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Economic Impact of Trade Liberalization for Other Field Crops in Sri Lanka

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ABSTRACT. Reduction in import tariff on agricultural products in Sri Lanka will be inevitable due to commitments with global and regional trade agreements. Implications of such on Other Field Crop (OFC) sector is the main concern among the public in recent years, since it was the first to liberalize trade in the agricultural sector in Sri Lanka. The objective of this study is to assess the impact of reduction in price faced by Sri Lankan producers and consumers in the OFC sector. Partial equilibrium models were developed for potato, onion and chilli markets to achieve the objective of the study. Secondary data on production, consumption and prices was used to estimate the behavioral relationships in the models. Results of the estimation indicate that demand, supply and price transmission elasticities are inelastic. Results of the simulation show that gain in consumer surplus is much higher than the loss in the producer surplus in all sectors. Potato producers are more adversely affected than onion and chilli producers.

INTRODUCTION

Due to commitments with global and regional trade agreements such as General Agreement on Trade and Tariff (GATT), South Asian Preferential Trade Agreement (SAPTA), South Asian Free Trade Agreement (SAFTA) and Indo Lanka Free Trade Agreement and also due to pressure from donor agencies, Sri Lanka may have to lower import tariffs, in the agricultural sector. Implications of this on the Other Field Crop (OFC) sector, which was the first to face liberalized trade, is analyzed in this paper. This is a matter of concern to the general public in recent years as OFCs make an important contribution to the Sri Lankan economy.

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Production of OFCs accounted for 7.62% of total agricultural production in the country. Production of potato, onion and chilli contribute 36.2% to the total OFC production (Central Bank, 1996). Of the total extent under OFCs cultivation in Sri Lanka, these three crops contribute 23.9%. The total imports of these three crops in 1997 were 240,961 Mt (Central Bank, 1997). The economic significance of OFCs in the Sri Lankan economy is given in Table 1.

Table 1. Economic significance of OFCs (1995).

Crop	Production (MT)	Consumption (MT)	Imported Quantities (MT)	Extents Cultivated (Ha)
Potato	101,581	113,563	11,982	9,025
Chilli	28,048	38,868	10,820	28,112
Onion	112,549	162,763	50,214	12,174

Prior to liberalization, policies in the OFC sector were biased towards producers (Athukorala and Kelegama, 1996). According to neo-classical economic theory, free trade improves the efficiency of countries engaged in trade, even though it may have adverse impact on equity. Relative magnitudes of the gains and losses due to trade liberalization depend on price responsiveness and hence, welfare gains and losses may differ from sector to sector. The objective of this paper is to assess the impact of price reduction caused by trade liberalization on the OFC sector on domestic producers and consumers, consumption, production, and consumer and producer welfare.

Past studies to evaluate different policies in the OFC sector have provided estimates of Nominal Protection Coefficient (NPC) and Effective Protection Coefficient (EPC). The NPC, which is the ratio of domestic price to boarder equivalent price, measures the incentives provided for the outputs whereas EPC, which is the ratio of value added at domestic price to value added at world prices, measures the incentives provided for production in terms of traded inputs. According to Shilpi (1995) NPC for potato, onion and chilli in 1993 was 1.6, 2.0 and 1.3 respectively. The average EPC for these

crops was 1.53. Even though these indices show the degree of protection provided for OFC producers, they cannot be used for assessing the welfare implications of trade liberalization. This study uses a partial equilibrium model to overcome this limitation.

METHOD

Conceptual model

The partial equilibrium model adopted in this paper, consists of 6 equations; (*i.e.*, Supply equation, Demand equation, Price linkage equation, Quantity linkage equation and Equations for consumer surplus and producer surplus) for each market (Sadoulet and Janvry, 1995). The endogenous variables in the models are supply, demand, imports, farm gate price and consumer and producer surplus. Retail price was considered as exogenous since it depends on the world market price. The equations for the model used are discussed below.

(i) Demand equation

Demand function shows the relationship between demand for a commodity and price of the commodity, prices of substitutes and complements, income and taste and preferences. Algebraically the demand function is given by,

$$Q_d = f(P_d, P_i, M, t)$$

Where,

Q_d = Quantity demanded
P_d = Retail price
P_i = Prices of substitutes and complements (i = 1, 2 ... n)
M = Income
t = Index for taste and preferences

(ii) Supply equation

Supply function which shows the relationship between the supply of a good with own price, input prices and technology, is given by,

$$Q_s = g(P_s, P_i, t)$$

Where,

Q_s = Quantity supplied
P_s = Producer price
P_i = Prices of inputs (i = 1, 2 ,3... n)
t = Index for technology

(iii) Price linkage equation

Price linkage function links the producer price of the commodity with the retail price of the commodity, which depends on the world market price and tariff rate.

$$P_s = h(P_d) \; : \; P_d = P_w(1 + tr)$$

Where,

P_w = World market price
tr = Tariff rate
P_s = Producer price
P_d = Retail price

(iv) Quantity linkage equation

If the market is open, and commodities are traded across the boundaries, then the equilibrium condition is achieved when,

$$Q_d = Q_s \pm T$$

Where,

T = Trade (Imports or exports)

(v) Consumer surplus

Consumer surplus (CS) which is measured by the area below the demand curve above the price line is given by,

$$CS = \int P_d Q_d \cdot dQ_d - P_d Q_d$$

(vi) Producer surplus

Producer surplus (PS) which is measured by the area above the supply curve and below the price line is given by,

$$PS = P_s Q_s - \int P_s Q_s \cdot dQ_s$$

Figure 1, further explains the structure of the model. The supply is Q_s and the demand for the commodity is Q_d.P* would be the domestic price (assumed as the average of producer and retail prices for graphical representation only) and P** would be the price line after the reduction in price due to trade liberalization.

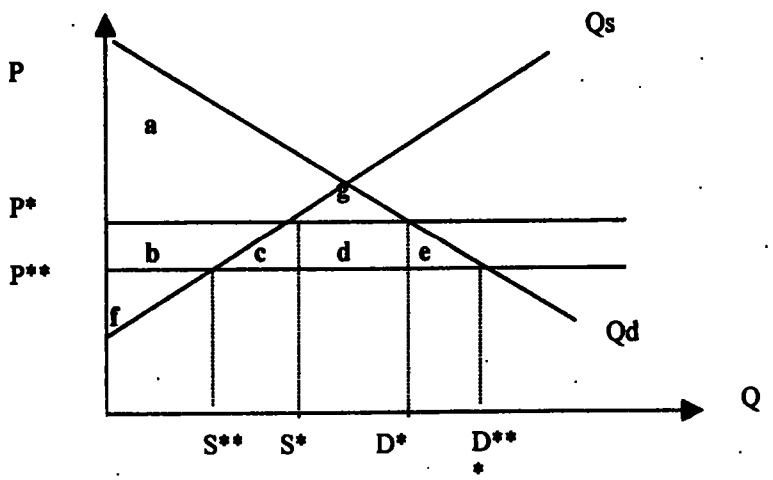

Figure 1. Graphical representation of the model.

Before the price reduction equilibrium quantity supplied was S* and quantity demanded was D* where the imports are given by (D* - S*). After the price reduction due to trade liberalization the equilibrium quantity supplied was S** and quantity demanded was D** where the imports are given by (D** - S**).

Before trade liberalization;

Consumer surplus	= a + g
Producer surplus	= f + b

After trade liberalization;

Consumer surplus	= a + b + c + d + e + g
Producer surplus	= f

Impact of trade liberalization;

Consumer gain	= b + c + d + e
Producer loss	= b
Total welfare gain	= c+d+e

Empirical model

Even though the conceptual model was developed based on the theory, the exact specification of the equations may depend on the type of the crop and the behavior of the agents. The following section presents the model specified for each market.

Potato

The following per capita demand equation for potato was specified in linear form and total demand was obtained by multiplying the per capita demand by population.

$$Qd = d_0 + d_1 Pr + d_2 M$$

Where,

Qd = Per capita quantity demanded (MT)
Pr = Retail price of potato (Rs/ Kg)
M = Per capita income (Rs)
d_0, d_1 and d_2 are parameters.

Area under potato cultivation was specified as a log-log function as given below and the supply was obtained by multiplying area (A) and yield per unit area (Y).

$$lA = a_0 + a_1 lPp + a_2 lPw + a_3 lPf$$

Where,

lA = log of area (Ha)
lPp = log of producer price (Rs/Kg)
lPw = log of wage rate (Rs/Md)
lPf = log of fertilizer price (Rs/Kg)
a_0, a_1, a_2 and a_3 are parameters

Onion

Demand function for onion which was specified as a linear function of retail price, income and time trend is given by,

$$Qd = d_1 + d_2 Pr + d_3 M + d_4 t$$

Where,

Q_d = Per capita quantity demanded (MT)
Pr = Retail price of onion (Rs/kg)
M = Per capita income (Rs)
t = Time trend
d_1, d_2, d_3 and d_4 are parameters

The supply of onion is specified as a function of producer price of onion and previous year supply.

$$Qs = s_1 + s_2 Qs_{-1} + s_3 Pp$$

Where,

Q_s = Quantity supplied (MT)
Pp = Producer price of onion (Rs/kg)
Qs_{-1} = lagged quantity supplied (MT)
s_1, s_2, and s_3 are parameters

Chilli

Demand function for chilli which was specified as a log-log function of retail price of chilli, per capita income, price of pepper, and the trend variable is given by,

$$lQd = d_1 + d_2\, lPr + d_3\, lPp + d_4\, lM + d_5\, t$$

Where,

lQ_d = log of per capita quantity demanded (MT)
lP_r = log of retail price of chilli (Rs/kg)
lP_p = log of price of pepper (Rs/kg)
lM = log of per capita income (Rs)
t = Time trend
d_1, d_2, d_3, d_4, and d_5 are parameters

Production of chilli which was specified as a log-log function of previous year price, previous year fertilizer price and the time variable is given by,

$$lQ_s = s_1 + s_2\, lPp_{-1} + s_3\, lPf_{-1} + s_4\, t$$

Where,

lQ_s = log of quantity supplied (MT)
lPp_{-1} = log of 1 year lagged average producer price of chilli (Rs/kg)
lPf_{-1} = log of 1 year lagged fertilizer price (Rs/MT)
t = Time trend
s_1, s_2, s_3 and s_4 are parameters

DATA

Secondary data for the study were gathered from Central Bank Annual Reports (1983, 1987, 1993), Hector Kobbakaduwa Agrarian Research and Training Institute, the Department of Agriculture and Fertilizer Secretariat of Sri Lanka. Data sources and means and standard deviations of the data used for the study are annexed in Appendices 1, 2 and 3.

RESULTS AND DISCUSSION

Results of the estimates

All the functional forms were estimated using Ordinary Least Square method except for chilli supply and onion demand, which were estimated using first order auto regression technique. Goodness of fit values for demand

functions for potato, onion and chilli were 0.44, 0.51 and 0.44 respectively. Goodness of fit values for supply functions for potato, onion and chilli were 0.65, 0.82 and 0.27 respectively. The detailed regression results are presented in Appendices 4, 5 and 6.

The estimated elasticities, which explain the percentage change in the dependent variable due to one percent change in one of its explanatory variables, are provided in the Table 2. All the supply elasticities with respect to own price are positive and demand elasticities with respect to own price are negative, and are inelastic even though they are not statistically significant for the chilli model.

Recent studies show that the income and price elasticities of potato are 2 and 1.2 respectively (Suraweera and Agalawatte, 1983). According to Naleem (1996), supply elasticities with respect to fertilizer use for potato, red onion, big onion and chilli are, 0.06, 0.21, 0,18 and 0.01, respectively.

Table 2. Results of the estimation.

Variables	Potato	Onion	Chilli
Supply elasticity with respect to Own price	0.19 (2.94)**	0.06 (1.70)*	0.69 (1.0)
Supply elasticity with respect to Input price	-0.36 (2.99)**	n.a.	-0.56 (1.08)
Demand elasticity with respect to Own price	-0.73 (3.66)**	-0.285 (3.01)**	-0.31 (0.86)
Demand elasticity with respect to Income	0.37 (2.15)**	-1.23 (1.78)*	0.55 (0.30)
Price transmission elasticity	0.75 (5.62)**	0.54 (4.16)**	0.95 (4.94)**

(Figures in parenthesis are t statistics)
** - Significant at 5%
* - Significant at 10%

Results of the validation

The estimated equations were used to develop simulation models for potato, chilli and onion markets. Validation statistics such as correlation

coefficient and percentage biases of the actual and predicted variables for the market models are calculated to check the validity of the model (Table 3). The correlation coefficient provides the degree of the relationship between the actual and predicted series whereas the minuteness of the mean of the deviation of predicted values and actual values are given by bias. Higher the correlation coefficient, higher the validity of the model and lower the bias higher the validity of the model (Table 3).

In the case of potato, the correlation coefficient between actual and predicted values for retail price and production are around 80% and the percentage biases are significantly low. The correlation coefficients for all the variables in onion model are above 60%, showing a very high correlation between actual and predicted series of all the variables. The percentage biases are less than 1% in onion model. However in the chilli model correlation coefficients are relatively low and percentage bias values are relatively high. Despite the problems in chilli model, all the models were used for the simulation experiments.

Table 3. Results of the validation tests.

Variables	Potato		Onion		Chilli	
	Correlation Coefficient	% Bias	Correlation Coefficient	% Bias	Correlation Coefficient	% Bias
Demand	0.25	0.0011	0.85	0.0593	0.28	0.0527
Supply	0.79	0.0029	0.85	0.0123	0.05	0.8694
Retail Price	0.84	0.0194	0.76	0.0378	0.77	0.0009

Results of the Policy Simulation

The results of the simulation experiments on trade liberalization for potato, onion and chilli markets are given in Tables 4 to 6.

According to Table 4, which shows the production, consumption and price effects in the potato market, 10% reduction in retail price increases consumption by 3.96% and decreases production by 2.02% due to reduction in farm gate price by 5.54%. Further reduction in retail price, *i.e.*, by 20%,

increases consumption by 7.94%, decreases production by 4.22% due to 12.3% reduction in farm gate price. Reduction in prices by 10% and 20% increases consumer surplus from the base by Rs. 193 million and Rs. 276 million, respectively. However, reduction in price has an adverse effect on producers. It is estimated that producer welfare decrease from the base by Rs. 89 million and Rs. 126 million due to reduction in retail price by 10% and 20% respectively.

Table 4. Results of the simulation on production, consumption and farm gate price for potato, at the mean of the sample (1984 to 1993).

Variable	Units	Base	10% reduction in retail price	20% reduction in retail price
Demand	MT	82084.67	85336.75 (3.96)	88606.00 (7.94)
Supply	MT	80883.60	79252.60 (-2.02)	77468.00 (-4.22)
Farm gate price	Rs/kg	26.91	25.42 (-5.54)	23.60 (-12.30)
Imports	MT	1201.07	6084.15 (4.06)	11138.00 (8.2)

(Figures in parenthesis are percentage change from the base).

According to Table 5, which shows the production, consumption and price effects in the onion market, 10% reduction in retail price increases consumption by 3.55% and decreases production by 28.01% due to reduction in farm gate price by 7.61%. Further reduction in retail price, *i.e.*, by 20%, increases consumption by 6.60%, decreases production by 51.36% due to 13.92% reduction in farm gate price. Reduction in prices, which leads to increase in consumption, increases consumer surplus from the base by Rs. 246.73 million and Rs. 250.48 million, respectively. However reduction in price has an adverse effect on producers. It is estimated that producer welfare

Table 5. Results of the simulation on production, consumption and farm gate price for onion, at the mean of the sample (1984 to 1995).

Variable	Units	Base	10% reduction	20% reduction
Demand	Kg/capita	5.91	6.12 (3.55)	6.30 (6.60)
Supply	MT	16682.56	12009.18 (-28.01)	8114.69 (-51.36)
Farm gate price	Rs/kg	19.32	17.85 (-7.61)	16.63 (-13.92)
Imports	MT	3868.27	12129.32 (213.56)	19013.52 (391.53)

(Figures in parenthesis are percentage change from the base)

decrease from the base by Rs. 34.93 million and Rs. 55.47 million due to reduction in retail price by 10% and 20% respectively.

According to Table 6, which shows the production, consumption and price effects in the chilli market, 10% reduction in retail price increases consumption by 3.12% and decreases production by 6.13% due to reduction in farm gate price by 8.67%. Further reduction in retail price, *i.e.* by 20%, increases consumption by 5.80%, decreases production by 11.37% due to 99.94% reduction in farm gate price. Reduction in prices by 10% and 20% increases consumer surplus from the base by Rs. 308.23 million and Rs. 312.58 million, respectively. Reduction in price has an adverse effect on producers. It is estimated that producer welfare decrease from the base by Rs. 1.50 million and Rs. 2.67 million due to reduction in retail price by 10% and 20% respectively.

Table 7 shows that consumers gain due to both levels of price reductions whereas the producers lose. Among the three markets, chilli market shows the highest change in consumer surplus and lowest change in producer surplus.

Table 6. **Results of the simulation on production, consumption and farm gate price for chilli at the mean of the sample (1986 to 1994).**

Variable	Units	Base	10% price reduction	20% price reduction
Demand	Kg/capita	2.24	2.31 (3.12)	2.37 (5.80)
Supply	MT	303.62	285.01 (-6.13)	269.09 (-11.37)
Farm gate price	Rs/kg	65.64	59.95 (-8.67)	36.49 (-99.94)
Imports	MT	37714.15	38891.90 (3.12)	39996.86 (6.05)

(Figures in parenthesis are percentage change from the base)

Table 7. **Results of the welfare analysis at the mean of the sample (in Rs. Million).**

Crop	Sample	Change in consumer surplus		Change in producer surplus	
		10% Price Reduction	20% Price Reduction	10% Price Reduction	20% Price Reduction
Potato	1984 - 1993	193.00	276.00	-89.00	-126.00
Onion	1984 - 1995	246.73	250.48	-34.93	-55.47
Chilli	1986 - 1994	308.23	312.58	-1.50	-2.67

CONCLUSIONS

This study examines economic impact of trade liberalization in the OFC sector in Sri Lanka. Despite public concern over trade liberalization, this study reveals that consumer gain due to tariff reductions which cause 10% in real price, as high as Rs. 193.00, 246.73 and 308.23 million in potato, onion and chilli markets respectively and producer losses are as low as Rs. 89.00,

34.93 and 1.50 million respectively. This study does not compute government costs of trade liberalization due to unavailability of accurate data and hence does not provide welfare gains and losses to society. According to the implicit assumptions models constructed, consumer gains are high enough to compensate such losses as well.

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APPENDICES

Appendix 1. Means and standard deviation of data used for potato.

Variable	Units	Source	Mean	Standard Deviation
Production	MT	DOA	81747.50	7717.040
Consumption	MT	DOA	80960.42	7459.057
Imports	MT	DOA	747.08	257.990
Farm gate price	Rs/kg	DOA	18.99	11.080
Retail price	Rs/kg	DOA	27.77	14.180

DOA - Department of Agriculture

Appendix 2. Means and standard deviation of data used for onion.

Variable	Units	Source	Mean	Standard Deviation
Production	MT	CB	12703.21	12952.98
Retail price of B. onion	Rs/kg	CB	0.03	0.01
Retail price of red onion	Rs/kg	CB	0.03	0.01
Population	,000	CB	16316.06	1135.58
GNP	Rs. mill	CB	236774.65	168112.14
Imports	MT	HARTI	27.84	23.88
CPI	-	CB	870.56	479.21
Production	MT	CB	82469.82	25057.38
Producer price of B. onion	Rs/kg	CB	18.89	7.86
Price of fertilizer	Rs/MT	FS	5303.40	2544.17
Price of labour	Rs/md	CB	61.99	35.69
Producer price of red onion	Rs/kg	CB	17.42	8.69
PPI	-	CB	568.21	191.01

CB - Central Bank of Sri Lanka
HARTI - Hector Kobbakaduwa Agrarian Research and Training Institute
FS - Fertilizer secretariat

Appendix 3. Means and standard deviation of data used for Chilli.

Variable	Units	Source	Mean	Standard Deviation
Production	MT	CB	31910.60	6989.22
Retail price of chilli	Rs/kg	CB	72.77	36.82
Retail Price of pepper	Rs/kg	CB	87.18	39.30
Population	,000	CB	16546.66	999.55
GNP (per capita)	Rs. mill	CB	15158.73	8568.34
Imports	MT	HARTI	5135.06	3538.51
CPI	-	CB	946.43	458.05
Producer Price of Chilli	Rs/kg	CB	60.65	29.36
Price of fertilizer	Rs/MT	FS	5285.90	2268.65
Price of labour	Rs/md	CB	82.12	38.94

CB- Central Bank of Sri Lanka
HARTI-Hector Kobbakaduwa Agrarian Research and Training Institute
FS- Fertilizer Secretariat

Appendix 4. Regression results of the potato model.

Function	Variable	Co-efficient	Goodness of fit Durbin-Watson
Demand	Constant	6.72 (5.9)	R^2=43.60
	Retail price	-122.063 (3.66)	DW=2.35
	Income	0.107 (2.15)	
	Trend		
Area response	Constant	7.13 (11.55)	R^2=64.5
	Laged farm gate price	0.19 (2.94)	DW=2.01
	Laged wage rate	-0.36 (3.26)	
	Fertilizer price	-0.13 (2.99)	
Price linkage	Constant	0.013 (4.66)	R^2=72.10
	Farm gate price	0.757 (5.62)	DW=2.06

(Figures in parenthesis are t statistics)

Appendix 5. Regression results of the onion model.

Function	Variable	Co-efficient	Goodness of fit Durbin-Watson
Demand	Constant	22.76 (3.28)	R^2=51.12
	Retail price	-191.97 (3.01)	DW=2.05
	Income	-1079 (1.78)	
	Trend	0.33 (1.64)	
Supply	Constant	-9923 .7(1.14)	R^2=82.36
	Lagged supply	0.89 (6.15)	DW=1.69
	Farm gate price	409672 (1.70)	
Price linkage	Constant	0.01 (1.66)	R^2=59.15
	Farm gate price	0.54 (4.16)	DW=0.74

(Figures in parenthesis are t statistics)

Appendix 6. Regression results of the chilli model.

Function	Variable	Co-efficient	Goodness of fit Durbin-Watson
Demand	Constant	1.66 (0.55)	R^2=43.9
	Retail price	-0.31 (0.86)	DW=2.1
	Pepper price	-0.14 (1.90)	
	Income	-0.55 (0.30)	
	Trend	0.02 (0.90)	
Supply	Constant	-12.98 (5.1)	R^2=27.18
	Laged farm gate price	0.69 (1.0)	DW=2.98
	Laged fertilizer price	-0.56 (1.08)	
	Trend	-0.59 (1.02)	
Price linkage	Constant	0.02 (2.03)	R^2=67.1
	Farm gate price	0.95 (4.94)	DW=1.16

(Figures in parenthesis are t statistics)