INDEXING PARTICIPATION IN THE MARKET ECONOMY THROUGH FACTOR ANALYSIS: IMPLICATIONS FOR FOOD SECURITY

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The paper aims to determine patterns used by emerging farmers to participate in the market economy. The eight components of participation (six crop sales, livestock sales and off-farm earnings) were subjected to factor analysis. The results indicate that there are five sources of market participation; viz. sales of staples, cash crops, snacks, livestock and off-farm earnings. That is, participation in the market through one of the sources may or may not be pre-conditioned by another source. Implications for food security are that commercialisation of both maize and beans should be promoted to ensure starch and protein intake respectively, while cotton and vegetables will provide income and employment, livestock as a food risk management base, and off-farm income as a livelihood enhancing mechanism.

1. INTRODUCTION

The major concern in South Africa is how to promote participation of previously excluded farmers into the agricultural market economy (Department of Agriculture, 1995). It is anticipated that such participation will

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result in creation of jobs and subsequent growth (RDP, 1994; GEAR, 1996) and food security (Department of Agriculture, 1995). Unfortunately, it has never been clear as to how such a participation should take place. Current options emphasise income diversification (Reardon, 1996) manifested by farm/non-farm linkages (Delgado, 1997). Diversification within agriculture is considered for risk management through intercropping (Spio, 1996) and identifying comparative advantages for policy (Yao, 1997; LAPC/IFPRI, 1996). However, there are no studies linking diversification pattern with participation in the market economy. The research question is whether there are distinct methods that farmers use to participate in the agricultural market economy. The objective of this paper is to identify the patterns at which farmers use various sources to become commercial. The basic question is do farmers use these sources individually or in some combination to become commercial.

2. CONCEPTS, DATA AND METHOD

2.1 Defining Participation in the market economy

Various definitions of market participation have been advanced. A number of them offer arbitrary definitions (Wharton, 1965; de Lange, 1991; Wessel-Bayer, 1990), others equate technology adoption to commercialisation, while others imply it in potential for participation (Steward, 1985). Otherwise the use of ratios for participation (Von Braun, de Haen, and Blanken, 1991) is not a good measure of level of market participation.

The paper employs the definition in Makhura (1994), Makhura et al (1996) and Latt & Nieuwvoudt (1988). Commercialisation or market participation is defined as earnings from market activities. The eight SALE components considered are earnings from maize sales (MS), groundnut sales (GS), yucobeans sales (YS), sales of beans (BS), cotton sales (CS), sales of vegetables (VS), sales of livestock (LS), and earnings from off-farm sources (OI).

2.2 Data and measurement

The survey of small scale farmers provided a variety of information about socio-economic characteristics of farm households in the developing areas of South Africa. The survey (by Coetzee, 1987) involved about 394 households in the former Kangwane area, now part of one of the regions in Mpumalanga Province. Only 392 households were used in further analysis since two observations had unreliable data.
Commercialisation variable was measured in rands as a value of sales and income. The sales values were computed as the product of amount of output sold and prices. Farmers were asked to indicate the amount of crop output sold, value of livestock sold, and amount of income contributed to family income from off-farm sources. The prices were obtained from the DBSA (1989 & 1990) and DAEC (1990).

### 2.3 Factor Analysis (FA) model for market participation

There were data on eight sources of revenue. The basic question was do farmers use these sources individually or in some combination to participate in markets. Factor analysis (FA) is a generally accepted method of answering such question. Its essential purpose is to describe the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors (Johnson & Wichern, 1990; Hair et al., 1995). The FA model is organised in such a way that all variables within a particular group are highly correlated among themselves but have relatively small correlations with variables in another group.

The factor analysis model can be illustrated as follows: Suppose the observable random variable vector $\text{SALE}$ has eight components with means of $\mu$ and covariance of $\Sigma$. The FA model postulates that $\text{SALE}$ is linearly dependent upon a few unobservable random variables $F_1, F_2, ... F_m$, called common factors, and eight additional sources of variation $\epsilon_1, \epsilon_2, ..., \epsilon_8$, called errors or specific or unique factors. In particular, the model is

$$
\begin{align*}
\text{SALE}_{\text{MS}} - \mu_{(\text{MS})} &= \ell_{(\text{MS})1}F_1 + \ell_{(\text{MS})2}F_2 + ... + \ell_{(\text{MS})m}F_m + \epsilon_{\text{MS}} \\
\text{SALE}_{\text{BS}} - \mu_{(\text{BS})} &= \ell_{(\text{BS})1}F_1 + \ell_{(\text{BS})2}F_2 + ... + \ell_{(\text{BS})m}F_m + \epsilon_{\text{BS}} \\
&\quad \ldots \\
\text{SALE}_{\text{OF}} - \mu_{(\text{OF})} &= \ell_{(\text{OF})1}F_1 + \ell_{(\text{OF})2}F_2 + ... + \ell_{(\text{OF})m}F_m + \epsilon_{\text{OF}}
\end{align*}
$$

or, in matrix notation,

$$
\text{SALE} - \mu = L * F + \epsilon
$$

The coefficients or weights of the variable are called factor loadings. For example, $\ell_{ij}$ is a loading of the $i$th variable on the $j$th factor, so the matrix $L$ is the matrix of factor loadings. The $i$th unique factor $\epsilon_i$ is associated only with the
ith response $SALE_i$. The eight deviations $SALE_{MS} - \mu_{(MS)}$, $SALE_{BS} - \mu_{(BS)}$, ..., $SALE_{OI} - \mu_{(OI)}$ are expressed in terms of $8 + m$ random variables $F_1, F_2, ..., F_m, \varepsilon_{MS}, \varepsilon_{BS}, ..., \varepsilon_{OI}$ which are unobservable.

The factor model can be verified by looking at the assumptions of $F$ and through some covariance relationships. It is assumed that

$$(3) \quad E(F) = 0, \quad Cov(F) = E[FF'] = I_{mx1} \quad (mxm)$$

That is, a factor has a zero mean and unit variance.

$$(4) \quad E(\varepsilon) = 0, \quad Cov(\varepsilon) = E[\varepsilon\varepsilon'] = \psi \quad (8x1) (8x8)$$

That is, the error term has mean of zero and a constant variance. Finally, the $F$ and $\varepsilon$ are independent so that;

$$(4-5) \quad Cov(\varepsilon, F) = E(\varepsilon F^T) = 0.$$ 

The factor model implies a covariance structure for $SALE$;

$$(5) \quad \Sigma = Cov(SALE) = LL^T + \psi.$$ 

The portion of the variance of the $i$th variable contributed by $m$ common factors is called the $i$th communality ($h^2$). That portion of $V(SALE_i) = \sigma_{ii}$ due to the specific factor is called uniqueness, or specific variance.

$$\sigma_{ii} = \ell_{i1}^2 + \ell_{i2}^2 + ... + \ell_{im}^2 + \varphi_i$$

$$V(SALE_i) = \text{communality} + \text{specific variance}$$

The $i$th communality is the sum of squares of loadings of the $i$th variable on the $m$ common factors.

So, the important feature of factor analysis is that it retains most of the information contained in the original data while reducing the number of variables in the data set.

Factor analysis is superior to principal components in that the results can be used for further analysis. Secondly, unlike principal component that uses a loading method leading to inflation of factor loadings, factor analysis offers
alternative loading methods. In economics FA has been applied in technology adoption (Rauniyar, 1990), dairy management (Ford & Shokwiller, 1994), stages of economic development (Yotopoulos & Nugget, 1976), food buying practices (Herrmann and Warland, 1990) and sources of risk (Bullock et al., 1994). Thus, factor analysis was considered appropriate for understanding the underlying dimension of the commercialisation data.

3. EMPIRICAL RESULTS

3.1 Household market participation characteristics

Commercialisation is presumed to emanate from three main sources; viz. sales of crops, sales of livestock, and off-farm income. These sources are displayed in Table 1.

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean</th>
<th>Std dev</th>
<th>Min</th>
<th>25%(Q1)</th>
<th>50% (Median)</th>
<th>75%(Q3)</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop sales (N=204)</td>
<td>1,853</td>
<td>4,041</td>
<td>30</td>
<td>280</td>
<td>700</td>
<td>1,976</td>
<td>40,814</td>
</tr>
<tr>
<td>Maize (N=155)</td>
<td>1,255</td>
<td>2,621</td>
<td>70</td>
<td>210</td>
<td>560</td>
<td>1,400</td>
<td>27,720</td>
</tr>
<tr>
<td>Groundnut (N=84)</td>
<td>553</td>
<td>724</td>
<td>14</td>
<td>172</td>
<td>336</td>
<td>669</td>
<td>5,264</td>
</tr>
<tr>
<td>Yucobean (N=22)</td>
<td>290</td>
<td>295</td>
<td>50</td>
<td>80</td>
<td>155</td>
<td>400</td>
<td>1,250</td>
</tr>
<tr>
<td>Beans (N=26)</td>
<td>2,035</td>
<td>5,738</td>
<td>8</td>
<td>106</td>
<td>546</td>
<td>1,275</td>
<td>29,614</td>
</tr>
<tr>
<td>Cotton (N=11)</td>
<td>4,801</td>
<td>5,753</td>
<td>945</td>
<td>1,470</td>
<td>3,150</td>
<td>5,880</td>
<td>2,100</td>
</tr>
<tr>
<td>Vegetable (N=20)</td>
<td>1,255</td>
<td>1,967</td>
<td>41</td>
<td>108</td>
<td>600</td>
<td>1,647</td>
<td>8,880</td>
</tr>
<tr>
<td>Livestock sales (N=69)</td>
<td>1,710</td>
<td>2,011</td>
<td>6</td>
<td>550</td>
<td>900</td>
<td>2,000</td>
<td>11,050</td>
</tr>
<tr>
<td>Largestock (N=64)</td>
<td>1,819</td>
<td>1,978</td>
<td>300</td>
<td>585</td>
<td>1,080</td>
<td>2,170</td>
<td>10,250</td>
</tr>
<tr>
<td>Small Stock (N=9)</td>
<td>176</td>
<td>272</td>
<td>6</td>
<td>20</td>
<td>60</td>
<td>125</td>
<td>800</td>
</tr>
<tr>
<td>Off-farm Earnings (N=260)</td>
<td>3,335</td>
<td>3,724</td>
<td>120</td>
<td>960</td>
<td>2,160</td>
<td>4,350</td>
<td>24,960</td>
</tr>
<tr>
<td>Household Head (N=103)</td>
<td>2,532</td>
<td>2,571</td>
<td>60</td>
<td>840</td>
<td>1,680</td>
<td>3,600</td>
<td>14,400</td>
</tr>
</tbody>
</table>

3.1.1 Sales of crops

The households produced numerous crops. But for the period under study commercialisation was achieved through the sales of maize, yucobean, groundnuts, drybeans and greenbeans, cotton, and vegetables. About 204 households reported to have sold crops at an average sales value of R1,853. The lowest value of sales was R30, while the largest value is R40,814. Twenty five percent of the households sold less than R280, 50% sold less than R700 and 75% sold below R1,976.

About 155 households sold maize at an average value of R1,255. Of the 155 households who sold maize, 50% sold less than R560 worth. About 84 households sold an average of R553 worth of groundnuts, while 22 and 26
households sold an average of R290 and R2,035 worth of yucobeans and beans respectively. Only eleven households produced cotton, at an average sales value of R4,801. Vegetables were sold by twenty households at the average sales value of R1,255.

3.1.2 Sales of livestock

Livestock revenue was from the sales of largestock (bulls, oxen, and cows), smallstock (sheep, goats, and pigs), and poultry. For the 69 households who sold livestock, the average revenue was R1,710. The lowest value of sales was R6 and the highest value was R11,050. About 50% of the households sold less than R900 worth of livestock. About 25% sold less than R550 worth, while 75% sold less than R2,000 worth. Of the 64 households who sold largestock, the average sales were R1,819. Those selling small stock, including poultry, had average sales of R176.

3.1.3 Off-farm income

Off-farm income is generated as the households members engage in income earning activities off the farm. This source includes professional employment, semi-skilled and unskilled employment, and businesses. About 260 households received income from off-farm sources, and the average income was R3,335. The lowest income received was R120, while the highest income was R24,960. About 50% of the households received less than R2,160 of income from off farm sources, whereas 25% received less than R960 and 75% received less than R4,350. Only 103 households heads earned off-farm income. The average earnings of household head were R2,532, with the lowest earnings being R60 and the highest being R14,400. About 50% of the household heads working off farm earned income of less than R1,680.

3.1.4 Sources of commercialisation used

Eight items were used to represent commercialisation. They included the six items on crop sales, total livestock sales, and the total off-farm income. Having described the sources of commercialisation, the next endeavour was to determine the types of activities used in becoming commercial.

3.2 Indexing market anticipation

As discussed above, it was suspected that farmers use various combinations of the eight commercialisation activities. To determine if this was true, the data on the eight sources of commercialisation were subjected to factor
analysis. In the factor analysis procedure, principal axis factor extraction method was selected. Unlike the principal component method which uses prior communalities of one, the principal axis factor uses squared multiple correlations as prior communalities so that factor loadings are not inflated.

Three factors were suggested by the criterion of Eigenvalues greater than unity and the three factor solution appeared reasonable. On these factors the livestock and off farm income activities had low factor loadings and/or loaded on multiple factors. This result suggested, for example, that the off-farm earnings of the household are unrelated to the agricultural activities. This result is not surprising given the fact that most households earn off farm income and it typically exceeds farm income. Accordingly, off-farm income and livestock sales were excluded and the factor analysis was rerun on the six crop activities. The factor loadings from the orthogonal rotation are presented on Table 2. The factor loadings are unambiguous in that each activity had a high loading on only one factor. The three factors explained 61% of the variance in the six commercialisation components. The three factors are represented as the indexes of commercialisation and are referred to as Staple Crops (Factor 1), Cash Crops (Factor 2), and Snacks (Factor 3). A discussion of these factors follow.

Table 2: Rotated factor patterns of sources of market participation

<table>
<thead>
<tr>
<th>Sources of Commercialisation</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize sale (MS)</td>
<td>0.610</td>
<td>-0.020</td>
<td>0.175</td>
</tr>
<tr>
<td>Beans sale (BS)</td>
<td>0.565</td>
<td>0.002</td>
<td>-0.073</td>
</tr>
<tr>
<td>Vegetables sales (VS)</td>
<td>0.002</td>
<td>0.452</td>
<td>0.005</td>
</tr>
<tr>
<td>Cotton sales (CS)</td>
<td>-0.015</td>
<td>0.442</td>
<td>-0.008</td>
</tr>
<tr>
<td>Yucobeans sales (YS)</td>
<td>0.063</td>
<td>-0.018</td>
<td>0.514</td>
</tr>
<tr>
<td>Groundnuts sales (GS)</td>
<td>-0.002</td>
<td>0.009</td>
<td>0.240</td>
</tr>
<tr>
<td>Percentage Variance Explained</td>
<td>22.8</td>
<td>20.0</td>
<td>18.6</td>
</tr>
</tbody>
</table>

3.2.1 Factor 1: Staple crops

The first factor in the factor analysis, Staple Crops, explained 23% of the total variance in the sample. Maize and beans sales were the commercialisation activities that loaded heavily on this factor. The loadings for both items had positive sign implying that these two activities were positively correlated.
These two crops constitute staple food, and they are often intercropped. So, the decision to produce and sell one crop influences the quantity of the other. Actually, beans are known to provide maize with nutrients.

3.2.2 Factor 2: Cash crops

The second factor, Cash crops, explained 20% of the total variance in the six cropping activities. Vegetables and cotton sales loaded heavily in this factor. Both crops had positive signs which implied that a household that produced cotton for market was likely to also sell vegetables. Two reasons may explain this association. Since cotton is a seasonal crop, the household may use labour and land to produce vegetables to sell during slack periods. Cotton also requires chemical treatment. So, cotton farmers are more knowledgeable in the use of chemicals, such that it is generally easier for them to treat vegetables.

3.2.3 Factor 3: Snacks

The third factor, Snacks, explained 19% of the total variance in the six commercialisation activities. Yucobean and groundnuts sales loaded much more heavily on this than any other factor. Both sources had positive loadings, again meaning that they are typically sold together. Yucobean and groundnuts belong to the same family of crops, so they tend to thrive well in similar conditions (climate and/or soil type). As such, farmers who grow one crop are likely to grow the other.

4. CONCLUSIONS

4.1 Implications of factor analysis results

The factor analysis revealed that the six agricultural commercialisation activities were described reasonably well by three factors. The weak interfactor correlations have important implications for the market participation process. The implication is that the three factors are more or less distinct and independent of one another. The results suggest, for example, that households commercialising in Staple Crops, may or may not be commercialising in Cash Crops nor Snacks. Thus, the probability of commercialising in Staple Crop is not conditioned by commercialisation in Cash Crops and vice versa.

Since commercialisation pattern is prevalent, strategies should consider that promotion of one enterprise may require supplement from another. Another
obvious implication is that market participation requires different strategies. Strategy for promoting market participation through staple enterprise will be different from that of cash crops or livestock.

4.2 Implications for food security

Market participation holds a lot for food security. In this study, it has been made a sufficient condition for food security. This was done by correlating the maize sales variable with the maize surplus variable, derived by deducting household requirement from production. It was found that the two variables were correlated, implying that typically, for dual purpose items households will satisfy domestic requirements of food before they consider selling.

A more interesting observation relates to the factor analysis results; Obviously, the promotion of commercialisation in staples will improve availability, accessibility and utilisation of maize (supplying carbohydrates) and beans (supplying proteins). Similarly, promotion of commercialisation in cash crops will lead to employment (since they are intensive enterprises) and income generation (as high value crops). The snacks are in between the other categories as they can provide proteins, and have reasonable value. On the other hand, while livestock is regarded as a base for collateral and social status, its sales is an act of coping during times of food insecurity, i.e. during crop failure. So, the farmer behaviour of not marketing livestock anytime should be viewed as rational act rather than sole inclination for social status.

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