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EMPIRICAL ANALYSIS ON GENERAL EQUILIBRIUM PERFORMANCE OF AGRICULTURAL TRADE OF SRI LANKA UNDER ADJUSTMENT POLICY REFORM[1][2]

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ABSTRACT

This paper empirically evaluates the impact of Structural Adjustment Policy Program on Sri Lanka's agricultural sector with special reference to the food imports and agricultural exports, which are considered as major components of policy reform. We attempted to use the Two Sector General Equilibrium model with Growth Accounting Approach, which comprises Growth Rate Multiplier, and combination of effect and contribution in this paper to measure the impact of the exogenous policy variables on endogenous variables. In this paper, we concentrated only on the agricultural trade, which is the component of food imports and agricultural exports, as the exogenous factor and evaluated the impact. Further important agricultural input, fertilizer, was also considered as an exogenous variable. Performance of exchange rate is also analyzed in relation to food imports and agricultural exports since exchange rate performance is considered one of the important policy variables here. Our results were quite different from earlier studies and reveals that policy changes are favorable to the overall agricultural development though their impact on the domestic food sector, which comprise the majority of the small farmer and fragmented land holdings, is negative. Agricultural exports and food imports are open under the new policy reforms, and they make considerably large impact on the agricultural production. Agricultural exports positively helped the overall agriculture development. Food imports negatively impacted the domestic food sector. We could also see from this study that devaluation of currency helped to reduce the real food imports and increase the agricultural exports. Furthermore, our study clearly indicates that the fertilizer prices changing under the policy adjustments affect the agricultural production and it was also negatively affecting the domestic food production.

Key words: *Structural Adjustment Policy; Sri Lanka's Agricultural Sector; Agricultural Exports, Food Imports, Currency Devaluation; Fertilizer Prices; General Equilibrium Growth Accounting..*

JEL Classification: O11, O13, O41, Q18

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1. INTRODUCTION

Many of the people in the South Asian countries are involved in agriculture and allied vocations. The majority of them live in rural agricultural areas and employment opportunities of these people are provided by agriculture only. Similarly, these countries are not developed in non-agricultural sectors so as to compete with the developed countries. Having understood the importance of the agricultural sector, successive Governments' priority policy in Sri Lanka was to develop the agricultural sector as this sector provided the largest share of revenue through exports, especially from plantation sector. At the same time, with rice and other subsidiary food stuffs which account for a major part in imports, any reduction thereof could not only help in redressing the foreign exchange imbalance but also release foreign exchange resources for import of capital goods for much needed development activities. Therefore, development of domestic agriculture has been a major policy of successive governments since independence.

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 on agricultural exports as well as food imports and fertilizer price changes in relation to exchange rate reforms. We use General Equilibrium Growth Accounting approach to evaluate the impact of these exogenous variables on endogenous variables and the following sections deal with these aspects in detail.

2. BASIC THEORETICAL ASSUMPTIONS IN EVALUATING ADJUSTMENT POLICIES WORLDWIDE

As Sarris (1987) explained, in a generic phenomenon, most adjustment programs emerge from an existing or anticipated deterioration in the external balance, due to factors not likely to be reversed in the short-run and the external deficit which is not sustainable in the medium term. Further, adjustments entail the realignment of domestic demand with available resources and changing supply and the production structure to eliminate the external deficit. Since demand can be curtailed more easily and faster through changes in public expenditures and money supply, it tends to be the focus of the first attempts at correcting economic deterioration. Changes on the supply side, however, are more difficult and slower to implement and therefore tend to be associated with medium term structural adjustment efforts. As the elimination of the external disparity is the primary focus of adjustment,

trade policies figure prominently in all adjustment programs. Trade policies usually comprise two sets of measures, one aimed at export promotion and the other at import liberalization.

Adjustment programs in many countries have caused considerable internal controversy, because they provide visible and easily identifiable factors upon which to blame all irregularities of the economy. This situation clearly makes monitoring more difficult as several interpretations can be made of the same trends. The first issue is whether the program of reforms as outlined in agreement between the government and the financing institutions really takes place. Given that some reforms have taken place the major question concerning monitoring is whether the observed outcomes or changes are due to the policy changes or would have occurred anyway. Such a question brings out the issue of counterfactual analysis. This type of approach consists of constructing a scenario for the economy that would have prevailed in the absence of the policy reforms. Such a scenario should include controls for exogenous shocks unrelated to the policy reforms[3].

3. SRI LANKA'S AGRICULTURAL SECTOR AND EVENT-HISTORY ANALYSIS OF POLICY REFORMS

Sri Lanka was one of the first among the developing countries which implemented a far reaching program of economic policy reforms as early as 1977, mainly under the structural adjustment policy packages designed and introduced by the World Bank. Consequently 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 factor 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 in 1994, Bandara and Gunawardana 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.

During the Pre-Reform period of 1970-1977, Sri Lanka followed a closed economic policy under which foreign exchange limitation and restrictions on imports of food and agricultural inputs took place. The Government adopted a policy of food self-sufficiency under increased Government

[3] Comparison of the observed and the counter factual values of the economic variables would then indicate the differential impact of the adjustment policy reforms on the economy. The problem is that the estimation of a detailed counterfactual path cannot be done in the absence of a consistent multi-sectoral general equilibrium model. The construction of such a model is rather difficult and time-consuming task without proper and comprehensive data (Sarris, 1987). Hence we propose General Equilibrium Growth Accounting approach which captures the effect of changes of exogenous variables on endogenous variables and extended the initial framework suggested by Sarris completely.

interventions in domestic factor and product markets. Many private business ventures were taken into Government control and management while vast areas of land cultivated with tea, rubber and coconut were nationalized under land reform program[4]. Due to the change of Government in 1977, a new economic reform policy was introduced.

Following the closed economy period, the new Government which came to power in 1977 implemented various policy reforms in order to achieve a number of declared objectives such as accelerate economic growth, create employment opportunities, increase capacity utilization, stimulate savings and investment, improve the balance of payments and achieve international competitiveness (Athukorala and Jayasuriya, 1994). To attain these objectives, the following measures were taken by the then Government. Tariff system was introduced in place of non tariff measures, the exchange rate was unified and allowed to be market determined, exchange controls were removed, Sri Lankan currency (Sri Lanka Rupee) was devalued substantially, massive public sector investment programs were introduced and export processing zones were also introduced. Trade liberalization was a major component of the policy reform package. The introduction of this open economy policy also led to the elimination of most of the controls. Major fiscal policy reforms included the replacement of generic food subsidies with a targeted food stamp scheme in 1978 and the reduction of fertilizer subsidies. Government concessions on agricultural credit were reduced (Lakshman, 1994).

After the leadership changed in 1989, the same Government implemented a second series of policy reforms for several reasons. Macroeconomic stability, compounded government mismanagement of the domestic economy, mounting ethnic violence and insurgency blocked the progress of the initial waver of incomplete reforms and liberalization during 1977-1988 (Dunham and Kelegama, 1994). The first wave of reforms caused hardships to certain sections of the community. The social cost of the adjustment also forced the government to implement a converted version of the policy under the second phase which involved two types of policy reforms and initiatives such as technically important but low profile adjustments and high profile projects. These high profile projects included further privatization of a number of public institutions, new emphasis placed on export-oriented industrialization under more liberalized trade regimes and the major program for poverty alleviation. Also the private sector was allowed to carry out fertilizer imports and the fertilizer prices were aligned with world markets. Interest rates on rural credit scheme were increased[5].

4. SOME DESCRIPTIONS ON POLICIES MADE BY ADJUSTMENT REFORMS

Here we focus on three policies which were carried out based on adjustment policies.

[4] See Gunawardana, 1981.
[5] See Dunham and Kelegama, 1994 for detailed description of second wave policy reforms.

4.1 Trade Policy

Trade policy included the effects of tariff, tax and the exchange rate. For tariff, quantitative restrictions were removed and were changed to adopt the tariff system (from 10 to 500%) and maximum import duty was fixed at 60 %. Also, the number of tariff bands was reduced to 13. Therefore, food import had a tendency to increase. Export duties were abolished and Ad-valorem sales tax on exports was also abolished. Therefore, food export had a tendency to increase too. For exchange rate, devaluation of Rupee was done. Therefore, food export has a tendency to increase and food import has a tendency to decrease. Among these, the effect of the devaluation of the Rupee was very large and export increased and import decreased in the Ist (1970-74), IInd (1975-1979) and IIIrd (1980-1984) periods.

4.2 Fiscal and Monetary Policy

For fiscal policy, fertilizer subsidy was abolished and the price of fertilizer increased very much as shown in Table 2. The increase of cost owing to this increase of fertilizer price attacked the Sri-Lankan agriculture. And the export of exportable goods had a pressure to decrease. The replacement of generic food subsidies with targeted food stamp schemes were done in 1978. This has a tendency to decrease the food import and poor people on the poverty line increased. Very low interest loans were abolished and this prevented people from investing in new machinery and other usages. This tends to decrease the agricultural export and increase the agricultural import.

4.3 Privatization of Plantation

The government initiated the action to privatize certain plantations owned by the government. Accordingly management of these estates was transferred to private companies and they were called Estate Management Companies (EMC). These EMCs are comprised of various corporate sector organizations. Though Government intervention and shares were detained, it was kept under lowest possible level. The government expected better outcomes from this transformation. With this brief introduction of policy reforms scenario, we used the following analytical framework to evaluate the major impacts of this reform on the agricultural sector.

5. DISCUSSION ON MODEL USED FOR ANALYSIS

There were many studies dealing with adjustment policy effects on the economy in Sri Lanka. The two notable works were Bandara and Gunawardana (1989) and Cooray (1998). Though their models dealt with domestic food sector through CGE approach, they failed to discuss the effects of the policy changes in the sub-sectors of the domestic food sector. Also the important aspects of technical changes were not discussed along with nonagricultural determinants. Our model is stated in Appendix

1. In our static model, we have 23 equations which include agricultural and nonagricultural 2 production functions, 3 consumption functions, equations for income and equations for labor allocation in both sectors[6]. From these 23 equations, we obtained the dynamic model which is reduced to 21 equations as shown in Table 1. Here the model uses the General Equilibrium Growth Accounting Approaches[7] to find the impact of 11 exogenous variables on 21 endogenous variables.

Table 1: Matrix form of the Model

	X1	X2	X3	XA	C1	C2	C3	Cf	P1	P2	P3	Pf	PA	CPI	DEF	LA	Y	GDP	E	XN	LN			
(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	0	0	0	0	-1	0	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	0	$-q$	0	0	$\hat{C}_1$		$\hat{d}+\hat{N}$
(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	$a\mu_A/(1-b)$	-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	$\hat{CPI}$		$(\mu_A-1)\hat{P}_N$
(15)	0	0	0	0	0	0	0	0	0	0	0	0	$b\mu_A/(1-b)$	0	0	$a\mu_A/(1-b)$	0	-1	0	$1-\mu_A$	0	$\hat{DEF}$		$\frac{\mu_A}{b-1}\hat{T}_A+\frac{b\mu_A}{1-b}\hat{P}_F$
(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	$\hat{GDP}$		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	$-\xi$	$\hat{X}_N$		$\hat{T}_N$
(21)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	l_A	0	0	0	0	l_N	$\hat{L}_N$		$\hat{L}$

[**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 1 came from equation (A-10) in Appendix. Equation (2) came from equation (A-11) in Appendix where $S_2=X_2/C_2$. Equation (3) came from equation (A-12). Equation (4) came from equations (A-8) and (A-9) where $\upsilon_i = P_1X_1/(P_1X_1+P_2X_2+P_3X_3)$. 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 1. Equation (16), (17) and (18)

[6] Please see the discussion paper 0407, Yamaguchi and SriGowri Sanker for full description of the model, the variables and their effects.

[7] Papers among these studies are Yamaguchi and Binswanger (1975), Yamaguchi (1982) & Yamaguchi and Kennedy (1983).

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 $l_A=L_A/L$, $l_N=L_N/L$.]

As shown in Appendix 1, we have rectified the models of Bandara and Gunawardana (1989) and Cooray (1998) with a three sector model which uses GRM (as will be shown later) approach to find the effects. In this model the economy is composed of two sectors such as agriculture and non-agriculture and the agricultural sector has been further divided into three sub-sectors. The following assumptions are also made in this model. (1) Agriculture will produce three products (or sectors) such as exportable (sector 1)[8], import substitute (sector 2)[9] and the final one is both domestically produced and consumed (sector 3)[10]. That is the agricultural sector has been categorized into 3 sub-sectors as stipulated above. (2) 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. The price of the fertilizer is given for agriculture and will change under adjustment. (3) The price of the nonagricultural sector will be determined by factors largely outside agriculture in order to see the effect of it on 21 endogenous variables.

Here we considered a two sector General Equilibrium Growth Accounting model to analyze the above trend. Many development countries in the Asia and Africa regions have adopted SAPs to resuscitate their economy as discussed in the previous sections. Hence the suitability of this model to analyze the above trends in the Sri Lankan Agricultural sector has been firstly tested. Sarris made a very good basic framework of a model in 1990 but our model as stated in Appendix 1 of this paper has been converted and extended much more to suit the structure of the economy of Sri Lanka. First, Sarris did not show what the endogenous variables were and what the solving equations were as a whole. In other words, the number of endogenous variables and the number of equation were not same. Therefore, we could not solve the equation fully. In other words, he did not specify the way to solve the equations in order to capture the impact (effects) of the all exogenous variables on all endogenous variables fully. Second, Sarris' model also did not specify anything about the non-agricultural sector. For example, his model did not contain a non-agricultural production function. Furthermore, his model did not contain the equation for intersectoral flow of labor. Third, he neglected the domestic consumption of exportable goods.

In our model these drawbacks have been rectified. First, we showed clearly 21 equations and 21 endogenous variables. Therefore, we can solve the equation. Second, it has been modified with inclusion of non-agricultural variables, such as technical change in both agricultural (T_A) and non-agricultural (T_N) sectors and non-agricultural labor force (L_N). We introduced the Growth Rate Multiplier (GRM) approach (as we will see later) to solve the model to capture the effects of the exogenous variables on endogenous variables. Therefore, Sarris' model has been further extended and

[8] This sector includes tea, rubber, coconut and minor export crops.
[9] This sector includes food crops such as rice, maize, pulses and grains.
[10] This sector includes items produced and consumed domestically such as vegetable, fruits and other field crops.

converted completely. Third, we included the domestic consumption of exportable goods in our model. Though we have constructed four converted versions of the model, in this paper we discuss only the final version[11] of the converted version of the model. In concrete, we added completely new equations (5), (7), (19), (20) and (21) in Table 1, which were not included in Sarris model, and extended equations of (1), (6), (12) and (15) in Table 1. Here the model uses the growth accounting approach to find the impact of 11 exogenous variables on 21 endogenous variables. Many studies have been done with the General Equilibrium Growth Accounting Approaches[12] to evaluate the policy impacts.

Having stated the above model, impact of various exogenous but adjustment related variables on various endogenous variables could be obtained. In order to do this, the above static form of the model should be converted to the dynamic log differential form. If X denotes the log-derivative, namely the quantity dX/X (Growth Rate $\hat{X}$), all variables will be expressed in this way throughout the analysis. The equations in Table 1 were derived from earlier equations from (A-1) to (A-23) in Appendix 1 after changing them into log derivative form.

After this transformation, the model has the general form $Ax=b$ as indicated in the matrix form (Table 1) where A is a matrix of order (21 X 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}). The inverse of A displays the ***Growth Rate Multipliers* (GRM)**[13]. As an example, $(A^{-1})_{8,2}$ element is $\partial \hat{C}_f \big/ \partial \hat{M}_2$ (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 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 endogenous variables. In addition, the contribution of exogenous variables to the endogenous ones

[11] Version 1 of the model is the first step conversion of Sarris' model with the conversion only in the consumption from Sector one. Sarris argued that Sector one's output (X_1) is totally exportable (E_1) as $X_1=E_1$. But in the case of Sri Lanka, some portion from Sector 1 is also consumed (C_1) but not as food. So the relevant change is $X_1=E_1+C_1$ where $C_1=0.2X_1$. In this Version 2, this consumption is assumed as function of per capita income (E) and the price of this product (P_1). Version 3 deals with Agricultural labor force (L_A) and Technical Change in Agriculture (T_A) and non-agriculture (T_N) sector along with the total labor force (L) in order to catch the push-pull effect. The dynamic form of this relationship is $\hat{L}_A = \gamma_1 \hat{T}_A + \gamma_2 \hat{T}_N + \gamma_3 \hat{L}$. In Version 4, more non-agricultural sector variables (e.g., non-agricultural Labor L_N) are also included in the model to see the impact on non-agricultural side such as $\hat{L} = l_A \hat{L}_A + l_N \hat{L}_N$ and $\hat{X}_N = \hat{T}_N + \zeta \hat{L}_N$.

[12] Papers among these studies are Yamaguchi and Binswanger (1975), Yamaguchi (1982) & Yamaguchi and Kennedy (1983).

[13] For further details of the application of GRM, see Yamaguchi (1982), Yamaguchi and Kennedy (1984), Yamaguchi and Binswanger(1975) .

could be calculated by multiplying the GRM of each year interval by the corresponding rates of change of the exogenous variables. For example, $CX_1M_2 = (\frac{\partial \hat{X}_1}{\partial \hat{M}_2})\hat{M}_2$, where CX_1M_2 is the contribution of the agricultural food imports M_2 to the agricultural production for exports X_1, and $(\frac{\partial \hat{X}_1}{\partial \hat{M}_2}) = (X_1M_2)$ is the relevant GRM which shows how many percentage (%) of X_1 would increase when M_2 increases by 1%. The calculated values of these effects and contributions are given in Appendix Tables 2 & 3.

Data used here to obtain parametric values are from secondary sources such as Central Bank of Sri Lanka, Department of Census and Statistics, Customs Department and Department of Agriculture for the period starting from 1970 to 1996. The parameters of the model are not assumed to be constant and were obtained for every five-year period starting from 1970 to 1996. This allows us to trace structural changes in the economy and to measure how the effect of the exogenous variables has changed over time for growth accounting by using the structural changes in each period.

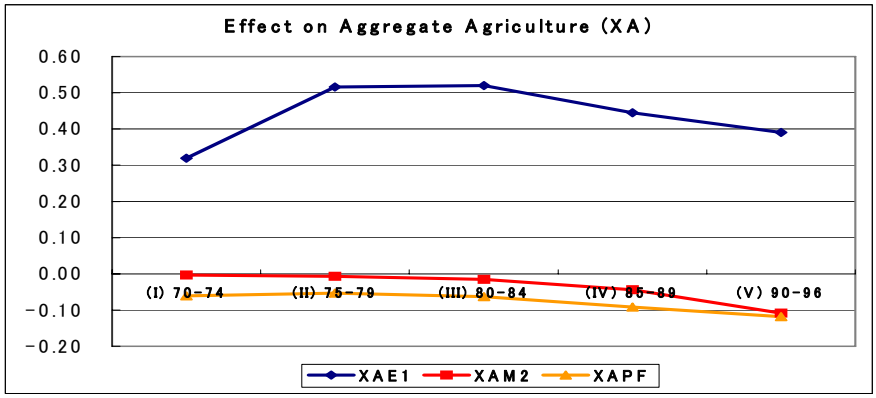
6. DISCUSSION ON RESULTS

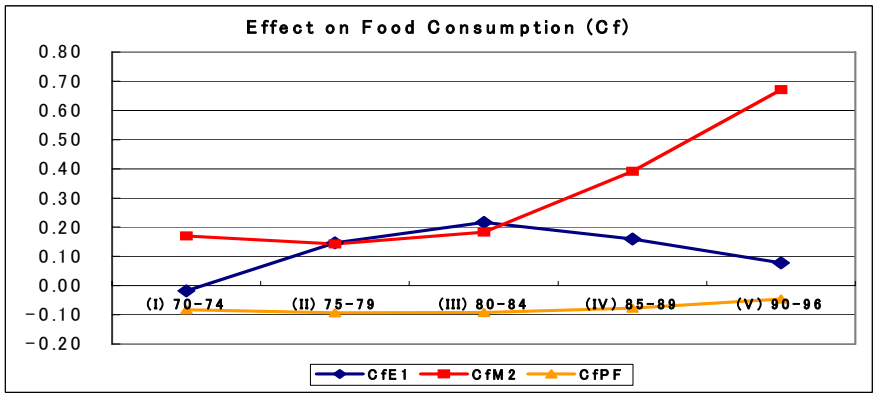
Now let us see the results of this analysis and impact evaluation as explained in the previous sections. Further, effects and contributions of exogenous variables to endogenous variables are given in Figures 1 and 2, and Appendix Tables 2 and 3. We hereby analyze the results according to the welfare of producers, consumers and overall economy which include the impact on agricultural prices.

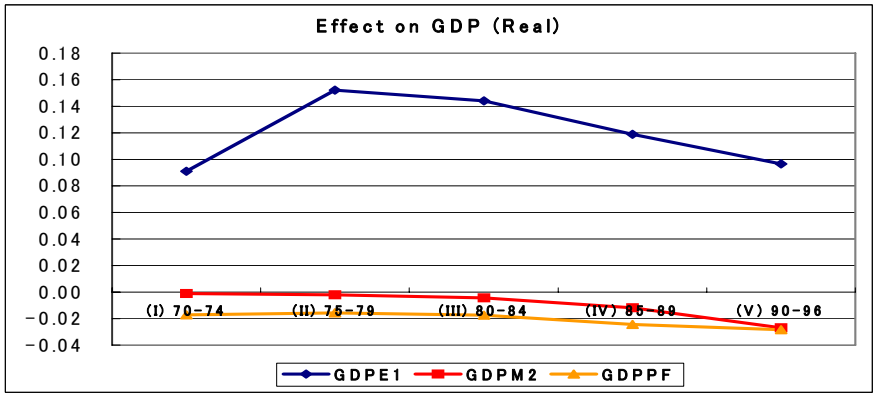
6.1 Discussion on Results of *Effects:*

The Effects based on the GRMs are given in Figure 1 (See Appendix Table 1 for detail values) in relation to this model, which has 21 endogenous variables and 11 exogenous variables providing 231 Effects in total in one period. Hence, it is extremely complicated to describe the performance of the entire Effects but only focus on the principal effects such as the effects of export (E_1), Import (M_2), fertilizer price (P_F) and others, which clearly describe the policy effects. In fact, we focus these E_1, M_2, P_F effects on the welfare of three groups, first, on the producer (the effects on X_1, X_2, X_3, and X_A), second, on the consumer (the effects on C_f), and third, on the overall economy (the effects on *GDP)*.

Figure 1: Effect of Three Exogenous Variables to Agricultural Output, Food Consumption and GDP







Effect of E_1 on agricultural producer: Firstly, we focus agricultural export (E_1) on the producer's welfare. It is quite evident to see the trend of agricultural exports had made a notable impact on the agricultural production both exportable and domestically produced and consumed items (X_1, X_2 and X_3). The effect on X_1 by E_1 (X_1E_1 in Appendix Table 1) is quite large compared to the other two sectors X_2 (X_2E_1) and X_3.(X_3E_1). This is expected under SAP but the effect of E_1 on X_2 is a little bit larger than that of X_3. Though these two effects are negative before 1975, the larger positive effects on X_2 and X_3 after 1975 clearly show that both sectors, import substitute and domestic food production, are affected by agricultural exports after the policy reforms since 1978 (mostly, X_1E_1, X_2E_1, X_3E_1>0).

Nevertheless, the overall agricultural production X_A (X_AE_1>0 in Figure 1 and Appendix Table 1) shows positive increasing trend of effects since 1975-79 to 1980-84 and again a declining trend until

1996. This clearly shows the initial shift in the production by agricultural exports soon after the policy reforms and the decline in the later stages of the reforms due to various other exogenous factors affecting the exports and the production.

Effect of M_2 on agricultural producer: Next, let us view the effect of agricultural imports (M_2). Since the opening of trade allowed food imports M_2, the negative effect has been felt in domestic food production as well as on the overall agricultural production (mostly, X_1M_2, X_2M_2, X_3M_2, X_AM_2 <0). Please refer to Figure 1 and Appendix Table 2 for details.

Effect of E_1 and M_2 on agricultural prices: It is also fairly important to look at the prices of agricultural products (P_1, P_2, P_3) in relation to the other exogenous variables because agricultural prices affect both producers and consumers.

Our study reveals that the prices of agricultural commodities from sectors 1, 2 and 3 are considerably affected by the important policy variables of food exports E_1, food imports M_2, fertilizer prices P_F, and non-agricultural prices P_N. The increase of food exports E_1 raises the price of food products from sectors 1, 2 and 3 (P_1E_1, P_2E_1, P_3E_1 >0). Hence we could conclude that the increase of exports from sector one increases the price of both exportable and domestic food production. Therefore, the exports from sector 1 (E_1) increase the production of agriculture considerably (X_1E_1, X_2E_1, X_3E_1, X_AE_1> 0) owing to the price increase. But the imports of food items reduces the prices of P_2 and P_3 (P_2M_2 <0, P_3M_2 <0, only P_1M_2 >0), thus harming the agricultural producer which includes local small-scale producers (mostly, X_1M_2, X_2M_2, X_3M_2, X_AM_2 <0 as shown above). Please refer to Figure 1 and Appendix Table 2 for details.

Effect of E_1 and M_2 on consumer: Secondly, let us shed light on consumer's welfare although we showed only C_f *in* Figure 1 and Appendix Table1 because of the clarity and focus. Although the effect of E_1 did not give a positive effect on the consumption from this sector in the pre-reform period (C_1E_1 <0, e.g., -0.36 in 1970-74), this effect became positive with increasing trend in the post reform periods. E_1 had a positive effect on food consumption from sectors 2 and 3 (C_2E_1, C_3E_1, C_fE_1 >0). It is interesting to note that the effect of food imports M_2 considerably affect the domestic food sectors of sectors 2 and 3. As understood, the effect of M_2 was negligible on consumption from sector 1, (C_1M_2 was very small) but it increased the consumption from sector 2 (C_2M_2 >0 and it was 0.13 in 70-74, but increased to 0.22 in 90-96) as this sector is the import substitutable food production sector.

The effect of this M_2 was negative in sector 3 as the food imports reduced the consumption from sector 3 of domestically produced and consumed items (e.g., C_3M_2 = -0.12 in 90-96). This is the notable effect due to the policy reforms. But the overall food consumption increased (see C_fM_2 >0 in Figure 1 and Appendix Table 1) due to the food imports since sector 2 holds the majority of the food consumption in Sri Lanka. In other words, although there was a negative effect of these imports on sector 3, overall consumption increased as food imports increased. This comes from the increase of C_f due to the decrease of agricultural prices. It was nearly 0.17% increase in the pre-reform period per

1% increase of food imports and it increased to 0.67% in the period of 1990-1996 (See $C_fM_2>0$ and increased very much). Please refer to Figure 1 and Appendix Table 2 for details.

Effect of E_1 and M_2 on *GDP*: Thirdly, we shift our focus on the overall economy. This could be seen from the effect trend of GDP (In fact, real *GDP*). The ultimate objective of SAP is to re-structure the economy to register positive economic growth through the increase of GDP and the trend of effects in relation to GDP explains this. As expected under the policy reforms, exports tended to increase the GDP ($GDPE_1 >0$) and it was quite evident after the reforms in 1977-1978. Further food imports and the increase of fertilizer prices tended to decrease the GDP growth ($GDPM_2$, $GDPP_F <0$). Though the import of food and fertilizer price have negative effects, the positive effects from the exports negate these negative effects thus registering a positive growth of GDP. Please refer to Figure 1 and Appendix Table 2 for details.

Effect of P_F on X_A, P_i, C_f and *GDP*: The increase of fertilizer price decreased agricultural production (i.e., $X_1P_F<0$, $X_2P_F<0$, $X_3P_F<0$ and $X_A P_F<0$). The degree of decrease ranges from –0.05 to –0.12 % when fertilizer price increased by 1%. It can also be seen that the effect of fertilizer prices was relatively severe on the domestic food sector ($X_2P_F<0$ and $X_3P_F<0$) than on X_1 ($X_1P_F<0$) due to its usage pattern. For example, 100% increase of fertilizer prices would bring down production of X_1, X_2 and X_3 by 1.02%, 10.2% and 9.92% in 1970-1974 to 2.83%, 16.41% and 15.4% in 1990-1996 respectively.

Also, the increase of fertilizer price decreased food consumption C_f in all periods (i.e., $C_fP_F<0$). The degree of decrease ranges from –0.04 to –0.09 % when fertilizer price increased by 1%. This comes from the fact that P_1, P_2, and P_3 increase, therefore C_f decreases. In fact, the price increase of exportable goods P_1 is very large and ranges from 0.8 to 1.3 % when one percentage of the fertilizer price increases. When we consider the price increase of substitutable goods P_2 and domestically produced and consumed goods P_3, they are fairly large and range from 0.18 to 0.42 % and 0.2 to 0.49 % respectively when one percentage of the fertilizer price increases.

GDP decreased from 0.045 to 0.09% when one percentage of the fertilizer price increased. Therefore, the increase of P_F decreases X_A, C_f and *GDP* and it can be said that the increase of fertilizer price due to SAP has a very detrimental effect on Sri Lanka's economy. Please refer to Figure 1 and Appendix Table 2 for details.

6.2 The Change of Endogenous and Exogenous Variables under Policy Reform

Having completed the observation on effects of exogenous variables on endogenous variables (i.e.,GRM), it is important to see the contributions now. In order to see the contribution of exogenous variables to endogenous variables, we need to obtain the growth rate of exogenous variables. Therefore, we need to see the change of both exogenous and endogenous variables. We focus only some variables which are important for evaluating the policy reforms and these are given in Table 2.

Table 2: The Change of Endogenous and Exogenous Variables

Endogenous Variable	(I) 1970-1974	(II) 1975-1979	(III) 1980-1984	(IV) 1985-1989	(V) 1990-1996
GR(X1)	0.43	2.26	−0.53	−4.93	−1.11
GR(X2)	4.02	8.72	2.89	−0.92	10.45
GR(X3)	3.76	6.89	1.12	0.78	8.73
GR(XA)	2.52	14.15	0.45	−2.31	7.35
GR(Cf)	1.35	4.23	−4.01	5.87	2.45
GR(P1)	−11.61	1.66	17.79	−2.51	−40.93
GR(P2)	12.01	14.24	30.72	4.26	32.61
GR(P3)	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) 1970-1974**	**(II) 1975-1979**	**(III) 1980-1984**	**(IV) 1985-1989**	**(V) 1990-1996**
(1) GR(E1)	0.31	26.94	0.09	−7.38	−2.41
(2) GR(M2)	−11.68	−6.94	−25.89	10.76	−1.87
GR(PF)	5.73	−3.43	16.78	10.43	−3.62
GR(PN)	16.63	12.98	27.11	16.65	20.34
GR(TA)	0.16	4.23	−0.44	−3.40	5.30
GR(TN)	0.36	−0.25	−0.06	0.28	2.00
Devaluation Variable	**(I) 1970-1974**	**(II) 1975-1979**	**(III) 1980-1984**	**(IV) 1985-1989**	**(V) 1990-1996**
(3) GR(ER)	2.86	21.32	10.38	7.27	6.37
(1)-(3) E1'	−2.55	5.62	−10.29	−14.65	−8.78
(2)+(3) M2'	−8.82	14.38	−15.51	18.03	4.50

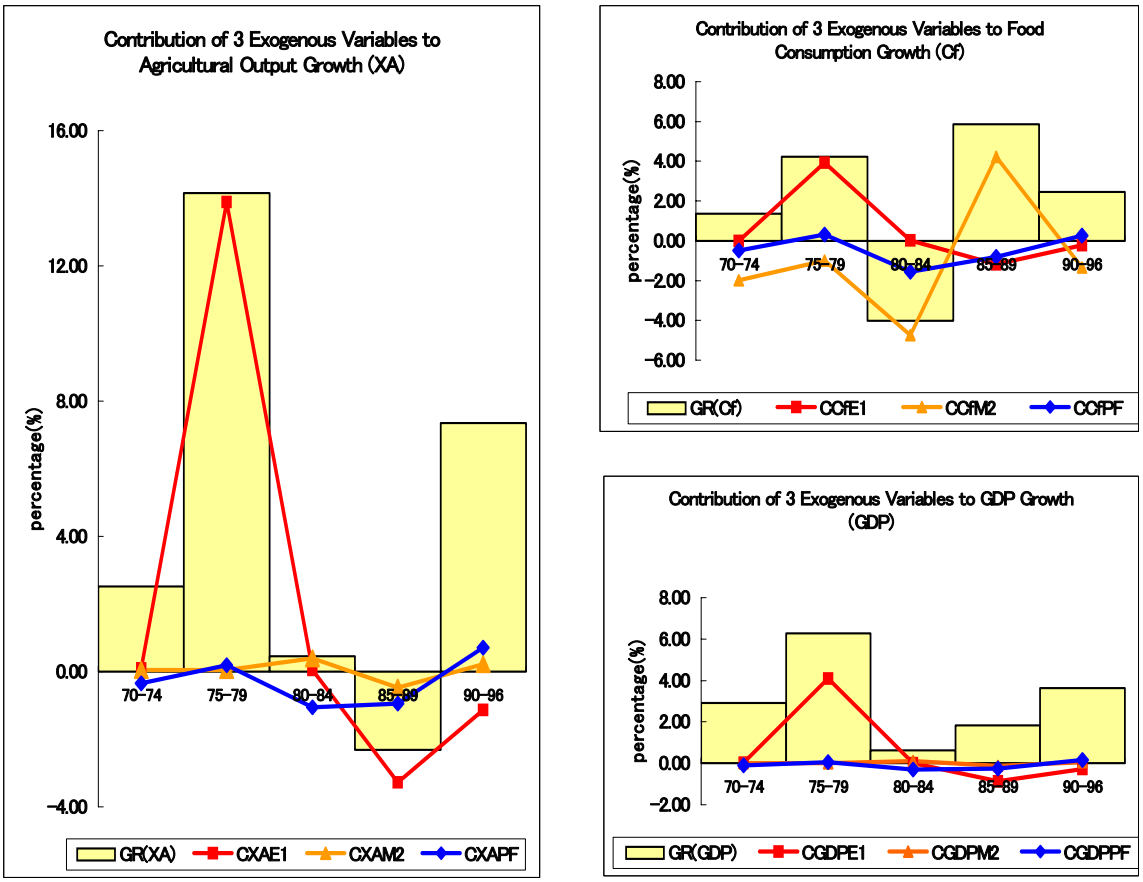
There were two domestic conflicts respectively in April of 1983 and in 1987-88 in Sri Lanka. Also, the first reform was done in 1977. Second reform was done in 1989. The values of both endogenous and exogenous variables show how these happenings affected the Sri Lankan economy. In the third period (1980-84) which includes the period of the first war in 1983, all the growth rates of sectoral output (X_1,X_2,X_3), food consumption (C_f) and real *GDP* were very small or negative and inflation was prevailing (see high growth rates of P_1, P_2, P_3). The same thing happened in the forth period, which also includes the period of another big war in 1987-88. For exogenous variables, the influence of reform was also obvious. The degree of devaluation of Rupee was very large (21.32% devaluation in each year average, as shown in GR(ER) of Table 2) in the second period which includes the period of the first reform time (1977). Export increased very much and import decreased in this period owing to the devaluation. As the speed of devaluation of Rupee decreased, the growth rate of export decreased and finally became negative. Technical change in both sectors were very small in the war times of the second and third periods (T_A=-0.44 and -3.40, and T_N=-0.06 and 0.28). Also, the growth rates of both P_F and P_N are very large (inflation) in war times like the second and third period. Therefore, we can see that the influences of internal conflicts, insurgencies and reforms were very large for the Sri Lankan economy.

6.3 Discussion on Results of Contributions

Contribution of E_1 and M_2 to producer: Here, the contributions provide the percentage of the amount of contribution of the exogenous variable to the endogenous variable (The sum of contribution

of 11 exogenous variables in one period equals the growth rate of the respective endogenous variable in that period)[14] . The most important values in relation to agricultural output X_A is given by the E_1, M_2, P_F and P_N. According to the values in Appendix Table 3, the biggest contribution of exportable to agricultural output (CX_AE_1) was in 1975-1979 just at the beginning of the policy reform and the production was affected positively by the biggest contribution from exports with almost 100% (CX_AE_1=98.19%) contribution to the growth of X_A. In Figure 2, the histogram shows the growth rate of X_A, C_f and *GDP* in each period. For example, the height of X_A in 70-74 shows 2.52% and the contribution of E_1 is 0.10 (3.90%) in the same period. In 75-79, the height of X_A is 14.15 and the contribution of E_1 is 13.89 (98.19%) in the same period. It further shows clearly a decrease in the period of 1985-1989 due to the civil conflict and the decrease of the exports due to this fact, had 142.02% of contribution to the decrease of the output. In III period (1980-84), the decrease of agricultural import M_2 (25.89% annually) made a very large positive contribution (88.89%) to the growth of X_A.

Figure 2: Contribution of Three Exogenous Variables to Agricultural Output, Food Consumption and GDP



[14] Although we have 11 exogenous variables, here we focus only on three exogenous variables such as E_1, M_2, and P_F.

Contribution of E_1 and M_2 on agricultural prices: Here we see that the contribution of agricultural exports E_1 to the price of agricultural exports P_1 was large and positive for all four periods except the I period. Especially, in the beginning of the policy reform, II period (1975-1979), this contribution was very large (CP_1E_1=742.92%). Similarly contribution of E_1 to prices of domestically produced items P_2 and P_3 was also large and positive in the II period (CP_2E_1=55.87% and CP_3E_1=81.43%) and negative in the III and IV period (CP_2E_1, CP_3E_1<0) respectively. This clearly shows the importance of E_1 on P_1 (the increase of P_1 means inflation) after policy reforms. Further, food imports M_2 negatively contributed to P_1 as CP_1M_2<0 for the first four periods. Contribution of M_2 to P_2 was positive in the I, II, III and V periods and it was negative and large in the IV period (CP_2M_2=136.53%). It is also notable that contribution of M_2 to P_3 was also negative in the I and IV periods and positive in the II, III and V periods respectively. Large negative contribution of M_2 to P_3 was in the IV period as similar to the pattern of P_2 (CP_3M_2=17.12). This shows us the negative effect of food imports on domestically produced items. Please see Appendix Table 3 for detail values.

Contribution of E_1 and M_2 to the consumer.: For the growth of food consumption C_f, the increase of E_1 in the II period (93.18%) and the increase of M_2 in the IV period (71.88%) made very large positive contributions to the growth of C_f. On the other hand, the decrease of food import M_2 in the periods of I, II, III and V made very large negative contributions to the growth of C_f. The above given Figure 2 explains this graphically. Values are given in Appendix Table 3.

Contribution of E_1 and M_2 to GDP: Agricultural exports helped to increase the *GDP* and the contribution of this ($CGDPE_1$) was nearly 65.15% in the beginning of the policy reforms in 1975-79. Further the decrease of the growth rate of *GDP* was also evidenced here in the period of 1985-89 following that of 1980-84. The contribution of decrease of agricultural exports in the decreased *GDP* was evident here with 48.20%. The contribution of agricultural import M_2 was not so large to the growth of *GDP*. Only in III period (1980-84), the decrease of agricultural import (25.89% annually) made a relatively large positive contribution (18.17%) to the growth of *GDP* and diagrammatic representation is given in Figure 2 in this regard. Fairly large positive contributions were also made by non-agricultural price P_N in the periods of III, IV and V periods. Please see Figure 2 above and Appendix Table 3 for detail.

Contribution of P_F to X_A, P_i, C_f and *GDP*: The increase of fertilizer price P_F in III and IV periods contributed negatively (234.78% and 41.18%) to the growth of X_A. Also, the increase of fertilizer price P_F in the I, and IV periods contributed negatively (35.14%, and 13.66%) to the growth of C_f. This comes from the fact that the increase of fertilizer price increased (contributed positively to the increase of) P_1, P_2, and P_3 (i.e., inflation) and therefore, C_f decreased. Further, the increase of fertilizer price P_F in I, III and IV periods contributed negatively (3.39%, 47.99% and 14.03%) to the growth of *GDP*. Figure 2 above clearly demonstrates these observations and values are given in Appendix Table 3.

Contribution of Real E_1 (E_1') and Real M_2(M_2') to X_A, C_f and *GDP* : So far, we treated E_1 and M_2 as exogenous variables in order to see the effect of E_1 and M_2 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 and M_2 (not E_1' and M_2') in this paper. Therefore what we have to do is to see the effect of SAP on E_1 and M_2, in order to observe the overall effect of SAP, and we try to treat E_1 and M_2 as if they were endogenous variables for SAP. In order to see the effect of the exchange rate, we define $GR(E_1')$ and $GR(M_2')$ as follows: $GR(E_1')=GR(E_1)-GR(ER)$ and $GR(M_2')=GR(M_2)+GR(ER)$. 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 ($GR(ER)$) from the growth rate of E_1 ($GR(E_1)$). Therefore, E_1' shows how much is the growth rate of exportable goods in case that we remove the effect of devaluation of Rupee. The values of E_1' decrease very much as compared with E_1 as shown in Table 3 below. Table 2 shows how to calculate the values of E_1' and M_2'. The growth rate of E_1' was positive only in the II period. This is very different from the growth rate of E_1 because E_1 was positive in three periods (I, II and III). 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 II, IV and V periods (Growth rate of M_2 was positive only in IV period). Therefore, we can understand that the growth rate of export decreased and that of import increased fairly much when we removed the effect of the devaluation of the Rupee.

From these values, we can calculate the contribution of E_1' and M_2' to all (21) endogenous variables. However, here we focus only 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 II period although the contributions of E1 were positive in I, II and III 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 I and III periods although M_2 contributed positively in 4 periods (I, II, III and V periods).

For the contribution to C_f, the contribution of E_1' to C_f decreased fairly much when compared with the contribution of E_1 to C_f. However, the contribution of M_2' to C_f rather increased when compared with the contribution of M_2 to C_f. The contribution of M_2' is positive in 3 periods (II, IV and V) although M_2 contributed positively only in IV period.

The contribution of E_1' and M_2' to GDP also decreased. The contribution of E_1 to GDP was positive in 3 periods (I, II and III). However, the contribution of E_1' to GDP is positive only in one period (II period). The contribution of M_2' had no positive contribution in 5 periods although the contribution of M_2 was positive in 4 periods (I, II, III and V).

These observations show the positive implications of currency devaluation to Sri Lanka's economy under SAP.

Table 3: The growth rate of real agricultural export (E_1') and real food import (M_2') and the contribution of E_1', M_2', E_1 and M_2' to X_A, C_f and *GDP*.

Year (in parenthesis)	GR(E1') (GR(E1))	GR(M2') (GR(M2))	CXAE1' (CXAE1)	CXAM2' (CXAM2)	CCfE1' (CCfE1)	CCfM2' (CCfM2)	CGDPE1' (CGDPE1)	CGDPM2' (CGDPM2)
I 1970-74	−2.55	−8.82	−0.82	0.00	0.05	−1.50	−0.23	0.00
	(0.31)	(−11.68)	(0.10)	(0.04)	(−0.01)	(−1.98)	(0.03)	(0.01)
II 1975-79	5.62	14.38	2.92	−0.14	0.84	2.01	0.84	0.00
	(26.94)	(−6.94)	(13.89)	(0.05)	(3.94)	(−0.99)	(4.10)	(0.01)
III 1980-84	−10.29	−15.51	−5.35	0.31	−2.26	−1.85	−1.44	0.00
	(0.09)	(−25.89)	(0.05)	(0.40)	(0.02)	(−4.75)	(0.01)	(0.11)
IV 1985-89	−14.65	18.03	−6.45	−0.72	−2.34	7.03	−1.76	−0.18
	(−7.38)	(10.76)	(−3.28)	(−0.48)	(−1.17)	(4.22)	(−0.88)	(−0.13)
V 1990-96	−8.78	4.50	−3.42	−0.50	−0.70	3.02	−0.88	−0.14
	(−2.41)	(−1.87)	(−1.13)	(0.22)	(−0.23)	(−1.35)	(−0.28)	(0.05)

(1) *GR*(E_1') means the growth rate of E_1'.

(2) CXAE1', for example, shows the contribution of E_1' to X_A.

7. CONCLUSION

First, we can summarize the content of this paper as follows:

(1)The effects of M_2 and P_F were negative but the positive effect of E_1 was larger than these negative two effects. Therefore, policy reforms had a positive effect on Sri Lanka's Economy, though it had negative impact on sector 2 and sector 3 which are involved with domestic food production and small farmers.

(2)As we saw, many policies such as trade policy, fiscal and monetary policy, and privatization are affected in such a way to either increase or decrease E_1 and M_2. However, the effect of devaluation of the Sri Lankan currency (Sri Lanka Rupee) was very large and increased E_1 and decreased M_2 respectively. These increased E_1 and decreased M_2 contributed very much to the growth of X_A and *GDP* in I, II and III periods although the decrease of M_2 contributed negatively to consumers.

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

(5) It can be seen from this study that devaluation of the currency helped to reduce real food imports and increase agricultural exports. Consequently these impacted positively on agricultural production and GDP. Hence, this could also be attributed as positive outcome of the reforms.

We understood that the total effects of E_1, M_2 and P_F on *GDP* (real) were positive. The performance of these variables and consequent effects and contributions impacted the GDP change. This is visible from our study and it can be said that an increase of GDP increased the human development index from 0.616 in 1975 to 0.741 in 2000. Though the policy reforms may not have direct effect on this, we can strongly claim that their effects in these can not be neglected. According to the studies by Dunham and Kelegama in 1994, it can be seen that macroeconomic mismanagement and initial conditions were the major factors for the low progress of the reforms. Other studies also pointed out this factor. But in the agricultural sector, it can be said that domestic food sector was not benefited while export agriculture positively contributed to the GDP growth.

Based on the above conclusion of the study, it is noteworthy to mention that exports from sector 1 (E_1) changed in a notable manner and also impacted the aggregate agricultural production as well as the GDP. Concretely, exports from sector 1 (E_1) decreased in the III period (1980-1984) from the second period considerably and again in IV period (1985-1989). These decreases are attributed to ethnic conflict in 1983 and internal insurgency in 1987/1988 and also the problems due to privatization of plantations. Having understood the problems in relation to privatization of plantations and transferring the responsibility of management to estate management companies (EMCs), the government took some remedial measures to rectify. These measures included tightening the government control on EMCs, introduction of export regulation, establishment of ministry to deal with estate matters, introduction of minimum wage rate and working days for estate workers. These measures started yielding fruitful results as the E1 registered growth in the V period.

Second, it is important to consider micro point of macro policy too. We can see the fairly large contributions of the increased E_1 and decreased M_2 to X_A, C_f and *GDP* in I, II and III periods. The increase of GDP increased the HDI. More than 80% of the poor live in the rural sector which is characterized mainly by small farmers of domestic food sector. According to our study, it can be said that though policy reforms brought about positive results to overall agricultural production and GDP, its negative effect on small farmers and domestic food sector was also one of the reasons for the existence of rural poverty.

REFERENCES

Athukorala, P. and S. Jayasuriya. 1994. Macroeconomic Policies, Crises and Growth in Sri Lanka: 1969-90. World Bank, Washington D.C.

Bandara, J. S. and P. J. Gunawardana. 1989. Trade Policy Regimes and Structural Changes: The Case of Sri Lanka. Discussion Paper No. 6/89. Australia: School of Economics. La Trobe University.

Central Bank of Sri Lanka. Various Years. Annual Report of Central Bank of Sri Lanka. Colombo.

Cooray, N. S. 1998. Macro Economic Management in Developing Countries: An Econometric Modelling Approach to the Sri Lankan Case. *Regional Development Studies. Vol.*4. UNCRD.

Dunham, D. and S. Kelegama. 1994. The Second Wave of Liberalization in Sri Lanka 1989-93: Reform and Governance. Proceedings of International Conference on Economic Liberalization of South Asia, Australian National University, Canberra, December.

Dunham, D. and S. Kelegama. 1994. Stabilization and Liberalization: A Closer Look at the Sri Lankan Experience 19977-1993. Macro economic Series No.8, Institute of Policy Studies, Colombo.

Gunawardana, P. J. 1981. Land Policy and Agrarian Change in Independent Sri Lanka. *Sri Lanka Journal of Agrarian Studies Vol.* 2: 27-43.

Lakshman, W. D. 1994. Structural Adjustment Policies in Sri Lanka: Imbalances, Structural Disarticulation and Sustainability, Proceedings of *International Conference on Economic Liberalization of South Asia,* Australian National University, Canberra, December.

National Planning Division. 1984. National Agriculture, Food and Nutrition Strategy: A Change of Perspective. Ministry of Finance and Planning, Colombo.

Powell, A. H. and F. H. G. Gruen. 1968. The Constant Elasticity of Transformation Production Frontier and Linear Supply System. *International Economic Review* 9(3).

Sarris, A. 1987. Agricultural Stabilization and Structural Adjustment Policies in Developing Countries. FAO Economic and Social Development Paper No. 65, Rome.

Sarris, A. 1990. Guidelines for Monitoring the Impact of Structural Adjustment Programs on the Agricultural Sector. FAO Economic and Social Development Paper No. 95, Rome.

World Bank. 1990. Sri Lanka Sector Study and Programming Mission: Final Report. Washington D.C.

Yamaguchi, M. 1982. The Sources of Japanese Economic Development: 1880-1970. *Economic Studies Quarterly No.* 33: 126-146.

Yamaguchi, M. and H. Binswanger. 1975. The Role of Sectoral Technical Change in Development of Japan, 1880-1965. *American Journal of Agricultural Economics* 32*:* 269-278.

Yamaguchi, M. and G. Kennedy 1984. A Graphic Model of the Effects of Sectoral Technical Change: The Case of Japan, 1880-1970. *Canadian Journal of Agricultural Economics* 32*:* 71-92.

Yamaguchi, M. and M.S. SriGowri Sanker 2004. Empirical Analysis of Sri Lanka's Agriculture in Relation to Policy Reforms with General Equilibrium Growth Accounting Approach (1970-1996). Discussion Paper 0407. Graduate school of Economics, Kobe University, Kobe, Japan. June.

APPENDIX 1

Here, we start to explain our model which is a wide extension of Sarris' model. The Aggregate production function for agriculture will be of the form

$$X_A = T_A L_A^a X_F^b \quad a,b>0 \;\; a+b<1 \tag{A-1}$$

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

$$\text{Max } V_A = P_A X_A - P_F X_F \tag{A-2}$$

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

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

The aggregate agricultural supply is given by equation (4)

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

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

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

We assume that the agricultural sector produces three products. In order to allocate X_A, let us specify X_A as CET[15] index of the quantities X_1, X_2 and X_3 of the three produced products.

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

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.

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

The above maximization yields the following allocation functions.

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

where the price index P_A turns out to be the following

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

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

$$X_1 = E_1 + C_1 \tag{A-10}$$

$$X_2 + M_2 = C_2 \tag{A-11}$$

$$X_3 = C_3 \tag{A-12}$$

[15] For further analysis on CET function, refer Powell and Gruen, 1968.

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 called food that a CES function of the quantities of the two domestically consumed agricultural food products.

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

where σ is the elasticity of substitution and 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.

$$\text{Min } (P_2 C_2 + P_3 C_3) \quad \text{(A-14)}$$

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

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

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

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

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.

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

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

$$Y = (P_A X_A - P_F X_F) + P_N X_N \Rightarrow Y = V_A + P_N X_N \quad \text{(A-18)}$$

Please note that from (A-17) & (A-18), we have abstracted 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 the 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.

$$L_A = g(T_A, T_N, L) = L_{A0} T_A^{\gamma 1} T_N^{\gamma 2} L^{\gamma 3} \quad \gamma_1, \gamma_2 < 0 \quad \gamma_3 > 0 \quad \text{(A-19)}[16]$$

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

$$X_N = T_N L_N^{\xi} \quad \text{(A-21)}$$

[16] This equation (A-19) comes from our earlier papers (Yamaguchi (1982), Yamaguchi and Binswanger (1975), Yamaguchi and Kennedy (1984)). 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 which includes labor and capital markets.

$$C_1 = dNP^nE^q \quad (d\text{: demand shifter}) \tag{A-22}$$

$$E = GDP / N \tag{A-23}$$

Equation (A-19) comes from the push effect of agricultural technical change and the pull effect of nonagricultural technical change (Yamaguchi and Kennedy (1984)). Equation (A-20) is the equation of sectoral allocation of labor, and equation (A-21) is the production function of nonagricultural sector. Equation (A-22) is the domestic demand function of exportable goods. Finally, Equation (A-23) is the definition of per capita income.

Please see the following Appendix Table 1 for specifications of notations and variables.

Appendix Table 1: Endogenous and Exogenous Variables

Endogenous Variables (21 variables):

X_i :Agricultural output of sector i, where i =1, 2, 3

X_A : Aggregate output of agricultural sector (sector 1, sector 2, and sector 3).

C_1 : Domestic Consumption of sector 1.

C_2 : Domestic Consumption of sector 2.

C_3 : Domestic Consumption of sector 3.

C_f : Food consumption from sectors 2 and 3.

Pi : Agricultural prices of three sub-sectors, where i = 1,2, 3

P_f : Price of food consumption (sectors 2 and 3).

P_A : Agricultural price.

CPI : Consumer Price Index.

DEF : Deflator.

L_A : Total agricultural labor force.

Y : Nominal GDP

GDP: Real GDP

E : Per capita income

X_N : Non-agricultural output.

L_N : Non-agricultural labor force.

Exogenous Variable (11 variables):

E_1: Exports of agricultural sector 1

M_2: Food imports such as basic cereals that are perfect or near perfect substitutes.

d : Demand shifter of consumption (sector 1).

e : Demand shifter of consumption (food, sectors 2 and 3).

T_A : Technical change in agriculture

T_N : Technical change in non-agriculture.

P_F : Fertilizer price.

P_N : Non-agricultural price.

L : Total labor.

N : Population

L_{A0} : Initial value of agricultural labor.

Appendix Table 2: Effects of Exogenous Variables on Endogenous Variables

Effect on X1	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
X1E1	0.75	0.75	0.74	0.71	0.65
X1M2	0.00	0.00	0.00	0.00	−0.01
X1PF	−0.01	−0.01	−0.02	−0.02	−0.03

Effect on X2	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
X2E1	−0.02	0.18	0.28	0.29	0.28
X2M2	−0.02	−0.04	−0.06	−0.11	−0.20
X2PF	−0.10	−0.11	−0.12	−0.14	−0.16

Effect on X3	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
X3E1	−0.02	0.17	0.27	0.27	0.27
X3M2	0.00	0.00	−0.01	−0.05	−0.12
X3PF	−0.10	−0.11	−0.11	−0.13	−0.15

Effect on XA	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
XAE1	0.32	0.52	0.52	0.44	0.39
XAM2	0.00	−0.01	−0.02	−0.04	−0.11
XAPF	−0.06	−0.05	−0.06	−0.09	−0.12

Effect on Cf	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
CfE1	−0.02	0.15	0.22	0.16	0.08
CfM2	0.17	0.14	0.18	0.39	0.67
CfPF	−0.08	−0.09	−0.09	−0.08	−0.05

Effect on P1	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
P1E1	5.78	4.47	3.52	3.07	2.66
P1M2	−0.01	0.01	0.04	0.14	0.41
P1PF	0.79	0.96	1.06	1.19	1.32

Effect on P2	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
P2E1	0.59	0.67	0.49	0.30	0.21
P2M2	−0.16	−0.25	−0.36	−0.54	−0.84
P2PF	0.18	0.29	0.37	0.40	0.42

Effect on P3	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
P3E1	0.60	0.62	0.41	0.20	0.09
P3M2	0.02	−0.01	−0.05	−0.15	−0.35
P3PF	0.20	0.32	0.41	0.45	0.49

Effect on Y	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
YE1	0.91	1.01	0.72	0.48	0.32
YM2	−0.01	−0.01	−0.02	−0.05	−0.09
YPF	0.11	0.19	0.19	0.17	0.15

Effect on GDP	(I) 70-74	(II) 75-79	(III) 80-84	(IV) 85-89	(V) 90-96
GDPE1	0.09	0.15	0.14	0.12	0.10
GDPM2	0.00	0.00	0.00	−0.01	−0.03
GDPPF	−0.02	−0.02	−0.02	−0.02	−0.03

Appendix Table 3: Contribution of Exogenous Variables to the Endogenous Variables

Percentage Contribution of Exogenous Variables to Value of Production of Exportable Commodities (X1)

Year	GR(X1)	GR(X1) (%)	CX1E1	CX1E1 (%)	CX1M2	CX1M2 (%)	CX1PF	CX1PF (%)
(I) 1970-1974	0.43	100.00	0.23	53.89	-0.00	-0.16	-0.06	-13.55
(II) 1975-1979	2.26	100.00	2.01	89.09	0.00	0.05	0.05	2.04
(III) 1980-1984	-0.53	100.00	0.07	-12.46	0.02	-3.62	-0.27	51.76
(IV) 1985-1989	-4.93	100.00	-5.21	105.58	-0.03	0.66	-0.22	4.48
(V) 1990-1996	-1.11	100.00	-1.89	170.34	0.02	-1.80	0.17	-15.42

Percentage Contribution of Exogenous Variables to Value of Production of Import Substitute Food Commodity

Year	GR(X2)	GR(X2) (%)	CX2E1	CX2E1 (%)	CX2M2	CX2M2 (%)	CX2PF	CX2PF (%)
(I) 1970-1974	4.02	100.00	-0.01	-0.18	0.27	6.71	-0.58	-14.55
(II) 1975-1979	8.72	100.00	4.78	54.79	0.27	3.10	0.39	4.47
(III) 1980-1984	2.89	100.00	0.03	0.87	1.56	54.07	-2.00	-69.37
(IV) 1985-1989	-0.92	100.00	-2.13	231.90	-1.13	123.32	-1.46	158.54
(V) 1990-1996	10.45	100.00	-0.82	-7.88	0.40	3.81	0.99	9.49

Percentage Contribution of Exogenous Variables to Value of Production of Domestically Produced and Consumed Food Commodity (X3)

Year	GR(X3)	GR(X3) (%)	CX3E1	CX3E1 (%)	CX3M2	CX3M2 (%)	CX3PF	CX3PF (%)
(I) 1970-1974	3.76	100.00	-0.01	-0.18	-0.05	-1.24	-0.57	-15.13
(II) 1975-1979	6.89	100.00	4.61	66.89	0.02	0.23	0.38	5.46
(III) 1980-1984	1.12	100.00	0.02	2.16	0.35	31.38	-1.92	-171.10
(IV) 1985-1989	0.78	100.00	-2.02	-259.04	-0.50	-64.71	-1.38	-177.09
(V) 1990-1996	8.73	100.00	-0.77	-8.85	0.25	2.85	0.93	10.65

Percentage Contribution of Exogenous Variables to Agricultural Output(XA)

Year	GR(XA)	GR(XA) (%)	CXAE1	CXAE1 (%)	CXAM2	CXAM2 (%)	CXAPF	CXAPF (%)
(I) 1970-1974	2.52	100.00	0.10	3.90	0.04	1.76	-0.35	-13.79
(II) 1975-1979	14.15	100.00	13.89	98.19	0.05	0.34	0.18	1.28
(III) 1980-1984	0.45	100.00	0.05	10.38	0.40	88.89	-1.06	-234.78
(IV) 1985-1989	-2.31	100.00	-3.28	142.02	-0.48	20.63	-0.95	41.18
(V) 1990-1996	7.35	100.00	-1.13	-15.38	0.22	3.00	0.71	9.71

Percentage Contribution of Exogenous Variables to Food Consumption (Cf)

Year	GR(Cf)	GR(Cf) (%)	CCfE1	CCfE1 (%)	CCfM2	CCfM2 (%)	CCfPF	CCfPF (%)
(I) 1970-1974	1.35	100.00	-0.01	-0.42	-1.98	-146.75	-0.47	-35.14
(II) 1975-1979	4.23	100.00	3.94	93.18	-0.99	-23.42	0.32	7.60
(III) 1980-1984	-4.01	100.00	0.02	-0.48	-4.75	118.56	-1.54	38.49
(IV) 1985-1989	5.87	100.00	-1.17	-19.99	4.22	71.88	-0.80	-13.66
(V) 1990-1996	2.45	100.00	-0.23	-9.26	-1.35	-55.23	0.27	11.14

Percentage Contribution of Exogenous Variables to Average Price of Export Agricultural Output(P1)

Year	GR(P1)	GR(P1) (%)	CP1E1	CP1E1 (%)	CP1M2	CP1M2 (%)	CP1PF	CP1PF (%)
(I) 1970-1974	-11.61	100.00	1.77	-15.28	0.10	-0.85	4.53	-39.05
(II) 1975-1979	1.66	100.00	12.33	742.92	-0.04	-2.43	-3.29	-198.38
(III) 1980-1984	17.79	100.00	0.32	1.77	-0.94	-5.28	17.77	99.88
(IV) 1985-1989	-2.51	100.00	-2.67	106.48	1.53	-60.95	12.43	-495.27
(V) 1990-1996	-40.93	100.00	-7.71	18.83	-0.82	2.01	-8.00	19.54

Percentage Contribution of Exogenous Variables to Average Price of Import Substitute Food Commodity (P2)

Year	GR(P2)	GR(P2) (%)	CP2E1	CP2E1 (%)	CP2M2	CP2M2 (%)	CP2PF	CP2PF (%)
(I) 1970-1974	12.01	100.00	0.18	1.52	1.90	15.82	1.03	8.55
(II) 1975-1979	14.24	100.00	7.96	55.87	1.75	12.32	-1.00	-7.05
(III) 1980-1984	30.72	100.00	0.04	0.14	9.35	30.44	6.23	20.29
(IV) 1985-1989	4.26	100.00	-2.19	-51.52	-5.82	-136.53	4.18	98.14
(V) 1990-1996	32.61	100.00	-0.59	-1.82	1.70	5.22	-2.53	-7.76

Percentage Contribution of Exogenous Variables to Average Price of Domestically Produced and Consumed Food Commodity (P3)

Year	GR(P3)	GR(P3) (%)	CP3E1	CP3E1 (%)	CP3M2	CP3M2 (%)	CP3PF	CP3PF (%)
(I) 1970-1974	10.92	100.00	0.18	1.68	-0.21	-1.91	1.13	10.34
(II) 1975-1979	20.67	100.00	16.83	81.43	0.06	0.28	-1.10	-5.30
(III) 1980-1984	22.34	100.00	0.04	0.16	1.28	5.71	6.82	30.54
(IV) 1985-1989	9.45	100.00	-1.44	-15.25	-1.62	-17.12	4.70	49.69
(V) 1990-1996	27.52	100.00	-0.25	-0.92	0.71	2.57	-2.94	-10.68

Percentage Contribution of Exogenous Variables to GDP

Year	GR(GDP)	GR(GDP)(%)	CGDPE1	CGDPE1 (%)	CGDPM2	CGDPM2(%)	CGDPPF	CGDPPF (%)
(I) 1970-1974	2.92	100.00	0.03	0.96	0.01	0.43	-0.10	-3.38
(II) 1975-1979	6.29	100.00	4.10	65.15	0.01	0.23	0.05	0.86
(III) 1980-1984	0.61	100.00	0.01	2.12	0.11	18.17	-0.29	-47.99
(IV) 1985-1989	1.82	100.00	-0.88	-48.20	-0.13	-7.00	-0.26	-14.03
(V) 1990-1996	3.63	100.00	-0.28	-7.68	0.05	1.50	0.17	4.74