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Journal of Innovation and Entrepreneurship (2023) 12:19
https://doi.org/10.1186/s13731-023-00284-1

Journal of Innovation and Entrepreneurship

RESEARCH

Open Access

Enhancing competitiveness through technology transfer and product quality: the mediation and moderation effects of location and asset value

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Abstract

The direct effects of technology transfer and innovation on the productivity and competitiveness of economies and businesses are well established. However, research is yet to establish the explanatory variables and the boundary conditions within which these relationships exist. This study examines the extent to which product quality mediates the relationship between technology transfer and competitiveness of small-scale agricultural businesses (SSABs). Moreover, the study explores the extent to which the geographical location moderates the technology transfer–business competitiveness relationship, including whether asset value moderates the product quality–competitiveness relationship. A cross-sectional survey was conducted on 400 SSAB owners and managers in the Free State and Mashonaland Central Provinces of South Africa and Zimbabwe, respectively. Of the 400 questionnaires distributed, 268 usable questionnaires (67%) were returned for analysis. The results suggest that product quality partially mediated the relationship between technology transfer and competitiveness of SSABs. The results demonstrate further that the relationship between product quality and competitiveness was moderated by asset value such that at low levels of product quality, SSABs with larger asset values became more competitive than those with smaller asset values. However, as product quality increased, SSABs with smaller asset values became increasingly competitive until the competitive advantage of those with larger asset values was eliminated. SSABs in South Africa reported higher product quality and competitiveness than those in Zimbabwe. The relationship between the location in which the SSAB was situated and competitiveness was direct, and location did not moderate the relationship between technology transfer and competitiveness. The study illuminates the critical importance of product quality for SSABs, especially those with small asset values. It also demonstrates that while technology transfer may influence the competitiveness of SSABs directly, the influence of quality products cannot be underestimated. The study is one-of-a-kind that simultaneously considers explanatory and moderated effects of technology transfer–competitiveness nexus in SSABs, in the context of South Africa and Zimbabwe.

Keywords: Asset value, Competitiveness, Product quality, Small-scale agro-businesses, Technology transfer

Introduction

Agricultural productivity and international competitiveness on one hand, and their drivers on the other hand, have attracted the attention of researchers and policymakers for a considerable time. In Africa, agriculture remains one of the key drivers of socio-economic development (Ntshangase et al., 2018; Rambe & Khaola, 2021). For instance, in South Africa, agriculture contributes 3% to the gross domestic product (GDP); employs about 885,000 people; and directly and indirectly supports about 8.5 million people (Aguera et al., 2020). To increase agricultural productivity and competitiveness, the importance of the inclusion of small-scale farmers in the application of advanced and digital technologies cannot be overemphasised (Aguera et al., 2020).

Even though technology transfer and innovation have been advanced as possible solutions to the low competitiveness of small-scale farmers in South Africa and Zimbabwe (Gumbochuma, 2017; Rambe & Khaola, 2021), the adoption of new technologies in sub-Saharan Africa remains disappointingly low (Mgendi et al., 2019; Ntshangase et al., 2018; Omara et al., 2021). Despite the inadequate participation of African countries in global digital transformation in agriculture, there is consensus in literature on the importance of technology transfer, innovation and quality in the sustained competitiveness of firms (Baran & Zhumabaeva, 2018; Shi et al., 2018). Technology transfer spurs innovation (Rambe & Khaola, 2021), and innovation exerts some significant impact on product quality (Shi et al., 2018). In turn, product quality enhances product market positions through the promotion of their reputation, thus increasing the market share of firms (Calantone & Knight, 2000).

Even though the effects of technology transfer and innovation on the productivity and competitiveness of economies and businesses are well documented (Monova & Yu, 2017; Shi et al., 2018), the mechanisms through which technology transfer influences competitiveness are not clear, especially among SSABs. Similarly, scholarly literature on the boundary conditions within which technology transfer in SSABs affects competitiveness is yet to emerge in literature.

Technology transfer is the flow of knowledge, research results, and business models from the creator to users for the purpose of further development and application in practice (Mazurkiewicz & Poteralska, 2017). The process of transfer, therefore, includes the exchange of ideas, practices, technical knowledge, skills, inventions and scientific knowledge from research universities and institutes to businesses (Kooli-Chaabane et al., 2014). In summary, the process of technology transfer facilitates the movement of hard and soft skills essential for improving farm productivity (Mgendi et al., 2019).

Closely related to the concept of technology transfer is the process of innovation, which encapsulates the process of transforming new ideas, new knowledge into new products and services (Baran & Zhumabaeva, 2018). This process consists of the invention of new and useful ideas, and the implementation and commercialisation of those ideas (Khaola & Coldwell, 2019).

While there is no universally accepted definition of quality, it is often described in terms of the inherent features of a product or service (e.g., performance, reliability, conformity to standards, durability, serviceability, and overall reputation), and meeting the perceived expectations of the customer. We, therefore, follow Ndukwe's (2011) operationalisation of quality products as those products that have attributes that satisfy the customer's needs and wants or market requirements relative to those of competitors in exchange for monetary considerations. Closely linked to quality is the concept of competitiveness, which we define as the ability of the SSAB to produce and sell products of acceptable quality at local and international markets at competitive prices, while generating adequate returns on the resources employed or consumed in producing them (Rambe & Khaola, 2021). Competitiveness is also related to productivity, defined as output per unit of input (Atkinson, 2013). In fact, Porter (1990) describes productivity as the only meaningful characterisation of competitiveness at national level.

Researchers concur that international competitiveness of SSABs in developing countries is affected by several factors, including high production costs, lack of physical access to markets, information asymmetries, and poor quality of products and services from these countries (Rambe & Agbotame, 2018).

The South African National Small Business Amendment Act (2003) defines SSABs as agricultural firms employing less than 100 employees, with a total annual turnover of less than R5 million and a total gross asset value of less than R5 million. In Zimbabwe, SSABs are understood as smallholder farming businesses largely concentrated in rural areas, which rely predominantly on semi or unskilled agricultural workers and unsteady incomes for their food security and economic activities (Gumbochuma, 2017). The land holding of such entities tends to be small, often limited to few hectares, and largely dependent on rain-fed agriculture and inconsistent application of synthetic fertilisers, which contribute to sub-optimal productivity per unit cost of inputs used (Gumbochuma, 2017).

The aims of this article are twofold. First, we evaluate empirically the mechanism through which technology transfer influences the competitiveness of SSABs and propose product quality as one of the key explanatory variables. Second, we examine the roles of asset value (size) and location of SSABs as moderating variables of the product quality–competitiveness and technology transfer–business competitiveness relationships, respectively.

We contribute to organisational literature on technology transfer, product quality and competitiveness in two substantial ways. First, we use the Diamond Model of Competitiveness (Porter, 1990) to hypothesise and empirically examine the capacity of product quality to explain (mediate) the relationship between technology transfer and competitiveness of SSABs in South Africa and Zimbabwe. While prior studies in these countries have focused on the impact of technology transfer on productivity and competitiveness (Gumbochuma, 2017; Rambe & Khaola, 2021), they did not provide explanatory variables in these relationships, and as such, eclipsing our understanding of these relationships. We postulate that product quality is a potent explanatory variable in the interaction between technology transfer and competitiveness, thus capacitating farming communities with mechanisms to improve the competitiveness of their businesses. Second, and relatedly, we propose that SSABs can leverage their competitive advantage through the production of quality products. Big corporations are often more productive, sell more products, and earn more profits than small businesses (Manova & Yu, 2017). While some policy debates centre on reducing costs for small-scale firms to compete successfully (production efficiency), we argue that SSABs can equally compete on quality in national and international markets, with the potential to advance theory and practice in agrarian studies.

The next section focuses on the review of relevant literature and the development of hypotheses.

Literature review

Theoretical framework

We deploy Porter's (1990) Diamond Model for competitiveness and the Resource-Based View (RBV) as guiding theories in this study. The Diamond Model acknowledges the importance of external and internal factors in the firm's international competitiveness. According to Porter, factor conditions; demand conditions; related and supporting industries; and firm strategy, structure and rivalry are the interrelated attributes of a nation that determine a firm's ability to compete in international markets (Porter, 1990). Factor conditions include human resources, physical resources, knowledge resources, capital resources and infrastructure (Smit, 2010). For Porter (1990), demand conditions involve domestic buyers exerting pressure on indigenous firms to innovate faster than their foreign rivals. To achieve the high standards imposed by domestic buyers, firms must source inputs from related suppliers that are globally competitive. While the national conditions determine how firms are created, organised and managed, intense localised rivalry within each industry is critical to spurring change, innovation and continuous development. If the above four conditions are favourable, domestic firms will be compelled to innovate continuously, and hence improve their production processes to become competitive internationally (Porter, 1990).

Another underpinning theory for this study is the Resource-Based View (RBV). According to this theory, firms gain a competitive advantage by developing some bundles of valuable and rare resources that are inimitable and non-substitutable (Barney, 1991; McIver & Lengnick-Hall, 2018). Thus, SSABs can exploit internal capabilities such as human capital, unique routines, and quality products to obtain a sustainable competitive advantage over their local and foreign rivals.

The relationship between technology transfer and competitiveness

Innovation is central to a firm's competitive advantage. According to Porter (1990, p. 75), 'companies achieve competitive advantage through acts of innovation'. Technology transfer and innovation are very closely related (Rambe & Khaola, 2021). In fact, Kooli-Chaabane et al., (2014, p. 74) suggest that 'a process of technology transfer is a process of innovation'. Since innovation is associated with the launch of new products, improvements in the process models, opening of new markets, implementation of new marketing instruments, and developing new industries, it provides opportunities for increased competitiveness of firms (Baran & Zhumabaeva, 2018).

For innovation to take place, according to the Diamond Model for competitiveness, firms need factor conditions that include human resources, physical resources, knowledge resources, capital resources and infrastructure. Thus, the transfer and acquisition of ideas, best practices, skills, technical knowledge, intellectual property, and creativity;

coupled with demanding domestic customers and rivalry among firms, are necessary conditions for SSAB's pursuit of innovation and competitiveness.

Several studies confirm the positive relationships between technology transfer and innovation on the one hand, and productivity and competitiveness on the other (Gumbochuma, 2017; Ntshangase et al., 2018; Rambe & Khaola, 2021). As such, in line with prior studies, we expected that there would be positive relationships between technology transfer and SSAB competitiveness.

Hypothesis 1 There is a positive relationship between technology transfer and competitiveness.

Product quality as a mediating factor in the relationship between technology transfer and competitiveness

Product quality is an important factor in the competitiveness of firms (Monova & Yu, 2017). We argue that product quality mediates the relationship between technology transfer and competitiveness. This is because the transfer of skills, technical knowledge, expertise and ideas should plausibly result in quality products, which in turn should increase SSAB's competitiveness. Technology transfer enables the generation of invaluable and inimitable core competencies that facilitate the production of high-quality products and induce process improvements that rival firms fail to imitate, thereby affording the innovating firm some competitive advantage over its competitors (McIver & Lengnick-Hall, 2018).

There is compelling evidence to buttress this postulation. For instance, Porter (1990, p. 78) argues that Japanese automakers obtained sustained competitive advantage through process improvements that enhanced product quality and increased customer satisfaction. Shi et. al. (2018) contend that technological innovation practices exert a positive impact on product quality in China, and that firm size moderates the positive relationship between technological innovation practices and attractive quality. In turn, all forms of product quality (normal quality and attractive quality) influence product market positioning, which can be conceived as a dimension of firm competitiveness. Monova and Yu (2017) affirm the impact of quality on the competitiveness of exports in China. Specifically, these authors demonstrate that the 'firm's core competence is in varieties of superior quality that command higher prices but nevertheless generate higher sales than cheaper goods of lower quality' (p. 117). In an earlier study, Lakhal (2009) found that quality had a direct impact on the competitive advantage of organisations in Tunisia.

Collectively, the studies mentioned above suggest that technological improvements lead to improved quality of products, and product quality enhances the competitiveness of firms. Therefore, it is plausible to expect technology transfer in SSABs to influence their competitiveness via product quality. We, therefore, hypothesise that:

Hypothesis 2 The relationship between technology transfer and competitiveness is mediated by product quality.

Location of a business as a moderator of the relationship between technology transfer and competitiveness

The stage of development of a country is likely to affect the extent to which firms adopt and use new technologies. We submit that the location of the SSAB may moderate the influence of technology transfer on its local and international competitiveness. Specifically, while agricultural outputs have declined in both South Africa and Zimbabwe (Gumbochuma, 2017; Rambe & Khaola, 2021), there is incontrovertible evidence to suggest that there has been an accelerated economic decline in Zimbabwe than in South Africa, especially after the implementation of the Fast Track Land Redistribution Programme (FTLRP) in 2000. Mazwi et. al. (2019) explain that despite government subsidies, productivity has been low in Zimbabwe, probably due to challenges of access to agricultural inputs and lack of domestic demand of grains. Since it was not possible to have a rivalry in the state-led contract farming model, the innovation and competitiveness of SSABs in Zimbabwe were probably negatively affected. Furthermore, even if there were some semblances of agricultural technology in Zimbabwe, in the absence of high-order skills that fled the country after the FTLRP, technology acquisition and transfer would not be as effective in Zimbabwe as it is in South Africa. We, therefore, propose the location of an SSAB as a boundary condition for technology transfer to influence competitiveness. We specifically hypothesise as follows:

Hypothesis 3 The country in which the SSAB is located moderates the relationship between technology transfer and competitiveness such that the relationship is stronger for SSABs located in South Africa than those located in Zimbabwe.

The moderating effects of asset value in the relationship between product quality and competitiveness

As indicated before, the size of the organisation has some implications for its competitiveness. Since big agricultural firms have a large asset base, more sophisticated human capital and competencies that enable them to exploit technologies; we postulate that they have a competitive advantage over small firms. Manova and Yu (2017) suggest that big organisations are more productive, sell more products, and earn more profits than small organisations do.

Asset value is sometimes used as a proxy of business size. As such, we expected that SSABs with large asset values could compete better than SSABs with smaller asset values. However, the foregoing advantage could in fact depend on the quality of products brought to the market (Lakhal, 2009; Manova & Yu, 2017; Shi et al., 2018). Consequently, we expected quality products to compensate organisations with smaller asset values such that, as product quality improves, the competitive advantage of SSABs with smaller asset values increases up to a point where size no longer gives all firms any competitive advantage. This brings us to our last hypothesis as follows:

Hypothesis 4 The relationship between product quality and competitiveness is moderated by the asset value (size) of the SSAB such that the relationship is stronger for SSABs with high asset values when the product quality is low rather than high.

Figure 1 illustrates the conceptual model of the entire study.

Method

Research design

A quantitative, deductive research design was used to address the hypotheses. This research design was deemed appropriate because the study sought to relate one variable to another (Cooper & Schindler, 2018).

Target population, sample size and procedures

The population for this study was all SSABs (including suppliers of agricultural equipment and inputs, farming associations and other farm-related businesses) in Mashonaland Central and Free State Provinces of Zimbabwe and South Africa, respectively. We obtained data estimates from relevant ministries in both Zimbabwe and South Africa. At the time of study, the Department of Agriculture, Forestry and Fisheries in the Free State estimated that there were approximately 3000 SSABs in the Free State, and the Ministry of Agriculture, Mechanisation and Crop Production in Zimbabwe provided an estimate of about 4000 SSABs in Mashonaland Central Province. Thus, the estimated target population for the two countries was 7000 agribusiness firms.

We chose a convenience sample of 400 respondents (200 from each country) for this study. According to the guide provided by Sekaran and Bougie's (2016) statistical tables for determining the sample, this sample size was higher than the one required ($n=364$) for the target population ($N=7000$).

Four hundred (400) self-administered questionnaires were distributed to respondents (SSAB owners and managers) for completion in the two provinces. While some questionnaires were completed on the same day, some respondents requested the research assistants to drop them at the workplace and collect them later. Of the distributed questionnaires, 277 were returned and 268 were found usable, constituting a usable response rate of 67%. Of the returned questionnaires, 106 (39.6%) were from Zimbabwe, and 162 (60.4%) were from South Africa. The respondents came from different types of SSABs,

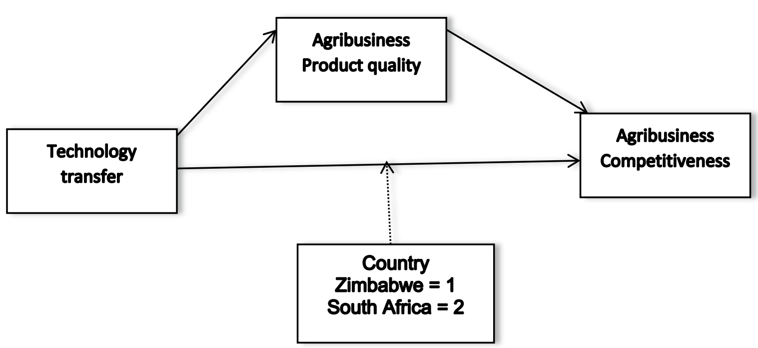

Fig. 1 The conceptual model

including animal husbandry (9.3%), crop production (31.3%), horticulture (21.6%), manufacturing or agro-processing (19.4%), sale of agro-equipment (9.3%), and marketing of agro-equipment or implements (9%).

The largest number of SSABs (37%) has been in operation for a period ranging from 11 to 15 years, and in terms of the number of employees, the highest number of firms (36.2%) employed between 51 and 100 employees. In terms of total assets, the highest number of firms (45.1%) owned between R200,000 and R499,999 inclusive.

Measures

Research assistants conducted two pilot studies in Mashonaland West and North West Provinces of Zimbabwe and South Africa, respectively. A total of 16 questionnaires were administered on SSABs in each of the two study areas. The respondents in the pilot study were selected in such a manner that they closely reflected the characteristics of the sampled elements in both Zimbabwe and South Africa. The face validity of the questionnaire distributed to participants was assessed based on inputs from these pilot studies. There were no major changes required on the original questionnaire after pilot studies.

Competitiveness. The variables were measured based on scales adapted from existing literature. The competitiveness construct was measured using several dimensions, namely product market competitiveness, customer satisfaction, market pricing competitiveness, business market dominance, and promotion strategy (Awale & Rowlinson, 2014; Dlamini, 2012; Gumbochuma, 2017). On a scale ranging from 1 (strongly disagree) to 5 (strongly agree), respondents were asked to indicate the extent to which they agreed with the given statements.

Sample items under product market competitiveness included 'the business has established strong agro-processing brands/services in the market compared to competitors', and 'agro-processing products/services have considerable competitive advantage over those of its competitors'.

Sample items under *customer satisfaction* were 'customers are satisfied with the agro-business' brands/services compared to those of its competitors', and 'business' agro-processing products/services are bought by customers ahead of those of competitors'.

Sample item under the *market pricing competitiveness* dimension was 'the agribusiness has favourable pricing compared to competitors.

Concerning business market dominance dimension, participants were asked to state, on a scale ranging from strongly disagree to strongly agree, the level of business dominance on certain issues, for example, dominance in domestic markets over competitors, dominance in research and development, and marketing skills dominance.

After systematically deleting items that tended to lower Cronbach's alphas (α) of respective scales, product market competitiveness was measured with two items ($\alpha = 0.89$), customer satisfaction with four items ($\alpha = 0.92$), and business market dominance with five items ($\alpha = 0.90$). Items meant to assess marketing price competitiveness and promotional strategy were not summed together because the internal reliability measures (α) of these dimensions were low.

Overall competitiveness was measured as an index of different dimensions of the construct ($\alpha = 0.88$).

Technology transfer. This construct was assessed based on items tapping into internal and external technology transfer (Henry et al., 2009; Masum et al., 2013), transfer of agricultural business skills, transfer of agricultural business abilities, the extent to which the business uses biotechnology products (technology types), and the extent to which a business uses certain technologies for processing products and services (technology for processing). Apart from transfer of business skills which was assessed on the scale ranging from 1 (strongly disagree) to 5 (strongly agree), all other dimensions of the construct were measured on a scale ranging from 1 (not all) to 5 (to a large extent). In summary, the respondents were asked to state the extent to which they agreed with given statements under different dimensions of this construct. Sample items included 'the business encourages the free flow of new agricultural information within the organisation', 'agricultural business imparts new agricultural entrepreneurial skills on employees', 'the business uses technology to facilitate marketing activities', 'the business develops biotechnology products and services', 'the business uses agricultural processing technologies for storage and preservation of agricultural products', and 'our agricultural processing involves provision and use of spray-drying'.

After systematically deleting items which tended to decrease Cronbach's alphas (α) of dimensions of this construct, internal and external technology transfer construct was measured with five items ($\alpha = 0.86$), transfer of agribusiness skills with four items ($\alpha = 0.85$), transfer of agricultural business abilities with four items ($\alpha = 0.91$), use of biotechnology with 14 items ($\alpha = 0.90$), and technology for processing products with five items ($\alpha = 0.85$).

Overall technology transfer construct was measured as an index of all dimensions of this construct ($\alpha = 0.86$).

Product quality. This construct was measured by four items adapted from the quality management literature. The items used were 'the business develops/produces high-quality agro product/services', 'the business has ISO certification of products to meet local quality requirements', 'the business' products or services meet the international quality standards set by global institutions', and 'the business participates in continuous agro product development and improvement'. The first item 'prodqual1' was deleted because it did not load well on the latent construct. The Cronbach's alpha (α) of the remaining items was 0.77.

The items used to assess the scale variables are shown in "Appendix".

Other variables

The categorical variables included the country in which the SSAB was located, the number of years the SSAB had been in operation, the number of employees the SSAB had, the asset value of SSAB, and the nature of SSAB.

Data analysis

We used the Statistical Package for Social Sciences (SPSS, v. 20) and Smart PLS 3 software packages to analyse data. More specifically, we examined correlations, analysis of variance (ANOVA), convergent and discriminant validity, and total, direct and indirect effects to address the hypotheses.

We used PLS-SEM (variance-based approach to structural equation modelling) as our main analytical tool in the current study. Compared to covariance-based SEM (CB-SEM), PLS-SEM is appropriate where the focus of research is on prediction and explanation of key constructs; the sample size is small; the model is made of reflective and formative constructs; the model consists of single-item constructs; the model is complex; available data are not normal; and when the study is exploratory in nature (Hair et al., 2011, 2019).

We selected PLS-SEM over CB-SEM because the focus of the current study was prediction; the model tested was relatively new, and comprised reflective and formative constructs, as well as single-item constructs (e.g., asset value). As indicated by Henseler et. al. (2009, p. 296), PLS-SEM is 'primarily intended for casual predictive analysis in situations of high complexity but low theoretical information'. Our study involved novel contexts of emerging economies with a paucity of rigour in the theoretical examination of the constructs under study. It should be noted that our selection of variance-based SEM was occasioned by the context of the study and does not in any way suggest that one approach to SEM is superior to the other (Hair et al., 2011, 2017).

PLS path modelling follows a two-step process involving the assessment of the measurement (outer) model and the assessment of the structural (inner) model (Henseler et al., 2009). The assessment of outer model involves the calculation of reliability and validity of constructs, and the assessment of inner model provides information on the relationships among latent constructs (Henseler et al., 2009).

Due to the large number of items used to measure technology transfer and competitiveness constructs, we used dimensions of these construct as indicators in our SEM model. According to Matsunaga (2008) and Little et. al. (2013), using item parcels as indicators may be justified for latent constructs with substantial number of items.

We evaluated the adequacy of the measurement model by assessing the convergent and discriminant validity (Hair et al., 2011, 2017).

Among other indicators, convergent validity is confirmed when all standardised loadings are at least 0.70 and statistically significant; the average variance extracted (AVE, average amount of variation that a latent variable explains in the observed variable) is 0.50 or higher; and the composite reliability is 0.70 or higher (Hair et al., 2011; Khaola & Rambe, 2020; Rambe & Khaola, 2021).

To assess discriminant validity, we used Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio of correlations. According to Fornell–Larcker criterion, the AVE of each variable should be greater than the shared variance (squared-correlations) of that variable with other variables in the model (Hair et al., 2011, 2019; Musiiwa et al., 2020). Discriminant validity is also confirmed where HTMT is less than 0.85.

The next section presents the results of the study.

Results

Assessment of the measurement model

To assess the adequacy of the measurement model, we examined the model's convergent validity (the extent to which indicators of one latent construct are related) and discriminant validity (the extent to which indicators of one latent construct are different from indicators of another construct).

Table 1 The model's convergent validity

Constructs	Item/dimension	Outer loadings	AVE	CR	α
Technology transfer	Internal and external technology transfer	0.698	0.643	0.899	0.862
	Transfer of business skills	0.800			
	Transfer of business skills and ability	0.831			
	Technology for processing	0.799			
	Technology types	0.869			
Agribusiness product quality	Product quality 2	0.828	0.681	0.865	0.766
	Product quality 3	0.848			
	Product quality 4	0.799			
Agribusiness competitiveness	Customer satisfaction	0.926	0.810	0.927	0.882
	Product market competitiveness	0.911			
	Business market dominance	0.862			

We calculated the average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (α) to assess the model's convergent validity. Table 1 shows the indicators of convergent validity.

As shown in Table 1, the outer loadings of all indicators were not only 0.70 or higher, but they were also all significant. Furthermore, each latent construct had the AVE and the composite reliability (CR) figures that were higher than 0.50 and 0.70, respectively (Hair et al., 2019). These results provide reasonable evidence of convergent validity of constructs under study.

To assess the discriminant validity, we used both the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio of correlations. The results of Fornell–Larcker criterion are summarised in Table 2.

The results from Table 2 suggest that the AVE of each construct (shown in parentheses on the diagonal) was higher than corresponding shared variance with other variables; indicating that the measurement model had adequate discriminant validity.

Despite the popularity of Fornell–Larcker criterion, according to Hair et. al. (2017) and Henseler et. al. (2015), this criterion sometimes performs poorly in the assessment

Table 2 The results of Fornell–Larcker criterion

Variable	1	2	3
1. Technology transfer	**(0.643)**		
2. Agribusiness product quality	0.389	**(0.681)**	
3. Competitiveness	0.423	0.468	**(0.810)**

Bold values refer to AVE of each construct

Numbers on the first row refer to corresponding variables on the first column

Table 3 HTMT ratios of construct correlations

	1	2	3
1. Technology transfer	–		
2. Agribusiness product quality	0.747	–	
3. Competitiveness	0.712	0.810	–

Numbers on the first row refer to corresponding variables on the first column of discriminant validity when construct indicator loadings vary marginally (Hair et al., 2017). As a result, we also used the more robust HTMT method to evaluate discriminant validity. Table 3 shows the HTMT ratios of correlations.

As shown in Table 3, all the HTMT ratios of correlations were below the threshold of 0.85, ranging from a minimum of 0.712 to a maximum of 0.810 (Henseler et. al., 2015). Overall, based on both Fornell–Larcker criterion and HTMT ratios of correlations, we concluded that the constructs used in the study demonstrated sufficient discriminant validity.

Having assessed the adequacy of the measurement model, we proceeded to examine the hypotheses. To have a general view of the results, we first examined the inter-correlations among the study variables. The zero-order correlations are shown in Table 4.

Table 4 suggests that technology transfer is positively and significantly related to product quality ($r = 0.62$, $p < 0.01$) and SSAB's competitiveness ($r = 0.65$, $p < 0.01$), intimating that firms experiencing high levels of technology transfer produced high product quality and realised stronger competitiveness, and vice versa. Similarly, there was high correlation between product quality and competitiveness ($r = 0.67$, $p < 0.01$), suggesting that high-quality products resulted in stronger SSAB's competitiveness.

Assessment of the structural model

The structural (inner) model shows the relationships (paths) between latent constructs (Hair et al., 2011), and helps to address the hypotheses of the current study.

Assessment of directs effects (Hypothesis 1)

The results of structural model are shown in Fig. 2.

Figure 2 indicates that technology transfer significantly predicted product quality ($\beta = 0.62$, $t = 18.45$, $p < 0.01$), which in turn significantly predicted competitiveness ($\beta = 0.32$, $p < 0.01$). In addition, as expected, technology transfer significantly predicted

Table 4 Inter-correlations among study variables

Variable	Country	Business years	Employees	Asset value	Nature of business	Technology transfer	Competitiveness	Product quality
1. Country	–	0.266**	0.162*	0.350**	0.181**	0.626**	0.672**	0.487**
2. Business years		–	0.714**	0.614**	0.365**	0.433**	0.412**	0.317**
3. Employees			–	0.592**	0.255**	0.348**	0.378**	0.336**
4. Asset value				–	0.462**	0.351**	0.553**	0.294**
5. Nature of business					–	0.234**	0.308**	0.134*
6. Technology transfer						–	0.651**	0.624**
7. Competitiveness							–	0.671**
8. Product quality								–

*$p < 0.05$; **$p < 0.01$

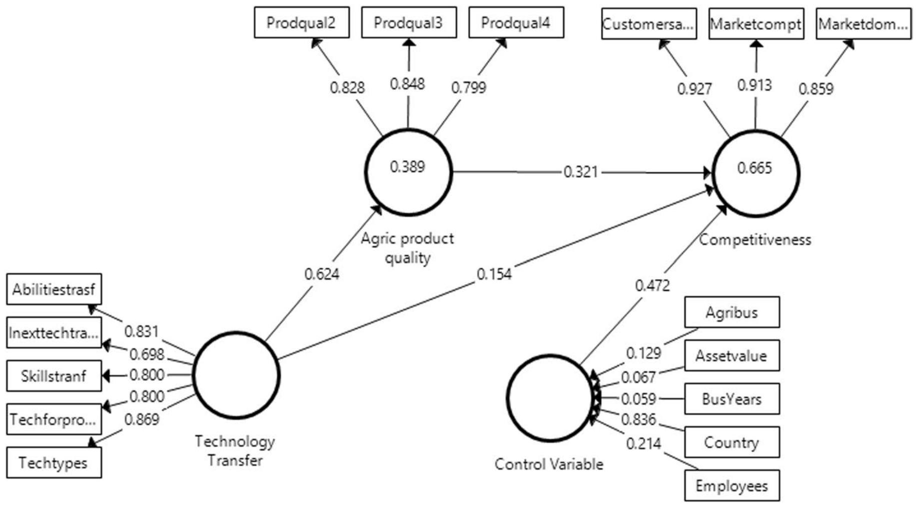

Fig. 2 The structural (path) relationships

Table 5 Total, total indirect, and specific indirect effects

Type	Relationship	beta	*t*-value	*p*-value	95% bias-corrected confidence interval	
					2.5%	2.97%
Total effects	Technology transfer >>>>>> product quality	0.624	19.239	0.000	0.558	0.686
	Product quality >>>>>> competitiveness	0.321	6.200	0.000	0.217	0.422
	Technology transfer >>>>>>> competitiveness	0.356	8.132	0.000	0.272	0.445
	Control variables >>>>>>>>> competitiveness	0.472	12.893	0.000	0.390	0.530
Total indirect effects	Technology transfer >>>>>>> competitiveness	0.200	5.695	0.000	0.134	0.272
Specific indirect effects	Technology transfer >>> product quality >>> competitiveness	0.200	5.693	0.000	0.134	0.272

Because the model has only one mediator and one independent variable, total indirect effect and specific indirect effects are the same

competitiveness ($\beta = 0.15$, $t = 2.99$, $p < 0.01$). Though the relationship was relatively weak, the prediction is in line with Hypothesis 1, which predicted that there would be a direct relationship between technology transfer and competitiveness of SSABs. Thus, the results supported Hypothesis 1.

Assessment of mediated effects (Hypothesis 2)

The examination of mediation in PLS-SEM requires at least three steps—the assessment of total effects; the assessment of total indirect effects; and the assessment of specific indirect effects. The summary of relevant results from PLS-SEM analysis is shown in Table 5.

As shown in Table 5, the total effects of all relationships were significant, including the one between technology transfer and competitiveness (*t*-values with *p*-values less than 0.01, and confidence intervals that did not cross zero). The significant total effect of technology transfer–competitiveness relationship confirms that technology transfer was an important factor in the competitiveness studies SSABs.

Further unpacking of results in Table 5, shows that the total indirect effects of technology transfer on competitiveness were significant, suggesting the presence of some mediation effects.

As indicated by the specific indirect effects ($\beta = 0.200$, $t = 5.693$, $p < 0.01$), the product quality mediated the relationship between technology transfer and competitiveness. Since technology transfer also had some significant direct effects on competitiveness ($\beta = 0.15$, $t = 2.99$, $p < 0.01$), the mediation was partial. Hypothesis 2 was hence supported.

Assessment of moderated effects (Hypotheses 3 and 4)

To test for moderated effects, we added the two hypothesised moderators (technology transfer * country, and product quality * asset value) on the model shown in Fig. 1. The results are shown in Fig. 3.

The moderating effects added about 2% variance in the explanation of competitiveness. While the moderating effect of technology by country was not significant ($\beta = -0.02$, $p > 0.05$), that of product quality by asset value was significant ($\beta = -0.12$, $p < 0.05$). Thus, while the results supported Hypothesis 3, they did not support Hypothesis 4.

It is worth noting that the country in which the SSAB was located had direct impact on competitiveness of SSABs ($\beta = 0.37$, $p < 0.05$), with SSABs in South Africa (mean = 3.97) reporting higher competitiveness than those in Zimbabwe (mean = 3.04), t (263) = 15.57, $p < 0.01$. These relationships are illustrated in Fig. 4.

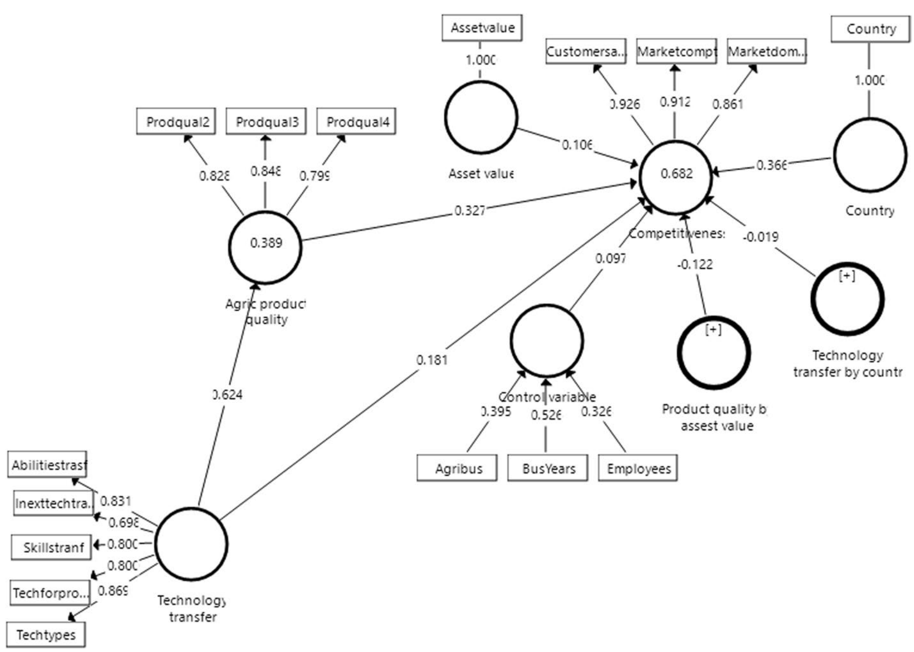

Fig. 3 The moderating effects of country and asset value on the relationship between technology transfer and competitiveness

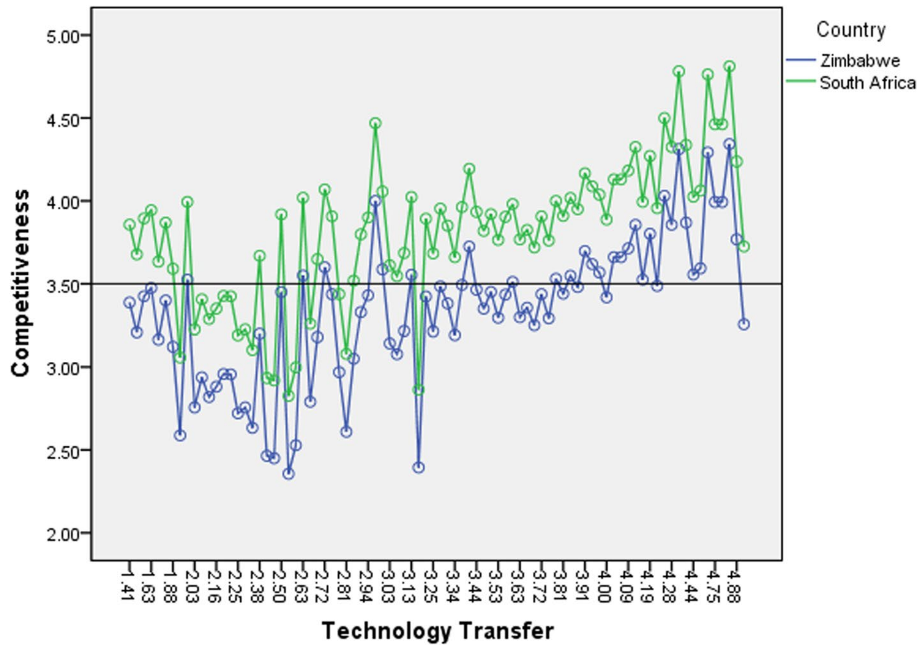

Fig. 4 Country differences of SSABs on competitiveness

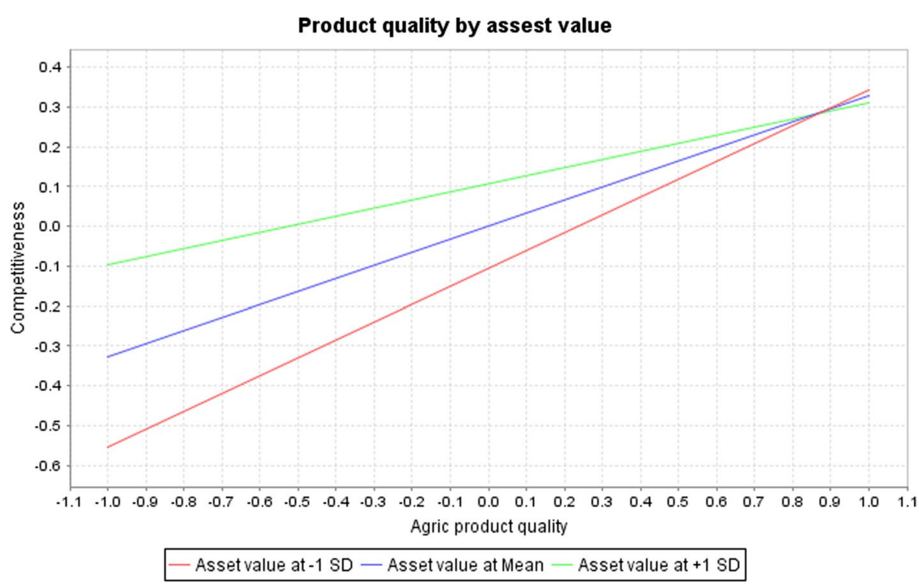

Fig. 5 The moderated effects on competitiveness of product quality by asset value

The significant negative moderating effects of asset value in the product quality–competitiveness relationship intimate that as product quality increases, the effects of asset value on competitiveness become less significant or important. The moderating effects of product quality by asset value on competitiveness are illustrated in Fig. 5.

As shown in Fig. 5, at low levels of product quality, SSABs with larger asset value became more competitive than SSABs with smaller asset values; but as product quality increased, SSABs with smaller asset values became increasingly competitive until the competitive advantage of those with larger asset values was eliminated. In fact, Fig. 5 suggests that the correlation between product quality and competitiveness was steeper or more impactful on SSABs with smaller asset values than those with larger asset values.

Discussion and conclusions

Based on a usable sample of 268 SSABs operating in South Africa and Zimbabwe, the current study examined the extent to which the relationship between technology transfer and competitiveness of SSABs was mediated by product quality. The study further explored the extent to which location (country of operation of the business) and asset value moderated the technology transfer–competitiveness and product quality–competitiveness relationships, respectively.

Our results demonstrate that technology transfer exerted a significant effect on the competitiveness of SSABs. This resonates with prior studies (Gumbochuma, 2017; Mgendi et al., 2019; Rambe & Khaola, 2021) that considered technology transfer as a vital factor for accentuating the competitive advantage of firms. The results further support the Diamond Model of competitiveness, which underscores the significance of human and technological factors in the competitiveness of firms. The study also resonates with the RBV, which considers internal capabilities such as technology as integral to the enhancement of firm competitiveness. It is probable that the transfer of input factors such as technical and soft skills afforded SSABs a competitive advantage that cannot be easily imitated (Barney, 1991).

While prior studies revealed the importance of technology transfer in the productivity and competitiveness of small-scale farmers in Africa (Mgendi et al., 2019; Ntshangase et al., 2018), few explained the mechanisms through which technology transfer ultimately affects competitiveness (Rambe & Khaola, 2021). Our results reveal that product quality partially mediates the relationship between technology transfer and competitiveness of SSABs. This finding suggests that technology transfer affects product quality (Shi et al., 2018), which in turn affects competitiveness of firms (Lakhal, 2009; Monova & Yu, 2017). In line with the Diamond Model of competitiveness and the RBV, it is possible that SSABs in South Africa and Zimbabwe that utilised technology to produce quality products, gained core competencies that SSABs that produced low-quality products found difficulty to imitate.

The results show further that the asset value (firm size) moderated the relationship between product quality and competitiveness such that at low levels of product quality, SSABs with larger asset values become more competitive than SSABs with smaller asset values. Interestingly, as product quality increased, SSABs with smaller asset value became increasingly competitive until the competitive advantage of SSABs with larger asset value dissipated. In an earlier study, Shi et. al. (2018) found firm size moderates the relationship between technological innovation process and product quality. We build on this study to propose and confirm that asset value (firm size) is a potent moderator of the relationship between product quality and competitiveness. Our results suggest that small-scale businesses can compete successfully with their larger counterparts if they focus on producing quality products.

The relationship between the location in which the SSAB was located and competitiveness was direct, and the location did not moderate or accentuate the relationship between technology transfer and competitiveness. Put differently, while we hypothesised that the effectiveness of technology transfer on competitiveness would depend on the location of business operations, the results did not support this conjecture. However, SSABs in South Africa reported higher product quality and competitiveness than those in Zimbabwe. As indicated by several authors, it is possible that the fast-track land reform programme (FTLRP) affected the competitiveness and quality of agricultural products in Zimbabwe, especially those of small-scale farmers (Gumbochuma, 2017; Mazwi et al., 2019). In other words, the competitiveness of products in South Africa compared to those in Zimbabwe may not be due to technological differences between the two countries, but other geopolitical events worsened by FTLRP.

Like many quantitative studies of this nature, the current study has some limitations. First, the cross-sectional design adopted in the study makes it difficult to infer the causality between variables. For instance, while we hypothesised that product quality improves the competitiveness of SSABs, the reverse causality where competitiveness influences the quality of products is possible. Even though the relationships were premised on sound theories, longitudinal and/or experimental designs are needed to confirm causality between variables. Second, the samples based on only two provinces (albeit large ones) from South Africa and Zimbabwe limit the generalisability of the results. Future studies can be based on stratified random samples of farmers from all provinces of the two countries. Third, data collection was based on self-reports of small-scale farmers, and this raises the possibility of same-source bias. In general, even though the assumed relationships were based on sound theories, the interpretation of the results should be made with caution.

Notwithstanding the possible limitations, the study has several practical implications. Even though the adoption of new agricultural technologies in sub-Saharan Africa is low (Mgendi et al., 2019; Ntshangase et al., 2018; Omara et al., 2021), the current study confirms the critical importance of technology transfer on product quality and competitiveness of small-scale farmers. It is therefore necessary for African countries to invest in new technologies and education of small-scale farmers on the role of technology in promoting the competitiveness of firms. There is some robust evidence suggesting that education can change the attitudes of small-scale farmers in adopting new technologies (Ntshangase et al., 2018). The results intimate that the influence of technology transfer on competitiveness is explained by product quality, further cementing the importance of product quality on competitiveness of firms and countries (Shi et al., 2018). More exciting is the finding that, while small-scale farmers with large asset values are generally more competitive than small-scale farmers with small asset values, the latter can increase their competitiveness through quality products. Overall, the study shows that small-scale farmers can leverage their competitive advantage through the quality of their products.

Conclusion

The purpose of the current study was to examine if the relationship between technology transfer and competitiveness of SSABs was mediated by product quality, including the extent to which the location (the country in which the business operates) and asset value (size) moderate technology transfer–competitiveness and product quality–competitiveness relationships, respectively. The results suggest that product quality partially mediated the relationship between technology transfer and competitiveness of SSABs, and that the relationship between product quality and competitiveness was moderated by asset value such that at low levels of product quality, SSABs with larger asset value become more competitive than those with smaller asset value. However, as product quality increased, SSABs with smaller asset value became increasingly competitive until the competitive advantage of those with larger asset values became nonexistent. Overall, the results suggest that SSABs can leverage their competitive advantage through technology transfer and the quality of their products.

Appendix

1. **Technology transfer**

   Internal and external technology transfer (Scale: not at all, to a least extent, to a moderate extent, to a great extent)

   i. The business encourages the free flow of new agro-processing information within the organisation.
   ii. The business emphasises the use of high-technology ideas, methods and technique in agro-business acquired from within the organisation.
   iii. The business has invested much capital in the use of technology in agro-business.
   iv. The business contributes to the diffusion of agriculture knowhow and knowledge.
   v. The business invest in research and development (RandD) in agro-business.
   vi. The business acquires the best available technology outside the organisation.
   vii. The external acquisition of agro-business technology has increased marketing knowledge in the agro-business.
   viii. The external acquisition of agro-business processing technology has reduced the time to market business products.
   ix. External sourcing of agro-business technology has increased the knowledge base of developing new products and techniques.

Transfer of business skills (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

   i. The agro-business emphasises the development of new productive agro-business methods.

ii. The agro-business imparts new agricultural entrepreneurship skills on employees.
iii. The agro-business uses agriculture skills development to develop its manpower.
iv. The external acquisition of technologies methods has improved efficiency and effectiveness.
v. The acquisition of the best available technology outside the organisation has made the agro-business to focus on capabilities.
vi. The external acquisition of agro-business technology has increased competitiveness in the agro-business.

Transfer of business abilities (Scale: not at all, to a least extent, to a moderate extent, to a great extent)

i. The business employs agro technologies for its enterprise development activities.
ii. The agro-business used technology to facilitate marketing activities.
iii. The agro-business employs agriculture technology to develops its planning processes and operations.
iv. The business uses technology to facilitate the diffusion of technical services.
v. The business employs commercialisation techniques and strategies to make farmers more innovative.
vi. The business uses techniques and strategies to market and distribute agro-business products and services.

Use of agro-processing types (Scale: not at all, to a least extent, to a moderate extent, to a great extent)

i. The business develops biotechnology products and services.
ii. The business distributes biotechnology products and services.
iii. The business markets some biotechnology products and services.
iv. Agro-processing technology for storage and preservations.
v. Please state the degree which your agro-business uses each of these technologies for storage and preservation of agro-processed products.
vi. The business employs technology in storage.
vii. The agro-business use agro-processing technology such as controlled environments for processing its products.
viii. The agro-business processing pasteurises and sterilise its products.
ix. The business uses agro-processing technologies equipment to pack and preserve its products.
x. Transportation and Distribution of agro products.
xi. The business uses technologies for transportation such as cold chain distribution, transportation by refrigerated cars, planes and boats.
xii. Our business uses cold chain distribution to preserve its products.

xiii. The business uses refrigerated vehicles (cars/lorries/trucks), planes or boats to transport its agro-processed products. ask the same for its primary raw materials.

Technology for processing (Scale: not at all, to a least extent, to a moderate extent, to a great extent)

i. Our agro-processing involves the provision and use of freeze-drying.
ii. Our agro-processing involves the provision and use of spray-drying.
iii. Our agro-processing involves the provision and use of micro-wave drying.
iv. Our agro-processing involves the provision and use of frozen-drying.
v. Our agro-processing involves the provision and use of frozen-grinding.
vi. Our agro-processing involves the provision and use of high-pressure processing.
vii. Our agro-processing involves the provision and use of membrane-filtration.

2. **Competitiveness of *SSABS***

Product's market competitiveness (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. The business has established strong agro-processing brands/services in the market compared to its competitors.
ii. The business' agro-processing products or services are easily recognisable in the market compared to those of its competitors.
iii. The business 'agro-processing enjoy higher sales in the market compared to those of competitors.
iv. The agro-processed products or services have more dominance over those of the organisations competitors.

Customer satisfaction (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. The customers are satisfied with the business' agro-business brands/services compared to that of its competitors.
ii. The business' agro-processing products/services are bought by customers ahead of those of competitors.
iii. The business' agro-processing products/services are preferred by customers compared to those of competitors.
iv. The price of the business' agro-processing products/services are preferred by customers compared to those of its competitors.
v. The business has strong relationship with its customers base compared to its competitors.

Market pricing competitiveness (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. My business in agro-processing has developed competitive pricing model.
ii. The agro-business has favourable pricing compared with other businesses.

Business market dominance (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. Please state the business' level of dominance of the domestic market over competitors.
ii. Please state the business' level of dominance of its research and development and development (RandD) locally.
iii. Please state the business' level of dominance of its research and development and development (RandD) internationally.
iv. Please state the business' level of production dominance of agro products and services.
v. Please state the marketing skills dominance of the business' employees.

Promotion strategy (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. The business' product promotion help has helped it o to be dominant on the market.
ii. The business emphasises effective and unique agro product promotion techniques.

Organisational competitiveness (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. The organisation has invested in production capacity that is competent.
ii. The business agro-business has developed competitive, efficient and effective agro organisational structure.

Organisational competitiveness (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

3. **Product quality** (Scale: strongly disagree, disagree, neutral, agree, strongly agree)

i. The business develops/produces high-quality agro product/services.
ii. The business have ISO certification of products to meet local quality requirements.
iii. The business' products or services meet the international quality standards set by global institutions.
iv. The business is involved in continuous agro product development and improvement.

Abbreviations

ANOVA	Analysis of variance
AVE	Average variance extracted
CR	Composite reliability
CB-SEM	Covariance-based structural equation modelling
FTLRP	Fast-track land reform programme
GDP	Gross domestic product
HTMT	Heterotrait monotrait
SSABs	Small-scale agricultural businesses
Smart PLS	Smart partial least squares
PLS-SEM	Smart partial least squares structural equation modelling
SEM	Structural equation modelling
SPSS	Statistical Package for Social Sciences
RBV	Resource-Based View

Acknowledgements
The authors are grateful to Justin Gumbochuma who collected the research data for this study and the respondents for completing the questionnaire.

Author contributions
The first author conceptualised and wrote up the conceptual and literature sections of this manuscript. He also proofread the first and second drafts of the manuscript. The second author developed the model and wrote the methodology. All authors read and approved the final manuscript.

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Funding
No funding was availed in the development of this research and write-up of this article.

Availability of data and materials
The data and material used in this study are available upon request.

Declarations

Competing interests
The authors declare that there are no competing interests in the write-up of this paper.

Received: 19 October 2022 Accepted: 4 March 2023
Published online: 21 March 2023

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