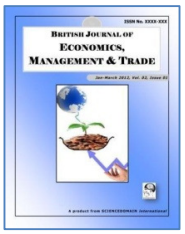

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# Cost-Price Squeeze in Export Oriented Crop Production: Welfare Implication for Commercialized Smallholder Tea Producers in Kenya

**B. L. Kiplimo[1*], L. Inyanje[2], V. Ngeno[2], T. Kipkurgat[2] and M. C. Lopokoiyit[3]**

*[1]Department of Earth, Environmental and Physical Sciences, University of Siena, P.O. Box 44-53100, Italy.*
*[2]Department of Agricultural Economics and Resource Management School of Business and Economics Moi University, P.O. Box 3900-30100, Kenya.*
*[3]Department of Agricultural Education and Extension, P.O. Box 20115-536, Egerton University, Kenya.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. Author BLK designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors VN and LI compiled the secondary data and analyses while Authors MCL and TK managed the literature searches and improved on the final draft. All authors read and approved the final manuscript.*

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## ABSTRACT

Tea production, a leading export crop in Kenya and produced largely by smallholders was analyzed to determine how the input and output prices adjust to both inflation and exchange rates. It was hypothesized that prices received and prices paid by farmers are not cointegrated and that a cost-price squeeze could not be rejected in the long-run. Based on cointegration analysis results, we could not reject the null hypothesis of no cointegration between prices paid and prices received in the long run. Macroeconomic variables impacts unevenly on the tea sector with probable negative effects on the welfare of smallholders. The livelihood of export oriented cash crop producers in less developed countries, therefore, becomes integrally vulnerable to market forces. Price volatility coupled with constant market shocks could impact negatively on the general livelihoods of the smallholder export farmers particularly food access at the household level.

**Corresponding author: E-mail: langatben2002@gmail.com;*

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## 1. INTRODUCTION

The effect of macroeconomic variables on agriculture prices has been the concern of most economists since 1970s [1-5]. However, the volatility in food prices following the recent financial crisis has revived an intensive debate as to the impact of macroeconomic variables on the smallholders actively involved in the market [6-10]. The impact of such market fluctuations could be more significant among farmers involved in export oriented cash crops, especially those in developing countries.

Previously, studies have highlighted the central role played by exchange rates among other macroeconomic variables in agriculture. Attention has been focused on the relationship between the exchange rate and agriculture output and input markets [11]. Other studies have also analysed the impact of inflation on the agriculture sector prices [12]. The concern is that inflation has a greater impact on prices paid by farmers than prices received by farmers resulting in a declining ratio of prices received to prices paid. This phenomenon has been termed cost-price squeeze.

It has been hypothesised that farmers face a dual market structure, a competitive output market structure and an oligopolistic input market structure [1,3]. Under the two market conditions, farmers are purely price takers who buy inputs and sell outputs through integrated trade. Fluctuations in output prices and costs of inputs such as labour, energy and fertilizers are often beyond the control of smallholder farmers. This holds true particularly for smallholder commercialized subsistent farmers in developing countries who produce their outputs mainly for export market using imported inputs. Market integration of traditional agriculture into regional, national, and international exchange economies is generally aimed at spurring growth in the sector with expected positive welfare effects accruing to the rural population dependent on the sector. The net gains to smallholder farmer are, however, not always priori assured [13]. Integrating these farmers into regional and international markets further increases their vulnerability to the volatile international market prices.

The cost-price squeeze phenomenon hypothesised in agriculture presumes that input prices tend to responds more readily to inflation than output prices [14]. The major concern is that if inflation is much more apparent in prices paid by farmers than prices received by farmers then it will result in a declining ratio of prices received to prices paid, this phenomenon is referred to as "cost-price squeeze" [5]. According to the cost-price squeeze theory, when inflation is present, prices paid by farmers increase more than prices received by farmers [15]. The manifestation of cost-price squeeze at the farm is largely attributed to the cyclical nature of agricultural markets [16]. Few studies have investigated the existence of cost-price squeeze in agriculture and the source of it [14,5,17,18]. Most of these studies have used time series cointegration approach to test the evidence of cost-price squeeze in agriculture. If prices received and prices paid are cointegrated then the hypothesis of cost-price squeeze in the long-run is rejected. These studies have, however, arrived at varied conclusions.

Using recent data from a developing country, the cost-price squeeze is tested by examining if prices paid and prices received by farmers are cointegrated. If prices paid and prices received are cointegrated, then a fixed long-run equilibrium would be implied between the two and hence the absence of cost-price squeeze.

Tweeten [3] found that general inflation impacts unevenly on the supply and demand curves for farm output hence changing the ratio of prices received to prices paid by farmers. Moss [1] examined the evidence of a cost- price squeeze in U.S. agriculture and found that prices paid by farmers and prices received by farmers were not cointegrated. However, when [5] repeated the same analysis, there was no evidence of cointegration. Campiche et al. [12] did analyses for specific commodities and their results were confirmed. No further attempts in literature have been done to affirm either finding elsewhere other than US data.

The current study investigates the evidence of cost price–squeeze in Kenya's smallholder tea sector and considers the role of inflation and exchange rates on input and output prices in the subsector. Purchasing power parity (PPP) theory presupposes cointegration between the nominal exchange rate and foreign and domestic prices [19]. The exchange rate may, however, impact unevenly on the demand and supply of goods

and services depending on the size and balance of trade of a country. The paper begins with a brief review of post liberalization changes in the experience of smallholder tea sector in Kenya, and the factors behind fluctuations in the international trade. This shall provide the foundation for a conceptual framework for considering the key issues affecting the smallholder farming in Africa when they shift from food production to cash crop production. Building on this framework we use time series data to investigate the evidence of cost price squeeze in tea subsector in Kenya. We conclude from the empirical results giving necessary policy recommendations.

### 1.1 Smallholder Tea Sub-sector in Kenya

Kenya is one of the two leading black-tea exporting countries globally. Kenya's small-holder tea sub-sector has been dubbed Africa's success story [20]. Tea is the largest export earner with the value of tea exports comprising about 3 percent of the gross domestic product (GDP) [21]. Kenya has about 560, 000 small-holders, comprising 62 percent of the total tea production in the country [21]. When smallholder farmers were first introduced into cash crop production in Kenya, the Kenyan government established the defunct Kenya Tea Development Authority (KTDA) to regulate and put in place strategies to guarantee sufficient household food supply. Farmers were required to set aside a given minimum land size for food production, they were also supposed to cultivate a minimum given size of land to ensure economies of scale. However, the advent of market liberalization saw these strategies abandoned. Subsequently, despite favourable prices during the past market periods, food security and poverty levels have persisted among the tea farm households.

Real primary producer prices of tea production have fallen dramatically over the last three decades threatening its sustainability [22]. Globally, tea trade is dominated by few international companies profiting from stable retail prices. Production costs are estimated to account for up to 8% of the retail price of tea in the foreign market, including labour, input, and transport costs [22]. Tea production is labour intensive and the cost of labour constitutes the largest share of production cost in the sector. In Kenya, tea industry has experienced increasing cost of labour wages due to pressure from trade unions and increasing cost of living. Efforts to adopt cost cutting technologies have not been feasible. Smallholder farmers do not have the capacity to acquire new cost cutting technologies. Coupled with this, fertilizer and energy costs have been rising over time. Prices of imported fertilizer are affected by global prices and exchange rate fluctuations. Generally, the future livelihoods of smallholder farmers relying on the industry in Kenya cannot be guaranteed given the existing market conditions.

## 2. METHODOLOGY

### 2.1 Data

Five year monthly data from April 2009 to March 2014 was used. The NPK (triple superphosphate) monthly prices were used to represent input prices paid by farmers. Fertilizer constitutes the single most variable input in tea production. The data was obtained from compilation of Index Mundi sourced from World Bank and measured in US Dollars per metric ton. Mombasa average monthly auction prices in US cents per Kilogram were used as output prices. These are the prices of Best Pekoe Fanning traded at Mombasa Auction. Output prices were also obtained from the compilation of index Mundi originally sourced from IMF [23]. Monthly exchange rate data were obtained from Central Bank of Kenya (CBK) [24]. Consumption price indices, obtained from the Kenya national Bureau of Standards (KNBS) were used to measure inflation [25].

### 2.2 Empirical Analysis

Cointegration test was used to determine if the model gives empirically meaningful relationships and to test the hypothesis. If variables have different trend processes, it implies that they cannot stay in fixed long-run relation to each other, and we cannot model the long-run and therefore nothing can be inferred validly based on standard distributions [26]. There are several tests for cointegration. The two commonly used methods include Johansen and the Engle Granger approach [27,28]. Engel Granger approach is commonly used to test single equations [5]. But the Johansen test is the most fundamental and most superior test [26]. Johansen approach allows for more than one cointegrating relationships to be estimated [5]. Johansen approach is widely applied than the Engle–Granger test which is based on Dickey–Fuller (or the augmented) test for unit roots in the residuals from a single (estimated) cointegrating

relationship [28]. We used Johansen approach I the present study.

Following Campiche et al. a multivariate autoregressive Johansen model [1] in a vector error correction (VECM) form is used to estimate multiple cointegration relationships.

$$\Delta \mathbf{X}_t = \mathbf{\Gamma}_1 \Delta \mathbf{X}_{t-1} + ... + \mathbf{\Gamma}_{k-1} \Delta \mathbf{X}_{t-k+1} + \prod \mathbf{X}_{t-K} + \mathbf{u}_t, \quad [1]$$

Where $\boldsymbol{X_t}$ is a vector of *n* possible endogenous variables and $\boldsymbol{X_t}$ are the unrestricted vector autoregression (VAR) models including k-lags of $\boldsymbol{X_t}$. The parameters $\boldsymbol{\Gamma_i}$ measures the short-run adjustment to$\Delta \boldsymbol{X_t}$, whereas **Π** contains information on the long-run adjustment to$\Delta \boldsymbol{X_t}$. Testing for cointegration entails testing the rank of coefficient **Π,** such that if **Π** has full rank, then the variables are stationary. If the rank of **Π** is zero, it implies cointegration relationships do not exist. If **Π** has reduced rank, **Π** can be divide into **Π** = **αβ**', where **α** represents the speed of adjustment and **β** is a matrix of long-run coefficients. The cointegration hypothesis provides the inference for the existence of cost price squeeze. Cointegration is used to estimate a multivariate model to determine if prices received and prices paid by farmers are cointegrated with each other or with the general price level or the exchange rate.

Usually, the first step in Johansen cointegration is to test for unit root. This property is investigated prior to the construction of an econometric model. Unit root test is a descriptive tool performed to classify series as either stationary or non-stationary at level [26]. Cointegration is a necessary criterion for stationarity among non-stationary variables [27]. If the variables are integrated it will lead to non-standard distributions and possibly spurious regression results. If a data series appear to be stationary, which is the maintained hypothesis then, we reject the null hypothesis of a unit root. The Augmented Dickey-Fuller Test (ADF) was utilized in this study to test for unit root. After establishing the unit root for each variable, cointegration rank (r) was then estimated to determine if cointegration relationships exist between the variables. The properties of a range of maximum eigenvalue and trace tests for the cointegrating rank of a vector autoregressive process were compared to arrive at the rank of the cointegration. If the rank is non-zero, it implies that there is cointegration among variables and that there is long run association among the variables (i.e. variables move together in the long run). When the variables are cointegrated it implies that we can model both the long run and short run relationships using the VECM Model. If the variables are not cointegrated (integrated of rank order I(0)), then we can only model short run relationships using unrestricted (VAR). Either the VECM or VAR models can be used to make inferences about the causal relationships among variables.

## 3. RESULTS AND DISCUSSION

Results in Table 1, present the ADF tests of the four variables. From the table we accept the null hypothesis of unit root with non-differenced data. We reject the null hypothesis of unit root with 1 differenced in the data of all the variables. This implies that all variables are integrated of order one and can be tested for cointegration. According to lag selection criteria in Table 7, two lags were used in a vector error correction model to test Johansen co-integrating rank.

Table 2 shows the Johansen cointegration rank test. We do not reject the null hypothesis of no cointegration among the variables. The maximum eigenvalue statistics in Table 3 confirm our results in Table 2. This implies that there is no long run association among the four variables and that prices received and paid by farmers do not move together in the long run.

These results are consistent with the results in [14] but inconsistent in those of [5,17]. When the prices received and prices paid do not move together it implies that cost price squeeze will exist in the long run [14]. Our results show that even after excluding other macroeconomic variables in Tables 4 and 5, the prices paid and prices received are not cointegrated.

Since there are no long run association among variables we model short run association using unrestricted VAR model to test the causal relationships. From Table 6, it is clear that changes in tea output prices do not adjust to the changes in general price level (CPI) and exchange rate (EXR), but the changes in CPI adjusts to the changes in tea output prices.

**Table 1. Augmented Dickey-Fuller test for unit root**

| Number of obs = 59, Sample: April 2009-March 2014 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit root in non-differenced data | | | | Unit root with 1 differenced data | | | |
| | Tea price | NPK | CPI | EXR | DTea | DNPK | DCPI | DEXR |
| Test statistic | -2.093 | -0.962 | -2.240 | -1.783 | -3.775 | -3.100 | -3.095 | -3.679 |

*Critical values for rejection of hypothesis of unit root at 5% Critical Value=-3.491 for Non-Differenced and -2.927 with 1 Differenced Source: Authors computation 2014*

**Table 2. Johansen tests for cointegration**

| Trace statistic test | | | | | |
|---|---|---|---|---|---|
| Trend: | Constant | | | Number of obs= 58 | |
| Sample: | April 09- Mar-14 | | | Lags = 2 | |
| Maximum rank | Parms | LL | eigenvalue | Trace statistic | 5% critical value |
| 0 | 20 | 805.64599 | . | 34.0657* | 47.21 |
| 1 | 27 | -797.06889 | 0.25604 | 16.9115 | 29.68 |
| 2 | 32 | -791.82381 | 0.16545 | 6.4213 | 15.41 |
| 3 | 35 | -789.12068 | 0.08900 | 1.0151 | 3.76 |
| 4 | 36 | -788.61315 | 0.01735 | | |

*Source: Authors computation 2014*

**Table 3. Max eigenvalue statistic test**

| Trend: | Constant | | | Number of obs = 58 | |
|---|---|---|---|---|---|
| Sample: | April 09- Mar 14 | | | Lags = 2 | |
| Maximum rank | Parms | LL | eigenvalue | Trace statistic | 5% critical value |
| 0 | 6 | -514.51178 | . | 5.4156* | 15.41 |
| 1 | 9 | -512.67589 | 0.06134 | 1.7438 | 3.76 |
| 2 | 10 | -511.80399 | 0.02962 | | |

*Source: Authors computation 2014*

**Table 4. Johansen tests for cointegration without macroeconomic variables**

| Trace statistic test | | | | | |
|---|---|---|---|---|---|
| Maximum rank | Parms | LL | eigenvalue | Max statistic | 5% critical value |
| 0 | 20 | -805.64599 | . | 17.1542 | 27.07 |
| 1 | 27 | -797.06889 | 0.25604 | 10.4901 | 20.97 |
| 2 | 32 | -791.82381 | 0.16545 | 5.4063 | 14.07 |
| 3 | 35 | -789.12068 | 0.08900 | 1.0151 | 3.76 |
| 4 | 36 | -788.61315 | 0.01735 | | |

*Source: Authors computation 2014*

**Table 5. Max eigenvalue statistic test without macroeconomic variables**

| Maximum rank | Parms | LL | eigenvalue | max statistic | 5% critical value |
|---|---|---|---|---|---|
| 0 | 6 | -514.51178 | . | 3.6718 | 14.07 |
| 1 | 9 | -512.67589 | 0.06134 | 1.7438 | 3.76 |
| 2 | 10 | -511.80399 | 0.02962 | | |

*Source: Authors computation 2014*

Changes in input prices (NPK), however, adjusts to changes in both the CPI and EXR. When the CPI increases or the EXR decreases, the real income for smallholder tea farmers will subsequently decrease since the tea output prices do not respond to these changes. Similarly, cost of input readily adjusts to the changes in EXR which may impact negatively on the cost of production when the change is not favourable to the farmer. The Kenyan shilling has been losing value since 2010 following the financial crisis. If NPK prices adjust to the decrease in the value of the shilling then the cost of production will increase.

**Table 6. Granger causality Wald tests**

| Equation | Excluded | chi2 | df | Prob> chi2 |
|---|---|---|---|---|
| Tea price | NPK | 0.29096 | 2 | 0.865 |
| | CPI | 0.18723 | 2 | 0.911 |
| | EXR | 0.40661 | 2 | 0.816 |
| | **ALL** | **1.4653** | **6** | **0.962** |
| NPK | Tea price | 5.9616 | 2 | 0.051 |
| | CPI | 4.2854 | 2 | 0.117 |
| | EXR | 8.8293** | 2 | 0.012 |
| | **ALL** | **23.447*** ** | **6** | **0.001** |
| CPI | Tea price | 6.2424** | 2 | 0.044 |
| | NPK | 5.8505 | 2 | 0.054 |
| | EXR | 1.1901 | 2 | 0.552 |
| | **ALL** | **19.549*** ** | **6** | **0.003** |
| EXR | Tea price | 4.8243 | 2 | 0.090 |
| | NPK | 11.786*** | 2 | 0.003 |
| | CPI | 3.1704 | 2 | 0.205 |
| | **ALL** | **12.736** ** | **6** | **0.047** |

*Source: Authors computation 2014*

**Table 7. Lag selection-order criteria**

| Sample: April 09 – March 14 | | | | | Number of obs = 52 | | | |
|---|---|---|---|---|---|---|---|---|
| **Lag** | **LL** | **LR** | **df** | **P** | **FPE** | **AIC** | **HQIC** | **SBIC** |
| 0 | -898.201 | | | | 1.4e+10 | 34.7 | 34.7576 | 34.8501 |
| 1 | -720.535 | 355.33 | 16 | 0.000 | 2.8e+07 | 28.4821 | 28.7698 | 29.2326* |
| 2 | -692.702 | 55.666 | 16 | 0.000 | 1.8e+07* | 28.027* | 28.5449* | 29.3779 |
| 3 | -687.673 | 10.059 | 16 | 0.864 | 2.8e+07 | 28.449 | 29.197 | 30.4002 |
| 4 | -671.875 | 31.597 | 16 | 0.011 | 3.0e+07 | 28.4567 | 29.4349 | 31.0083 |
| 5 | -653.76 | 36.229 | 16 | 0.003 | 3.0e+07 | 28.3754 | 29.5838 | 31.5274 |
| 6 | -646.914 | 13.691 | 16 | 0.622 | 5.0e+07 | 28.7275 | 30.166 | 32.4799 |
| 7 | -619.519 | 54.791 | 16 | 0.000 | 4.0e+07 | 28.2892 | 29.9579 | 32.642 |
| 8 | -598.81 | 41.417* | 16 | 0.000 | 4.7e+07 | 28.1081 | 30.007 | 33.0612 |

*Endogenous: Tea price, NPK, CPI, ER, exogenous: _cons, Source: Authors computation 2014*

Consequently, the changes in both tea output price and input prices will be impacted unevenly hence cost-price squeeze in the sector cannot be ruled out in the long run. There is an apparent uneven impact of macroeconomic variables in the export oriented sector. Therefore the negative impacts on the revenue and general welfare of the farmer in this sector is evident.

## 4. CONCLUSION AND POLICY RECOMMENDATION

The presence of cost-price squeeze in export oriented crop was investigated. Tea production, a leading export crop in Kenya and produced largely by smallholders was analysed to determine how the input and output prices adjust to both inflation and exchange rates. We hypothesized that prices received and prices paid by farmers were not cointegrated and that a cost-price squeeze could not be rejected in the long-run. Based on the cointegration analysis results, we could not reject the null hypothesis of no cointegration between prices paid and prices received in the long run. Macroeconomic variables impacts unevenly on the tea sector with negative effects on the welfare of smallholders. The livelihoods of export oriented cash crop producers in less developed countries may become more vulnerable to market forces when they commercialize all their farm production and rely entirely in the market for food. Integrating the livelihoods into the market with high price volatility coupled with constant market shocks could impact negatively on the food access of the farmers.

The long run viability of the smallholder tea sub-sector in Kenya depends largely on adoption of efficient technologies, market integration and expansion of its consumer base in the market. A shift from high cost conventional production technologies to modern production methods will

help cut down the cost of production. In order to be sustainable, the sub-sector should integrate vertically by engaging in value addition and supplying their products directly to the retail market. The government, through Export Promotion Council, should support farmers to package and sell their teas directly in the foreign market. The Kenya Tea Development Authority should seek alternative markets in the short run. To increase the profit margins and safeguard the smallholder farmers, Kenyan government should support processors in the industry to widen its consumer base by investing in value addition products thus capturing the diverse tastes and premium prices and new market segments. The government can zero rate modern processing and value addition equipment to enable the industry actors tap on the new market opportunities.

Further research should be done using more input data and with datasets covering longer periods. Labour inputs and energy prices constitute significant cost of inputs in tea production and data from these variables can give a much clearer picture of cost-price squeeze in the sector.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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