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Abstract

The development path that the livestock sector follows in Africa will have important economic, social and environmental implications for the region. In recent years, livestock development has become highly market driven in Africa. In this regards, several studies have attempted to project the future market perspectives for the livestock sector. Most of these studies have used theory-based simultaneous equations model approaches. This paper argues that under the complex dynamics that characterize the market for livestock products in Africa a Vector Autoregressive model could be a more appropriate methodological approach. The results show that size of the livestock market in Africa can be partly explained by the past realizations of each subsector, the cross feedback effect of other subsectors, and the changes in the levels of gross national income and population. The paper highlights that market size for livestock products in Africa by 2030 could fluctuate considerably depending on the level of economic growth achieved in the region.

Key words: Market Perspectives, Livestock, Vector Autoregressive Model

1. Introduction

The African Union (AU) has started the formulation of a Continental Livestock Development Strategy. Although for many years the development of the livestock sector in Africa was driven by public interventions, during the last decade it has become highly driven by markets (AU-IBAR, 2010). Thus population and economic growth will remain among the factors that will shape the development of livestock sector in Africa for the coming years. According to recent studies, population in Africa is projected to increase to almost 1.634 million by 2030 with an average rate of growth of 2.5 percent per year (UNFPA, 2012), while the economy of the region could grow at an average rate of 5.0 percent per year (World Bank, 2013).

In recent years various studies (FAO, 2012; IFPRI, 2012; OECD-FAO, 2013) have attempted to model the future market perspectives for the livestock sector in Africa. Traditionally, these projections have been estimated using theory-based simultaneous equations model (SEM) approaches. SEMs have been regularly criticized because the assumptions behind the models are often ad hoc and not backed by fully developed theories (Lutkepohl, 2011). Nevertheless, these approaches have shown to be particularly powerful when substantial certainty regarding the true structure of the market exist, good data information is available for all variables (Myers et al, 1990), and when the parameters that appear on the right hand side in one

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equation belong in principle to the right hand side in all other equations as well (Enders, 2004).

Under the complex market dynamics that characterize the livestock sectors in Africa, the uncertainty about the true economic structure of the market, the lack of adequate information for all commodities, and the fact that some subsectors could have a cross effect in some but not all other subsectors, the use of SEM approaches are becoming less attractive (Mason et al, 2013). This paper argues that the use of a Vector Autoregressive VAR model can be a more appropriate methodological approach when conducting estimations about the medium term market projections for the livestock sector in Africa, since it allows for a better analysis of the complex dynamics existing among the different variables ignoring any predetermine market structure; permits variables to affect each other by incorporating their feedback effect; allows to impose restrictions in some of the parameters based on statistical procedures, and are set up in a way that current values can be partly explained by the past realizations of their own and other variables.

While there is no known single formula for stimulating sustainable development of the livestock sector in Africa, information about the market perspectives can help policy-makers better understand the forces that will shape the future of the sector, and therefore guide any evidence-base policy work towards its improvement. In this context the aims of this analysis are twofold: first to introduce an alternative methodological approach to assess the market perspectives for the livestock sector; and second to validate this approach by estimating the market potential for the livestock sector in Africa for the coming years. Following this introduction the rest of the paper is organized as follows: section two introduces the methodology, section three presents the data used, section four discusses the main results, and finally some conclusions and recommendations are offered.

2. Methodology

A multivariate vector autoregressive (VAR) model was used to assess the market perspectives for the livestock sector in Africa. As known, regressions involving non-stationary time series could produce spurious results showing a significant relationship between variables that are not correlated (Hamilton, 1994). However, considering that even under the presence of unit roots, the estimates of the VAR parameters are still consistent, though not efficient (Hamilton, 1994), and taking into account that the aim of a VAR analysis is not to determine the parameters estimates but to assess the interrelationships among the different variables (Manson, 2013), we decided not to differentiate neither to detrend the time series in order to avoid missing valuable information (Sims, 1980; Watson, 1990; Abadir & Hadri, 2000).

Our first step was to construct a multivariate structural vector autoregressive model in order to forecast the expected rate of growth in the demand for livestock products for each subsector. It is important to highlight that the VAR model was not used to forecast the future demand for livestock products in Africa directly but to forecast the rate of growth of the demand for livestock products, borrowing then after the different elasticities obtained to project the expected changes in the demand. We believe that the rate of growth for the demand of livestock products can be partly explained by the past realizations of each variable, the cross demand elasticities existing among the various variables, and the changes in the level of gross national income (GNI).

Thus, the VAR model included a vector of linear trends (t); a vector endogenous variables related to the apparent consumption of beef (ln b), poultry (ln c), eggs (ln h), mutton (ln m), milk (ln l) and pork (ln p); a vector of exogenous variables including gross national income (ln i); and a vector of error terms ((e). One of the main difficulties encountered during the process was related to the small sample of observations. Therefore in order to avoid losing degrees of freedom a main methodological challenge was to fit a parsimonious model rather than an over-parameterized model. We impose some restrictions in the model based on the *t*-ratios. Restrictions were imposed using a sequential elimination (SER) strategy, where regressors with the smallest t-ratios were eliminated sequentially until no further reduction was possible avoiding an over-identified matrix.

The structural VAR model estimated can be written as:

$$\begin{bmatrix} \ln b_t \\ \ln c_t \\ \ln h_t \\ \ln m_t \\ \ln l_t \\ \ln p_t \end{bmatrix} = \begin{bmatrix} \upsilon_{10} \\ \upsilon_{20} \\ \upsilon_{30} \\ \upsilon_{40} \\ \upsilon_{50} \\ \upsilon_{60} \end{bmatrix} \begin{bmatrix} t_1 \\ t_2 \\ t_3 \\ t_4 \\ t_5 \\ t_6 \end{bmatrix} + \begin{bmatrix} 1 & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} \\ \gamma_{21} & 1 & \gamma_{23} & \gamma_{24} & \gamma_{25} & \gamma_{26} \\ \gamma_{31} & \gamma_{32} & 1 & \gamma_{34} & \gamma_{35} & \gamma_{36} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 & \gamma_{45} & \gamma_{46} \\ \gamma_{51} & \gamma_{52} & \gamma_{53} & \gamma_{54} & 1 & \gamma_{56} \\ \gamma_{61} & \gamma_{62} & \gamma_{63} & \gamma_{64} & \gamma_{65} & 1 \end{bmatrix} \begin{bmatrix} \ln b_{t-1} \\ \ln c_{t-1} \\ \ln h_{t-1} \\ \ln m_{t-1} \\ \ln l_{t-1} \\ \ln p_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \\ \alpha_{30} \\ \alpha_{40} \\ \alpha_{50} \\ \alpha_{60} \end{bmatrix} \begin{bmatrix} \ln i_{bt-1} \\ \ln i_{ct-1} \\ \ln i_{ht-1} \\ \ln i_{mt-1} \\ \ln i_{lt-} \\ \ln \grave{i}_{p`t-1} \end{bmatrix} + \begin{bmatrix} e_{bt} \\ e_{ct} \\ e_{ht} \\ e_{mt} \\ e_{lt} \\ e_{pt} \end{bmatrix}$$

Or in its compact form as:

$$\mathrm{B}lx_t = \Gamma_0 + \Gamma_1 lx_{t-1} + \Gamma_2 li_{t-1} + \varepsilon$$

Where

x_t = a vector of the livestock commodities demand endogenous variables
Γ_0 = a vector of linear trends variable
Γ_1 = a vector of livestock demand endogenous variables coefficients
Γ_2 = a vector of gross national income exogenous variable
ε_t = a vector of error terms

Second, we used the estimated elasticities derived from the VAR model in order to project expected changes in demand for livestock products in AFRICA by 2030. For this purposes we constructed three different possible scenarios. In all scenarios we assumed an average population growth of 2.5 % per year following UNFPA (2012) projections, and three different levels of economic growth following World Bank (2014) global economic prospects. Thus, for scenario A we assumed an average income growth of 3 percent per year; for scenario B an average income growth of 5 percent per year; and for scenario C an average income growth of 7 percent per year.

3. Data

To conduct the analysis we assembled a time series database using yearly observations from 1980 to 2010 on variables such as gross national income (GNI), population size, and aggregate apparent demand of various livestock products including bovine meat, poultry

meat, pig meat, goat and mutton meat, eggs, and milk. One of the main limitations encountered during the process was to find sufficient observations for all the requested variables in the different countries. In this regard from the 56 countries initially included, we had to exclude 9 countries due to an insufficient number of observations.

4. Results

The results of the multivariate structural VAR model (Table 1), show that the rate of growth for the demand for beef, poultry, pork, milk, eggs, and mutton can be partly explained by the past realizations of each variable, the cross demand elasticities existing among the various variables, and the changes in the level of gross national income (GNI). The output of the model highlights the complex dynamics existing among the different time series, and the highly significant coefficients of the per-capita level of income parameters.

Table 1. VAR estimation results

Parameter	Equation					
	Log Beef (LB)	Log Poultry (LC)	Log Pork (LP)	Log Milk (LM)	Log Eggs (LH)	Log Mutton (LG)
Trend (t)	0.003 (0.8)	0.009 (2.9)	0.011 (2.3)	-0.001 (-0.8)	0.001 (1.3)	-0.001 (-1.3)
Log Beef LB (t-1)	0.14 (1.0)	-0.39 (-2.2)	-	-	-	-
Log Poultry LC (t-1)	-0.37 (-2.5)	0.37 (2.5)	-0.47 (-2.2)	-	-	-
Log Pork LP (t-1)	-0.33 (-4.1)	-0.47 (-1.8)	0.75 (7.0)	-0.39 (-6.1)	-	-
Log Milk LM (t-1)	-	-	-	0.18 (2.4)	-	-
Log Eggs LH (t-1)	-	-	0.35 (1.9)	-0.18 (-2.1)	0.25 (1.6)	-
Log Goat & Mutton LG (t-1)	-	-0.36 (-2.1)	-0.74 (-3.4)	-	-	0.57 (3.7)
Log Income LI (t-1)	0.87 (5.8)	0.84 (4.0)	0.57 (3.5)	0.87 (7.5)	0.40 (4.9)	0.23 (2.9)

For interpretation purposes, we could use the coefficients from the beef equation as example and say that in Africa an increment of a 1.0 percent in the demand for beef in the previous year could lead to an increment of 0.14 percent in the current period, that a simultaneous growth of a 1.0 percent in the demand for poultry or pork have a negative cross demand effect in the demand for beef reducing it in 0.37 percent and 0.33 percent respectively, and that an increase of a 1.0 percent in the per capita level of income could cause an increment of about 0.87 percent in the demand for beef. The coefficients of the parameters in the other equations should be interpreted in a similar manner.

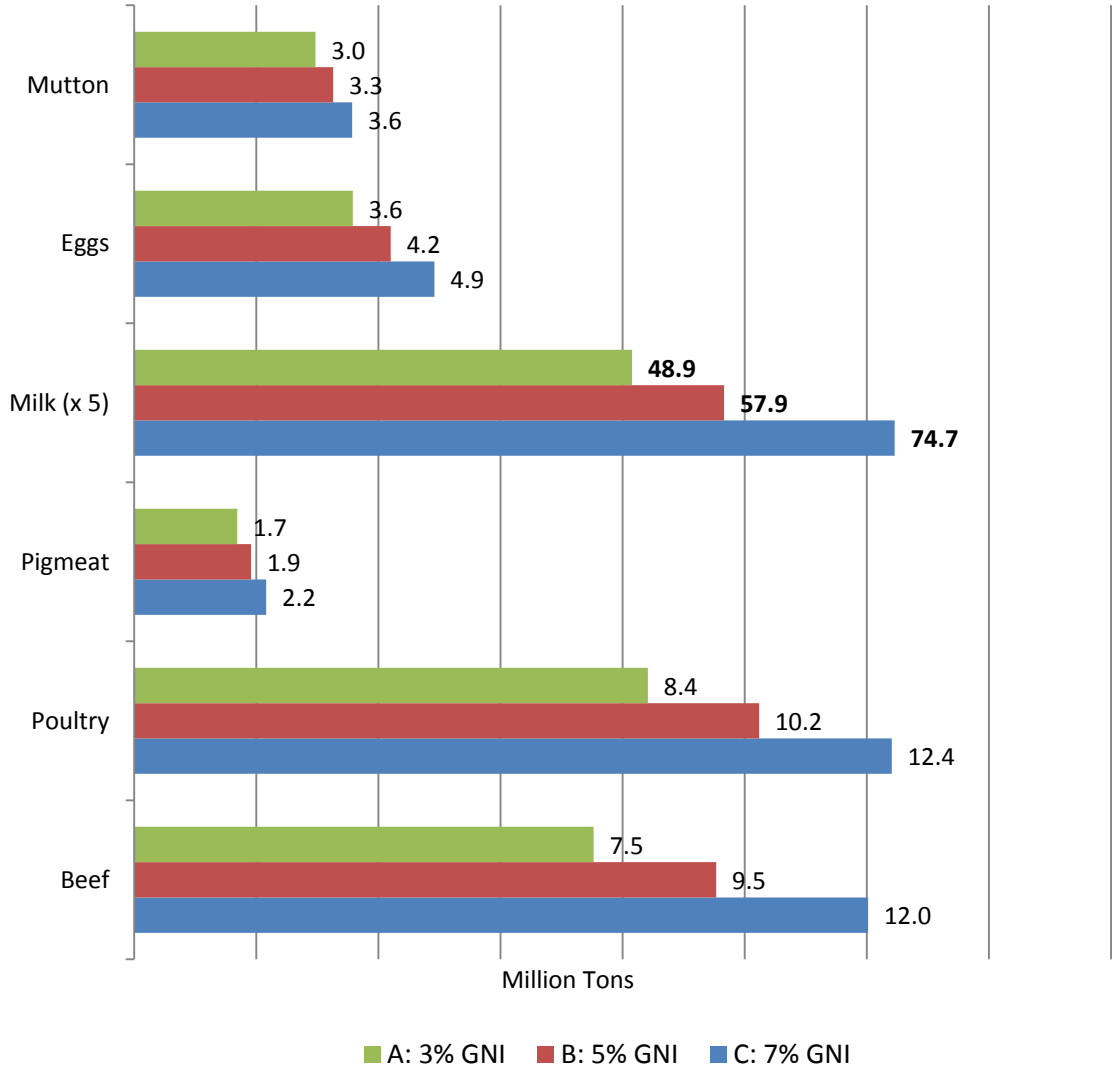

Figure 1. Livestock market perspectives for Africa by 2030.

We used the coefficients derived from the VAR model in order to project the expected changes in demand for livestock products in Africa by 2030 (Figure 1). In this regards we constructed three different scenarios assuming an average gross national income growth of 3, 5 and 7 percent per capita per year. The results of the analyses show that by 2030 the size of the livestock market in Africa could differ highly depending on the level of economic growth achieved, highlighting that a change in the level of income won't have the same effects among the different subsectors. This is mainly due to the differences in the income elasticity of demand. In this regard it is likely that those sectors with the highest levels of income elasticity, such as beef, poultry and milk will grow relatively faster under a high level of economic growth scenario than others subsectors.

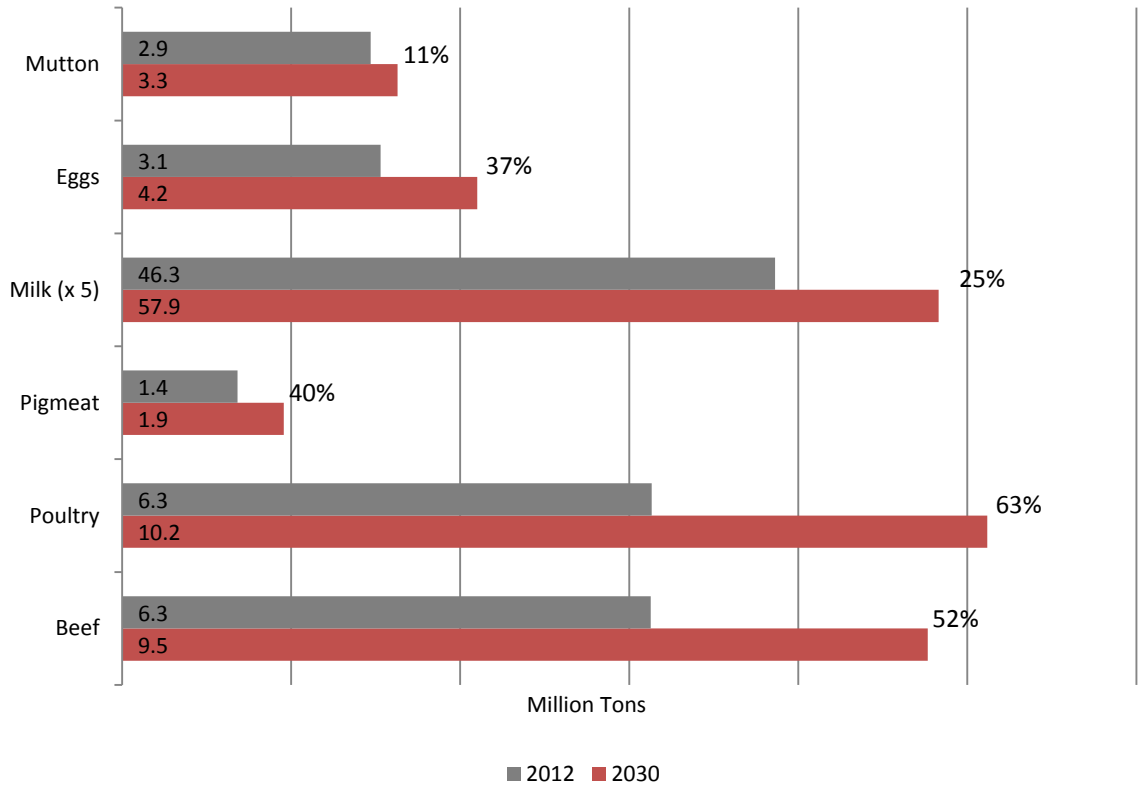

Figure 2. Potential livestock market size increment by subsector 2010 - 2030

Finally, in order to assess the market expansion potential among the different subsectors we compared the size of the respective markets in 2012 and 2030 for each subsector. Taking into account the future economic perspectives for Africa, we selected scenario B as the most feasible economic scenario. The results of the analysis (Figure 2) suggest that, under an average rate of economic growth of 5.0 percent per capita per year, the subsector with the highest level for market expansion will be poultry (63%), followed by beef (52%), pork (40%), eggs (37%), milk (25%), and mutton (11%).

Conclusions

We have employed a multivariate structural vector autoregressive model as alternative approach to assess the market perspective for the livestock sector in Africa. The highly significant coefficients of the model parameters suggest that the rate of growth for the demand for livestock products can be partly explained by the past realizations of each variable, the cross demand elasticities existing among the various variables, and the changes in the level of gross national income (GNI). The output of the model particularly highlights the complex dynamics existing among the different time series, and the highly significant effect that an increase on the level of income per capita has on the demand for livestock products. The results of the analysis show that the market size for livestock products in Africa by 2030 could fluctuate considerably depending on the level of economic growth achieved by the region. Taking into account the heterogeneity of the African region it would be

recommended to conduct specific market projections per sub-region in order to have a more precise picture of the sector to be used for policy purposes.

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