Derivation of Latent Factors for Measurement of Performance of Interdependent Agricultural Value Chains: An Exploratory Factor Analysis

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Abstract. Agriculture remains the best opportunity for rural households to escape poverty, generates employment and rural non-farm multiplier. In spite of challenges, it remains the best opportunity to improve food security and incomes for smallholder producers even in arid regions. The realization of meaningful benefits requires deep understanding of interdependent and dynamic agricultural enterprises to generate incomes and food security for smallholder households. The reality of smallholder farmers has been understood mostly from fragmented enterprises ignoring the interconnectedness and dynamic interactions of different agricultural enterprises. The lack of measurement scale and tested and validated constructs that measure the performance of agricultural value chains as a system at smallholder level in arid landscapes such as the Zambezi Valley motivated this study. Exploratory factor analysis technique identified 24 out of 50 variables derived from transaction costs common in agricultural value chains. The ULS extraction and oblique rotation derived seven factors: farm specific; household specific; livestock specific; inputs and livestock markets; crop marketing; crop value addition; and location specific from variables that hanged together, with meaningful and parsimonious interpretation. Further research is required to validate the ability of extracted factors to measure the performance of interrelated, interdependent and dynamic enterprises combinations for smallholders.

Keywords: agriculture value chains, EFA, factors, smallholder farmers

Introduction

Agriculture remains the best opportunity for smallholder households in rural areas to work and trade their way out of poverty (World Bank, 2008), generates growth four times more effective in reducing poverty relative to other sectors, and creates multiple pathways that reduce poverty including real incomes changes, employment generation, rural non-farm multiplier effects and food prices effects (Schneider & Gugerty, 2011). In spite of numerous challenges, agriculture remains the best opportunity to enhance people’s livelihoods in Zimbabwe and even in arid regions such as the Zambezi Valley. However, to realise meaningful benefits from agriculture requires deep understanding of the potential of agricultural enterprises, the dynamics and ways of improving value of produce to generate incomes and food security of smallholder households.

The reality of smallholder farmers has been understood mostly from fragmented analysis underscoring the need for a holistic investigation of smallholder farmers performance in a system comprised of different agricultural enterprises. The interconnectedness and dynamic interactions of different agricultural enterprises has not been given adequate attention in spite of the great potential of improving incomes and food security for smallholder producers. Further, despite numerous studies that have been conducted to assess agricultural value chains particularly in high potential areas, there is lack of studies that have objectively targeted low potential, unique areas such as the Zambezi Valley and interrelated agricultural enterprises at smallholder producer’s household level. Literature also shows that most value chain studies have focused on single sectors or sub-sectors for example beef study by Mujeyi et al. (2015) and goat sector study by Tui and van Rooyen (2009) groundnuts by Tui et al. (2016). Yet, in reality, smallholder farmers rarely engage in single enterprise value chains, but rather on agriculture as a complete economic system, where a couple of crops and different livestock are integrated on the same farm (Barret, 1989, cited in Pender et al., 1997) and other income generating occupations.

Being a scene of countless food relief efforts (Musona, 2011; Mubaya, 2010; 2006) due to limited agricultural productivity, value addition presents the best opportunity to enhance smallholder farmers' food security and livelihoods in the Zambezi Valley. Agriculture in this landscape takes place in a dynamic and unique environment with a number of contextual drivers and presents a unique opportunity to understand the performance of interrelated, interconnected and dynamic and mixed agricultural enterprises value chains as a system that enhance smallholder farmers' food security and livelihoods. Based on this premise, an investigation of the interdependence, dynamic interaction and interconnectedness of the various agricultural enterprises in a specific location became critical. Thus, analysis of how agricultural enterprises interact, and contribute collectively to livelihoods and food security based on systems perspective is critical.

In spite of the undeniable fact of dependence on multiple interrelated agricultural enterprises, very little research has focused on this uniqueness using a value chain analysis framework. While the transaction cost theory (TCT) has been used to explain the difficulties, constraints and obstacles to access markets, and yet its application can be widened to better understand benefits accruing to smallholder households. The understanding of the reality that smallholders depend on numerous agricultural enterprises has received very little attention. While Muronda et al. (2020) suggests a theoretical framework combining the TCT, system dynamics application to smallholder value chains, bits application to smallholder reality has not been tested and validated. TCT has been conceptualized, categorized and operationalized differently by researchers. For example; transaction costs are specific to the agri-business firm, farm specific, location specific and crop-specific (Pingali et al., 2005), costs of information, search, negotiation, screening, monitoring, coordination and enforcement; fixed and proportional transaction costs (Key et al., 2000), location specific transaction costs and their magnitude arise due to variances across regions (Cuevas, 2014) and an inter-play between two main assumptions of human behaviour or characteristics of transactors (Williamson, 1985; 1991). By engaging in interrelated, interdependent and specific agricultural enterprises, smallholder producers are involved in transactions. In engaging in farming; from decisions to undertake certain enterprises, procuring farming inputs, tending crops and livestock, harvesting, storing, processing and marketing, smallholder households are often exposed to conflict, mutuality and order (Commons, 1932) of this system. In carrying out the different activities to transform decisions to a series of activities and products across different phases, smallholders are transactors as suggested by Hobb (1995). Even though it is undeniable that the TCT is the theory of choice; but its application has been largely on single enterprises, mostly in high potential regions, to understand single outcomes for example access to markets. However, the TCT fails to adequately explain the dynamic interaction and relationships across a series of phases engaged by smallholders – the value chain. In line with suggestions by Muronda et al. (2020), it is important to test, validate and disprove the application of TCT, complemented by systems dynamics to understand the undeniable reality of smallholders who depend on integrated value chains for their food security and incomes.

The study sought to simplify, further explain large, numerous and seemingly unrelated observed transaction cost variables to be developed into theory that measure the complex and interrelated smallholder agricultural value system made of numerous enterprises as suggested by Reio Jr and Shuck (2015), Thompson (2004), cited in Oamen (2021). Further, the study intended to discover the number and nature of latent variables that explain the variation and covariation of the measured transaction-related variables, identify the smallest number of hypothetical constructs that could be easily analysed, tested and interpreted to understand the performance of interdependent, interconnected and complex agricultural enterprises at smallholder household level in unique environments in line with recommendation by MacCallum (2003) and Waltikins (2018). The latent factors derived in this study will be used to develop and confirm a theoretical model to explain the performance of agricultural value chains at smallholder household level.

Methodology

To identify transaction costs related latent variables derived from the numerous variables that will be used to measure performance of smallholder households in a landscape characterized by human-wildlife interface, uniquely isolated from main high agricultural potential areas, the study selected the Zambezi Valley. Specifically, Kariba District, which is a typical landscape with unique features that resemble human-wildlife interface was covered. A sample of 380 households were interviewed face to face using a semi-structured questionnaire. Of these 380 households interviewed 376 (98.95%) were able to provide complete responses that were used in the study. The sample size exceeds a rule of thumb (300) suggested by Tabachnick and Fidell (2007), cited in Williams (2010); and good sample following recommendations by Pett, Lackey and Sullivan (2003) and Gorshuch (1983). The identification of latent variables was a precursor to the assessment of the performance of intertwined agricultural enterprises in the provision of food and income security for smallholder households.

The semi-structured questionnaire contained numerous questions from demographic data, crop and livestock enterprises production, consumption trends, value addition, experience of lean and high productivity seasons and marketing of produce by smallholder producers in the Zambezi Valley, being measured by 180 variables. However, 50 variables were exposed to EFA based on literature review to isolate transaction cost related human behaviour and transaction attributes variables that closely hang together as recommended by Ho (2006). Some of the variables were categorized as household specific, farm specific, crop specific following Pingali et al. (2005) supplemented by the interplay between human behaviour and transaction features argument by Williamson (1991, 2008) inputs specofic by Coggan et al. (2013), supplemented by Alchian and Demsetz (1972) and Barzel (1982) and a third category livestock specific was created following the logic of crop related transaction costs. The items are shown in Table 1 below.

Table 1. Categorization of transaction costs related variables

No	Household specific	Farm specific	Location specific	Crop specific	Livestock specific
1	Household size	Crop selling point	Distance to Karoi	Number of crop enterprises	Chickens owned
2	Active household members	Improved inputs used	Relative location of origin of head	Cereal crop area	Cattle owned
3	Phone ownership	Livestock selling arrangements	Road density	Cereal produce	Goats owned
4	Gender of head	Crop selling period	Inputs source centre	Frequency of crop combinations over 3-year period	Class of livestock owned
5	Age of head	Post-harvest practices	Livestock selling points	Number of crops added value	LUs owned
6	Education of head	Crop-livestock combination		Crop value addition forms	LUs sold
7	Farming experience of head	Combined crop-livestock added value		Cropped area	LUs consumed
8	Occupation of head	Total income		Crop produce	LUs lost to diseases

No	Household specific	Farm specific	Location specific	Crop specific	Livestock specific
9	Period of Stay in Valley	Total consumed produce		Crop yields	LUs lost to wild animals
10	Origin of household head	Average sales period		Crop income	Income - goats
11		Experience of crop high production season			Income - cattle
12		Number of crops experienced low production seasons			Income - chickens
13					Livestock income

Note: Based largely on Pingali et al. (2005)

The study used the conceptualization of transaction costs in line with Pingali et al. (2005), Williamson (1991, 2008) as explained by Coggan et al. (2013), immeasurability by Shenalski and Klein (1995) and complexity by Alchian and Demsetz (1972) and Barzel (1982). The study attempted to analyse data using numerous analysis techniques and expected to infer some useful meanings consistent with the categorizations without success. To explore relationships, unobserved variables and structure, EFA was adopted. As much as the study tried to follow a specific conceptualization, it was clearly impossible due to the interconnectedness, large number of variables that were suggested to contribute to understanding of the performance of smallholder households. Also, studying the complex relationships of integrated agricultural value chains requires the development of new set of variables and structure. Thus, it was imperative to explore twenty-four variables to be reduced to some unobservable (latent variables) that measure a certain construct. Latent variables meaning was derived from the type and relationships of variables that combined together

Data Analysis

Data Characteristics

The descriptive characteristics of the data for variables used are shown in Table 2 below. Of the 376; 364 (96.81%) had complete data for all the variables used in the EFA, while the remainder lacked some data on certain variables.

Table 2. Descriptive statistics for variables

Variable Description	N	Mean	Std. Deviation	Skewness	Kurtosis	h^2
Active household members	376	3.79	2.12	1.54	4.46	0.26
Age of household head	376	44.78	14.35	0.72	-0.29	0.93
Total cropped area (hectares)	376	1.31	1.03	2.62	11.30	0.29
Crop-livestock enterprises	376	3.48	1.95	0.08	-1.54	0.52
Farming experience of head	376	20.53	13.09	0.97	0.48	0.74
Number of crop enterprises	376	1.86	0.98	0.93	0.18	0.83
Nutrition groups	376	1.52	0.73	0.96	0.08	0.80
Distance to Karoi	376	2.34	0.96	0.47	-0.72	0.58
Original location of head	366	1.79	1.46	1.52	0.59	0.65
Crop selling period	373	2.02	1.32	0.64	-1.45	0.74
Crop selling points	376	2.02	1.47	1.10	-0.30	0.75
Crop value addition forms	376	1.57	0.67	0.76	-0.53	0.64
Farming inputs source centre	376	1.63	1.96	0.69	-1.09	0.43
Farming inputs used	376	2.25	1.44	0.66	-1.03	0.53

Livestock selling points	376	0.38	0.79	2.75	9.05	0.38
Livestock buyers	376	0.35	0.52	1.30	2.09	0.67
Livestock selling arrangements	376	0.32	0.63	2.39	6.37	0.39
Number of crops value added	376	0.88	1.01	2.80	19.07	0.52
Period of stay in the valley	376	37.00	12.93	0.41	1.06	0.42
Road density	376	3.19	1.36	-0.37	-1.12	0.37
LUs consumed	376	0.14	0.33	6.79	70.49	0.69
LUs lost to diseases	376	0.21	0.55	4.54	26.10	0.47
LUs lost to wild animals	376	0.12	0.48	7.81	69.09	0.33
LUs sold	376	0.21	0.74	10.27	140.31	0.83

Note h^2 = communality

Kim (2013) recommends that a skewness statistic larger than 2 or an absolute kurtosis statistic larger than 7 indicates sub-normality of data for samples sizes greater than 300. Thus, as shown in Table 2 above, seven of the twenty-five variables deviated from normality on the basis of the skewness statistic.

Appropriateness of Data for Exploratory Factor Analysis (EFA)

The Bartlett's test of sphericity, which tests the adequacy of the correlation matrix (Bartlett, 1954) indicated that the correlation matrix was not random, $X^2(300) = 4,283.14$, $p<0.000$ (<0.05), and the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.70, which is well above 0.5. The results of these two tests confirmed that the correlation matrix was appropriate for factor analysis as suggested by Waltikins, (2014) and Ho (2006).

After confirming the correlation matrix was factorable, the data was imputed for EFA using IBM SPSS version 28 (2021 release). Common factor analysis was selected over PCA since the intent was to identify a latent factor structure as suggested by Fabrigar et al. (1999) cited in Waltikins (2018).

A Pearson bivariate correlation of all the items was carried out in Excel. A conditional formatting was set for any correlations with an absolute value greater than 0.8. Pearson bivariate was used owing to the demonstrated ability in limiting differences between Pearson' and polychoric correlations when Unweighted Least Squares (ULS) extraction method is used as argued by Parry & McArdle (1991). Some variables exhibited many significance values greater than 0.05, but their effect was minimal given that the determinant correlation factor was 0.055 (well above 0.0001 cut-off point). All the correlation coefficients were lower than 0.9, thus observed patterns met the multi-collinearity assumption in line with Field (2013).

Factor Extraction Method

The ULS method was used to extract factors owing to its tolerance to data distribution assumptions, ability to minimize the sum of the least squared differences between the observed and reproduced correlation, and suitability when the communality of a variable is greater than 1 as recommended by Skerman et al. (2012). ULS performs well under different ordinal data distribution shapes, different number of response categories and sample sizes (Li, 2016) a characteristic of the data used in this study. It provides more accurate factor loadings, interactor correlation and structural coefficient estimates. Further, the ULS was a method of choice due to its demonstrated ability in limiting differences between Pearson' and polychoric correlations (Parry & McArdle, 1991). Even though the latter is deemed the better of the two by many researchers, the need for large samples, lack of the function in SPSS version 28 prohibited its use in this study.

Correlation values less than -0.8 or greater than 0.8 were analysed and considered unacceptable since they imply identity matrix following advice from Oamen (2021). Communalities were extracted using a 0.2 cut off point following recommendations by Child

(2005) and variables with communalities below 0.2 were removed from the analysis. Initially 50 variables were entered into SPSS EFA., and underwent 18 runs in different factor extraction (principal axis factoring, ULS, maximum likelihood) and rotation methods (varimax-orthogonal, direct oblimin and Promax -oblique). All the factor and rotation methods selected showed nearly similar results. The results of ULS using direct oblimin were the most convincing and reported in this study.

Following advice of Velicer et al. (2000), Preacher and MacCallum (2003), and Costello and Osborne (2005), parallel analyses, scree plot and the Eigenvalues>1 concept and parsimony (Waltikins, 2018) were used to retain seven factors. The extracted factors were assumed to be correlated due to the nature of constructs, and oblimin rotation was used as recommended by Child (2006), Carrol (1978).

To facilitate interpretation of factor loadings, oblique rotation was used. As argued by many authors for example Meehl (1990) cited in Waltikins (2018), factors in social sciences are correlated, thus use of oblique was rather a necessity. Use of oblique factor rotation was informed by compelling argument provided by Fabrigar and Wegener (2012) that of realistic representation of all data, generation of easily interpretable solution and revelation of information not available in orthogonal rotations. Direct oblimin was used given that it would give same results as promax. Oblique rotation however sometimes results in pattern coefficients that exceed 1.0 and cannot be squared to obtain a proportion of unique variance contributed by a factor (Walkins, 2018). To overcome this weakness, the study used the ULS, factor extraction method which demonstrated ability to overcome the problem after failing to generate factor loadings with principal axis factoring following several attempts.

The direct oblimin rotation method produces pattern and structure coefficients, which are important indicators of variable-factor relatedness as suggested by Waltikins (2018). The loadings on pattern and structure coefficients appeared not to be different by inspection, suggesting that factor intercorrelations were low. The factor correlation matrix confirmed that the inter-factor correlations were mostly very low to moderately low. Low factor intercorrelation implies that orthogonal varimax rotation method might be used without any effect on the factor loadings. The observation suggests that varimax (the most popular orthogonal) rotation could potentially produce the same results, thus further investigation of the same variables; using the principal axis factoring (PAF) and ULS extraction method was recommended in further studies.

Table 1. Description of variables and factors extracted

Variable name	**Variable Description**	**Factor number**	**Factor Description**
Food groups produced on the farm	0. No cereals/groundnuts/cowpeas/tuber 1. Cereal/groundnuts/cowpeas/tuber 2. Cereal+groundnuts/cowpeas/tuber 3. Cereal+groundnuts+cowpeas/tuber 4. Cereal+groundnuts+cowpeas+tuber .	1	Farm specific
Number of crop enterprises	Crop enterprises produced in 2016/17 season		
Number of crop and livestock enterprises on the farm	1. Produced one crop only 2. Produced more than one crop with no livestock 3. Produced one crop + one livestock class 4. Produced one crop + more than one livestock class 5. Produced more than one crop + one livestock class 6. Produced more than one crop + more than one livestock class		
Total cropped area (ha)	Cropped area in 2016/17 season		
Number of LUs sold	Livestock units sold by the household	2	Livestock specific
Number of LUs consumed	Livestock units consumed by the household		

Variable name	Variable Description	Factor number	Factor Description
Number of LUs lost to disease	Livestock units lost to diseases		
Number of LUs lost to wild animals	Livestock units lost to .wild animals		
Age of head	Age of household head	3	Household specific
Farming experience of head	Farming experience of head of household		
Period of stay in the valley	Period stay of household head in the Kariba District		
Number of active household members	Number of household members 15 to 64 years of age		
Livestock buyers	1. Did not sell livestock 2. Local buyers 3. Private/paricha 4. Harare market	4	Inputs and livestock markets
Livestock selling points	1. Did not sell livestock 2. Homestead 3. Village 4. Siakobvu and other areas 5. Magunje 6. Harare		
Livestock selling arrangements	0. Did not sell livestock 1. Spot and regular 2. Auction 3. Contract		
Type of inputs used on farm	1. Used none of the 4 inputs - fertilizer, improved seed, pesticides and veterinary drugs 2. Used one of the 4 inputs -fertilizer, improved seed, pesticides and veterinary drugs 3. Used two of the 4 inputs-fertilizer, improved seed, pesticides and veterinary drugs 4. Used three of the 4 inputs -fertilizer, improved seed, pesticides and veterinary drugs 5. Used four of the 4 inputs - fertilizer, improved seed, pesticides and veterinary drugs		
Inputs sources	1. Did not use improved inputs 2. Government+NGO 3. Local shops 4. Gokwe 5. Karoi		
Point of sale for crop produce	1. Homestead 2. Village level 3. Local business centres (Siakobvu, MOLA, Negande, Makande) 4. Magunje+Karoi+other places	5	Crop marketing
Period of crop produce selling	1. Never sold 2. April to June 3. July to September 4. October and later		
Number of crops added value	Number of crops added value	6	Crop value addition
Value addition forms	1. Did not add value to crops 2. Used one value addition form 3. Used two or more value addition forms		
Road density	1. No connector roads 2. One connector road 3. Two to three connector roads .4. Four to five connector roads 5. More than five connector and at least one major road	7	Location specificity
Distance from ward centre to Karoi (which is the nearest town)	1. > 260 km 2. 181-260 km 3. 101-180 km 4. 100 km or less		
Origin of household head ordered as 1. ..	1. Native (valley) 2. Hurungwe 3. Binga, Gokwe, Kadoma and Zvimba 4. Midlands Province 5. Other provinces		

The seven factors extracted accounted for a total variance of 57.37%, which is above the minimum acceptable limit of 50%. Factor 1 accounted for 18.50%, 2 for 9.20%, 3 for 8.31%, 4 for 6.89%, 5 for 5.79%, 6 for 4.64% and factor 7 accounted for 4.04% as shown in Table 4 below. There were no differences in variance accounted by factors before and after rotation.

Pattern coefficients loadings were mildly high to quite high for six of the seven factors extracted. Loadings for factor 3 had the largest range (0.35 to 0.90), factor 6 had the least range.

All factors had at least variables except two; factors 5 and 6 owing to need for parsimony and interpretability.

Table 4. Pattern matrix loadings

Variable	Factor						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of crop enterprises	0.96						
Nutrition groups	0.86						
Crop-livestock enterprises	0.51						
Total cropped area (hectares)	0.49						
LUs sold		0.92					
LUs consumed		0.81					
LUs lost to diseases		0.67					
LUs lost to wild animals		0.55					
Age of head			0.90				-0.39
Farming experience of head			0.85				
Period of stay in the valley			0.59				
Active household members			0.35				
Livestock buyers				0.80			
Livestock selling arrangements				0.63			
Farming inputs used				0.61			
Livestock selling points				0.56			
Farming inputs source centre				0.54			
Crop selling period					-0.87		
Crop selling point					-0.78		
Crop value addition forms						0.76	
Number of crops value added						0.75	
Original location of head							-0.75
Distance to Karoi							-0.72
Road density							-0.46
Eigenvalues	4.82	2.56	2.37	2.06	1.73	1.52	1.35
% Variance	18.50	9.20	8.31	6.89	5.79	4.64	4.04
Cronbach's alpha	0.73	0.79	0.73	0.70	0.85	0.70	0.73

All pattern coefficients ≥ 0.33. Structure coefficients were almost identical to pattern coefficients due to factor correlations that were close to zero as explained below.

Results

In keeping with contextualization by Pingali et al. (2005), farm specific transaction costs related factor comprised of crop-livestock enterprise combinations was made of number of enterprises, number of crop and livestock enterprises combined, and total cropped area (hectares) accounted for the largest variance. Livestock related transaction cost factor constituted of livestock units (equivalent of 350 kg body weight) sold, livestock units (LUs) consumed, LUs lost to diseases, and LUs lost to wild animals. The livestock related transaction factor is a new revelation and inconsistent with Pingali et al. (2005) grouping, but distant reflection of frequency of transaction specificity. While livestock selling and consumption reflect a depletion of livestock, households derive income and food as benefits, loss of livestock to diseases and wild animals do not bring any benefits to households. Thus, this factor construct requires further investigation to understand the underlying relationships. The fourth transaction cost factor was largely composed of inputs and livestock markets; livestock buyers, livestock selling points, livestock selling arrangements, type of inputs used, and inputs selling centre. Thus, it was named "inputs and livestock markets". Crop marketing composed of selling point and selling period variables was the fifth factor, and a new revelation. Number of crops added value and value addition forms constituted the sixth factor, named "crop value addition". The last (seventh) factor interpreted as location specific in line with Pingali et al. (2005) was constituted of road density of residence of households, distance to nearest town, Karoi from ward and relative location of origin of household head.

Even though only two variables were accepted for two of the seven factors; crop marketing and crop value addition, the parsimony-simplicity principle coined the "Occam's razor" justified their inclusion. The two factors provide simpler explanations of latent constructs of observed variables; crop selling points and selling period and number of crops value added and value addition forms. This is in line with arguments that simpler observations are likely to be correct, are preferable when they make good match for highly regular, lawful worldview, more manageable, comprehensible and more testable (Feldman, 2016). Even though evidence of truthfulness might be contestable for example, the study revealed that the variable combinations measure the same latent variable in a seemingly simple way.

While the obilimin oblique factor rotation is most suitable where factors are correlated, in this study, the inter-factor correlations were very low (factor 1 and 6; factor 2, with factor 3, 5, 6 and 7; factor 3 and factors 4,5,6 and 7; factor 4 and factor 6; factor 5 and 6; and factor 6 and 7). The rest of the inter-factor correlations were moderately low. This is contrary to the universal position that factors in the social sciences field are not independent.

Cronbach's alpha was used to assess reliability of variables constituting each of the seven factors. As shown in Table 4 above all the factors had a value of at least 0.7, and factor 6 had the highest Cronbach's alpha (0.85). Thus, the variables were accepted as reliable constructs of the seven factors.

Discussion

Using the EFA, this study found that out of an initial 50 variables; nearly one half (24) variables coalesced into seven oblique transaction cost factors in a sample of 376 smallholder producers involved in mixed, interdependent and interrelated agricultural value chains in Kariba District in the Zambezi Valley. These results are broadly consistent with the categorization of transaction costs by Pingali et al. (2005), and to a great extent follows the conceptualization of transaction costs by Williamson (1985, 1991,2008), and to a limited extent to work by Alchian and Demsetz (1972) and Barzel (1982). However, the contribution and effect of the transaction costs on food and income security of smallholder producers remains to be tested and validated. The farm specific factor resonated well with categorization by Pingali et al. (2005), while livestock specific transaction cost factor was distantly consistent with Pingali et al. (2005) categorization, partly related to dedicated assets specificity, but combination of sales and consumption (benefits in income and food), losses to diseases and wild animals reflected more of uncertainty (Williamson, 1991, 2008). The combination of livestock benefits and losses in the factor resonates very well with the work of Alchian and Demsetz (1972) and Barzel (1982) of complexity. The household specific factor was revelation of both Pingali et al. (2005) definition of household characteristics and Williamson (1991) due to the variables age, farming experience and period of stay in the Zambezi Valley by household head and number of active members. Livestock and inputs markets factor is consistent with site specificity (Williamson, 1991), location specific transaction costs as suggested by Pingali et al. (2005), and inputs used resonate with categorization by Coggan et al. (2013). Crop marketing factor is consistent with site and location specific transaction costs by Williamson (1991), and Pingali et al. (2005) and temporal specificity by Williamson (1991). The study isolated an uncommon factor, crop value addition which requires further investigation to be validated. Location, site and asset specificity describes the seventh factor consistent with Williamson (1991, 2008), and Pingali et al. (2005). The overlapping combinations of the variable constructs, similar interpretations and different interpretations of the same factors even in the categorization of the same authors is a reflection of complexity and to some extent immeasurability (suggested by Shenalski & Klein, 1995) of factors as transaction costs.

Conclusions

Notwithstanding the complexities raised above, the EFA showed latent variables, elucidated the relationships among variables, and demonstrated plausible underlying constructs from an initial data set of 50 variables that were reduced to a seven-factor solution. These were identified to help develop theory to understand the interconnected, complex and interdependent agricultural value chains. The factor combinations and interactions require further analysis to confirm or disprove their explanation of interconnected, interdependent and complex relationships among agricultural value chains at smallholder producers' household level.

To verify the claim that using oblique rotation, the pattern and structure coefficients were not different, further investigation into the applicability of the varimax (the most popular orthogonal) rotation of the same variables; using the principal axis factoring (PAF) and ULS extraction method is necessary. Also, the cut-off points to distinguish between similar and dissimilar pattern and structure coefficients loadings need to be established.

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