

Modelling the Dynamic Impact of Replanting Subsidy on Tea Production in Sri Lanka: Policy Analysis Using the ARDL Model Approach

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Abstract: The tea industry in Sri Lanka plays a vital role in the economy with its direct and indirect contribution to the gross domestic products, employment, and foreign exchange earnings. The successive governments have introduced subsidy schemes for replanting to increase tea production. However, according to the authors' knowledge, there are no comprehensive quantitative studies undertaken to effectively investigate and quantify the effect of tea replanting subsidy scheme on tea production of the various geographic elevations of tea cultivating lands. The significant contribution of this paper is the quantification of the impact of tea replanting subsidy schemes on tea production in the short-run and long-run at different altitudes. This research takes time series data from 1970 to 2018 of three different heights or elevations-high, medium, and low. The Autoregressive Distributed Lag (ARDL) Model examines the short-run and long-run dynamics of the subsidy scheme on tea production. The results reveal that there is a cointegration between tea production and three variables; tea replanting subsidy, tea prices and tea bearing area; in all three elevations. But tea replanting subsidy is not significant in long run for all three elevations, separately. In the short-run analysis, the impact of replanting subsidy is significant only for tea production in low heights with one-year time lag. Since the study reveals that tea replanting subsidy increases, the tea production of low elevation also increases, and almost 60% of the tea extent and 73% of the total tea production gained from low heights, we recommend that the government continue the tea replanting subsidy schemes as it is benefitted by whole tea industry in long run.

Keywords: ARDL Approach, Cost of Production, Tea Production, Tea Prices, Tea Replanting Subsidy, Sri Lanka.

INTRODUCTION

The tea industry in Sri Lanka plays a vital role in the economy with its direct and indirect contribution to the gross domestic products, employment, and foreign exchange earnings. Currently, Sri Lanka is the third largest tea exporter and fourth-largest tea producer of the world. However, the industry faces several challenges that affect overall productivity in the industry. The Ministry of Plantation Industries (2015) highlights that inadequate replanting and new planting as significant factors affecting productivity.

In Sri Lanka, the tea smallholding sector (TSH), with tea extent of fewer than 10 acres, contributes almost 60% of the total tea extent and provide nearly 73% of the total tea production (Ministry of Plantation Industries, 2017). Tea is a perennial crop, and it produces harvest up to 20 years of the plantations. Bandula *et al.* (2017) revealed that 88% of TSH plantations are above 20 years old. Therefore, it is essential to do replanting. The government has estimated a replanting figure of 2% of the total tea extent of the tea smallholding sector annually.

In Sri Lanka, respective governments since independence have promoted tea replanting through various programmes. However, Weerahewa *et al.* (2010) stated that in general, developing countries had been criticized for not providing subsidy schemes to the target group, misappropriation, and corruption in the distribution process, burdening the government budget. Despite this criticism, there is a significant demand for subsidy schemes to increase replanting. According to Bandula *et al.* (2017), 78% of the TSH holders are willing to receive more replanting subsidy than the current amount to develop their lands. The decision to continue providing subsidy or not is a politically very sensitive issue in Sri Lanka. International studies by Holden & Fisher (2015), and Trivedi (1992) revealed that their cultivation area increased substantially due to a similar subsidy programme.

This politically sensitive debate in Sri Lanka motivated us to investigate the effectiveness of the replanting subsidy scheme. In other words, we attempt to find out if the current government should continue to provide subsidy or not. Moreover, there is no comprehensive quantitative study to effectively investigate and quantify the effect of tea replanting subsidy scheme on tea production, taking the geographic elevation of tea cultivating lands into consideration. The current study significantly bridges the literature gap by examining the dynamic

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relationship between tea replanting subsidy scheme on elevation wise tea production in the short-run and long run.

The paper organizes as follows: Section 2 presents a literature review, and Section 3 introduces methodology with data sources. Section 4 elaborates on data analysis and empirical findings. The concluding remarks and the policy implications are given at the end.

BRIEF REVIEW OF LITERATURE

In Sri Lanka, a few studies have investigated the effectiveness of the subsidy schemes in the plantation sector. According to Weerahewa *et al.* (2010), subsidies are only a government burden due to misappropriation and corruption in the distribution process in Sri Lanka. Contradicting this statement, Abeysinghe (2014), revealed that 32% increment in fertilizer usage (because of the fertilizer subsidy) generates a 17% increment in paddy yield in Matale district during 2005 to 2008 and Chatura & Katsuhiko (2017) revealed, complete reduction of fertilizer subsidy would reduce rice production by around 4%. In the global context, Holden & Fisher (2015) applied a three-year panel data analysis for 350 Malawian farm households to find out factors affecting for widespread adoption of drought-tolerant (DT) maize varieties. This study revealed that DT maize cultivation increased substantially from 2006 to 2012, due to the subsidy programmes. Trivedi (1992) applied aggregate time-series data and tried several concepts of vintage production models to deal separately with replanting decisions and new planting decisions regarding cocoa cultivation. And results show that replanting and new planting subsidies significantly change the profitability of the cocoa sector in Bahia, Brazil..

Karunasena (1985), Cooray (1995), and Kodituwakku (2001) studied the impact of land area and tea prices on tea production using macrolevel models. However, those studies have not considered subsidy schemes explicitly taking the dynamic aspect of tea subsidy using ARDL. Moreover, subsidy schemes may affect the replanting and then tea production of different altitude differently. The limited studies in Sri Lanka have not considered those altitude differences.

Most of the researchers have applied the ARDL approach to examine the existence of cointegration and to estimate short-run and long-run parameters in their

studies Tiwari & Shahbaz (2013), Narayan (2005), and Perman (1991) etc.

In an economy, change in any economic variables may bring change in another economic variable beyond the time. This change in a variable is not what reflects immediately, but it distributes over future period. So that ARDL model plays an important part when comes a need to analyze an economic scenario. The autoregressive distributed lag (ARDL) deals with single cointegration and is introduced originally by Pesaran and Shin (1999) and further extended by Pesaran *et al.* (2001).

This so called autoregressive distributed lag (ARDL) models are superior and popular since this method has certain econometric advantages in comparison to other single cointegration procedures. According to Halicioglu(2004), the reasons to apply ARDL are avoiding the endogeneity problems and inability to test hypotheses on the estimated coefficients in the long-run associated with the Engle-Granger method, the long and short-run parameters of the model are estimated simultaneously, all variables are assumed to be endogenous, and the econometric methodology is relieved of the burden of establishing the order of integration amongst the variables and of pre-testing for unit roots. Further he explained that all other methods require that the variables in a time-series regression equation are integrated of order one, i.e., the variables are $I(1)$, only that of Pesaran *et al.* could be implemented regardless of whether the underlying variables are $I(0)$, $I(1)$, or fractionally integrated.

DATA SOURCES AND METHODOLOGY

As mentioned earlier, this study investigates the impact of government subsidy schemes on tea production. We have taken the average tea price and tea land as control variables and a dummy variable to adjust the impact of irregular variations in two years, 1992 and 2016. Production of tea varies according to geographical elevations, and the subsidy also affects the output in different magnitudes. Moreover, production level, land area, and tea prices have been changing drastically according to the geographical elevations since 1970. Therefore, this study uses time-series data from 1970 to 2018 at three altitudes high, medium, and low. The data sources include Statistical Bulletin of the Tea Board, Various Annual Reports of Central Bank of Sri Lanka, Tea Small Holdings Development Authority, and the Department of Census & Statistics of Sri Lanka.

Table 1: Variable Notations

| Variable | High Grown | Medium Grown | Low Grown |
|-------------------|------------|--------------|------------|
| LOG(Production) | LOGQTHG | LOGQTMG | LOGQTLG |
| LOG(Subsidy) | LOGSUBSIDY | LOGSUBSIDY | LOGSUBSIDY |
| LOG(Tea price) | LOGTPHGA | LOGTPMGA | LOGTPLGA |
| LOG(Bearing Area) | LOGBAHG | LOGBAMG | LOGBALG |

We applied Augmented Dicky Fuller (ADF) unit root test developed by Dickey and Fuller (1981) to test the time-series properties of the collected data.

As explained in the literature review, three ARDL models have been developed to investigate long run and short run relationships among the variables of three elevations. The variable notations are displaying in the following Table 1 and ARDL representations of equations 1,2, and 3 are formulated accordingly.

ARDL model for High grown tea production is;

$$\Delta \ln QTHG_t = a_0 + \sum_{i=1}^m a_{1i} \Delta \ln QTHG_{t-i} + \sum_{i=0}^m a_{2i} \Delta \ln SUBSIDY_{t-i} + \sum_{i=0}^m a_{3i} \Delta \ln TPHGA_{t-i} + \sum_{i=0}^m a_{4i} \Delta \ln BAHG_{t-i} + \sum_{i=0}^m a_{5i} \Delta Dummy_{t-i} + a_6 \ln QTHG_{t-1} + a_7 \ln SUBSIDY_{t-1} + a_8 \ln TPHGA_{t-1} + a_9 \ln BAHG_{t-1} + a_{10} Dummy_{t-1}$$

ARDL model for medium grown tea production is;

$$\Delta \ln QTMG_t = a_0 + \sum_{i=1}^m a_{1i} \Delta \ln QTMG_{t-i} + \sum_{i=0}^m a_{2i} \Delta \ln SUBSIDY_{t-i} + \sum_{i=0}^m a_{3i} \Delta \ln TPMGA_{t-i} + \sum_{i=0}^m a_{4i} \Delta \ln BAMG_{t-i} + \sum_{i=0}^m a_{5i} \Delta Dummy_{t-i} + a_6 \ln QTMG_{t-1} + a_7 \ln SUBSIDY_{t-1} + a_8 \ln TPMGA_{t-1} + a_9 \ln BAMG_{t-1} + a_{10} Dummy_{t-1}$$

ARDL model for low grown tea production is;

$$\Delta \ln QTLG_t = a_0 + \sum_{i=1}^m a_{1i} \Delta \ln QTLG_{t-i} + \sum_{i=0}^m a_{2i} \Delta \ln SUBSIDY_{t-i} + \sum_{i=0}^m a_{3i} \Delta \ln TPLGA_{t-i} + \sum_{i=0}^m a_{4i} \Delta \ln BALG_{t-i} + \sum_{i=0}^m a_{5i} \Delta Dummy_{t-i} + a_6 \ln QTLG_{t-1} + a_7 \ln SUBSIDY_{t-1} + a_8 \ln TPLGA_{t-1} + a_9 \ln BALG_{t-1} + a_{10} Dummy_{t-1}$$

Investigation of the presence of a long-run relationship amongst the variables of three equations are tested by means of bounds testing procedure of Pesaran *et al*(2001). The bounds testing procedure is based on the F or Wald-statistics and is the first stage of the ARDL cointegration method testing following hypotheses;

H₀: Does not exist cointegration among variables

H₁: There exists cointegration.

Thus, two sets of critical values are computed by Pesaran *et al.* for a given significance level. One set assumes that all variables are I (0) and the other set assumes they are all I (1). If the computed F-statistic exceeds the upper critical bounds value, then there exists cointegration (H₀ is rejected). If the F-statistic

falls into the bounds, then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no cointegration.

Diagnostic tests, which include the serial correlation test (Breusch-Godfrey Test), normality tests (Jarque-Bera Test), heteroscedasticity (Breusch-Pagoan-Godfrey Test), and cumulative sum of recursive residuals (CUSUM) proposed by Brown *et al.* (1975), examined the validity of the ARDL models.

DATA ANALYSIS AND EMPIRICAL FINDINGS

Following table presents the descriptive analysis of the variables.

According to the summary values in Table 2, low elevation tea has highest amount of production, tea price, and bearing area while comparing values of the other two elevations.

The stationary tests, ARDL modelling (cointegration), and the validity tests of the ARDL models are given below.

The variables are tested for the presence of stationary by applying the Augmented Dickey-Fuller (ADF) unit root test before performing an econometric analysis. Table 3 report the results for high, medium, and low grown, respectively.

The results of the unit root test indicate that all the variables are stationary at I (0) or I (1) and this is to ensure that the none of the variables are in I (2). Therefore, this result leads us to proceed with the ARDL approach to examine the long-run relationship between tea production and tea subsidy treating other two variables; tea land and average tea price act as control variables, and a dummy variable.

Results of the ARDL bound testing approach to cointegration are shown in Table 4.

Results reported that F-statistics for high grown (4.72), medium grown (9.28) and low grown (5.91), are

Table 2: Descriptive Statistics

| Statistic | High Grown | Medium Grown | Low grown |
|--------------------------------------|------------|--------------|-----------|
| Average production (kg) | 75773989 | 54675762 | 125168749 |
| Average price per kg. (Rs.) | 145.20 | 136.34 | 161.62 |
| Average bearing area (hec) | 57305.3 | 74051.37 | 76232.12 |
| Average tea replanting subsidy (Rs.) | 124561.2 | 124561.2 | 124561.2 |

Table 3: Estimation of Unit Root Tests

| ADF Test | | | | | | | | |
|--------------|-------------|---------|--------------|-------------|---------|--------------|-------------|---------|
| High Grown | | | Medium Grown | | | Low Grown | | |
| Variables | t-Statistic | P-value | Variables | t-Statistic | P-value | Variables | t-Statistic | P-value |
| LOGQTHG | -4.54 | 0.006* | LOGQTMG | -2.57 | 0.11 | LOGQTLG | -1.03 | 0.73 |
| ΔLOG QTHG | -8.49 | 0.000* | ΔLOG QTMG | -11.19 | 0.000* | ΔLOG QTLG | -7.83 | 0.000* |
| LOGHGATP | -1.19 | 0.66 | LOGMGATP | -1.85 | 0.35 | LOGLGATP | -1.75 | 0.399 |
| ΔLOGHGATP | -6.61 | 0.000* | ΔLOGMGATP | -6.97 | 0.000* | ΔLOGLGATP | -6.63 | 0.000* |
| LOGBAHG | -0.46 | 0.89 | LOGBAMG | -1.12 | 0.70 | LOGBALG | -0.94 | 0.765 |
| ΔLOGBAHG | -6.27 | 0.000* | ΔLOGBAMG | -5.50 | 0.000* | ΔLOGBALG | -5.85 | 0.000* |
| LOGSUBSIDY | -1.95 | 0.30 | LOGSUBSIDY | -1.95 | 0.30 | LOGSUBSIDY | -1.73 | 0.409 |
| Δ LOGSUBSIDY | -5.67 | 0.000* | Δ LOGSUBSIDY | -5.68 | 0.000* | Δ LOGSUBSIDY | -5.66 | 0.000* |

Source: Author's own calculations.

Note: The asterisks * and ** denote the significant at 5% level and 1% level respectively.

Table 4: The Results of the Cointegration Test

| Panel I: ARDL Long Run Form and F Bounds Tests | | | |
|--|--|---|---|
| Elevation | High-Grown | Medium-Grown | Low-Grown |
| Estimated model | LOGBAHG, LOGHGATP, LOGSUBSIDY, DUMMY LOGQTHG | LOGBAMG, LOGMGATP, LOGSUBSIDY, DUMMY on LOGQTMG | LOGBALG, LOGLGATP, LOGSUBSIDY, DUMMY on LOGQTLG |
| ARDL | (3,0,1,3,2) | (1,3,1,2,2) | (4,4,3,2,4) |
| F-statistics | 4.72** | 9.28** | 5.91** |
| Outcome | Presence of cointegration at 1% | Presence of cointegration at 1% | Presence of cointegration at 1% |
| Critical values | | | |
| Lower Bounds | | Upper Bounds | |
| 2.5 percent level | | 3.15 | |
| 1 percent level | | 3.65 | |
| | | 4.08 | |
| | | 4.66 | |
| Panel II: diagnostic tests | | Statistics | Statistics |
| R ² | | 0.69 | 0.89 |
| Breusch-Godfrey Serial Correlation LM test | | 0.32(0.73) | 0.059(0.94) |
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | 1.91(0.07) | 0.44(0.94) |
| Normality Test Jarque-Bera Test | | 4.33(0.512) | 2.01(0.36) |
| CUSUM (See Appendix) | | Stable | Stable |
| | | Stable | Stable |

Source: Authors' own calculations.

Note: The asterisks * and ** denote the significant at 5% level and 1% level respectively. The parenthesis () is the probability values of diagnostic tests.

higher than the upper critical bound of 4.66 at 1% level of significance. These results imply that there are long-run relationships between tea production and the other three variables (tea replanting subsidy, tea land and tea price) in all three elevations. The diagnostic tests have been conducted to test whether the results are free from the problem of serial autocorrelation, heteroscedasticity and normality of residuals. The Table 4 shreds of evidence for the validity of these three models. Figures 1-3 in appendix depicts the stability of the models using the plot of the cumulative sum of recursive residuals (CUSUM TEST).

Table 5 depicts the short-run results and their robustness for three elevations. The previous year tea replanting subsidy is significant only for tea production in low elevation. Table 5 provided a negative and considerable error correction term for all three elevations indicating that any disequilibrium in the model of tea production will get corrected with the rate of adjustment of 127%, 105%, and 7% on an annual basis, in high, medium and low elevations respectively.

Table 5: Short Run Results from ARDL Error Correction Regression of High Grown, Medium Grown & Low Grown

| High Grown | | |
|-------------------|-------------|---------|
| Variable | Coefficient | p-value |
| CointEq(-1)* | -1.27 | 0.0000 |
| Medium Grown | | |
| CointEq(-1)* | -1.05 | 0.0000 |
| Low Grown | | |
| D(LOGSUBSIDY(-1)) | 0.177 | 0.0000 |
| CointEq(-1)* | -0.07 | 0.0000 |

CONCLUSIONS AND POLICY IMPLICATIONS

The main objective of this study was to analyse the short-run and long-run effects of tea replanting subsidy on tea production, considering the three geographical elevations in Sri Lanka. The results of ARDL bound testing revealed that there is a cointegration between tea production and three variables; tea replanting subsidy, tea prices and tea bearing area; in all three elevations. But when considering long run coefficients separately, the tea replanting subsidy is not significant with tea production in long run in all three elevations.

The short-run impact of the replanting subsidy on tea production is significant only for the low elevation area. We also found that the replanting subsidy has become more productive with a one-year time lag. The results of this study are different from that of Weerahewa *et al.* (2010).

According to our literature review, small tea holdings are in low elevation and the majority of them have a land area of less than one acre. And most of the planters apply for government subsidy schemes. This information and our empirical investigation suggest that subsidy schemes are more effective in replanting and on tea production in low elevation regions. Given the findings of this study, one can argue the government should continue the tea replanting subsidy schemes in Sri Lanka as it will pay off in the long-run.

APPENDIX

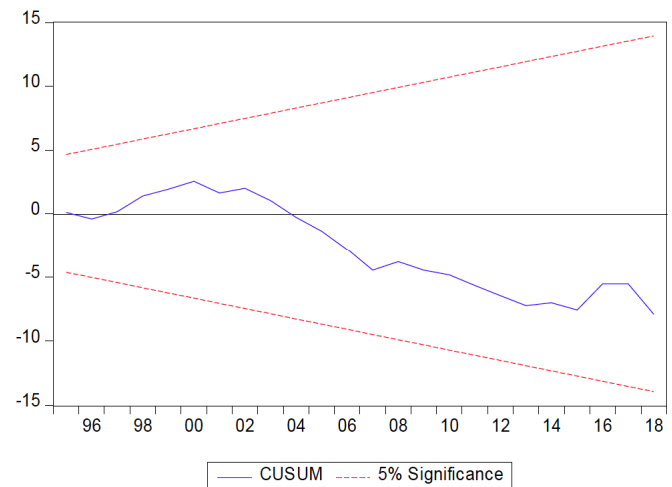


Figure 1: Stability Test for High Grown Tea Production.

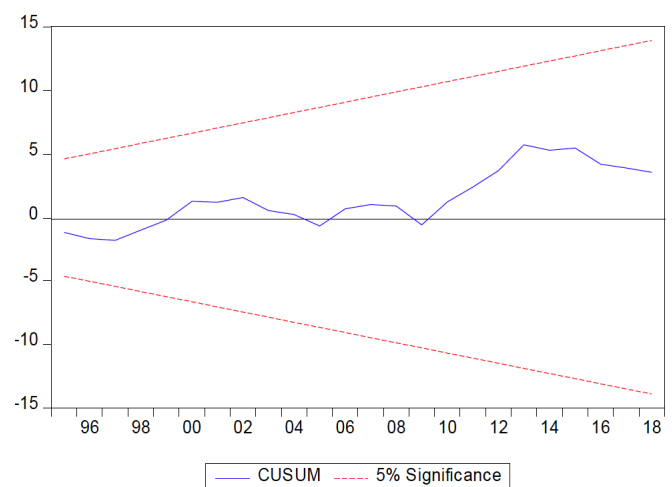


Figure 2: Stability Test for Medium Grown Tea Production.

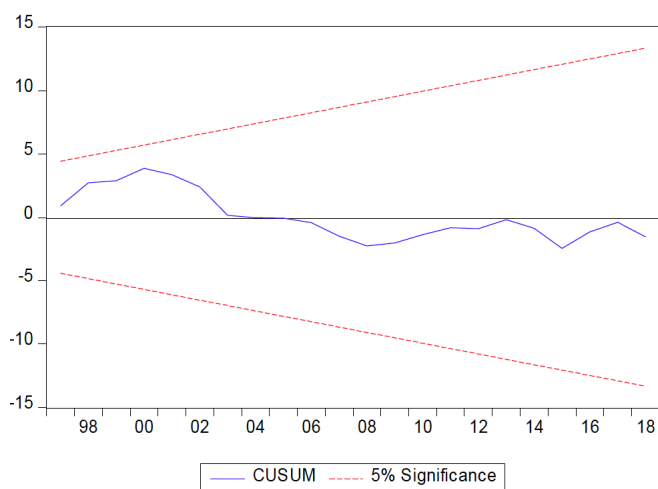


Figure 3: Stability Test for Low Grown Tea Production.

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