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Empirical Evaluation of Performance and Effect of Currency Devaluation with Special Reference to Export and Import under Policy Reforms on Sri Lanka's Agriculture

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In this paper an empirical evaluation of the performance of Sri Lanka's agricultural sector under policy reforms with respect to the exchange rate implications is made. By the policy reforms, the exchange rate reforms made considerable impact on the agriculture exports, input and food imports and economic development. In our general equilibrium growth accounting approach, the real contributions of agricultural exports, food imports and fertilizer price reveal that without the exchange rate reform the contributions would have been really detrimental to the agricultural production as well as to the economy of Sri Lanka. In this way, Sri Lanka's policy reform had a positive effect on the economy through the exchange rate reform, although it had negative impact on the domestic food production sector and related small farmers. Further analysis on the contributions of technical changes in agriculture and non-agriculture supports the push-pull effect concept in both sectors in this paper.

Key words: general equilibrium growth accounting, exchange rate, domestic food production sector, policy reform, Sri Lanka's economy, push-pull effect.

1. Introduction

Since 1977, Sri Lanka implemented a far reaching program of economic policy reforms, mainly under the structural adjustment policy packages designed and introduced by the World Bank. Therefore, the major economic policy reforms implemented in Sri Lanka includes following aspects such as reduction of protection provided to the import competing sectors, provision of incentives to export oriented sectors, exchange rate adjustments, fiscal and monetary reforms, liberalization of domestic factors and product markets from government intervention thus allowing free play of market forces and privatization of government owned enterprises (Central Bank of Sri Lanka Annual Reports, various years). Athukorala and Jayasuriya [1] in 1994, Bandara and Gunawardana [2] in 1989 mainly studied the historical process of economic reforms in Sri Lanka, particularly in relation to macroeconomic effects.

The impact of such policy reforms on the domestic food sector was not evaluated having understood its importance in terms of contribution to the national income and employment. It is also important to study the relevant periods in which various economic policy packages were implemented. In 1977 the new government which came to power introduced structural adjustment policy programs to resuscitate the Sri Lankan economy. The agricultural sector also faced many policy changes under policy reforms through trade policy, fiscal and monetary policies and privatization programs. In this paper, we give more emphasis to agricultural exports as well as food imports and fertilizer price changes in relation to exchange rate reforms.

Two methods are commonly used to investigate the impact of macro economic policy changes. The first method uses the usual esti-

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mation method using least square approach. The parameters of this method are estimated values, and thus the conclusion depends on estimated values. The second method uses the CGE model. There are several methods for adopting the parameters of the second model. However, the most widely prevailing method uses the parameter values which are prepared in the CGE package. The problem with the first method is that the conclusion depends on the estimated values. Therefore, the estimated values absolutely influence the whole conclusion. Therefore, sensitivity tests are very important and often made to obtain a robust conclusion. The problem with the second method is that the packaged parameter values strongly influence the conclusion. The authors can manipulate the conclusion by using many kinds of combinations of parameter. The works of Kelley and Williamson [8, 9] are a typical example. They obtained completely opposite conclusions for the contribution of the Japanese population to economic development. They concluded a very optimistic view for the Japanese population in one book but a very pessimistic view in another book, even though they used exactly the same model (but using different parameters).

Therefore, we use General Equilibrium Growth Accounting approach to evaluate the impact of exogenous variables on endogenous variables, and the following sections deal with these aspects in detail. In our model, we use parameters estimated (which are fully checked with other works like Houthaker [6] and Jureen [7]) using real data or estimated from real data for Sri Lanka. The most important merit of this model is that it explains almost all of the real features because it adopts the method of growth accounting.

2. Sri Lanka's Exchange Rate Reforms

This section describes what actually has been done under the Macroeconomic reforms and the Structural Adjustment Policies (SAP) adopted since 1977. The experience of Sri Lanka may be conveniently understood in terms of periodizing the era in which major policy reform events took place. During the phase from 1977 to 1978 is considered as the initial stage of these reforms. First the Foreign Exchange Entitlement Certificate (FEEC) scheme was abolished and the exchange rate was unified at a depreciated level. The Convertible Rupee Accounts (CRA), introduced in 1973 to grant import entitlement facilities to non-traditional exporters, was withdrawn. Measures were also taken to revise the export and import duty structure entirely. Quantitative Restrictions and Exchange Control restrictions on most goods and services were also abolished.

During the period of 1979 to 1981, subsidies in wheat flour, fertilizer, milk products and petroleum products were reduced. The Sri Lankan currency Rupee was substantially devalued (by 46%) and the exchange rate unified. Amendments to the Finance Act were introduced to enable foreign banks to operate in Sri Lanka. Universal food subsidies were removed and replaced by a food stamp scheme. An attractive package for Foreign Direct Investment (FDI) including the creation of a Free Trade Zone (FTZ), relaxation of import licensing requirements, and an offer of tax holidays was introduced. In response, the IMF gave Sri Lanka and External Fund Facility (EFF) the period 1979 to 1981 to help reduction of unemployment, maintain an average annual rate of GDP growth of 6%, and to contain inflation.

The process of liberalization was accelerated after 1989. A number of restrictions on imports, travel abroad and foreign education were relaxed. In order to attract foreign capital, restrictions on foreign participation at the Colombo Stock Exchange were eased off. Extended facilities were also granted to foreigners for making investments under Board of Investment (BOI). Furthermore, the following measures were taken.

- Reduction of the maximum nominal tariff on imports from 100% to 50% and the introduction of a four-band tariff.
- Tax reforms to reduce income and corporate taxes and the abolition of wealth and capital gains taxes to stimulate the capital market.
- The progressive elimination of export duties on traditional crops, further devaluation of the rupee and a major drive towards export-led growth.
- Further liberalization of the commodity market: prices of certain key commodities (wheat and fertilizer) were aligned with the world market price.

- Liberalization of exchange controls on the current account of the balance of payment and the abolition of the compulsory currency surrender requirements for exports.
- A high interest rate policy to bring the level of inflation to a single digit figure.
- A program of privatization with the objective of reducing the fiscal burden on the government.

In 1992, the management of the state-owned plantation sector was put in private hands and attempts were made to restructure the two state-owned banks. Following the removal of exchange control restrictions on current account transactions, in March 1994 Sri Lanka accepted Article VIII status of the IMF. Accordingly, Sri Lanka agreed not to impose any restrictions on import or export of goods and services.

The actions described above have been taken in terms of macroeconomic and structural adjustment to which the government committed itself. The two processes are related, but it must be understood that there are important conceptual differences between them. Macroeconomic reforms aim at stabilization in the short and medium term where as structural adjustment was oriented to the long-term adjustment towards opening the market. The former included the aim of rapid restoration of macroeconomic balance through the adoption of policies to reduce both the level and composition of aggregate demand. That is, it concentrated on demand-reducing and expenditure-switching policies. The SAP on the other hand had the long-term goals of improving the efficiency and growth rate of the economy including its flexibility and adaptability through liberalization of trade and domestic pricing policies and institutional reform through the structural and sectional adjustment loans.

The principal SAPs included those relating to fiscal, exchange rate, pricing, trade, income, credit, and institutional reforms. The details of these components and the policy tools of Sri Lanka's SAPs are briefly reviewed below.

1) Fiscal policies

A major objective of the stabilization program has been to reduce the budget deficit via both reductions in government spending and increase in tax revenue. Government spending may be cut on recurrent expenditure (e. g. reduction in public sector wages, food subsidies) and public sector investment and lending to the private sector. Its major aim was the reduction of government intervention, the privatization of the economy and the reduction of the size of the public administration.

2) Exchange rate policies

Since this was one of the key aspects under the SAP, we analyzed this effect on Sri Lanka's agriculture under these policy reforms in this paper. Devaluation of the exchange rate to make the currency realistic was central to the structural adjustment. This measure though could have inflationary impact, but it could also increase the volume of exports. The monetary and fiscal instruments are demand reducing but do not necessarily ensure that simultaneous balance is achieved on both the government budget deficit and the balance of payments. To ensure this, additional instruments to change the composition of demand from foreign to domestic goods and to increase incentives for production of exports and or import substituting goods are needed.

3) Pricing policies

Since the price mechanism was believed to be the best system for the allocation of resources, price controls were removed and the market was allowed to work so that the economy was able to produce all those goods and services for which it had comparative advantage. Price control and subsidies have frequently been used in developing countries both to stabilize the markets and to achieve income support for the poorer groups in the society. The WB and IMF regarded these as a major domestic distortion and source of economic rigidity. Dismantling of agricultural input subsidies and food subsidies were therefore recommended.

4) Trade policies

Under this, the external trade liberalization aimed to improve resource allocation, reducing protection for some commodities due to comparative advantage and to increase aggregate supply, eliminating inflationary pressures.

5) Income policies

Wage control was one of the most important measures of stabilization policies but it was also used in the SAPs too. The objective

was to reduce the domestic demand (consumption) so the pressure on the demand side will decrease. This was considered to eliminate the cost push on production costs so that there would be less inflation.

6) Credit policies (financial liberalization)

IMF had two main instruments, credit ceilings and higher interest rates. The objectives were to reduce inflation, to increase real savings, and to rationalize the use of domestic credit/savings. These measures could also bring negative impacts such as inflation associated with high interest rates. Hence lifting interest rate controls was suggested to increase savings and improve resource allocation and more investments.

7) Institutional reforms

In order to get the positive impact of the SAP, through supply response, non-price measures should be combined with the trade and domestic pricing reforms. Under this, in addition to the pricing policies, varying degrees of institutional reforms and privatization programs were considered. This included institutional reforms on infrastructure development, stimulation of technological innovation (in agriculture) and extension services. It also included the privatization of the state-owned estate sector (please see Dunham and Kelegama [4], Gunawardana [5], and Lakshman [10] for further detail).

These policy reforms, in terms of positive relationship among above mentioned variables, aimed economic growth. Though theoretically it may be correct, we intended to analyze the impact of this on Sri Lanka's agriculture sector. Here we used the agriculture production, food consumption, GDP growth and agriculture input variables as proxies to see the exchange rate effect on these. The following sections deal with the model description and empirical results and their interpretation.

3. Model for Empirical Framework

In our analytical framework, the following assumptions are made. First, we assume that agriculture will produce three products (or sectors): exportable (sector 1), import substitute (sector 2) and the final one is both domestically produced and consumed (sector 3). Second, we assume that aggregate agricultural production will depend on factors that are fixed in the short term such as land and capital as well as variable factors such as labor and imported input fertilizer. Here the fertilizer price, which is considered as an important policy actor in this study, is given for agriculture and will change under adjustment. Third, we also assume that another important policy actor, the price of the non-agricultural sector will be determined by factors largely outside agriculture in order to see the effect of it on endogenous variables.

In our model, a three sub-sectors model with the GRM (Growth Rate Multiplier) approach, which calculates the effect of policy variables on target variables (please see the detailed explanation on page 21), is used to find the major policy effects. [1] Here the economy was assumed to be of two sectors, agriculture and non-agriculture. In order to evaluate the impact of the plantation sector, the agricultural sector has been further divided into three sub-sectors. The basic framework of the model was developed using the initial work done by Sarris [12] in 1990. In our static model, we have 23 equations which include 2 agricultural and non-agricultural production functions, 3 consumption functions, equations for income and equations for labor allocation in both sectors. [2]

The detailed description of the variables and the parameters are those used in the model given below.

Description of Variables

Target (endogenous) variables (21 variables)

Variables		Description
1	X_i	Agricultural output of sector i, where $i=1, 2, 3$
2	X_A	Aggregate output of agricultural sector (sector 1, sector 2, and sector 3)
3	C_1	Domestic consumption of sector 1
4	C_2	Domestic consumption of sector 2
5	C_3	Domestic consumption of sector 3
6	C_f	Food consumption from sectors 2 and 3
7	P_i	Agricultural prices of three sub-sectors, where $i=1, 2, 3$
8	P_f	Price of food consumption (sectors 2 and 3)

9	P_A	Agricultural price
10	CPI	Consumer price index
11	DEF	Deflator
12	L_A	Total agricultural labor force
13	Y	Nominal GDP
14	GDP	Real GDP
15	E	Per capita income
16	X_N	Non-agricultural output
17	L_N	Non-agricultural labor force

Policy (exogenous) variable (11 variables)

Variables		Description
18	E_1	Exports of agricultural sector 1
19	M_2	Food imports such as basic cereals that are perfect or near perfect substitutes
20	d	Demand shifter of consumption (sector 1)
21	e	Demand shifter of consumption (food, sectors 2 and 3)
22	T_A	Technical change in agriculture
23	T_N	Technical change in non-agriculture
24	P_F	Fertilizer price
25	P_N	Non-agricultural price
26	L	Total labor
27	N	Population
28	L_{A0}	Initial value of agricultural labor

Variables: 2, 9-19, 25-27; Central Bank of Sri Lanka, 1, 3-8, 22-24, 28; HARTI, Sri Lanka, 20, 21; calculated by authors from residuals.
* Further details on the parameters are available from the authors upon request.

Having explained the Variables and Parameters we used in our model, here, we start to explain our model which is a wide extension of the Sarris model. The Aggregate production function for agriculture will be of the form

$$X_A = T_A L_A^a X_F^b \qquad a, b>0 \quad a+b<1 \text{ (A-1)}$$

The aggregate supply of agriculture will be given by maximization of agricultural value added V_A

$$\text{Max } V_A = P_A X_A - P_F X_F \qquad \text{(A-2)}$$

The solution for the demand of fertilizer X_F is given by equation (3)

$$X_F = (T_A L_A^a)^{1/1-b} (P_A/P_F)^{1/1-b} b^{1/1-b} \text{ (A-3)}$$

The aggregate agricultural supply is given by equation (4)

$$X_A = (T_A L_A^a)^{1/1-b} (P_A/P_F)^{b/1-b} b^{b/1-b} \text{ (A-4)}$$

Hence the Agricultural value added is given by equation (A-5)

$$V_A = (T_A L_A^a)^{1/1-b} P_A^{1/1-b} P_F^{(1-b)/b} (1-b) b^{1/1-b} \qquad \text{(A-5)}$$

We assume that the agricultural sector produces three products. In order to allocate X_A, let us specify X_A as CET[3] index of the quantities X_1, X_2 and X_3 of the three produced products.

$$X_A = (\sum_{i=1}^{3} \alpha_i^{-\tau} X_i^{(1-\tau)/\tau})^{\tau/(1-\tau)} \qquad \text{(A-6)}$$

where τ is the positive elasticity of transformation and α_i are positive parameters.

Given the prices P_i of three agricultural sub-sectors, allocation of X_A to the three sectors is done by maximizing the total value of agricultural output.

$$\text{Max } \sum_{i=1}^{3} P_i X_i \qquad \text{(A-7)}$$

The above maximization yields the following allocation functions.

$$X_i = \alpha_i^{-\tau} X_A (P_i/P_A)^{\tau} \qquad i=1, 2, 3 \quad \text{(A-8)}$$

where the price index P_A turns out to be the following

$$P_A = (\sum_{i=1}^{3} \alpha_i^{-\tau} P_i^{1+\tau})^{1/(1+\tau)} \qquad \text{(A-9)}$$

The supply utilization accounts (namely the commodity balance equations) for the three agricultural products are given as follows.

$$X_1 = E_1 + C_1 \qquad \text{(A-10)}$$
$$X_2 + M_2 = C_2 \qquad \text{(A-11)}$$
$$X_3 = C_3 \qquad \text{(A-12)}$$

where E_1 denotes the exports of agricultural sector 1 and some percentages (C_1) are consumed locally. M_2 denotes the imports of basic cereals that are perfect or near perfect substitutes for locally produced cereals. C_2 and C_3 denote the quantities of the two different types of food that are demanded domestically. The equations (A-10), (A-11) and (A-12) are the equilibrium relations in the model.

We define an index of a consumed commodity to be food that is a CES function of the quantities of the two domestically consumed agricultural food products.

$$C_f = (\beta_2 C_2^{(\sigma-1)/\sigma} + \beta_3 C_3^{(\sigma-1)/\sigma})^{\sigma/(\sigma-1)} \qquad \text{(A-13)}$$

Description of Parameters

Parameters	Description	1970-74	1975-79	1980-84	1985-89	1990-94
1 a	Elasticity of production w. r. t agriculture labor	0. 80	0. 75	0. 70	0. 65	0. 60
2 b	Elasticity of production w. r. t quantity of fertilizer used	0. 10	0. 15	0. 20	0. 20	0. 34
3 η	Income elasticity of demand for food	0. 50	0. 60	0. 70	0. 75	0. 80
4 ε	Price elasticity of demand for food	0. 80	0. 70	0. 60	0. 55	0. 50
5 τ	Positive elasticity of transformation (CET function)	0. 15	0. 15	0. 15	0. 15	0. 15
6 n	Price elasticity of C_1	0. 06	0. 06	0. 06	0. 06	0. 06
7 q	Price elasticity of E_1	0. 22	0. 22	0. 22	0. 22	0. 22
8 σ	Elasticity of substitution (CES function)	0. 70	0. 70	0. 70	0. 70	0. 70
9 $s_1=C_1/X_1$	Ratio of consumption from sector 1	0. 18	0. 20	0. 22	0. 25	0. 30
10 $s_2=X_2/C_2$	Initial self sufficiency ratio of sector 2	0. 85	0. 80	0. 75	0. 70	0. 65
11 $\upsilon_i=\upsilon_1, \upsilon_2, \upsilon_3$	Value of shares of each agricultural product in the total value $i=1, 2, 3$					
	υ_1	0. 44	0. 60	0. 55	0. 39	0. 31
	υ_2	0. 22	0. 16	0. 19	0. 25	0. 28
	υ_3	0. 34	0. 16	0. 19	0. 25	0. 28
12 μ_A	Share of agriculture in the GDP	0. 30	0. 29	0. 28	0. 37	0. 42
13 V_f	Share of food products (sectors 2 & 3) in the total consumer budget	0. 51	0. 46	0. 40	0. 40	0. 36
14 λ_2	Share of sector 2 agriculture to total agriculture *GDP*	0. 39	0. 40	0. 40	0. 41	0. 42
15 ξ	Elasticity of production (non-agriculture) w. r. t non-agriculture labor	0. 50	0. 52	0. 62	0. 65	0. 70
16 γ_1	Elasticity of T_A w. r. t agriculture labor	−0. 05	−0. 10	−0. 15	−0. 20	−0. 25
17 γ_2	Elasticity of T_N w. r. t agriculture labor	−0. 05	−0. 05	−0. 05	−0. 05	−0. 05
18 γ_3	Elasticity of L w. r. t agriculture labor	0. 90	0. 90	0. 90	0. 90	0. 90
19 l_A	Share of agriculture labor force to total labor (L_A/L)	0. 72	0. 68	0. 66	0. 62	0. 60
20 l_B	Share of non-agriculture labor force to total labor (L_A/L)	0. 28	0. 32	0. 34	0. 38	0. 40

Note: The data for this study were obtained from the Central Bank of Sri Lanka, Annual Statistics Appendix (various years), Socio-Economic Data of Sri Lanka by the Central Bank (various years) and data bank of Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), Ministry of Agriculture, Government of Sri Lanka. Many of the parameters' values were estimated and certain values were also obtained from the Central Bank and HARTI.
Parameters: 1, 2, 6-10, 15-18; author's estimation using these data, 12-14, 19, 20; Central Bank of Sri Lanka, 3-5, 11; HARTI, Sri Lanka.
* Further details on the parameters are available from the authors upon request.

where σ is the elasticity of substitution β_i are positive parameters. $i=2, 3$

Given C_f the quantities of C_2 and C_3 will be found as if consumers act by minimizing the cost of purchasing the given quantity.

$$\text{Min}(P_2C_2+P_3C_3) \qquad \text{(A-14)}$$

Based on equations (A-13) and (A-14), the allocation functions will be as follows.

$$C_i = C_f\beta_i^{\sigma}(P_i/P_f)^{-\sigma} \quad i=2, 3 \qquad \text{(A-15)}$$

where P_f is the domestic food price index and given as follows.

$$P_f = (\sum_{i=2}^{3}\beta_i^{\sigma}P_i^{1-\sigma})^{1/(1-\sigma)} \qquad \text{(A-16)}$$

The quantity of total domestically consumed food C_f is found as a function of domestic income, and the prices of food and non-food products.

$$C_f = f(N, Y, P_f, P_N) = eN(Y/P_N)^{\eta}(P_f/P_N)^{-\varepsilon}$$
(e: demand shifter) (A-17)

Y is the domestic nominal income and the sources of this are from both agriculture and non-agriculture and given as follows.

$$Y = (P_AX_A-P_FX_F)+P_NX_N \Rightarrow Y = V_A+P_NX_N \qquad \text{(A-18)}$$

Please note that from (A-17)&(A-18) that we have abstracted from the savings behavior of income earners as well as taxation. This is done for simplicity and to focus on the agricultural sector only. The assumption on supply side link between agriculture and non-agriculture is that the available agricultural labor L_A is a negative function of the quantity of non-agricultural production.

$$L_A = g(T_A, T_N, L) = L_{A0}T_A^{\gamma 1}T_N^{\gamma 2}L^{\gamma 3}$$
$\gamma_1, \gamma_2<0 \quad \gamma_3>0$ (A-19)[4]

$$L = L_A+L_N \qquad \text{(A-20)}$$

$$X_N = T_NL_N^{\xi} \qquad \text{(A-21)}$$

$$C_1 = dN(P_1/P_N)^{-n} \quad (d\text{: demand shifter}) \qquad \text{(A-22)}$$

$$E = GDP/N \qquad \text{(A-23)}$$

Equation (A-19) comes from the push effect of agricultural technical change and the pull effect of non-agricultural technical change (Yamaguchi and Kennedy [15]). Equation (A-20) is the equation of sectoral allocation of labor, and equation (A-21) is the production function of non-agricultural sector. Equation (A-22) is the domestic demand function of exportable goods. Finally, equation (A-23) is the definition of per capita income. Detail description of the variables, parameters and the data source are given below.

From these 23 equations, we obtained the dynamic model which is reduced to 21 equations as shown in Table 2. Here the model uses the General Equilibrium Growth Accounting Approaches[5] to find the impact of 11 exogenous variables on 21 endogenous variables.

In the dynamic model, it has the general form $Ax=b$ where A is a matrix of order (21 $\times$21) of structural parameters, x is the column vector of rates of change of 21 endogenous variables ($X_1, X_2, X_3, X_A, C_1, C_2, C_3, C_f, P_1, P_2, P_3, P_f, P_A, CPI, DEF, L_A, Y, GDP, E, X_N, L_N$) and b is the column vector of rates of change of 11 exogenous variables ($E_1, M_2, d, e, T_A, T_N, P_F, P_N, L, N, L_{A0}$).[6]

The inverse of A displays the Growth Rate Multipliers (GRM).[7] As an example, $(A^{-1})_{8,2}$ element is $\partial\hat{C}_f/\partial\hat{M}_2$ (We write this as C_fM_2) which indicates by how much the rate of change of aggregate consumption of food C_f changes (effects) due to an increase or decrease in the growth rate of import substitute M_2. Similarly we could attribute it to other exogenous variables. As said earlier, GRMs are obtained by calculating the inverse of above matrix of structural parameters.

Further these GRMs will be used to find out the influence of the exogenous variables on the endogenous. In addition the contribution of exogenous variables to the endogenous ones could be calculated by multiplying the GRM of each year interval by the corresponding rates of change of the exogenous variables. For example, $CX_1M_2=\left(\frac{\partial\hat{X}_1}{\partial\hat{M}_2}\right)\hat{M}_2$, where CX_1M_2 is the contribution of the agricultural food imports M_2 to the agricultural production for exports X_1, and $\left(\frac{\partial\hat{X}_1}{\partial\hat{M}_2}\right)=(X_1M_2)$ is the relevant GRM which shows by what percentage (%) X_1 would increase when M_2 increases by 1%. As our attention here is focused on the exchange rate impact, only these major results which are influenced by the exchange rate reform are discussed here.

So far, we treated E_1 and M_2 as exogenous variables in order to see the effect of E_1, M_2

Table 1. Dynamic matrix form of the model

	X_1	X_2	X_3	X_A	C_1	C_2	C_3	C_f	P_1	P_2	P_3	P_f	P_A	CPI	DEF	L_A	Y	GDP	E	X_N	L_N			
(1)	1	0	0	0	$(-s_1)$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\hat{X}_1$		$(1-s_1)\hat{E}_1$
(2)	0	s_2	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$\hat{X}_2$		$(s_2-1)\hat{M}_2$
(3)	0	0	1	0	0	0	-1	0	0	0	0	0		0	0	0	0	0	0	0	0	$\hat{X}_3$		0
(4)	0	0	0	0	0	0	0	0	v_1	v_2	v_3	0	-1	0	0	0	0	0	0	0	0	$\hat{X}_A$		0
(5)	0	0	0	0	1	0	0	0	(n)	0	0	0	0	0		0	0	0	$(-q)$	0	0	$\hat{C}_1$		$\hat{d}+\hat{N}+n\hat{P}_N$
(6)	0	0	0	-1	0	0	0	0	0	0	0	0	$b/1-b$	0	0	$a/1-b$	0	0	0	0	0	$\hat{C}_2$		$\frac{1}{b-1}\hat{T}_A+\frac{b}{1-b}\hat{P}_F$
(7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	$\hat{C}_3$		$\gamma_1\hat{T}_A+\gamma_2\hat{T}_N+\gamma_3\hat{L}+\hat{L}_{A0}$
(8)	0	0	0	0	0	1	0	-1	0	σ	0	$(-\sigma)$	0	0	0	0	0	0	0	0	0	$\hat{C}_f$		0
(9)	0	0	0	0	0	0	1	-1	0	0	σ	$(-\sigma)$	0	0	0	0	0	0	0	0	0	$\hat{P}_1$		0
(10)	0	0	0	0	0	0	0	0	0	λ_2	$1-\lambda_2$	-1	0	0	0	0	0	0	0	0	0	$\hat{P}_2$		0
(11)	0	0	0	0	0	0	0	-1	0	0	0	$(-\varepsilon)$	0	0	0	0	η	0	0	0	0	$\hat{P}_3$	=	$\eta\hat{P}_N-\varepsilon\hat{P}_N-\hat{e}-\hat{N}$
(12)	0	0	0	0	0	0	0	0	0	0	0	0	$\mu_A/1-b$	0	0	$a\mu_A/1-t$	-1	0	0	$1-\mu_A$	0	$\hat{P}_f$		$\frac{\mu_A}{b-1}\hat{T}_A+\frac{b\mu_A}{1-b}\hat{P}_F+(\mu_A-1)\hat{P}_N$
(13)	0	0	0	0	0	0	0	0	0	0	0	V_f	0	-1	0	0	0	0	0	0	0	$\hat{P}_A$		$(V_f-1)\hat{P}_N$
(14)	0	0	0	0	0	0	0	0	0	0	0	0	μ_A	0	-1	0	0	0	0	0	0	$C\hat{P}I$		$(\mu_A-1)\hat{P}_N$
(15)	0	0	0	0	0	0	0	0	0	0	0	0	$b\mu_A/1-t$	0	0	$a\mu_A/1-t$	0	-1	0	$1-\mu_A$	0	$D\hat{E}F$		$\frac{\mu_A}{b-1}\hat{T}_A+\frac{b\mu_A}{1-b}\hat{P}_F$
(16)	-1	0	0	1	0	0	0	0	τ	0	0	0	$(-\tau)$	0	0	0	0	0	0	0	0	$\hat{L}_A$		0
(17)	0	-1	0	1	0	0	0	0	0	τ	0	0	$(-\tau)$	0	0	0	0	0	0	0	0	$\hat{Y}$		0
(18)	0	0	-1	1	0	0	0	0	0	0	τ	0	$(-\tau)$	0	0	0	0	0	0	0	0	$G\hat{D}P$		0
(19)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	$\hat{E}$		$\hat{N}$
(20)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	$-\zeta$	$\hat{X}_N$		$\hat{T}_N$
(21)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ι_1	0	0	0	0	ι_2	$\hat{L}_N$		$\hat{L}$

Note: Equation (1) ($\hat{X}_1=(1-S_1)\hat{E}_1+S_1\hat{C}_1$ (where $S_1=X_1/C_1$)) in Matrix A in Table 2 came from equation (A-10) above. Equation (2) came from equation (A-11) above where $S_2=X_2/C_2$. Equation (3) came from from equation (A-12). Equation (4) came from equations (A-8) and (A-9) where $v_i=P_iX_i/(P_1X_1+P_2X_2+P_3X_3)$. Equation (5) came from equation (A-22). Equation (6) came from equation (A-4). Equation (7) came from equation (A-19). Equation (8) came from equation (A-15). Equation (9) came from equation (A-15). Equation (10) came from equations (A-13 and A-16), where, $\lambda_2=P_2X_2/(P_2C_2+P_3C_3)$. Equation (11) came from equation (A-17). Equation (12) came from equations (A-5) and (A-18), where μ_A = share of agriculture in GDP. Equation (13) and (14) came from definitions. Equation (15) came from equations (6) and (20) in Table 2. Equation (16), (17) and (18) came from equation (A-8). Equation (19) came from equation (A-23). Equation (20) came from equation (A-21). Equation (21) came from equation (A-20) where $l_A=L_A/L$, $l_N=L_N/L$.

and P_F on 21 endogenous variables. This comes from the fact that the elimination of the external disparity was the primary focus of adjustment and we wanted to see the effect of E_1, M_2 and P_F (not E_1', M_2' and P_F') in this paper. Therefore what we have to do is to see the effect of SAP on E_1, M_2 and P_F in order to observe the overall effect of SAP, and we try to treat them as if they were endogenous variables for SAP. In order to see the effect of the exchange rate, we define $GR(E_1')$, $GR(M_2')$ and $GR(P_F')$ as follows:

$$GR(E_1') = GR(E_1) - 0.3GR(ER),$$
$$GR(M_2') = GR(M_2) + 0.6GR(ER),$$

Table 2. Change of exogenous and endogenous variables

Endogenous variable	(I) 1970-74	(II) 1975-79	(III) 1980-84	(IV) 1985-89	(V) 1990-96
GR (X_1)	0.43	2.26	−0.53	−4.93	−1.11
GR (X_2)	4.02	8.72	2.89	−0.92	10.45
GR (X_3)	3.76	6.89	1.12	0.78	8.73
GR (X_A)	2.52	14.15	0.45	−2.31	7.35
GR (C_f)	1.35	4.23	−4.01	5.87	2.45
GR (P_1)	−11.61	1.66	17.79	−2.51	−40.93
GR (P_2)	12.01	14.24	30.72	4.26	32.61
GR (P_3)	10.92	20.67	22.34	9.45	27.52
GR (GDP)	2.92	6.29	0.61	1.82	3.63
Exogenous variable	(I) 1970-74	(II) 1975-79	(III) 1980-84	(IV) 1985-89	(V) 1990-96
(1) GR (E_1)	0.31	26.94	0.09	−7.38	−2.41
(2) GR (M_2)	−11.68	−6.94	−25.89	10.76	−1.87
(3) GR (P_F)	5.73	−3.43	16.78	10.43	−3.62
GR (P_N)	16.63	12.98	27.11	16.65	20.34
(4) GR (T_A)	0.16	4.23	−0.44	−3.40	5.30
(5) GR (T_N)	0.36	−0.25	−0.06	0.28	2.00
Devaluation variable	(I) 1970-74	(II) 1975-79	(III) 1980-84	(IV) 1985-89	(V) 1990-96
(6) GR (ER)	2.86	21.32	10.38	7.27	6.37
(1)−0.3 (6) GR (E_1')	−0.55	20.58	−3.02	−9.56	−4.32
(2)+0.6 (6) GR (M_2')	−9.95	5.85	−19.66	15.12	1.98
(3)−(6) GR (P_F')	2.87	−24.75	6.40	3.16	−9.99

Note: The analysis and results in this paper are based on these important variables. GR (X_1), for example, means the growth rate of X_1 (agricultural output of sector 1).

$$GR(P_F') = GR(P_F) - GR(ER).$$

Here, $GR(E_1')$ is the growth rate of a real export which is obtained by subtracting the growth rate of the devaluation of the Rupee ($GR(ER)$) multiplied by 0.3 from the growth rate of E_1 ($GR(E_1)$),[8] $GR(M_2')$ is the growth rate of real food imports which is obtained by adding the growth rate of the devaluation of the Rupee ($GR(ER)$) multiplied by 0.6 to the growth rate of M_2 ($GR(M_2)$), and GR (P_F') is the growth rate of real fertilizer price which is obtained by subtracting the growth rate of the devaluation of the Rupee (GR (ER)) from the growth rate of P_F ($GR(P_F)$). Therefore, E_1' shows how much the growth rate of exportable goods is in the case that we remove the effect of devaluation of the Rupee. Similarly we can understand the other real variables mentioned here. Table 1 above shows how to calculate the values of E_1', M_2' and P_F'. Numerical performance of these varibles are explained in the following section.

4. Numerical Performance of Major Exogenous and Endogenous Variables of the Study in the Sri Lankan Context

In this paper we have mainly considered the exogenous variables of agricultural exports, food imports, fertilizer price and agriculture and non-agriculture technical changes and used them as the principle variables to see the impact of the policy. Agriculture exports really changed under the policy reforms in Sri Lanka and are considered to be the engine of foreign exchange earning. The policy reforms also addressed this issue. Food imports become open under the policy reforms and its

impact is also widely felt by the domestic food sector. Further, fertilizer continued to play an important role under the reforms. Gradually the subsidies were removed and surprisingly the usage and the price increase were always increasing. So this impact is found to be imperative to monitor. Agriculture and non-agriculture technical changes contributed to the push-pull effect of agriculture development. So in this paper we tried to see this impact on the agriculture sector using the exogenous variables in relation to the exchange rate variable.

The detailed description of the variables and the parameters used in the model was already given in the previous section. Following Table 1 shows the trend of major exogenous and endogenous variables in relation to the exchange rate variable.

These trends quite clearly show the structure of the economy and its performance. The ethnic conflict in 1983 and also the internal unrest in 1987 and 1988 also contributed to the decreasing trend of exports and food imports. Further, the devaluation of the local currency under policy reforms also contributed to increase agriculture exports. With this brief introduction of the policy reform scenario, we used the following analytical framework to evaluate the major impacts of this reform on the agriculture sector.

5. Explanation of Empirical Results

1) Contribution of real $E_1(E_1')$, real M_2 (M_2'), and real $P_F(P_F')$ to X_A, C_f and GDP and exchange rate effect

So far, we treated E_1, M_2 and P_F as exogenous variables in order to see the effect of E_1 M_2 and P_F on 21 endogenous variables. This comes from the fact that the elimination of the external disparity was the primary focus of the policy reform in Sri Lanka and we did comprehensive analysis to see these effects in our previous studies. Since the exchange rate was one of the primary factors that played a crucial role under the policy reform through devaluation of local currency, it is of paramount importance to see the effect of the contribution of devaluation (exchange rate effect) to the target variables. Hence the following analysis focuses only on the performance of the exchange rate and its contribution to policy variables and the effect on the target variables.

The following Table 3 shows the comparative version of growth rates of E_1', M_2' and P_F' with E_1, M_2 and P_F and their contributions, removing the exchange rate effect, to X_A, C_f and GDP.

Accordingly, the growth rate of E_1' was positive only in the IInd period. This is very different from the growth rate of E_1 because E_1 was positive in three periods (Ist, IInd and IIIrd). On the other hand, the values of M_2' increased fairly much as compared with that of M_2. The growth rates of M_2' were positive in the IInd, IVth and Vth periods (growth rate of M_2 was positive only in the IVth period). Further the growth rates of P_F' were positive in the Ist, IIIrd and IVth periods and negative in the IInd and Vth periods. Therefore, we can understand that the growth rate of export decreased and that of import increased fairly much in the case that we removed the effect of the devaluation of the Rupee. In addition the growth rate of fertilizer prices decreased

Table 3. The growth rate of real export (E_1'), real food import (M_2) and real fertilizer price (P_F') and their contributions to X_A, C_f, and GDP

Year	$GR\ (E_1')$ $GR\ (E_1)$	$GR\ (M_2')$ $GR\ (M_2)$	$GR\ (P_F')$ $GR\ (P_F)$	CX_AE_1' CX_AE_1	CX_AM_2' CX_AM_2	CX_AP_F' CX_AP_F	CC_fE_1' CC_fE_1	CC_fM_2' CC_fM_2	CC_fP_F' CC_fP_F	$CGDPE_1'$ $CGDPE_1$	$CGDPM_2'$ $CGDPM_2$	$CGDPP_F'$ $CGDPP_F$
I 1970-74	−0.55	−9.55	2.87	−0.18	0.04	−0.17	0.01	−1.09	−0.24	−0.05	0.01	−0.05
	(0.31)	(−11.68)	(5.73)	(0.10)	(0.04)	(−0.35)	(−0.01)	(−1.28)	(−0.47)	(0.03)	(0.01)	(−0.10)
II 1975-79	20.58	5.85	−24.75	10.61	−0.04	1.31	3.01	0.84	2.32	3.13	−0.01	0.39
	(26.94)	(−6.94)	(−3.43)	(13.89)	(0.05)	(0.18)	(3.94)	(−0.99)	(0.32)	(4.10)	(0.01)	(0.05)
III 1980-84	−3.02	−19.66	6.40	−1.57	0.32	−0.40	−0.65	−3.61	−0.59	−0.44	0.08	−0.11
	(0.09)	(−25.89)	(16.78)	(0.05)	(0.40)	(−1.06)	(0.02)	(−4.75)	(−1.54)	(0.01)	(0.11)	(−0.29)
IV 1985-89	−9.56	15.12	3.16	−4.25	−0.67	−0.29	−1.52	5.93	−0.24	−1.14	−0.18	−0.08
	(−7.38)	(10.76)	(10.43)	(−3.28)	(−0.48)	(−0.95)	(−1.17)	(4.22)	(−0.80)	(−0.88)	(−0.13)	(−0.26)
V 1990-96	−4.32	1.98	−9.99	−1.69	−0.22	1.18	−0.34	1.33	0.45	−0.42	−0.05	0.28
	(−2.41)	(−1.87)	(−3.62)	(−1.13)	(0.22)	(0.43)	(−0.23)	(−1.25)	(0.16)	(−0.28)	(0.05)	0.10

once we removed the effect of the devaluation of the Rupee. This shows that the exchange rate contributed to the increase of fertilizer prices.

From these values, we can calculate the contribution of E_1', M_2' and P_F' to all (21) endogenous variables. However, here we focus only on 3 endogenous variables, X_A, C_f and *GDP*.

For the contribution to X_A, the values of contribution of E_1 'to X_A decreased fairly much as compared with the contribution of E_1 to X_A. The contribution of E_1' to X_A was positive only in the IInd period although the contributions of E_1 were positive in the Ist, IInd and IIIrd periods. The contribution of M_2' to X_A was also smaller than M_2 and M_2' contributed positively to X_A only in the Ist and IIIrd periods although M_2 contributed positively in four periods (Ist, IInd, IIIrd and Vth periods). The contribution of P_F' to X_A increased fairly much compared to that of P_F to X_A and it was positive in the IInd and Vth period and negative in the other three periods.

For the contribution to C_f, the contribution of E_1' to C_f decreased fairly much as compared with the contribution of E_1 to C_f. However, the contribution of M_2' to C_f rather increased as compared with the contribution of M_2 to C_f. The contribution of M_2' is positive in three periods (IInd, IVth and Vth) although M_2 contributed positively only in the IVth period. The contribution of P_F' to C_f increased in comparison to P_F contribution to C_f and it was positive in the IInd and Vth periods and negative in the other three periods.

The contribution of E_1' and M_2' to *GDP* also decreased. The contribution of E_1 to *GDP* was positive in three periods (Ist, IInd and IIIrd). However, the contribution of E_1' to *GDP* is positive only in one period (IInd period). The contribution of M_2' is positive in the Ist and IIIrd periods although the contribution of M_2 was positive in four periods (Ist, IInd, IIIrd and Vth). It can also be seen that contribution of P_F' to *GDP* increased in comparison to contribution of P_F to *GDP*. This was positive in the IInd and Vth periods and negative in the other three periods.

The following Table 4 shows the total contribution of the exchange rate to the variables of X_A, C_f and *GDP*. Here, we would consider theoretically the effect of the exchange rate on the economic development of Sri Lanka. The devaluation of the Rupee would increase export and fertilizer price and decrease import. The increase of export of agricultural exportable goods (E_1) increases the agricultural output (X_A), *GDP* (real) and food consumption (C_f). The decrease of food import increases the agricultural output X_A and *GDP* (real), but decreases food consumption (C_f). The increase of fertilizer price (P_F) decreases all the variables (agricultural output (X_A), *GDP* (real) and food consumption (C_f)). Therefore, we can calculate total impact (contribution) by adding these posi-

Table 4. Total contribution of exchange rate to X_A, C_f, *GDP* and overall development

Contribution of exchange rate to agricultural output X_A

Period	X_A			Sub-total 1
	E_1	M_2	P_F	
(I) 1970-74	0.274	0.002	−0.173	0.103
(II) 1975-79	3.280	0.090	−1.129	2.241
(III) 1980-84	1.621	0.077	−0.654	1.044
(IV) 1985-89	0.971	0.189	−0.663	0.497
(V) 1990-96	0.557	0.436	−0.753	0.240

Contribution of exchange rate to overall development *GDP*

Period	*GDP*			Sub-total 2
	E_1	M_2	P_F	
(I) 1970-74	0.080	0.020	−0.049	0.051
(II) 1975-79	0.970	0.026	−0.336	0.660
(III) 1980-84	0.445	0.026	−0.181	0.290
(IV) 1985-89	0.257	0.049	−0.178	0.128
(V) 1990-96	0.136	0.101	−0.181	0.056

Contribution of exchange rate to food consumption C_f

Period	C_f			Sub-total 3
	E_1	M_2	P_F	
(I) 1970-74	−0.020	−0.189	−0.237	−0.446
(II) 1975-79	0.929	−0.155	−1.999	−1.225
(III) 1980-84	0.674	−1.140	−0.955	−1.421
(IV) 1985-89	0.350	−1.710	−0.559	−1.919
(V) 1990-96	0.109	−2.580	−0.288	−2.759

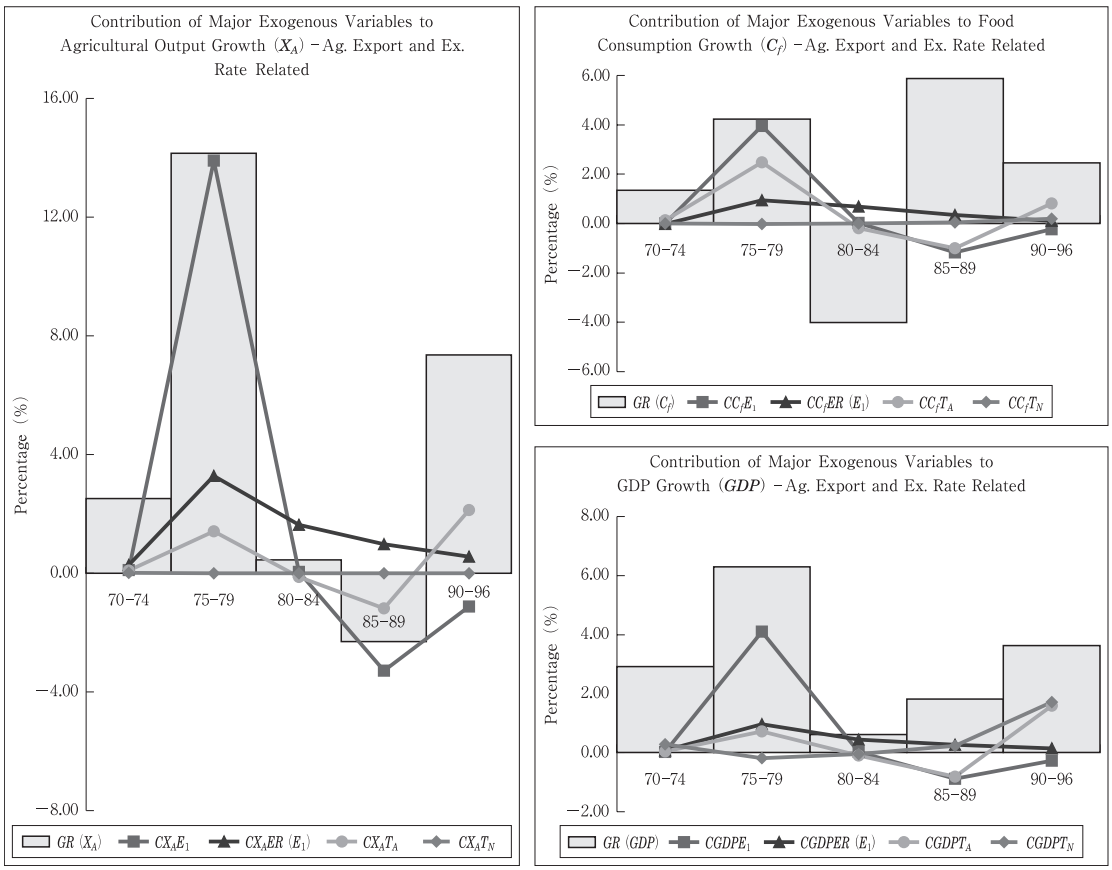

Figure 1. Contributions of major exogenous variables to X_A, C_f and GDP (E_1 and exchange rate related)
Note: We made a sensitivity test for the contribution of exchange rate (in case of $\varepsilon=\eta=0$, i.e., no consideration of price effect). The contribution of $ER(E_1)$ and $ER(M_2)$ became 2.5 times larger than the values in Figures 1 and 2.

tive and negative values together.

From these both positive and negative contributions of the exchange rate, we can aggregate these three contributions to see the total contribution of the exchange rate. For agricultural output X_A, the total contributions are calculated and shown in the subtotal 1 column (total for the agricultural output X_A) of Table 5. The values range from 0.103 to 2.241. For GDP (real) too, the total contributions are calculated and shown in the sub-total 2 column (total for GDP (real)). The values range from 0.051 to 0.660. For food consumption (C_f), the total contributions are calculated and shown in the subtotal 3 column (total for food consumption (C_f)). The values range from −2.759 to −0.446.

These observations show the positive implications of currency devaluation to Sri Lanka's economy under the policy reform. But it is important now to see how much exchange rate growth contributed to these three variables. The following discussion reveals the amount of contribution of exchange rate on X_A, C_f and GDP.

Figures 1 to 3 show how exogenous (policy) variables such as agricultural exportable goods (E_1), food import (M_2), fertilizer price (P_F), technical change in agriculture (T_A), non-agriculture (T_N) and exchange rate (ER) contribute to 21 endogenous (target) variables. These Figures show the calculated results of the impact of the exchange rate. The height of the histogram in each variable shows how many % it increased in each period. For example, the height of X_A in the Ist period (1970-74) in all Figures shows 2.52.

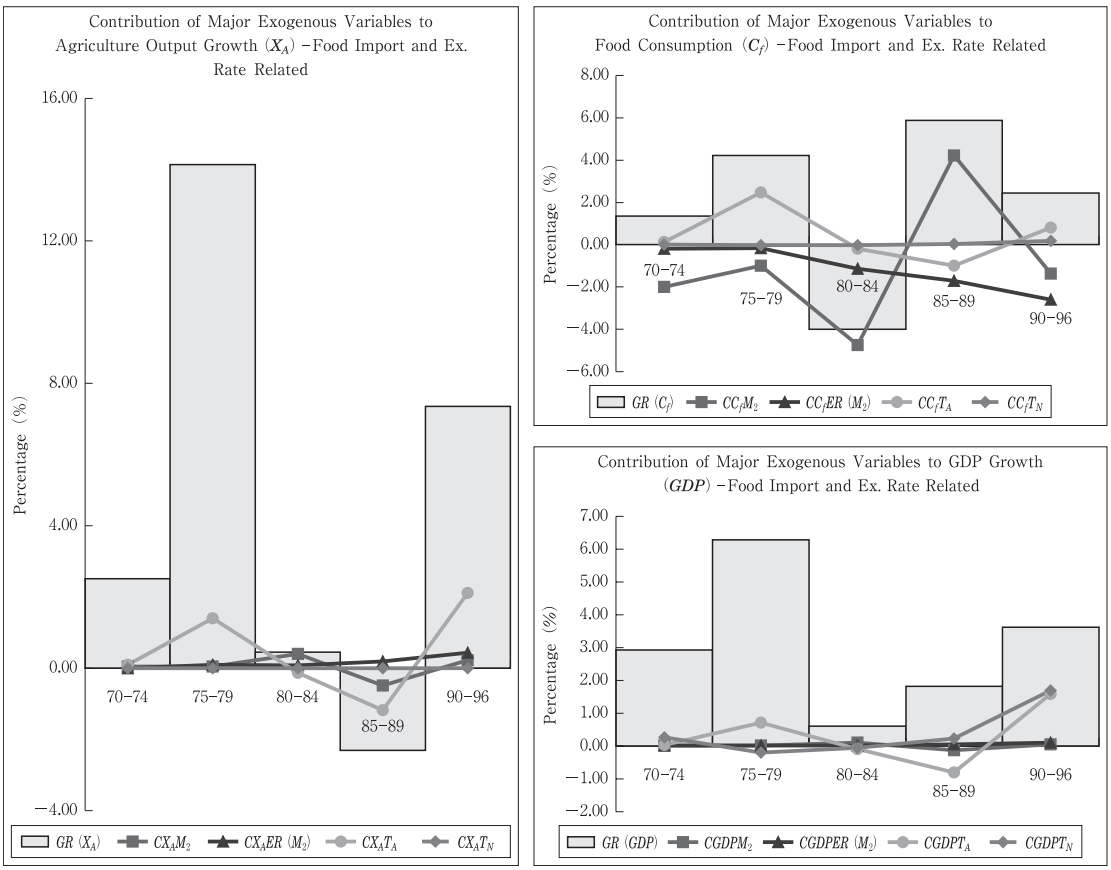

Figure 2. Contributions of major exogenous variables to X_A, C_f and GDP (M_2 and exchange rate related)

This means that the average growth rate of X_A in Ist period was 2.52%. Figure 1 shows that the contribution of agricultural exportable goods E_1 was 0.10. In the same way, the height of X_A in the IInd period (1975-79) shows 14.15. This means that the average growth rate of X_A in the IInd period was 14.15%.

Based on Table 3, Figure 1 also shows that the contribution of export of agricultural exportable goods E_1 in the IInd period was 13.89 (CX_AE_1). The contribution of devaluation through E_1 is measured by $CX_AE_1 - CX_AE_1'$ and reported as $CX_AER(E_1)$ which is 3.28 in the same figure. The same rule applies to other figures.

As Figure 1 shows above, the contributions of the exchange rate (devaluation of the Rupee) through the export of agricultural exportable goods are all positive and very large for three target (endogenous) variables (X_A, C_f and GDP). For example, the contribution of export of agricultural exportable goods E_1 in the IInd period was 13.89 as we showed above. However, the contribution of the exchange rate (devaluation of the Rupee) through the export of agricultural exportable goods was 3.280. This means that 23.61 (3.280/13.89)% of the contribution of export of agricultural exportable goods E_1 comes from the devaluation of the Rupee. Therefore, the contribution of export of agricultural exportable goods E_1 was only 10.610 (= 13.89-3.280), i.e., 76.386 (=10.610/13.89) % if there was no devaluation of the Rupee. From Figure 1, we can calculate the growth rate of agricultural output X_A in the case of no devaluation of the Rupee by deducting the value of the contribution of the exchange rate (such as 3.280) from the value of the height of the histogram (such as 13.89). In same way, we can calculate all values of other pe-

riods.

As shown in Figure 2, almost the same things (i. e., positive contributions) happen to the growth of agricultural output X_A and *GDP* (real) from the contributions of the exchange rate (devaluation of the Rupee) through the agricultural import M_2. However, these contributions are fairly small as compared with the export of exportable goods (E_1) case. Therefore, we can understand that the growth rate of both the agricultural output X_A and *GDP* (real) would become only a little bit smaller than the real growth became of the contributions of the exchange rate (devaluation of the Rupee) through the agricultural import M_2 if there was no devaluation of the exchange rate. The contributions of the exchange rate (devaluation of the Rupee) through the import of agricultural goods to food consumption C_f are not positive but negative and fairly large. In other words, we can say that the food consumption C_f would have been larger if there had been no devaluation of the Rupee.

However, completely different phenomena are seen in the case of fertilizer price, as shown in Figure 3.

The contributions of the exchange rate (devaluation of the Rupee) through the fertilizer price are all negative and fairly large for two target (endogenous) variables (X_A and C_f. For *GDP*, the values are not so large as compared with above stated two variables). For example, the contribution of fertilizer price P_F in the II[nd] period was 0. 182. However, the contribution of the exchange rate (devaluation of the Rupee) through the fertilizer price was − 1. 129. This means that − 620. 330 (−1. 129/0. 182) % of the contribution of fertilizer price P_F comes from the devaluation of the Rupee. Therefore, the contribution of fertilizer price P_F was 1. 310 (=0. 182-

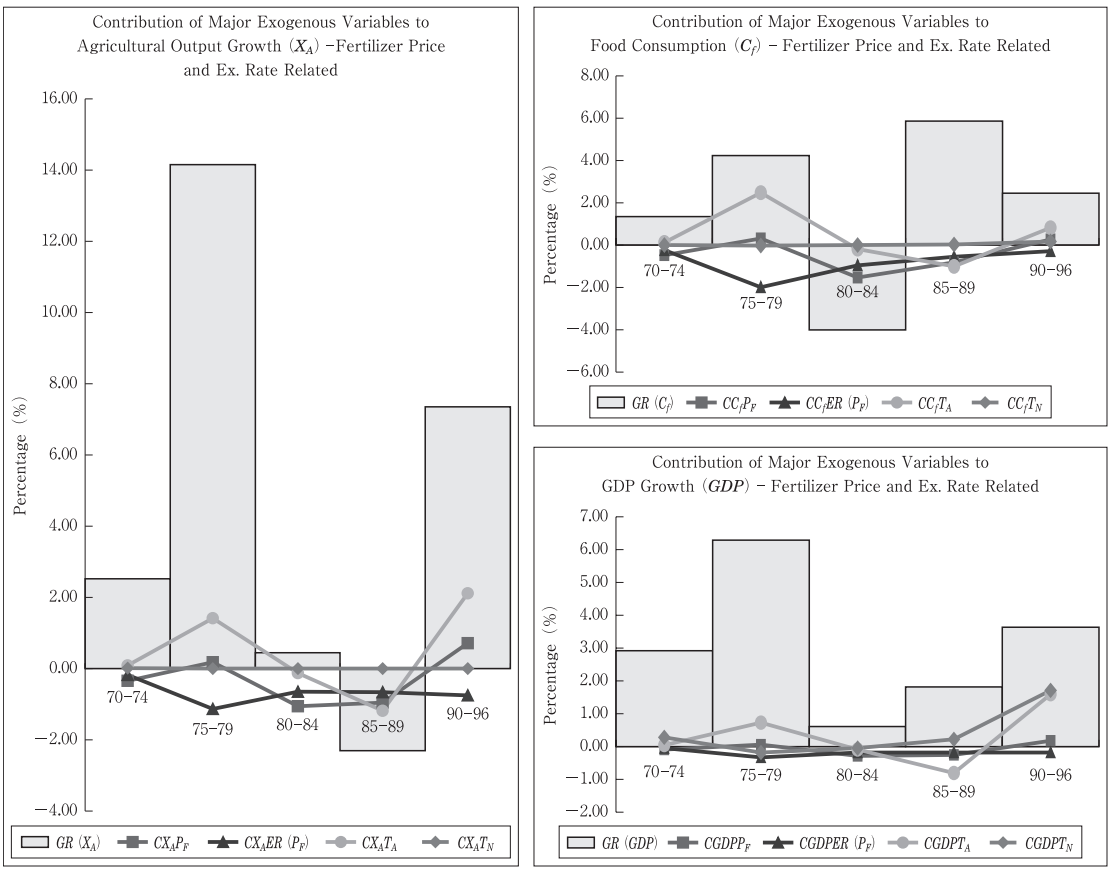

Figure 3. Contributions of major exogenous variables to X_A, C_f and *GDP* (P_F and exchange rate related)

Table 5. Contribution of agriculture and non-agriculture technical change

Contribution of agricultural technical change (T_A)

Contribution (T_A)		GR (T_A)	CX_AT_A	CP_1T_A	CP_2T_A	CP_3T_A	CC_fT_A	$CGDPT_A$	CL_AT_A	CL_NT_A
(I)	1970-74	0.160	0.094	−1.211	−0.268	−0.296	0.128	0.037	−0.008	0.021
(II)	1975-79	4.230	1.409	−25.057	−7.403	−8.112	2.486	0.720	−0.423	0.899
(III)	1980-84	−0.440	−0.131	2.085	0.666	0.739	−0.191	−0.094	0.066	−0.128
(IV)	1985-89	−3.400	−1.183	14.285	4.111	4.749	−0.995	−0.811	0.680	−1.109
(V)	1990-96	5.300	2.121	−20.735	−4.615	−5.825	0.809	1.595	−1.325	1.988

Contribution of non-agricultural technical change (T_N)

Contribution (T_N)		GR (T_N)	CX_AT_N	CP_1T_N	CP_2T_N	CP_3T_N	CC_fT_N	$CGDPT_N$	CL_AT_N	CL_NT_N
(I)	1970-74	0.360	0.008	0.218	0.203	0.202	0.005	0.276	−0.018	0.046
(II)	1975-79	−0.250	−0.003	−0.099	−0.174	−0.169	−0.015	−0.189	0.013	−0.027
(III)	1980-84	−0.060	0.000	−0.011	−0.054	−0.052	−0.007	−0.047	0.003	−0.006
(IV)	1985-89	0.280	0.001	−0.028	0.294	0.272	0.034	0.227	−0.014	0.023
(V)	1990-96	2.000	0.002	−1.006	2.532	2.258	0.183	1.705	−0.100	0.150

(−1.129)) % if there was no devaluation of the Rupee. From Figure 3, we can calculate the growth rate of agricultural output X_A, in the case of no devaluation of the Rupee, by deducting the value of the contribution of the exchange rate from the value of the height of the histogram.

2) Contribution of technical change (T_A) in agriculture and non-agriculture (T_N)

The devaluation of the Rupee increased agricultural exports and decreased food imports in Sri Lanka. When we consider development in a country like Sri Lanka, technical change in both sectors is very important. Technical changes in agriculture and non-agriculture both increase the export and decrease the import. Therefore, the devaluation of the Rupee and technical change in both sectors have the same kinds of nature for economic development in this sense. We attempted to evaluate the impact of these technical changes and compare with the effect of the devaluation of the Rupee on Sri Lanka's economy. Table 5 shows that technical change in agriculture T_A contributed fairly much for the growths of both agricultural output X_A and GDP except in the IVth (1985-89) period in which internal unrest (1987-88) occurred. On the other hand, the contribution of technical change in non-agriculture T_N was very small to three target variables.

However, the contribution of technical change in non-agriculture to the growths of GDP became gradually large and finally contributed very heavily for the Vth (1990-96) period. This comes from the push-pull effects of technical change in both sectors. As we have shown before (Yamaguchi and Binswanger [14], Yamaguchi and Kennedy [15]), technical change in both sectors has a non-symmetrical effect on agricultural labor. In other words, technical change in agriculture pushes agricultural labor to the non-agricultural sector. However, technical change in non-agriculture does not push non-agricultural labor to the agricultural sector but pulls agricultural labor to the non-agricultural sector. This non-symmetrical effect comes from the low income and price elasticities of agricultural goods. The labor pulled by non-agricultural labor contributed positively to non-agricultural output and this led to the growth of GDP.

6. Conclusion

Here, we would like to summarize the content of this paper as follows.

(1) The contributions of M_2 and P_F were negative but the positive contribution of E_1 was larger than these two negative effects. Further the real contributions of these three variables, E_1', M_2' and P_F' (excluding the ex-

change rate effect), pointed out that without the exchange rate reform the contributions would have been fairly detrimental to the agricultural production and economy of Sri Lanka. Therefore, policy reform had a positive effect on Sri Lankan economy through the exchange rate reform (which is completely different from Cooray [3]), though it had a negative impact on sector 2 and sector 3, which involve domestic food production and small farmers.

(2) As we saw, many policies such as trade policy, fiscal and monetary policy, and privatization affected in such a way to either increase or decrease E_1, M_2 and P_F. However, the effect of the devaluation of Sri Lankan currency (Sri Lanka Rupee) was very large and increased E_1 and P_F, and decreased M_2. These increased E_1 and P_F and decreased M_2 contributed fairly much for the growth of X_A and *GDP* in the Ist, IInd and IIIrd periods although the decrease of M_2 contributed negatively to the consumer. The increase of P_F due to devaluation of the currency (exchange rate increase) negatively contributed to X_A and *GDP*. But the overall contribution to X_A and *GDP* was positive.

(3) However, internal conflicts in 1983 and 1987/1988 decreased E_1 and increased M_2 in the IIIrd and IVth periods respectively. Therefore, the contribution of E_1 and M_2 to X_A and *GDP* were negative and fairly large in the IIIrd, IVth and Vth periods. Only one exception was the positive contribution of increased M_2 to the consumption increase in the IVth period.

(4) The increase of P_F contributed negatively not only to the agricultural producer but also to the consumer and *GDP* (X_A, C_f and *GDP*).

It could be seen from this study that devaluation of the currency helped to reduce the real food imports and increase the agricultural exports, although it increased the fertilizer prices. Consequently these impacted positively on agricultural production and GDP. Hence, this could also be attributed as positive outcome of the reforms. In this paper, we focused on the effects of export and import through the change of the exchange rate. Therefore, we dared not to treat the export and import as endogenous variables. In the future, we would like to construct a completely different model in which export and import are treated as endogenous variables.

1) For the detailed information about the model variable please see discussion paper 0407 of Yamaguchi and SriGowri Sanker [16].
2) Please see the discussion paper 0407, Yamaguchi and SriGowri Sanker [16] for full description of the model, the variables and their effects.
3) For further analysis on CET function, refer to Powell and Gruen [11].
4) This equation (A-19) comes from our earlier papers (Yamaguchi [13], Yamaguchi and Binswanger [14], Yamaguchi and Kennedy [15]). These papers show the effect of several exogenous variables such as T_A, T_N, L, K, Q, and others on 8 endogenous variables (L_A is one of them). Here the reduced form $L_A=L_{A0}T_A^{\gamma 1}T_N^{\gamma 2}L^{\alpha}K^{\beta}Q^{\delta}$ could be derived from the original model and from there we picked up only T_A, T_N, and L for this study. Further, we have the condition that the marginal product of labor in both sectors is equal to the wage rate and the marginal product of capital in both sectors is equal to the interest rate as shown in the above three papers. Equation (A-19) comes from these models and includes labor and capital markets (proof is available upon the reader's request).
5) Papers among these studies are Yamaguchi and Binswanger [14], Yamaguchi [13], Yamaguchi and Kennedy [15].
6) Detailed description of the exogenous and endogenous variable can be seen from the discussion paper 0407 of Yamaguchi and SriGowri Sanker [16].
7) For further details of the application of GRM, see Yamaguchi [13], Yamaguchi and Kennedy [15], Yamaguchi and Binswanger [14].
8) This comes from the following equations. $E=E_0(P_E/ER)^{\eta}$ where, $-\infty<\eta<0$ (1) and $M=M_0(P_M/ER)^{\mu}$ where, $0<\mu<\infty$ (2). In other words, equations (1) and (2) consider the price effect due to the change of exchange rate (Rupee devaluation in our case). Therefore, the influence of the exchange rate on export E depends on price elasticity η. From this equation (1), we can obtain the following equation: $GR(E)=\eta GR(P_E)-\eta GR(ER)$. Therefore, the influence of the exchange rate which considers the price effect on export is $-\eta GR(e)$. This means that the export increases because $-\eta$ is positive (η is negative). We estimated η and obtained -0.3 by using the data obtained from the Central Bank of Sri Lanka. Similarly, we estimated μ and obtained 0.6 by using the same data.

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