ESTIMATING TOTAL FACTOR PRODUCTIVITY IN THE MANUFACTURING SECTOR ACROSS MUNICIPALITIES IN SOUTH AFRICA

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Abstract
This study estimates total factor productivity (TFP) in the manufacturing sector in South Africa across municipalities and empirically examines its main determinants. The study used growth-accounting techniques to determine values of total factor productivity as the residual. Furthermore, the study uses the generated values of TFP to examine its determinants and assess whether heterogeneity exists across South African municipalities. The growth-accounting model shows that the average level of TFP is higher in the metros, followed by that in secondary cities and in local municipalities. Moreover, the results show that growth in TFP is one of the most essential factors of gross value added (GVA) growth in the manufacturing sector. Overall, the average TFP level for South Africa over the period 1993 to 2016 is 6.52. Fixed-effects techniques are used and the following factors were found to be determinants of higher TFP levels: access to electricity and water, trade openness, secondary education, post-secondary education and population density. On the other hand, HIV rate and specialisation were found to have a negative impact on TFP. The magnitude of the coefficients of both secondary and post-secondary education shows that all levels of education are the most important determinant of TFP. Based on the fact that TFP differs across municipalities, and that the identified key macroeconomic variables identified in this study affect TFP differently across municipalities, it is evident that economic policy makers at the municipal level need to take cognisance of the need for policy to vary according to the economic profile and specificities of individual municipalities. Also, from a policy-making perspective, measures targeting the previously mentioned determinants should prioritise both secondary and post-secondary education

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1. INTRODUCTION

This paper is based on the premise that sustained growth in total factor productivity (TFP) is one way of increasing economic growth. In the long run, productivity is everything: "a country's ability to improve its standard of living over time depends almost entirely on its ability to increase total factor productivity (TFP), output per worker and output per capital" (Krugman, 1997:9). TFP refers to

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output that is not attributable to factor inputs. TFP is important because it generates benefits, both from within the manufacturing sector and beyond. First, from the manufacturing sector's viewpoint, TFP enables firms to be more competitive (Tocco, 2015). Second, TFP generates benefits beyond the manufacturing sector in that, "in the long run, living standards depend on the efficiency with which our economic resources are utilised" (Beckman & Buzzell, 1957:26). At the municipal level, TFP plays a key role in raising living standards and spurring economic growth. Besides the accumulation of factor inputs, TFP is the main driver behind differences in economic growth between regions in the long run. This has been suggested by the empirical results of Benhabib and Spiegel (1994), Easterly and Levine (2002) and Klenow and Rodriguez-Clare (1997).

The recent underperformance of South Africa (SA) in the manufacturing sector begs the question whether it has the potential to drive the long-term economic growth prospects enshrined in the National Development Plan (NDP) (National Planning Commission, 2011) and the Industrial Policy Action Plan (IPAP) (Department of Trade and Industry, 2016). The manufacturing sector's contribution to output in SA is declining at a faster pace than in countries such as Brazil, Russia, India and China (BRIC), which have also have experienced a decline, but not at as fast a pace as in SA, over the last two decades. The decline is in the manufacturing sector's contribution to national output, employment and investment. For instance, the sector experienced a decreasing proportion of the total employment, gross value added (GVA) and the proportion of total fixed capital formation. The proportion of employment decreased from 14.84 per cent in 1993 to 9.39 per cent in 2016. The proportion of GVA decreased from 21.26 per cent in 1993 to 13.50 per cent in 2016, and the proportion of total fixed capital formation decreased from 22.45 per cent in 1993 to 13.13 per cent in 2016 (Quantec, 2018). Therefore, in order to expand this sector, it is important to understand the cause of the decline. One way to do this is by understanding key characteristics of manufacturing at a local level and from the perspective of production function techniques.

Despite the declining trend, the industrial or manufacturing sector remains one of the key sectors in the SA economy. The sector constitutes a critical pillar in terms of employment, GVA and gross fixed capital formation (GFCF) for the economies of municipalities and of SA in general. Kreuser and Newman (2018) compares the productivity of the manufacturing sector in relation to other sectors of the economy and highlights that manufacturing firms are generally more productive than firms in the agricultural or service sectors and serve as an important source for job creation. Several studies, including by Li and Zhang (2008), Mahmood et al. (2014), Millin and Nichola (2005) and Wells and Thirwall (2003), support the primacy of the manufacturing sector in determining output growth and job creation.

Given the importance of the manufacturing sector to SA's economy, this study contributes to understanding the activity, performance and key determinants of TFP within the sector at the municipal level. Due to its prevailing regional disparities, South Africa presents a particularly interesting case for studying the distribution of economic activity across space. Disparities exist between rural and urban municipalities in South Africa in terms, amongst others, of road infrastructure, access to water and sanitation. Such geographical conditions are receiving growing attention as channels for growth dynamics, indicating that developing countries are not equivalently capable to absorb technology, grow or even converge with developed economies (Braun & Cullmann, 2011).

This study explores growth-accounting techniques and determinants of TFP using municipal level data, which will assist in revealing whether heterogeneity exists. The study aims to identify the impact of macroeconomic variables, for example infrastructure, HIV rate, tress index, trade openness, completed secondary education and higher education, on TFP. In the case of SA, not only are there wide differences in municipal GVA, GFCF and employment in the manufacturing sector, but this has increased with time. For example, the manufacturing sector in the eight metros accounted for 44.36 per cent in employment in the manufacturing sector in 1993, and this has since increased to 52.1 per cent by 2016. According to Mitra, Varoudakis and Véganzonès-Varoudakis (2002), targeting factors such as infrastructure, which varies across municipalities, strongly promotes the convergence of TFP and could be a key component of a balanced growth policy. Studies that examined this issue include that by Beugelsdijk, Klasing and Milionis (2018), which shows that a large share of regional income differences are a result of the variation in TFP. Beaugelsdijk et al. (2018) find that differences in TFP are related to economic structure, cultural characteristics, institutional quality and history in 257 European Union regions. Otsuka (2017) observes that the concentration of internationally competitive manufacturing outlets improves the TFP of that region's economy. Other main drivers at the regional level include education, infrastructure, health, etc. Ismail, Sulaiman and Jajri (2014) state that countries that invest more in health and education, for example, tend to experience growth in TFP. It seems likely that identifying the main drivers of TFP would help to revive this vital economic sector.

The analysis in this study adds to previous studies in several ways. First, the link between macroeconomic variables and TFP in manufacturing productivity at the municipal level is examined for the first time in the context of SA. Second, the sets of determinants include HIV as a proxy for health, instead of the life expectancy or mortality rates that other studies use. HIV is included mainly because this paper wants to clearly identify the drivers of TFP relevant to developing countries and to Southern Africa. HIV is one of the leading causes of death in Southern Africa (Statistics South Africa, 2018). The epidemic imposes a drag on human capital. For example, Cohen (2002) highlights that the epidemic affects productivity in the world of work by reducing labour supply and earnings. This is mainly due to the loss of young adults in their most productive years, and also lost time due to illness, recruitment and training costs to replace workers. Overall, productivity declines because of a loss of valuable skills and experience.

2. THE RELATED LITERATURE REVIEW

This section highlight recent studies that estimated TFP using various methodological frameworks. The most used model specifications are the stochastic frontier analysis (SFA), growth-accounting techniques and CD production function regressions. Most studies that employ the SFA usually go further and analyse the technical efficiencies rather than just TFP. The objective of this section is to highlight methods and to identify factors that affect TFP, specifically regarding manufacturing sector studies in emerging countries. Most of the findings for developing countries highlight that their growth is dependent on capital accumulation, infrastructure and trade specialisation, among other things, and that there is no role for TFP.

Önder et al. (2003) measure technical efficiency and TFP in the manufacturing industry of 18 selected provinces of Turkey. The TFP was estimated using a translog SFA for eight years, from 1990 to 1998. The study separated the private sector and public sector manufacturing industries, and included the factors to explain TFP – including the role of firm size, regional agglomeration, manufacturing industrial specialisation, population density, number of establishments and ownership. Most of these coefficients in the model are found to be significant.

The application of nested panel and SFA was employed by Braun and Cullmann (2011) to estimate regional production functions for the Mexican manufacturing industry. The study is done at the municipal level (2 038 municipalities) and the factors that explain growth in TFP are electricity and water access, among others. Due to methodological issues, the study employs panel and SFA models to capture state and municipality. The results of the study reflect the northern states as being efficient on average compared to states in the south of the country. This is because states in the north benefit from the connectivity to trans-border markets in the United States in terms of superior intermediate inputs and capital, spill-overs such as knowledge or technology transfer, and competitive pressures fostering efficiency (learning by exporting effects). The south is disadvantaged, as it has less updated technology and domestic market orientation. The southern region further is marginalised because of the low-skilled workforce and insufficient infrastructure, especially water.

Marrocu, Paci and Usai (2013) examine how the different roles played by local agglomeration-specialisation and diversity-externalities affect TFP. The regions included in the study are all regions of Europe, that is EU15 members plus Norway and Switzerland (UR15+), and the new accession countries (UR12), that is 10 eastern countries plus the Mediterranean islands of Malta and Cyprus, covering 276 regions and 13 economic sectors in total. The data used was disaggregated at the sectoral level and consists of all market sectors for both manufacturing and services. The study uses an estimation-based measure of sectoral TFP derived without imposing an a priori restriction on input elasticities, and thus accounting for the remarkable heterogeneity observed across sectors. The study enriches the set of regional controls by introducing two intangible assets, namely human and technological capital endowments, and uses the spatial econometric models (spatial error models and two-stage least squares) to capture the potential cross-regional dependence arising from spatial spill-overs or from unobserved spatial features. The results show that the specialisation externalities result in the strongest positive impact in the low-tech manufacturing activities located in the newly developing countries of Europe. The study also shows that the positive effect on TFP growth exerted by the intangible assets and, in particular, by the regional endowment of human capital, shows a much stronger growth-enhancing impact than technological capital.

Otsuka (2017) investigated social overhead capital and population agglomeration as drivers of TFP growth in 48 regions of Japan and the determinants of TFP. The study employs the SFA for the TFP index of Battese and Coelli (1995) and the gross accounting method of Otsuka, Goto and Sueyoshi (2010). The study uses panel data obtained from annual reports on prefectural accounts pooled from 47 regions from 1980 to 2010 obtained from Annual Reports on prefectural accounts. The study found that the provision of social overhead capital and population agglomeration contributes positively to TFP.

Yoshino and Nakahigashi (2018) estimate the effect of infrastructure using the production function and TFP regression by industry for Thailand and Japan from 1976 to 2012. Their study decomposes the GDP into the contribution of inputs to factors and TFP to provide clarity on the contribution of technical progress to economic growth. The study shows that, in Thailand, TFP increased in the manufacturing and services sectors. The production function analysis reveals a productivity effect from infrastructure investment only in the manufacturing sector. The TFP regressions show that investment in transport infrastructure, which is less developed in Thailand than in Japan, has a positive effect on TFP, especially in the manufacturing and service sectors. This implies that investing in transport infrastructure is indispensable for future economic development. In Japan, growth-accounting regressions by industry and region show that TFP growth in secondary and tertiary industries is higher in urban areas than in rural areas. The level of TFP is also higher in urban regions than in other regions.

Kreuser and Newman's (2018) study appears to be the only one that uses firm-level data to estimate TFP in South Africa. Their study uses tax administrative data obtained from the SA Revenue Services (SARS) for the period 2010 to 2013 to analyse the evolution of productivity in the SA manufacturing sector. This study uses the two-step generalised method of moments estimator techniques adopted by Ackerberg, Caves and Frazer (2006). The study finds that the TFP grew on average between 2010 and 2013; however, there are some sub-sectors that experienced a decline in productivity during the period under review. Concerning the determinants of TFP, the study finds that firms that are involved in international trade and invest in research and development are more productive. Since the purpose of this research is to determine the determinants of TFP at the regional level, we do not pay much attention to those determinants at the firm level.

Beugelsdijk et al. (2018) attempt to quantify the regional differences in TFP and determine the factors that can explain regional differences in TFP across EU regions. The technique of development accounting across 257 NUTS-2 regions embedded in 21 of the current 26 European Union countries using data from EUROSTART based on 2017 data was used to make this determination. This paper focuses on both across and within countries' TFP differences and explains most of the observed variations in output per worker. The paper reveals that 75 per cent of the differences in regional economic development can be attributed to differences in TFP. When regressing the computed regional TFP levels on factors that relate to economic and physical geography, the paper finds that the observed variation in TFP can largely be attributed to regional differences in terms of economic geography and historical development paths.

From the literature reviewed, it is evident that most studies use various methods to calculate TFP and to determine the various determinants. Table 1 presents a summary of the reviewed studies.

Table 1: Determinants of total factor productivity

Study	Dataset and methodology	Regions/country	Main determinants
Önder *et al.* (2003)	CD production function and translog stochastic analysis (SFA)	18 provinces in Turkey	Firm size, regional agglomeration, manufacturing specialisation, population density, number of establishments and ownership
Braun, and Cullmann (2011)	Stochastic frontier analysis (SFA)	2 038 municipalities in Mexico	Access to water and electricity and connectivity to trans-border markets
Marrocu *et al.* (2013)	Spatial error models and 2SLS	276 regions of Europe (EU15 members plus Norway and Switzerland)	Specialisation externalities
Beugelsdijk *et al.* (2018)	Growth-accounting techniques	257 NUTS-2 regions embedded in 21 of the current 28 EU countries	Economic geography, historical development and agglomeration
Kreuser and Newman (2018)	Tax administrative data (SARS) Two-step GMM estimator	South Africa	International Trade and R&D
Otsuka (2017)	Stochastic frontier analysis (SFA)	Japan (47 regions)	Social overhead capital and population agglomeration
Yoshino and Nakahigashi (2018)	CD production function	Regions in Thailand and Japan	Transport infrastructure
Beugelsdijk *et al.* (2018)	Growth-accounting techniques	257 NUTS-2 regions (21 European countries)	Economic and physical geography

From the literature, it is evident that the most commonly used methods of measuring TFP are CD production function regressions and growth-accounting techniques. The economic theory prescribes the production function as a concept that quantitatively defines the technological relationship between output and other means of production. In the literature, however, the SFA is included, and it is widely used to measure technical efficiency building on the work of Battese and Coelli (1995). It is not used to study production relationships. However, the advantages associated with growth-accounting techniques are used in this study because the model is found to be the most appropriate one when measuring the production function for the manufacturing sector in developing countries (Hossain, Bhatti & Ali, 2004).

Although the focus of the literature review has been on the manufacturing sector at a regional level, it is acknowledged that the studies differ significantly from one another in terms of location, climatic conditions, etc. However, the variables identified serve as a starting point for the decision about which factors to analyse as determinants of TFP.

3. Discussion of the methodology

3.1. Model and estimation techniques

Henceforth, this paper adopts the following, widely used CD form from the production function:

$$Y_{it} = A_{it}K_{it}^{a}L_{it}^{\beta}, \quad (1)$$

where the i $(i = 1, \ldots N)$ and t (*t = 1, … T*) indices denote municipalities and year respectively, K_{it} denotes capital and L_{it} is labour, Y_{it} denotes gross value added and A_{it} denotes the TFP of municipality i at time *t*. In this equation, a and β denote the elasticities of output with respect to capital and labour. Using the natural logarithms to both sides of the equation to transform the above equation into a linearised model and ease interpretations to straightforward elasticities, the production function yields:

$$lnY_{i,t=}lnA_{i,t} + alnK_{i,t} + \beta lnL_{i,t} \quad (2)$$

Equation 2 is a linear version of equation 1. TFP is denoted by $lnA_{i,t}$, and it captures all sources of growth other than capital and labour. In equation 3, $lnA_{i,t}$ is replaced by $ln(TFP_{i,t)}$. We then compute TFP values across municipalities as proposed by Bilgic-Alpaslan (2015), as follows:

$$lnTFP_{i,t} = lnY_{i,t} - alnK_{i,t} - \beta lnL_{i,t} \quad (3)$$

Equation 3 is used to get figures of TFP across municipalities and over time. The study also extends this equation using labour and capital shares for each municipality to calculate the contribution of capital and labour to TFP growth; that is, the growth-accounting exercise as proposed by Solow (1957). Equation 3 can thus be expressed as follows:

$$\Delta lnTFP_{i,t} = \Delta lnY_{i,t} - a\Delta lnK_{i,t} - \beta\Delta lnL_{i,t} \quad (4)$$

Equation 4 enables one to calculate the contribution of TFP to GVA for each municipality and year in growth rate. The study starts by calculating the labour shares and capital shares. These shares are used in equation 4 to calculate the contributions of factor input growth to output growth. The difference between the growth of output and sum of growth of inputs is attributed to the growth of TFP. The labour share is calculated as the ratio of total compensation of workforce to the GVA. We then compute the capital share as the difference between 1 and the labour share. Low labour shares will indicate that competition in the labour markets is high and salaries are low. Higher capital shares might indicate the ongoing capital-deepening process. The equation for labour share is given as follows:

$$\beta_{it} = \frac{wl_{it}}{Y_{it}}, \quad (5)$$

where β_{it} is the labour share or the ratio of labour force compensation to total value add, wl_{it} is the total labour force compensation, and Y_{it} is the total value add. Thus, the equation for capital share can be written as follows:

$$a_{it} = 1 - \beta_{it}, \quad (6)$$

where a_{it} is the capital share for each municipality. Equations 5 and 6 are employed to calculate the average factor shares across municipalities.

Once labour and capital shares are calculated for municipalities, TFP as well as the contributions of inputs to the growth can be calculated. The difference between the actual growth rate and the sum of growth rates of inputs can then be used to calculate the contribution of TFP to growth.

3.2.2 Determinants of TFP

To assess the macroeconomic factors that affect TFP across municipalities in South Africa, this study builds on the specification proposed by Kalio *et al.* (2012), Khan (2006)) and Kim and Park (2018). These studies use the neoclassical model to estimate the role of macroeconomic and other variables in determining TFP. These TFP models are composed of various factors in relation to the economic theory of both regional and cross-country studies. As such, our functional form is specified as follows:

$$In(TFP)_{it} = C_t + \beta_1 ELC_{it} + \beta_2 \text{WAT} + \beta_3 HIV_{it} + \beta_3 lnSP_{it} + \beta_4 OPEN_{it} + \beta_5 MATR_{it} + \beta_6 HIGHER_{it} + \beta_7 lnPOPD + \gamma_i + v_{it}, \quad (7)$$

where *lnTFP* is the logarithm of total factor productivity, ELC is the percentage of households with access to electricity, WAT is the percentage of households with access to water, HIV is the rate of people living with HIV and AIDS, and $lnSP$ is the logarithm of the tress index (used as proxy for industry specialisation). $OPEN$ is the percentage of imports plus exports as percentage of GDP, $HIGHER$ is the percentage of the population with post-secondary qualifications, and $MATR$ is the percentage of the population that has completed secondary education. $lnPOPD$ is population density, C_t is a constant time trend, γ_i is a parameter capturing the municipality's individual fixed effects, v_{it} is the error term, i refers to the respective municipalities and t refers to time.

The study hypothesises that the variables in equation 7 are primary determinants of TFP in developing countries. This specification has been used recently by Algarini (2017), Kim and Park (2017) and Tocco (2015). This paper adds HIV rate to the specification instead of mortality rates or life expectancy as a proxy for health, because this paper wants to identify drivers of TFP relevant to South Africa. Statistics South Africa (2018) states that HIV/AIDS is one of the leading causes of death in South Africa, and Cohen (2002) highlights the epidemic impact on human capital in the world of work as a result of a loss of valuable skills and experience.

The review of the literature predicts that infrastructure-related variables, such as electricity and water, are positively correlated with TFP (Algarini, 2017). Moreover, trade openness, secondary education, post-secondary education and population density are also positively correlated with TFP (Tocco, 2015). On the other hand, the higher rate of HIV, as well as specialisation, are negatively correlated with TFP (Alemu, Roe & Smith, 2005). Consequently, equation 7 was estimated and the estimated parameters are interpreted and analysed in relation to the economic literature and past empirical findings.

3.2.3 Estimation Strategy

The empirical literature suggests that pooled OLS can be used in the specification of equation 7 when estimating β_j (Algarini, 2017). In using pooled OLS, a strong assumption is made that the municipalities' individual fixed effects do not play a consistent role in explaining TFP. This means that the pooled OLS pools all the municipalities together as one municipality and runs the regression model, neglecting the cross-sectional individual fixed-effects aspect. However, one can relax this assumption and assess whether the municipalities' individual fixed effects play a significant role in explaining TFP across municipalities. As such, panel fixed effects or random effects can be applied to equation 7. The choice between fixed and random effects can be made as suggested by Hausman (1978). The Hausman test is conducted under the null hypothesis, H_0: the panel random effect is appropriate, against the alternative H_1: the panel fixed effect is appropriate. If we fail to reject the null hypothesis, the panel random effect estimate is preferred.

We first present the results from the pooled OLS that control for both heteroscedasticity and the serial correlation of the series. However, the pooled OLS estimates serve as a starting point for analysis prior to the fixed and random effects estimates. We secondly relax the assumption of homogeneity. That is, we consider that each municipality has an individual fixed effect that is different from other municipalities in the determination of total factor productivity. This assumption leads to estimates of parameters that include each municipality's fixed effect and assesses whether all the fixed effects jointly are equal to zero. The assessment of the joint significance of all the municipalities' individual fixed effects relies on the null hypothesis, H_0: that all the γ_i are jointly equal to zero, against the alternative, H_1: that at least one of the γ_i is statistically different from zero. The F-statistics, as well as the related probability value, are presented in the same table that reports the results for the fixed effects.

4. Data presentation

All variables used in this paper are secondary data from the Easy Data (Quantec) database on the manufacturing sector Standard Industrial Classification (SIC3) (Quantec, 2018). The time period considered is 1993 to 2016 and the variables include gross value added in South African rand (2010 constant prices), employment (number) and gross fixed capital formation (GFCF) (2010 constant prices). This is shown in Table 2 below for estimating TFP and determining the production structure of the manufacturing sector. The study uses GVA as a proxy for output. To achieve the objective of this paper, of determining the probable sources of differences in TFP, the study adds seven variables. These are post-secondary school qualification, completed secondary education (grade 12), HIV rate, access to water, access to electricity, trade openness, and tress index.

Table 2: Variables used

Symbol	Variable	Variable description
Y	Gross value added	Gross value added (GVA) by manufacturing sector (SIC3) in 2010 constant prices. GVA is a measure of output (total production) of a municipality in terms of the value that was produced within that municipality. GVA can be broken down into various production sectors, in this case the manufacturing sector.
L	Employment	Total employment (number of employees) in manufacturing industries. The labour force includes people aged 15 and older who meet the Statistics South Africa and International Labour Organization definition of working. All those people counted in manufacturing sector employment, and who participated in the production of goods or services during a specific period
K	Gross fixed capital formation	Gross fixed capital formation (GFCF) in 2010 constant prices. It includes fixed capital stock such as plant, machinery and equipment purchased for use in the manufacturing sector
HIGHERD	Post-secondary education	Percentage of the population with university education. It means the proportion of the municipality's population aged 20 years and older that has enrolled and completed specific post-secondary qualification.
MATR	Secondary education	Percentage of the population with secondary education. It means the proportion of the municipality's population that has completed secondary education regardless of age; however, those counted were 20 years or older.
WAT	Access to water	Percentage of households with access to water inside the dwelling, piped water in the yard or communal piped water less than 200 m from the dwelling.
ELC	Access to electricity	Percentage of households with access to electrical connections for three uses: cooking, heating and lighting. This time series sums the categories and reports the percentages of electrical connectivity in a municipality.
HIV	HIV rate	Percentage of the population living with HIV and AIDS.
SP	Tress index	The tress index measures the degree of concentration of the municipality's economy on a sector basis.
OPEN	The ratio of trade to GDP	Trade openness measures the value of exports and the value of imports of goods and services to GDP.
POPD	Population density	Population density measures the concentration of people in a municipality. To calculate this, the population of a municipality is divided by the area of that municipality. The output is presented as the number of people per square kilometre.

DESCRIPTIVE STATISTICS

Table 3: Descriptive statistics per sub-group of municipalities, 1990 to 2016

	Metros		Secondary cities		Local municipalities	
Variable	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
GVA	25 992.25	16 016.84	2 600.53	2 313.84	263.84	427.44
GFCF	6 088.48	3 927.32	636.18	671.84	60.32	133.84
Labour	121 350.1	71 547.83	11 939.09	8 437.56	1741.9	2243.3
ELC	0.83	0.07	0.82	0.08	0.69	0.19
WAT	0.81	0.08	0.78	0.12	0.59	0.28
SP	52.19	3.22	52.91	9.89	50.73	11.47
OPEN	0.24	0.17	0.12	0.15	0.04	0.09
MATR	0.2	0.03	0.17	0.03	0.1	0.04
HIGHER	0.09	0.02	0.06	0.02	0.03	0.02
POPD	963.23	726.41	174.99	213.03	44.16	51.02

Source: Own calculations using Quantec (2018) data.

Table 3 presents the summary statistics for all variables that are used in the empirical analysis conducted in this study. The metro municipalities have higher average values of GVA, labour and capital compared to the other two categories. The mean for GVA is 25 992.250 (R25.99 billion), capital it is 6 088.479 (R6.08 billion) in 2010 constant prices, and the units of labour force (i.e. number of people employed by the sector) are 121 350 for the metros. For secondary cities, GVA is 2 600.528 (R2.60 billion), capital is 671.835 (R671 million), and the mean for the labour force is 11 939. For local municipalities, the mean for GVA is 263.836 (R263 million), capital has a mean of 60.318 (R60 million), and the labour force is 1 741. The descriptive statistics show that metropolitan municipalities comprise the largest concentration of the manufacturing sector in SA, with the sector accounting for 64.2 per cent of the GFCF, 63.8 per cent of GVA and 52.1 per cent of total employment in 2016. As one would expect, water, secondary school education and higher education have higher average values in the metros than in secondary cities and local municipalities. The mean of the tress index is higher in secondary cities, followed by the metros and local municipalities. This implies that secondary cities have one sector that dominates the economy over local municipalities and metros. The mean of HIV rate is higher in metros, followed by secondary cities and local municipalities. This implies that South Africa has many people who are HIV positive in the metros compared to in secondary cities. The mean for trade openness is higher in the metros, followed by the secondary cities and then local municipalities. This implies that much of the international trading activities are taking place in the metros compared to the secondary cities and local municipalities.

5. Empirical results, discussion and policy recommendation

5.1 GROWTH-ACCOUNTING EXERCISE

5.1.1 Labour and Capital Shares

As described in our methodology for the growth accounting exercise, the estimation of equation 4 passes through the calculation of both labour and capital share across municipalities and over time. Table 4 presents the average labour and capital shares for 234 municipalities in SA grouped together for the period 1993 to 2016. The reported values are the averages of the three groups of municipalities (metros, secondary cities and local municipalities) over the study period.

Table 4: Average factor shares per sub-group of municipalities, 1993 to 2016

Municipality sub-group	Labour share	Capital share
Metros	0.55	0.45
Secondary cities	0.47	0.53
Local municipalities	0.48	0.52
All municipalities	0.48	0.52

Source: Own calculations using Quantec (2018) data

The labour shares are lower in the local municipalities than in the secondary cities; the average labour share for secondary cities is 0.47, while it is 0.48 for local municipalities and 0.55 for metros for the period 1993 to 2016. This implies that the manufacturing sector in secondary cities and local municipalities is more capital intensive, with averages of 0.53 and 0.52 respectively, while metros are less capital intensive, with a capital share of 0.45.

The literature shows that most OECD countries have labour shares that range between 0.55 and 0.70, and these shares have not changed significantly in the past few decades (Algarini, 2017; Bilgic-Alpaslan, 2015). Our findings are in line with studies investigating the growth and productivity in developing countries' secondary cities and local municipalities. Our results support the literature in that labour shares are low in developing countries compared to developed countries. The literature shows that, in most developing countries, the share of labour is low, reflecting and hinting that competition in labour markets is high and wages are low (Bilgic-Alpaslan, 2015). In 2016, SA's labour share within that of the OECD band was 0.59 (Algarini, 2017). The results of this literature are also reflected in the labour shares of the metros; however, they are not reflected in the labour shares of all local municipalities when disaggregated. Our results also show that the labour shares have increased significantly in SA municipalities, from an average of 0.48 in 1993 to 0.59 in 2016. The results of this analysis provide a case that is not provided in the literature, namely that municipalities are not homogenous and therefore labour and capital shares differ vastly. This tells us that there is a need for subnational decomposition in terms of growth-accounting analysis if we are to understand the characteristics of the SA economy.

The structure of production in the manufacturing sector across SA municipalities in terms of whether the manufacturing sector is labour intensive or capital intensive provides interesting results. The results of this analysis show that there is a big difference concerning capital and labour shares across SA municipalities, with some municipalities having labour shares of 0.28, while others have shares of

0.83. Overall, the SA municipalities are showing an increasing trend in labour shares and the economy was more labour intensive (0.59) and less capital intensive (0.41) in 2016 compared to 1993, when the manufacturing sector was more capital intensive (0.52) and less labour intensive (0.48). Although one can observe differences in labour share across municipalities, the shares within the metros do not vary much between the periods under review when compared to the local municipalities.

4.3.2 Municipalities' TFP values

After calculating labour and capital shares for all municipalities, this study estimated equation 4 using factor inputs (capital and labour) to get cross-municipalities figures of TFP. Table 5 presents the municipal sub-group average TFP level.

Table 5: TFP per sub-group of municipalities, 1993 to 2016

Municipality sub-group	TFP
Metros	7.38
Secondary cities	6.62
Local municipalities	6.48
All municipalities	6.52

Source: Own calculations using Quantec (2018) data

The results show that the average level of TFP in South Africa is higher in the metros, followed by secondary cities and then local municipalities. The metros recorded an average TFP level of 7.38, with the value being 6.62 for secondary cities and 6.48 for local municipalities. Overall, the average TFP level for South Africa over the period 1993 to 2016 is 6.52. The results imply that TFP, as a contributor to the manufacturing sector's output, accounts more for total output in the metros compared to that in secondary cities and local municipalities.

4.3.3 Growth-Accounting Results

Table 6 presents the contribution of factor inputs and TFP to GVA growth over the period 1993 to 2016, as specified in equation 7. For all GVA measures, TFP and capital accumulation contribute more than labour over this period. TFP growth accounts for 84.58 per cent of GVA in the manufacturing sector in all municipalities, while TFP growth accounts for 94.23 per cent in metros, 87.46 per cent in secondary cities and 84.02 per cent in local municipalities over the period 1993 to 2016. This implies that TFP growth in metros in SA plays a more important role in explaining GVA than it does in the secondary cities and local municipalities.

Table 6: Growth accounting per sub-group of municipalities: 1993 to 2016

	Total municipalities		Metros		Secondary cities		Local municipalities	
Variables	**Annual average**	**Contribution to GVA growth**	**Annual average**	**Contribution to GVA growth**	**Annual average**	**Contribution to GVA growth**	**Annual average**	**Contribution to GVA growth**
Capital stock	0.015	0.193	0.012	0.192	0.012	0.185	0.015	0.193
Labour force	-0.003	-0.038	-0.008	-0.135	-0.004	-0.059	-0.003	-0.034
TFP	0.065	0.846	0.05739	0.942	0.057	0.875	0.067	0.840
GVA growth	0.077		0.06090		0.065		0.079	

Notes: Capital stock growth is calculated as $a\frac{\Delta K_t}{Kt}/\frac{\Delta Y_t}{Y_t}$; labour growth as $a\frac{\Delta L_t}{Lt}/\frac{\Delta Y_t}{Y_t}$; TFP growth as $\frac{\Delta A_t}{A_t}$; and GVA growth as $\frac{\Delta Y_t}{Y_t}$

Source: Own calculations using Quantec (2018) data

The TFP growth in the local municipalities is the least compared to the metros and secondary cities. Capital and labour in all municipalities contribute 19.26 per cent and (-3.83) per cent respectively to GVA growth. The metros' capital and labour contribute 19.25 per cent and (-13.48) per cent respectively. Secondary cities' capital and labour are 18.45 per cent and (-5.91) per cent respectively, while local municipalities' capital and labour contribute 19.33 and (-3.35) per cent to GVA growth in the manufacturing sector respectively. It can be noted that growth in GVA across all municipal groupings is driven by capital and TFP rather than by labour.

The results for the growth accounting show that the contribution of TFP accounts for a larger share of GVA growth than the accumulation of capital and labour. The average annual growth of TFP is highest in local municipalities compared to secondary cities and metros. The local municipalities have an average annual growth of 6.66 per cent, whereas it is 5.69 per cent for secondary cities and 5.74 per cent for metros. Overall, the average TFP growth is 6.54 for the period under review. Positive TFP is important, as it indicates that the factors of production are used efficiently, for example most growth successes are attributable to positive developments in TFP. The United States of America and China, for example, experienced a TFP of 92 per cent and 80 per cent respectively on average over the past 25 years (Espinoza, 2012).

This paper observes a decline in TFP across municipalities over the period 1994 to 1998, and mostly an expansion from 1998 to 2016, as shown in Figure 2. This analysis shows that positive growth in TFP is one of the most essential triggering factors for GVA growth in the manufacturing sector. According to Burger (2015), this can be explained by the increased use of capital-augmenting labour and energy-saving technology. Capital growth plays a relatively important role in growing the output of the manufacturing sector. This finding is in line with most of the literature (see Tocco, 2015), as it implies that the emerging countries owe their growth to capital accumulation.

Figure 2 shows the TFP growth among municipalities over the period 1994 to 2016. It can be observed that TFP growth across municipalities tends to be close together, even if the level of growth differs by municipal type. The figure shows negative TFP growth across all municipalities grouped together from 1994 to 1997, and mostly positive TFP growth from 1997 going forward.

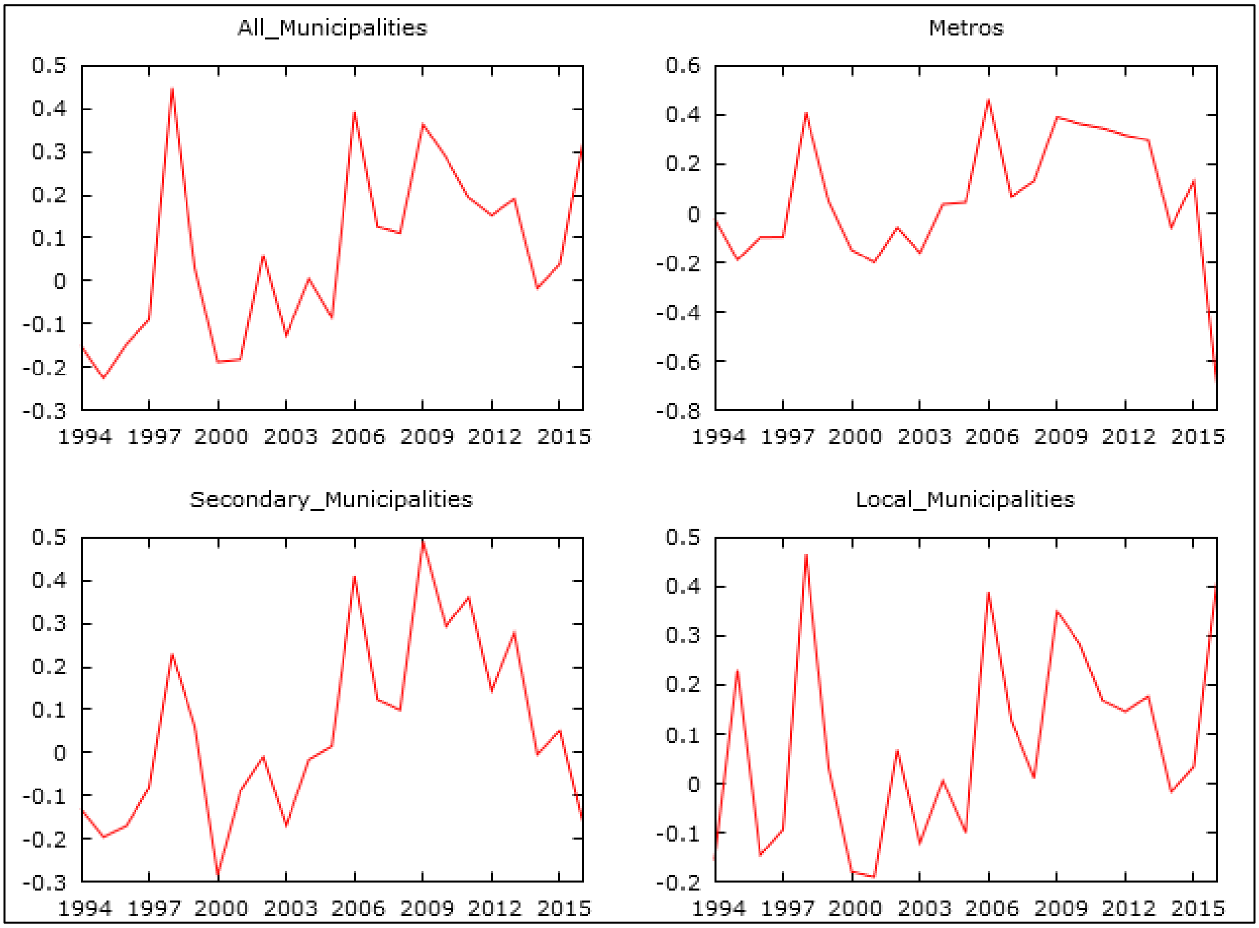

Figure 2: TFP growth across South African municipalities
Source: Own calculations using Quantec (2018) data

The South African constitution of 1996 mandates municipalities to raise the welfare of their cities, and this objective cannot be achieved without attaining sustained economic growth. This study on productivity growth in SA municipalities is vital for several reasons. First, one way to attain sustained growth is through sustained growth in TFP. Second, rapid growth in output that comes about as a result of increases in labour and capital rather than TFP cannot continue indefinitely because of the diminishing returns to production. Finally, higher TFP is key to achieving GVA growth in the manufacturing sector. Because our results show that TFP differs across municipalities, it will be informative to investigate the determinants of TFP. The next section estimates and analyses these macroeconomic variables to explain the growth patterns in TFP across municipalities.

4.4 DETERMINANTS OF TFP IN SOUTH AFRICA ACROSS MUNICIPALITIES

This section starts by estimating equation 7 using the pooled OLS technique, and then the fixed and random effects estimation techniques follow to account for individual municipality fixed effects. The results of the pairwise correlation matrix indicate that access to electricity and water, trade and education are positive and significant when considering the total sample, and significantly correlated with TFP, while HIV is negative and significantly correlated with TFP. From the initial inspection, the findings appear to be in line with the expectation for the total sample; however, the cross-correlation of the variable is not the same across the municipal groupings.

4.4.2 Fixed-Effects and Random-Effects Regression Model

The fixed-effects model permits heterogeneity or individuality among municipalities by allowing each individual to have a different intercept term; however, the intercept does not vary over time (i.e. it is time invariant). The random-effects model, on the other hand, has a common mean value for the intercept, which allows the slopes to vary over an individual, and the error term of each municipality is not correlated with the independent variables, which allows for time-invariant variables to play a role as explanations. As shown above, Hausman (1978) provides a test statistic that allows a decision to be taken on the appropriate estimates between the fixed- and random-effects models. The test is conducted under the null hypothesis, H_0: The random-effects estimate is appropriate, against the alternative, H_1: The fixed-effects estimate is appropriate. This study estimates both the fixed effect and the random effect and applies the Hausman test, which rejects the null. The rejection of the null indicates that the fixed-effects estimate is appropriate. Table 8 reports the fixed-effects estimates, including the statistics of the Hausman test.

Table 8: Fixed-effects estimates of the determinants of TFP (dependent variable: TFP)

Variables	All municipalities	Metros	Secondary cities	Local municipalities
ELC	1.398***	20.135***	-4.489***	1.0516***
	(0.223)	(3.257)	(1.213)	(0.237)
WAT	1.238***	-3.000	0.307	1.008***
	(0.344)	(3.280)	(1.400)	(0.354)
HIV	-10.745***	-30.269***	-19.999***	-9.793***
	(0.579)	(2.996)	(1.760)	(0.620)
lnSP	-0.6202***	0.028	0.189	-0.794***
	(0.152)	(1.921)	(0.341)	(0.170)
OPEN	0.539***	0.411	2.439***	0.3196***
	(0.154)	(0.660)	(0.468)	(0.168)
MATR	31.102***	27.041***	37.221***	31.483***
	(1.339)	(7.745)	(5.237)	(1.394)
HIGHER	25.924***	30.239*	18.971***	35.468***
	(2.954)	(17.053)	(8.238)	(3.904)
lnPOPD	0.860***	2.824**	4.468***	0.369**
	(0.159)	(1.180)	(0.595)	(0.167)
CON	0.559***	31.035***	-17.020***	3.326**
	(0.815)	(9.779)	(2.830)	(0.861)
R^2-overall	0.124	0.084	0.126	0.094
Pro-F	0.000	0.000	0.000	0.000
Hausman test	χ^2 = 779.43	χ^2 = 117.74	χ^2 = 98.62	χ^2 = 585.68
H_0: RE is appropriate	[0.000]	[0.000]	[0.000]	[0.000]
F-Test for joint sign	F-stat. = 31.84	F-stat. = 54.63	F-stat.= 34.06	F-stat. = 31.23
H_0: all the γ_i = 0	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Figure in parentheses show the value of the standard deviation and *, ** and *** are the level of significance at 10%, 5% and 1% probability level. Figure in square parentheses exhibit probability values.
Source: Own calculations using Quantec (2018) data

The results of the fixed effects presented in Table 9 vary from those of the pooled OLS and are the most consistent from a statistical and policy-prescription point of view. They show that access to electricity is statistically significant for all types of municipalities, except secondary cities. For all municipalities grouped together, the results imply that a one per cent increase in electricity will lead to a 1.40 per cent increase in TFP. In the metros, a one per cent increase in electricity will lead to a 20.13 per cent increase in TFP. In secondary cities, a one per cent increase in electricity will lead to a 4.49 per cent decrease in TFP, while in local municipalities, a one per cent increase in electricity will lead to a 1.05 per cent increase in TFP. Overall, access to electricity by households is found to be a positive driver of TFP in South Africa. However, the positive impact of access to electricity by households is higher in the metros than in local municipalities. This implies that, for the enhancement of factor productivity, particular attention must be paid to local municipalities through appropriate policies.

Moreover, access to water is positive, as expected, when all municipalities were grouped together and in local municipalities, but is not significant in the metros and secondary cities. The results show that a one per cent increase in access to water will lead to a 1.24 per cent increase in TFP when the municipalities are grouped together, and to a 1.01 per cent increase in TFP in local municipalities. These results show that access to water, which is proportionally lower in local municipalities than in metros and secondary cities, is important in explaining TFP, and therefore local municipalities should accelerate the provision of water (a basic human right in South Africa) to their residents if they are to attain higher levels of TFP. These results also reflect the important role of the penetration of the water network into the largely arid areas, where water quality and connectivity have frequently been identified as a serious risks to any economic activity (e.g. Asad & Dinar, 2006).

The impact of HIV rate is negative across all municipal groupings and is significant in explaining TFP. The expected negative relationship between TFP and HIV is obtained in the results. The results show that a one per cent increase in HIV rate will result in a 10.75 per cent decrease in TFP when all the municipalities are grouped together. In the metros, the results show that one per cent increase in HIV rate will result in a -30.27 per cent decrease in TFP. In the secondary cities, the results show that a one per cent increase in HIV will lead to a 20.00 per cent decrease in TFP. In local municipalities, a one per cent increase in HIV results in a 9.79 per cent decrease in TFP. These results show that HIV poses a major threat to the manufacturing industry in South Africa. The highest impact is experienced in the metros, with a coefficient of 30.27, compared to 9.79 in local municipalities. The results of the fixed effects are consistent with the results of Alemu *et al*. (2006), in that HIV poses a threat to the economic performance of Southern African countries.

The tress index appears to have a negative and significant impact when grouping all municipalities together and in local municipalities. The results show that a one per cent increase in tress index leads to a 0.62 per cent decrease in TFP when all municipalities are grouped together, and to a 0.79 per cent decrease in local municipalities. The negative coefficient of the tress index means that the municipalities in which the manufacturing industry is composed of more sectors are more productive than those that are specialised in few sectors. This implies that diversified production causes positive externalities. The findings on the tress index are quite informative, as specialisation does not have any significant impact on TFP in secondary cities and metros, because these municipalities are more mature in terms of diversifying their economies, while there is a negative and significant coefficient in local municipalities, which often rely on agricultural, mining and tourism activities, and this means they attain a higher TFP as they diversify into other sectors.

Trade openness appears to have a significant positive impact on TFP in all municipalities grouped together, in secondary cities and in local municipalities. The results show that a one per cent increase in trade openness leads to a 0.54 per cent increase in TFP in all municipalities grouped together, a 2.44 per cent increase in TFP in secondary cities, and a 0.32 per cent increase in TFP in local municipalities. These results show that trade openness does not have any significant impact on TFP in the metros, and that the impact is higher in secondary cities. This implies that secondary cities should increase their international trade if they are to improve their level of TFP, although all municipalities should participate in international trade.

Secondary education has a positive and significant impact on TFP in all municipal sub-groupings. The results show that a one per cent increase in secondary education leads to a 31.10 per cent increase in TFP when all municipalities are grouped together. For metros, a one per cent increase in secondary education leads to a 27.04 per cent increase in TFP. For secondary cities, a one per cent increase in secondary education leads to a 37.22 per cent increase in TFP, while for local municipalities, a one per cent increase in secondary education leads to a 31.48 per cent increase in TFP. These results imply that secondary education plays an important role in increasing the level of TFP of the manufacturing sector.

Post-secondary education has a positive, significant impact on all municipal groupings in South Africa. For all municipalities grouped together, the results imply that a one per cent increase in post-secondary education leads to a 25.92 per cent increase in TFP. For metros, a one per cent increase in post-secondary education leads to a 30.24 per cent increase in TFP. For secondary cities, a one per cent increase in post-secondary education leads to a 18.97 per cent increase in TFP. For local municipalities, a one per cent increase in post-secondary education leads to a 35.47 per cent increase in TFP. This finding is consistent with economic theory.

Population density has the same impact on TFP across all municipal groupings, which is positive and significant. For all municipalities grouped together, a one per cent increase in population density will result in a 0.86 per cent increase in TFP. For metros, a one per cent increase in population density will result in a 2.82 per cent increase in TFP. For secondary cities, a one per cent increase in population density will result in a 4.47 per cent increase in TFP, while it will lead to a 0.37 per cent decrease in TFP for local municipalities. These results show that population densities should be encouraged across all municipalities in South Africa. The finding of positive coefficient in municipalities is in line with Önder *et al.* (2003). This entails that the manufacturing industry gains some probable positive externalities, such as interactions between firms, the availability of qualified labour, and so forth.

Furthermore, the null hypothesis of equal municipalities' individual fixed effects is rejected in the fixed-effects regression for all municipalities grouped together, as well as for the sub-groups of municipalities. This implies that each municipality's individual fixed effects play a significant role in explaining TFP in South Africa.

Overall, access to electricity and water, HIV, specialisation, trade openness, secondary education, post-secondary education and population density are found to be significant determinants of TFP across municipalities in South Africa. However, the sub-group regressions indicate that, in the metros, electricity, HIV, secondary education, post-secondary education and population density are the most driving sources of TFP. In the secondary cities, electricity, HIV, trade openness, secondary education, post-secondary education and population density are the most driving sources of TFP. In the local municipalities, electricity, water, HIV, specialisation, trade openness and secondary education are the most driving sources of TFP. To increase the level of TFP in South Africa, the sub-group results imply that policy makers at the local and national government level should implement particular measures that will improve factors that are driving the most change in TFP.

The results show that, of all the variables identified, priority should be given to secondary and post-secondary education. The magnitude of the coefficients of both secondary and post-secondary education shows that all levels of education are the most impactful determinant of TFP across municipal sub-groupings. It is very clear that a labour force equipped with knowledge and skills is needed to enter occupations in the manufacturing sector.

6. Conclusions

Total factor productivity is important because it is a key driver of national, long-run economic growth and higher living standards (Easterly & Levine, 2001; Klenow & Rodriquez-Clare, 1997). Analysing TFP and its determinants enables us to understand which factors policy makers can target in order to achieve higher TFP. This will enable the manufacturing sector to become more competitive and allow the achievement of sustainable, long-run GVA growth and higher living standards across municipalities in SA.

This study has established the contribution of the labour force, capital formation and TFP to GVA in the manufacturing sector for SA municipalities sub-grouped in terms of local municipalities, secondary cities and metros. Our main findings can be outlined as follows. First, the study established whether the manufacturing sector is labour or capital intensive in order to understand the structure of production in the manufacturing sector. The study finds that the labour share in SA was 0.59 in 2016; however, there are disparities, with an average of 0.55 and 0.45 for metros, 0.47 and 0.53 for secondary cities, and 0.48 and 0.52 in local municipalities for labour shares and capital shares respectively for the period 1993 to 2016. The results of the labour and capital shares are consistent with those of OECD countries, which vary between 0.55 and 0.70, and also with studies such as those by Algarini (2017) and Bilgic-Alpaslan (2015), which calculated such shares for developing countries. The study also observes the increasing trend in labour shares as the manufacturing sector becomes more labour intensive. This trend can be explained by the fact that labour shares are calculated as the ratio of total labour force compensation to municipal GVA, in relation to which salaries in SA have been increasing as the result of union bargaining and the implementation of minimum wages, a policy that would most likely raise labour share and cause capital share to fall modestly.

Second, the estimation results of the growth-accounting techniques reveal that capital accumulation and TFP are higher than the contribution of labour to GVA across municipalities for the period reviewed. The results show that TFP accounts for 84.58 per cent of GVA growth when we all municipalities are pooled together, 94.24 per cent of GVA growth in the metros, 87.47 per cent of GVA growth in the secondary cities and 84.03 per cent of GVA growth in the local municipalities. This contribution to GVA is higher in the metros compared to secondary cities and local municipalities. These results imply that the manufacturing industry needs to enhance TFP in secondary and local municipalities to increase its contribution to GVA. According to Algarini (2017), TFP is imperative because it involves efficiency in input use, which is linked to reducing the cost of production and improvement.

Third, the study established whether there are differences in TFP across municipalities by calculating the average value of TFP for each municipality. The study finds that the average level of TFP in South Africa is higher in the metros, followed by secondary cities and then local municipalities.

Finally, the study attempted to investigate factors than can explain the municipal difference in TFP. The study identifies access to water and electricity, HIV rate, tress index, trade openness, secondary education, higher education and population density as macroeconomic variables that affect TFP. The study estimated the pooled OLS as a benchmark model for all municipalities, metropolitan municipalities, secondary cities and local municipalities. All variables identified are impactful determinants from the pooled OLS regression; however, the extent of the impact differs by municipal sub-groupings for certain variables. The most impactful determinants from the pooled OLS regression are access to electricity, secondary education and HIV – these variables are positive and significant. Access to water is only positive and significant in the secondary cities and local municipalities. The tress index and trade openness do not have the same signs and significance. Population density is positive but not significant in explaining TFP. This paper does not use the results of the pooled OLS to draw policy conclusions due to the fact that the pooled OLS ignores individual fixed effects and that it is not an appropriate model, as shown by the results of the Hausman test.

The results of the Hausman test indicate that the fixed-effects estimate is appropriate and therefore this study uses the results of the fixed effect to draw policy conclusions. The results of the fixed-effects model shows that access to electricity and water is mostly positive and significant. These results imply that infrastructure in South African municipalities is important in increasing the level of TFP. HIV and the tress index are positive and significant. These results imply that the HIV rate should be reduced, as it has a negative effect on TFP.

The negative and significant coefficient on the tress index means that the municipalities in which the manufacturing industry is composed of more sectors are more productive than those specialising in just a few sectors. This implies that diversified production causes positive externalities. The findings on the tress index are quite informative, as the index shows a negative impact on TFP across all municipalities, which implies that all municipalities should be more mature in terms of diversifying their economies. It also means that local municipalities, which often rely on agricultural, mining and tourism activities, will attain a higher TFP if they diversify into other sectors.

Trade openness is positive and mostly significant. This result indicates that participation in international trade is important in enhancing TFP. According to Sachs *et al.* (1995), trade openness is expected to enhance technological innovation through either the direct or indirect benefits of trade that boost productivity. Secondary education, post-secondary education and population density are positive and significant in explaining TFP. These results indicate that the overall education system in South Africa is appropriate to meet the needs of the manufacturing sector. This implies that the country should continue to spend more on education, as it helps labour to gain the relevant skills that boost productivity. Also, the results indicate that the greatest priority should be given to education if the country is to prioritise increasing TFP in the manufacturing sector, as the size of the coefficient of both secondary and post-secondary education shows that education at all levels is the most impactful determinant of TFP.

Understanding the drivers of performance in the manufacturing sector in terms of TFP analysis is important for designing policies aimed at expanding the output of the manufacturing sector, arguably the key driver of productivity, job creation and exports in the economy. Since our research only considered the manufacturing industry as a broad industry (SIC3), future research should consider subindustries of the sector, thus offering a more comprehensive understanding of TFP levels and their determinants across the subsectors of the manufacturing industry. It will indicate which sectors have a higher TFP and what the significant determinants are at the sub-sectoral level. As the manufacturing sector has been the main focus of this study, an extension of the research should include other sectors, such as the service sector. Such research would indicate whether one sector or the other largely drives municipal aggregate TFP, and whether TFP is differentially determined in each. Since SA and its municipalities are shifting from the dominance of the industrial sector towards the service sector, the inclusion of the service sector would help to determine whether such a shift is beneficial to national or subnational aggregate TFP growth.

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