ employees)	Total
Chamber	Auto	9	9	**18**
	Metal	119	41	**160**
	Auto Comp.	16	6	**22**
	New Tyre	2	6	**8**
	Plastics	33	13	**46**
	Total	**179**	**75**	**254**

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022).

When considering the distribution of establishments by size, we see that our sample includes a larger number of SMMEs than large establishments. This is partly by design, and partly due to the underlying structure of the MER sector, which is dominated by a larger number of smaller establishments. In both cases – i.e. SMMEs and large establishments – the overall sample size is reasonable, however, when considering the interaction with chamber, we see that some cells have very few respondent establishments. In particular, the New Tyre, Auto and Auto Components chambers, when divided by establishment size, result in very small samples. These small sample sizes suggest that analysis that aims to interrogate differences along both

[29] The Auto chamber comprises the Original Equipment Manufacturers (OEMs) that assemble motor vehicles. The sample frame that is compiled from merSETA administrative data indicates that 121 firms belong to this chamber, which is substantially more than the expected number of OEM firms in the chamber.

establishment size and chamber simultaneously, is ill-advised. To this end, we will not be able to provide specific analysis for SMMEs in each chamber, but will only analyse SMMEs across the MER sector as a whole.

Implicit stratification by province was undertaken to ensure that our final sample of establishments was sourced from both the major manufacturing hubs in South Africa (Gauteng, Western Cape, KwaZulu-Natal and Eastern Cape), as well as from other less-agglomerated hubs. Table 3 presents the distribution of respondent establishments across provinces. Unsurprisingly, the majority of establishments are located in Gauteng, which is South Africa's largest manufacturing hub. The overall distribution of establishments follows the expected distribution across provinces fairly well, however, once again, the sample sizes will not be sufficient to conduct any analysis that cuts the data both by province and another stratification variable.

The final sample of 254 firms represents a survey response rate of approximately 35 percent, which, as indicated in the previous section, is sub-optimal, as it decreases the reliability of our sampling weights. Furthermore, a low response rate in a survey means that any calculated sampling weights are not guaranteed to aggregate the estimates up to a correct representation of the underlying population. However, based on the preliminary overview of our sample and the fact that the distribution across each of our stratification variables is relatively consistent with that presented in our sampling frame, we feel comfortable employing sampling weights in our analysis.

Table 3: Overview of analysis sample by implicit stratification variable: province

Province	Number of establishments
Gauteng	129
Western Cape	44
KwaZulu-Natal	31
Eastern Cape	18
Other	32
Total	**254**

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022).

Although we use the sampling weights in this analysis, we draw the reader's attention to a few caveats: Firstly, the fact that the response rate is only 35 percent means that our weighted estimates are likely to be more noisy than they would have been if the response rate had been higher. In other words, some results – especially where sample sizes are small – may not be truly representative of the MER sector as a whole. Secondly, the sampling weights are calculated to aggregate the estimates to a population that is representative of the sampling frame. As a result, the estimates presented in this report are at best only as accurate as the initial sampling frame. While every effort has been made to ensure the sampling frame was a true reflection of the MER sector as a whole, it is possible that due to the data challenges faced, there may be idiosyncratic differences that undermine the generalisability of these results to the true structure of the MER sector. In order to remind the reader of these concerns, all estimates in this analysis are reported along with the relevant 95% confidence interval

associated with the estimate. A technical discussion of the meaning of a confidence interval is presented in Box 2, below.

Box 2: Understanding Confidence Intervals

The confidence interval is a construct of statistical theory that aims to indicate a researcher's level of uncertainty surrounding a given estimate. The notion of a confidence interval is intricately linked to the fact that statistical analysis makes use of a sample of data in order to infer information about the underlying population the sample was drawn from.

In the context of the MER sector, consider the following: We know that in South Africa, there are a number of establishments who are part of the MER sector. Let us assume that there are N such establishments. We say, then, that N is the number of establishments in the **population** of MER sector firms.

If we were not constrained by limited resources, we would be able to interview every single one of these firms and obtain data on them. In this case, we could calculate statistics like average employment levels or distributions by firm size exactly. However, due to limited resources, such as money and time, we choose to draw a sample of establishments for analysis. Generally speaking, we might draw a **sample** of size n where $n < N$ – i.e., we draw a strict subset of the firms in the population to act as our analysis sample.

If we were to imagine that N=5000 and n=100, then we are saying that we have drawn a sample of 100 firms out of the total population of 5 000. This sample can be drawn as a simple random sample, or – as is the case in this study – it could be drawn using a complex survey design to ensure representation of certain key subgroups. The difficulty we have with this set-up, no matter our choice of method for drawing our sample, is that there are still 4 900 firms for whom we have not collected data, and we have no way of knowing if those firms are like or unlike the 100 firms whose data we have collected.

The fact that we have unobserved (i.e. unsampled) establishments in the population means that we cannot be sure that our estimates based on our observed sample are truly representative of the population. Whether we make use of sampling weights or not, the fact of the matter is that there are establishments we know nothing about because they were not sampled, and we do not know how their information would impact our results if we had sampled them.

However, given our sampling design, and the fact that we systematically chose our sample from a sampling frame, we want to be able to say something about the population based on our sample. This is where the confidence interval comes in. A confidence interval embodies the uncertainty associated with the single sample that we observe, and describes a range in which we may expect the true population value of our estimate would lie. To calculate a confidence interval for a mean, you make use of the following formula:

$$CI = \left(\bar{x} - \frac{c^*\sigma}{\sqrt{n}};\ \bar{x} + \frac{c^*\sigma}{\sqrt{n}}\right) \quad (1)$$

where $\bar{x}$ is the point estimate of the mean, σ is the point estimate of the standard deviation of the mean, n is the sample size, and c^* is the critical value from either Student's t-distribution or the normal distribution that corresponds with the level of the confidence interval you are calculating. The confidence interval is clearly a range around the estimate of interest that, to some extent, describes the "margin of error" associated with our estimate.

To specifically describe a confidence interval, you should imagine that you could draw the sample of x establishments from your population many times over. So, imagine that we drew 100 establishments from our population of 5 000 establishments many times, each time picking our 100 firms randomly. This means that each sample of 100 establishments drawn *could* be completely different, although they do not have to be. Imagine you have drawn 200 different samples of 100 establishments and you calculate the average establishment size for each sample. You would get a different average value each time since the sample of 100 establishments drawn is different each time, representing the uncertainty surrounding our estimate due to the fact we are working with a sample and not the population.

The technical definition of a confidence interval is then as follows: a 95% confidence interval provides a range in which, if you were to draw numerous random samples from your population and calculate the confidence interval around the statistic of interest, 95% of these confidence intervals would include the true value of the estimate as you would find it if you had calculated it over the entire population.

We make use of confidence intervals throughout this report, and each time we present an estimate, we present the associated confidence interval. Although theoretically, it is hard to understand precisely what a single confidence interval is, we suggest that the reader think about it as a range within which we are relatively confident the population parameter of interest would lie, with relatively higher percentage confidence intervals indicating relatively greater confidence that the parameter would lie in that range.[30] In other words, if presented with an average establishment size of 102 with a confidence interval of [99; 105], then one could interpret this approximately as follows: our sample suggests that the estimate of average establishment size is 102 employees, however, the best we can truly say is that we believe that the true estimate lies somewhere between 99 and 105 employees.

Confidence intervals are impacted by a number of things, which are depicted in formula (1) above. Firstly, the smaller the sample size in use, the larger the confidence interval – corresponding to the fact that smaller samples are likely to result in more uncertainty about the population estimate. Secondly, the level of the confidence interval dictates the size thereof: a 90% confidence interval would only need to include the true value 90% of the time, and thus is able to be narrower than a 95% or 99% confidence interval which would need to include the population value more often. Finally, the amount of variation in the data under analysis will also influence the confidence interval, with noisier data resulting in wider confidence intervals due to the additional implied uncertainty that arises due to data that is not closely clustered together.

[30] In other words, if a 99% confidence interval and a 95% confidence interval were reported for a given estimate, we could be relatively more confident about the population parameter lying in the 99% confidence interval than we would be about it lying in the 95% confidence interval. Note that a 95% confidence interval would lie entirely within the corresponding 99% confidence interval by construction, which hopefully assists with the intuition behind this interpretation.

5 Constraints to Growth and Diversification of the MER Sector

In this section, we tackle the research objective of detailing the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities in the MER sector. Using the MER Sector Enterprise Survey, we start by presenting a descriptive overview of the characteristics of establishments in the MER sector (Section 5.1). We then outline the employment structure of MER sector establishments (Section 5.2). This is followed by a detailing of the extent to which MER sector establishments are either currently engaged in the manufacture of frontier products, and/or aim to diversify into frontier products in the future, thereby allowing us to identify *frontier establishments* (Section 5.3). The analysis shifts to an examination of constraints faced by establishments in the MER sector, with particular emphasis on *frontier establishments* (Section 5.4). Finally, we examine in greater detail the role and importance of skills as a constraint to establishments in the MER sector.

5.1 Characteristics of the MER Sector Establishments

Using the weighted sample of MER sector manufacturing establishments from the MER Sector Enterprise Survey, we present in Table 4 the aggregate characteristics of these establishments, in terms of firm structure, establishment size, chamber, location and age.

A key aspect of MER sector establishments is that two-thirds (61.97%) of these establishments fit within larger multi-establishment firms. Further, approximately 90 percent of these establishments, belonging to multi-establishment firms, have partner establishments engaged in manufacturing activities in other countries (or 55% of all establishments). This is important because this large quantum of establishments that fit within multi-establishment firms validates the choice of unit of analysis – the establishment level – applied in the MER Sector Enterprise Survey. Thus, when information on constraints and capabilities are extracted from the establishment, they are specific to the operations of the establishment within its given geographic and macroeconomic context. Put differently, firm-level information, in the context of multi-establishment firms, particularly those engaged in foreign operations, may conflate information on constraints and capabilities across these operational contexts.

x.[31] We find that approximately 90 percent of establishments, and the firms within which they fit in the case of multi-establishment firms, are private companies, while closed corporations and public companies account for 8.61 and 4.17 percent of establishments, respectively. In terms of the distribution of manufacturing establishments across chamber (or sub-sector), we note that the metal sector accounts for close to three-quarters of all establishments in the MER sector. Plastics are the next largest chamber comprising 18.87 percent of the establishments, followed by 6 percent for the automotive components chamber, while the automotive and new tyre chambers account for considerably smaller shares, sitting at 3.57 and 0.58 percent of establishments, respectively. As one would expect, the distribution of establishments, in terms of firm size, is skewed toward SMMEs, which constitute a greater share of total establishments in the MER sector. We observe that SMMEs (<150 employees) comprise 87.48 percent of MER sector establishments, and large establishments (150+ employees) account for 12.52 percent.

[31] The distribution of establishments across chambers, as per the findings from the MER Sector Enterprise Survey, are broadly consistent with sectoral distributions evident in other datasets. Please see Appendix Table A 2 with shares of firms (establishments) across chamber for different data sources.

However, we do observe in Section 5.2, that large firms account for a disproportionate share of employment in the sector. In terms of geographic distribution, half of the MER sector manufacturing establishments reside in Gauteng, with the distribution of the remaining establishments being skewed toward other major economic centres in the country. The second largest provincial share of establishments is in the Western Cape (22.1%) followed by KwaZulu-Natal (14.53%), and the Eastern Cape (2.84 %). The remaining 10.95 percent of firms reside in the other five provinces. Disaggregating the distribution of establishments by firm age, we observe that just over half of all MER sector establishments are between 10 and 29 years old, while firms that have been operational for over 30 years account for 35.96 percent of establishments in the sector. Approximately 10 percent of establishments have been in operation for 10 years or less.

Table 4: Characteristics of MER Sector Establishments

	Share	95% CI
Part of a multi-establishment firm (n=174)	61.97	[51.78; 72.16]
Type of firm		
Sole Proprietorship (n=1)	0.16	[0.00; 0.49]
Partnership (n=1)	0.66	[0.00; 1.96]
Close Corporation (CC) (n=17)	8.61	[2.40; 14.81]
Personal Liability Company (Inc) (n=1)	0.66	[0.00; 1.96]
Private Company (Pty Ltd) (n=222)	85.45	[78.03; 92.87]
Public Company (Ltd) (n=10)	4.17	[0.00; 8.38]
External Company / Branch (n=1)	0.25	[0.00; 0.74]
Chamber		
Automotive (n=18)	3.57	[1.28; 5.86]
Metal (n=160)	70.9	[61.30; 80.50]
Automotive components (n=22)	6.08	[2.65; 9.50]
New tyre (n=8)	0.58	[0.10; 1.06]
Plastics (n=46)	18.87	[9.47; 28.27]
Firm size		
SMME (< 150 employees) (n=179)	87.48	[81.61; 91.66]
Large (+150 employees) (n=75)	12.52	[8.34; 18.39]
Province		
Gauteng (n=129)	49.57	[39.43; 59.75]
Western Cape (n=44)	22.1	[14.43; 32.31]
KwaZulu-Natal (n=31)	14.53	[8.27; 24.27]
Eastern Cape (n=18)	2.84	[1.50; 5.32]
Other (n=32)	10.95	[7.11; 16.50]
Firm age		
< 10 years (n=15)	10.64	[5.72; 18.96]
10 - 29 years (n=50)	53.4	[43.22; 63.3]
30 - 59 years (n=48)	28.4	[20.51; 37.87]
60+ years (n=16)	7.56	[9.92; 14.10]

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted sums of employment on aggregate and by establishment characteristic. 2. All estimates weighted using sampling weights after accounting for complex survey design. 3. 95% confidence intervals presented in brackets. 4. Based on the unweighted sample, there was 1 establishment that refused to provide their firm type.

While, and as expected, SMMEs account for a larger share of manufacturing establishments relative to large establishments, there is a degree of heterogeneity in this relationship across chambers. Looking at Table 5, the relatively large share of SMMEs is evident in the metal (88.85%) and plastics (91.86%) chambers. However, in the case of the auto (67.70%) and auto component (74.17%) chambers, this SMME skewed relative share is less pronounced. [32] The new tyre chamber is an exception with about two-thirds of establishments being large.

[32] While the merSETA report only seven OEMs (Original Equipment Manufacturers) in the Auto sector, all of which are international brands, we find 121 establishments in this chamber. This difference is that, when using the chamber classification codes supplied by merSETA (SIC Code 381), additional establishments appear in the Auto chamber. This is also true when establishments are asked to self-select into a particular chamber in the screening section of the survey. In addition, there are establishments within the Auto chamber that have other SIC codes, both in the data supplied by the merSETA and the data provided by firms in the screening section. At this point we are unsure of the reason for this.

However, the MER Sector Enterprise Survey has very few new tyre establishments in its sample, which includes a handful of large tyre producers. In column 3 we present the ratio of the share of large firms in each chamber relative to the share of large firms in the MER sector as a whole – this allows us to get a relative sense of the firm size-chamber composition in the MER sector. We observe that there are disproportionately more large firms in the automotive, auto component, and new tyre chambers.

Table 5: Firm Size by Chamber

Chamber	SMME	Large	Share large in chamber: Share large in total
Automotive	67.70 (n=9) [42.07; 93.32]	32.3 (n=9) [68.68; 57.93]	9.05
Metal	88.85 (n=119) [82.75; 94.95]	11.15 (n=41) [5.05; 17.25]	0.16
Auto component	74.17 (n=16) [49.94; 98.41]	25.83 (n=6) [1.59; 50.06]	4.25
New tyre	38.51 (n=2) [0.00; 79.05]	61.49 (n=6) [20.95; 100.00]	106.02
Plastics	91.86 (n=33) [85.55; 98.16]	8.14 (n=13) [5.05; 17.25]	0.43

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted sums of employment on aggregate and by establishment characteristic. 2. All estimates weighted using sampling weights after accounting for complex survey design. 3. 95% confidence intervals presented in brackets. 4. Column 3 presents the ratio of the share of large establishments in a chamber relative to the share of large establishments in the full sample of MER sector establishments. Ratios greater than unity indicate a greater relative proportion of large establishments in a chamber relative to the sector as a whole. 5. The Automotive chamber should be primarily large, but there is an issue with the data collected.

Linkages to foreign markets is a potential channel of productive knowledge and capabilities to MER sector establishments.[33] There is much evidence of foreign linkages when considering a variety of indicators. Previously, we identified that 61.97 percent of establishments in the MER sector are part of multi-establishment firms. Of these multi-establishment firms, a substantial share, approximately 90 percent, engage in activities outside of South Africa. In Table 6 it is evident that approximately 17.25 percent of these multi-establishment firms have partner establishments in other countries that perform only manufacturing activities, with an additional 73.14 percent performing a combination of manufacturing and sales and services activities. Less than 1 percent of foreign establishments linked to these multi-establishment MER sector firms engage only in sales and services activities.

Another metric which points to linkages to foreign markets and productive knowledge, is the share of multi-establishment firms with foreign-based head-quarters. Provided that the

[33] For example, tier 1 automotive component manufactures that supply global OEMs that assemble motor vehicles in South Africa are exposed to the latest technologies and innovations to meet their supply obligations.

interviewed establishment is not the headquarters, we observe that one in ten of these multi-establishment firms have headquarters outside of South Africa. This provides partial evidence of foreign productive capabilities and knowhow entering into manufacturing activities within the MER sector.

Table 6: Attachment and Linkages to Foreign Markets

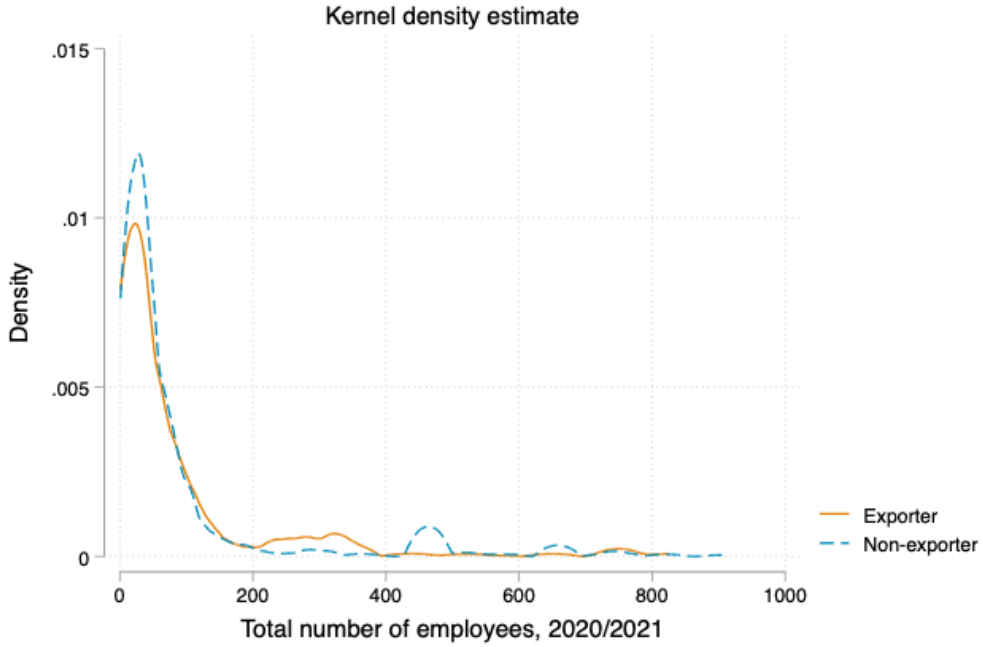
	Share	95% CI
Activities in other countries if multi-establishment firm		
Manufacturing only (n=30)	17.54	[0.76; 29.49]
Sales/services only (n=3)	0.63	[0.19; 2.05]
Both (n=130)	73.41	[60.77; 83.11]
Location of headquarters if multi-establishment firm, and interviewed establishment is not the headquarters		
In South Africa (n=40)	84.82	[67.09; 93.87]
Outside South Africa (n=10)	10.20	[3.73; 24.98]
Exporter (n=115)	37.08	[27.34; 46.81]
International certification (n=91)	28.03	[19.23; 36.83]

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted sums of employment on aggregate and by establishment characteristic. 2. All estimates weighted using sampling weights after accounting for complex survey design. 95% confidence intervals presented in brackets. 3. Based on the unweighted sample, there were 11 establishments belonging to multi-establishment firms that had neither manufacturing nor service and sales activities outside of South Africa. In addition, two establishments responded "don't know" when asked for the location of their headquarters, provided they were an establishment part of a multi-establishment firm that was not the headquarters. 4. Of the unweighted sample, 37 establishments responded either "don't know" or "refused" when asked if they were an exporter. 5. Of the unweighted sample, 34 firms responded either "don't know" or "refused" when asked if they had any international certifications.

Further evidence of linkages to foreign capabilities and productive knowledge can be observed in the export status of MER sector establishments and whether they have internationally recognized certifications. We find that one in three establishments (37.08%) in the MER sector are exporters, thus indicating substantial exposure to foreign markets and foreign productive knowhow. It is worth noting that this exporting establishment share is higher than that for the manufacturing sector as a whole – Edwards, Sanfilippo & Sundaram (2018) show that approximately one in four South African manufacturing firms are exporters. We also observe that 28.03 percent of MER sector establishments have international recognized certifications, with half of these establishments reporting that these certifications are required to directly access export markets. Interestingly, of these establishments with internationally recognized certifications, 17.86 percent do not participate in export activities. However, it may be the case that they supply intermediate components to exporting firms, and thus require these certifications to link into global value chains.

Figure 4 shows that when considering the distribution of employment for both exporters and non-exporters, a similar mean value is observed. However, the figure shows that non-exporter firms have a more populated tail, indicating that there are a few exceptionally large non-exporter firms, as well as a higher density of non-exporter micro enterprises.

Figure 4: Distribution of employment by export status



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.

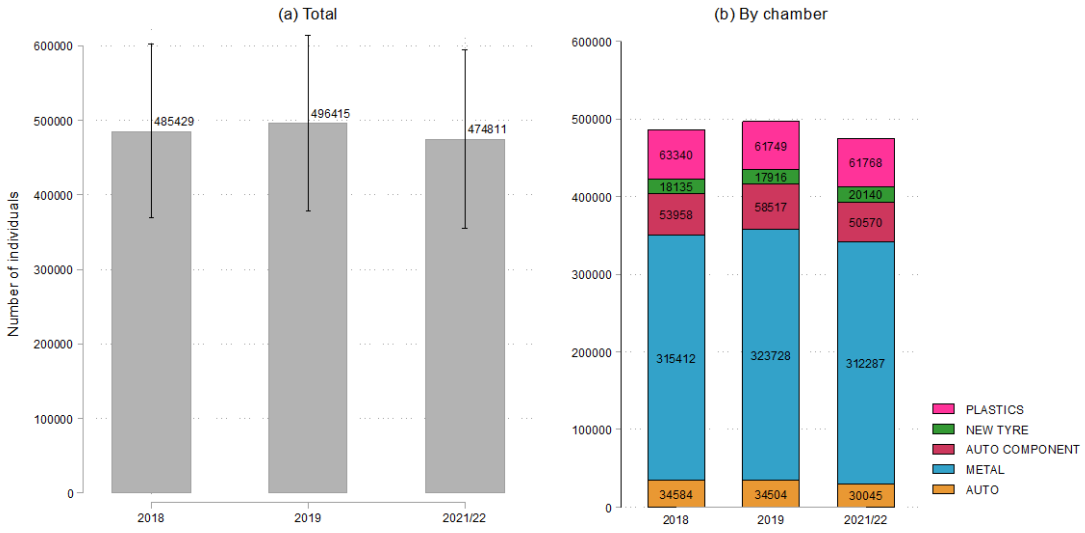
To summarise, MER sector establishments are largely located in the Metals chamber (70%) and to a lesser extent in the Plastics chamber (18.87%). A relatively smaller share of establishments is located in the Automotive Component, Automotive and New Tyre chambers. Consistent with what one would expect of firm size distributions, the majority of establishments in the sector are SMMEs, and these establishments are more likely to be found in the Metals and Plastics chambers. While still having greater shares of SMME establishments, the Automotive Component and Automotive chambers are relatively more likely to have large firms in their chambers. This is more apparent in the New Tyre chamber which has more large establishments than SMMEs. The provincial distribution of MER sector establishments is clustered around the three economic hubs in South Africa – Gauteng, Western Cape and KwaZulu Natal. One in two MER sector establishments have been in operation for between 10 and 30 years, while one in ten establishments are relatively 'young' and have been in operation for fewer than 10 years. A large share of MER sector establishments have access to the capabilities and productive knowhow of larger organisations, with approximately two-thirds of these establishments being part of multi-establishment firms. Further, of these establishments belonging to multi-establishment firms, the majority (90%) are linked to establishments engaged in manufacturing activity in other countries, which suggests access to foreign capabilities and productive knowhow. Export activity is relatively common in the MER sector, with one in three establishments engaged in exporting.

5.2 Employment Structure of MER Sector Firms

In this section we provide an overview of the employment structure of the MER sector. We look at variation in the distribution of employment across several establishment characteristics, including chamber, establishment size, export status, age, and location.

The employment estimates measuring the size of the MER sector that emerge from the MER Sector Enterprise Survey are in line with estimates from other sources. Figure 5 presents employment estimates from 2018 to 2021/22 (or the period of the survey), on aggregate and by chamber. The weighted data suggest that approximately 475 000 employees were employed in MER sector manufacturing establishments at the time of the survey, with a 95% confidence interval (CI) of 355 099 – 594 524 workers. This estimate is in line with employment estimates reported in alternative sources, such as merSETA's Sector Skills Plan 2022/2023 which reports an employment level of 472 000 employees in 2021.[34]

Figure 5: Total employment in the MER Sector, on aggregate and by chamber: 2018 - 2021/22



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the weighted sums of employment on aggregate over time. 2. All estimates weighted using sampling weights after accounting for the complex survey design. 3. Capped spikes represent 95% confidence intervals.

We do observe a slight decline in employment across manufacturing establishments in the MER sector over the COVID period, although, these estimates must be interpreted with caution.[35] The onset of the COVID-19 pandemic and associated economic lockdown in early 2020 saw employment in the South African economy reduce by 13 percent year-on-year, and 19 percent in the manufacturing sector (Statistics South Africa, 2020). Looking at Figure 5 we observe a 4.2 percent decline from the employment estimate for 2019 in relation to the corresponding estimate for 2021/2022. Relative to the labour market as a whole, this corresponds to the (manufacturing) MER Sector representing 3.2 percent of total employment in the country (and 30.1 percent of manufacturing) as of the beginning of 2022, which is largely unchanged from the 3 percent share (28.2 percent of manufacturing) in 2019.[36] However, this small absolute decrease in the estimated level of employment must be treated with caution as this change is

[34] It should be noted that the sample from the MER Sector Enterprise Survey is representative of employment in manufacturing (and not services) establishments in the MER Sector, so it is likely that our employment estimates are lower than the broader MER Sector, which includes these services establishments; particularly those in the Motor Retail Services chamber.

[35] It is important to note that the research project did not set out to analyse the impacts of the COVID-19 pandemic on the MER sector. For this reason, the survey was not designed to accurately measure these impacts and what is reported should be interpreted with caution. Nevertheless, given that we collected employment data ranging from before to after the pandemic period, it is worth reporting these results.

[36] Calculated using Statistics South Africa's Quarterly Labour Force Survey (QLFS) for the first quarter of 2022 and the 2019 Labour Market Dynamics of South Africa.

not statistically significant considering the magnitude of the confidence intervals.[37] Further, given that the 'post-COVID' estimates come from establishment responses in late 2021 and early 2022, a degree of employment recovery may have already taken place in the sector. Overall, this relatively small change in net employment levels is suggestive of the resilience of the MER Sector to covariate shocks such as COVID-19.

In Table 7, we present employment estimates across a range of establishment characteristics over time. As is widely-documented, the Metals chamber accounts for the vast majority of employment in the sector (66% in 2021/22), a share which has remained relatively constant over the period (which can also be said for the employment shares of the remaining chambers). This is unsurprising given that, as discussed in the preceding section, the majority of MER sector manufacturing establishments operate in the Metals chamber (71%) – see Table 4.

Looking at establishment size, while large establishments account for a disproportionate share of employment in the MER sector, the share accounted for by SMMEs is not negligible. While only accounting for 12.5 percent of manufacturing establishments in the MER sector (see Table 4), large establishments account for 60 percent of employment in the sector.[38] In contrast, SMMEs account for 87 percent of establishments and 39 percent of employment. Neither establishment group accounts for a non-negligible share of employment, and if one is interested in developing policy targeting employment growth, then one needs to look at both sets of establishments and whether the factors impacting their growth vary. This may offer a more nuanced approach to formulating policy.

In terms of export status, we do not observe any significant distinction in employment levels. Manufacturing establishments engaged in export activity account for 43 percent of employment in the sector, while establishments not engaged in export activity account for 48 percent of employment. This is somewhat peculiar since we know that firms engaged in export activity tend to be larger (Bernard, et al., 2007), and should thus account for correspondingly large shares of employment.

With respect to establishment location, there is a clear clustering of manufacturing activity in South Africa. It is evident from Table 7 that approximately 82 percent of employees work in establishments that are operating out of just three provinces in South Africa, namely, Gauteng, Western Cape and KwaZulu-Natal. Further, the majority (52%) operate in Gauteng. Provincial shares of employment have remained relatively stable over the period.

[37] Respondents reported employment for 2018 and 2019 retrospectively, so it should be noted that such responses may be subject to recall bias. Further, it should be noted that this absence of statistically significant changes over the period may simply be due to the size of the MER Sector Enterprise Survey sample.

[38] It is worth noting that this estimate is in line with what we would expect. Tsebe et al. (2018) show that large manufacturing firms account for approximately 52 percent of employment in the manufacturing sector in South Africa. The fact that they define large firms as those with 250 employees or more and we define large as 150 employees and more, may account for our estimate being higher than theirs. Suffice to say, our estimates are in line with what one would expect: larger firms account for disproportionate shares of employment.

Table 7: Levels and composition of employment, by establishment characteristic, 2018 - 2021/22

	2018		2021/22		Change (2018-2021/22)	
	Estimate	Share (%)	Estimate	Share (%)	Absolute	%
Total	485 429 [368 709; 602 148]	100.0	474 811 [355 099; 594 524]	100.0	-10 618	-2.19
Chamber						
Automotive (n=18)	34 584 [13 839; 55 330]	7.1	30 045 [11 345; 48 746]	6.3	-4 539	-13.12
Metal (n=160)	315 412 [214 274; 416 550]	65.0	312 287 [208 014; 416 560]	65.8	-3 124	-0.99
Auto Comp. (n=22)	53 958 [1 463; 106 452]	11.1	50 570 [-2 346; 103 486]	10.7	-3 387	-6.28
New Tyre (n=8)	18 135 [5 106; 31 165]	3.7	20 140 [5 558; 34 723]	4.2	2 005	11.05
Plastics (n=46)	63 340 [36 342; 90 338]	13.0	61 768 [34 567; 88 969]	13.0	-1 572	-2.48
Establishment size						
SMME (n=196)	193 095 [165 297; 220 894]	39.8	187 962 [159 189; 216 735]	39.6	-5 133	-2.66
Large (n=58)	292 334 [172 061; 412 606]	60.2	286 849 [163 608; 410 090]	60.4	-5 485	-1.88
Establishment age (years)						
< 10 (n=23)	25 127 [4 039; 46 215]	5.4	45 303 [14 581; 76 024]	9.8	20 176	80.29
10-29 (n=108)	221 127 [118 549; 323 705]	47.1	216 359 [112 289; 320 428]	46.9	-4 769	-2.16
30-59 (n=88)	171 051 [105 631; 236 471]	36.4	154 368 [89 236; 219 500]	33.5	-16 683	-9.75
60+ (n=24)	52 019 [23 833; 80 206]	11.1	44 958 [18 744; 71 173]	9.8	-7 061	-13.57
Export status						
Exporter (n=115)	209 674 [157 587; 261 760]	43.2	202 959 [150 244; 255 674]	42.7	-6 715	-3.20
Non-exporter (n=102)	223 279 [112 833; 333 726]	46.0	226 616 [112 846; 340 385]	47.7	3 336	1.49
Province						
Gauteng (n=129)	263 151 [158 339; 367 962]	51.6	255 393 [148 824; 361 963]	51.6	-7 757	-2.95
Western Cape (n=44)	58 373 [36 250; 80 496]	10.8	54 149 [32 623; 75 675]	10.1	-4 224	-7.24
KwaZulu-Natal (n=31)	91 060 [29 809; 152 310]	18.8	96 038 [32 314; 159 762]	20.2	4 979	5.47
Eastern Cape (n=18)	34 169 [9 008; 59 329]	7.0	34 275 [10 688; 57 862]	7.2	106	0.31

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted sums of employment on aggregate and by establishment characteristic over time. SMME refers to establishments with employment levels below 150 workers. 2. All estimates weighted using sampling weights after accounting for the complex survey design. 95% confidence intervals presented in brackets. 3. n = number of observations at the time of the survey. 4. Sample of establishments who responded with either "refuse" or "don't know" for the export status sub-section, and all provinces other than Gauteng, Western Cape, KwaZulu-Natal, and Eastern Cape were omitted for brevity. 5. Auto Comp. = Auto Component.

We observe a changing composition of employment by establishment age in the MER Sector from 2018 to 2021/22. As of the time of the survey, most employees work for establishments that have been operating for at least 10 years (90%). However, the importance of younger establishments has increased notably over the period. Establishments younger than 10 years accounted for 5.4 percent of employees in 2018, and this share has approximately doubled to

just under 10 percent in 2021/22.[39] Even in absolute terms, employment in young establishments increased over this period by over 20 000 workers (therefore, nearly doubling). Considering the contraction in employment shares for establishments older than 30 years, this may be indicative of an employment shift away from older establishments.

In Table 8, we shift from focusing on the level and composition of MER sector employment, and we consider the distribution of employment in terms of mean and median employment levels by analytical characteristic. We find that the average manufacturing establishment in the MER sector employs approximately 94 employees, as of the time of the survey in 2021/22, which represents a slight (but again, not statistically significant) decrease relative to the years prior. Notably, the disparity between this mean estimate of 94 and the median of 29 (that is, 50% of establishments employ fewer than 29 workers) suggests that the distribution of employment is heavily skewed to the right by a relatively smaller number of establishments that employ a particularly large number of workers. This is consistent with what we would expect.

We observe a degree of heterogeneity in the distribution of employment by chamber. Despite accounting for the two largest shares of employment in the MER sector, the Metals and Plastics chambers exhibit the lowest mean number of workers, with 87 and 65 employees on average for the 2021/2022 period, respectively. This is consistent with establishments in these sectors accounting for the largest share of SMMEs – see Table 5. Consistent with the presence of large Original Equipment Manufacturers (OEMs) in the New Tyre and Auto chambers, we observe the mean employment levels in these chambers being relatively high. For example, establishments in the Auto chamber employ, on average, 166 employees, which is consistent with this chamber exhibiting a relatively higher proportion of large establishments (see Table 5).

Shifting to employment distribution by establishment size, we observe a larger relative contraction of average employment in SMMEs over the period compared to large establishments in the MER Sector. Specifically, we estimate that SMMEs in the sector experienced a 16 percent decrease in employment on average, compared to just 1 percent for large establishments. It is plausible that these contractions are attributable to the COVID-19 pandemic. However, we need to be tentative in making conclusive claims given that we do not have evidence that these job losses would not have occurred in the absence of the pandemic. Nevertheless, if these employment effects are indeed true, then this is in line with the global literature, which highlights the disproportionate effects of the pandemic on smaller firms (Lin et al., 2021).

[39] However, these changes over time are not statistically significantly different from zero, which is likely at least in part due to the small sample size.

Table 8: Mean and median employment levels, by establishment characteristic: 2018 - 2021/22

	2018		2021/22		Change in means (2018-2021/22)	
	Median	Mean	Median	Mean	Absolute	%
Total (n=254)	32.0	98.5 [74.8; 122.2]	29.0	93.6 [70.0; 117.2]	-4.9	-5.0
Chamber						
Auto (n=18)	92.0	190.9 [72.1; 309.8]	87.0	165.9 [59.4; 272.3]	-25.1	-13.1
Metal (n=160)	32.0	90.9 [61.6; 120.3]	29.0	86.8 [57.6; 116.0]	-4.1	-4.5
Auto Comp. (n=22)	80.0	184.9 [48.7; 321.0]	70.0	164.0 [26.2; 301.8]	-20.9	-11.3
New Tyre (n=8)	111.0	612.2 [49.0; 1 175.3]	515.0	679.8 [141.4; 1 218.3]	67.7	11.1
Plastics (n=46)	25.0	66.2 [35.5; 96.8]	22.0	64.5 [33.6; 95.5]	-1.6	-2.5
Establishment size						
SMME (n=196)	30.0	47.3 [40.7; 53.8]	25.0	41.1 [35.0; 47.2]	-6.2	-13.1
Large (n=58)	470.0	571.9 [488.4; 655.4]	463.0	575.7 [488.0; 663.4]	3.8	0.7
Establishment age (years)						
< 10 (n=23)	33.0	63.2 [33.0; 93.4]	32.0	83.9 [37.0; 130.8]	20.7	32.8
10-29 (n=108)	25.0	81.6 [44.1; 119.1]	22.0	79.9 [41.8; 117.9]	-1.8	-2.2
30-59 (n=88)	50.0	118.7 [73.6; 163.9]	46.0	107.1 [62.7; 151.6]	-11.6	-9.8
60+ (n=24)	50.0	184.4 [15.7; 353.2]	46.0	159.4 [7.3; 311.5]	-25.0	-13.6
Export status						
Exporter (n=115)	32.0	114.5 [78.7; 150.3]	32.0	107.9 [73.4; 142.4]	-6.6	-5.8
Non-exporter (n=102)	40.0	98.3 [53.6; 143.1]	32.0	95.8 [51.4; 140.3]	-2.5	-2.6
Province						
Gauteng (n=129)	32.0	104.6 [64.7; 144.6]	32.0	101.5 [60.8; 142.3]	-3.1	-2.9
Western Cape (n=44)	21.0	52.0 [29.7; 74.4]	21.0	48.3 [27.3; 69.2]	-3.8	-7.2
KwaZulu-Natal (n=31)	25.0	130.9 [33.2; 228.6]	25.0	130.3 [34.0; 226.6]	-0.7	-0.5
Eastern Cape (n=18)	100.0	240.7 [64.4; 417.0]	90.0	237.8 [70.6; 405.0]	-2.9	-1.2

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted means and median levels of employment on aggregate and by establishment characteristic. 2. All estimates weighted using sampling weights after accounting for the complex survey design. 95% confidence intervals presented in brackets. 3. n = number of observations at the time of the survey. 4. Sample of establishments who responded with wither "refuse" or "don't know" for the export status sub-section, and all provinces other than Gauteng, Western Cape, KwaZulu-Natal, and Eastern Cape were omitted for brevity. 5. Auto Comp. = Auto Component.

We observe a positive association between establishment age and employment. That is, on average, older establishments employ more workers, although these differences are not statistically significant. We estimate that, at the time of the survey, the average 'young' establishment (less than 10 years old) and those that are between 10 and 29 years old, employed, on average, 84 and 80 employees, respectively. This is in contrast to 107 employees, on average, in establishments that have been operating for between 30 and 59 years. Notably, at the time of the survey, the average establishment that has been operating for at least 60

years, employed, on average, approximately double the number of employees (159), relative to establishments that have been operating for 10 years or less. The presence and 'gradient' of this relationship between establishment age and employment has remained relatively constant over the period. However, employment in the average 'young' establishment has increased by 33 percent from 63 employees in 2018 to 84 in 2021/22. This is accompanied by a contraction in average employment among all other establishment size categories. This is in line with our analysis of the estimates in Table 7 which suggest an employment shift away from older establishments.

Looking the distribution of employment across establishments varying by export status, we do note that exporters are larger on average, but that the difference is smaller than we would expect.[40] Exporters employ, on average, 108 employees, while non-exporters employ 96 employees. We note that this difference is not statistically significant. However, we do find some evidence of a larger incidence of job loss among exporting establishments over the period. It appears that, on average, exporting establishments have experienced greater job loss than non-exporting establishments from 2019 to 2021/22 (contractions of 6.4 and 3.2 percent, respectively). It is plausible that this may be attributable to the COVID-19 pandemic. Although both exporting and non-exporting establishments were subjected to domestic restrictions, exporting establishments were additionally affected by supply-side disruptions such as export restrictions and labour shortages at ports, which both slowed the movement of goods – as well as demand-side factors such as widespread job and wage losses which reduced the demand for international goods (Barlow et al., 2021; Kutlina-Dimitrova & Rueda-Cantuche, 2021).

In summary, several findings stand out from our analysis of employment within the manufacturing component of the MER Sector. Overall, we estimate that the sector comprises approximately 475 000 employees as of 2021/22. Despite the COVID-19 pandemic, this level has remained largely unchanged over the period, suggestive of the resilience of the MER Sector to covariate shocks such as COVID-19. The average establishment employs 94 workers. However, as expected, the distribution of employment is heavily skewed to the right, with large establishments (who represent 12.5% of all establishments) accounting for a disproportionate share of employment (60%). Nevertheless, SMMEs account for a non-negligible share of employment, and worryingly have experienced a larger degree of job loss over the period. The composition and distribution of employment within the MER sector exhibits substantial heterogeneity across chambers (sub-sectors). The Metals and Plastics chambers comprise the largest shares of employment, while having the smallest average establishment size, which is consistent with these chambers accounting for more SMMEs in the sector. In contrast, the Auto and New Tyre chambers comprise relatively smaller shares of employment in the sector, but have larger establishments, on average. As such, it is important to take these distributional and compositional nuances into account when considering policy interventions in the sector. Employment in the MER sector is clustered in three provincial locations with the majority of employees (82%) being located in just three provinces, namely Gauteng, Western Cape, and KwaZulu-Natal. When considering exporter status, we do not observe any significant distinction in employment, however we do observe a larger incidence of job loss among exporting establishments over the period, which may be attributable to trade disruptions related to the COVID-19 pandemic. Finally, we document an interesting changing composition of employment

[40] It is well documented in the literature that exporting firms tend to be larger than firms not engaged in exporting activity (Bernard, et al., 2007).

by establishment age. Although most employees (90%) work for establishments that have been operating for at least 10 years, and, on average, older establishments employ more employees, employment in 'young' establishments (less than 10 years) has increased substantially over the period. Coupled with an employment contraction in older establishments, these estimates are indicative of a significant shift in employment toward younger establishments.

5.3 MER Sector Establishments Producing, or Planning to Produce, Frontier Products

This section shows the extent to which MER sector establishments are either currently engaged in the manufacture of frontier products, and/or aim to diversify into frontier products in the future. This allows us to get a sense of the extent and composition of 'frontier establishments' before we analyse the constraints that these establishments need to overcome in order to grow and diversify frontier product markets. We identify 'frontier establishments' by mapping product-level data from the MER Sector Enterprise Survey on the products that establishments currently manufacture, and those that they aim to manufacture in the future, to the frontier product list compiled by Allen Whitehead & Bhorat (2021).

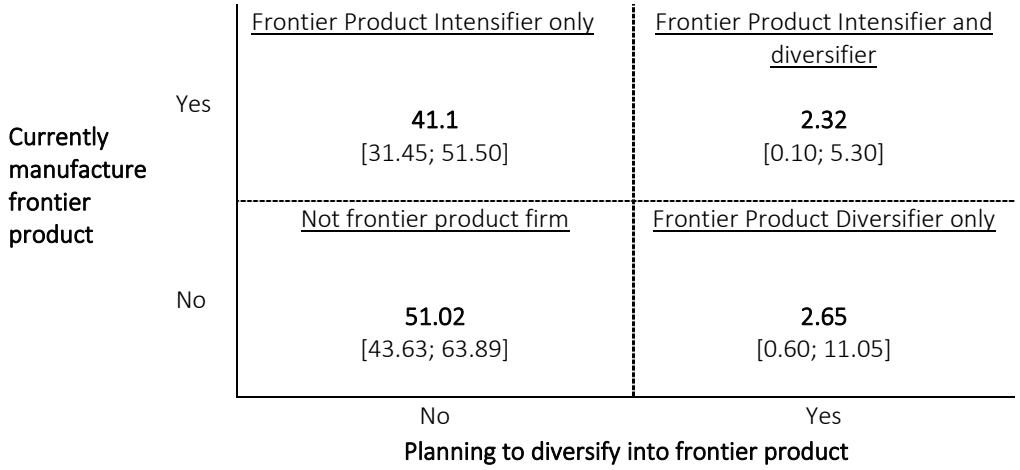
In Figure 6 we show the distribution of MER sector establishments according to whether they are engaged, or plan to engage, in frontier product activity. The bottom left quadrant shows instances where there are establishments that do not currently manufacture MER sector frontier products and do not envision diversification into such products in the future. The other three quadrants represent 'frontier products' establishments. They may only be currently manufacturing frontier products, in which case we are interested in understanding the constraints to the intensification of production of these products – top left quadrant. They may only be positioned to diversify into frontier products in the future, in which case we are interested in understanding the constraints and capabilities associated with this diversification – bottom right quadrant. Or they may be a combination of both – top right quadrant. Our analysis is thus structured to delineate between diversifiers and intensifiers, as we feel that the constraints and capabilities associated these products may vary across these types of establishments.

It is evident that approximately 51 percent of MER sector establishments do not currently manufacture frontier products, and do not intend on diversifying into frontier products in the future. Of the remaining establishments, 41.1 percent currently manufacture frontier products, but do not intend diversifying into other frontier products in the future. We call these establishments 'intensifiers'. There is a further 2.65 percent of establishments that are not currently engaged in frontier product activity, but aim to diversify into frontier products in the future. These are termed 'diversifiers'. Finally, there is a subset of establishments – 2.32 percent – that currently manufacture frontier products and aim to diversify into additional frontier products in the future.

We now consider the compositional characteristics of these frontier establishments – as reported in Table 9. In absolute terms, the distribution of frontier establishments across chamber follows a similar pattern to that of the sector as a whole. For instance, it is immediately clear that frontier establishments are predominantly in the metal chamber (67.19%), with a substantial contingent of establishments from the plastics chamber (19.51%), followed by smaller shares in the automotive (6.38%), automotive components (6.38%), and new tyre (0.54%) chambers. In relative terms, looking at the frontier-non-frontier establishment ratios

in column 3, we observe that establishments in automotive, plastics, new tyre and automotive component chambers are more likely to be frontier establishments.[41]

Figure 6: Distribution of MER Sector Manufacturing Establishments by Frontier Product Status



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. All estimates weighted using sampling weights after accounting for complex survey design. 2. 95% confidence intervals presented in brackets. 3. Frontier product establishments are defined as establishments that are either currently manufacturing frontier products and/or looking to diversify into frontier products in the future.

We observe that that, in absolute terms, the majority of these frontier establishments are SMMEs (85.62 percent). However, when we consider the ratio of frontier to non-frontier establishments (in column 3), we find that large firms are relatively more likely to be frontier establishments. Considering the provincial distribution of frontier establishments, we identify that the majority of these establishments reside in Gauteng (43.66 percent), followed by an approximately 20 percent share in the Western Cape and KwaZulu-Natal. Our findings show that frontier establishments are more likely to be younger establishments, with the majority of these establishments being younger than 29 years, and with a relatively large share having been in operation for fewer than 10 years. Compared to the sample as a whole, frontier establishments are less likely to be exporters.[42]

[41] The frontier-non-frontier establishment ratio takes the ratio of the share of frontier establishments in a sector to the share of non-frontier establishments in a sector. A ratio greater (less) than one suggests that frontier establishments are more (less) likely to exist in a sector.

[42] The manner in which frontier products are defined suggests that this finding regarding exporters makes sense. Products that South Africa already exports competitively and at scale are by definition not to be defined as frontier products. Only products that are not exported competitively and at scale can be defined as frontier products, As such, it makes sense that frontier establishments are less likely to be exporters.

Table 9: Characteristics of frontier product establishments in the MER sector

	Share	95% CI	Ratio Frontier vs Non-Frontier
Chamber			
Automotive (n=13)	6.38	[1.60; 11.16]	2.60
Metal (n=65)	67.19	[53.56; 80.83]	0.68
Automotive component (n=13)	6.38	[1.32; 11.44]	1.44
New tyre (n=5)	0.54	[0.00; 1.09]	1.67
Plastics (n=33)	19.51	[6.88; 32.13]	2.54
Establishment size			
SMME (n=82)	86.52	[80.63; 92.41]	0.85
Large (n=47)	13.48	[7.59; 19.37]	1.68
Province			
Gauteng (n=57)	43.66	[29.44; 58.89]	0.79
Western Cape (n=23)	19.39	[10.20; 34.18]	1.10
KwaZulu-Natal (n=22)	20.31	[9.90; 37.16]	2.44
Eastern Cape (n=11)	4.01	[1.65; 9.34]	1.57
Other (n=16)	12.64	[6.92; 21.95]	1.00
Firm age			
< 10 years (n=15)	17.38	[4.95; 29.82]	1.88
10 - 29 years (n=50)	44.41	[29.22; 59.60]	0.86
30 - 59 years (n=48)	29.41	[16.58; 42.24]	1.20
60+ years (n=16)	8.79	[0.00; 18.18]	0.84
Exporter (n=53)	31.23	[17.91; 44.56]	0.26

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents the weighted sums of employment on aggregate and by firm characteristic. 2. All estimates weighted using sampling weights after accounting for complex survey design. 3. 95% confidence intervals presented in brackets. 4. Frontier product establishments are defined as establishments that are either currently manufacturing frontier products and/or looking to diversify into frontier products in the future.

Given the extent and composition of frontier establishments, a number of points emerge regarding the analysis to follow: First, we observe both frontier products intensifiers and diversifiers (with a number of establishments doing both) and thus examine the constraints facing both sets of establishments – given that the factors impacting on intensification may vary from those impacting on diversification – and any resulting policy prescription would need to take this into account. Second, we note that SMMEs comprise a similar share of frontier establishments to that of the sector as a whole, which is substantial – in excess of 80 percent. This is important because if one is to follow frontier product industrial diversification pathways, then one is to facilitate the growth and graduation of SMMEs. Third, the fact that at least two in every five MER sector establishments are frontier establishments, indicates that should the sector experience growth and diversification, it is likely to result in the building of economic complexity in the sector.

5.4 Constraints Facing MER Sector Establishments

In order to engage in smart specialisation policies and realise frontier product industrial diversification opportunities, establishments, firms and state entities need to understand a sector's current productive structure and how existing capabilities and constraints can be leveraged, or overcome, in order to encourage economic growth and development. Allen

Whitehead & Bhorat (2021) identify frontier product industrial diversification opportunities that are feasible for MER sector establishments to diversify into, given their relative proximity and potential to build economic complexity in the MER sector. In theory, the capabilities to produce these frontier products exist in the South African MER sector, and establishments should be able to diversify into the production of these new products. However, constraints exist that hamper this movement between productive processes, and present additional challenges to enacting smart specialisation policies informed purely through a frontier product identification exercise. To this end, a module was included in the MER Sector Enterprise Survey questionnaire that aimed to unpack and explore constraints faced by MER sector establishments, so as to provide guidance on the challenges that establishments face in their attempts to intensify or expand production.

This section of the paper aims to provide an overview of the constraints faced by establishments in the MER sector. We first explore the constraints faced by establishments in the MER sector generally before focussing in on those constraints related to frontier products specifically. In focussing on frontier products, we consider the two distinct groups of establishments laid out in the previous section: namely, those that are currently frontier product producers who may be able to intensify their production (i.e. production intensifiers), and those who have indicated that avenues for diversification in their business include the production of a frontier product (i.e. diversifiers).

We begin by considering Table 10, which presents the incidence of constraints among establishments in the MER sector. In other words, figures in Table 10 represent the proportion of establishments that indicated that they faced the given constraint, after accounting for sampling weights and the complex survey design. We consider the overall MER sector, as well as each individual chamber as individual subsamples, and report the results accordingly. Constraints within each subsample are colour-coded from green (relatively few establishments reported facing the constraint) to yellow (relatively many establishments reported facing the constraint).

Notably, in the MER sector as a whole, the most pressing concern is that of infrastructure, followed by financial constraints, competition, and skills. Approximately two in three (66.3%) establishments in the MER sector indicate that they face constraints related to infrastructure, which include challenges related to the cost, quality and provision of electricity, water, transport, and land. Over half of establishments in the MER sector – 57.5 percent – indicate that cost of and access to financial resources is a constraint to expanding their current portfolio. A lack of skills presents as a constraint for 43 percent of establishments, highlighting the importance of quality education and workplace training programmes as a way of enabling establishments to expand their productive capabilities.

Table 10: Incidence of constraints to current product portfolio, by chamber

	Overall	Auto	Metal	Auto Comp.	New Tyre	Plastics
Infrastructure	0.663	0.700	0.666	0.661	0.791	0.641
	[0.556; 0.770]	[0.489; 0.912]	[0.549; 0.782]	[0.425; 0.897]	[0.493; 1.089]	[0.342; 0.941]
Business Regulations	0.409	0.285	0.393	0.433	0.556	0.479
	[0.298; 0.519]	[0.044; 0.526]	[0.272; 0.513]	[0.172; 0.693]	[0.160; 0.952]	[0.170; 0.788]
Product Standardisation	0.336	0.265	0.330	0.406	0.497	0.345
	[0.233; 0.439]	[0.028; 0.502]	[0.214; 0.447]	[0.144; 0.668]	[0.110; 0.884]	[0.071; 0.619]
Labour regulations	0.411	0.220	0.431	0.406	0.556	0.367
	[0.300; 0.521]	[0.002; 0.438]	[0.307; 0.555]	[0.144; 0.668]	[0.160; 0.952]	[0.094; 0.640]
Skills	0.430	0.309	0.435	0.596	0.556	0.379
	[0.325; 0.536]	[0.060; 0.558]	[0.312; 0.557]	[0.350; 0.843]	[0.160; 0.952]	[0.107; 0.651]
Export regulations	0.297	0.145	0.281	0.387	0.497	0.353
	[0.198; 0.397]	[-0.022; 0.312]	[0.175; 0.387]	[0.071; 0.702]	[0.110; 0.884]	[0.079; 0.626]
Import regulations	0.263	0.145	0.241	0.290	0.556	0.348
	[0.170; 0.356]	[-0.022; 0.312]	[0.147; 0.336]	[0.055; 0.525]	[0.160; 0.952]	[0.074; 0.622]
Production	0.361	0.285	0.371	0.298	0.556	0.353
	[0.257; 0.465]	[0.044; 0.526]	[0.253; 0.490]	[0.062; 0.533]	[0.160; 0.952]	[0.079; 0.626]
Competition	0.439	0.297	0.417	0.544	0.556	0.508
	[0.325; 0.552]	[0.053; 0.540]	[0.295; 0.539]	[0.290; 0.798]	[0.160; 0.952]	[0.201; 0.816]
Financial	0.575	0.265	0.592	0.761	0.791	0.503
	[0.467; 0.683]	[0.028; 0.502]	[0.476; 0.707]	[0.604; 0.917]	[0.493; 1.089]	[0.195; 0.810]
Macroeconomic	0.356	0.215	0.364	0.317	0.556	0.360
	[0.253; 0.460]	[0.002; 0.428]	[0.246; 0.482]	[0.080; 0.555]	[0.160; 0.952]	[0.086; 0.633]
Crime	0.419	0.239	0.421	0.568	0.556	0.394
	[0.309; 0.529]	[0.018; 0.461]	[0.302; 0.539]	[0.312; 0.824]	[0.160; 0.952]	[0.122; 0.665]
Policy uncertainty, government	0.348	0.170	0.351	0.317	0.556	0.374
	[0.246; 0.450]	[-0.007; 0.346]	[0.236; 0.465]	[0.080; 0.555]	[0.160; 0.952]	[0.102; 0.647]
Sample size	254	18	160	22	8	46
Weighted size	5074	181	3597	308	30	957

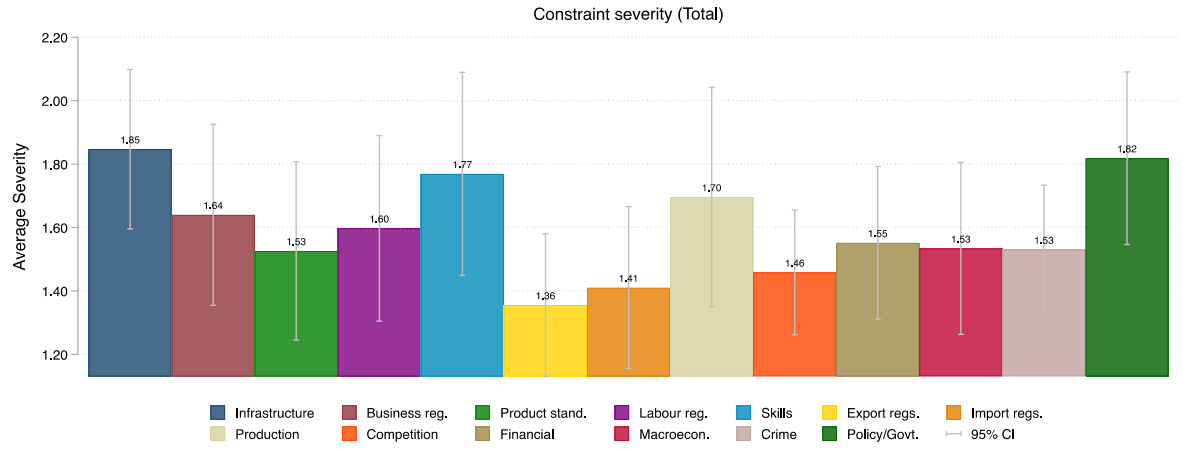
Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Table presents proportion of establishments classifying a constraint as applicable to them. 2. All estimates weighted using sampling weights and corrected for complex survey design. 3. 95% confidence intervals presented in brackets below estimate. 4. Colour coding of estimates runs within-column from green (minimum value in column) to yellow (maximum value in column).

Although export regulations do not appear to impact a large proportion of establishments – 29.7 percent, or just under 1 in 3 establishments – it is worth noting that approximately 37 percent of all MER sector establishments actually export their products. If we consider the proportion of exporters who face export regulation constraints, we see that approximately 33 percent of exporters face challenges with export regulations, while 27 percent of non-exporters face the same. This is interesting from a policy perspective since it suggests that non-exporters may, in fact, opt out of exporting because of challenges associated with export regulations. Given the rise of globalisation and the importance of international trade in the current economy, this result is of particular concern and should be noted as a key area of intervention for policymakers. Furthermore, industrial growth and diversification in economies with relatively small domestic markets, such as the case with South Africa, can only be achieved through export growth. Thus, to the extent that export regulations hinder export growth, these regulations hinder industrialisation.

Although there is a certain amount of heterogeneity across chambers, the main constraints reported by establishments across all five manufacturing chambers of the MER sector remain fairly consistent: Infrastructure and financial constraints are most commonly reported, while concerns around competition and skills also remain important. Around half of establishments in the Metal, Motor and New Tyre chambers also report crime and labour regulations as constraints that limit their ability to expand their current productive structure.

From a policy perspective, while it is useful to know the extent of establishments affected by a given constraint, this does not necessarily provide insight on the severity of the constraints faced by establishments. The survey instrument accounts for this by asking establishments, for each listed constraint, to rank its severity on a scale of one to four, where a score of one indicates a minor obstacle and a score of four indicates a severe obstacle.[43] We then calculated an average severity score of each constraint across establishments in the MER sector that reported they faced the given constraint. In other words, those establishments that reported they did not face a constraint were left out of the severity score calculation. The results for the MER sector as a whole are presented in Figure 7, below.

Figure 7: Average constraint severity score for expanding current product portfolio



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the average severity score for each constraint, as measured out of 4. Individual scores interpreted as: Scores are interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 2. All estimates weighted using sampling weights and corrected for complex survey design. 3. Estimates calculated only over those individuals who reported a constraint as applicable to them – i.e. sample excludes establishments indicating a constraint was "No obstacle" to their operations.

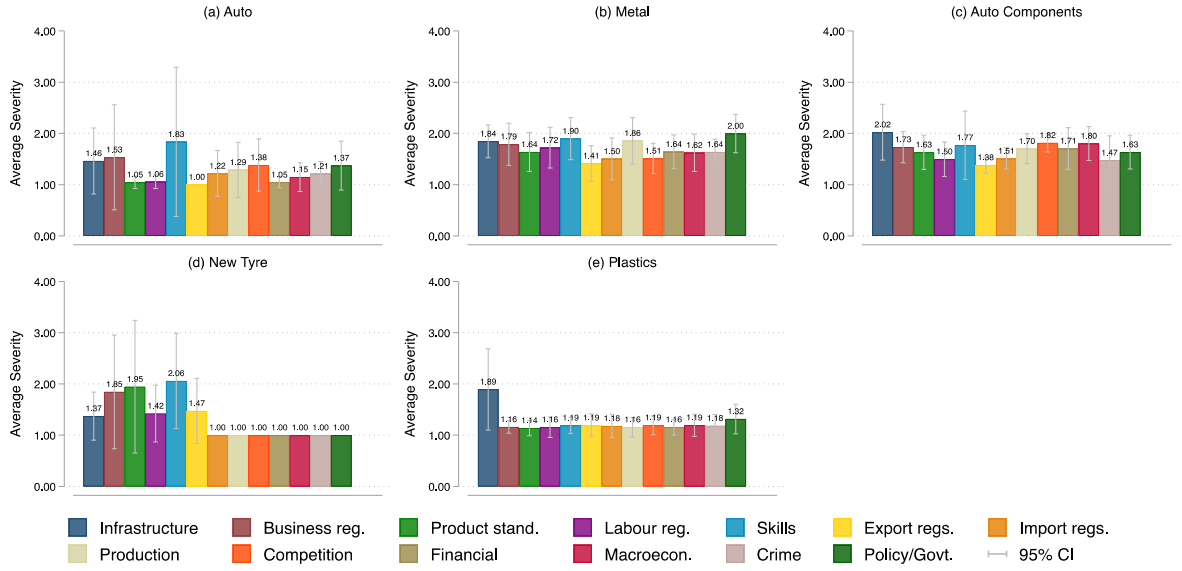
Overall, constraints range between 1.36 and 1.85 out of a maximum severity score of 4, indicating minor to moderate constraints on production. For the most part, the constraints that were widely reported by MER sector establishments also appear as the most severe constraints: Infrastructure has a severity score of 1.85 out of 4, while the skills constraint scores 1.77 out of 4. However, policy uncertainty and government inefficiency, while only reported as a constraint by approximately one in three establishments, ranks as the second most severe

[43] Scores are interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". A score of 0 indicates "No obstacle", but these scores are not included in our calculation of the severity score, as a score of 0 implies that the establishment did not face that constraint.

constraint to expanding current MER sector production, with a severity score of 1.82 out of 4. Production constraints related to raw material procurement and insufficient production capacity also rank highly with an average severity score of 1.7. Interestingly, financial constraints, which were widely reported as constraints faced by MER sector establishments, rank amongst the least severe.

As with the incidence of constraints, there is heterogeneity across chambers in the relative severity of constraints. However, as depicted in Figure 8, a lack of skills tends to stand out as the most severe constraint faced by MER sector establishments, regardless of their chamber. Infrastructure also stands out as a relatively severe constraint faced by establishments across all chambers, except perhaps New Tyre, where it is relatively less important.[44] Instead, in the New Tyre chamber, business regulation and product standardisation follow skills as the next-most severe constraints faced by establishments in the chamber. The relative severity of policy uncertainty and government inefficiency in the MER sector is driven by the fact that this constraint ranks as the most severe challenge in the MER sector's largest chamber: Metals.

Figure 8: Constraint severity for growing current product portfolio, by chamber



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the average severity score for each constraint, as measured out of 4. Individual scores interpreted as: Scores are interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 2. All estimates weighted using sampling weights and corrected for complex survey design. 3. Estimates calculated only over those individuals who reported a constraint as applicable to them – i.e. sample excludes establishments indicating a constraint was "No obstacle" to their operations.

The results in this section also broadly suggest the presence of two distinct types of constraints that establishments face: First, "exogenous" constraints, such as infrastructure, labour regulations, and government inefficiency, which are generally not within an establishment's ability to control or influence. Second, "endogenous" constraints, such as skills or production constraints, which are those where intervention on the part of the establishment may go some

[44] Although, as has been pointed out earlier in this report, estimates for the New Tyre chamber should be interpreted with caution due to the small sample size.

way towards overcoming such constraints. While exogenous constraints, in the form of infrastructure and government inefficiency stand out as the most severe constraints across most chambers, there are still certain endogenous constraints – such as skill constraints – that provide potential avenues for the design of active policy to combat and overcome the challenges facing firms.

Overall, while there exists some heterogeneity in the constraints faced by MER sector establishments across chambers, there are some constraints that cut across chambers and seem to challenge the MER sector as a whole. Infrastructure and skills stand out as widespread in terms of incidence, as well as ranking amongst the most severe constraints faced by establishments in the MER sector. While financial constraints seem to afflict a large proportion of MER sector establishments, they do not rank as particularly severe. On the other hand, policy uncertainty and government inefficiency appears as a particularly severe constraint, with the second highest severity score among all constraints, even though it was only reported by approximately 35 percent of MER sector establishments. It seems as if this relatively high severity score is driven by the Metals chamber, where policy uncertainty and government inefficiency is listed as the most severe constraint faced by establishments in the chamber.

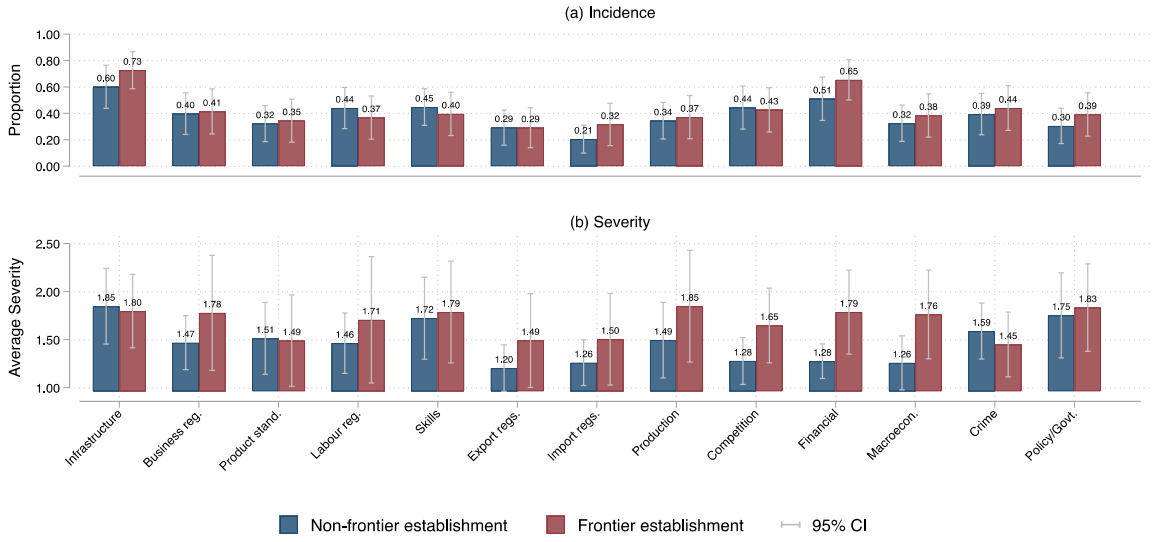
5.4.1 Constraints to Growth: Intensification

Having gained an overview of the types of constraints facing the MER sector as a whole, we now turn our attention to the subset of establishments in the MER sector who are producing one of the frontier products identified by Allen Whitehead & Bhorat (2021). Just under half (approximately 43%) of all MER sector establishments are already producing these frontier products, but not competitively, or at sufficient scale (top left and top right quadrants of Figure 6). This section thus aims to understand the constraints faced by these frontier product-producing establishments in an attempt to provide insights on how to intensify production of these products and thus develop the complexity of the MER sector further.

Given that frontier establishments are producing frontier products, although on a relatively small scale to be globally competitive, it is possible that they face different constraints to those establishments that do not currently produce frontier products at all (hereafter referred to as "non-frontier establishments"). In order to better understand how frontier and non-frontier establishments differ, we consider both the incidence and severity of constraints for frontier and non-frontier establishments separately. The results of this analysis are plotted in Figure 9, below.

For the most part, the results indicate that frontier and non-frontier establishments do not face significantly different types of constraints in general. Overall, the proportion of establishments that report facing a given constraint (shown in panel (a)) is similar across all constraints, although frontier establishments seem to be slightly more likely to face challenges related to finance, policy uncertainty and government inefficiency, and import regulations. However, these differences are not statistically significant. On the other hand, however, it does seem that frontier establishments are likely to face constraints more acutely than non-frontier establishments: average severity scores for business regulation, export regulation, production, competition, financial and macroeconomic constraints are substantially larger for frontier establishments than they are for non-frontier establishments (see panel (b)).

Figure 9: Incidence and severity of constraints facing establishments, by frontier establishment status



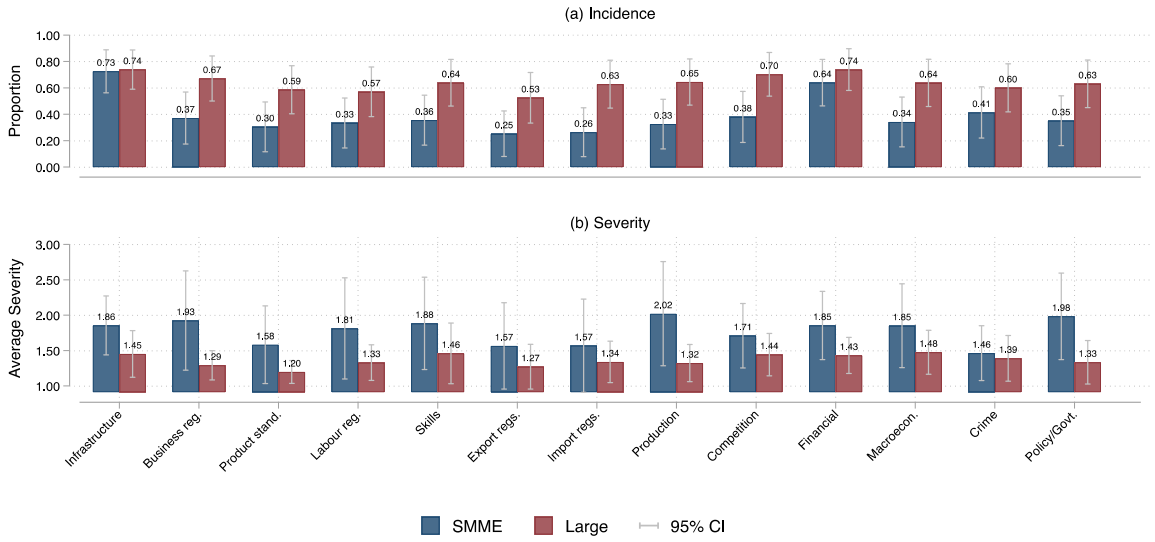
Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Frontier establishments defined as those establishments currently producing a frontier product as identified in Allen Whitehead & Bhorat (2021). 2. Panel (a) presents the proportion of establishments out of the total MER sector that report a constraint as applicable to them. Panel (b) presents the average severity score for each constraint, as measured out of 4. Individual scores interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 3. All estimates weighted using sampling weights and corrected for complex survey design. 4. Severity estimates calculated only over those individuals who reported a constraint as applicable to them – i.e. sample excludes establishments reporting a score of 0, indicating a constraint was "No obstacle" to their operations.

However, within the subset of frontier establishments, there is likely to be heterogeneity in the constraints faced by establishments. Although sample size precludes us from reasonably analysing heterogeneity by chamber within the subset of frontier establishments, we are able to interrogate differences in constraints faced by large establishments and SMMEs in this subgroup. The result of this analysis is presented in Figure 10.

The results in Figure 10 show quite clearly that large establishments are, in general, much more likely to report facing a given constraint than SMMEs, however, when SMMEs face a constraint, they face it much more acutely than their larger counterparts. This result holds in the broader MER sector as well, however, the differences are starker amongst frontier establishments than they are in the broader MER sector.[45] We see that across all constraints except infrastructure, large frontier establishments are substantially more likely to report the given constraint as a barrier to expanding current productive structures than SMMEs. Large establishments are approximately 1.84 times more likely to report facing competition constraints than SMMEs, and they are also 1.77 times more likely to report facing skills constraints than SMMEs. Although likely driven by the fact that large establishments are more likely to operate in international markets, we also see that large establishments are 2.42 times more likely to experience import regulation constraints than SMMEs, as well as 2.12 times more likely to face export regulation constraints.

[45] The results for the broader MER sector are graphed and presented in the appendix as Figure A 1.

Figure 10: Frontier establishment constraint incidence and intensity, by establishment size



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. SMMEs defined as those establishments with employment levels of lower than 150 employees; large establishments are those with 150 employees or more. 2. Panel (a) presents the proportion of establishments out of all MER sector frontier establishments that report a constraint as applicable to them. Panel (b) presents the average severity score for each constraint, as measured out of 4. Individual scores interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 3. All estimates weighted using sampling weights and corrected for complex survey design. 4. Severity estimates calculated only over those individuals who reported a constraint as applicable to them – i.e. sample excludes establishments reporting a score of 0, indicating a constraint was "No obstacle" to their operations.

Conversely, SMMEs are prone to experiencing constraints more acutely. In particular, SMMEs find production constraints and business regulation constraints to be 1.5 times more severe than large establishments. This result could be driven by a combination of economies of scale and specialisation of workers in larger establishments, since large establishments are able to produce more efficiently, and they are able to employ administrative staff to assist in processing documentation and ensuring compliance with business legislation such as BBBEE and taxation laws. It is interesting to note that SMMEs, despite being the focus of a large amount of government policy, experience policy uncertainty and government inefficiency to be 1.5 times more severe than large establishments. This result suggests that policy directed towards supporting SMMEs may need to be better targeted in order to truly be effective at assisting these establishments.

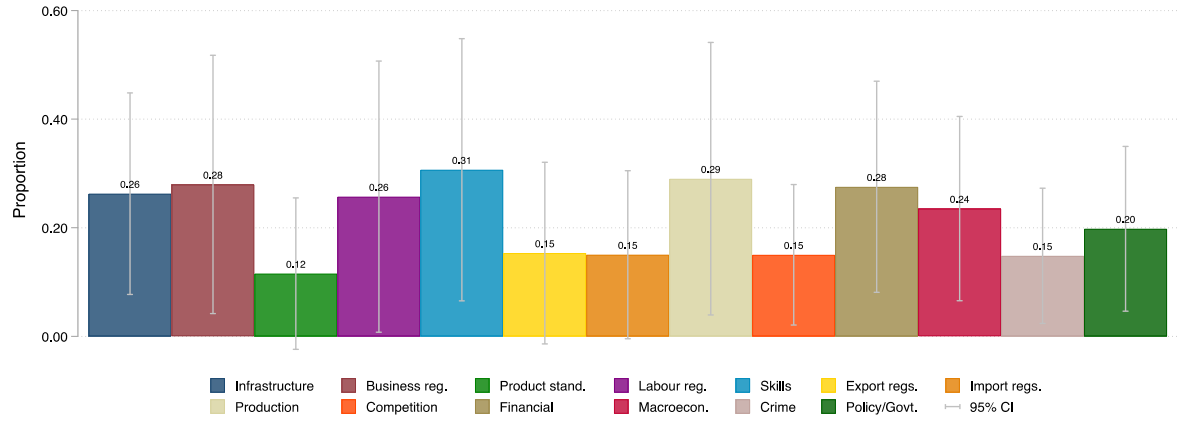
SMMEs also show evidence of being more credit constrained than large establishments with financial constraints being, on average, 1.3 times more severe than for large establishments. Skills constraints are also approximately 1.3 times more severe amongst SMMEs than large establishments, perhaps indicating that SMMEs find it harder to attract appropriately skilled workers to their establishments and/or that they do not have access to the same resources for workplace training programmes to assist in closing the skill gaps that are present in their workforce.

Although the severity score is a useful metric for understanding how acutely establishments experience certain constraints, it can mask certain useful findings related to the distribution of the score. For example, the average severity score for all constraints lies between 1 and 2 out

of four, indicating a moderate constraint. However, this tells us nothing about whether most establishment responses indicate that the constraint is, indeed, moderate, or whether there are actually a variety of extreme responses, with a large number of establishments ranking the constraint as a major or severe constraint to operations. To this end, we plot, as a proportion of establishments reporting a constraint, the number of establishments that report a given constraint as major or severe. These results are presented in Figure 11.

Skills stand out as the most commonly reported major or severe constraint amongst frontier establishments in the MER sector, followed by production constraints, financial constraints, business regulation, infrastructure, and labour regulation. As a guide to interpreting these figures: when considering skills constraints, almost one third (31%) of frontier establishments who indicated that they faced skills constraints indicated that these constraints were major or severe. With a large number of constraints being reported as severe by almost one in three establishments facing such constraints, it is clear that intervention is required in order to assist establishments in overcoming these challenges. However, in order to effectively assist these establishments to overcome their constraints, we need to understand what specific factors are driving the severity of the constraint.

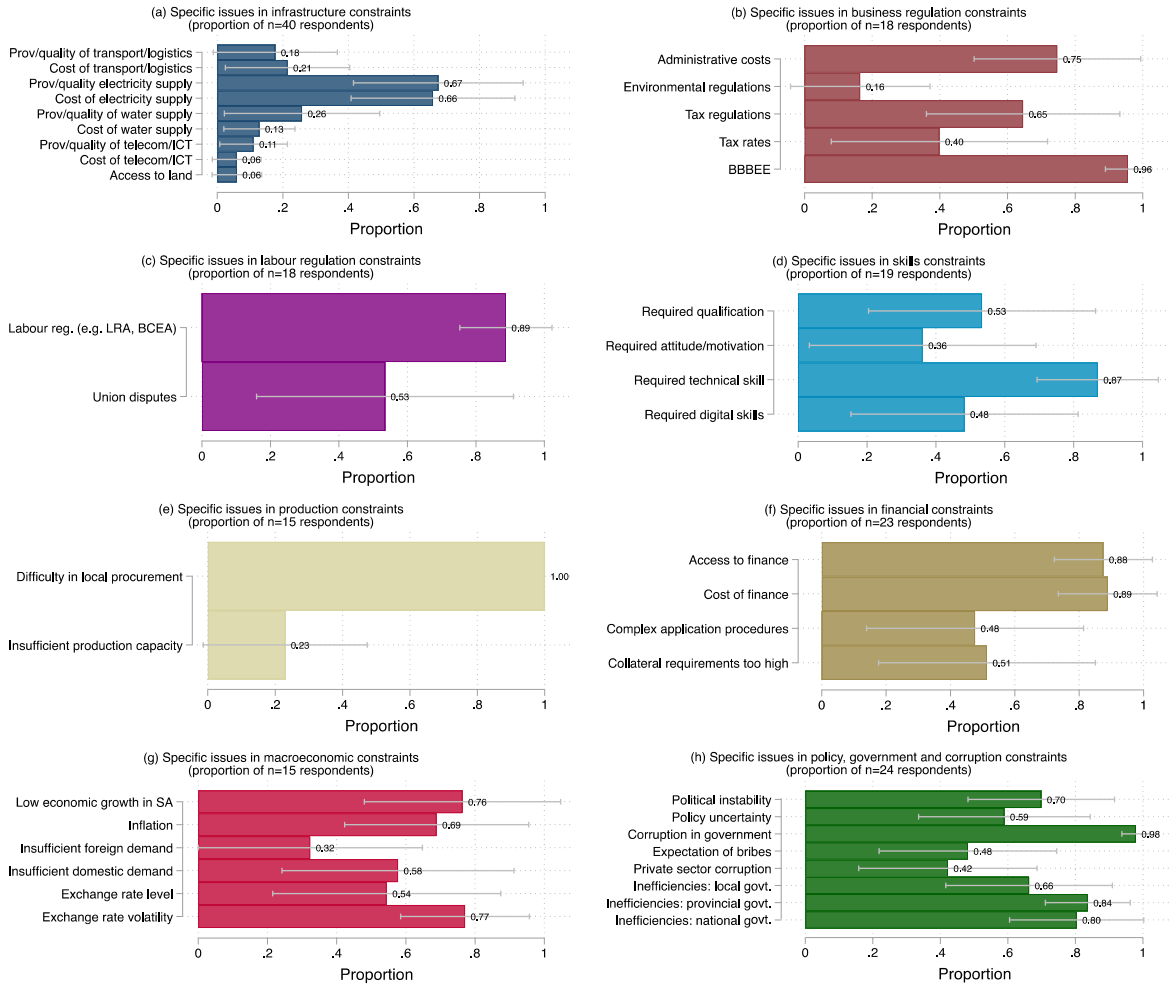
Figure 11: Proportion of frontier establishments facing a given constraint that indicate it presents a major/severe obstacle to their operations



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Figure presents proportion of frontier establishments facing a given constraint that reported the level of the constraint as "Major" or "Severe". 2. All estimates weighted using sampling weights and corrected for complex survey design.

Figure 12 unpacks some of the specific reasons that establishments reported a constraint as major or severe. Specifically, Figure 12 reports on establishments that listed a constraint as major or severe, and presents the proportion of establishments who cited a specific reason for their response. In general, establishments seem to feel that inefficient governance and poorly managed state institutions are a major driving force behind why constraints become more difficult to overcome. In particular, high proportions of firms report challenges with the provision, quality and cost of electricity supply, which is unsurprising given the challenges of loadshedding brought on due to diminished generation capacity at South Africa's chief power provider, Eskom. Similar concerns regarding government inefficiencies, corruption and BBBEE all speak to the challenges establishments face as a result of inefficient governance in South Africa.

Figure 12: Specific drivers of major/severe constraints reported by establishments



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Figure presents proportion of frontier establishments classifying a constraint as "Major" or "Severe" that listed the given reason as the reason for their classification of the constraint as such. 2. All estimates weighted using sampling weights and corrected for complex survey design. 3. Specific constraints analysed here chosen on the basis of proportion of establishments listing constraint as severe (see Figure 8).

From an active policy-making perspective however, there are other areas that can be seen as key for active intervention. Firstly, panel (b) above shows that three quarters of establishments who listed business regulations as a major or severe constraint did so because administrative costs and burdens were too large. This result suggests that policy to help streamline business administrative procedures surrounding the application of licenses and permits could go a long way towards assisting establishments in overcoming their business regulation constraints. Furthermore, in panel (d), we see that approximately half of all establishments list a lack of correctly qualified workers as a reason for their classification of skills as a severe constraint, while 87 percent report a lack of required technical skills as a reason for their classification. Taking these results together, we see that there are more establishments who find a lack of technical skills than those who find a lack of appropriate qualification. The natural corollary of this finding is that workers entering the labour market and presenting themselves to the labour market may be qualified, but their qualification does not correctly or adequately prepare them for the work they are required to do. This suggests that education and training institutions

should re-evaluate what they teach as part of their qualifications and try to better align their programmes with industry standards and needs.

Access to finance and cost of finance is also a major concern for establishments, which suggests that providing establishments with information about and access to affordable loans may have strong positive effects on the growth of the MER sector in the long run. A particularly striking finding can be seen in panel (e), where all respondents indicated that difficulty in local procurement of resources was a driving force behind why production constraints were classified as severe. While this could be related to BBBEE procurement rules, it is also possible that a lack of appropriate transport infrastructure or lack of local supply could aggravate such challenges. Policies that promote ease of access to resources could have strong positive effects on the development of the MER sector in the future.

While certain of these constraints – such as provision of electricity or challenges with labour regulations – are purely within the sphere of government or state-run institutions, policy to address constraints that are more endogenous – such as skills constraints – could be driven on the part of firms as well. Policy that aims to address skills shortages in industry could be driven by firms actively engaging with education and training institutions in order to provide information on their requirements and/or introduce partnership programmes that allow learners to build the necessary skills to narrow skill gaps in the future. For example, if a firm identifies a skill gap amongst a certain occupational grouping, this firm could assist in overcoming this challenge through the implementation of learnership programmes and apprenticeships in partnership with a tertiary institution that would assist in overcoming these challenges. Of course, such programmes require administrative buy-in and need to be structured within the current educational framework prescribed in South Africa. However, policymakers may be able to leverage off firms' desires to overcome these constraints, as well as their relevant knowledge of the industry, to jumpstart interventions and assist firms in overcoming these constraints.

On the whole, frontier establishments are seen to be relatively similar to non-frontier establishments in the MER sector, at least insofar as the types of constraints they face. This is useful from a policy perspective, as it doesn't require policies that specifically target establishments that are producing frontier products, ultimately making the administrative burden of enacting policy lower. However, the constraints faced by frontier establishments do differ significantly by establishment size, with larger firms much more likely to experience a given constraint, but SMMEs generally experiencing the constraints much more acutely. Skills, production, finances, business regulation, infrastructure and labour regulation were reported as severe constraints by between 26 and 31 percent of firms who experienced these constraints – in other words, between one in three and one in four establishments experiencing such a constraint found it to be a major or severe challenge to their operations. When unpacking the reasons for these results, certain factors stood out, including inefficient governance, training that was not aligned with industry standards, and credit constraints. While we cannot say more at this time, we will further unpack what establishments mean by these responses in a future study, using qualitative interview techniques.

5.4.2 Constraints to Growth: Diversification

We now shift our focus away from those establishments who are already producing frontier products – albeit, not competitively – and refocus on those establishments who indicated that frontier products were an opportunity for future diversification. It should be noted, however, that the sample of firms who indicated that they saw opportunities for diversification is small: a weighted total of 7.6 percent of all establishments indicated that they planned on diversifying in the future. More specifically, only 5 percent of all establishments – or a total of 12 respondents – indicated that they planned on diversifying into frontier products (top right and bottom right quadrant of Figure 6). While this suggests that the majority of diversification in the MER sector may be along frontier product lines, the samples are too small to draw any strong conclusions.

Furthermore, due to the small number of diversifying establishments, this section of the report does not generalise to the MER sector as a whole, and does not provide any weighted estimates of results. Inference and generalisation of findings based on such a small sample would be statistically inappropriate since one cannot guarantee the reliability of the sampling weights on such a small subsample of observations. This decision is further informed by the structure of the questionnaire, which at this point focusses on product-level capabilities and constraints to diversification, rather than the establishment-level focus of previous sections. As a result, since the sampling weights are created at the establishment level, it would be inappropriate to weight responses in this section to provide product-level information. We thus present the results for diversifying establishments more as a case study, where results are informative for future research, but do not necessarily represent the views of all such establishments in the MER sector.

In our data, 12 unique establishments listed a total of 13 unique frontier product diversification opportunities that fall into 8 of the 4-digit frontier product codes identified by Allen Whitehead & Bhorat (2021).[46] A full breakdown of these results is presented in Table 11. The most commonly-cited diversification opportunity was that of "parts of motor vehicles", which is not wholly surprising given the fairly well-established automotive industry in South Africa. In particular, establishments listed products such as "Diff carriers" and "Wheels" as specific avenues for diversification. "Polymers of styrene" and "Tubes, seamless, of iron and steel" were reported as the next-most common diversification opportunities, with two products from each of these categories being listed by diversifying establishments. All other diversification opportunities listed by establishments, such as "Stoves" or "Escalators", fell in unique 4-digit product classifications.

Enabling establishments to diversify into the production of these frontier products hinges on two complementary concepts: First, what capabilities the firms currently possess that would enable the diversification to take place; and second, what constraints exist that hinder the diversification. We will first turn our attention to existing capabilities establishments indicated they currently possess that would enable diversification into a given frontier product. The unit of analysis changes here to be the frontier product rather than the establishment – in other

[46] For detailed information on exactly what products were listed as diversification opportunities and the subsequent mapping to the 4-digit HS code, the reader is directed to Table A 3 in the appendix.

words, we now group responses according to frontier product code so that the results are interpreted as capabilities and constraints pertaining to the production of a given product.

Table 11: Frontier products listed as diversification opportunities by MER sector establishments

HS Code	Product Description	Number of times listed	Number of establishments
8708	Parts of motor vehicles	4	4
3903	Polymers of styrene	2	1
7304	Tubes, seamless, of iron or steel	2	2
7321	Stoves and similar non-electric appliances of iron or steel	1	1
8716	Trailers and semi-trailers	1	1
8428	Other lifting machinery	1	1
7610	Aluminium structures (bridges, towers etc)	1	1
3208	Paints and varnishes, nonaqueous	1	1
	Total	13	12

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Products reported by establishments were mapped to appropriate 4-digit HS Code for analysis. A detailed list of reported products is reported in Table A 1. 2. Estimates are not weighted or corrected for complex survey design due to sample size and questionnaire structure.

In Table 12, we present an overview of the capabilities that establishments currently possess that would enable them to diversify into a given frontier product. The table is colour-coded from green (indicating that all respondent establishments indicated that they possess the given capability for diversification) to red (indicating that none of the respondent establishments indicated that they possess the given capability). Capabilities are then ordered from left to right, with the left-most column indicating the capability that, on average, is most ubiquitously possessed by establishments, and the right-most column indicating the capability that is, on average, possessed by the fewest establishments. Products are ordered from top to bottom where the topmost product is one where, on average, establishments indicated that they were in possession of the most listed capabilities, while the bottom-most product is the one where, on average, establishments did not indicate they were in possession of most of the listed capabilities.[47]

[47] Note that this list of capabilities is not in any way exhaustive. As a result, there may be other capabilities that establishments require to diversify into a given product, which may result in changes to the relative ranking presented. However, based on the responses received, and the lack of responses to the "Other, specify" option in this question, we have chosen to present the results in this manner.

Table 12: Map of extent to which establishments report having capabilities to diversify into frontier products

HS code	Product description	Times reported	Sufficient factory space	Employees with requisite knowledge of production process	Workers with requisite skills to manufacture product	Access to required networks	Employees with requisite knowledge to design product	Repurposing existing machinery and production processes	Access to raw materials/ resources	Supply chain relations to get product to market	Market knowledge of the product	R&D investment that enables innovation	Excess production capacity
8708	Parts of motor vehicles	4											
3903	Polymers of styrene	2											
7610	Aluminium structures (bridges, towers etc)	1											
7321	Stoves and similar non-electric appliances of iron or steel	1											
8716	Trailers and semi-trailers	1											
8428	Other lifting machinery	1											
7304	Tubes, seamless, of iron or steel	2											
3208	Paints and varnishes, nonaqueous	1											

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Products reported by firms were mapped to appropriate 4-digit HS Code for analysis. 2. Estimates are not weighted or corrected for complex survey design due to sample size and questionnaire structure. 3. Table presents average proportion of establishments who indicated that they were in possession of a given capability that would enable diversification into the listed product. 4. Colour coding runs from green (all firms are in possession of the capability) to red (no firms are in possession of the capability). 5. Capabilities listed in decreasing order of ubiquity from left to right, while products listed from top to bottom in decreasing order of average capabilities possessed by relevant establishments.

With this in mind, we can see that the capabilities that are most ubiquitous across the sample of responding diversifying frontier establishments include possession of sufficient factory space to produce the new product, and employees and workers with the requisite skills and knowledge to manufacture the new product. This may stand in stark contrast to the result that a lack of skills stood out as a common, and fairly severe, constraint amongst frontier establishments in the previous section. However, at this point it is worth remembering that the sample of diversifying establishments is small, and may present idiosyncratic results. If, however, we were to believe that this sample were representative of diversifying establishments in the MER sector, then it is possible that establishments may opt to select into diversification opportunities because of the fact that they possess workers with skills that could be utilised in the new production process – a type of "reverse causality", where the skills of the existing workforce guide the opportunities that establishments choose to act on.

The capabilities that are least commonly reported amongst diversifying frontier establishments include excess production capacity, R&D, and market knowledge of the product. The lack of excess production capacity is juxtaposed with the fact that most establishments indicated they had sufficient factory space. This, perhaps, indicates that these establishments might have sufficient space in their factory to expand production, but that the underlying infrastructure or workforce capacity does not exist – e.g. it is possible that unreliable electricity supply, which was suggested as a major obstacle to frontier establishments in the previous section, may curtail operations of establishments, which would then lead to diminished productive capacity, ultimately restricting the ability of establishments to diversify their production.

On the whole, it seems that establishments aiming to produce motor vehicle parts are in possession of the most capabilities to enable diversification, while the establishment aiming to diversify into paints and varnishes is in possession of the fewest.[48] Although not representative of the MER sector as a whole, this may suggest that establishments aiming to diversify into motor vehicle parts are better able to repurpose their current productive structures to diversify into producing the new product. On the other hand, the establishment indicating that it wants to diversify into paints and varnishes may have to do the most restructuring of its current productive structure in order to facilitate diversification into producing this frontier product.

We now shift focus to the severity of product-level constraints faced by frontier establishments looking to diversify into a given frontier product. Once again, we colour-code our results in Table 13 from green (indicating that a constraint has a severity score of 0 across all establishments reporting it – i.e. it presents no obstacle to diversification for the establishment) to red (indicating that a constraint has a maximum severity score of 4 across all establishments reporting it – i.e. it presents a severe obstacle to diversification for the establishment). Once again, constraints are ordered from left to right, in increasing order of average severity score, and products are ordered from top to bottom with the average severity of the obstacles faced to diversify increasing as you run down the table.

In contrast to the results for all frontier establishments presented in Section 5.4.1, it seems that infrastructure and production constraints are, on average, among the least severe constraints

[48] Note that the specific product description of the product classified under "Paints and varnishes, nonaqueous" is "Paint plastic paving".

faced by diversifying establishments. These two constraints were consistently ranked as among the more severe ones faced by frontier establishments, which makes it interesting that they seem less severe amongst diversifying frontier establishments. Once again, this could be due to the small sample size being unrepresentative of the broader MER sector, but it could also be the result of firms only choosing to diversify if the so-called "big ticket" items are in place – i.e. establishments only choose to diversify if infrastructure and production capacity are favourable enough for them to do so.

The most severe constraints facing diversifying firms include policy uncertainty and government inefficiency, as well as competition, macroeconomic constraints, financial constraints, skills, and business regulations. This is consistent with the results presented in Section 5.4.1 for frontier establishments as a whole, which may indicate that these are cross-cutting obstacles that require intervention in order to facilitate innovation and diversification of the MER sector as a whole.

When interpreting the results presented in Table 13 at the frontier product level, it is useful to consider them in conjunction with the results presented in Table 12 above. For example, the establishment that indicated that they saw opportunities to diversify into paints and varnishes had the fewest capabilities to enable diversification, but simultaneously faces the fewest constraints to diversification. On the other hand, establishments that indicate opportunities for diversification into motor vehicle parts seem to have the most capabilities to enable diversification, but face relatively more severe constraints to diversification. Policy to assist firms in their diversification efforts should also consider both capabilities and constraints together to piece together a more holistic picture. For example: the establishment that indicated diversifying into "paints and varnishes" lists employees with requisite knowledge of the production process and skills to produce the product as capabilities they do not possess that would enable their diversification. However, at the same time, this establishment lists skills as "no obstacle" to their diversification plans. This could suggest that the establishment is considering branching into a product that is new to their productive structure, and so they do not have appropriately skilled workers on their workforce at this time; however, they believe that there is a supply of these workers in the broader labour market, so they will not struggle to fill positions when they move forward with their diversification plans. Policymakers may do well to investigate such scenarios and support such firms as it would lead to accelerated job creation in the MER sector as a whole, and stimulate product development and growth in the sector. Future research on this topic will conduct a deeper dive into these constraints and unpack establishments' responses further through the use of qualitative firm surveys.

Table 13: Map of severity of constraints to diversifying into frontier products

HS code	Product description	Times reported	Export regs.	Prod. cons.	Infrastr.	Import regs.	Labour regs.	Crime	Product stand.	Business regs.	Skills	Financial	Macro-econ.	Comp.	Policy /govt.
3208	Paints and varnishes, nonaqueous	1													
8428	Other lifting machinery	1													
7321	Stoves and similar non-electric appliances of iron or steel	1													
7610	Aluminium structures (bridges, towers etc)	1													
8708	Parts of motor vehicles	4													
8716	Trailers and semi-trailers	1													
3903	Polymers of styrene	2													
7304	Tubes, seamless, of iron or steel	1													

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. Products reported by firms were mapped to appropriate 4-digit HS Code for analysis. 2. Estimates are not weighted or corrected for complex survey design due to sample size and questionnaire structure. 3. Table presents average severity score of constraints to diversification as reported by establishments. Scores were coded as follows: 0 – "No obstacle"; 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 4. Colour coding runs from green (severity score of 0 – i.e. constraint is, on average, no obstacle to diversification) to red (severity score of 4 – i.e. constraint is, on average, a severe obstacle to diversification). 5. Constraints listed in decreasing order of severity from left to right, while products listed from top to bottom in decreasing order of average constraint severity faced by establishments in diversifying into given product.

Overall, while the analysis of establishments who indicate they see opportunities for diversification is not generalisable to the broader MER sector, there are still useful insights to be gleaned from the results. For example, it seems that the majority of diversification opportunities in the MER sector are concentrated among frontier products, suggesting that encouraging diversification in general may help in growing the overall complexity of the MER sector. If, however, product-level interventions for diversification are required, it is important to consider both capabilities and constraints in formulating the correct policy. Based on the responses provided, it seems that motor vehicle parts present the greatest opportunity for establishments to adapt their current productive structure, since these establishments tended to be in possession of the majority of the listed capabilities. However, these same establishments faced rather more severe constraints than establishments that were looking to diversify into other products.

On average, policy uncertainty and government inefficiency, financial constraints, macroeconomic constraints, and skills were highlighted as being among the more severe constraints faced by diversifying establishments – a finding consistent with that of frontier establishments in general. On the other hand, infrastructure and production constraints were among the least severe constraints, which stood in stark contrast to the result for frontier establishments in general. This may suggest a level of selection whereby only those firms who are advantageously placed in terms of their capabilities and constraints consider diversifying into new products, but the sample size is not large enough to make any such conclusions in general. In the next section, we aim to focus in on skills constraints in particular, both given their relative importance to merSETA, as well as the fact that they have been consistently highlighted as an important constraint faced by establishments in the MER sector.

5.5 Skills Constraints Facing MER Sector Establishments

Following from our analysis of the various constraints faced by MER Sector establishments above, we now investigate in more detail the skills-related constraints so as to provide guidance to skills development policymaking. We begin by providing an overview of the skills profile of MER Sector establishments, and then analyse the incidence and distribution of both skills gaps and shortages. Finally, given that in the above section we found that skills-related constraints serve as a notable constraint for both the intensification of establishments' existing production portfolios as well as their ability to diversify into new product production, we interrogate these constraints further.

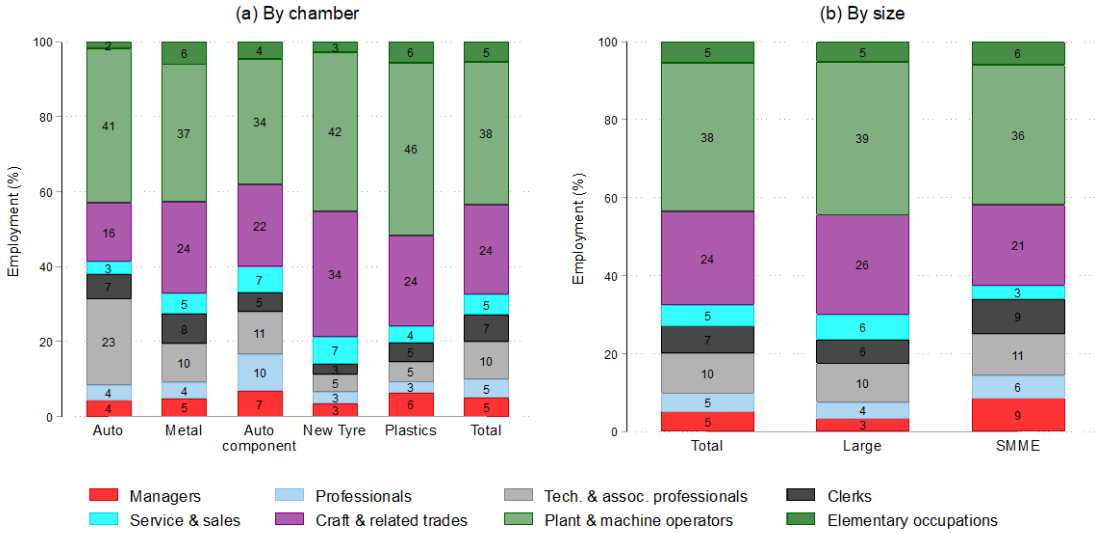
5.5.1 Skill profile of the MER Sector

We start by considering the occupational composition of employment in the MER sector. We examine the extent to which the distribution of employment across main occupation groups varies by chamber and firm size. These results are reported in Figure 13.

Overall, and expectedly given that establishments are engaged in manufacturing activity, plant and machine operators are the largest main occupation grouping in the MER Sector, representing over a third of all employees (38%). This group includes occupations such as metal processing and machine operators, assemblers, and drivers, and is the dominant occupation group within every chamber and establishment size. This is followed by craft and related trade

workers, comprising one in every four employees (24%), and which include structural metal workers, welders, blacksmiths, and other handicraft workers. The employment shares of other occupation groups vary between 5 and 10 percent.

Figure 13: Occupational composition of employment in the MER Sector by chamber and establishment size, 2021/22



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the weighted estimates of the occupational distribution of employment at the time of the survey by chamber and establishment size. 2. All estimates weighted using sampling weights.

We observe a degree of heterogeneity in occupational composition across chambers, with the exception of the Metals chamber that aligns closely with the overall distribution of the MER sector.[49] Within the Auto chamber, the second-largest group is not craft and related trade workers but rather technicians and associate professionals (23%). This may be a result of the production processes of automotive manufacturers being highly automated and capital-intensive, and thus requiring more technicians than in less automated production processes. In the Auto Components chamber, professionals (which includes engineers and legal and business professionals) represent a larger-than-average share of workers (10%), which varies between 3-5 percent in other chambers. By establishment size, the occupational compositions are not remarkably different. However, there is one exception: the share of workers that are managers (which includes executives, directors and other managers) in SMMEs (9%) is three times larger than that in large establishments (3%).

We next consider, within each of the eight main occupation groups referred to above, the composition of employment by the highest qualification typically held by employees. We present these estimates overall, and by chamber, in Figure 14, and then by establishment size in Figure 15. This gives us a sense of the predominant educational qualification associated with the workforce within each occupational grouping.

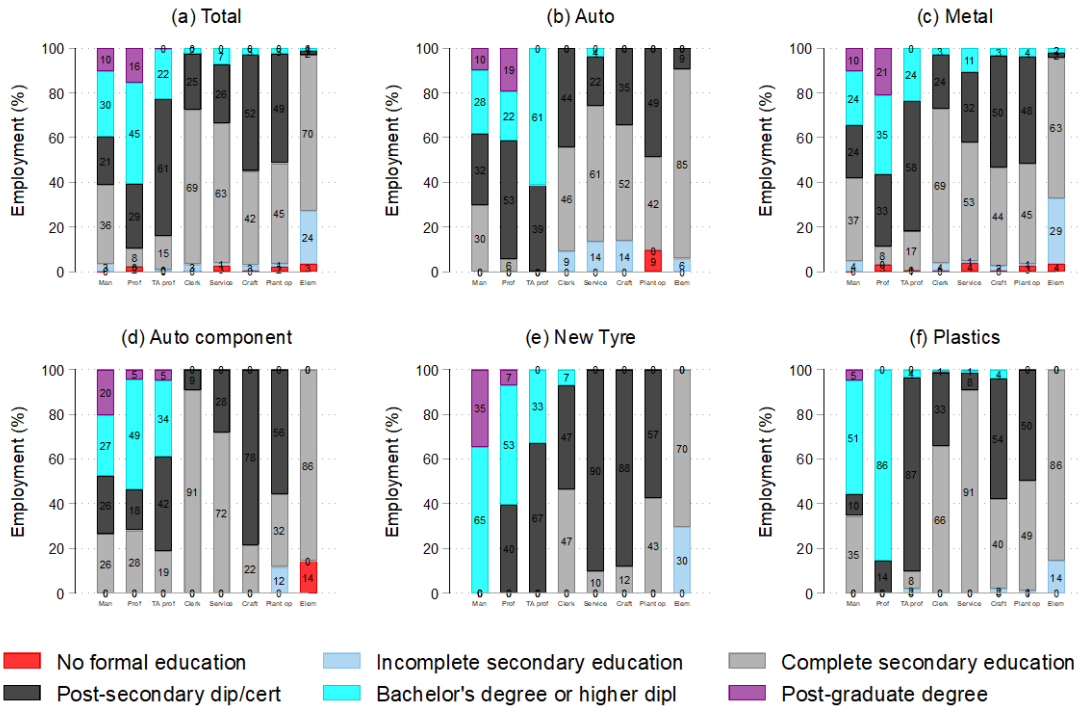
[49] This is consistent with the Metals chamber accounting for two-thirds of employment in the MER sector, and thus driving the overall occupational distribution of the sector.

Overall, the majority of employees in the sector have at least a completed secondary education (hereafter matric or equivalent), but we do observe variation in distribution of qualifications across occupations.[50] It is clear in Figure 14 that in all occupation groups, aside from elementary occupations, 96-98 percent of workers (depending on the chamber) have at least a matric qualification. While having at least a matric qualification is the norm in the sector, we do, however, observe a fairly substantial share of employees in elementary occupations – one in four employees – without a matric qualification (27%). Employees in Professional occupations exhibit the highest qualification level, with 61 percent having at least a bachelor's degree. In contrast, the corresponding share is 40 percent for managers, 23 percent for technicians and associate professionals, and 0 to 7 percent for other occupation groups. A large share of workers also holds post-secondary diplomas or certificates, ranging from 61 percent for technicians and associate professionals, to 21 percent for managers.

Regardless of chamber, the above statement holds: most workers in all occupation groups have at least a matric or equivalent qualification. The Metals chamber largely resembles the overall composition – consistent with it accounting for two-thirds of employment in the sector. In the Auto chamber, the composition is in line with the overall composition of the MER sector, but with few exceptions: larger shares of professionals and clerical support workers have a post-secondary diploma or certificate – 53 and 44 percent, respectively; a lower share of craft and related trade workers have higher than matric (35%). The Auto components chamber also largely resembles the overall composition, except most clerical and support workers (91%) have at most a matric, and most craft and related trade workers have a post-secondary diploma or certificate (78%). In the New Tyre chamber, all managers have a bachelor's degree or higher, while almost all service and sales workers (90%) and craft and related trade workers (88%), and most clerical and support workers (54%), have some post-secondary qualification. Finally, in Plastics, most managers and professionals have a bachelor's degree or higher (56 and 96 percent, respectively), while nearly all technicians and associate professionals have a post-secondary diploma or certificate (87%) – the largest such share within this occupation group and between chambers.

[50] The prevalence of completed secondary education, or a matric equivalent qualification, is consistent with previous qualitative work conducted by Bhorat et al. (2019), which reports that the entry level qualification into manufacturing firms is a complete secondary education with mathematics as a completed subject.

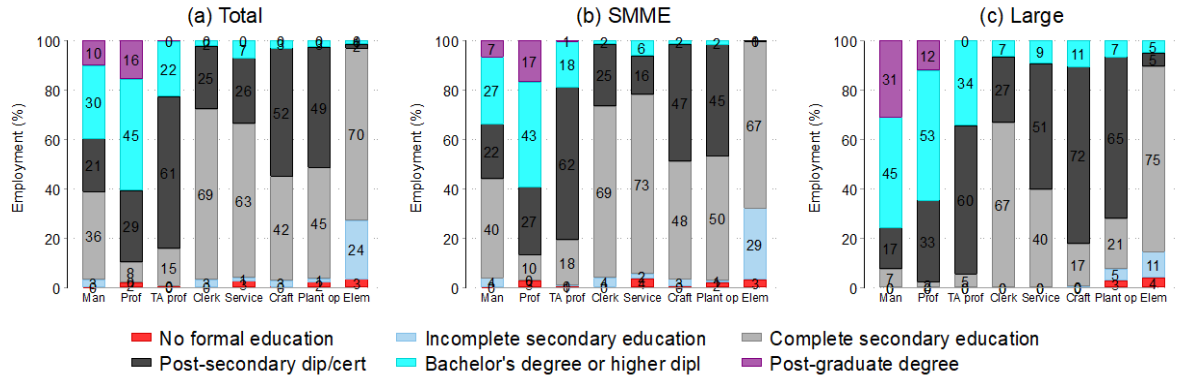
Figure 14: Distribution of qualifications in the MER Sector in 2021/22, by occupation and chamber



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the distribution of typical qualification held for each main occupation group for the MER Sector and by chamber. 2. All estimates are weighted using sampling weights. 3. Man = Managers; Prof = Professionals; TA prof = Technical and Associate professionals; Clerk = Clerical Support Workers; Service = Service and sales workers; Plant op = Plant and machine operators and assemblers; Elem = Elementary occupations.

We observe that the distribution of qualifications by occupation group varied by establishment size, and our estimates provide suggestive evidence on education-related selection into establishments by size. In other words, more qualified workers tend to find their way into larger establishments. For instance, as shown in Figure 15, we see that a larger share of managers in large establishments have a bachelor's degree or higher compared to their SMME counterparts (76 versus 34 percent). Conversely, we observe that 40 percent of managers in SMMEs have a matric compared to just 7 percent of managers in large establishments. A significantly greater share of service and sales workers, craft and related trade workers, and plant and machine operators in large establishments have post-secondary qualifications relative to their SMME counterparts. It is plausible that these differences are due to the greater ability of larger establishments to attract more educated workers in the recruitment process, or alternatively their greater ability to upskill workers they currently employ. Either way, it is clear that the targeting of skills development programmes ought to consider such differences in qualifications by establishment size.

Figure 15: Distribution of qualifications in the MER Sector in 2021/22, by occupation and establishment size

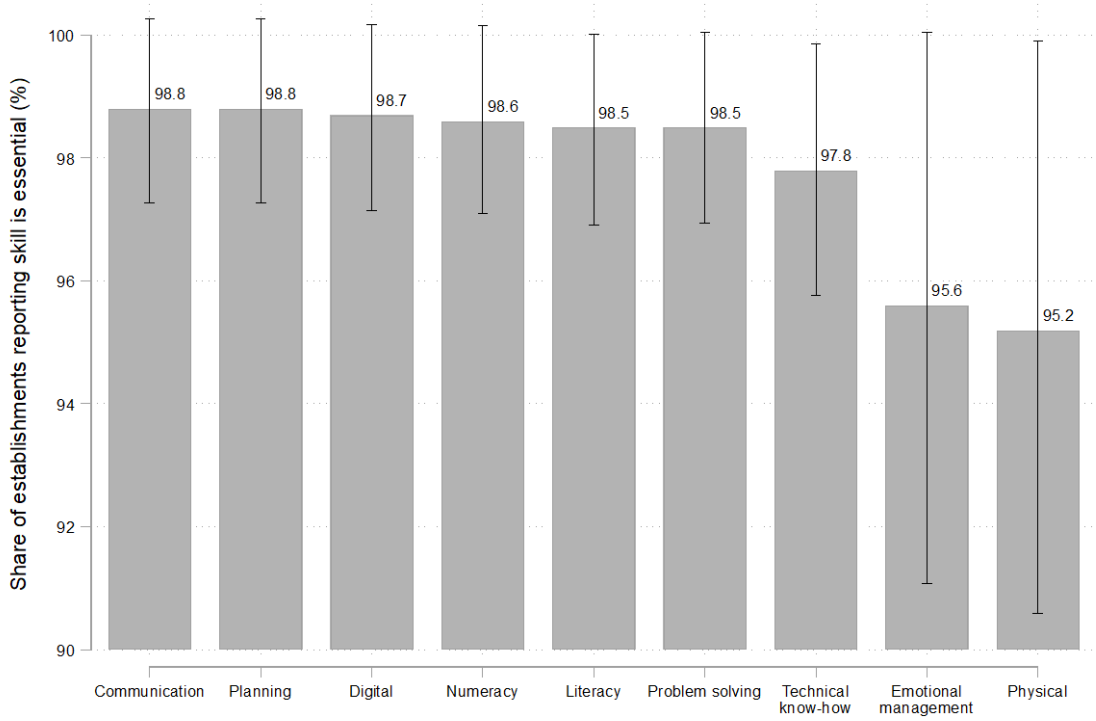


Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the distribution of typical qualification held for each main occupation group for the MER Sector and by establishment size. 2. All estimates are weighted using sampling weights. 3. Man = Managers; Prof = Professionals; TA prof = Technical and Associate professionals; Clerk = Clerical Support Workers; Service = Service and sales workers; Plant op = Plant and machine operators and assemblers; Elem = Elementary occupations.

Skills and qualifications, however, are not equivalent. That is, employees within a given occupation and across occupations vary considerably in the skills they possess. The MER Sector Enterprise Survey asked establishments to rate the importance of nine different skills types in meeting the demands of the jobs within each of their occupation groups.[51] In Figure 16 we present the overall estimated shares of establishments who rated each skill as essential for at least one occupation group – we refer to this as 'skill importance'. The key point to emerge from this analysis is that at the establishment level, every one of these skills is essential. The degree of variation with respect to skill importance across these skills is marginal, with estimates ranging between 95 and 99 percent. As such, we shift our focus to whether the relative importance of these skills vary both across and within occupational groupings.

[51] Establishments responded by making use of a scale from 1 to 4 where 1 is "not important at all", 2 is "a low level of importance", 3 is "moderately important" and 4 is "essential". Establishments could also report if a given skill was not relevant, if they did not know, or they could refuse to answer the question.

Figure 16: Skill importance: Share of establishments reporting a given skill as essential



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the distribution of skill importance for nine sets of skills in the MER Sector. Specifically, the share of establishments who report that a given skill is 'Essential' in meeting the demands of any occupation group in its existing workforce. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented as capped spikes. 4. Skills are as follows: Communication = Instructing, negotiation, client communication, team work etc.; Planning = Personal time management and planning ahead for a project; Digital = Use a computer, create a spreadsheet, search and collect information online, software design, adapt to new technology; Numeracy = Being able to do basic mathematical calculations – add, subtract, divide etc.; Literacy = Reading and writing; Problem solving = Detecting, diagnosing, analysing, and resolving problems; Technical know-how = Knowing how to use/maintain tools, equipment, monitor operations, and knowledge of the product; Emotional management = Managing one's own feelings and those of others; and Physical = Use of stamina in a job.

We find that there is indeed a much higher degree of variation in skill importance within occupation groups. Table 14 presents the relevant estimates of the share of establishments who reported that a given skill is essential in meeting the demands for a given occupation group in its existing workforce. For each occupation (row), the estimates are colour-coded according to the degree of importance, with shades of green indicative of greater importance and yellow indicative of less importance. For example, 96.7 percent of establishments report 'Literacy' as an essential skill for managers, while 80.9 percent report 'Physical' as an essential skill for managers.

Table 14: Distribution of skill importance, by occupation

	Literacy	Numeracy	Physical	Communication	Planning	Problem solving	Technical know-how	Emotional management	Digital
Managers	96.7	97.0	80.9	97.3	94.9	94.8	92.4	89.6	96.2
	[93.0; 98.5]	[93.8; 98.6]	[71.9; 87.6]	[94.1; 98.8]	[87.7; 98.0]	[87.6; 97.9]	[85.3; 96.2]	[81.1; 94.6]	[92.7; 98.1]
Professionals	95.3	93.8	79.6	93.7	87.7	92.4	87.2	78.3	91.9
	[88.3; 98.2]	[85.2; 97.5]	[63.2; 89.9]	[85.1; 97.5]	[68.7; 95.9]	[84.1; 96.5]	[69.2; 95.3]	[58.5; 90.3]	[82.5; 96.5]
Tech. and assoc. professionals	87.4	85.5	81.8	76.0	76.4	76.1	84.8	64.8	81.0
	[71.0; 95.2]	[69.3; 93.9]	[67.2; 90.7]	[58.4; 87.7]	[61.9; 86.5]	[58.5; 87.8]	[68.9; 93.3]	[47.2; 79.1]	[65.7; 90.4]
Clerical support workers	96.6	90.8	45.6	92.2	88.6	90.2	63.9	68.0	93.2
	[93.0; 98.4]	[82.3; 95.4]	[34.3; 57.3]	[84.2; 96.3]	[80.8; 93.4]	[82.3; 94.8]	[51.5; 74.7]	[55.5; 78.3]	[85.2; 97.1]
Service and sales workers	96.1	92.1	62.3	94.6	85.8	61.5	61.3	44.9	84.2
	[92.5; 98.1]	[69.4; 98.4]	[44.9; 77.0]	[90.9; 96.8]	[76.8; 91.7]	[47.4; 73.9]	[43.4; 76.6]	[30.8; 59.8]	[67.2; 93.3]
Craft and related trades workers	76.9	71.6	87.5	59.5	67.3	64.6	85.4	49.2	51.4
	[63.5; 86.5]	[58.6; 81.8]	[76.6; 93.8]	[44.6; 72.8]	[54.4; 78.0]	[49.3; 77.4]	[74.9; 92.0]	[36.2; 62.4]	[37.3; 65.3]
Plant and machine operators	82.4	70.0	89.3	66.6	56.6	59.5	79.5	51.9	53.4
	[70.0; 90.4]	[57.5; 80.1]	[78.2; 95.1]	[51.5; 78.9]	[42.3; 70.0]	[48.3; 69.9]	[64.1; 89.4]	[38.6; 65.0]	[39.2; 67.1]
Elementary occupations	38.8	37.6	56.1	22.0	11.1	12.0	10.2	11.7	7.3
	[25.0; 54.7]	[23.9; 53.6]	[38.3; 72.4]	[14.0; 32.9]	[5.6; 20.9]	[6.0; 22.7]	[4.8; 20.3]	[5.7; 22.4]	[2.8; 17.7]

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.

Notes: 1. This table presents the distribution skill importance for nine sets of skills by main occupation group for the MER Sector. Specifically, the share of establishments who report that a given skill is 'Essential' in meeting the demands for a given occupation group in its existing workforce. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented in brackets. 4. Rows are shaded according to variation in reported skill importance within occupations and across skills. 5. Skills are as follows: Communication = Instructing, negotiation, client communication, team work etc.; Planning = Personal time management and planning ahead for a project; Digital = Use a computer, create a spreadsheet, search and collect information online, software design, adapt to new technology; Numeracy = Being able to do basic mathematical calculations - add, subtract, divide etc.; Literacy = Reading and writing; Problem solving = Detecting, diagnosing, analysing, and resolving problems; Technical know-how = Knowing how to use/maintain tools, equipment, monitor operations, and knowledge of the product; Emotional management = Managing one's own feelings and those of others; and Physical = Use of stamina in a job.

We observe variation in the relative importance of these skills, in general, across occupations. If we take the average share of occupations that find a given skill as essential for each occupation (average share across each row), we observe that greater shares of establishments report these nine skills to be essential as we move from managers through to elementary occupations. For example, in the case of managers we observe that for most skills, over 90 percent of establishments report them being essential. This stands in stark contrast to the shares of establishments that report these skills as essential for elementary occupation workers – the average across elementary occupations is 23 percent.

We also observe within occupation variation in skill importance. For employees in Managerial, Professional, Clerical Support, and Service and Sales occupations, 'Physical' skills are relatively less essential to other skills for workers within these occupation groups. Conversely, 'Physical' skills are the most important skill for employees within the Craft and Related Trade, Plant and Machine Operator and Elementary Occupations Occupational groupings. For employees in Technical and Associated Professional occupations, 'Literacy', 'Numeracy' and 'Technical Know-how' are the essential skills, while 'Emotional management' is the least essential. For Clerical Support employees, 'Literacy', 'Communication', 'Numeracy', 'Digital' and 'Problem Solving' are the most essential skills, while 'Physical' skills and 'Technical Know-how' are the least essential. For Service and Sales employees, 'Literacy', 'Numeracy', 'Communication', 'Planning' and 'Digital' skills are the most essential, while 'Physical' skills and 'Technical Know-how' are the least essential. In the case of Craft and Related Trade and Plant and Machine Operator employees, the estimates indicate that 'Physical', 'Numeracy', 'Literacy' and 'Technical Know-how' are the most essential skills, while the least essential skills are 'Emotional management' and 'Digital' skills. A similar pattern is evident for employees in Elementary occupations but with very low shares of skills being essential.

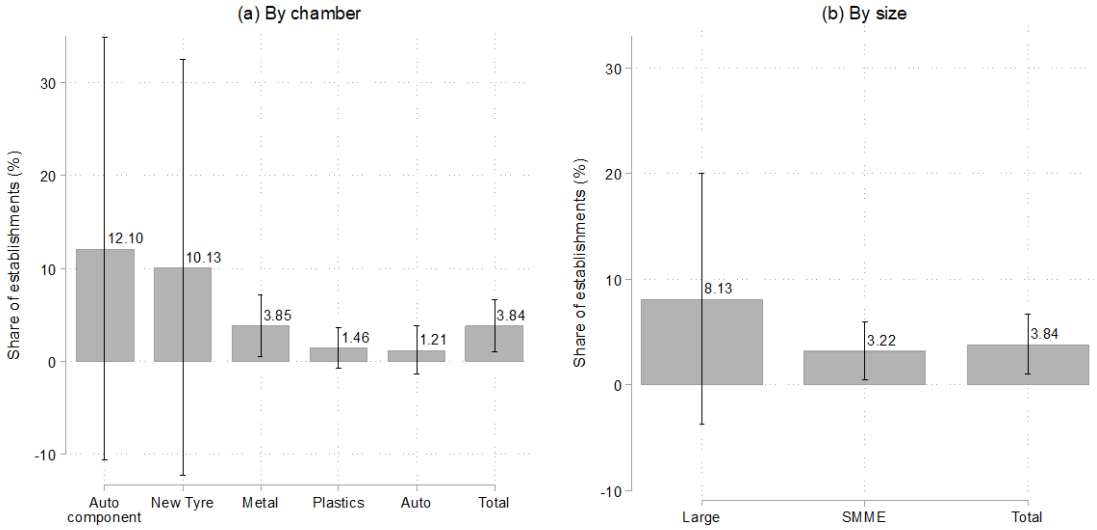
5.5.2 Skills gaps

In this section, we explore the incidence of skill gaps within the existing MER sector workforce. Skill gaps can arise for numerous reasons, such as establishments not being able to find suitably skilled applicants, or intentionally taking on recruits who are not fully experienced in order to train them up to the establishments way of doing things. Skill gaps may also arise because of the changing skill needs of the establishment. Persistent skill gaps can hinder the establishment's ability to function effectively and harm its productivity, profitability and ability to innovate. While the standard approach to measuring skills gaps is to estimate the share of an establishment's workforce which it regards as not fully proficient, we begin the analysis in this section using an alternative measure of a skill gap. In Figure 17 we present estimates on the share of establishments who report that the qualifications they require of their employees exceed the qualifications currently held by their employees. We present this measure for the overall MER sector, as well as by chamber and establishment size.

Our estimates of the establishment level discrepancy between the qualifications that MER sector establishments require of their employees, and the qualifications currently held by those same employees, suggests that establishments in the sector are able to find suitably qualified workers. Overall, just under 4 percent of establishments in the MER sector report a discrepancy between qualification required and qualification held. In other words, the majority of workers being hired seem to have the right qualification for their job as defined by the establishment.

In panel (b) of Figure 17, our estimates suggest that large establishments are more likely to experience this discrepancy than SMMEs (8 versus 3 percent, respectively). By chamber, this discrepancy is highest in the Auto Component (12%) and New Tyre (10%) chambers, while Metals (3.85%) is in line with the sector as a whole.

Figure 17: Incidence of qualifications required exceeding qualifications currently held, by chamber and establishment size



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents estimates of the share of establishments who report excess qualifications required to qualifications currently held, calculated as the difference between the typical level of qualification that is required and currently held for each occupation group. 2. Estimates are disaggregated by chamber and establishment size. 3. All estimates are weighted using sampling weights and account for the complex survey design. 4. 95% confidence intervals presented as capped spikes.

We observe above that when skill gaps are defined by qualifications, we estimate a relatively small gap. We next turn to the standard approach for measuring skill gaps, which estimates the share of an establishment's workforce which it regards as not fully proficient (i.e. workers who are unable to do their job to the required level).[52] MER sector establishments reported these shares for each occupation group in its existing workforce. We present the relevant estimates in Table 15, both overall, by chamber, and by establishment size.

With only one in every ten establishments reporting a skills gap, the vast majority of establishments considered all their staff to be fully proficient at their job. In Table 15, we estimate an aggregate skill gap of 10 percent – that is, 10 percent of establishments have some non-zero share of their workforce as not fully proficient.[53] This is equivalent to approximately 507 MER sector establishments exhibiting a skills gap, and translates to just under 22 000 MER

[52] The MER Sector Enterprise Survey follows the approach, and definition, to identifying skill gaps that is applied in the United Kingdom Employer Skills Survey of 2019 (Winterbotham et al., 2020). Respondents are asked, for each occupational grouping, the percentage of its current workforce that is not fully proficient, and hence unable to do their job at the required level. One potential shortcoming of this measure is that it only captures the skill gaps that employers are aware of and report. Thus, if employers pay little attention to their employees' skills and the needs of the establishment, then they are less likely to report skill gaps.

[53] As a reference point, the United Kingdom Employer Skills Survey of 2019 reports a skill gap incidence among employers in the UK economy of 13 percent in 2019 (Winterbotham et al., 2020).

sector employees not being proficient at their jobs.[54] Taking these aggregate measures further, these establishments exhibit a skills gap of 43 employees, on average. When asked to what extent these establishments with skills gaps think that the existence of these gaps have negatively impacted their performance, the majority (64.5%) reported that they had a negative impact to some extent. Moreover, and perhaps unsurprisingly, establishments with skill gaps are substantially more likely than those without such gaps to report that the skills and education of their available workforce is a constraint to intensification (70 versus 40 percent, respectively). Notably, given that this gap of 10 percent is more than double that estimated under the 'qualifications' definition, this suggests that there are a number of workers who are not fully proficient despite having the required qualification for their occupation. Potentially, this suggests an inadequacy of the relevant education and training institutions in meeting industry needs.

We find that the largest incidence of skill gaps exists within the Plastics chamber, where 16 percent of establishments (or one in every six) report having some share of their workforce as not fully proficient. Skill gaps appear to impact on the Plastics chamber disproportionately: 30 percent of establishments reporting skill gaps are from the Plastics chamber, while the establishments in this chamber account for only 19 percent of MER sector establishments (see Section 5.1). Hence, exhibiting an establishment skill gap ratio of 1.6 – Plastics is the only chamber which exhibits such a ratio in excess of one.[55] Similarly, in the case of employment, 15 percent of employees in the Plastics chamber are considered as having a skills gap, while Plastics chamber workers account for 13 percent of MER sector employment (see Section 5.2). Hence exhibiting an employment skills gap ratio of 1.14. In absolute terms, the majority of establishments (62.86%) with skills gaps, and employees (77.78%) with skill gaps, come from the Metals chamber. The corresponding shares of Metal establishments and employees in the MER sector sits at 71 and 66 percent, respectively. As such, the share of Metal *establishments* with skills gaps is not unexpected given the chamber's overall share of establishments in the sector; however, the chamber does exhibit a disproportionate share of *employees* with skill gaps.

In terms of establishment size, we observe a marginally higher incidence among large establishments, with 11.42 percent of these establishments exhibiting a skills gap. However, it is worth noting that the difference between large establishments and SMMEs, in terms of skills gap incidence, is relatively small and not statistically significant. At the employment level, however, we observe a disproportionate share of employees from SMMEs lacking proficiency relative to employees in large establishments. While SMMEs account for 39.6 percent of MER sector employment, SMME employees account for 50.67 percent of MER sector employees with skill gaps, hence exhibiting an employment skills gap ratio of 1.28. This then provides some guidance for the targeting of skills development programmes to mitigate the presence and magnitude of such gaps.

[54] The 21 956 employees with skill gaps in the MER sector represent 4.62 percent of total employment in the sector.

[55] The skills gap ratio is the ratio of the share of establishments with skill gaps to the share of establishments in total, where a ratio above one indicates a disproportionate skill gaps incidence.

Table 15: Skill gap incidence, by chamber and establishment size

	Share of establishments that report skill gap (%)	Number of establishments			Number of employees		
		Level	Share of total (%)	Establishment skill gap ratio	Level	Share of total (%)	Employment skill gap ratio
Total	10.00 [4.18; 15.83]	507 [212; 803]	100.00	1.00	21 956 [2811; 41101]	100.00	1.00
Chamber							
Auto	5.59 [-0.44; 11.62]	10 [0; 20]	2.00	0.56	1 436 [-908; 3780]	6.54	1.03
Metal	8.87 [4.05; 13.68]	319 [147; 491]	62.86	0.89	17 078 [-1450; 35607]	77.78	1.18
Auto Comp.	7.62 [-1.66; 16.89]	23 [-5; 52]	4.63	0.76	70 [-45; 186]	0.32	0.03
New Tyre	5.91 [-6.93; 18.74]	2 [-2; 5]	0.34	0.59	105 [-113; 324]	0.48	0.11
Plastics	15.99 [-8.76; 40.75]	153 [-86; 392]	30.17	1.60	3 266 [-948; 7481]	14.88	1.14
Firm size							
SMME	9.80 [3.19; 16.41]	435 [142; 728]	85.70	0.98	11 115 [-2692; 24922]	50.62	1.28
Large	11.42 [3.59; 19.25]	73 [28; 117]	14.30	1.14	10 841 [-2595; 24278]	49.38	0.82

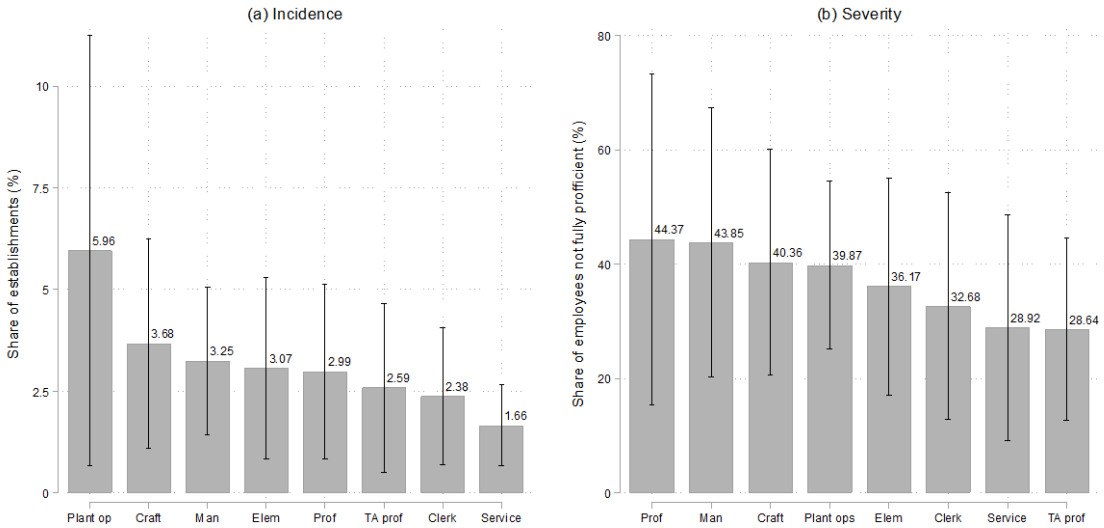
Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.

Notes: 1. This table presents estimates of the incidence of skill gaps by chamber and establishment size, derived by the share a establishment's workforce which is regarded as not fully proficient (someone who is unable to do the job to the required level). 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented in brackets. 4. Auto Comp. = Auto Component. 5. Skill gap ratios refer to the ratio of the share of establishments or employment with skill gaps to the share of establishments or employment in total.

The above analysis is useful to estimate the *incidence* of the overall skill gap in the MER Sector – that is, the share of establishments who report any skill gap for any occupation. We now turn to analysing how the incidence of this gap varies across occupations, as shown in panel (a) of Figure 18. We also investigate the *severity* of skill gaps for each occupation, defined as the average share of employees who are not fully proficient for a given occupation among establishments who report a skill gap for that occupation, as shown in panel (b).

We observe that while the incidence for occupation-specific skill-gaps is relatively low, the severity of these gaps is non-negligible. Panel (a) shows that occupation-specific skill-gaps range between 1.7 percent for the service and sales workers occupation group, and 6 percent for the plant and machine operators occupation group. However, the severity of these gaps, as shown in panel (b), range between 28.6 and 44.4 percent. For example, although just 6 percent of establishments have a skill gap for plant and machine operators, the average establishment that does, has a skill gap for 40 percent of its employees in the plant and machine operators occupation group. In other words, two in every five (40%) plant and machine operators in these establishments are not fully proficient. The occupation with the most severe skill gap is professionals, estimated at just under half (44.4%).

Figure 18: Incidence and severity of skill gaps, by main occupation

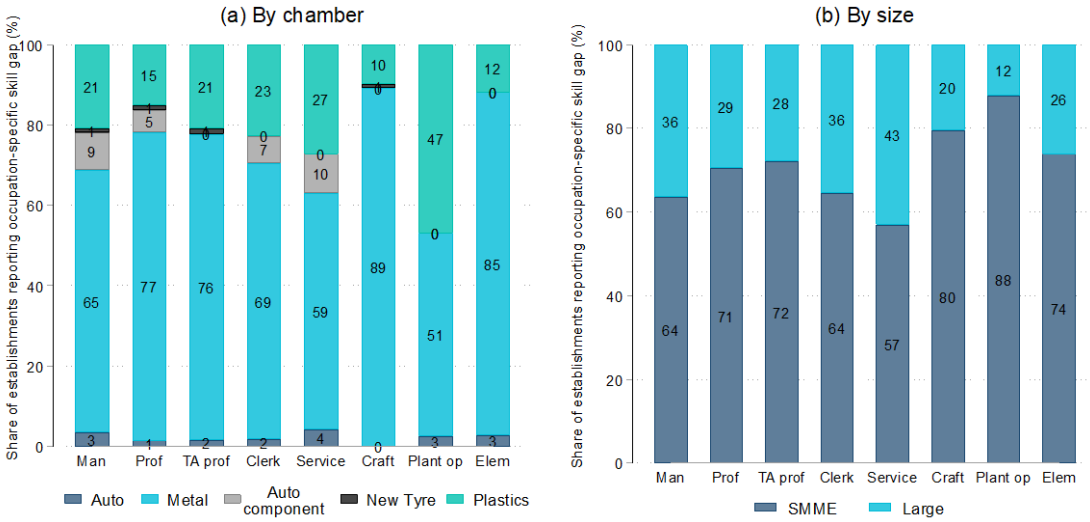


Authors' own calculations. Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022).
Notes: 1. This figure presents estimates of the distribution and severity of skill gaps by main occupation. Magnitude of skill gaps calculated as the share of establishments who report any skill gap (defined as any non-zero share of their workforce for a given occupation that is not fully proficient, i.e. someone who is unable to do the job to the required level). 2. Severity of skills gaps calculated as, among establishments who report a skill gap for a given occupation, the average share of employees who are regarded as not fully proficient. 3. All estimates are weighted using sampling weights and account for the complex survey design. 4. Capped spikes represent 95% confidence intervals.

How are occupation-specific skill gaps distributed between establishments of different chambers and sizes? In Figure 19 we present the distribution of skill gaps for each occupation by chamber and establishment size. We find that skill gaps are concentrated in the Metal and Plastics chambers, regardless of occupation. For example, over half (51%) of establishments who report a skill gap for plant and machine operators are in the Metals chamber. By establishment size, the same can be said for SMMEs. That is, most establishments who report a skill gap are SMMEs and this is the case for all main occupation groups. Both these findings

align with our analyses of Table 15. However, despite the concentration of skill gaps within smaller establishments, it should be noted that they exist within large establishments too, and in some cases to non-negligible degrees. For instance, 43 percent of establishments with skill gaps for service and sales workers are large.

Figure 19: Occupation-specific skill gap distribution, by chamber and establishment size



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents estimates of the distribution of occupation-specific skill gaps by chamber and establishment size, derived by the share a firm's workforce which the respondent regards as not fully proficient (someone who is unable to do the job to the required level). 2. All estimates are weighted using sampling weights.

5.5.3 Skills shortages

The previous section, analysing skill gaps, places emphasis on skills that are lacking internally within establishments. This section shifts the focus to the demand for skills and the ability of the labour market to meet this demand. This is achieved by examining the incidence and distribution of skill shortages. Skill shortages are defined as the presence of vacancies within an establishment. We start by presenting skill shortage estimates in Table 16, where we provide estimates for the MER sector as a whole, as well as by chamber and establishment size.

We estimate a skill shortage rate of 12.15 percent for the MER sector. That is, over 12 percent of establishments in the MER Sector have vacancies. This is equivalent to 616 establishments, and translates to approximately 1 500 vacancies in the sector. When asked to what extent these establishments with hard-to-fill (HTF) vacancies think that their existence negatively impacts their performance, the vast majority (88.5%) reported that they had a negative impact to some extent. Skill shortages are highest in the Metal chamber, with 15.4 percent of establishments in this chamber reporting vacancies. Further, Metals chamber establishments account for under 90 percent of all establishments with skill shortages. Given that these establishments account for just 71 percent of all establishments in the MER Sector, it can be said that the Metals chamber exhibits a disproportionate share of skill shortage: with an establishment skills shortage ratio of 1.27 – it is the only chamber with a ratio in excess of one.[56] In terms of the

[56] The establishment skills shortage ratio is calculated as the ratio of the share of establishments with skill shortages to the share of establishments in total, where a ratio above one indicates a disproportionate skill shortage incidence.

overall level of vacancies, similar can be said of the Metals chamber. This is followed by the Automotive (10.62%) and the Auto Component (7.67%) chambers, with skill shortage rates lowest in the Plastics chamber. This suggests that skills development interventions aimed at meeting market demand need to focus in on the demands of the Metal chamber if they are to have a substantial impact on skill shortages in the sector overall.

In terms of establishment size, large establishments are relatively more likely to have skill shortages, but in absolute terms, skill shortages are more pervasive in SMMEs. The skill shortage rate is 17.41 percent for large establishments in the MER sector, who represent just 12.5 percent of all establishments, hence exhibiting an establishment skill shortage ratio of over one (1.44). In other words, it can be said that large establishments are disproportionately affected by skills shortages. The skills shortage rate for SMMEs on the other hand, is 11.4 percent. Despite this, skill shortages are concentrated among SMMEs, as indicated by their employment skills shortage ratio of 1.58. This is driven by the observation that SMMEs account for nearly two-thirds of all vacancies, but just 40 percent of total employment in the sector. Overall, it can be said that skill shortages disproportionately affect large establishments at the establishment-level, but SMMEs at the employment level.

Further interrogation reveals that most of these vacancies are regarded as being HTF. Of establishments who have vacancies, the majority (80.4%) report that these vacancies are HTF. Looking at the distribution of hard-to-fill vacancies across chambers, we find that all establishments in Auto, Automotive component, and New Tyre chambers, who report any vacancies, indicate all of them as being HTF vacancies. In the case of the Metal and Plastics chambers, the corresponding shares of HVT vacancies are 80 and 62 percent, respectively. However, these estimates ought to be interpreted with caution given very small sample sizes.[57] Considering the distribution of HTF vacancies by establishment size, we note that nearly all SMMEs (87%) and half of all large establishments who have any vacancies reported them as being HTF.[58]

[57] For example, 22 establishments in our sample in the Metal chamber reported their vacancies are HTF. However, for the remaining chambers the equivalent numbers ranges between one to four establishments.

[58] The sample sizes used to arrive at these weighted estimates are as follows: 15 SMME establishments and 19 large establishments.

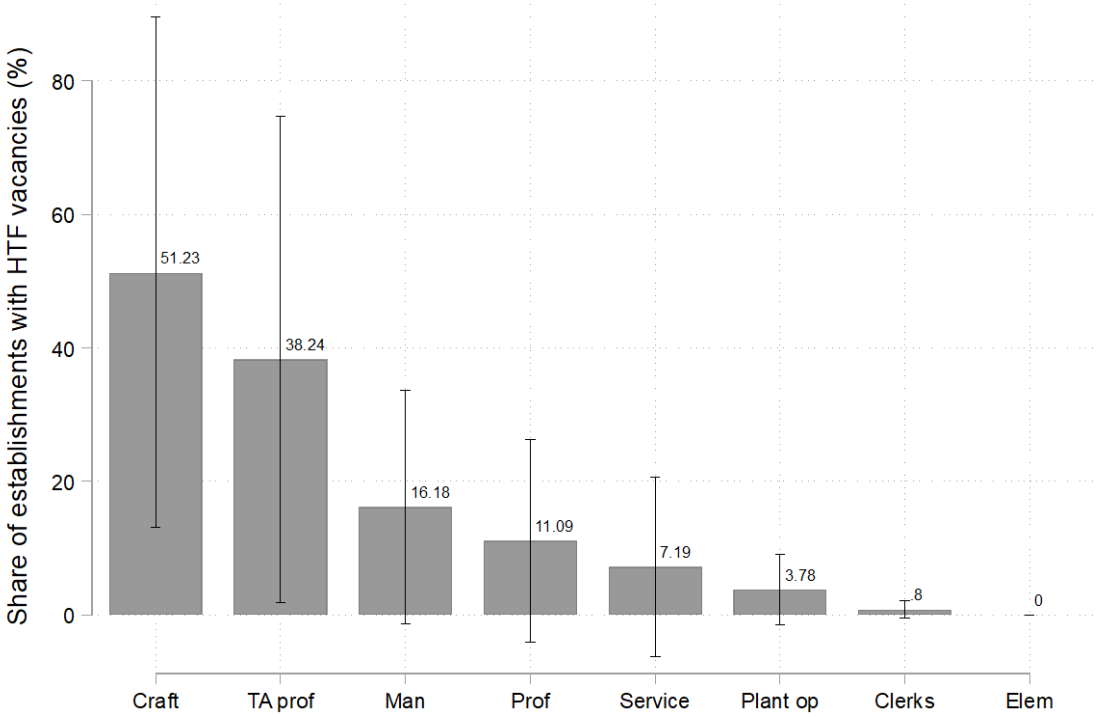
Table 16: Skill shortage incidence, by chamber and establishment size

	Share of all establishments with any vacancies (%)	Number of establishments with any vacancies			Number of vacancies		
		Level	Share of total (%)	Establishment skills shortage ratio	Level	Share of total (%)	Employment skills shortage ratio
Total	12.15 [6.3; 22.3]	616 [222; 1 011]	100.00	1.00	1503 [688; 2 319]	100.00	1.00
Chamber							
Auto	10.62 [-4.7; 25.9]	19 [-8; 46]	3.08	0.86	92 [-64; 248]	6.12	0.97
Metal	15.38 [5.1; 25.7]	553 [161; 945]	89.77	1.27	1343 [536; 2 150]	89.35	1.36
Auto Comp.	7.67 [-3.1; 18.4]	24 [-9; 56]	3.90	0.64	24 [-20; 68]	1.60	0.15
New Tyre	5.91 [-6.9; 18.7]	2 [-2; 5]	0.32	0.56	5 .	0.33	0.08
Plastics	1.93 [-0.5; 4.3]	18 [-4; 41]	2.92	0.15	39 [7; 71]	2.59	0.20
Firm size							
SMME	11.39 [2.6; 20.2]	506 [115; 896]	82.14	0.94	942 [616; 1 269]	62.67	1.58
Large	17.41 [6.9; 27.9]	111 [52; 169]	18.02	1.44	561 [-202; 1 324]	37.33	0.62

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents estimates of the incidence of skill shortages by chamber and establishment size, derived by the presence of vacancies within an establishment. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented in brackets. 4. Auto Comp. = Auto Component. 5. Skill shortage ratios refer to the ratio of the share of establishments or employment with a skill shortage to the share of establishments or employment in total.

HTF vacancies fall predominantly within the craft and related trades and technicians and associate professionals occupation groupings.[59] Although we find evidence of HTF vacancies across seven of the eight main occupation groups, it is clear that certain occupations face a higher skills shortage risk than others. As depicted in Figure 20, we find that over half (51.2%) of establishments who have HTF vacancies report these vacancies being for workers in the craft and related trades occupation. This is the highest skills shortage rate for any occupation group. We also estimate a relatively high rate for the technicians and associate professionals, at 38.2 percent, while the estimated magnitudes of the rates for the remaining occupations are relatively low and, statistically speaking, are not different from zero.

Figure 20: Incidence of hard-to-fill (HTF) vacancies, by occupation



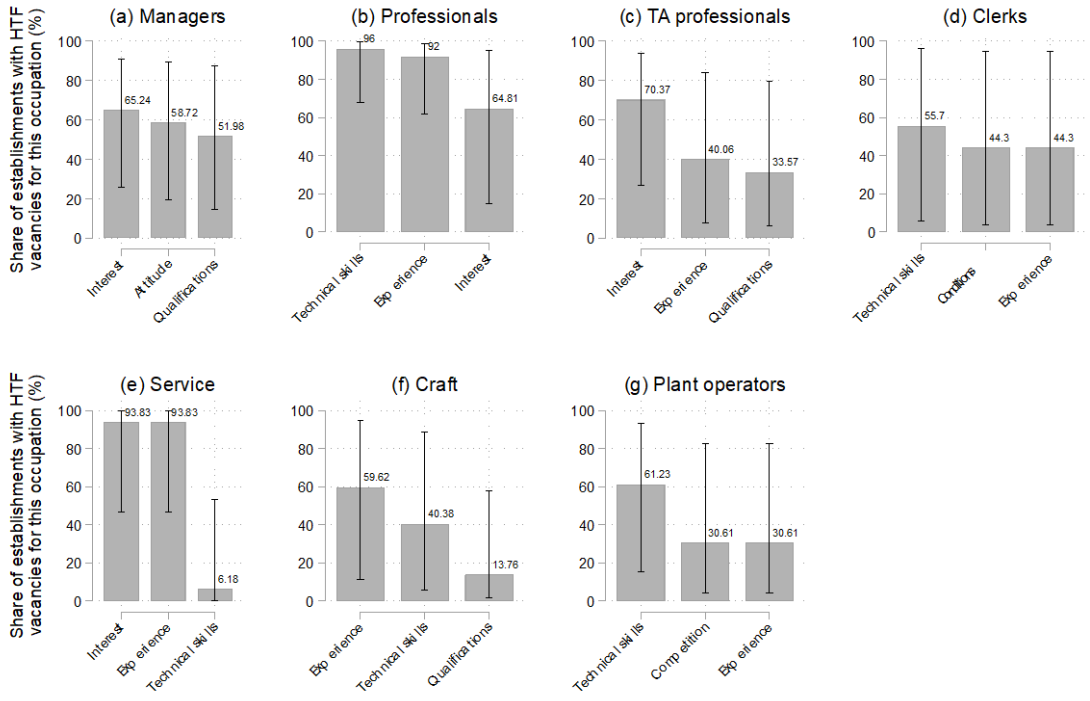
Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents, for all establishments who reported having any hard-to-fill (HTF) vacancies, estimates of the incidence of HTF vacancies by main occupation. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. Capped spikes represent 95% confidence intervals.

The MER Sector Enterprise Survey allows respondents reporting HTF vacancies to detail the top five specific occupations or job titles that these HTF vacancies referred to. These responses were detailed in some instances, while in others they were, unfortunately, vague. The majority of responses related to the craft and related trades occupation (as evident in Figure 20) and included boilermakers, welders, designers, millwrights, electricians, fitter and turners, and toolmakers – collectively accounting for 31 percent of reported HTF occupations. 'Managers', including safety and security managers, and foremen, accounted for nearly a quarter (24%) of occupations mentioned here, followed by 'Technicians' (18%). The remaining occupations included plant and machine operators and assemblers, engineers, technologists, supervisors, clerical support workers, master data controllers, sales representatives, and quality inspectors.

[59] The MER Sector Enterprise Survey asks respondents to report in which main occupation groups their HTF vacancies fall.

The MER Sector Enterprise Survey further interrogates the reasons behind certain vacancies being hard to fill. In Figure 21, we present estimates on the top three reasons for HTF vacancies for each main occupation group.[60] Specifically, for a given occupation group, the figure shows the share of establishments with HTF vacancies for that occupation group that reported a given reason.

Figure 21: Top 3 reasons for hard-to-fill (HTF) vacancies, by occupation



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1, This figure presents, for all establishments who reported having any hard-to-fill HTF vacancies for a specific occupation, estimates of the top three reasons why these vacancies are HTF. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. Capped spikes represent 95% confidence intervals. 4. No HTF vacancies were reported for elementary occupations. 5. Reasons are as follows: Competition = Too much competition from other employers; Interest = Not enough people interested in doing this type of job; Technical skills = Low number of applicants with the required technical skills; Attitude = Low number of applicants with the required attitude, motivation or personality; Experience = Lack of work experience; Qualifications = Lack of qualifications; and Conditions = Poor terms and conditions (e.g. pay) offered for post.

We find several reasons for the existence of HTF vacancies, but notably, for every occupation group we find that reasons related to qualifications and technical skills served as a dominant reason, but to varying degrees. For instance, half of the establishments (52%) who have HTF vacancies for managers reported that this is due to a lack of qualifications. The corresponding estimates for establishments with HTF vacancies for technicians and associate professionals, and craft and related trade workers, are 34 and 14 percent, respectively. Technical skills is of particular importance to vacancies in the professionals (96%), plant and machine operators and assemblers (61%), clerical support (56%), and craft and related trade (40%) occupations. These

[60] Establishments who reported having any HTF vacancies for specific occupation groups were asked to report the reasons for the vacancies in each occupation group being HTF. Respondents selected the reasons out of a list of 11 options, selecting as many as were applicable, or they could specify a reason (in the final dataset, no establishments specified their own reason).

collectively speak to the relevance of merSETA's skills development mandate in addressing skills shortages in the MER sector.

However, although qualifications and skills are among the dominant reasons across occupations, in some cases other reasons appear more important. For instance, for three occupation groups – service and sales workers, managers, and technicians and associate professionals – the dominant reason relates to a lack of interest ('Not enough people interested in doing this type of job'). This suggests that although skills development indeed plays an integral role in mitigating vacancies, there are other factors curtailing the labour market's ability to supply skills demanded by industry.

5.5.4 Skills as a constraint to the intensification of existing product portfolio

In Section 5.4.1, where we analyse the constraints hindering frontier establishments from intensifying existing production of frontier products, we find that skill constraints come up strongly as a constraint. In this section, we extend this analysis by further interrogating the skills-related constraints to intensification.

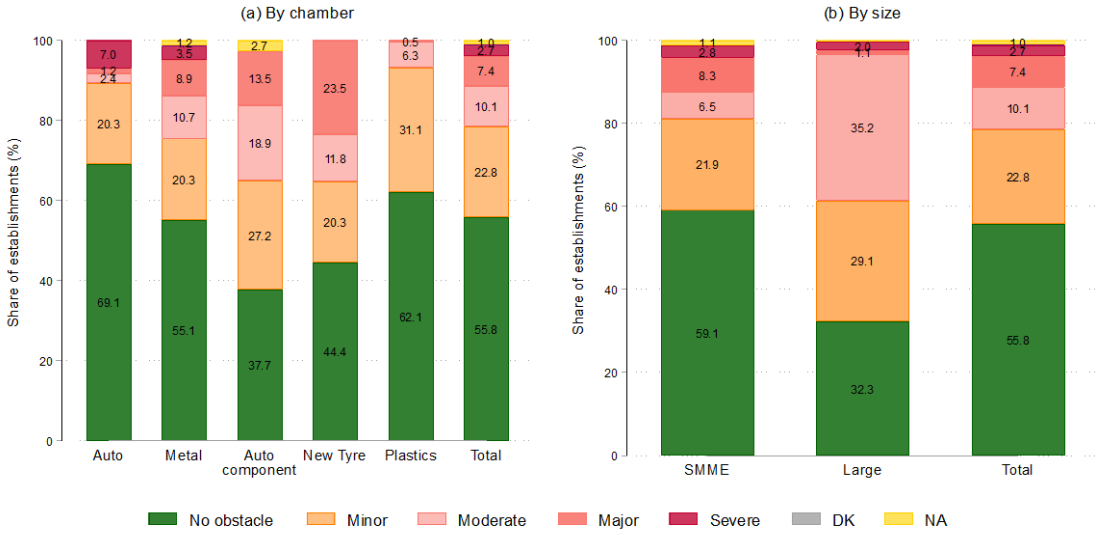
We begin by analysing to what extent establishments believe the skills and education of its available workforce are a constraint to the intensification of its current product portfolio. In response to the relevant question, establishments could respond from 'No obstacle' to 'Severe', for instance. This is analogous to the estimates in Table 10 where 43 percent of MER sector establishments consider skills as a constraint. However, here we consider the distribution of responses (i.e. from 'No obstacle' to 'Severe') as opposed to whether skills is a constraint regardless of severity (i.e. at least 'Minor') or not. We plot this distribution in Figure 22, both overall, by chamber, and by establishment size.

Overall, we find that of establishments that regard the skills and education of its available workforce as a constraint, the largest share consider it a minor constraint. However, we do observe notable heterogeneity by chamber and establishment size. Specifically, over two in every five establishments (43%) report that the skills and education of their current workforce constrains the production and sale of its current product portfolio. Approximately a quarter of establishments (23%, or over half of those who consider it a constraint to any extent) consider it a minor constraint, and 10 percent a moderate constraint, while just 10 percent of establishments consider it a major or severe constraint. By chamber, these skills-related constraints appear the most prevalent in the Auto Component and New Tyre chambers with 60 and 56 percent of establishments, respectively, reporting them as an obstacle to any extent. However, in the Auto Component chamber the largest share report them as minor (27%), while in New Tyre the largest share report them as major (24%). In fact, the prevalence of skills as a 'major' constraint is highest in this chamber. Interestingly, the prevalence of skills as a 'severe' constraint is only evident in two chambers: Metal and Auto, and is most prevalent in the latter (7%).

While it is clear that skills, as a constraint, is evident in both large establishments and SMMEs, we find that large establishments are significantly more likely to experience it as a constraint. Over two-thirds (67%) of large establishments report skills as a constraint to any extent, in comparison to 40 percent of SMMEs – a difference that is statistically significant at the 1

percent level. Moreover, the severity of skills as a constraint appears higher among large establishments. The largest share of large establishments reporting it as a constraint consider it a moderate constraint (35%), whereas among SMMEs, the largest share consider it as a minor constraint (22%).

Figure 22: Distribution of the degree skills and education of the current workforce are a constraint to the growth of existing product portfolio, by chamber and establishment size



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents, by chamber and establishment size, the distribution of the degree to which establishments report the skills and education of its available workforce are a constraint to the growth of the production and sale of its current product portfolio. 2. All estimates are weighted using sampling weights. 3. DK = Don't know; NA = Not applicable.

We find that a lack of technical skills serves as the dominant reason why establishments experience skills as a constraint. For those establishments who report that the skills and education of its available workforce are a *major* or *severe* constraint to the growth of their existing product portfolios (which represents 17.5% of establishments in the sector estimated from a sample of 19 establishments), we asked them to specify which of a list of issues were of concern.[61] In Table 17 we show that the vast majority (87%) reported that this was because employees do not have the required technical skills. This is followed by employees not having the required qualifications (53%), or required digital skills (48%).

[61] Respondents were instructed to select as many options as were applicable, and if there were other relevant issues then to list these. No respondents listed any additional concerns.

Table 17: Reasons for skills as a major or severe constraint to the growth of existing product portfolios, by chamber and establishment size

	Reason (% of establishments who indicated constraint is major/severe)			
	Qualification	Attitude	Technical skills	Digital skills
Total (n=19)	**53.39**	**36.17**	**87.01**	**48.32**
	[20.44; 86.35]	**[3.27; 69.07]**	**[69.39; 104.62]**	**[15.35; 81.30]**
Chamber				
Auto (n=2)	100.00	0.00	100.00	85.18
	.	.	.	[49.97; 120.38]
Metal (n=13)	48.15	40.67	92.51	51.84
	[11.05; 85.25]	[3.65; 77.69]	[77.82; 107.21]	[14.75; 88.94]
Auto Comp. (n=2)	80.19	0.00	19.81	0.00
	[35.89; 124.49]	.	[-24.49; 64.11]	.
New Tyre (n=1)	100.00	0.00	100.00	0.00
	.	.	.	.
Plastics (n=1)	100.00	100.00	100.00	100.00
	.	.	.	.
Establishment size				
SMME (n=16)	51.57	36.67	86.50	46.75
	[17.44; 85.71]	[2.60; 70.74]	[68.14; 104.85]	[12.58; 80.92]
Large (n=3)	100.00	23.26	100.00	88.63
	.	[-23.27; 69.80]	.	[63.38; 113.87]

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents estimates of the reasons why firms reported that the skills and education of its available workforce are a severe or major constraint to the growth of the production and sale of its current product portfolio. 2. Sample restricted to those who reported the constraint is major or severe (n=19). 3. Reasons are as follows: Qualification = Employees do not have the required qualifications; Attitude = Employees do not have the required attitude, motivation or personality; Technical/Digital skills = Employees do not have the required technical/digital skills. 4. All estimates are weighted using sampling weights and account for the complex survey design. 5. 95% confidence intervals presented in brackets. 6. Auto Comp. = Auto Component.

By establishment size, we find that employees not having the required technical skills served as the dominant reason among both SMMEs (87%) and large establishments (100%). In the Metal chamber, a lack of the required technical skills was also the dominant reason (93%), while approximately half of these establishments reported employees not having the required qualifications or required digital skills as additional issues of concern (48 and 52 percent, respectively). We observe some variation within the remaining chambers but emphasize caution in interpretating the accuracy of the estimates given the very small sizes of the subsample in each case.

5.5.5 Skills as a constraint to the diversification of new products

We now shift our focus to skills-related constraints to establishments aiming to diversify their product portfolio. This section builds on Section 5.4.2 – which found that skills is a key constraint to diversification – by interrogating this constraint in greater depth. Throughout this section unless otherwise specified, it should be kept in mind that only a small sample of establishments indicated that they saw diversification opportunities in this timeframe (a weighted total of 7.6% of all establishments, or 26 establishments in the sample). As such, given the size of the sample of 'diversifiers', estimates, and resultant conclusions, must be considered with caution.[62]

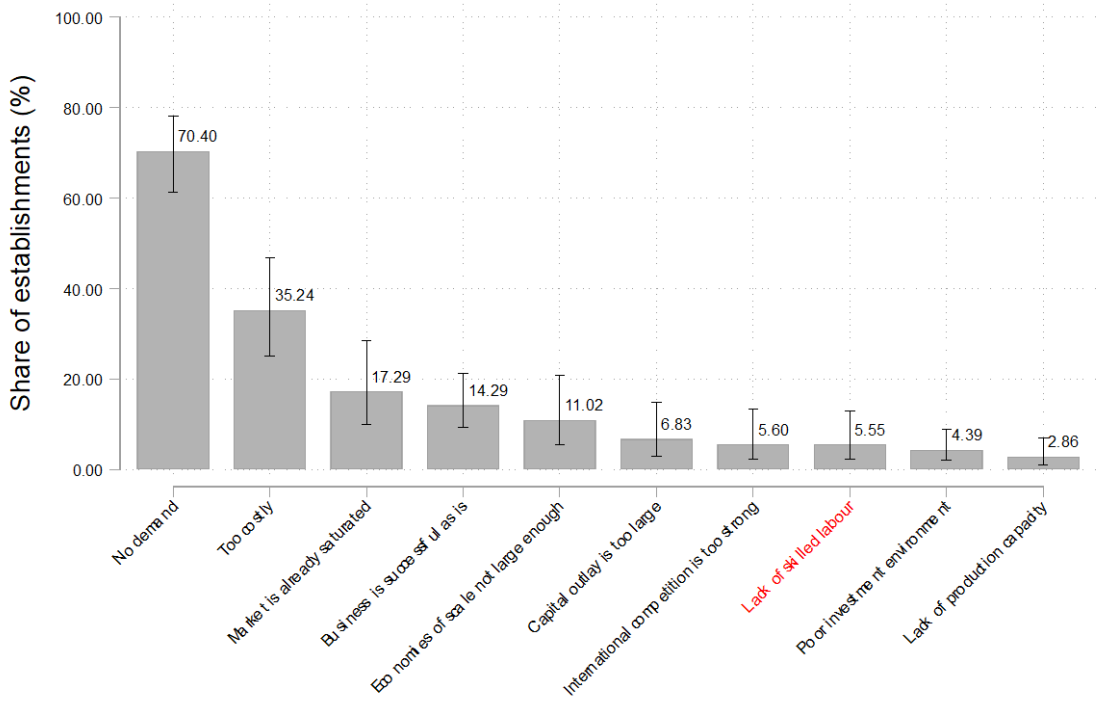
The MER Sector Enterprise Survey asked those establishments who indicated that they do not see any opportunities for diversification in the future, to report their main reasons for such an

[62] The reader is referred to more details in this regard in Section 5.4.2.

indication. Here, establishments selected from a list of ten reasons and were instructed to select as many as applicable, and were additionally given the option of reporting additional reasons. We plot the distribution of these reasons in Figure 23.

It is clear that a lack of demand for new products serves as the dominant reason behind a lack of diversification opportunities, at least by self-reports from establishments. This is perhaps consistent with the fact that the South African economy has been stuck in a low growth trap for some time (Andreoni & Tregenna, 2021). Over 70 percent of establishments report a lack of demand as a main reason behind not seeing any diversification opportunities in the future. This is followed by over a third of establishments reporting that it is too costly to develop new products, and approximately one in every six (17%) reporting that the market is already saturated. Notably, only a small share of establishments reports that a lack of skilled labour to produce new products is a main reason behind not being able to diversify (6%).

Figure 23: Reasons why establishments do not see any diversification opportunities

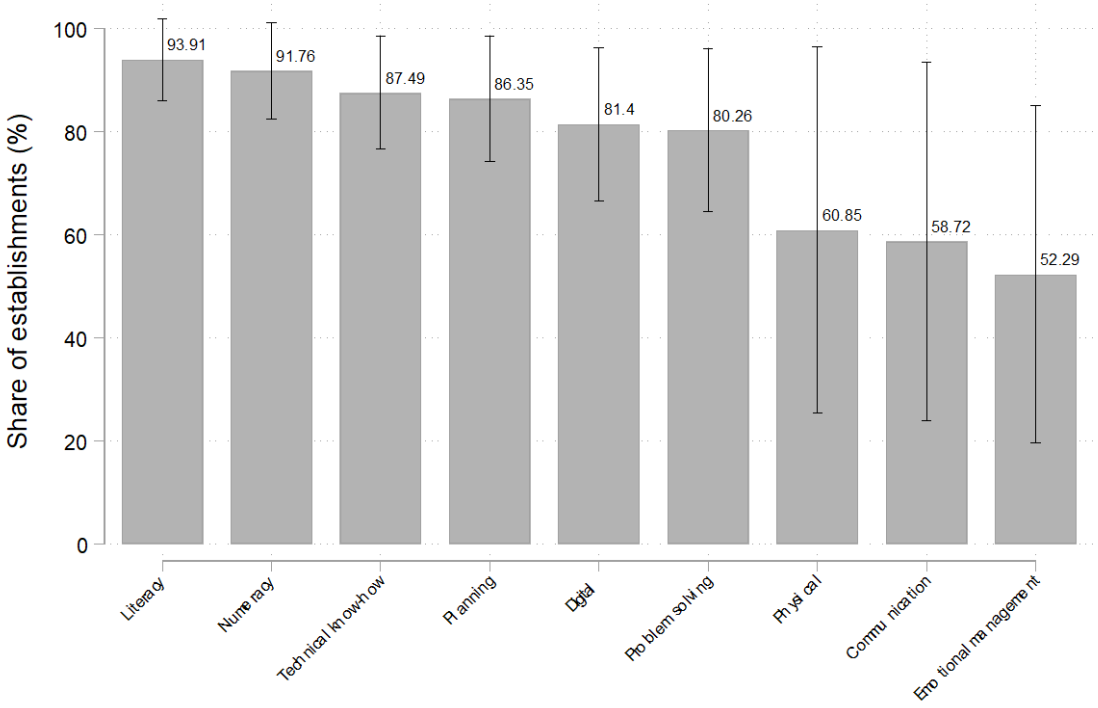


Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents estimates, for the subsample of establishments who do not report seeing any opportunities for diversifying into new products in the next five years (n=228), on the main reasons why they do not see such opportunities. 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented as capped spikes.

We observe a notable degree of variation in skill importance reported to enable product diversification. As discussed in the preceding section, establishments reporting diversification opportunities were asked to report three products that offer the greatest potential for diversification. Thereafter, they were asked to rate the importance of nine sets of skills to enable such diversification. We plot these estimates below in Figure 24, where a given estimate is interpreted as the share of 'diversifying' establishments who reported that a given skill is 'Essential' for at least one product they listed. For each of the nine sets of skills listed, most

establishments reported them as essential for enabling diversification, but to varying extents. Literacy and numeracy rank highest in terms of importance at 94 and 92 percent, respectively, while emotional management (52%), communication (59%), and physical skills (61%) rank the least important.

Figure 24: Skill importance among diversifiers: Share of establishments reporting a given skill is essential to enable diversification



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This figure presents the distribution of skill importance for nine sets of skills to enable establishments to diversity into new products in the next five years (specifically, the share of establishments who report that a given skill is 'Essential' for at least one of three products listed). 2. All estimates are weighted using sampling weights and account for the complex survey design. 3. 95% confidence intervals presented as capped spikes. 4. Skills are as follows: Communication = Instructing, negotiation, client communication, team work etc.; Planning = Personal time management and planning ahead for a project; Digital = Use a computer, create a spreadsheet, search and collect information online, software design, adapt to new technology; Numeracy = Being able to do basic mathematical calculations - add, subtract, divide etc.; Literacy = Reading and writing; Problem solving = Detecting, diagnosing, analysing, and resolving problems; Technical know-how = Knowing how to use/maintain tools, equipment, monitor operations, and knowledge of the product; Emotional management = Managing one's own feelings and those of others; and Physical = Use of stamina in a job.

The above sets of skills, however, are relatively broad. As such, the MER Sector Establishment Survey asked establishments to provide a description of the most important skills that they predict would be in demand should they choose to diversify into their listed products. They were also asked to rate, on a scale from 1 ("Not competent at all") to 5 ("skill level beyond what is required"), the typical proficiency of their existing employees for each of these specific skills. We present these specific skills and their corresponding levels of typical proficiency in Table 18 for the sub-sample of establishments that listed specific skills (n=15). Establishments listed an array of specific skills, from knowledge of equipment, machinery, and waste management laws, to plastics extrusion and press machine tool frame building. We observe that among the 23 listed skills, over a third of skills (8, or 35% of skills listed) are associated with either not currently

existing in establishments' existing workforces or, conditional on existing, having a low level of competence. The remaining 65 percent of skills listed are associated with either a moderate or large degree of competence in establishments' existing workforces.

Table 18: Self-reported skills required to enable diversification, by current proficiency

Skill	Proficiency
Product knowledge	Skill does not exist in existing workforce
Knowledge of equipment and machinery	Skill does not exist in existing workforce
Sourcing of products and raw materials knowledge	Skill does not exist in existing workforce
Quality control	Low level of competence
Toolmakers	Low level of competence
Engineering	Low level of competence
Press machine tool frame building	Low level of competence
Machine setters	Low level of competence
Welding	Moderately competent
Artisans	Moderately competent
Employee management	Moderately competent
Technical know-how	Moderately competent
Technical Skills	Very competent
Information technology	Very competent
Knowledge of waste management laws and recycling process	Very competent
Literacy and numeracy	Very competent
Mechanically minded	Very competent
Plastics extrusion	Very competent
Qualified Artisans & Engineers	Very competent
Technicians	Very competent
Product development	Very competent
Technical Knowledge	Skill level beyond what is required
Market experience	Skill level beyond what is required

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. This table presents, among the sample of establishments who indicated that they saw diversification opportunities in the next five years, the most important specific skills that establishments predict would be in demand should they choose to diversify into the products they listed, ranked by the corresponding typical proficiency of their existing employees. A sample of 15 establishments reported specific skills and the corresponding proficiencies.

5.5.6 Summary

In summary, when looking at the educational and skill profile of employees in the MER sector, the following key observations emerge: First, two in three MER sector employees are found in the plant and machine operator and craft and related trade occupational groupings. Second, the majority of MER sector workers have at least a matric level educational qualification. A substantial share have a matric or a matric plus a diploma or certificate, because this is the typical level of education of plant and machine operators and craft and related trade workers – the two largest occupational groupings. Thus, skill development interventions would need to take cognisance of this base level of education for employees in the sector. Fourth, over a quarter (27%) of employees do not have a matric education, and these employees are concentrated in elementary occupations. Fifth, larger firms have more qualified workers relative to SMMEs, which may be attributable to size-specific differences in abilities to recruit workers or upskill workers who are already employed. As such, skills development interventions targeting SMMEs would need to take this lower base level of education into account. Sixth, the relative importance of different skill sets varies across occupations. If we take plant and machine operators and craft and related trade workers – who account for two-thirds of all MER

sector employees – we note that physical skills, literacy, numeracy, and technical know-how are essential skills to develop.

When looking at the skill constraints facing MER Sector establishments, several findings stand out: We therefore analyse the incidence and distribution of skills gaps and shortages. We estimate an aggregate MER Sector skills gap of approximately 10 percent – that is, 10 percent of establishments have some share of their workforce that is not fully proficient. Accompanying this gap, we show that although the majority of workers seem to have the right qualification for their job as defined by their establishment, 4 percent of establishments have workers whose qualification is less than what is required. As such, there are a number of workers who are not fully proficient, despite having the required qualification for their occupation. This may speak to a disconnect between the skills that education institutions are supplying and those that industry are demanding. By chamber and size, establishments in the Plastics chamber are most likely to exhibit skill gaps, while the vast majority of establishments with skill gaps are SMMEs. Despite the incidence of skill gaps by occupation being relatively low, ranging between 2 and 6 percent of establishments, the severity of skill gaps are non-negligible and range between 29 and 44 percent of workers within skill gap establishments. Considering skill shortages (vacancies), we estimate a skill shortage rate of 12 percent. Skill shortages are concentrated in the Metal chamber and in SMMEs. Most vacancies (80%) in the sector are hard-to-fill (HTF) and are concentrated in the craft and related trades occupation, which includes boilermakers, welders, millwrights, fitter and turners, and toolmakers. Qualifications and skills are among the dominant reasons behind HTF vacancies for every occupation, but to varying degrees.

Lastly, we analyse the skills-related constraints to the intensification and diversification of production within the MER Sector. On intensification, 44 percent of establishments consider that the skills and education of their current workforce constrains the growth of its current product portfolio. However, of those that do, over half consider it only a minor constraint. By chamber, this constraint is most prevalent in the Auto Component and New Tyre chambers, where establishments in the latter consider it a more severe constraint. Large establishments are significantly more likely than SMMEs to experience this constraint in terms of both incidence and severity. A lack of technical skills serves as the dominant reason behind this constraint. Considering diversification, most establishments (92%) indicated that they did not see opportunities to diversity into new products in the future. It is clear that a lack of demand for new products serves as the dominant reason with 70 percent of establishments reporting so, while just 6 percent of establishments report a lack of skilled labour as a main reason. In terms of skill importance to enable diversification, of the 8 percent of establishments who do see diversification opportunities, literacy and numeracy rank the highest, while emotional management and communication appear the least important. Over a third of the specific required skills listed by these establishments are associated with either low competency among the existing workforce, or do not exist.

6 Policy Discussion

Motivating for the expansion and diversification of the MER sector, and formulating policy that would enable such growth, is built on the foundation that such growth would build economic complexity and shift the South African economy to higher levels of economic development. Allen Whitehead & Bhorat (2021) examine the role of the MER sector in driving the reindustrialisation of the South African economy, and show that MER sector products are, on average, more complex than other traded products, thus suggesting that growth and diversification of MER sector products is likely to build the economic complexity of the South African economy. Thus, they identify a set of product-level industrial diversification opportunities – namely, MER sector *frontier products* – that provide a pathway to the reindustrialisation of the South African economy. This paper examines the constraints that hinder, and capabilities that enable, MER sector firms from growing and diversifying these frontier products markets. Such analysis provides key insights for requisite policy formulation and guidance. This section provides a discussion on such policy insights.

6.1 Framing Constraints and Policy

What is clear from the analysis in Section 5, which examines the constraints facing MER sector establishments, is that these constraints can be divided into two groups: First, there is a set of exogenous constraints, which are those constraints that firms have relatively little control or influence over. Firms simply have to wait for these constraints to be addressed by the relevant government institutions. Infrastructure constraints relating to the reliable provision of electricity is a good example of such a constraint. Even within this group, there are some which are close to impossible for firms to influence, such as inflation and other macroeconomic factors. Second, there is a set of endogenous constraints, which are those that firms have some control over, or can at least influence to some degree. Skill constraints, which comes up strongly in the discussion above, provides a good example of such a constraint because firms can actively participate in addressing skills interventions. For example, policy that aims to address skills shortages in industry could be driven by firms actively engaging with education and training institutions in order to provide information on their requirements and/or introduce partnership programmes that allow learners to build the necessary skills to narrow skill gaps in the future.

Thus, the locating of constraints within these two groups provides a framework for thinking about policy formulation and policy guidance. We start by considering the former group of constraints and the policy implications that potentially arise. Thereafter, we provide policy input into the skills constraint challenge facing MER sector establishments.

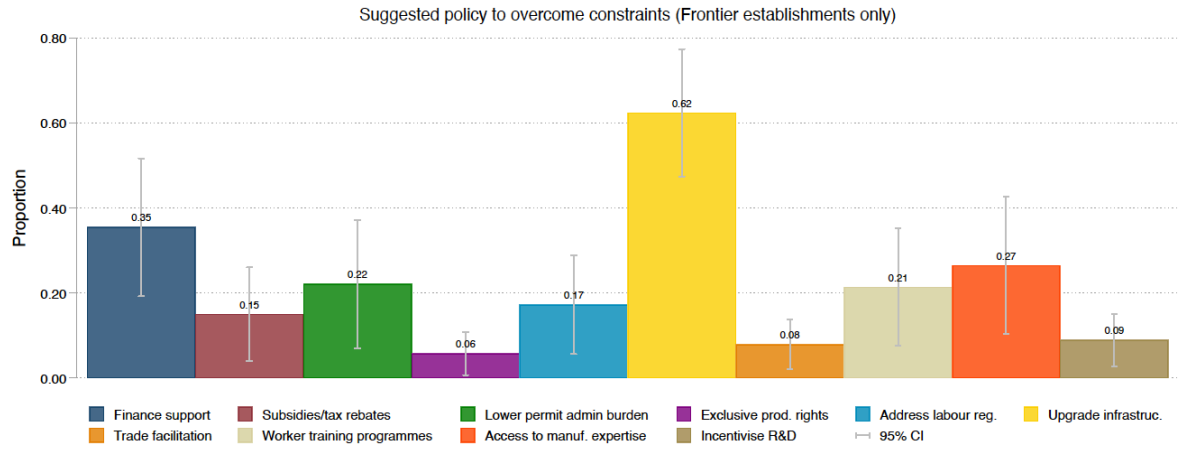
6.2 Exogenous Constraints

Infrastructure constraints: What is clear from Section 5.4.1 is that infrastructure constraints, particularly the reliable provision of electricity, is a key constraint facing MER sector establishments – both frontier and non-frontier. Ultimately, the limited generation capacity of the South African energy sector imposes a ceiling on the extent to which the South African economy can grow, particularly if that growth is to be driven by relatively energy-intensive industrial growth, say in the MER sector. While little can be done to actively address this exogenous constraint, it is worth mentioning because the energy constraint effectively acts as

a limiter and prevents the economy from being able to shift to higher levels of economic growth. However, there is certainly a role for industry-driven lobbying for the formulation, and importantly, implementation of appropriate energy policy at the national level. Certainly, overcoming this constraint is key: In Figure 25 we observe that two-thirds of frontier intensifier establishments state that upgrading infrastructure is a key policy intervention. The corresponding figure for *frontier diversifier establishments* is 87 percent – see Figure 26.

Exporters regulatory constraints: Industrial growth and diversification in economies with relatively small domestic markets, such is the case with South Africa, can only be achieved through export growth. However, we observe that a substantial share of MER sector establishments face export regulation constraints. We see that approximately 33 percent of exporters face challenges with export regulations, while 27 percent of non-exporters face the same. This is interesting from a policy perspective since it suggests that non-exporters may, in fact, not be able to access export markets because of challenges associated with export regulations. Ultimately, the growth of frontier products and the building of economic complexity in the MER sector requires export growth, and to the extent that export regulations hinder export growth, these regulations hinder this pathway toward reindustrialisation. A third (33%) of *frontier diversifier establishments* state the trade facilitation policy interventions will assist in opening up these industrial diversification pathways.

Figure 25: Suggested policy to overcome constraints to current production



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.

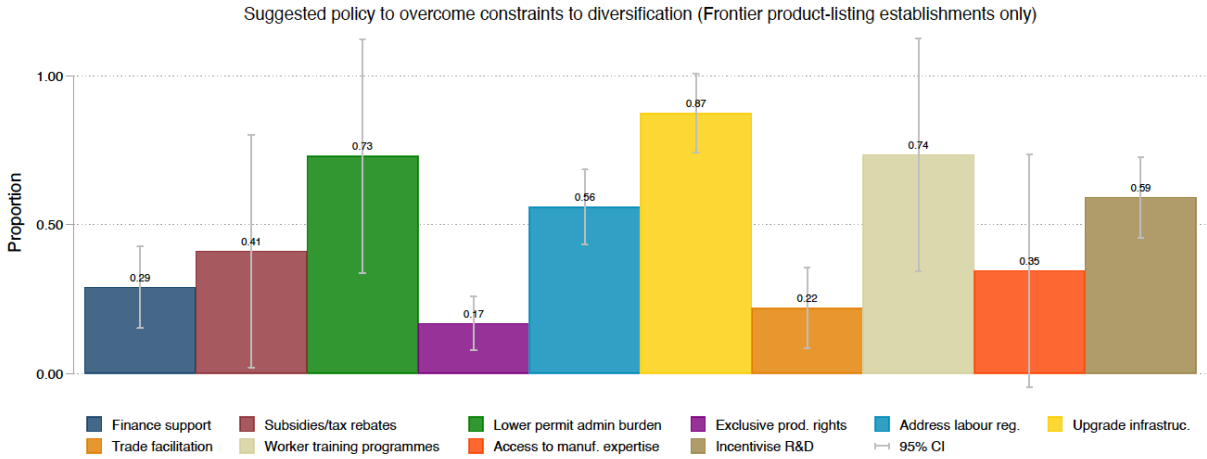
Business regulation constraints: A further regulatory constraint adversely impacting the sector is that of business regulatory constraints. Approximately two in five frontier establishments report facing business regulatory constraints. Of the establishments facing business regulatory constraints, three quarters of them have listed business regulations as a major or severe constraint did so because administrative costs and burdens were too large. This result suggests that policy to help streamline business administrative procedures surrounding the application of licenses and permits could go a long way towards assisting establishments in overcoming their business regulation constraints. In Figure 25 we note that one in five *frontier intensifier establishments* indicate that lowering reducing the administrative and financial burden faced when applying for licenses and permits is a policy priority. In the case of *frontier diversifier establishments*, three-quarters (73%) of these establishments note that reducing the

administrative and financial burden faced when applying for licenses and permits will assist the diversification process – see Figure 26.

6.3 Endogenous Constraints – Skills Constraints

The skills of the MER sector workforce emerges as a prominent constraint in the discussion above. Two in every five (44%) MER sector establishments regard the skills of its workforce as a constraint, and it comes up as the second most severe constraint, behind infrastructure constraints. In the case of *frontier intensifier establishments*, a third of those that report skills as a constraint, report it as a severe. Similarly, *frontier diversifier establishments* also report skills as a key constraint to diversifying into frontier products. With respect to addressing this constraint through providing access to worker training programmes, one in five *frontier intensifier establishments* note this as a key policy intervention (see Figure 25), while three in four *frontier diversifier establishments* note this as a key intervention of overcome constraints to diversification (see Figure 26).

Figure 26: Suggested policy to overcome constraints to diversification



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.

One in ten MER sector establishments report a skills gap: We estimate an aggregate MER Sector skills gap of approximately 10 percent – that is, 10 percent of establishments have some share of their workforce that is not fully proficient. This corresponds to approximately 22 000 employees not being proficient at their jobs – or 4.62 percent of employment in the sector. Establishments in the Plastics chamber are most likely to exhibit skill gaps, while the vast majority of establishments with skill gaps are SMMEs (86%).

One in ten MER sector establishments report a skills shortage: We estimate a skill shortage rate of 12.15 percent, which translates into approximately 1500 vacancies in the sector. Skill shortages are concentrated in the Metal chamber and in SMMEs. Most vacancies (80%) in the sector are hard-to-fill (HTF) and are concentrated in the craft and related trades occupation, which includes boilermakers, welders, millwrights, fitter and turners, and toolmakers. Qualifications and skills are among the dominant reasons behind HTF vacancies for every occupation. The dominant reasons for these vacancies in this occupation grouping include a lack of qualifications and technical skills as well as experience. Policymakers ought to take these

reasons into account when designing initiatives to adequately match jobseekers with establishments supplying jobs.

The majority of employees in the MER sector are plant and machine operators or craft and related trade workers, which have, on average at least a matric education: The majority of employees in the MER sector – 62 percent – fit within the plant and machine operator and craft and related trade occupational groupings. Most workers have at least a matric qualification as this seems to be the minimum employment criteria in the sector. Plant and machine operators and craft and related trade workers have a pretty even distribution between those with a matric (49 and 52 percent, respectively) and those with a matric plus diploma or certificate (45 and 42 percent, respectively). As such, skill interventions in the sector will largely be focused on workers within these occupational groupings and would need to build off this base level of education.

SMMEs are a significant component of the MER sector and experience constraints more acutely than large firms: SMMEs account for 87 percent of establishments and approximately 40 percent of employment in the MER sector. Further, 86 percent of *frontier establishments* are SMMEs. We observe that large establishments are, in general, much more likely to report facing a given constraint than SMMEs, however, when SMMEs face a constraint, they face it much more acutely than their larger counterparts. This is certainly the case for skill constraints, which is consistent with the relative prevalence of skill gaps and skill shortages among this groups of establishments. Thus, policy interventions aimed at addressing the skill constraint needs to place emphasis on this important group of establishments.

There is a discontinuity between skills obtained through educational qualifications and skills required to meet industry needs: The analysis in Section 5.5.2 indicates that almost all workers seem to have the right qualification for their job as defined by their establishment (96% of establishments). However, the overall estimated skill gap of 10 percent suggests that there are a number of workers who, despite having the required qualification, are not fully proficient for their occupation – as mentioned above, approximately 22 000 employees in the MER sector. Further, of the establishments reporting skill constraints as severe, approximately half of them list a lack of correctly qualified workers as a reason for their classification of skills as a severe constraint, while 87 percent report a lack of required technical skills as a reason for their classification. Taking these results together, we see that there are more establishments who find a lack of technical skills than those who find a lack of appropriate qualification. The natural corollary of this finding is that workers entering the labour market and presenting themselves to the labour market may be qualified, but their qualification does not correctly or adequately prepare them for the work they are required to do. Overall, this suggests that establishments are largely able to hire workers with adequate qualifications but still face skill problems, which is indicative of the education system not adequately equipping graduates with the skills required in the sector. Policymakers ought to take such discontinuity into account when formulating skills development initiatives.

7 CONCLUSION

This paper details the constraints to overcome, and the capabilities required, to realise frontier product industrial diversification opportunities in the MER sector. Specific focus is placed on

the extent to which the skills of the MER sector workforce constrain, and/or enable, the realisation of these industrial diversification opportunities. We also analyse these constraints and capabilities through the establishment size lens, which allows one to identify the role and importance of these constraints and capabilities in realising frontier product industrialisation opportunities.

These research objectives are addressed by conducting statistical analysis on representative data obtained from the 2021 MER Sector Enterprise Survey. The MER Sector Enterprise Survey is an establishment level survey focused on establishments engaged in manufacturing activity in the automotive, automotive component, metals, plastics, and new tyre sub-sectors of the MER sector. A survey instrument was designed to capture establishment level data on manufacturing and production, employment and skills, constraints to current production, opportunities and constraints to diversification, and financial information. Product-level information on products currently manufactured by establishments and the products that establishments aim to diversify toward in the future, allows one to link establishment-level information on constraints to frontier product industrialisation opportunities, and thereby analyse the role and importance of these constraints.

Looking at the characteristics of MER sector establishments, the modal firm is a domestically owned, private company, operating in the metals industry, located in Gauteng, having operated for less than 29 years, and is almost always an SMME. We find that establishments are largely located in the Metals chamber (70%), and to a lesser extent the Plastics chamber (18.87%). Consistent with what one would expect of firm size distributions, the majority of establishments in the sector are SMMEs, and these establishments are more likely to be found in the Metals and Plastics chambers. While still having larger absolute shares of SMME establishments, the Automotive Component and Automotive chambers are relatively more likely to have large firms in their chambers. MER sector establishments are clustered in the three economic hubs in South Africa – Gauteng, Western Cape and KwaZulu Natal.

We observe that substantial shares of MER sector establishments have access to the capabilities and productive knowhow of larger organisations, some of which have further access to foreign capabilities and productive knowhow. Approximately two-thirds of MER sector establishments are part of multi-establishment firms. Further, of these establishments belonging to multi-establishment firms, the majority (90%) are linked to establishments engaged in manufacturing activity in other countries. Export activity is relatively common in the MER sector, with one in three establishments engaged in exporting. This all points to a relatively dynamic sector that is engaged in global value chains.

Looking at employment, we note that the average MER sector establishment employs 94 employees. However, as expected, the distribution of employment is heavily skewed to the right, with a relatively small share of large establishments (12.5%) accounting for a disproportionate share of employment (60%). Nevertheless, SMMEs account a non-negligible share of employment. As such, it is advisable that policy formulation targeting the growth and diversification of the sector takes into account any differences in the constraints impacting these two sets of establishments.

The composition and distribution of employment within the MER sector exhibits substantial heterogeneity across chambers. The Metals and Plastics chambers comprise the largest shares of employment, while having the smallest average establishment size, which is consistent with these chambers accounting for more SMMEs in the sector. In contrast, the Auto and New Tyre chambers, comprise relatively smaller shares of employment in the sector, but have larger establishments, on average. As with the distribution of establishments, employment in the MER sector is clustered in the three provincial economic hubs. Although most employees (90%) work for establishments that have been operating for at least 10 years, and, on average, older establishments employ more employees, employment in 'young' establishments (fewer than 10 years) has increased substantially over the period. Coupled with an employment contraction in older establishments, these estimates are indicative of a significant shift in employment toward younger establishments.

We identify *frontier establishments*, and observe both frontier products *intensifiers* and *diversifiers* in the MER sector. It is thus important to examine the constraints facing both sets of establishments, given that the factors impacting on intensification may vary from those impacting on diversification, and any resulting policy prescription would need to take this into account. SMMEs comprise a similar share of frontier establishments to that of the sector as a whole, which is substantial – in excess of 80 percent. This is important because if one is to follow frontier product industrial diversification pathways, then it is vital to facilitate the growth and graduation of SMMEs.

While there exists some heterogeneity in the constraints faced by MER sector establishments across chambers, there are some constraints that cut across chambers and seem to challenge the MER sector as a whole. Infrastructure and skills stand out as widespread in terms of incidence, as well as ranking amongst the most severe constraints faced by establishments. While financial constraints seem to afflict a large proportion of MER sector establishments, they do not rank as particularly severe. On the other hand, policy uncertainty and government inefficiency appears as a particularly severe constraint. This is driven by the Metals chamber, where policy and government is listed as the most severe constraint faced by establishments in the chamber.

Looking at the constraints to intensification facing *frontier establishments*, we note that the constraints faced by *frontier establishments* differ little from those faced by *non-frontier establishments*. This is useful from a policy perspective, as it doesn't require policies that specifically target establishments that are producing frontier products, ultimately making the administrative burden of enacting policy lower. However, the constraints faced by frontier establishments do differ significantly by establishment size, with larger firms much more likely to experience a given constraint; but SMMEs generally experiencing the constraints much more acutely. Skills, production, finances, business regulation, infrastructure and labour regulation were reported as severe constraints by between 26 and 31 percent of firms who experienced these constraints. When unpacking the reasons for these results, certain factors stood out, including inefficient governance, training that was not aligned with industry standards, and credit constraints. While we cannot say more at this time, we will further unpack what establishments mean by these responses in a future study, using qualitative interview techniques.

The majority of diversification opportunities in the MER sector are concentrated among frontier products, suggesting that encouraging diversification in general may help in growing the overall complexity of the MER sector. Based on the responses provided, motor vehicle parts present the greatest opportunity for establishments to adapt their current productive structure, since these establishments tended to be in possession of the majority of the listed capabilities. However, these same establishments faced rather more severe constraints than establishments that were looking to diversify into other products.

In terms of the constraints facing diversifying *frontier establishments*, policy uncertainty and government inefficiency, financial constraints, macroeconomic constraints, and skills were identified as being among the more severe constraints. This is consistent with the constraints faced by *frontier establishments* in general. On the other hand, infrastructure and production constraints were among the least severe constraints, which stood in stark contrast to the result for frontier establishments in general. Tentatively, this may suggest a level of selection whereby only those establishments who are advantageously placed in terms of their capabilities and constraints consider diversifying into new products.

Looking at the education and skill profile of employees in the MER sector, we find that the majority of MER sector workers have at least a matric level educational qualification. A substantial share have a matric or a matric plus a diploma or certificate because this is the typical level of education of plant and machine operators and craft and related trade workers – the two largest occupational groupings. Skills development interventions need to pivot off this base level of education. Larger firms have more qualified workers relative to SMMEs, which may be attributable to size-specific differences in abilities to recruit workers or upskill workers who are already employed. As such, skills development interventions targeting SMMEs need to take this lower base level of education into account. The relative importance of different skill sets varies across occupations. We note that physical skills, literacy, numeracy, and technical know-how are essential skills for plant and machine operators and craft and related trade workers – occupational groupings that account for two-thirds of all MER sector employees.

In terms of skills constraints, we estimated skills gaps and skills shortages for the MER sector. We estimate an aggregate MER Sector skills gap of approximately 10 percent – that is, 10 percent of establishments have some share of their workforce that is not fully proficient. We observe that there are a number of workers who are not fully proficient despite having the required qualification for their occupation. This may speak to a disconnect between the skills that education institutions are supplying and those that industry are demanding. Establishments in the Plastics chamber are most likely to exhibit skill gaps, while the vast majority of establishments with skill gaps are SMMEs. We estimate a skill shortage rate of 12 percent. Skill shortages are concentrated in the Metal chamber and in SMMEs. Most vacancies (80%) in the sector are hard-to-fill (HTF) and are concentrated in the craft and related trades occupation, which includes boilermakers, welders, millwrights, fitter and turners, and toolmakers. Qualifications and skills are among the dominant reasons behind HTF vacancies for every occupation, but to varying degrees.

Focusing on constraints facing *frontier establishments* we estimate that 44 percent of establishments consider that the skills and education of their current workforce constrains the intensification of its current product portfolio. Large establishments are significantly more likely

than SMMEs to experience skills constraint in terms of both incidence and severity. A lack of technical skills serves as the dominant reason for establishments experiencing this constraint. Most establishments (92%) indicated that they did not see opportunities to diversify into new products in the future, with the main reason being a lack of demand for new products. Only 6 percent of establishments report a lack of skilled labour as a main reason. In terms of skill importance to enable diversification, of the 8 percent of establishments who do see diversification opportunities, literacy and numeracy rank the highest, while emotional management and communication appear the least important. Over a third of the specific required skills listed by these establishments are associated with either low competency among the existing workforce or do not exist.

Constraints facing MER sector establishments can be divided into two groups: exogenous and endogenous constraints. Locating constraints within these two groups provides a framework for thinking about policy formulation and policy guidance. Exogenous constraints are those that firms have relatively little control or influence over. Firms simply have to wait for these constraints to be addressed by the relevant government institutions. The evidence points to infrastructure constraints, particularly in relation to the provision and cost of electricity, to be particularly pervasive. To a lesser extent, business regulations and export regulations hinder growth and diversification in the sector. There is scope for industry-led lobbying for policy solutions to some of these constraints. Endogenous constraints are those that firms have some control over, or can at least influence to some degree. Skill constraints provides a good example of such a constraint. Policy that aims to address skills shortages in industry could be driven by firms actively engaging with education and training institutions in order to provide information on their requirements and/or introduce partnership programmes that allow learners to build the necessary skills to narrow skill gaps in the future.

REFERENCES

Allen Whitehead, C. and Bhorat, H. 2021. Understanding economic complexity: an application to the MER sector. *DPRU Working Paper 202105*. Development Policy Research Unit: Cape Town (South Africa).

Allen Whitehead, C., Bhorat, H., Hill, R., Köhler, T. and Steenkamp, F. 2021. The potential employment implications of the fourth industrial revolution technologies: The case of the Manufacturing, Engineering and Related Services Sector. *DPRU Working Paper 202106*. Development Policy Research Unit: Cape Town (South Africa).

Andreoni, A. and Tregenna, F. 2021. The middle-income trap and premature deindustrialisation in South Africa. In *Structural Transformation in South Africa: The Challenges of Inclusive Industrial Development in a Middle-Income Country*. A. Andreoni, P. Mondliwa, S. Roberts and F. Tregenna, Eds. Oxford University Press.

Barlow, P., van Schalkwyk, M.C., McKee, M., Labonté, R. and Stuckler, D. 2021. COVID-19 and the collapse of global trade: building an effective public health response. *The Lancet Planetary Health*: *5*(2): e102-e107.

Bernard, A.B., Jensen, J.B., Redding, S.J. and Schott, P.K. 2007. Firms in international trade. *Journal of Economic perspectives*. 21(3):105-130.

Bhorat, H., Cassim, A., and Hirsch, A. 2014. Policy co-ordination and growth traps in a middle-income country setting. *WIDER Working Paper 2014/155*. UNU-WIDER: Helsinki (Finland).

Bhorat, H., Ewinyu, A., Lilenstein, K., Rooney, C., Steenkamp, F. and Thornton, A. 2019. Economic complexity and employment expansion: The case of South Africa. DPRU: Cape Town.

Bhorat, H., Lilenstein, K., Oosthuizen, M. and Steenkamp, F. 2022. Economic Growth, Rising Inequality, and Deindustrialisation: South Africa's Kuznetsian Tension. In *The Developer's Dilemma: Structural Transformation, Inequality Dynamics, and Inclusive Growth*. A. S. Alisjahbana, K. Sen, A. Sumner, A. A. Yusuf (Eds). Oxford University Press.

de Vries, G., Arfelt, L., Drees, D., Godemann, M., Hamilton, C., Jessen-Thiesen, B., Kaya, A. I., Kruse, H., Mensah, E. and Woltjer, P. 2021. The Economic Transformation Database (ETD): Content, Sources, and Methods. *WIDER Technical Note 2/2021*. UNU-WIDER: Helsinki (Finland).

Edwards, L., Sanfilippo, M. and Sundaram, A. 2018. Importing and firm export performance: New evidence from South Africa. *South African Journal of Economics*. 86(S1): 79-95.

Hausmann, R., Hialdo, C.A., Bustos, S. Coscia, M., Chung, S., Jimenez, J., Simoes, A. and Yildirim, M.A. 2014. The Atlas of Economic Complexity: Mapping Paths to Prosperity. Puritan Press: Cambridge MA.

Hausmann, R. and Chauvin, J. 2015. Moving to the adjacent possible: Discovering paths for export diversification in Rwanda. *CID Working Paper Series 2015.294*. Harvard University: Cambridge, MA.

Hidalgo, C.A., Klinger, B., Barabási, A.L. and Hausmann, R. 2007. The product space conditions the development of nations. *Science*. *317*(5837):482-487.

Hidalgo, C.A. and Hausmann, R. 2009. The building blocks of economic complexity. *Proceedings of the National Academy of Sciences*. 106(26):10570-10575.

Hidalgo, C.A. 2021. Economic complexity theory and applications. *Nature Reviews*. 3: 92-113.

Kerr, A., Ardington, C. and Burger, R. 2020. Sample design and weighting in the NIDS-CRAM survey. NIDS-CRAM Wave 1 Technical Report B.

Kutlina-Dimitrova, Z. and Rueda-Cantuche, J.M., 2021. *The impact of COVID-19 on exports related jobs* (No. 2021-1). Directorate General for Trade, European Commission.

Lin, K., Aragão, C. and Dominguez, G. 2021. Firm Size and Employment during the Pandemic. *Socius*. 7: 1-16.

Muneepeerakul, R., Lobo, J., Shutters, S.T., Goméz-Liévano, A. and Qubbaj, M.R. 2013. Urban economies and occupation space: Can they get "there" from "here"?. *PloS one*. 8(9): e73676.

Neffke, F., Henning, M. and Boschma, R. 2011. How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography*. 87(3):237-265.

Rodrik, D. 2016. Premature deindustrialisation. *Journal of Economic Growth*. 21(1): 1-33.

StatsSA. 2019. Manufacturing Industry: Financial, 2017. Report 30-02-03 (2017). Pretoria.

Statistics South Africa. 2020. Quarterly Labour Force Survey Quarter 2: 2020. Statistical release P0211. Pretoria, South Africa. Available: http://www.statssa.gov.za/publications/P0211/P02112ndQuarter2020.pdf.

The Growth Lab at Harvard University. 2019. International Trade Data (HS, 92). Harvard Dataverse V2. https://doi.org/10.7910/DVN/T4CHWJ

Timmer, M. P., de Vries, G. J., and de Vries, K. 2015. Patterns of Structural Change in Developing Countries. In *Routledge Handbook of Industry and Development*. J. Weiss, & M. Tribe (Eds.) (pp. 65-83). Routledge.

Tsebe, M., Vukeya, V., Lewis, C., Calvino, F., and Criscuolo, C. 2018. Firm dynamics in South Africa. *Economics Department Working Papers No. 1528*. OECD Economics Department: Paris.

Winterbotham, M., Kik, G., Selner, S., Menys, R., Stoud, S. and Whittaker, S. 2020. Employer Skills Survey 2019: Research Report. UK Department of Education.

World Bank. 2022. World Development Indicators. World Bank: Washington D.C. (United States)

APPENDIX

Table A 1: List of MER sector frontier products identified in Allen Whitehead & Bhorat (2021)

Rank	Chamber	Product description	PCI
1	Plastics	Polymers of styrene	2.921
2	Automotive components	Parts suitable for use with spark-ignition engines	2.898
3	Automotive components	Parts of motor vehicles and tractors	2.813
4	Automotive components	Vehicle Bodies	2.739
5	Metals	Other lifting machinery	2.668
6	New tyre	Vulcanized rubber plates	2.650
7	Metals	Radar	2.637
8	Metals	Other firearms	2.631
9	Metals	Other alloy steel in primary form	2.611
10	Metals	Other agricultural machinery	2.598
11	Metals	Other parts for machines and appliances	2.575
12	New tyre	Other articles of vulcanized rubber	2.534
13	Metals	Water gas generators	2.529
14	Metals	Parts for use with electric generators	2.514
15	Metals	Radiators for central heating of iron or steel	2.513
16	Metals	Direction finding compasses	2.459
17	Plastics	Other articles of plastic	2.457
18	Metals	Industrial furnaces	2.444
19	Metals	Other articles of nickel	2.440
20	Metals	Nuclear reactors and related equipment	2.408
21	Metals	Parts of military weapons	2.383
22	Metals	Flat-rolled iron, width < 600mm, clad	2.324
23	Metals	Other engines and motors	2.299
24	Metals	Dairy machinery	2.295
25	Metals	Other articles of iron or steel	2.267
26	Metals	Harvesting or agricultural machinery	2.230
27	Metals	Railway track fixtures	2.225
28	Metals	Tractors	2.173
29	Metals	Electrical boards for protecting electrical circuits	2.131
30	Metals	Military weapons, other than pistols	2.123
31	Metals	Flat-rolled iron, width < 600mm, not clad	2.122
32	Plastics	Other colouring matter	2.121
33	Metals	Machinery for soil preparation or cultivation	2.096
34	Plastics	Sulphonitric acids	2.088
35	Metals	Munitions of war	2.084
36	Metals	Other cast articles of iron or steel	2.063
37	Plastics	Non-radioactive isotopes	2.059
38	Plastics	Other plastic plates, sheets etc.	2.051
39	Metals	Parts of other aircraft	2.034

Rank	Chamber	Product description	PCI
40	Metals	Work trucks	2.004
41	Automotive components	Trailers and semi-trailers	1.985
42	Metals	Automatic goods-vending machines	1.982
43	Metals	Nickel waste and scrap	1.960
44	Metals	Pulleys and winches	1.937
45	Metals	Refrigerators, freezers	1.934
46	Metals	Tubes, seamless, of iron or steel	1.876
47	Metals	Electric heaters	1.837
48	Metals	Titanium	1.829
49	Metals	Railway cars, not self-propelled	1.829
50	Plastics	Baths, sinks etc.	1.807
51	Plastics	Ethers	1.800
52	Metals	Railway construction material of iron or steel	1.799
53	Metals	Central heating boilers	1.793
54	Metals	Wire etc. used for welding	1.768
55	Metals	Self-propelled bulldozers, excavators and road rollers	1.758
56	Metals	Other articles of zinc	1.757
57	Plastics	Monofilament	1.753
58	Metals	Other articles of aluminium	1.700
59	Metals	Medical, dental or veterinary furniture	1.645
60	Metals	Other articles of copper	1.633
61	Plastics	Polymers of vinyl chloride	1.596
62	Plastics	Sodium or potassium hydroxides or peroxides	1.589
63	Plastics	Other plates of plastics, noncellular and not reinforced	1.577
64	Plastics	Carbon	1.531
65	Automotive	Motor vehicles for the transport of > 10 persons	1.514
66	Metals	Hot rolled bars of iron	1.481
67	Metals	Aluminium containers, >300 litters	1.444
68	Metals	Stoppers, caps and lids of metal	1.399
69	Metals	Other metals	1.398
70	Metals	Other floating structures	1.389
71	Metals	Tin waste and scrap	1.359
72	Metals	Aluminium structures (bridges, towers etc)	1.355
73	Metals	Hydraulic turbines, water wheels and regulators	1.354
74	Plastics	Plastic builders' ware	1.354
75	Metals	Other arms (air guns, truncheons, etc.)	1.352
76	Metals	Machinery for preparing tobacco	1.306
77	Automotive	Special purpose motor vehicles	1.230
78	New tyre	Used pneumatic tires of rubber	1.225
79	Plastics	Sulphuric acid, oleum	1.189
80	Metals	Cadmium	1.180
81	Metals	Stainless steel in ingots	1.156

Rank	Chamber	Product description	PCI
82	New tyre	New pneumatic tires of rubber	1.142
83	Plastics	Sulphur, sublimed or precipitated	1.139
84	Plastics	Other inorganic acids	1.127
85	Metals	Copper wire, uninsulated	1.110
86	Metals	Prefabricated buildings	1.089
87	Metals	Flat-rolled iron, width > 600mm, cold-rolled, not clad	1.020
88	Plastics	Hydrogen peroxide	0.988
89	Plastics	Rosin and resin acids	0.949
90	Metals	Hand-tools for gardening	0.936
91	Metals	Surveying instruments	0.915
92	Metals	Flat rolled iron, width > 600mm, clad	0.913
93	Metals	Nails and similar articles of iron or steel	0.905
94	New tyre	Rubber hygienic or pharmaceutical items	0.900
95	Metals	Tanks etc. > 300 litres, iron or steel	0.863
96	Plastics	Sulfonated, nitrated derivatives of hydrocarbons	0.861
97	Plastics	Silicates	0.845
98	Plastics	Polymers of ethylene	0.797
99	Plastics	Chlorates, bromates, y iodates	0.746
100	Metals	Other vessels	0.733
101	Plastics	Zinc oxide or peroxide	0.733
102	Plastics	Plastic tubes and fittings	0.686
103	Plastics	Oils etc. from high temperature coal tar	0.663
104	Metals	Stoves and similar non-electric appliances of iron or steel	0.654
105	Metals	Ferrous waste and scrap	0.600
106	Metals	Aluminium wire, not insulated	0.392
107	Metals	Tugs and pusher craft	0.330
108	Metals	Other moving, excavating or boring machinery	0.318
109	Plastics	Turpentines	0.288
110	Metals	Other tubes, pipes and hollow profiles of iron or steel	0.283
111	Plastics	Carbonates	0.266
112	Plastics	Packing lids	0.217
113	Metals	Fishing vessels	0.155

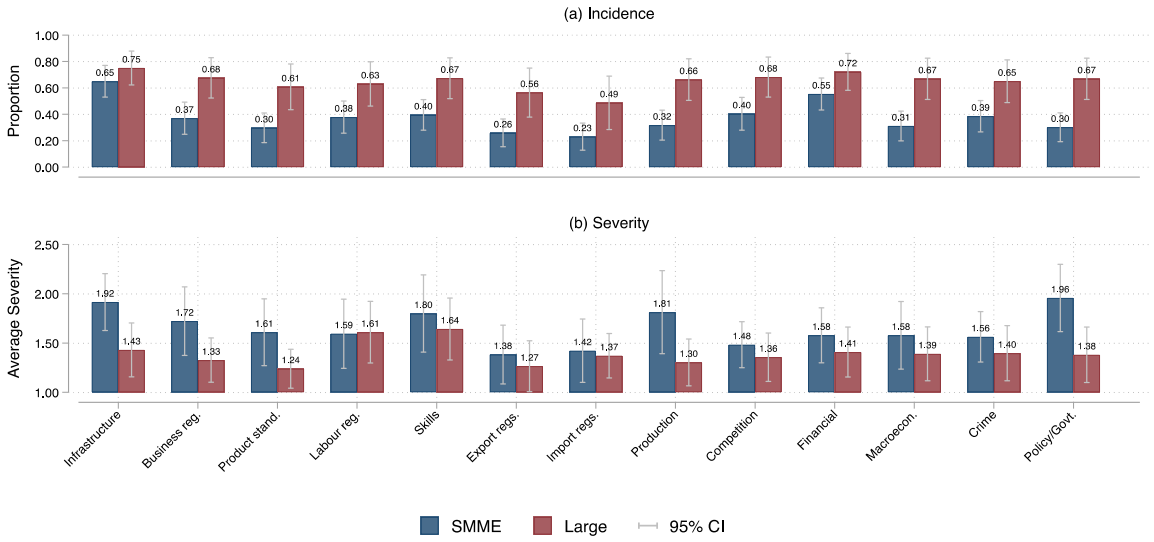
Source: Author's own calculations based on The Growth Lab at Harvard University (2019).

Table A 2: Alternative data sources

	MER Sector Enterprise Survey		MER Sector Enterprise Survey (Estimates)		Sector Skills Plan 2021		Levy Paying Dataset 2021	
	Number firms	Share (%)	Number firms	Share (%)	Number firms	Share (%)	Number firms	Share (%)
Total	254	100	5 073	100	3 008	100	9 436	100
Chamber								
Automotive	18	7.09	181	3.57	114	3.79	117	1.24
Metal	160	62.99	3 597	70.90	2 520	83.78	6 182	65.52
Auto Component	22	8.66	308	6.07	12	0.40	1 044	11.06
New tyre	8	3.15	30	0.59	8	0.27	105	1.11
Plastics	46	18.11	957	18.86	354	11.77	1 314	13.93
Unknown	0	0.00	0	0.00	0	0.00	674	7.14
Firm size								
SMME	179	70.47	4 438	87.48	2 548	84.71	8 531	90.41
Large	75	29.53	635	12.52	460	15.29	537	5.69
Unknown	0	0.00	0	0.00	0	0.00	368	3.90
Province								
Gauteng	129	50.79	2 515	49.58	1706	56.72	4 327	45.8
WC	44	17.32	1 121	22.10	531	17.65	1 586	16.8
KZN	31	12.20	737	14.53	381	12.67	1 166	12.36
EC	18	7.09	144	2.84	198	6.58	462	4.90
Other	32	12.60	556	10.96	192	6.38	1 895	20.08

Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022), Sector Skills Plan 2022/23 (merSETA, 2022), Levy Paying Data 2021 (merSETA, 2021). Authors' own calculations.
Notes: 1. SMMEs defined as those establishments' employment levels of lower than 150 employees; large establishments are those with 150 employees or more.

Figure A 1: Frontier establishment constraint incidence and intensity, by establishment size



Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022). Authors' own calculations.
Notes: 1. SMMEs defined as those establishments employment levels of lower than 150 employees; large establishments are those with 150 employees or more. 2. Panel (a) presents the proportion of establishments out of the total MER sector that report a constraint as applicable to them. Panel (b) presents the average severity score for each constraint, as measured out of 4. Individual scores interpreted as follows: 1 – "Minor obstacle"; 2 – "Moderate obstacle"; 3 – "Major obstacle"; and 4 – "Severe obstacle". 3. All estimates weighted using sampling weights and corrected for complex survey design. 4. Severity estimates calculated only over those individuals who reported a constraint as applicable to them – i.e. sample excludes establishments reporting a score of 0, indicating a constraint was "No obstacle" to their operations.

Table A 3: Mapping of frontier products listed as diversification opportunities

Establishment product description	Mapped product description	Mapped HS Code
Abs Coex With PmmaPc For Train Interiors And Windows	Polymers of styrene	3903
Automotive Components	Parts of motor vehicles	8708
Brick Making Machine Spares	Parts of motor vehicles	8708
Commercial	Aluminium structures (bridges, towers etc)	7610
Diff Carrier	Parts of motor vehicles	8708
Escalators	Other lifting machinery	8428
HipsHdpePp	Polymers of styrene	3903
Load Bed Manufacturing For The Transport Industry	Trailers and semi-trailers	8716
Paint Plastic Paving	Paints and varnishes, nonaqueous	3208
Rotary Pipe	Tubes, seamless, of iron or steel	7304
Sensor BossesTubes	Tubes, seamless, of iron or steel	7304
Stoves	Stoves and similar non-electric appliances of iron or steel	7321
Wheels	Parts of motor vehicles	8708

Authors' own mapping. Source: MER Sector Enterprise Survey (Development Policy Research Unit, 2022).

Development Policy Research Unit
University of Cape Town
Private Bag, Rondebosch 7701
Cape Town, South Africa
Tel: +27 21 650 5701
www.dpru.uct.ac.za