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Investigating tobacco auction floor price dynamics and market comovement with the stock market in Zimbabwe.

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ABSTRACT

This research is based on the theory of time series modeling. It investigates tobacco auction floor price volatility for the period 2009-2014 and show that they are predictable on a daily basis. If the auction floor prices are predictable, an approach of taking advantage of favorable prices can be developed. The current market scenario is that price is a surprise to farmers who cannot do anything except to wait in the queue as price move from favorable to very low levels. This shows limitations of the current auction system. Although there are many types of tobacco produced in Zimbabwe Flue Cured Variety constitutes more than 90% of the total output hence it the focus of study. The major thrust of this research has been the consideration of traditional auction theories as well as asset price diffusion theories including considerations from other established tobacco marketing boards such as India and Malawi. Quantitative secondary data was used to construct models and test hypothesis. The stock market is represented by BAT and TSL share prices while the tobacco auction floor prices were also used. The conclusions of the study are that the ARIMA (2,1) can forecast tobacco daily prices accurately for two days ahead. Beyond two days there are significant errors. Market comovement of prices based on BVAR model was not established there was no market comovement detected. Using GARCH (1.1) model Volatility spillover of prices between stock market and auction floor and vice versa was not detected. The open auction system is predictable from historical prices, by making use of the ARMA model. This means the weak form efficient holds true for tobacco auction market.

Key Words: Auction floor prices, Stock market share prices, Autoregressive, Comovement, Volatility spillover, Stationarity, Market efficiency.

Introduction

.Price volatility is inherent in the tobacco market with price being unstable both within and inter-season. It is a major cause of the collapse of markets and migration from one marketing system to another. The bid price evolves with time meaning that farmers can receive different prices for same type and grade of tobacco and this creates a challenge to the farmer who does not have means to diversify away the risk.

This study, is motivated by the need to preserve and rejuvenate the potential in the country`s agriculture markets which were at one point the backbone of the economy, the region and key to food security. Successful agricultural production is profitable for farmers if they have access to well functioning commodities markets.

Agriculture is the mainstay of the Zimbabwean economy contributing an average of 11.4 percent of the GDP, 22.8 percent of the foreign exchange earnings and about 23 per cent of formal employment [1]. This indicates that Zimbabwe like most low -income countries has a high population dependent on agriculture as their means of livelihood. Therefore what happens in the sector is of critical importance in determining economic development.

Table 1: Summary of agricultural sector`s percentage contribution to the GDP;

Industry/Year	**2009**	**2010**	**2011**	**2012**	**2013**
Agriculture	12.73%	12.28%	11.01%	11.06%	10.08%
GDP -	8.16 billion	9.42 billion	10.96 billion	12.39 billion	13.49 billion

Source: ZIMSTAT [2]

The above table shows the declining contribution of the sector to economic growth (GDP). The continued fall in agriculture has got a greater negative impact on many families and institutions which depend on it. Since agriculture is a major contributor to the Gross Domestic Product, big employer and foreign currency earner it is an important motive ensure that crop markets function efficiently to prevent market crash directly or indirectly.

In the agricultural sector the major cash crop measured by value is tobacco, commonly referred to as the golden leaf. Commercial cultivation of tobacco in Zimbabwe has got a long history dating back to colonial era. The country`s highest production capacity is known to be 236 million kilograms of unmanufactured tobacco. This production record was last achieved in the year 2000 [3] and earlier on the background of sound agricultural support and a growing economy.

The effectiveness of this research hinges on improving efficiency in pricing of unmanufactured tobacco in auction floors within season. Pricing is a very important parameter as it tends to be uncertain for primary commodities more than for manufactured goods. Farming therefore requires protection from such vulnerabilities which have a tendency to cause a market crash basing on recent experiences in the cotton market in Zimbabwe. The researchers suggest a mechanism over which farmers can receive fair prices for their produce and make them aware of likely ruling price for the next day.

The objectives of the study are as follows:

- produce a time series model for forecasting daily auction floor price
- examine the existence of market co-movement between tobacco auction floor and the stock market.
- evaluate the volatility spillover between the tobacco auction and stock market.
- suggest an approach to reduce the impact of price fluctuations on farmers income
- evaluate weak-form efficiency of traditional auction system.

The results of the research would assist farmers in making a sell decision. Farmers would sell high volumes when prices are high. The research covers the tobacco industry consisting of farmers, merchants, auctioneers, tobacco processor firms BAT and TSL listed on the Zimbabwe Stock Exchange to unearth price dynamics in the two markets. Tobacco industry has been selected for investigation due to its consistent success in providing ostensible income to peasant farmers, its international market performance and consistent data capturing. Data constraints were primarily faced in the design of a seasonal model due to large differences in frequency of observation of research variables such that work to construct a seasonal model was abandoned.

2 Hypothesis

For this study we test the following hypotheses

H_0: Tobacco auction floor price are predictable on a daily basis.

H_{02}: There is co-movement between tobacco auction floor prices and the Zimbabwe stock exchange price

H_{03}: There is volatility spill-over between tobacco auction floor prices and the Zimbabwe stock exchange price

H_{04}: The traditional auction market is weak-form efficient.

3 Literature Review

3.1 Traditional Auction Theory

According to [4], auctions use a competitive bidding process which intends to give growers the highest possible price given existing market conditions. In this view the most important goal is to provide a fair forum for growers and merchants to execute a trade, maximize profit while helping farmers to remain economically viable and influence livelihoods. Ultimately auctions facilitate product ownership transfer from primary owners to wholesalers, distributors and processors until final stages of consumption.

Auction theory which is equivalent to the game theory asserts that each investor bids according to the set of information available at his/her disposal and is aware of what the others bidders know about the product. Because of information diffusion the bidding process will converge to the market price (Bayesian Nash Equilibrium). This is possible if the bidder bids too high certainly he will win the auction but will take a risk of obtaining a loss/minimal return when reselling. Assuming that all bidders are being rational if one bids a lower price he/she will lose the auction. At the end the winning bidder will pay the market price in either auction systems discussed here under;

In the English/United States Auction or the Ascending System the price is successively increased until one last standing buyer remains. The auction can be conducted by having the seller or the buyer announce the price starting from low to high and buyers gradually quits the auction. Bidder`s often observe when other`s quit and this signal closeness to the market price.

In primary commodity markets the most important goal is to move larger volumes of products at the best price. A market price will be determined at a level where a larger volume could be transacted. It will make less economic sense to accept the highest bid whose volumes are too low.[4] viewed this market as slow in moving products through markets because of delays associated with selecting the appropriate buyer. It however gives growers opportunity to obtain a merchant who pays a higher price for their products. The English system is used to sell second hand goods, commodities and articles of manufacture like art designs.

The Dutch Auction (Netherlands) or a descending clock auction, was primarily developed to facilitate the sale of flowers and involves the bids initiated at a very high price and lowers it successively and the bidder who first accept high price win the object at that price. This market ensures the speed of sales and rapid movement of goods through markets.

First price-sealed bid auction each bidder independently submits a single bid without seeing other`s bids and the object is sold to the highest bidder. This method is applied to the sale of mineral rights, artwork, plantations, consultant services, real estate and properties but is also applicable to commodity auctions.

The Vickery/second price-sealed bid auction involves buyers submitting bids independently as the first price sealed bid while the object will be sold to the bidder who submits the highest bidding price. However the price paid is the second bidder`s price or second price. The overall conclusion from traditional auction theory is that it allows tobacco farmers to receive a market price for their produce as buyers often converge to the equilibrium price, by making it difficult for them to buy at less than market prices and unreasonable to pay a higher price than the market price. However since the price is market determined it tends to be uncertain and unstable throughout the marketing season. As the market begins the price is relatively unstable and latter own market correction takes place and it stabilizes.

3.2 Contract farming and price uncertainty (Contract Auctioning System)

Contract farming is a derivative form where the contract is similar to over the counter forward contract which cannot exchange hands on a registered exchange. The contract specifies the grade, quantity, maturity and quality but not price. The price unlike in other investment assets is determined at the auction date that is to say the tobacco contract does not specify a forward price at which the products are going to exchange hands. Furthermore the contracts are not marked to market on a daily basis.

In their simplified form the contracts represent a loan that will be repaid at time of selling the product. If the funds obtained from the sale of the golden leaf are not enough to offset the loan then the farmer will have to pay the difference from other sources or the loan will be rolled over to the next season or the loan may be written off depending on the initial agreements.

Tobacco contract farming system has shown its significance in Zimbabwe from 2010. The surge in contract farming is attributed to high average price since dollarization. Furthermore, farming is a capital intensive project hence contract farming provides cheaper alternative source of financing that is relatively long term in nature as it covers the whole season from planting to selling.

Price volatility under the contract system is largely unexplored empirically. According to the auction theory the system deviates slightly from the traditional system in that merchants could potentially negotiate for a higher price translating to more income for the farmer and contractors. While this association makes the market deviate from the fundamental laws of demand and supply due to institutionalized sell side the prices are also not stable as they change on a daily basis.

3.3 Theories that have been applied to investigate commodity price dynamics.

3.3.1 Ralph Nelson Elliot Wave Theory

Commodity prices have been known to have a non-linear relationship hence basic models of risk and return such as the Capital Asset Pricing Model and the Arbitrage Pricing Theory do not provide a best means of modeling commodity price movement. According to this theory prices do follow repetitive cycles as they go up and down while maintaining mean reversion property that is they maintain some long run value which is predictable [6].

Using this theory Elliott made detailed market predictions based on unique characteristics he discovered in the wave patterns. An impulsive wave, which goes with the main trend, always shows five waves in its pattern. On a smaller scale, within each of the impulsive waves, five waves can again be found. In this smaller pattern, the same pattern repeats itself infinitely.

From the theory of wavelets commodity prices do create an equal and opposite direction movement from time to time. A fall in commodity prices is likely to be followed by a rise moments later. The same theory has been applied to the stock market and the resulting evidence was a creation of equal and opposite price movement thus there is a cyclical movement of prices.

It leads to the conclusion that commodity prices rise in periods of booms and falls in recession periods.

3.3.2 The Efficient Market Hypothesis

The efficient market hypothesis stipulates that asset prices reflect all the information that affects its intrinsic value. In an active market involving knowledgeable and able investors, securities/financial assets will be fairly priced to reflect all available information [7]. The information can be historical, publicly available or current as well as private information. From this theory it can be concluded that price movement is largely a function of information that is brought to the market which have a material impact on price. Researchers testing for this theory found strong evidence for and against its existence by mainly using shares as proxy for financial assets.

3.3.3 Chaos Theory

Is an applied mathematical concept which explains the possibility of getting random results from normal equations. The premise behind this theory is the underlying notion of small changes significantly affecting the outcomes of seemingly unrelated events, for example an error programming problem. The chaos theory can also be referred to as the Non-linear Dynamics [7]

.

Chaos theory has been used to predict dynamics of many different things like weather patterns, commodity prices and the stock market. It involves an attempt to see and understand the underlying order of complex systems that may appear to be without order. In markets the theory ascertains that price is the last thing to change for an asset. According to this theory price changes are determined by the following factors in their fundamental equations which are complex and nonlinear in nature; volume, acceleration and momentum behind the changes.

3.4 Empirical Investigations

[8] pioneered the empirical literature on commodity prices based on unit root tests. Many of these tests fail to reject the unit root null hypothesis and conclude that commodity prices are random walks and no mean reversion. These findings suggest that relative commodity price changes are all permanent changes. Since most of these studies rely on descriptive univariate time series models such as low order Auto-Regressive (**AR (1)**) processes, the results indicate that the lagged commodity price has limited ability to forecast future commodity prices. This implies that time series are not a good forecasting model. Dickey suggested that since commodities are random and volatile a long term forecasting model is required. His study recommends the use of structural models to predict the future price movement.

[9] investigated the accuracy of using time series models to predict the future price movement in commodities from developing countries. Cuddington used a sample of ten most internationally traded goods to find their conformity to time series models. The products include corn, wheat, coffee, tobacco, cocoa and sugar. From the sample they found out that the products

follow pure random walks and can be estimated to a significant extend with time series models. They employed the autoregressive model of order 1 to corn and wheat while an order of 2 was used to predict cocoa, tobacco and sugar with estimation errors of 2% and 5% respectively.

[10] undertook the comparison of both structural and mathematical models to investigate their predictive power of current market prices. Their research was primarily focused on futures markets covering corn, wheat, sugar and crude oil. From the selected commodities oil was found to be highly volatile both in the short and long term. Other products were investigated accurately by using trend stationary or difference stationary modeling (ARIMA) to capture the features of price dynamics. According to their results commodities are purely random walks and their recommendations suggested a model which considers structural variables to forecast oil prices on a long term basis while in other products either a time series or a structural model can be used.

[11] investigated the evolution of electricity prices and commodity prices in deregulated markets. Their model was able to capture several factors: seasonality, mean reversion, GARCH behavior and time-dependent jumps. Applying the model to equilibrium spot prices their results show that electricity prices are mean-reverting with strong volatility (GARCH) and jumps of time-dependent intensity even after adjusting for seasonality. The unit root test for both commodities and electricity were against mean reversion, in the presence of jumps and GARCH errors.

[12] investigated the long-term time-series properties of 33 individual commodity prices. Using a new methodology for examining cross-sectional variation of commodity returns and its components, he finds strong evidence that the prices of world primary commodities are extremely volatile. In addition the research states that, prices are roughly 30 percent more volatile under floating than under fixed exchange rate regimes. Using the capital asset pricing model as a loose framework for estimating relationship between risk and return, the results indicate that global macroeconomic risk components have become relatively more important in explaining commodity price volatility. Changes in commodity prices are therefore not localized but are influenced by other factors especially for internationally traded commodities. This reflects the effects of increasing international trade, globalized economy and factor mobility.

The persistence of commodity prices volatility however remains the subject of debate among academics. While there seem to be no conclusion as to whether structural models or time series models are the best forecasting models many studies suggest that the two models can be used to produce an accurate result. Time series is argued to be a perfect price modeling tool in the short term while structural models perform better in the long term. Academics do not agree on the stationarity property of primary commodity prices for example[9,13] From the available literature commodity prices can be predicted using both time series models and structural models. Time series models that series be stationary or a differencing model be applied to cater for that non-stationarity. Structural models examine the relationship existing between equilibrium price and factors affecting demand and supply schedules. They represent the economic equation of a particular asset and help us to generate a long term forecast. In contrast time series helps us to investigate major changes in commodity markets such as changes in price volatility, changes in the correlation between the returns of different commodities, changes in the correlation of commodity returns with various markets, such as stock market returns, risk and changes in correlation between manufactured and unmanufactured goods.

4 Methodology

4.1 Research Design

The objectives of this study is three fold in nature, first to forecast daily prices of flue cured unmanufactured tobacco, and secondly to establish the extend of return co-movement with stock markets. Thirdly determine volatility spill over between the two markets.

The research elements under consideration include all the tobacco auction floors in Zimbabwe registered with TIMB and the Zimbabwe Stock Exchange as represented by BAT and TSL. Although there are many types of tobacco produced in Zimbabwe Flue Cured Variety constitutes more than 90% [TIMB] of the total output hence it the focus of study. The sampling period under study spans 6 seasons from 2009 to 2014 taking the whole population from the tobacco market while a stratified sampling was used to categorize companies according to their industry.

VARIABLE	PROXY
APX	Traditional Auction Floor Price
CPX	Contract Auction Floor Price
AVPX	Average Price for Action and Contract Market
BATPX	BAT share price
TSLPX	TSL share price
EXP	Exports
IMP	Imports
YLD	A measure of productivity
MECH	Registered Merchants For that Season
STK	Year End Stock Levels
DUS	Domestic Consumption
GRW	Active Growers for that season

The research makes use of time series data. It is a secondary research which employs time series modeling properties. Tobacco auction floor prices are provided by the Tobacco Industry and Marketing Board for both contract and traditional auction platforms on a daily basis each season from 2009 to 2014. Import, export, productivity, registered merchants and registered farmers data is extracted from the yearly tobacco statistical analysis report [2013-2014] obtained from the Tobacco Industry and Marketing Board. The report gives summary of market activities for the whole year hence data points are at most observable at monthly and yearly intervals. Stock prices of BAT and TSL were obtained from the Zimbabwe stock exchange and MNC for the sampling period under consideration. The price refers to the final settlement prices after the bidding and offering process. It is the price at which the volume under reference is transacted at.

Table 2: Research Variables

4.1.1 Model for forecasting tobacco auction floor prices.

Daily tobacco auction floor prices for traditional and contract market systems from 2009 to 2014 were used. To achieve this objective the Auto regressive Moving Average model as shown below was used;

……. (1)

Where; **…………………………….. (2)**

Where **-** is the current value of the tobacco auction or contract floor price.

c - is a constant, which is the value taken when all regressors are zero.

- is the sensitivity of the lagged values to the explained variable.

– are the lagged values of tobacco prices

…………………..………..... (3)

Where **-** is the current price of the time series

- are the model parameters

- is the order/memory of the model

– is a series of residuals of tobacco auction prices

4.1.2 Market co-movement between auction market and the stock market.

Returns of BAT, TSL and Tobacco auction floors prices from 2009 to 2014 were used. To determine market return co-movement between the tobacco auction market and the stock market it is assumed that primary markets volatility spills into stock market through firms which are heavily invested in that particular market that is British American Tobacco and TSL. The Vector Auto regression Model is used to analyse data.

In its basic form it is a generalization of univariate autoregressive models or a combination of the simultaneous equations models and the univariate time series models. The returns for the markets has been assumed as percentage changes in the daily prices.

The following mean equations were estimated for each market returns and the returns of other markets lagged one period to analyze the existence of return spillover:

(4)

In the bivariate VAR (1) case with three variables tobacco prices, TSL and BAT share prices the model is

…………………… (5)

where is an 2x1 vector of daily returns at time t for each market. The diagonal elements of matrix are the respective market's own returns lagged one period, while the off-diagonal elements represent the mean spillover effect across markets. The 2x1 vector are constants while are white noise terms which are normally distributed and time dependent.

The return co-movement is given by the expanding the matrix and obtaining the off diagonal elements which are the products of;

and

Where the first product is the coefficient of the auction floor and the stock market and the second product is the coefficient between stock market and the auction floor.

4.1.3 Determine volatility spill over between the two markets.

Return series of the data from the two markets were used.

Return is calculated as = Ln () (6)
Where;
-is the day end closing price.
-Is the previous day closing price for the two markets.
To determine volatility we estimate a GARCH (**p** , **q**) model based on initial VAR lag selection criteria. The GARCH model is specified as;

……………………. (7)

Where 's and 's are non negative model parameters and in turn the above model specification ensures a non negative estimate of the conditional variance.

- is the residual series of the average combined tobacco auction floor price.

- is the variance series that is autoregressive.

- is the order of lag of residual terms.
- is the order of lag of the variance equation.

5 Results and Discussion

Table 3 Summary Statistics for Contract, open Auction, BAT and TSL share prices;

	CPX	APX	BATPX	TSLPX
Mean	334.9616	291.7893	430.9137	13.3749
Median	332.5000	295.0000	240.0000	8.5000
Maximum	443.0000	396.0000	1340.000	38.0000
Minimum	252.0000	174.0000	95.00000	5.8000
Std. Dev.	35.42213	53.24123	354.1272	9.0465
Skewness	0.066500	-0.206734	1.103136	1.4158
Kurtosis	2.090602	2.251821	2.662420	3.7034
Jarque-Bera	19.70952	17.05031	116.2372	198.6349
Probability	0.000052	0.000198	0.000000	0.000000

Source: Research findings

From the above table the average contract price was 335 cents. The average traditional auction mean price was 292 cents. The average stock market price for BAT was 431 cents while TSL share price had a mean of 14 cents.

5.1 Diagnostic tests

5.1.1 Phillips-Peron stationarity test

Using the Phillips-Peron stationarity test the traditional Auction floor price is stationary at 1% and 5% significance level considering the t-statistic which is greater than the critical values at 1% and 5% respectively with probability value of 0.06. The researchers estimates the ARMA model at 5% and 1% to satisfy the stationarity condition. The contract auction floor price failed the stationarity test at all levels. However using the Augmented Dickey Fuller Test all variables were stationary. The BAT share price is level stationary at all the significance levels. A high probability value suggests that we accept the null hypothesis and conclude that the data is stationary. The TSL share price is level stationary at the 1%, 5% and 10% significant levels. A high probability-value means that we can accept the alternative hypothesis that the data is stationary.

5.1.2 **Pearson Bivariate Correlation Matrix**

Table 4: Variable correlation matrix

	APX	AVOL	CPX	CVOL	BATPX	BATVOL	TSLPX	TSLVOL
APX	1.0000	0.0702	0.5888	-0.0243	0.0193	0.0793	-0.0082	-0.0249
AVOL	0.0702	1.0000	0.0974	0.5279	0.2121	0.0564	0.2859	-0.0465
CPX	0.5888	0.0974	1.0000	0.1725	0.3779	0.1374	0.2648	0.0143
CVOL	-0.0243	0.5279	0.1725	1.0000	0.5731	0.0671	0.6078	-0.0450
BATPX	0.0193	0.2121	0.3779	0.5731	1.0000	0.1180	0.9622	-0.0232
BATVOL	0.0793	0.0564	0.1374	0.0671	0.1180	1.0000	0.1134	-0.0257
TSLPX	-0.0082	0.2859	0.2648	0.6078	0.9622	0.1134	1.0000	-0.0267
TSLVOL	-0.0249	-0.0465	0.0143	-0.0450	-0.0232	-0.0257	-0.0267	1.0000

Source: Research findings

The above correlation matrix is interpreted with reference to [14]. The following conclusions can be drawn about the correlation between variables; There is a 96% strong correlation between TSLPX and BATPX. The two variables are from the same market, they are all proxy for the stock market hence they contain the same information hence their explanatory power is almost the same. This indicates that the two variables cannot be used in the same model. If used concurrently the ARMA model will suffer from stability problems by becoming too sensitive to small changes in the two variables.

There is a moderately high correlation between TSLPX and CVOL 60% and 59% between APX and CPX, 57% between BATPX and CVOL, 38% between CPX and BATPX, and 53% between CVOL and AVOL meaning that these variables may jointly cause model instability. The correlation between other variables AVOL and APX, APX and CVOL, APX and BATPX, APX and BATVOL, APX and TSLPX, APX and TSLVOL is moderately/weak low positive or negative meaning that the variables can readily be used in the same model with less caution for model instability.

The selected AR model has two lags based on the final prediction error (FPE), Akaike Information Criteria (AIC), Schwarz information criteria (SC) and the Hannan-Quinn Information criteria (HQ).

The APX`s ARMA model have moving average terms lagged one period as below;

Table 5: ARMA model estimation

Dependent Variable: APX				
MA Backcast: 2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	285.5961	16.51324	17.29497	0.0000
AR(2)	0.923877	0.022065	41.87135	0.0000
MA(1)	0.939043	0.019279	48.70708	0.0000
R-squared	0.919963	Mean dependent var		290.5717
Adjusted R-squared	0.919678	S.D. dependent var		54.15286
S.E. of regression	15.34754	Akaike info criterion		8.305083
Sum squared resid	132377.3	Schwarz criterion		8.328110
Log likelihood	-2343.186	Hannan-Quinn criterion.		8.314071
F-statistic	3229.869	Durbin-Watson stat		2.316558
Prob(F-statistic)	0.000000			
Inverted AR Roots	.96	-.96		
Inverted MA Roots	-.94			

Source: Research findings

The CPX failed the stationarity test at levels, first difference and second difference hence there is no meaningful time series model which can be developed for daily contract auction floor price. The model specification is therefore;

………………. (8)

A forecast carried out using the model in log form yielded the following estimation errors which are statistically significant. The small values for mean absolute, mean percentage, root mean square errors means that when the inputs are changed their respective change in actual values is smaller hence the model is significant. The ARM (2, 1) model can forecast two days ahead, for periods greater than 2 days the model will produce unreliable estimates as the coefficients from lag three are not significant.

5.2 Results of forecasting for a two day period.

Table 6: Results of forecasting for a two day period.

	Forecast Value
Mean Absolute Error	0.16262
Mean Percentage Error	82.89445
Thiel Inequality Coefficient	0.01749

Source: Research findings

The average MAE is 0.16262 is average magnitude of the errors in the forecast, without considering their direction. MAPE is 83% meaning that ARMA is accurate to 83% in constructing fitted time series values. Values of TIC which are less than one indicate better performance of the predictions as in this case it is 0.01749.

5.3 Results of market co-movement between auction market and the stock market.

The objective of VAR models is to determine whether the current values of a variable are dependent on its own past as well as on the past values of the other variables which then result in co-movement. However it may be that a particular variable is statistically related to its own past values but not to the past values of the other variables that is no co-movement.

.....(9)

The VAR model between traditional auction floor price and the stock market represented by BAT share price appear to be predominately affected by the lags in their own prices as expected in time series models. The open auction price is purely a function of its past two values with sensitivities 0.7733 and 0.2029 respectively. The two sensitivities were statistically significant at 5% level. The BAT share price is marginally affected by the contract prices lagged one period, as shown by a beta value of 0.0905 at 5% level.

....
.(10)

The relationship between the traditional auction and the stock market represented by TSL share price also do confirm that the tobacco auction and the stock market are largely influenced by their own lagged values than exogenous variables. TSL share price is related to the second lagged values of the traditional auction floor with sensitivity of -0.002 while it is also related to contract auction by 0.002.

Basing on this research model of market comovement, there is a slight comovement between the two markets, which can be summarized in the table below;

Table 27: Overall market comovement

VARIABLE	APX	CPX
BATPX	0	-0.0673CPX(-2) + 0.095CPX(-1)
TSLPX	-0.002APX(-1)	0.002CPX(-1)

Source: Research findings

While causality has been found to flow in two way directions on all the variables except for APX and CPX and BATPX and TSLPX it can be concluded that the co-movement is slight and insignificant based on the fact that the coefficient estimates are not efficient and also considering that stock market prices are affected by more factors than only the tobacco market. Durbin Watson Statistic is 2.017269 which is around the standard DW critical value of two, meaning that the auction price is not serially correlated with its explanatory variables. The respective statistic for the Contract, BAT and TSL models is 2.177298, 1.991754 and 2.004647, which are all valid for the hypothesis of no-serial correlation.

5.4 Result on volatility spill over between the two markets.

Table 7: Volatility model for traditional auction system

Dependent Variable: RAPX				
Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*RBATPX + C(7)*RTSLPX				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000434	0.002076	-0.209314	0.8342
RCPX	0.016435	0.026869	0.611691	0.5407
	Variance Equation			
C	0.000154	5.02E-05	3.071607	0.0021
RESID(-1)^2	0.209527	0.035390	5.920514	0.0000
GARCH(-1)	0.788223	0.030567	25.78637	0.0000
RBATPX	-0.000482	0.000549	-0.879263	0.3793
RTSLPX	0.002993	0.001035	2.892686	0.0038
R-squared	0.002252	Mean dependent var		-0.000963
Adjusted R-squared	0.000483	S.D. dependent var		0.057649
S.E. of regression	0.057635	Akaike info criterion		-2.990347
Sum squared resid	1.873514	Schwarz criterion		-2.936689
Log likelihood	853.2681	Hannan-Quinn criter.		-2.969405
Durbin-Watson stat	2.433318			

Source: Research findings

.... **.(11)**

This model is the Multivariate GARCH model or the BEKK-GARCH model used to estimate volatility transmission between two or more variables. A similar model was used by Manex Yonis in his research on Stock Market Co-Movement and Volatility Spillover between USA and South Africa in 2011. His result shows that there was evidence of volatility spill over between the two markets.

The above GARCH(1, 1) model was estimated under the normal Gaussian distribution, it evidently shows that volatility is mainly affected by internal shocks rather than shocks from external markets. This is evidenced by the fact that the generalized auto regressive conditional heteroscedasticity has a higher sensitivity at 0.788223 while the volatility of TSL price slightly affect volatility of the tobacco auction floor price with sensitivity of 0.002993. TSL volatility effect is significant at conventional significance levels of 1%, 5% and 10%. There is no volatility spillover from the BAT share price to the open auction system. The contract auction system is further affected by internal shocks with sensitivity 0.7591 for the garch(-1) parameter. BAT return volatility slightly affects the market with sensitivity 0.005966.

Table 8: GARCH (1, 1) confidence interval

		90% CI		95% CI		99% CI	
Variable	Coefficient	Low	High	Low	High	Low	High
C	0.209527	0.15122	0.26784	0.140014	0.27904	0.11806	0.30099
RESID(-1)^2	0.788223	0.73786	0.83898	0.728182	0.84826	0.70922	0.86723
GARCH(-1)	-0.000482	-0.00139	0.00042	-0.00156	0.00059	-0.00190	0.00094
RBATPX	0.002993	0.00129	0.00469	0.000961	0.00503	0.00032	0.00567
RTSLPX	0.000000	-4.4E-16	4.4E-156	-5.2E-156	5.2E-16	-6.9E-16	6.9E-16

Source: Research findings

Table 8, above model volatility and residuals from the tobacco auction market deviate from their lower and upper limits by less than 100% meaning that the variables can be used without causing the model to be unstable. However returns from BAT and TSL fluctuate by more than 100% from their lower and upper limits hence they are not reliable estimates of volatility spillover between the two markets when the conventional test size of 95% is used.

6 Conclusion and Recommendations

Forecasting ARMA (2.1) has been found to be a robust model for the open auction market for its daily price fluctuation. Two step ahead forecasts could be carried out with great precision while extended forecast beyond 2 days generated significant errors. These results conform to autoregressive integrated moving average (ARIMA) models used by [15]. Distributed-lag models by [16] which performed well in predicting agricultural commodity prices. Regarding market co-movement, based on **BVAR (2)** model the co-movement is slight and insignificant because the coefficient estimates are not efficient and also considering that stock market prices are affected by more factors than only the tobacco market. Market co-movement failed to hold true between the stock market and the tobacco auction market. The BVAR (2) model estimated resulted in the matrix co-efficient that are significant at least by a confidence level of 70%, which means that there is very little information if any that the farmers need to use from the tobacco auction flow to make an investment decision on stock market.

Volatility spillover between the two markets is insignificant. Volatility is largely a function of its lagged values and is transmitted at a significant level from the tobacco market to the TSL share price while BAT is not affected.

The tobacco auction floor price model has been established as an ARMA (2, 1) model which can forecast up to 93% of the current price. This means that the tobacco auction market is largely predictable from past returns the weak form efficiency hypothesis holds true. Weak form efficient means that we can use technical analysis to come up with an accurate forecast about tomorrow's price. The open auction system is predictable from historical prices, by making use of the ARMA model. Using the daily auction price forecasting model (ARMA), ARMA model had an r-square of 92%. r-square between 0.5 and 1 means the data is weak form efficient. The open auction system is therefore weak form efficient.

Based on this study the researchers recommend that a mobile buying system can be introduced which solve the queuing problem and enable large volumes of tobacco to be sold when price is favourable.

Reference

- RBZ annual report 2012

  Available at http//:www.rbz.co.zw

- Zimstat GDP 2009 to 2014

  Available; at http//:www.zimstat.co.zw

- Tobacco Industry and Marketing Board Annual Statistical Report; 2013 and 2014.

- Paul Klemperer, May 1999, Auction Theory: A Guide to the Literature, Journal of economic Surveys.

- Elliot ,1980, Wave Theory, Quick Start Guide, Traders Day Trading .

- Kenneth R. French and Eugene F. Fama,2004,Review of the Capital Asset Pricing Model:Theory and Evidence, Journal of Economic Perspectives.

- Henri Poincare (1890), Chaos Theory.

- Dickey, D. A.; Fuller, W. A. (1979). "Distribution of the Estimators for Autoregressive Time Series with a Unit Root". Journal of the American Statistical Association **74** (366): 427–431.

- Cuddington and Urzua, 1989, Agriculture Commodity Markets and trade: New approaches to analyzing markets. https://books.google.com/books

- Crucini, M. J and Bidarkota, P, 2000, Commodity Prices and the Terms of Trade, Review of International Economics.

- Alvaro Escribano et al 2002 Modelling Electricity Prices , International Evidence Socail Research Network.

- Mei-Hsiu Chen, August 2008, Understanding World Commodity Prices, Returns, Volatility and Diversification.

• Deaton 1992 The behaviour of Commodity Prices The review of Economic studies Vol. 59, No. 1 (Jan.,1992).
• Brooks, C. (2008). Introductory Econometrics for Finance. New York: Camprige University Press
• Tome and R. J. Myers (1993). Empirical Analysis of Agricultural Commodity Prices: A Viewpoint, Review of Agricultural Economics, 15(1):181- 202
• Hudson 2007 Agricultural prices and markets.