Growth Accounting for Sri Lanka's Agriculture with special reference to Fertilizer and Non-Agriculture Prices: Does Policy Reforms Affect Agriculture Development?

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Abstract

The agricultural sector of Sri Lanka, which was the back bone of the economy, suffered due to various reasons including the mostly argued policy reforms called Structural Adjustment Programmes (SAPs). Having considered the problems associated with the earlier models, we have used the two sector general equilibrium model with growth accounting approach using GRM which is the effect exogenous variables on endogenous variables in this paper. Since SAPs had many policy variables to analyze, we have considered only the most important variables as explained in this paper. Our analysis revealed the contradictory results in comparison to some of the earlier studies. The overall results point out that policy changes are favorable to the overall agriculture development though their impact on the domestic food sector is negative. Since we have considered the fertilizer effect as most serious determinant under policy change, our study clearly indicates that the fertilizer prices tremendously effect the agriculture production and it was also negatively affecting the domestic food production. Secondly this paper also analyzed the impact of non-agriculture products and prices and found out that these positively helped the development of overall agriculture. Thirdly, food imports are open under the new policy reforms and make considerably large impact on the domestic food production.

Key Words: Structural Adjustment Policy (SAP); Sri Lanka's Agricultural Sector; Domestic Food Sector; Two-Sector General Equilibrium Growth Accounting; Growth Rate Multiplier (GRM).

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1.0 Introduction:

Many of the Asian countries based on the agriculture economy and Sri Lanka is one among the tropical and agriculture economy based country located in the Indian Ocean. Rural agriculture development and food production towards achieving self sufficiency were the main objectives of almost all the governments came to power since independence. Though substantial amounts of resources on the agriculture and irrigation infrastructures were allocated through different policy alternatives in this regard, the rural agricultural economy of Sri Lanka confronts with various problems such as the use of low quality seed, following up old cultivation practices, insufficient and improper use of fertilizers and agriculture chemicals, inadequate agriculture production credits, and low rate of productivity. Absence or non-existence of reasonably priced production inputs as well as the inadequacy of well-organized farmer centered marketing facilities further deteriorated this problem.

Since about 60%-70% of the Sri Lanka's population live in the rural area depending on the agriculture and related activities and the increase of returning labor from non-agriculture sector, would contribute significantly both to increasing employment potential and raising income levels at rural areas through development of rural agriculture. Meanwhile, with rice and other subsidiary food items which compose majority of the imports, any reduction in those imports could not only help in remedy the foreign exchange imbalance but also allocate these resources for import of goods for much needed development activities. Therefore, resuscitating the agriculture sector with special reference to development of domestic agriculture has been a major policy issue of successive governments since independence. Though there were many policy issues, we consider the most important one among them was ***structural adjustment policies (SAP)***, implemented in 1977. Due to the reasons said above, it is imperative to estimate the effect of SAP on Sri Lanka's Agriculture. This paper aims to find out these results in the context of General Equilibrium Growth Accounting with special reference to agricultural fertilizer price, and non-agriculture price, with support of agriculture exports, and food imports.

2.0 Evaluation of SAP and SAP in the context of Sri Lanka's Agriculture:

Though there are many frameworks to study the tendency of the Adjustment Policy issues, we considered Sarris's analytical framework targeted the Asian economic structure as the most appropriate one. As Sarris (1990) discussed, majority of the adjustment programs come from an prevailing or expected decline in the external

balance, due to factors not likely to be inverted in short-run and the external deficit which is not sustainable in the medium term. Further, these adjustments require the domestic demand to be shifted with available resources and changing supply and the production structure to eliminate the external deficit. Since demand can be reduced more easily and faster by changes in money supply and public expenditures, it happens to be the focus of the first aim at correcting economic decline. Nevertheless, the improvements of the supply side are more difficult and slower to rectify. So, there is a tendency to be associated with medium term structural adjustment efforts. As the removal of the external inequality is the crucial focus of adjustment, trade policies appear significantly in all adjustment programs and they usually include two sets of measures such as export promotion and import liberalization.

It is quite notable from various countries which implemented said adjustment policies to develop their damaged economy that several internal controversies have been created about the results of the SAPs and the most important one is whether these results are due to the policy reforms or would have occurred otherwise? Such a question brings out the issue of counterfactual analysis which consists of constructing a scenario for the economy that would have prevailed in the absence of the SAP. Type of scenario should include controls for exogenous shocks unrelated to the policy reforms. Comparison of the observed and the counter factual values of the economic variables would then indicate the differential impact of the SAP on the economy. The problem is that the estimation of a detailed counterfactual path cannot be done in the absence of a consistent multi-sector general equilibrium model (Sarris, 1990). We consider that construction of such a model is rather difficult and time-consuming task without proper and comprehensive data which is the prime difficulty in the developing countries. Having understood this difficulty, especially in terms of Sri Lanka's economic structure, we propose General Equilibrium Growth Accounting approach which captures the effect of changes of exogenous variables on endogenous variables, based on the initial framework suggested by Sarris in this paper. Due to simplicity we concentrated on effects of two most important exogenous variables fertilizer and non-agriculture prices with the support of another two such as exportable and food imports.

Let us now concentrate on the relevance of SAP to Sri Lanka which was one of the first among the developing countries implemented the so called program of economic policy reforms as early as 1977, mainly under the structural adjustment policy packages designed and introduced by the World Bank. As a result, the major economic policy reforms introduced in Sri Lanka includes following aspects such as provision of incentives to export oriented sectors, reduction of protection provided to the import competing sectors, exchange rate changes, fiscal and monetary reforms, liberalization of domestic factor and product markets from Government intervention thus allowing independent function of market forces and privatization of Government owned enterprise. Athukorala and Jayasuriya in 1994, Bandara and Gunawardana in 1989

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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 though the sector's importance can not be neglected in terms of contribution to the GDP and labor market. Therefore we have considered the domestic food sector in more detail here and further divided this sector into three sub sectors.

2.1 Agriculture and Economic Conditions prevailed during 1970-1994

The period of 1970-1977 could be considered as pre-reform period as Sri Lanka followed a closed economic policy under which foreign exchange limitation and restrictions on imports of food and agricultural inputs took place. During this period the Government adopted a policy of food self-sufficiency under increased Government 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[1]. Due to the change of Government in 1977, a new economic reform policy was introduced.

First Stage during 1978-1988: After the above economy period which has also been regarded as closed economic period, the new Government came to power in 1977 implemented various policy reforms aiming to achieve 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). In order to achieve these, the Government has taken some measures and some of the important measures are given below. New 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 Lanka local currency (Rupee) was devalued substantially, many public sector investment programs were introduced and export processing zones were also introduced. As we saw earlier, trade liberalization was major component of the policy reform package. Accordingly, introduction of this open economy policy also led to the elimination of most of the controls. Major fiscal policy reforms also included of removal food subsidies and introduction of targeted food stamp scheme in 1978 and the reduction of fertilizer subsidies. Government concessions on agricultural credit were also reduced (Lakshman, 1994).

Second Stage during 1989-1994: In 1989 the leadership of the then Government changed, and the same Government implemented second series of policy reforms for various reasons. Macroeconomic stability, compounded government mismanagement of the domestic economy, escalation of ethnic violence and insurgency blocked the progress of initial stage of incomplete reforms and liberalization during 1977-1983

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[1] See Gunawardana, 1981.

(Dunham and Kelegama, 1994). The first stage of reforms caused many problems to the certain sections of the community. The social cost of the adjustment also forced the government to implemented converted version of policy under second phase which involved two types of policy reforms and initiatives such as technically important but low profile adjustments and high profile projects including privatization of more public institutions, placing further emphasis on export-oriented industrialization under more liberalized trade regime and the major program for poverty alleviation. Also the private sector was allowed to carry out the fertilizer imports and the fertilizer prices were aligned with world market.[2]

3.0 Performance of Major Exogenous and Endogenous Variables of the study in Sri Lankan Context

In this paper we have mainly considered the exogenous variables of agricultural exports, food imports, fertilizer price and non-agriculture price 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 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. Non-agriculture sector performance are always said to be a hurdle to agriculture development. Many of the policy reforms elsewhere tried to use this sector to resuscitate the economy by neglecting the agriculture sector. So in this paper we tried to see this impact on the agriculture sector using the price of non-agriculture, fertilizer price, agriculture exports and food imports. Following Table and the Figures show these trends clearly.

Table 1:

Growth Rate of Major Endogenous Variables					
	1970-1974	1975-1979	1980-1984	1985-1989	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

Figure 1:

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[2] See Dunham and Kelegama, 1994 for detailed description of second wave policy reforms.

Table 2:

Growth Rate of Major Exogenous variables
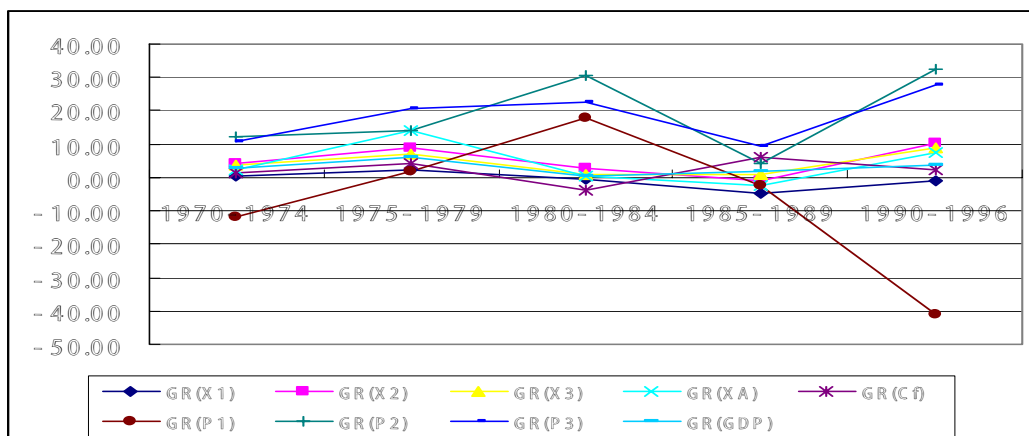
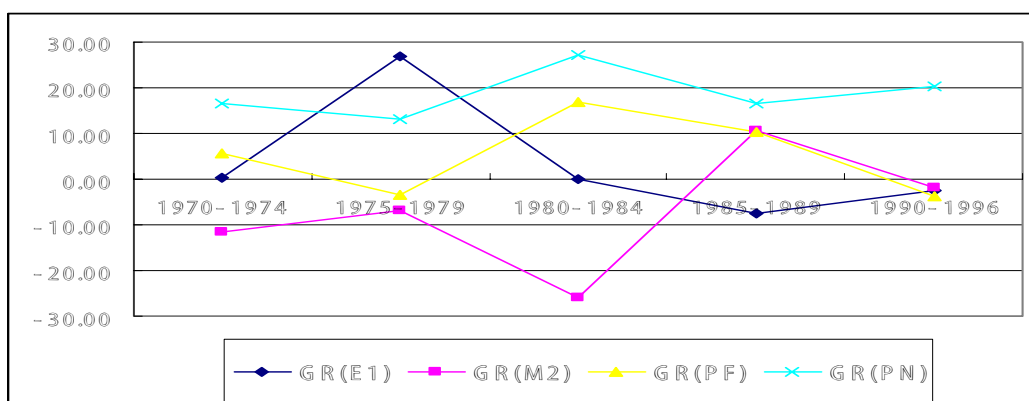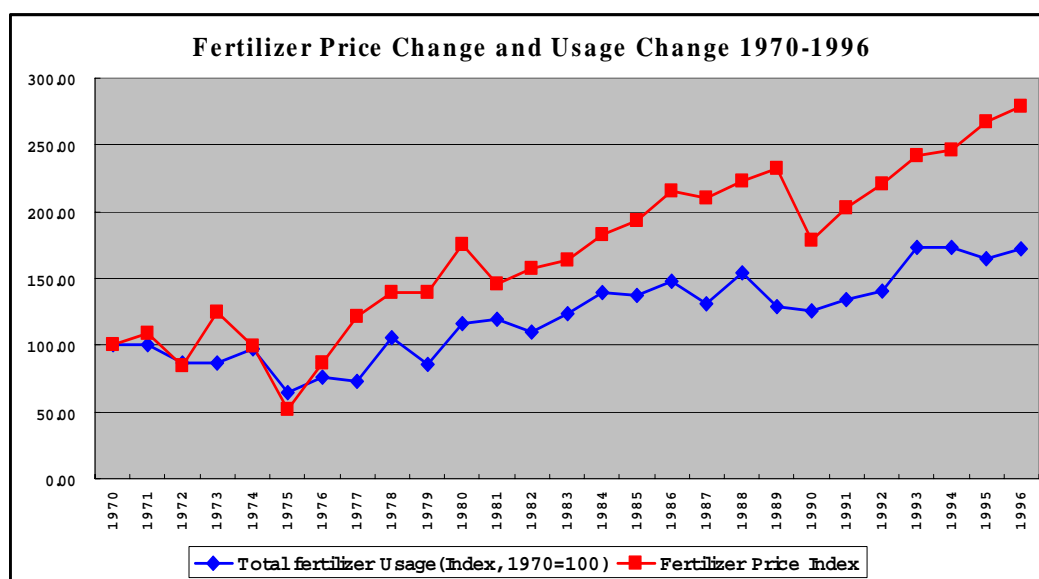|	1970-1974	1975-1979	1980-1984	1985-1989	1990-1996
GR(E1)	0.31	26.94	0.09	-7.38	-2.41
GR(M2)	-11.68	-6.94	-25.89	10.76	-1.87
GR(PF)	5.73	-3.43	16.78	10.43	-3.62
GR(PN)	16.63	12.98	27.11	16.65	20.34

Figure 2:

Figure 3

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 the exports and the increase of the non agriculture prices. With this brief introduction of policy reforms scenario, we used the following analytical framework to evaluate the major impacts of this reform on agriculture sector.

4.0 Structure of the Analysis and Model Construction

So far there were many studies dealt with adjustment policy effects on economy in Sri Lanka. In two pessimistic works by Bandara (1989) and Cooray (1998), sub-sectors of the domestic food sector were not considered. In our model, three sub-sectors model with GRM approach is used to find the major policy effects[3]. Here the economy was assumed to be of two sectors such as agriculture and non-agriculture. In order to evaluate the impact of plantation sector, the agricultural sector has been further divided into three sub-sectors. In our analytical framework, the following assumptions are made. First, we assume that agriculture will produce three products (or sectors) such as 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 nonagricultural sector will be determined by factors largely outside agriculture in order to see the effect of it on endogenous variables.

The basic framework of the model was developed using the initial work done by Sarris in 1990. But the model was developed in this paper. First, Sarris did not specify the way to solve the equations in order to capture the impact (effects) of the exogenous variables on endogenous variables fully. Second, Sarris model did not also specify anything about nonagricultural sector. Third, he neglected the domestic consumption of exportable goods which is not true in reality. Consequently our model has been developed rectifying these changes. 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[4]. From these 23 equations, we obtained the dynamic model which is reduced to 21

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[3] For the detailed information about the model variable please see discussion paper 0407 of Yamaguchi, M and SriGowri Sanker (2004).

[4] Please see the discussion paper 0407 for full description of the model, the variables and their effects.

equations as shown in Appendix Table 1. Here the model uses the General Equilibrium Growth Accounting Approaches[5] to find the impact of 11 exogenous variables on 21 endogenous variables. As our attention here is focused on the fertilizer and non-agriculture prices, only these major results are discussed here.

In dynamic model, it has the general form Ax=b 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})[6]. Please see Appendix Table 1 for details. The inverse matrix of A displays the ***Growth Rate Multipliers (GRM)***[7] which are obtained by calculating the inverse of above matrix of structural parameters. These effect values are given in the Appendix Table 2. Further these GRMs will be used to find the influence of the exogenous variables on endogenous. In addition, the contribution of exogenous variables to the endogenous variables could be calculated by multiplying the GRM of each year interval by the corresponding rates of change of the exogenous variables. The calculated values of these contributions are given in the Appendix Table 3. Now we would see the results of this analysis and impact evaluation as explained by these Tables given in the Appendix[8]. As our attention here is focused on the fertilizer and non-agriculture prices, only these major results are discussed here[9]. Appendix Table 1 summarizes our model framework as discussed above.

5.0 Discussion on Results
5.1 Discussion on Effects:

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

[6] Detail description of the exogenous and endogenous variable could be seen from the Discussion paper 0407 of Yamaguchi, M and SriGowri Sanker, M.S.

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

[8] We used data from the secondary sources such as Central Bank of Sri Lanka, Department of Census and Statistics, Customs Department and Department of Agriculture as well as from previous studies for the period starting from 1970 to 1996 to obtain parametric values which are not assumed to be constant and were obtained for every five-year period starting from 1970 to 1996. Due to space limitations, the data set is not included here and could be obtained from the authors by request.

[9] Please see the discussion paper 0407 for full description of the variables and their effects.

Appendix Table 2 gives the values of effects in detail in relation to this model based on the GRMs. It is rather difficult to describe the performance of the entire effects but only the principal effects, which are mentioned in the earlier sections in this paper and clearly describe the policy effects, are discussed here[10]. The effect of fertilizer price and nonagricultural price has a completely opposite effect on the economy. First, we focus on the fertilizer price. It can be seen that the effect of fertilizer price is much severe on the domestic food sector ($X_2 P_F < 0$ and $X_3 P_F < 0$) then on X_1 ($X_1 P_F < 0$) 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%, 10% and 10% in 1970-1974 to 3%, 16% and 15% in 1990-1996 respectively. It clearly shows the effect of fertilizer and the price increase under SAP.

The changing pattern of fertilizer prices always affects the prices of agricultural products from all the three sectors ($P_1 P_F$, $P_2 P_F$, $P_3 P_F > 0$). Under the SAP the fertilizer prices increased due to the reduction and removal of subsidies, which in turn negatively affected the production ($X_1 P_F$, $X_2 P_F$, $X_3 P_F < 0$), thus increases the prices agricultural products. It severely affected the agriculture after the policy reforms. Changing pattern of price indices of agriculture clearly show this argument registering an alarming increase in 1990-1996 in comparison to that of in 1970-1974 (e.g., $P_1 P_F$ increases from about 0.79 to 1.32. $P_2 P_F$ increases from about 0.18 to 0.42. $P_3 P_F$ increases from about 0.20 to 0.49). Hence it could be concluded from here that the severe effect is felt on the agricultural production and prices due to the change in fertilizer prices.

On the other hand, we could conclude that the expansion of the nonagricultural sector does not adversely affect the agricultural sector. It is also noteworthy to mention that the nonagricultural production and price (X_N and P_N) decreased the agriculture exportable production ($X_1 P_N < 0$) in the pre-reform period but after the policy reforms, X_N and P_N helped the production from sector 1 X_1 ($X_1 P_N > 0$. $X_1 P_N$ increases from about 0 to 0.03.). Positive effects could be observed in the case of import substitute and domestic food sectors ($X_2 P_N > 0$, $X_2 P_N$ increases from about 0.10 to 0.42. $X_3 P_N > 0$, $X_3 P_N$ increases from about 0.10 to 0.40.). Overall X_N and P_N tend to increase the production of aggregate agriculture X_A ($X_A P_N > 0$, $X_A P_N$ increases from about 0.06 to 0.29.). Though this effect was small in the beginning of the policy reform stages in 1970-1979 it increased in the 1990-1996 period.

Fertilizer price (P_F) decreases food consumption (C_f) and decreases real GDP although nominal GDP (Y) increases because of the increases of P_1, P_2, P_3 (i.e, inflation due to the increase of fertilizer price). However, Nonagricultural price (P_N)

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[10] Please see the discussion paper 0407 of Yamaguchi and SriGowri Sanker (2004) for detailed analysis and the performance pattern of the entire exogenous and endogenous variables of the model.

increases all the variables mentioned above, i.e., P_N increases food consumption (C_f)and increases nominal GDP (Y) and also increases real GDP (GDP). Therefore, the expansion of nonagricultural sector including P_N does not always adversely affect the economy. However, the increase of fertilizer price has a very bad effect on Sri Lanka's economy. It is quite evident to see the trend of agricultural exports had made notable impact on the agricultural production both exportable and domestically produced and consumed items. The effect in this regard is quite large comparatively to other two sectors such as sector 2 and 3. This is expected under SAP but the effect of exports on sector production is a little bit larger than that of sector 3. Though these two effects are negative before 1975, the larger positive effects on sector 2 and 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. Nevertheless, the overall agricultural production 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. Since the opening of trade allowed the food imports the negative effect is felt in the domestic food production as well as on the overall agricultural production.

5.2 Discussion on Contributions:

Further changes on these effects could be clearly understood from analyzing the results of contributions of the exogenous variables to endogenous variables as stipulated in the Appendix Table 3. Next we would observe the contributions provide the percentage of amount of contribution of the exogenous variable to the endogenous variable. The most important variable fertilizer and the non-agriculture prices have also contributed significantly to the agricultural output negatively and positively. First, according to the values in the Appendix Table 2, the fertilizer has about 235% of contribution in the decrease of the agricultural output (CX_AP_F=-234.78%) in 1980-1994. The contribution of these policy variables is also felt in the prices of the agricultural outputs. It is quite evident that the contribution of fertilizer prices on the prices of products of all the three sectors ($CP_1P_F, CP_2P_F, CP_3P_F$) is very high reaching the highest of 98.14% in the sector 2 during 1985-89. Mostly the contribution from the fertilizer prices is negative in the beginning of the policy reform endorsing the import benefits announced under SAP but tend to increase later on thus increasing the prices. Since the small-scale farmers are often affected by this increase, the policy option here should be the rationalizing the fertilizer subsidy based on the cultivation size. Further the decrease of the growth rate of GDP was also evidenced here in the period of 1985-89 following to that of 1980-84 and the contribution of decrease of agricultural exports in the decreased GDP is evident here with 48.20%. Also fertilizer price increase negatively

contributed to the GDP growth ($CGDPP_F$ <0) and the maximum contribution is in the year of 1985-89 with -47.99%.

It is noteworthy to mention that the prices of products from sector 2 and 3 (P_2 and P_3) are also considerably affected by the prices of nonagricultural price (P_N) as the contribution from this is quite strong thus indicating the strongest influence (CP_2P_N and CP_3P_N are very large). This trend further endorses that the development of nonagricultural sector tend increase its prices and this is positively affected the agricultural products too (CX_AP_N >0 in almost all periods). Agricultural output X_A is also affected by the change of other policy variables given by the E_1, and M_2. The biggest contribution of exportable to agricultural output is in the 1975-1979 just the beginning of the policy reform. And the production is affected positively by the biggest contribution from exports with almost 100% contribution to the growth of X_A. Also, the biggest contribution of import (owing to the decrease of import) to agricultural output is in the 1980-1984. And the production is affected positively by the biggest contribution from exports with almost 100% contribution to the growth of X_A. Hence the calculation of contribution further enriched the understanding of the performance of endogenous variables in relation to the effects of exogenous variables on the endogenous variables. As specified elsewhere in this paper, calculation of contribution helped to capture the inter-sector effects and only important contributions were discussed here though the calculation was made for every possible one.

6.0 Overall Conclusion

From this study, we obtained the following results.

(1) The fertilizer prices that change under the policy adjustments tremendously effect the agricultural production and it was further negatively effect the domestic economy.

(2) The impact of non-agricultural sector on agriculture is not affecting the overall economy but positive contribution though the latter experienced negative impact in the initial period of the policy reforms as the nonagricultural sector recorded rapid growth.

(3) It is quite evident from our study that SAPs are favorable to the overall agricultural development though their impact on the domestic food sector is negative and the increase of fertilizer price has negative impact on the economy. Since the revenue from the export earnings compensates the negative impact on the domestic food sector, the overall impact of agriculture is favorable for the development.

From these results, what we can say first is that the effect of fertilizer price and nonagricultural price has a completely opposite effect on the economy. Fertilizer price (P_F) decreases food consumption (C_f) and decreases real GDP (GDP) although nominal GDP (Y) increases because of the increases of P_1, P_2, P_3 (i.e., inflation due to the

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increase of fertilizer price). However, Nonagricultural price (P_N) increases all the variables mentioned above, i.e., P_N increases food consumption (C_f) and increases nominal GDP (Y) and also increases real GDP (GDP). Therefore, the expansion of nonagricultural sector including P_N does not always adversely affect the economy. However, the increase of fertilizer price has a very bad effect on Sri Lanka's economy. Due to the removal of various agricultural related subsidy schemes including important fertilizer subsidy, the production of domestic agriculture was affected with the increase of cost of production. Also, the rate of increase of the producer price in relation to that of the fertilizer price was not proportional and biased towards the fertilizer price increase. Therefore, the agricultural economy of Sri Lanka is greatly affected by this increase of fertilizer. It was evident from the Tables in relation to GRM effects and contributions.

From result (3), this is a completely different result from earlier research which is not divided agriculture into 3 sub-sectors such as exportable, domestically produced and substitutable, and domestically produced and consumed. In the beginning of the SAP implementation, the export agricultural sector was registering a positive growth and during the second wave of the policy changes, this increasing trend started to decline. In the beginning of the SAP implementation, the export agricultural sector was registering a positive growth and during the second wave of the policy changes, this increasing trend started to decline. Further, due to the various changes in the policy, the domestic agriculture was affected considerably. It is evident from this study as mentioned in the previous sections.

The important policy so far done by the Government is supported from this study theoretically and empirically in relation to the performance of variables P_F and P_N. As we saw earlier the effect and contribution from the fertilizer price negatively help the domestic agriculture production as well as the GDP growth. The corrective measure here is to control the escalation of the fertilizer prices to help the small farmers and domestic food sector. The government has also reinstated the fertilizer, subsidy which was removed in the initial stage of the SAP, in the end of second stage of the reform. Further, from these results we could see the non-agriculture price increase helped to the agriculture development as well as GDP growth. The Government has also focused to develop the non-agriculture sector, which helped in turn to overall economic development.

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.

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.

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.

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

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 SriGowri Sanker, M.S. 2004. Empirical Analysis of Sri Lanka's Agriculture in Relation to Policy Reforms with General Equilibrium Growth Accounting Approach (1970-1996), *Discussion Paper, No. 0407,* Graduate school of Economics, Kobe University, Kobe, Japan.

Appendix Table 1: Dynamic Form of the Model

Equation No.	Equations

(1) $\hat{X}_1 = (1-S_1)\hat{E}_1 + S_1\hat{C}_1 \quad$ where $S_1 = X_1/C_1$

(2) $S_2\hat{X}_2 + (1-S_2)\hat{M}_2 = \hat{C}_2 \quad$ where $S_1 = X_2/C_2$

(3) $\hat{X}_3 = \hat{C}_3$

(4) $\hat{P}_A = \sum_{i=1}^{3} \upsilon\hat{P}_i \quad$ where $\hat{\upsilon} = P_iX_i/(P_1X_1 + P_2X_2 + P_3X_3)$

(5) $\hat{C}_1 = -n\hat{P}_1 + q\hat{E} + \hat{N} + \hat{d}$

(6) $\hat{X}_A = \frac{1}{1-b}\hat{T}_A + \frac{a}{1-b}\hat{L}_A + \frac{b}{1-b}(\hat{P}_A - \hat{P}_F)$

(7) $\hat{L}_A = \gamma_1\hat{T}_A + \gamma_2\hat{T}_N + \gamma_3\hat{L} + \hat{L}_{A0}$

(8) $\hat{C}_2 = \hat{C}_f - \sigma(\hat{P}_2 - \hat{P}_f)$

(9) $\hat{C}_3 = \hat{C}_f - \sigma(\hat{P}_3 - \hat{P}_f)$

(10) $\hat{P}_f = \lambda_2\hat{P}_2 + (1-\lambda_2)\hat{P}_3 \quad$ where, $\hat{\lambda_2} = P_2X_2/(P_2C_2 + P_3C_3)$

(11) $\hat{C}_f = \eta(\hat{Y} - \hat{P}_N) - \varepsilon(\hat{P}_f - \hat{P}_N) + \hat{N} + \hat{e}$

(12) $\hat{Y} = \mu_A\left[\frac{1}{1-b}\hat{T}_A + \frac{a}{1-b}\hat{L}_A + \frac{1}{1-b}\hat{P}_A - \frac{b}{1-b}\hat{P}_F\right] + (1-\mu_A)(\hat{P}_N + \hat{X}_N)$

where μ_A = share of agriculture in GDP

(13) $\hat{CPI} = \nu_f\hat{P}_f + (1-\nu_f)\hat{P}_N$

(14) $\hat{DEF} = \mu_A\hat{P}_A + (1-\mu_A)\hat{P}_N$

(15) $\hat{GDP} = \mu_A\left[\frac{1}{1-b}\hat{T}_A + \frac{a}{1-b}\hat{L}_A + \frac{b}{1-b}(\hat{P}_A - \hat{P}_F)\right] + (1-\mu_A)\hat{X}_N$

(16) $\hat{X}_1 = \hat{X}_A + \tau(\hat{P}_1 - \hat{P}_A)$

(17) $\hat{X}_2 = \hat{X}_A + \tau(\hat{P}_2 - \hat{P}_A)$

(18) $\hat{X}_3 = \hat{X}_A + \tau(\hat{P}_3 - \hat{P}_A)$

(19) $E = GDP/N \rightarrow \hat{GDP} - \hat{E} = \hat{N}$

(20) $\hat{X}_N = \hat{T}_N + \xi\hat{L}_N$

(21) $\hat{L} = l_A\hat{L}_A + l_N\hat{L}_N \quad$ where $l_A = L_A/L, \; l_N = L_N/L$

Details of the variables and parameters used here are given below.

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	70-74	75-79	80-84	85-89	90-96
X1PF	-0.01	-0.01	-0.02	-0.02	-0.03
X1PN	0.00	0.00	0.00	0.01	0.03
X1E1	0.75	0.75	0.74	0.71	0.65
X1M2	0.00	0.00	0.00	0.00	-0.01

Effect on X2	70-74	75-79	80-84	85-89	90-96
X2PF	-0.10	-0.11	-0.12	-0.14	-0.16
X2PN	0.10	0.11	0.11	0.13	0.42
X2E1	-0.02	0.18	0.28	0.29	0.28
X2M2	-0.02	-0.04	-0.06	-0.11	-0.20

Effect on X3	70-74	75-79	80-84	85-89	90-96
X3PF	-0.10	-0.11	-0.11	-0.13	-0.15
X3PN	0.10	0.11	0.11	0.13	0.40
X3E1	-0.02	0.17	0.27	0.27	0.27
X3M2	0.00	0.00	-0.01	-0.05	-0.12

Effect on XA	70-74	75-79	80-84	85-89	90-96
XAPF	-0.06	-0.05	-0.06	-0.09	-0.12
XAPN	0.06	0.04	0.05	0.08	0.29
XAE1	0.32	0.52	0.52	0.44	0.39
XAM2	0.00	-0.01	-0.02	-0.04	-0.11

Effect on Cf	70-74	75-79	80-84	85-89	90-96
CfPF	-0.08	-0.09	-0.09	-0.08	-0.05
CfPN	0.08	0.09	0.09	0.07	0.12
CfE1	-0.02	0.15	0.22	0.16	0.08
CfM2	0.17	0.14	0.18	0.39	0.67

Effect on P1	70-74	75-79	80-84	85-89	90-96
P1PF	0.79	0.96	1.06	1.19	1.32
P1PN	0.12	-0.04	-0.12	-0.26	-1.08
P1E1	5.78	4.47	3.52	3.07	2.66
P1M2	-0.01	0.01	0.04	0.14	0.41

Effect on P2	70-74	75-79	80-84	85-89	90-96
P2PF	0.18	0.29	0.37	0.40	0.42
P2PN	0.81	0.70	0.62	0.59	1.56
P2E1	0.59	0.67	0.49	0.30	0.21
P2M2	-0.16	-0.25	-0.36	-0.54	-0.84

Effect on P3	70-74	75-79	80-84	85-89	90-96
P3PF	0.20	0.32	0.41	0.45	0.49
P3PN	0.79	0.67	0.59	0.54	1.38
P3E1	0.60	0.62	0.41	0.20	0.09
P3M2	0.02	-0.01	-0.05	-0.15	-0.35

Effect on Y	70-74	75-79	80-84	85-89	90-96
YPF	0.11	0.19	0.19	0.17	0.15
YPN	0.87	0.79	0.80	0.82	1.63
YE1	0.91	1.01	0.72	0.48	0.32
YM2	-0.01	-0.01	-0.02	-0.05	-0.09

Effect on GDP	70-74	75-79	80-84	85-89	90-96
GDPPF	-0.02	-0.02	-0.02	-0.02	-0.03
GDPPN	0.02	0.01	0.01	0.02	0.07
GDPE1	0.09	0.15	0.14	0.12	0.10
GDPM2	0.00	0.00	0.00	-0.01	-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) (%)	CX1PF	CX1PF (%)	CX1PN	CX1PN (%)	CX1E1	CX1E1 (%)	CX1M2	CX1M2 (%)
1970-1974	0.43	100.00	-0.06	-13.55	-0.01	-3.30	0.23	53.89	-0.00	-0.16
1975-1979	2.26	100.00	0.05	2.04	0.01	0.62	2.01	89.09	0.00	0.05
1980-1984	-0.53	100.00	-0.27	51.76	0.07	-13.05	0.07	-12.46	0.02	-3.62
1985-1989	-4.93	100.00	-0.22	4.48	0.09	-1.88	-5.21	105.58	-0.03	0.66
1990-1996	-1.11	100.00	0.17	-15.42	0.63	-56.77	-1.89	170.34	0.02	-1.80

Percentage Contribution of Exogenous Variables to Value of Production of Import Substitute Food Commodity (X2)

Year	GR(X2)	GR(X2) (%)	CX2PF	CX2PF (%)	CX2PN	CX2PN (%)	CX2E1	CX2E1 (%)	CX2M2	CX2M2 (%)
1970-1974	4.02	100.00	-0.58	-14.55	1.70	42.34	-0.01	-0.18	0.27	6.71
1975-1979	8.72	100.00	0.39	4.47	1.44	16.52	4.78	54.79	0.27	3.10
1980-1984	2.89	100.00	-2.00	-69.37	3.10	107.13	0.03	0.87	1.56	54.07
1985-1989	-0.92	100.00	-1.46	158.54	2.22	-241.74	-2.13	231.90	-1.13	123.32
1990-1996	10.45	100.00	0.99	9.49	10.10	96.63	-0.82	-7.88	0.40	3.81

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

Year	GR(X3)	GR(X3) (%)	CX3PF	CX3PF (%)	CX3PN	CX3PN (%)	CX3E1	CX3E1 (%)	CX3M2	CX3M2 (%)
1970-1974	3.76	100.00	-0.57	-15.13	1.66	44.03	-0.01	-0.18	-0.05	-1.24
1975-1979	6.89	100.00	0.38	5.46	1.39	20.17	4.61	66.89	0.02	0.23
1980-1984	1.12	100.00	-1.92	-171.10	2.96	264.24	0.02	2.16	0.35	31.38
1985-1989	0.78	100.00	-1.38	-177.09	2.11	270.03	-2.02	-259.04	-0.50	-64.71
1990-1996	8.73	100.00	0.93	10.65	9.47	108.53	-0.77	-8.85	0.25	2.85

Percentage Contribution of Exogenous Variables to Agricultural Output(XA)

Year	GR(XA)	GR(XA) (%)	CXAPF	CXAPF (%)	CXAPN	CXAPN (%)	CXAE1	CXAE1 (%)	CXAM2	CXAM2 (%)
1970-1974	2.52	100.00	-0.35	-13.79	0.93	36.91	0.10	3.90	0.04	1.76
1975-1979	14.15	100.00	0.18	1.28	0.58	4.08	13.89	98.19	0.05	0.34
1980-1984	0.45	100.00	-1.06	-234.78	1.44	320.55	0.05	10.38	0.40	88.89
1985-1989	-2.31	100.00	-0.95	41.18	1.36	-58.70	-3.28	142.02	-0.48	20.63
1990-1996	7.35	100.00	0.71	9.71	6.93	94.31	-1.13	-15.38	0.22	3.00

Percentage Contribution of Exogenous Variables to Food Consumption (Cf)

Year	GR(Cf)	GR(Cf) (%)	CCfPF	CCfPF (%)	CCfPN	CCfPN (%)	CCfE1	CCfE1 (%)	CCfM2	CCfM2 (%)
1970-1974	1.35	100.00	-0.47	-35.14	1.38	102.25	-0.01	-0.42	-1.98	-146.75
1975-1979	4.23	100.00	0.32	7.60	1.19	28.10	3.94	93.18	-0.99	-23.42
1980-1984	-4.01	100.00	-1.54	38.49	2.38	-59.44	0.02	-0.48	-4.75	118.56
1985-1989	5.87	100.00	-0.80	-13.66	1.22	20.84	-1.17	-19.99	4.22	71.88
1990-1996	2.45	100.00	0.27	11.14	2.78	113.50	-0.23	-9.26	-1.35	-55.23

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

Year	GR(P1)	GR(P1) (%)	CP1PF	CP1PF (%)	CP1PN	CP1PN (%)	CP1E1	CP1E1 (%)	CP1M2	CP1M2 (%)
1970-1974	-11.61	100.00	4.53	-39.05	2.08	-17.88	1.77	-15.28	0.10	-0.85
1975-1979	1.66	100.00	-3.29	-198.38	-0.48	-29.16	12.33	742.92	-0.04	-2.43
1980-1984	17.79	100.00	17.77	99.88	-3.39	-19.03	0.32	1.77	-0.94	-5.28
1985-1989	-2.51	100.00	12.43	-495.27	-4.35	173.47	-2.67	106.48	1.53	-60.95
1990-1996	-40.93	100.00	-8.00	19.54	-25.84	63.12	-7.71	18.83	-0.82	2.01

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

Year	GR(P2)	GR(P2) (%)	CP2PF	CP2PF (%)	CP2PN	CP2PN (%)	CP2E1	CP2E1 (%)	CP2M2	CP2M2 (%)
1970-1974	12.01	100.00	1.03	8.55	13.51	112.48	0.18	1.52	1.90	15.82
1975-1979	14.24	100.00	-1.00	-7.05	9.03	63.40	7.96	55.87	1.75	12.32
1980-1984	30.72	100.00	6.23	20.29	16.79	54.67	0.04	0.14	9.35	30.44
1985-1989	4.26	100.00	4.18	98.14	9.85	231.33	-2.19	-51.52	-5.82	-136.53
1990-1996	32.61	100.00	-2.53	-7.76	37.28	114.33	-0.59	-1.82	1.70	5.22

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

Year	GR(P3)	GR(P3) (%)	CP3PF	CP3PF (%)	CP3PN	CP3PN (%)	CP3E1	CP3E1 (%)	CP3M2	CP3M2 (%)
1970-1974	10.92	100.00	1.13	10.34	13.21	120.96	0.18	1.68	-0.21	-1.91
1975-1979	20.67	100.00	-1.10	-5.30	8.69	42.04	16.83	81.43	0.06	0.28
1980-1984	22.34	100.00	6.82	30.54	15.88	71.10	0.04	0.16	1.28	5.71
1985-1989	9.45	100.00	4.70	49.69	9.07	95.98	-1.44	-15.25	-1.62	-17.12
1990-1996	27.52	100.00	-2.94	-10.68	33.13	120.37	-0.25	-0.92	0.71	2.57

Percentage Contribution of Exogenous Variables to GDP

Year	GR(GDP)	GR(GDP)(%)	CGDPPF	CGDPPF (%)	CGDPPN	CGDPPN (%)	CGDPE1	CGDPE (%)	CGDPM2	CGDPM2(%)
1970-1974	2.92	100.00	-0.10	-3.38	0.26	9.06	0.03	0.96	0.01	0.43
1975-1979	6.29	100.00	0.05	0.86	0.17	2.71	4.10	65.15	0.01	0.23
1980-1984	0.61	100.00	-0.29	-47.99	0.40	65.52	0.01	2.12	0.11	18.17
1985-1989	1.82	100.00	-0.26	-14.03	0.36	19.92	-0.88	-48.20	-0.13	-7.00
1990-1996	3.63	100.00	0.17	4.74	1.71	47.13	-0.28	-7.68	0.05	1.50

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