TRADE LIBERALISATION AND POVERTY IN A COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODEL: THE SRI LANKAN CASE

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DECLARATION

I certify that the substance of this thesis has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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R. M. A. K. B. Naranpanawa
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DEDICATION

This thesis is dedicated with affection to my mother, Kamala Naranpanawa
and late father, K.M.S. Bandara Naranpanawa
who toiled to educate and guide me in the right path.

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Abstract

Many trade and development economists, policy makers and policy analysts around the world believe that globalisation promotes growth and reduces poverty. There exists a large body of theoretical and empirical literature on how trade liberalisation helps to promote growth and reduce poverty. However, critics of globalisation argue that, in developing countries, integration into the world economy makes the poor poorer and the rich richer. The most common criticism of globalisation is that it increases poverty and inequality. Much of the research related to the link between openness, growth and poverty has been based on cross-country regressions.

Dollar and Kraay (2000; 2001), using regression analysis, argue that growth is pro poor. Moreover, their study suggests that growth does not affect distribution and poor as well as rich could benefit from it. Later, they demonstrate that openness to international trade stimulates rapid growth, thus linking trade liberalisation with improvements in wellbeing of the poor. Several other cross-country studies demonstrate a positive relationship between trade openness and economic growth (see for example Dollar, 1992; Sach and Warner, 1995 and Edward, 1998). In contrast, Rodriguez and Rodrik (2001) question the measurements related to trade openness in economic models, and suggest that generalisations cannot be made regarding the relationship between trade openness and growth. Several other studies also criticise the pro poor growth argument based upon the claim of weak econometrics and place more focus on the distributional aspect (see, for example, Rodrik, 2000). Ultimately, openness and growth have therefore become an empirical matter, and so has the relationship between trade and poverty.

These weaknesses of cross-country studies have led to a need to provide evidence from case studies. Systematic case studies related to individual countries will at least complement cross-country studies such as that of Dollar and Kraay. As Chen and Ravallion (2004, p.30) argue, “aggregate inequality or poverty may not change with trade reform even though there are gainers and losers at all levels of living”. They further argue that policy analysis which simply averages across diversities may miss important matters that are critical to the policy debate.

In this study, Sri Lanka is used as a case study and a computable general equilibrium (CGE) approach is adopted as an analytical framework. Sri Lanka was selected as an interesting case in point to investigate this linkage for the following reasons: although Sri Lanka was the first country in the South Asian region to liberalise its trade substantially in the late seventies, it still experiences an incidence of poverty of a sizeable proportion that cannot be totally attributed to the long-standing civil conflict. Moreover, trade poverty linkage within the Sri Lankan context

has hardly received any attention, while multi-sectoral general equilibrium poverty analysis within the Social Accounting Matrix (SAM) based CGE model has never been attempted.

In order to examine the link between globalisation and poverty, a poverty focussed CGE model for the Sri Lankan economy has been developed in this study. As a requirement for the development of such a model, a SAM of the Sri Lankan economy for the year 1995 has been constructed. Moreover, in order to estimate the intra group income distribution in addition to the inter group income distribution, income distribution functional forms for different household groups have been empirically estimated and linked to the CGE model in "top down" mode: this will compute a wide range of household level poverty and inequality measurements. This is a significant departure from the traditional representative agent hypothesis used to specifying household income distributions. Furthermore, as the general equilibrium framework permits endogenised prices, an attempt was made to endogenise the change in money metric poverty line within the CGE model. Finally, a set of simulation experiments was conducted to identify the impacts of trade liberalisation in manufacturing and agricultural industries on absolute and relative poverty at household level.

The results show that, in the short run, trade liberalisation of manufacturing industries increases economic growth and reduces absolute poverty in low-income household groups. However, it is observed that the potential benefits accruing to the rural low-income group are relatively low compared to other two low-income groups. Reduction in the flow of government transfers to households following the loss of tariff revenue may be blamed for this trend. In contrast, long run results indicate that trade liberalisation reduces absolute poverty in substantial proportion in all groups. It further reveals that, in the long run, liberalisation of the manufacturing industries is more pro poor than that of the agricultural industries. Overall simulation results suggest that trade reforms may widen the income gap between the rich and the poor, thus promoting relative poverty. This may warrant active interventions with respect to poverty alleviation activities following trade policy reforms.

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List of Abbreviations

AGE - Applied General Equilibrium

AGW - Agricultural, Animal Husbandry, Fisheries and Forestry Workers

AMW - Administrative and Managerial Workers

CBSL - Central Bank of Sri Lanka

CDF - Cumulative Distribution Function

CES - Constant Elasticity of Substitution

CFS - Consumer Finance Survey

CGE - Computable General Equilibrium

CLW - Clerical and Related Workers

DCS - Department of Census and Statistics

ELIHH- Estate Low-income Households

FDI - Foreign Direct Investment

FTZ - Free Trade Zone

GCEC - Greater Colombo Economic Commission

GDP - Gross Domestic Product

GTAP - Global Trade Analysis Project

IDRC - International Development Research Centre

IFPRI - International Food Policy Research Institute

ILO -.International Labour Organisation

IMF - International Monetary Fund

IO - Input-Output

JVP - Janatha Vimuckthi Peramuna

LDC - Less Developed Countries

LES - Linear Expenditure System

LPW - Production and Related Transport Equipment Operators & Labourers

LTTE - Liberation Tigers of Tamil Eelam

MEP - Mahajana Eksath Peramuna

MIMAP -Micro Impact of Macroeconomic Adjustment Policies

ML - Maximum Likelihood

OW - Other Workers

PA - Peoples Alliance

PDF - Probability Density Functions

PE - Partial Equilibrium

PRSP - Poverty Reduction Strategy Paper

PTW - Professional, Technical and Related Workers

RHIDF - Representative Household Model Extended with Income Distribution Function

MM - Microsimulation Model .

RHIHH- Rural High-income Households

RHM - Representative Household Model

RLIHH- Rural Low-income Households

SALW - Sales Workers

SAM - Social Accounting Matrix

SERW - Service Workers

SLFP - Sri Lanka Freedom Party

SSA - Systematic Sensitivity Analysis

ULIHH- Urban Low-income Households

UNDP - United Nations Development

UNF - United National Front

UNP - United National Party

UPFA - United Peoples Freedom Alliance

URHIH- Urban High-income Households

WTO - World Trade Organisation

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Trade liberalisation is a key element in the fast-expanding globalisation process. One of the most important missions in this trade liberalisation process, which helps to integrate national economies with the global economy, is the improvement of wellbeing of the most vulnerable groups in the society. However, the relationship between trade reforms and poverty in less developed countries (LDCs) has been the subject of great controversy in recent years. Most of the leading multilateral institutions, including the World Bank, the International Monetary Fund (IMF) and the World Trade Organisation (WTO), believe that trade liberalisation would alleviate poverty in developing countries by accelerating growth. Nevertheless, recent observations in developing countries reveal that this phenomenon needs to be examined within a more detailed framework before any plausible conclusions can be made.

Despite the attempts of a few researchers to capture this empirical relationship within a more comprehensive framework such as a general equilibrium framework, the majority of studies have been focussed on direct impacts of this linkage. However, some of these analysts have decomposed this chain of linkages into many segments and have investigated the empirical associations among crucial variables at various sub levels. Hence, there is a growing body of empirical literature emerging at sub levels from which inferences about the linkage of trade and poverty can be made.

A substantial number of researchers believe that globalisation in general and trade liberalisation in particular promote growth and reduce poverty. A large body of theoretical and empirical literature exists on how trade liberalisation helps to promote growth and reduce poverty. Much of the empirical research related to the links between openness, growth and poverty has been based on cross-country regression. For instance, using this approach, Dollar and Kraay (2000, 2001, 2002 and 2004) examined the links between trade, growth and poverty. Their early findings have been summarised by Lubker, Smith and Weeks (2002, p.556) as follows: “(i) on average across countries and over time, growth is distribution neutral; thus (ii) any factor which increases the growth rate is good for the poor; (iii) World Bank and IMF policy packages increase the growth rate; therefore, (iv) these policy packages should be the core of poverty reduction strategies”.

In contrast, the critics of globalisation, particularly trade liberalisation, argue that, in developing countries, integration into the world economy makes the poor poorer and the rich richer. The most frequent criticism of trade liberalisation is that it augments poverty and inequality. For instance, the results of the Dollar and Kraay study have been subjected to severe criticism on the basis of methodology, data and definitions. Based on the main critical studies (Rodrik, 2000; Rodriguez and Rodrik, 2001; Ravallion, 2001; Lubker, Smith and Weeks, 2002; Wei, 2002; Wade, 2002; Chen and Ravallion, 2004), the main drawbacks of the research of Dollar and Kraay are (i) the empirical work based on theoretically unsound equations; (ii) the use of flawed data; (iii) inappropriately defined policy variables and their inconsistent testing; (iv) the inability to compare the income and inequality due to differences in definitions of key variables and methods of data collections; and (v) the differences in culture and institutions that may influence growth or inequality. Wade (2002) particularly is very critical about the poverty data published by the World Bank.

Apart from the research work described above, other researchers have adopted different empirical approaches such as partial equilibrium data-based analysis and general equilibrium analysis to identify this linkage. In addition to Dollar and Kraay, several others have found pro poor effects on trade reforms using partial equilibrium data-based analysis (Case, 2000; Minot and Goletti, 2000; Dercon, 2001) and using general equilibrium analysis (Bautista and Thomas, 1997; Ianchovichina and Soloaga, 2001; Hertel *et al*., 2001). In contrast, empirical evidence of negative impacts on the poor has been observed by several other researches using partial equilibrium data-based analysis (see Ravallion and Walle, 1991) or using general equilibrium analysis (see Lofgren, 1999; Harrison *et al*., 2000; Evans, 2001). Several others have found mixed results (for general equilibrium treatments, see Devarajan and Mensbrugghe, 2000; Cogneau and Robilliard, 2000; Cockburn, 2001). The research studies of Mckay *et al*. (2000); Winters *et al*. (2002); Reimer (2002); Andrew and Krueger (2003) and others provide a comprehensive coverage of empirical evidence on trade liberalisation and poverty linkage.

The weaknesses of cross-country studies have led to a need to provide evidence from case studies. Systematic case studies related to individual countries will at least complement cross-country studies such as that of Dollar and Kraay. As Chen and Ravallion (2004, p.30) argue, “aggregate inequality or poverty may not change with trade reform even though there are gainers and losers at all level of living”. They further argue that policy analysis that simply averages across diversities may miss important matters which are important to the policy debate. Using China as a case study, they have shown that the impact of trade liberalisation on multi-dimensional aspects of poverty, such as access to human and physical infrastructure and geographical disparities, are important in developing economy setting.

The identification of this linkage in an empirical context has been a complex exercise. Further complications come from the existence of different channels, which transmit impulses of trade policy shocks towards individual households, and from the difficulty in isolating the trade policy impacts from impacts coming from numerous other policy induced or natural shocks. Therefore, case studies which use more comprehensive analytical frameworks such as the general equilibrium framework would expect to shed more light into this ongoing debate.

While the incidence of poverty varies across the globe, the South Asian region attracts more attention due to the presence of some of the world's most populated poverty-stricken economies. According to UNDP (2003), South Asia comprises 24 per cent of the world's population; along with East Asia, it contains the largest number of people in income poverty. Amongst the south Asian nations, Sri Lanka provides a very good case study as it was the first country in the south Asian region to substantially liberalise its trade in the late seventies. It still maintains its position as one of the most open economies in the region. Despite this long association with trade reforms, Sri Lanka still experiences a sizeable proportion of incidence of poverty that cannot be totally attributed to the long-standing civil conflict.[1] In fact, the recently released Poverty Reduction Strategy Paper (PRSP) of the government of Sri Lanka (2003), the main policy document of the previous government, United National Front (UNF), and the

[1] Among the contemporary civil conflicts in the developing world, the Sri Lankan ethnic conflict can be identified as the most intensified and deadliest. Up to now nearly 64,000 people have been killed in the conflict and large numbers of others have suffered injuries (Lanka Page, 2001). Thousands of families in all ethnic groups – Singhalese, Tamils and Muslims – have lost their homes and have become refugees. This civil strife, initiated in early 1980s as a small urban guerrilla confrontation, over time, has developed into a guerrilla-cum-semi-conventional war. However, at the time of the writing of this chapter, the Sri Lankan government and the Liberation Tigers of Tamil Eelam (LTTE), the main militant group that confronted the Sri Lankan government, are engaged in a peace process to find a permanent solution to the conflict.

policy documents of the present government, United Peoples Freedom Alliance (UPFA), have also identified the acceleration of growth and reduction of poverty as key economic goals. Moreover, the trade poverty linkage within the Sri Lankan context has hardly received any attention, while a multi-sectoral general equilibrium poverty analysis within the Social Accounting Matrix (SAM) based Computable General Equilibrium (CGE) model has never been attempted. Therefore, a case study on Sri Lanka would shed more light on this trade and poverty link from a different perspective.

1.2 TRADE LIBERALISATION AND POVERTY IN SRI LANKA

Sri Lanka, with its reforms in the late 1970s, was the first South Asian country to initiate far-reaching policy reforms to allow it to integrate into the world economy. It has completed a quarter century of this globalisation process without any major interruption (such as going back to a closed economy). The recent process of Sri Lanka's integration into the global economy began with the major policy reform package implemented in Sri Lanka from 1977. This policy package included trade liberalisation, incentives for foreign direct investment (FDI), privatisation, a reduction in the size of the public sector, and a reduction in welfare expenditure. The economic impact of these programs on economic aggregates such as economic growth, employment, export orientation and industrialisation has been extensively investigated by a large number of studies (see for example Cuthbertson and Athukorala, 1991; Athukorala and Jayasuriya, 1994; Athukorala and Rajapathirana, 2000a, 2000b; Karunaratne, 2001). However, the impact of these programs on income inequalities, poverty and regional disparities has not received enough attention. Therefore, any evaluation of the impact of globalisation on the Sri Lankan economy which ignores these aspects would be both misleading and far from complete.

Many development and trade economists consider Sri Lanka to be well-known outlier among developing countries. Since the World War II, successive governments in Sri Lanka have given priority to the universal provision of education, health care and to secure a minimum level of consumption for all citizens. According to a recent World Bank report, "it was one of the first developing countries to understand the multi-dimensional nature of poverty, and has strongly emphasised policies aimed at promoting free health and education as early as the 1930s" (World Bank, 2000, p.27). There was extraordinary progress in education, health care and nutrition in Sri Lanka between the 1940s and the 1960s and Sri Lanka became an exception among developing countries (see Anand and Kambur, 1991; Isenman, 1980; Sen, 1981; Streeten, 1979). By the 1960s, Sri Lanka's human development indicators had improved to a status almost similar to those of both the developed countries and the fastest growing countries in South-East Asia. Sri Lanka became the third world welfare model because of its early emphasis on satisfying basic needs, the astonishing success of its welfare programs and its deep-rooted parliamentary democracy.

However, with continuation of the globalisation process, particularly the liberalisation of trade for nearly a quarter century without much policy interruption, Sri Lanka's image as a model of development and democracy has become rapidly and severely tarnished during the 1980s and 1990s. While Sri Lanka was struggling to maintain sustainable economic growth with a high level of welfare and peace, East Asian countries were maintaining higher economic growth and overtaking Sri Lanka's exceptional welfare indicators by the turn of the new century. Although the per capita income level of countries such as Singapore, Malaysia and Korea was similar to Sri Lanka in the 1960s, they achieved a per capita income level several times higher than that of Sri Lanka by the end of the 1990s. They also managed to maintain political stability. In contrast, Sri Lanka has performed poorly over the past two decades and is presently facing a huge economic and political crisis. In 2001, a negative GDP growth rate was recorded for the first time in the history of independent Sri Lanka. A political solution to the ethnic problem is yet to be found. Recently, a number of studies have attempted to explain the reasons for Sri Lanka's tragic story of development under the headings of 'A Tale of Missed Opportunities' (Snodgrass, 1999), 'Sri Lanka: What Went Wrong' (Kelegama, 2000) and 'Sri Lanka: Recapturing Missed Opportunities' (World Bank, 2000). According to these studies, Sri Lanka's underachievement and its economic crisis can be attributed to the 19-year-old war, some economic policy mistakes, the welfare-oriented inward-looking policies implemented in the 1960s and 1970s, the large and inefficient public sector and the poor governance.

When considering the inequality and the poverty situation in Sri Lanka, it is revealed that the country is facing a considerable degree of income inequality compared to the pre liberalisation period. For instance, according to Department of Census and Statistics (DCS) latest survey, the average household income of the urban sector was about twice as high than that of the rural sector and three times higher than that of the estate sector in 2002 (CBSL, 2004). However, recent studies indicate that poverty has declined when averaged across sectors over the post liberalisation period, though it is still high and volatile in absolute terms (see for example World Bank, 2000).

The above studies do not capture the direct and indirect effects of the trade liberalisation process on inequality and poverty in isolation. Rather, they include the effects coming from various other policy and external shocks over that period. Therefore, it appears that a clear understanding of the trade and poverty linkage within the Sri Lankan context cannot be gained, as all of the previous studies lack a comprehensive analytical framework such as a general equilibrium framework, which would isolate and capture the direct and indirect effects of trade reforms.

1.3 OBJECTIVES OF THE RESEARCH

The main objective of this study is to use a general equilibrium framework to identify and quantify the direction and the magnitude of the short run and long run implications of trade liberalisation on the household level absolute poverty[2] and income inequality in Sri Lanka. More precisely, the study intends to look at the effects of the reduction in import tariffs on macro variables, industry level variables and household level absolute poverty and income inequality. Analysing Sri Lanka as a case study will shed light on the on-going debate about the trade and poverty linkage.

Given the nature of policy experiments and the likelihood of far-reaching economy-wide implications, it is appropriate to adopt a computable general equilibrium model. Previous CGE models developed for Sri Lanka do not have the capabilities of capturing poverty within different household groups. Moreover, a multi-sectoral general equilibrium poverty analysis within the Social Accounting Matrix (SAM) based Computable General Equilibrium (CGE) model has never been attempted for Sri Lanka. For this study we intend to develop a poverty-focussed Computable General Equilibrium (CGE) model for the Sri Lankan economy to carry out trade policy experiments. This model will need to capture income variations within groups rather than between groups, as captured by traditional multi-household CGE models based on representative agents. To solve this problem, our study will attempt to link the CGE model with a sub model that incorporates empirically fitted functional forms of income distributions for different household groups to derive poverty and inequality indices by giving due recognition to within-group income variability. We try to endogenise the

[2] A standard of poverty based on a minimum level of subsistence below which families should not be expected to exist (Schaefer and Lamm, 1997)

change in the poverty line within the CGE model to accommodate the change in the poverty line in the calculations of poverty indices.

From this outline, the specific objectives of the dissertation define as:

(1) to develop a poverty-focused CGE model for Sri Lanka with multiple households while endogenising the change in the poverty line to carry out trade policy simulations.

(2) to empirically estimate the best-fit income distribution functional forms for different household groups and to link them with the CGE model to estimate different poverty and inequality indices.

(3) to carry out simulations to quantify the short run and long run impacts of tariff reduction in the manufactured products sectors, the agricultural products sectors and the across the board tariff cuts on the Sri Lankan economy at macro level, industry level and household level while giving important emphasis to absolute poverty and inequality.

(4) to review the literature on poverty-focused CGE models, particularly emphasising the poverty capturing mechanisms of such models.

(5) to construct the database for the Sri Lankan poverty-focused CGE model, particularly the Social Accounting Matrix (SAM) for the base year, 1995, and other data matrices.

(6) to conduct a systematic sensitivity analysis (SSA) on parameters in order to identify the sensitivity of model results to different parameter values. This is vital, as most of the parameters in the Sri Lankan model are not econometrically estimated. Moreover, a SSA has never been carried out in previous CGE policy simulations related to Sri Lanka.

1.4 OUTLINE OF THE THESIS

In order to achieve the objectives outline in the previous section, this thesis is organised under eight chapters structured as follows. The next chapter, Chapter 2, provides a historical overview of trade liberalisation, poverty and inequality experience in Sri Lanka. Chapter 3 surveys the available literature on poverty-focused CGE model applications. The main focus of the survey is to highlight the poverty capturing mechanisms in available CGE models. This chapter also presents a brief overview of the theoretical and empirical methodologies used in addressing the trade and poverty linkage. In Chapter 4 we develop the poverty-focused CGE model for Sri Lanka, which comprises multiple households and which has the capability to endogenise the change in the poverty line. Chapter 5 presents the empirical fitting of the best-fit income distribution functional forms for different households groups in Sri Lanka. It also estimates a wide range of poverty and inequality indices for Sri Lanka for the base case scenario. It further briefly explains the linking of income distribution functional forms with the CGE model developed in the previous chapter. The construction of the SAM for Sri Lanka and other data necessary for implementing the CGE model are discussed in Chapter 6. Chapter 7 presents the results of the trade policy simulation experiments carried out using the CGE model and the linked income distribution functional forms. It further presents the results of the systematic sensitivity analysis (SSA) for parameters. A summary and concluding remarks make up Chapter 8.

1.5 CONCLUDING REMARKS AND MAJOR FINDINGS

In this study, a poverty-focused CGE model was developed to understand the linkage of trade reforms with poverty and inequality using Sri Lanka as a case study. Using the Sri Lankan CGE model, simulation experiments were conducted in relation to 100 per cent tariff cuts in manufacturing industries, agricultural industries and the across the board case. The results of the simulation experiments carried out with the model have shed considerable light on the implications of trade reforms at macro level, sectoral level and, more importantly, at household level absolute poverty and inequality. Moreover, income distribution functional forms have been empirically estimated and linked to the CGE model within a "top down" approach while allowing the change of poverty line to be determined within the CGE model. In order to check the robustness of results, a SSA was carried out with respect to Armington elasticities.

The simulation results suggest that in the short run, trade liberalisation of manufacturing industries tends to increase the economic growth and to reduce absolute poverty in low-income household groups, although the improvement of absolute poverty seems to have been felt at a lesser degree by the rural low-income group. Reduction in the flow of government transfers to households following the loss of tariff revenue may be blamed for this negative consequence. Long run simulation results indicate that trade liberalisation reduces absolute poverty in all groups. It further reveals that, in the long run, trade liberalisation of manufacturing industries is more pro poor than that of agricultural industries. Overall simulation results suggest that trade reforms may widen the income gap between the rich and the poor, thus promoting income inequality. This may warrant active intervention for poverty alleviation activities following trade policy reforms.

The overall results of the SSA reveal a very low level of standard deviation values for most of the endogenous variables. This indicates that the model produces a rather robust set of results.

CHAPTER 2

TRADE LIBERALISATION AND POVERTY: SRI LANKAN EXPERIENCE

2.1 INTRODUCTION

As discussed in Chapter 1, much of the empirical research related to the link between openness, growth and poverty has been based on cross-country regressions, which may have its own drawbacks. The limitations of cross-country studies have led to the need to provide evidence from systematic case studies of individual countries, thereby shedding more light onto the country-specific characteristics. Such case studies will further complement the cross-country regression outcomes.

In this study Sri Lanka provides an interesting case study to investigate this linkage, because of the presence of a sizeable proportion of poverty, despite the liberalisation of its economy over two decades. Moreover, the trade poverty linkage within the Sri Lankan context has hardly received any attention.

The remainder of this chapter is organised as follows. Reasons for selecting Sri Lanka as a case study are discussed in Section 2.2. Section 2.3 explains the Sri Lankan experience of trade liberalisation. The trends in poverty and inequality within the Sri Lankan context are discussed in Section 2.4. The final section presents concluding remarks.

2.2 SRI LANKA AS A CASE STUDY

As the incidence of poverty differs across the globe, the South Asian region draws more concern due to the presence of some of the most populated poverty-stricken economies in the world. South Asia comprises 24 percent of world's population, along with East Asia, it contains the largest number of people in income poverty (UNDP, 2003). Amongst the south Asian nations, Sri Lanka serves as a very good case study due to a number of reasons. Firstly and most importantly, Sri Lanka was the first country to initiate far-reaching policy reforms to integrate into the world economy among South Asian countries in early as the late 1970s. It has completed a quarter century of globalisation process without much interruption. The recent process of Sri Lanka's integration into the global economy began with the major policy reform package implemented in Sri Lanka from 1977. This policy package contained reforms such as trade liberalisation, incentives to foreign direct investment (FDI), privatisation, a reduction in the size of the public sector, and a reduction in welfare expenditure. The impact of these reforms on economic aggregates such as economic growth, employment, export orientation and industrialisation has been comprehensively investigated by a large number of studies.[1] Yet, the impact of these reforms on income inequalities, poverty, regional disparities and other political, social and cultural dimensions has not received enough attention. Any evaluation of the impact of globalisation on the Sri Lankan economy which ignores these aspects would be misleading.

Secondly, many analysts consider Sri Lanka as a well-known outlier among developing countries. Since the World War II, successive governments in Sri Lanka have given

[1] See, for example, Athukorala and Jayasuriya, 1994; Athukorala and Rajapathirana, 2000a, 2000b; Cuthbertson and Athukorala, 1991; Kelegama, 1999.

priority to welfare measures such as universal provision of education, health care and securing a minimum level of consumption for all citizens. There was extraordinary progress in education, health care and nutrition in Sri Lanka between the 1940s and the 1960s and Sri Lanka became an exception among developing countries.[2] By the 1960s, Sri Lanka's human development indicators had improved to a position almost comparable to those of both the developed countries and the fastest growing countries in South-East Asia. The astonishing success of Sri Lanka's welfare programs and deep-rooted parliamentary democracy made the country a third world welfare model.

However, with continuation of the globalisation process, particularly the liberalisation of trade for nearly a quarter century, the country's image as a model of development and democracy has been rapidly and severely tarnished over the 1980s and 1990s. While Sri Lanka was making a great effort to maintain a sustainable economic growth with a high level of welfare and peace, East Asian countries were not only maintaining higher economic growth but also overtaking Sri Lanka's exceptional welfare indicators by the turn of the new century. The countries such as Singapore, Malaysia and Korea achieved a per capita income level several times higher than that of Sri Lanka by the end of 1990s. They also managed to uphold political stability. In contrast, Sri Lanka has performed poorly over the past two decades and it is currently facing a huge economic and political crisis. In 2001, a negative GDP growth rate was recorded for the first time in the history of independent Sri Lanka and a political solution to the ethnic problem is yet to be found.

Finally, regardless of the long association with trade reforms, Sri Lanka still experiences incidence of poverty in a considerable proportion. Although the long-standing civil conflict has exacerbated the poverty situation, that cannot be considered as the only

[2] See for instance Anand and Kambur, 1991; Isenman, 1980; Sen, 1981; Streeten, 1979

reason. In fact, the recently released documents such as the Poverty Reduction Strategy Paper (PRSP) of the government of Sri Lanka (2003), the main policy document of the previous government, United National Front (UNF), and the policy documents of the present government, United Peoples Freedom Alliance (UPFA), have also identified the acceleration of growth and reduction of poverty as key economic targets. Moreover, trade poverty linkage within the Sri Lankan context has hardly received any attention while multi-sectoral general equilibrium poverty analysis within Social Accounting Matrix (SAM) based Computable General Equilibrium (CGE) model has never been attempted.

2.2.1 Sri Lanka's Trade Liberalisation Experience

In this section, we present an overview of the historical trends and the present status of trade liberalisation process of Sri Lanka. There is a large body of literature which reviews and evaluates the trade policy in post-independent Sri Lanka (for example see Cuthbertson and Athukorala, 1991; Athukorala and Jayasuriya, 1994; Cuthbertson, 1997; Kelegama, 1999; Athukorala and Rajapathirana, 2000a, 2000b; Somaratne, 2000; and Bandara, 2003). Therefore, only a brief overview is presented in this section.

As noted in the previous section, Sri Lanka was considered as a most promising new nation among other newly independent developing nations when it gained independence from the British in 1948. Its trade policy regimes have been summarised in Table 2.1. It is evident from the table that the trade policy changes up until 1977 were associated with swings in the political pendulum. Since independence, the political power of Sri Lanka had been changing peacefully between two major political parties, i.e., the right-of-centre pro-western market-oriented United National Party (UNP) and the left-of-centre Sri Lanka Freedom Party (SLFP) or coalitions of parties until 1977. These major political parties (or coalitions led by them) held opposing political and economic ideologies (see Moore, 1997). This trend, however, changed after 1977, indicating both major parties are now in favour of integration of the Sri Lankan economy into the global economy. For instance, regarding the election of the Peoples Alliance (left-of-centre coalition) to office in 1994, Athukorala and Rajapatirana (2000a, p.44) note, “for the first time in the post-independence era, the change of government did not result in a shift in the basic trust of the national development policy”.

By looking at the political economic history of the country, we can observe that from 1948 to 1956 the first post-independent government (right-of-centre UNP) continued with a colonial open economy based on plantation agriculture. More than 90 per cent of its export earnings came from three agricultural products (tea, rubber and coconut). As a newly independent nation Sri Lanka committed to providing a wide range of welfare programs including food subsidy, free education and health, and subsidised public transportation while enjoying the benefits of the commodity booms after World War II and the Korean War under post-colonial open economic policy. The economic boom, however, collapsed by 1952, the government attempted to adjust prices of subsidised food, creating a political crisis in 1953 after a civil disobedience campaign led by the left parties. This background led to the defeat of UNP government: this change in government in 1956 created long-lasting impacts on Sri Lanka’s political and economic history. As Snodgrass (1999, p.95) notes “the 1956 election was a watershed in which the *Mahajana Eksath Peramuna* (MEP), a coalition led by the Sri Lanka Freedom Party (SLFP), came to power after mobilising an engulfing wave of accumulated political, cultural and economic grievances”. This government change in turn has led to significant changes in policy making. The political commitment of this left-of-centre government was to maintain consumer subsidies and extend direct government involvement in the production, services and trade sectors. Adverse commodity prices coupled with an expansionary fiscal policy led to balance of payments deficits continuously from 1957. The policy response to the balance of payments problems in the late 1950s had relied mainly on the imposition of import restrictions. This continued to be the major policy response right up to 1977. Details of the control regime (or closed economy from 1957 to 1977) have been documented in various trade studies. In general, salient features of the control regime include (i) introducing quantitative trade restrictions by replacing tariffs on most of the imported items; (ii) highly differentiating import tariff structure according to the magnitude of competition with domestic import-substitutes; (iii) introducing exchange control restrictions of foreign investments; and (iv) involving government directly in production, services and trade sectors. The left-of-centre governments held power between 1956 and 1965 (with a brief interruption of a few months in 1960); between 1970 and 1977 they continued the closed economic policy.

The protection of import substitution industries discriminated against exporting industries. The right-of-centre government, which came to power in 1965, favoured a gradual relaxation of controls on trade and exchange. The policy orientation during the period of 1965 to 1970 can be described as a partial departure from the control regime towards export promotion. In November 1977, the Sri Lankan rupee was devalued by 20 per cent following the devaluation of the British Pound. A dual exchange rate system was introduced to encourage exports. Despite the attempts at partial liberalisation, the adverse balance of payments continued to worsen during the period of 1966 to 1970. A coalition of the SLFP and left wing parties came to power in 1970 and its policy orientation favoured closed economic policies such as those of the previous left-of-centre governments. The immediate economic circumstances and their ideological leanings led to the abortion of the partial liberalisation attempts of the previous government and the reimposition of import and exchange controls.

Table 2.1

Changes in Policy Regimes: A Historical Overview

Historical period	Policy Regime	Political Regime	Average real economic growth (%)
1948–56: Continuation of colonial globalised economy	1948–56:Continuation of open economy with “populism”	Right-of-centre UNP government	3.2
1956–77:Closed economy with restrictions to globalisation	1956–60:Closing up with “populism”	Left-of-centre SLFP government	
	1960–65:Cotinuation of closed economy	Left-of-centre SLFP government	2.5
	1965–70:Partial departure from the closed economy	Right-of-centre UNP government	7.8
	1970–77:Backed to closed economy	Left-of-centre SLFP coalision government with left parties	4.0
1977 to date: Globalisation following the world trend	1977–89: Opening up – First phase	Right-of-centre UNP government	4.6
	1990–94: Opening up – Second phase	Right-of-centre UNP government	5.3
	1995–2001: Continuation of open economy	Left-of-centre PA government	2.9
	2002–2004: Continuation of open economy	Right-of-centre UNF government	5.0
	2004 to date: Continuation of open economy	Left-of-centre the UPFA government	

Source: Bandara and Naranpanawa (2005)

Despite the partial liberalisation towards the end of the 1960s, the policy regime during the whole period of 1956 to 1977 can be considered to have been a ‘controlled regime’ with anti-globalisation policies. The entire period was politically dominated by left-of-centre governments, except for a five-year interlude (1965–1970). The growth performance was poor (see Table 2.1) and the unemployment rate increased. Many industries suffered from a severe under-utilisation problem. Investment was low. Foreign investments were discouraged by the regime. On the other hand, postponement of the general election by two years, cuts in consumer subsidies, shortages of essential goods and nationalisation of the newspapers and some business undertakings turned public opinion against the government. This created the political climate for the defeat of the left-of-centre government in 1977 and it brought into power a pro western, market-oriented right-of-centre government of UNP with an overwhelming majority.

The economic policies of the newly elected government were said to be based on the experience of outward oriented economies in South East Asia. Thus, in formulating new economic policies, the government considered newly industrialised South Asian countries, particularly Singapore, as models to be followed. In line with this political and economic stance, the government initiated a series of liberalisation measures centred around a more outward-oriented growth strategy which drastically altered the previous policy orientation. In November 1977, the UNP government announced this new open economic policy package, which included far-reaching changes in trade and exchange rate policies. Both the IMF and the World Bank provided generous support to these policy adjustments. Besides these institutions, western donor countries promised the UNP government support for the implementation of the new policy package. By implementing this package in 1977, Sri Lanka became the first country in South Asia to introduce a radical liberalisation process.

Under the economic liberalisation policy package introduced in 1977, the trade policy in general and the country's tariff structure in particular have undergone a considerable revision. With the implementation of this package, quantitative restrictions on imports were replaced by a revised tariff system, retaining only 280 items under license. Furthermore, under the 'second wave' of liberalisation initiated in the late 1980s, import tariffs were further reduced by moving towards a three-band tariff system (with rates of 10, 20 and 35 per cent). The maximum tariff rate was further reduced to 30 per cent in

1998 and to 25 per cent in 1999. However, few agricultural products were left out of these revisions. By 1998, tariff rates in Sri Lanka's tariff schedule were considerably reduced. For instance, more than 50 per cent of the tariff lines contained tariff rates of 5 per cent or below while about 73 per cent of the tariff lines held rates of 10 per cent or below. Furthermore, about one-fifth of the tariff lines carried zero rates.

The details of this policy package have been extensively documented in recent studies (Cuthbertson and Athukorala, 1991, Athukorala and Jayasuriya, 1994 and Athukorala and Rajapathirana, 2000a, 2000b). Other main components of the 1977 policy package, apart from the revision to the tariff structure of the country can be summarised here. The previous dual exchange rate system was abolished and the exchange rate was unified. Many exchange controls were removed and a large devaluation took place. Measures were taken to attract foreign direct investment. Steps were taken to remove price controls; food subsidies were restricted to low-income groups. The government also initiated a massive public sector investment program centred around three 'leading projects'. The largest project was the *Mahaweli Development Project* (a major irrigation and power project), which involved extensive construction activities. The second major project was a housing construction program and the third was the setting up of the Greater Colombo Economic Commission (GCEC), which established the Free Trade Zone (FTZ) in order to attract foreign investors.

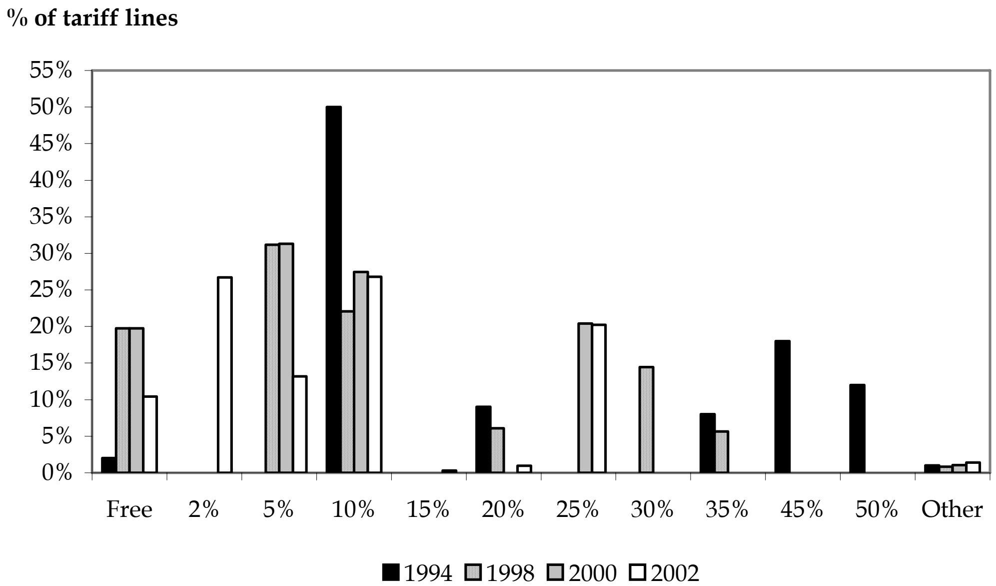
The initial reform package, opening up the Sri Lankan economy and integrating into the world economy, is known as the "first phase" of liberalisation. The eruption of ethnic riots in 1983, with the escalation of civil war in the North East, as well as the insurrection launched during the period of 1987 to 1989 by the Janatha Vimuckthi Peramuna (JVP: Peoples Liberation Front, a radical extreme left movement in the south), led Sri Lanka into political and social turmoil. Many observers believe that these events have been the main reasons for Sri Lanka's failure to achieve the full benefits of globalisation. Towards the end of the 1980s, Sri Lanka faced an increase in defence expenditure, a growing budget and current account deficits. The flow of foreign direct investment declined. Under this macroeconomic environment the government initiated the 'second phase' or second wave of liberalisation in June 1989 with the help of the World Bank and IMF. As Athukorala and Rajapatirana (2000a, p.43) summarise, this package "included an ambitious privatisation programme, further tariff cuts and simplification, the removal of exchange controls on current account transactions, commitment to a flexible exchange rate, and an initiate to cut the fiscal deficit". This phase of reform continued in the 1990s and is considered to be the intensification of the reform program introduced in 1977.

However, another main feature in the trade policy regime within the Sri Lankan context was the inconsistency and the ad hoc manner in which those policies were directed under the pressure coming from political institutions. WTO (2004, p viii) noted that "there have been some backward steps in the reform effort, as trade-related and other economic policies are changed frequently in an ad hoc manner, mainly because of political pressures, with detrimental effects on the transparency and predictability of Sri Lanka's trade policy regime".

After the second phase of liberalisation, the left-of-centre Peoples Alliance (PA) government came to power in 1994 by ending the UNP's 17 years of power (1977–1994). As noted earlier, the PA government committed to continue the previous government's open economic policy for the first time in the economic history of post independent Sri Lanka. During the period of PA government (1994–2001), the North East war intensified and defence expenditure rapidly increased. A negative economic growth rate was recorded in 2001 for the first time since independence. However, it maintained open economic policies. The United National Front (UNF) government led by the UNP and Tamil and Muslim minority parties came to power in December 2001 by promising to find a peaceful solution to the ethnic conflict and to maintain open economic policies. This regime was in power for only a brief period. In April 2004, the United Peoples Freedom Alliance led by the PA and JVP, left-of-centre alliance, came to power. This government is also continuing with open economic policies and the peace process. In fact, the opening up of the economy has become bipartisan policy in Sri Lanka now. All in all, the period from 1977 to date can be considered as the period of the globalisation process of the Sri Lankan economy.

The direction in the trade liberalisation process of Sri Lanka has somewhat reversed since 2001 due to the economic downturn in that year. In 2001, an across the board temporary surcharge of 40 per cent was introduced which excluded very few items. This surcharge was subsequently reduced to 20 per cent. Furthermore, new tariff bands of 2, 15 and 20 per cent (on top of the bands of 5, 10, and 25 per cent already in place) were introduced in 2002. Additionally, specific duties were re-introduced in place of ad valorem rates for some selected agricultural and industrial goods.

Despite some backward policy shifts in trade liberalisation in recent years, the country has achieved considerable progress in liberalising its trade regime during the last few decades. Figure 2.1 depicts the movements of tariff lines towards lower tariff bands over the last decade.

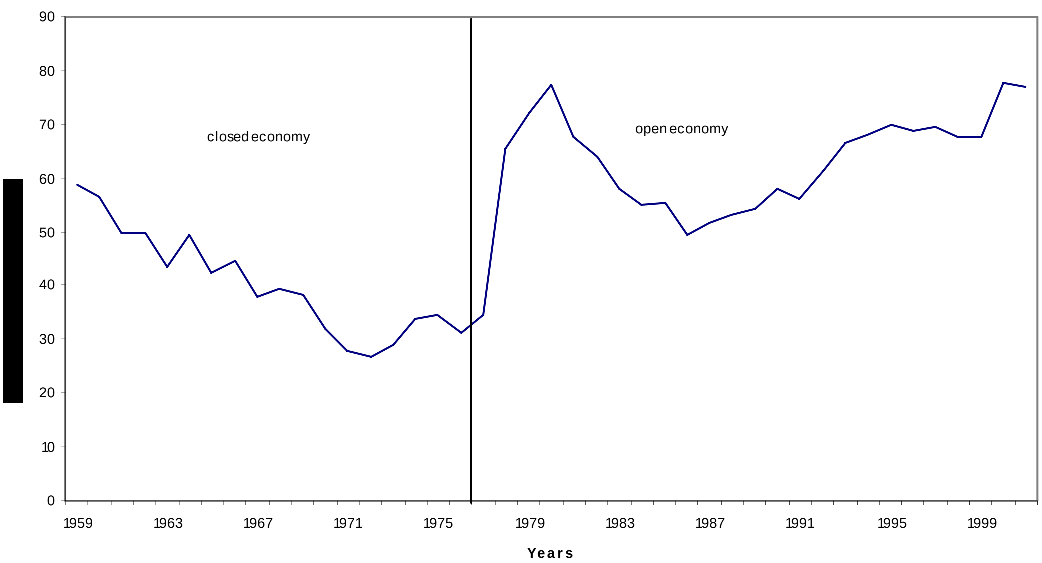


Source: Various government gazettes

Figure 2.1: Tariff Reforms in Sri Lanka

2.2.2 Achievements of the economic liberalisation process

The reform process since 1977 has resulted in significant integration of the Sri Lankan economy to the world economy. Figure 2.2 shows the increased openness of the Sri Lankan economy after 1977 (total trade expressed as a percentage of GDP).

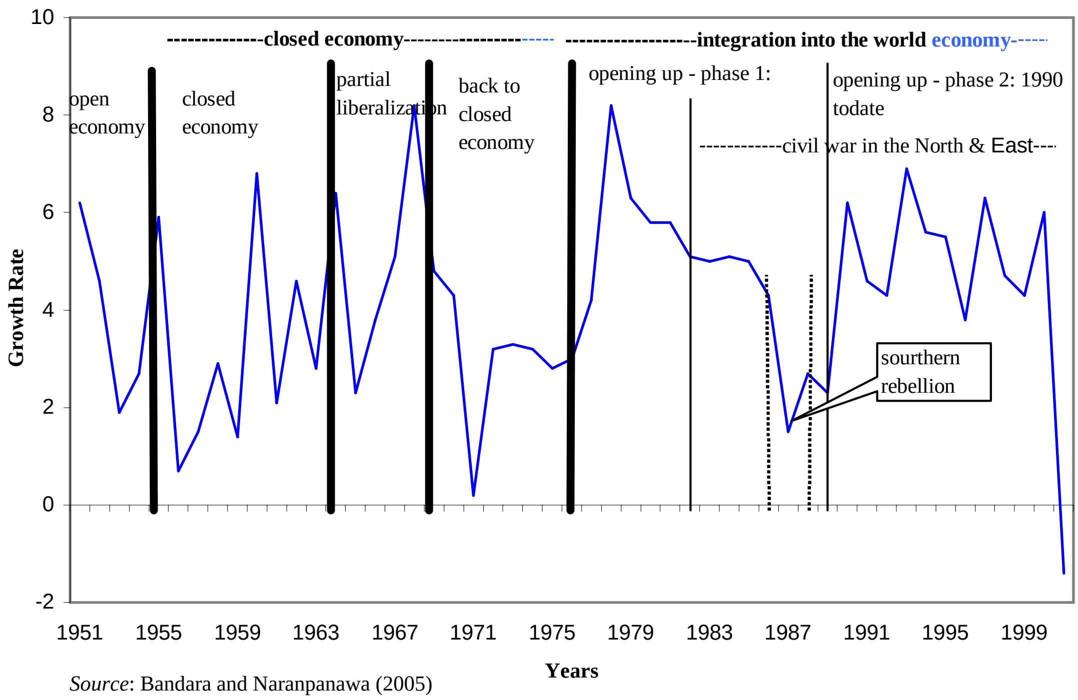


Source: Bandara and Naranpanawa (2005)

Figure 2.2: Openness of the Sri Lankan Economy

As many Sri Lankan observers have demonstrated, there are obvious achievements of globalisation for the Sri Lankan economy in terms of some macroeconomic indicators. As shown in Figure 2.3, the economic growth immediately after 1977 and before both the escalation of civil war and the Southern insurrection during the late 1980s reform was impressive, if not spectacular. Even with civil war the economy managed to maintain a satisfactory growth rate in the 1990s.

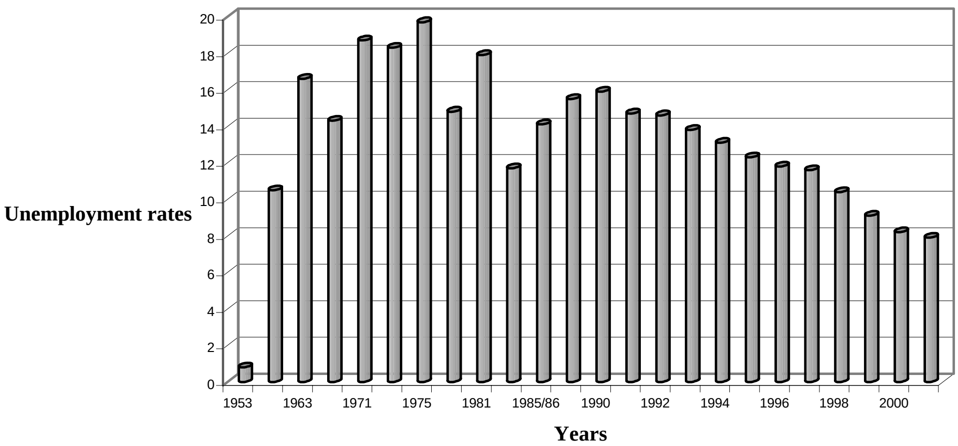
During the closed economy, one of the main economic problems in Sri Lanka was the higher unemployment rate. It was around 20 per cent just before the introduction of the reform package in 1977. As shown in Figure 2.4, the aggregate unemployment rate in the economy continuously declined from around 20 per cent in the mid 1970s to 8 per cent in 2001. This is a very impressive achievement.



Source: Bandara and Naranpanawa (2005)

Figure 2.3: Real GDP Growth in Sri Lanka – 1951 to 2001

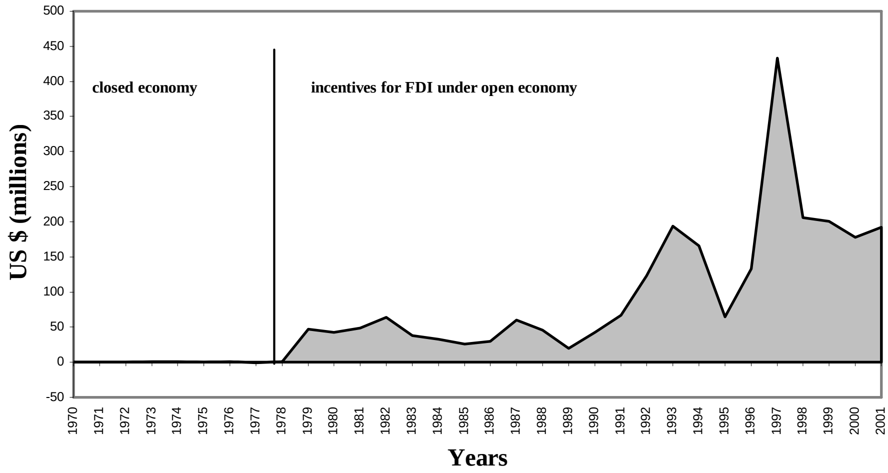
There are some combined factors of globalisation contributing to this impressive achievement of employment. There is no doubt that the export-oriented economic policies have created employment opportunities, particularly in the clothing industry. Other contributing factors to the lower unemployment rate in Sri Lanka include an increasing number of people permanently leaving the country, the temporary migration for overseas jobs, an increasing number of people joining the army and the LTTE, as well as the disappearance of more than 50,000 youth in the 1980.



Source: Bandara and Naranpanawa (2005)

Figure 2.4: Unemployment in Sri Lanka

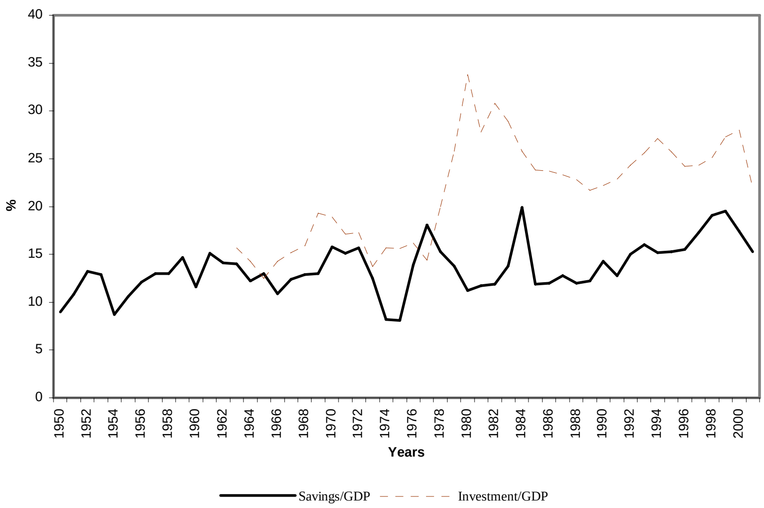
The other impressive achievement of the economy is the flow of FDI. Before 1977, the net flow of FDI to Sri Lanka was virtually zero. However, the flow of FDI has increased since 1977 with some fluctuations due to civil war (see Figure 2.5). FDI has generated employment opportunities and assisted industrialisation in Sri Lanka. The overall domestic investment in the economy has increased. As shown in Figure 2.6, while the aggregate investment ratio to GDP was around 15 per cent during the closed trade policy regime, it increased up to more than 25 per cent after 1977. However, the domestic saving ration did not increase much, creating a domestic resource gap.



Source: Bandara and Naranpanawa (2005)

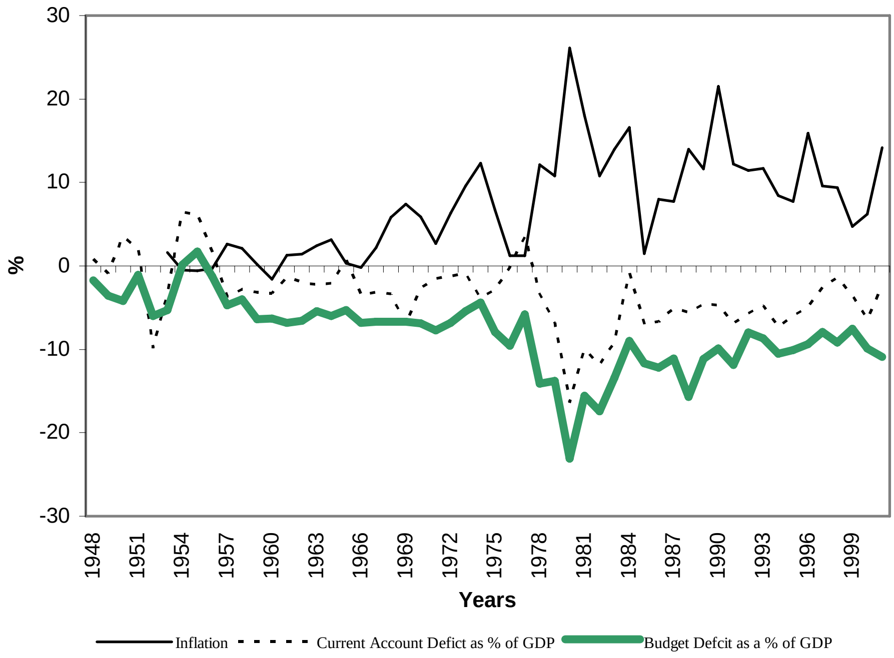
Figure 2.5: Net Foreign Direct Investment in Sri Lanka

Figure 2.7 demonstrates the behaviour of the other macroeconomic aggregates such as inflation, the current account deficit and the budget deficit. Many observers believe that the huge budget deficit has been the result of the defence expenditure. Moreover, the government has not been able to control inflation.



Source: Bandara and Naranpanawa (2005)

Figure 2.6: Domestic Savings & Investment as a % of GDP in Sri Lanka



Source: Bandara and Naranpanawa (2005)

Figure 2.7: Inflation, Current Account Deficit & Budget Deficit in Sri Lanka

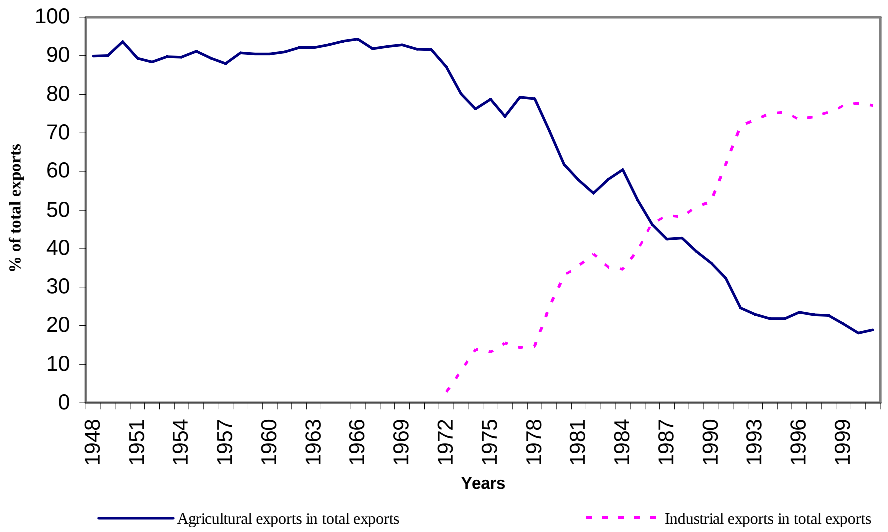
Athukorala and Rajapatirana (2000a, 2000b) have examined the link between liberalisation and industrialisation in Sri Lanka. According to them, Sri Lanka's performance in manufacturing is very impressive during the post-liberalisation period. Exports of industrial products have increased considerably (see Figure 2.8). Athukorala and Rajapatirana have highlighted the following favourable outcomes during the liberalised regime:

- The greater capacity utilisation of the manufacturing sector;
- An increase in manufacturing output;
- An increase in the ratio of exports to gross manufacturing output;
- The heavy concentration of clothing in manufacturing exports form Sri Lanka;

- The important role played by FDI in the expansion of manufacturing exports; and

- The creation of large number of jobs in the manufacturing sector.

Their study has praised the achievements of the post-liberalisation period in terms of industrial growth, export-oriented industrialisation, employment generation and the role of FDI in industrialisation. They further conclude that “the economic outcome of reform would have been much more impressive had it not been for policy inconsistencies, delays in the implementation of some key elements of the initial reform package, and perhaps more importantly, the continuing ethnic conflict since 1983 and the radical youth uprising during the period of 1986–9” (Athukorala and Rajapatirana, 2000a, p.189).



Source: Bandara and Naranpanawa (2005)

Figure 2.8: Changing the Composition of Exports in Sri Lanka

The above benefits of the liberalised regime can be considered as achievements of aggregates. The consideration of aggregate achievements alone, however, is not sufficient. It is important to evaluate the impacts of Sri Lanka's integration into the world economy on poverty, income distribution and regional disparities, as there may be winners as well as losers resulting from the economic reform process. In the next section, we examine the impact of trade liberalisation on inequality and poverty.

2.2.3 Trends in Income Distribution and Poverty in Sri Lanka

There has been a growing interest among researches in studying poverty and inequality within the Sri Lankan context. Numerous studies have been carried out to look at the poverty situation in Sri Lanka. Some of these studies try to link poverty status with education (see Athurupane, 1998), health (see De Silva, 1998) and growth and/or development (see Bruton, 1992 and Athurupane, *et al*., 1994). Others try to describe the characteristics and current status of income and/or consumption poverty for Sri Lanka (see for instance Rouse, 1990; Hopkins and Jogaratnam, 1990; Edirisinghe, 1990; World Bank, 1995; Lakshman, 1997; Datt and Gunewardena, 1997; Athurupane, 1999; Gunewardena, 2000a, 2000b; and others).

Similarly, several researches have examined the status of income distribution in Sri Lanka (see Lee, 1977; Glewwe, 1986, 1988; Kakwani, 1986; Bhalla and Glewwe, 1986; Maasland, 1989 and Divisekera and Felmingham, 1988). Some of these studies have focused on the historical trends and the current status of inequality in Sri Lanka while others have broadly looked into the implications coming from the economic reforms. However, the incidence of poverty, particularly with respect to trade liberalisation, has hardly been examined, while a comprehensive analysis in capturing the direct and indirect links of trade liberalisation and poverty within a general equilibrium framework has never been carried out to Sri Lanka.

Similar to many developed and developing countries, household expenditures and income surveys provide data on poverty and inequality in Sri Lanka. These surveys were carried out by the Department of Census and Statistics (DCS) and the Central Bank of Sri Lanka (CBSL) at regular intervals over the last few decades. Despite some problems and inconsistencies involved in income and expenditure surveys in Sri Lanka (see Dunham and Jayasuriya, 2000), firstly, we use Gini coefficients data estimated using different income and expenditure survey data by the CBSL and the DCS to understand what has been happening in terms of equality in the post-liberalisation period. During the welfare-oriented protectionist policy regime up to the late 1970s, Sri Lanka experienced a trend towards relative equality in income distribution as indicated by the Gini coefficients, which demonstrate the overall position of income distribution, shown in Table 2.2.

Table 2.2

Gini Coefficients for Sri Lanka

Gini Coefficient (G-C)	1953	1963	1973	1978/79	1980/81	1985/86	1990/91	1995/96	2002
G-C of household income									
All Island	0.46	0.45	0.35	0.43	0.43	0.46	0.47	0.46	0.48
Urban	NA	0.49*	0.40*	0.57*	0.44	0.47	0.62	0.47	0.51
Rural	NA	0.44*	0.37*	0.49*	0.38	0.43	0.42	0.46	0.46
Estate	NA	0.47*	0.37*	0.32*	0.27	0.31	0.25	0.34	0.32
G-C of income receivers income									
All Island	0.50	0.49	0.41	0.49	0.43	NA	0.52	0.52	0.55

*For income receivers income.
Source: CBSL, various reports and DCS (2002)

For example, the Gini coefficient declined from 0.46 in 1953 to 0.35 in 1973 indicating a significant move towards lower income inequality during the period of closed economy. However, as shown in Table 2.2 during the process of globalisation of the Sri

Lankan economy it increased in the 1980s, fell moderately in the middle of the 1990s and rose with the dawn of the new millennium. Overall, on the basis of the above data there is clear evidence that inequality has increased in Sri Lanka during the post-liberalisation period, with a weak trickledown effect of economic growth. Using the Gini coefficient data for the last two decades, the latest CBSL annual report notes the trend in inequality and growth effect as follows: "The estimated Gini coefficient, which measures the inequality in income distribution, increased from 0.43 in 1980/81 to 0.46 in 1995/96 and further to 0.48 in 2002, demonstrating an increase in the inequality in income distribution, indicating low trickledown effect of the benefits of economic growth" (CBSL, 2004, p.20).

As has been pointed out further in the latest annual report of the CBSL, "the income distribution is skewed more towards the high-income categories" (CBSL, 2004, p.14). This can clearly be observed when examining the income shares of different income deciles. For example, the share of the highest income decile in the total income was 38.6 per cent in 2002. This was twenty three times higher than the share of the lowest income decile in the total income, i.e. 1.7 per cent, (DCS, 2002). Disparities in terms of income between sectors have also been visible. For example, as the CBSL notes, the average household income of the urban sector was about twice as high than that of the rural sector and three times higher than that of the estate sector in 2002 according to DCS's latest survey (CBSL, 2004, p.20).

According to preliminary results of the latest Consumer Finance and Socio Economics Survey 2003/2004 undertaken by the CBSL, income received by the poorest 40 per cent of spending units had increased from 14.5 per cent in 1953 to 19.3 per cent in 1973, while income received by the richest 20 per cent of the economy had declined from 53.8

per cent in 1953 to 42.95 per cent in 1973 during the welfare oriented protectionist policy regime (see Table 2.3). This was due to the equity emphasis of government policy during the 1960s and 1970s. With the beginning of the new globalisation process, however, the income share of the poorest 40 per cent started to decline (despite a moderate improvement in the mid 1990s). Recently this share has declined from 15.2 per cent in 1995/96 to 13.8 per cent in 2002, the lowest in post independence Sri Lanka. On the other hand, the income share of the richest 20 percent increased from 49.9 percent to 53.7 percent in 2002, the highest in the last four decades. This trend is alarming in terms of inequality in Sri Lanka. This new evidence suggests that Sri Lanka is facing a considerable degree of income inequality.

Table 2.3

Income Share of the Poorest 40 per cent and the Richest 20 per cent Spending Unit

Income Groups	1953	1963	1973	1978/79	1981/82	1986/87	1995/96	2002
Poorest 40%	14.5	14.7	19.3	16.1	15.2	14.1	15.2	13.8
Richest 20%	53.8	52.3	43.0	49.9	52.0	52.3	49.9	53.7

Source: CBSL (1998) and DCS (2002).

Next, we look into the historical trends and the current status of the incidence of poverty in Sri Lanka. There is a growing concern among policy makers of Sri Lanka on the distributional and poverty implications of economic reform process. Previous studies carried out for Sri Lanka have revealed that poverty is predominantly a rural phenomenon (see Gunewardene, 2000a and Kelegama, 2001). The estimates of poverty measures computed for Sri Lanka in various years have been given in Appendix A Table A2.1. An extract from two of those studies is presented in Table 2.4. However, these measures are not comparable, as different studies have adopted different definitions of poverty line i.e., income/expenditure cut off point or dietary energy cut off points. Similarly, there is a wide variability in poverty measurements, which may be due to sampling problems and other inconsistencies such as variability in defining different sub groups[3]. However, the general trend suggests that the incidence of poverty had declined towards the early 1990's except for the households in the estate sector. For instance, if one considers the proportion of population in poverty estimated by using the poverty line based on Rs.791.67/person/month at 1995/96 prices, it can be observed that total poverty has dropped from 30.9 percent in 1985/86 to 19.9 percent in 1990/91 and has again increased to 25.2 percent in 1995/96. The marginal decline in the poverty indices towards 1990/91 may be attributed to the long run positive distributional effects emanating from the trade liberalisation process or from other factors which may have influenced the income transfers to rural areas. For instance, Dunham and Edwards (1997) identified migrant remittances, particularly coming from Middle East migrant workers and income coming from armed force personnel engaged in the North and East conflict zone of Sri Lanka, as two other vital factors that contribute to alleviating poverty among rural households.

Moreover, there are prominent disparities of income poverty among sectors (ie. urban, rural and estate). For example, poverty in the rural sector is much higher than that of the urban sector. The urban poverty seems to have declined over time towards 1995, nevertheless, poverty among rural and estate sector households has fluctuated. More importantly, poverty among households in rural and estate sectors has risen since 1990. As the rural population in Sri Lanka comprises around 70 per cent of the total

[3] See Gunetilleke (2000) for a discussion on problems related to different poverty estimates.

population (DCS, 2001) and as 90 per cent of the poor live in rural areas (CBSL, 2004, p.20), the current trend in poverty incidence attracts grave concern.

Table 2.4
Estimates of the Proportion of Population in Poverty
(in percentages)

Base Year	**Households**			
	Urban	**Rural**	**Estate**	**Total**
Income/ Expenditure based poverty line[1]				
1973	22.7	31.6	8.1	27.6
1978/79	24.4	23.8	8.9	22.7
1981/82	19.6	23.2	13.8	21.9
Rs 791.67/person/ month at 1995/96 prices taken as poverty line[2]				
1985/86	18.4	35.6	20.5	30.9
1990/91	15.0	22.0	12.4	19.9
1995/96	14.7	27.0	24.9	25.2

Sources: [1] Anand & Harris (1990) and [2] World Bank (2000).

Furthermore, as evaluated by a recent World Bank study, one-fourth of total population in Sri Lanka are living below the poverty line and "a large part of the population remains vulnerable to income fluctuations" (World Bank, 2000, p.27). Using the results of ongoing poverty-related research jointly undertaken by the Sri Lankan government and the World Bank, this study summarises the main features of poverty in Sri Lanka as follows:

- Income poverty remains high in Sri Lanka
- The long-term trend in overall poverty levels shows a decline over the period of 1985-96.
- Urban and rural poverty is declining, with significant fluctuations in rural poverty over the period of 1985 to 96.

- Income poverty in Sri Lanka is primarily a rural phenomenon.

- Acute regional disparities in poverty persisted and widened between 1990 and 1996 (World Bank, 2000, p.28).

A number of poverty alleviation programmes have been implemented by the successive governments since the late 1980s to protect vulnerable groups in the country. However, these programmes have suffered from design problems and implementation weaknesses leading to inefficiency of programmes. The World Bank study of 2000 has found three specific flaws of the poverty alleviation programmes implemented since 1989 to 1995 (*Janasaviya*[4] programme) and since 1995 to present (*Samurdhi*[5] programme). They are: (i) the political bias in implementing state-sponsored programmes; (ii) the non-materialisation of an expected improved quality of decentralised public service and the increased state's accountability to the poor and (iii) these large costly programmes have not given sufficient opportunities for creating employment opportunities for the poor (see World Bank, 2000, for details).

Recent studies indicate that poverty has declined when averaged across sectors over the post liberalisation period though it is still high and volatile. However, the trade and poverty linkage cannot be fully understood within the Sri Lankan context as all of the previous studies are lacking in an analytical framework such as general equilibrium framework that capture different channels of distribution of trade policy impulses towards households while simultaneously blocking out other contributory factors.

[4] Janasaviya programme was basically intended to increase employment and income of low income households through public works and micro-enterprises and also improve their nutritional status. Hence, monthly cash grants were given to targeted groups and mandatory savings were transferred to a specified accounts.

[5] Samurdhi programme replaced the Janasaviya programme in 1995. The objectives of this programme are similar to that of Janasaviya progamme. It provides income support to low income households in the form of food coupons and it further promotes self reliance and rural enterprises.

The above overview highlights the suitability of analysing Sri Lanka as a case study to investigate the link between trade openness and poverty within LDCs context. Empirical analysis on this link within the Sri Lankan context has hardly been attempted and, more importantly, computable general equilibrium based empirical analysis on this linkage has never been carried out for Sri Lanka. Therefore, a case study on Sri Lanka is expected to shed more light on this controversy and also would contribute to clarify things more clearly in the current debate on the trade and poverty linkage.

2.3 CONCLUDING REMARKS

In this chapter, we highlighted the importance of case studies, which shed more light on trade and poverty relationship in LDCs. Next, we presented the importance of Sri Lanka as a case study and analysed the trade liberalisation experience and the situation of poverty and inequality within the Sri Lankan context. It is revealed that Sri Lanka is facing a considerable degree of income inequality. Moreover, recent studies indicate that poverty has declined when averaged across sectors over the post-liberalisation period, though it is still high and volatile. However, the trade and poverty linkage cannot be fully understood within the Sri Lankan context, as all of the previous studies lack a comprehensive analytical framework such as a general equilibrium framework. Therefore, in the next chapter, we review the current literature on the studies, which capture poverty within a general equilibrium framework in order to trace out the methodological features, particularly the poverty capturing mechanisms that could be used in the Sri Lankan general equilibrium model to be developed in Chapter 4.

CHAPTER 3

LITERATURE SURVEY ON POVERTY FOCUSSED CGE APPLICATIONS IN DEVELOPING COUNTRIES

3.1 INTRODUCTION

Several attempts have been made in recent years to investigate the link between trade policy and poverty in the context of developing countries. As discussed in Chapter 1, the on-going debate on the trade and poverty link has motivated researchers to carry out empirical investigations either using cross-country or single country case studies. Moreover, these investigations have adopted different theoretical and empirical methodologies, which may have their own drawbacks. In this chapter, we first briefly scrutinise the theoretical and empirical methodologies adopted by previous investigators in investigating the trade poverty link.

Next, we focus on the importance of a general equilibrium framework in addressing the current research problem. Despite the fact that previous researchers have adopted different empirical methods, the difficulty experienced in isolating and identifying trade impulse transmission mechanism suggests that a counterfactual analysis within a general equilibrium framework provides an ideal experimental setting to discover this linkage. Apparently, the computable general equilibrium (CGE) modelling approach, an empirical counterpart of the well-known theoretical general equilibrium model, has become the most widely applied counterfactual analytical tool. A large number of CGE or ‘Applied General Equilibrium’ (AGE) models have been used to address a wide range of policy issues such as development strategy, trade policy, tax policy, long term growth and structural changes, structural adjustments to external shocks, income distribution, regional development, environmental issues and defence spending in both developed and less developed countries. The theoretical framework and applications of various CGE models have been reviewed in numerous surveys[1].

Although there is a large body of CGE literature on the impact of trade reforms on income distribution, very few attempts have been made to investigate the impact of trade liberalisation specifically on poverty within a general equilibrium framework. Therefore, this chapter reviews CGE studies which focus on the linkage of trade policy on poverty. However, due to the lack of a substantial body of literature specifically focusing on the trade and poverty linkage, the chapter intends to review the whole spectrum of available poverty focussed CGE applications. The focus in this review is to identify various mechanisms adopted in capturing and measuring poverty within a CGE framework in the LDC context, an area that has received hardly any attention in previous surveys.

Hence, the present survey has generally aimed at presenting a methodological overview of poverty focussed CGE applications with the following objectives: (1) to answer the question of why poverty focussed CGE models are important; (2) to study the poverty capturing mechanisms available in CGE models; (3) to survey the applications of these CGE models in analysing various poverty related policy issues; and (4) to provide a comprehensive list of references on poverty focussed CGE models applied to LDCs for the benefit of the reader.

[1] For comprehensive review of numerous applications see Shoven and Whally (1984); Pereira and Shoven (1988); de Melo (1988); Decaluwe and Martens (1988); Devarajan (1988); Bandara (1991); Robinson (1991), Shoevn and Whally (1992); Kraybill (1993); Bhattacharyya (1996); Dixon and Parmenter (1996); Ginsburg and Keyzer (1997); Patridge and Rickman (1998); Iqbal and Siddiqui (2001) and Devarajan and Robinson (2002).

In order to meet the above objectives the remainder of this chapter is arranged as follows. Section 3.2 briefly outlines the theoretical and empirical approaches used by various researchers to investigate the trade and poverty link. Section 3.3 highlights the importance of poverty focussed CGE modelling. Section 3.4 classifies CGE models based on the poverty capturing mechanism and briefly outlines the theoretical structure and empirical findings of these models. The final section presents concluding remarks.

3.2 THEORETICAL AND EMPIRICAL APPROACHES IN ANALYSING TRADE AND POVERTY LINKAGE

Existing literature suggests that various researchers have used different conceptual and empirical approaches. These varying approaches may have their own drawbacks, which could ultimately affect the outcome. Thus, the empirical evidence should be viewed in the light of strengths and weaknesses of the adopted conceptual and empirical approach. This section intends to briefly outline the theoretical and empirical methodologies adopted in various studies which analyse the linkage of trade policy and poverty.

Theoretical approaches

Income distribution and economic growth have been investigated by economists as far back as the 1950s. For instance, the seminal work of Simon Kuznets (1955) was a noteworthy contribution. According to his study, if inequality between the low productivity sector and the high productivity sector was substantial than that within each sector, as labour tends to move across sectors, the inequality would increase in the first instance and then fall once the economy attains a point where factor movement was equalising returns across sectors. This can be depicted by the stylised inverted 'U' shaped curve, better known as the Kuznets curve.

Theoretical explanation of the linkage between trade and poverty flows mainly from trade theory that focuses on income distribution. Theoretical models such as the specific factors model and the Stolper–Samuelson model deal with the distributional consequence of trade.

The specific factors model, which is a variant of the Recardian model, was originally developed by Viner and was generally known as Ricardo-Viner model (Suranovic, 1998). However, Jones (1971) and Mussa (1974) have further developed this model and formalised it mathematically. This model focuses on the short run implications of international trade on income distribution. The specific factors model assumes that an economy consists of two industries which produce two goods, an exportable commodity and an import substitution commodity, in a perfectly competitive market. Moreover, the industries use only two factors of production, labour and capital, in the production process of the above commodities. Furthermore, the model assumes that in the short run only one factor (labour) is mobile within industries while the other (capital) is specific and immobile between industries. Moreover, it is also assumed that the economy is in full employment; in other words, the sum of the labour used in each industry is assumed to be equal to labour endowment. Additionally, the labour is assumed to be homogenous.

As relative prices of exportable commodities rise due to free trade, more labour would be attracted to export industries as a result of the increase in wages. In contrast, import substitution industries suffer as profits decline. Furthermore, it can be seen that the real return to capital in the export industry tends to rise while return to capital in the import competing industry tends to fall with respect to purchases of both exports and imports. This implies that in this instance some degree of redistribution of income will take place. Accordingly, capital owners in the export industry will benefit while those who own capital in the import competing industry will suffer. However, the distribution of income among workers is ambiguous, as it would largely depend on the consumption pattern of workers (whether they purchase more of the exportable commodity, the import substitution commodity or a combination of the two). Accordingly, the real wages of workers increase in terms of the price of the import substitution commodity while it decreases in terms of the price of the exportable commodity.

The possible long run implication of trade liberalisation on income distribution is explained by the Stolper–Samuelson (S–S) model (Stolper and Samuelson, 1941) which is based on the neoclassical Heckscher–Ohlin trade model. As Metzler (1949) notes:

> According to the Stolper–Samuelson argument, a country with a comparatively small labour supply could thus increase its real wage rate by means of protection, even though national income as a whole were thereby diminished. To use a common expression, the workers would get not merely a larger share of a smaller pie but a share which was larger, in absolute magnitude, than their previous smaller share of larger pie. The detrimental effects of the tariff would be shifted entirely upon the country's "abundant" factors of production (p.5).

The S–S model can also be explained alternatively as follows. There are only two sectors in the country; one sector produces exportable commodities (export sector) and the other sector produces import competing commodities that directly compete with imports (import competing sector). We further assume that the import competing sector is relatively labour intensive (it uses a higher ratio of labour to capital than the export sector). According to this model, any increase of import tariff or any other shock that increases the relative prices of import competing sector, would ultimately lead to an expansion of the import competing sector. However, this expansion occurs at the expense of the export sector under a situation where both factors are at or close to full employment. Moreover, the expansion of the relatively labour intensive sector and the possible contraction of the relative capital intensive sector would tend to push wages up as these tend to increase the aggregate demand for labour relative to capital. Suppose we assume the price of exports is constant: higher wages would mean an absolute decline in the return to capital. This implies that import tariff will bring about a more than proportionate increase in wages. Thus, under this circumstance, the wage earners will be better off due to an increase in real wages while the capital owners will become worse off (Neary, 2004).

The S–S model is based on some restrictive assumptions. First, the model originally assumes that the economy consists of only two broad sectors (industries) and the production of two commodities is based on only two factors, namely, capital and labour. However, this has been later generalised by subsequent theoretical work which extended to many goods and factors (for instance, see Ethier, 1974 and Jones and Scheinkman, 1977). Second, unlike the specific factors model, the S–S model assumes that all factors are fully mobile between sectors. Thus, this could be considered to be the case in the long run. Third, the goods are homogenous across foreign and domestic suppliers. Fourth, the model assumes perfectly competitive goods and factor market. Fifth, industries are assumed to follow a constant return to scale.

However, according to the 'Metzler Paradox', Metzler (1949) pointed out that the S–S model outcome could show the exact opposite results under certain circumstances. Minabe (1974) notes on the Metzler Paradox that:

> …as L.A. Metzler pointed out, an *ad valorem* import tariff has two effects on the domestic price of imports. On the one hand, the tariff itself represents a direct increase in import prices, and, on the other hand, the resulting reduction in the demand for imports depresses the foreign prices of these goods relative to the

> corresponding prices for export goods. Therefore, whether a tariff increases or reduces the price of the intensive factor of the import industry (which is usually a scares factor of production in the home country if we exclude the case of the Leontif paradox) seems to depend upon which of these forces is the stronger (p.329).

On the other hand some researchers have found that empirical evidence does not always validate the S–S model outcome. For instance, Winters (2000a) notes that if one or more assumptions of the S–S model are violated, the model outcome does not offer definitive conclusions.

Empirical approaches

Apart from the above theoretical approaches, a number of researchers have adopted various empirical approaches in testing the trade and poverty linkage using single country or cross-country data. These different empirical approaches can be considered to follow some conceptual approaches. For instance, Kanji and Barrientos (2002) identified two main conceptual approaches in empirically understanding of this link. The first approach is based mainly on trade theory. This approach is firmly grounded on the view that trade liberalisation would increase the economic welfare of countries by enhancing growth. In this, poverty is defined based on the ability to purchase goods and services, in other words, consumption and income. Poverty measurements are based on market or imputed market prices. Most of the studies attempt to trace the linkage from a "top down" direction, that is, from macro down to micro level. However, this approach ignores micro level intricacies and other horizontal connections. The second approach to the trade and poverty link is a socioeconomic approach. This views poverty within a much broader framework and is based on concepts of vulnerability and livelihoods. According to this approach, poverty is viewed as a multi-dimensional concept encompassing social dimensions of living standards, i.e., health, education, and other factors like social and physical isolation, powerlessness, lack of voice, low social status and physical infirmity. As this approach attempts to capture complexities at micro level, this could be considered as a “bottom-up” approach. As Shankland (2000) and Norton and Foster (2001) pointed out, these two approaches have their own problems in guiding policy making where the economic approach is a more aggregated analysis that ignores micro complexities while the livelihood approach is more context-specific as it is strongly grounded on micro complexities resulting in less value in policy making.

It is apparent that several researchers have adopted different empirical methods to analyse the trade and poverty linkage. These different methodologies and their respective strengths and weaknesses have been reviewed by only a few researchers. For instance, McCulluch and Calandrino (2001) identified three main empirical approaches used by various researchers in exploring the link between trade and poverty: the descriptive or qualitative approach, the data-based approach and the modelling approach. The descriptive approach mainly explores the historical pattern of implementation of trade policy and the evolution of the incidence of poverty over a period. The main advantage of this approach is that it helps to obtain a better understanding of the nature of the trade reform process and it simultaneously allows the researchers to broadly appreciate the welfare status during the same period of interest. However, this approach does not provide any scientific evidence on the linkage of trade and poverty, nor does it allow us to test any theoretical hypothesis on this linkage. The data-based approach in turn provides a much richer framework than the previous method by allowing researchers to empirically test theoretical hypothesis on this linkage based on empirical data. This approach is, however, constrained by the availability of data and also ignores some qualitative variables. Moreover, due to the backward looking nature of analysis, it is difficult to use them in forward looking policy projections. In the modelling approach, models firmly grounded on theory are constructed. Furthermore, these models can be used to represent empirical realities by estimating parameters using actual data. The major advantage of this approach is the ability to conduct counterfactual analysis – analysis of what might have happened if an alternative policy had been implemented. Thus, this method would be used to generate forward looking policy projections, an invaluable tool for planning and policy analysis. Moreover, models provide policy makers with the flexibility to incorporate different types of linkages that exist between trade reforms and poverty. McCulluch and Calandrino (2001) have further identified that the modelling approach consists of different types of models mainly based on the point of focus. For instance, they categorise models based on geographic focus – global, multi-country or regional models, sectoral focus; models that incorporate single sector or multiple sectors; dynamic models – models that allow investigation of the time path by which a new equilibrium is reached; and finally, a focus on household disaggregation – models with highly aggregated or disaggregated households. Moreover, the above authors have presented a list of studies which come under different empirical approaches.

Alternatively, Reimer (2002) has categorised the empirical approaches that investigate the trade and poverty linkage into four broad groups, namely, cross-country regressions, partial equilibrium /cost of living analysis, general equilibrium simulations and Micro-Macro synthesis. However, according to the previous classification by McCulluch and Calandrino (2001), all of these approaches can be included in the data based and modelling approaches.

In the next section we focus on one particular modelling technique, CGE modelling, which is more versatile in handling the trade poverty linkage with theoretical rigour as well as empirical reality.

3.3 WHY POVERTY FOCUSSED CGE MODELS ARE IMPORTANT

Empirical investigation of the relationship between trade reforms and poverty has been a complex issue due to many reasons. As Winters (2002) notes:

> If trade liberaization and poverty were both easily measured, and if there were many historical instances in which liberalization could be identified as the main economic shock, it might be simple to derive simple empirical regularities linking the two. Unfortunately, these conditions do not hold, so there is relatively little direct empirical evidence on this question (p.1).

Hence, simultaneous impacts coming from various other policy measures and exogenous shocks make the process increasingly complex for researchers to use a relatively simple experimental framework to obtain empirical evidence. Moreover, the trade poverty link could well be identified as having multiple channels through which shocks are transmitted. This relationship therefore can be decomposed into various channels through which economic shocks are transmitted towards households.

According to Banister and Thugge (2001) the trade and poverty link could well be explained through several channels: (1) changes taking place in the prices of tradable goods – cheaper imports for poor consumers and producers and higher export prices for poor producers; (2) changes taking place in the relative prices of factors that affect employment and thus the income of the poor; (3) implications on government sponsored poverty alleviation programs – in terms of affecting government tariff revenue; (4) altering incentives for physical and human capital investments and technical innovations which ultimately affect the economic growth; and (5) affecting the vulnerability of the economy to external shocks which affect the poor. Most of these impulses may have direct as well as indirect effects on poor households. Several other researchers too have discussed the possible connection between trade and poverty and have traced similar channels through which trade shocks being transmitted to poor households (see Winters, 2000a, 2000b; Agenor, 2002). These researchers also emphasis that economic shocks generated in the trade reform process could reach households through channels such as factor payments, government transfers and product prices in the short to medium term, while adjustment to human capital accumulation and productivity would yield long term consequences.

The majority of empirical studies attempting to investigate the trade and poverty link rely on the partial equilibrium analytical framework (PE) (see for example, Case, 2000; Minot and Goletti, 2000; Dercon, 2001; and Dollar and Kraay, 2000; 2001; 2002; and 2004, Litchfield, *et al*., 2003; Huang, *et al*.,2003). The partial equilibrium framework, however, ignores the mutual relationships between prices, outputs of various goods and factors. Thus, the PE framework may be assumed to provide an incomplete picture of this complex transmission mechanism (Coxhead, 2003). Hence, these complexities demand a better experimental design in order to isolate the trade shocks from numerous other policy induced or natural shocks while tracing different channels through which this trade impulse transmission mechanism is operated.

The counterfactual analysis within a general equilibrium framework provides an ideal experimental setting to investigate this relationship. The general equilibrium framework not only allows analysts to capture the direct as well as the indirect interactions among different agents and markets, but also provides a convenient framework to carry out controlled policy experiments where the impact of trade reforms could be isolated from other shocks by fixing their impacts. The CGE models, the numerical counterparts of the well-known Walrasian general equilibrium analysis, are the most widely used general equilibrium analytical tool. For instance, Srinivasan and Whalley (1986) have noted:

> The major feature of the numerical general equilibrium approach is its attempt to blend theory and policy so as both to improve the analytic foundations of policy evaluation work and to bring the theoretical work that already exists in the literature more fully into the policy debate (p.4).

The CGE models, due to their capability of generating highly disaggregated micro level results while maintaining a consistent macro framework, dominate the whole spectrum of counterfactual analytical approaches (Dervis *et al.*, 1982; Adelman & Robinson, 1988; Taylor, 1990; De Janvry *et al.*, 1991; and Bourguignon *et al.*, 1991).

There is a growing interest in recent years among various development research organisations in using CGE models to address various poverty-related issues. The Micro Impact of Macroeconomic Adjustment Policies (*MIMAP*) project funded by the International Development Research Centre (*IDRC*), Canada; International Food Policy Research Institute (*IFPRI*) and the World Bank are some of the leading institutions working in this area. In addition, some academics work on this area in leading academic institutions. The following section scrutinises empirical applications of these models in addressing various poverty related policy issues within the developing country context.

3.4 APPLICATIONS OF CGE MODELS ON POVERTY ISSUES

The CGE models can be classified into different groups based on several attributes of concern. Various analysts have classified these models based on model specifications, solution techniques, model closure rules and simulated policy issues (see Bandara, 1991; Thesison, 1998). In the present study, we classify CGE models based on model specifications with respect to the poverty capturing mechanism. Classification of poverty focussed CGE models based on the poverty capturing mechanism is depicted in Figure 3.1. The main characteristics and policy conclusions of various applied models have been summarised in Table 3.1 (see end of chapter).

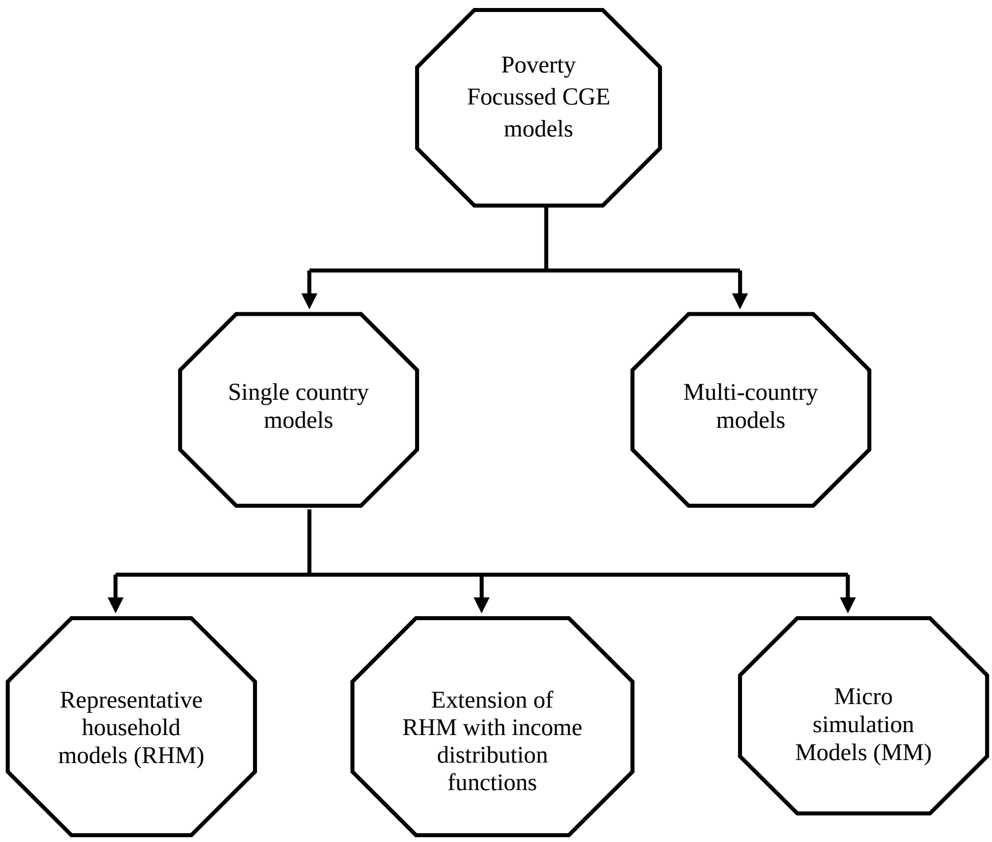


Figure: 3.1 Classification of Poverty Focussed CGE Models

There are CGE models developed for single countries as well as for multiple countries. Hence, the following section will scrutinise different approaches adopted by CGE modellers in specifying households in the single country poverty focussed models. Multi-country and global models are treated in Section 3.2.2.

3.4.1 Single Country Models

These models describe a single economy and consider the variables generated from rest of the world being exogenous to the model. In trade policy simulations, basically unilateral tariff reforms are experimented within this framework, whereas, multilateral tariff reforms are simulated using multi-country or global models. Poverty focused single country models could be classified into three categories based on the specification of household sector in order to capture relative or absolute poverty, i.e., representative households models (RHM), representative household model extended with income distribution function (RHIDF) and microsimulation models (MM).

3.4.1.1 *Representative households models*

The pioneering CGE models that focussed on the distributional consequences were mainly based on the representative agent hypothesis in terms of specifying the household sector**.** In these models, the household sector was disaggregated into different representative household groups, assuming that the representative agent from each group could well be representing the economic behaviour of the whole group. This representative agent hypothesis has been explained by Kirman (1992) as follows.

> … typically they assume that the choices of all the diverse agents in one sector – consumers for example – can be considered as the choices of one

> "representative" standard utility maximizing individual whose choices coincide with the aggregate choices of the heterogenous individuals (p.117).

In other words, these representative agents correspond to the mean values of variables such as income and expenditure of different household groups in a household income or consumption survey[2].

However, these models do not take into consideration the pattern of income distribution within a particular household group. Thus, these models assume that each representative agent represents a group of homogenous households whose income distribution could well be explained using a uniform distribution. Within group variation is therefore assumed to be zero. In the simulation process, these models would generate a new mean income for different representative household groups. Hence, these models are predominantly used to determine inter-group income inequality and they hardly explain the intra-group income inequality. However, with adequate disaggregation of representative household groups with respect to socio-economic and location criteria while supplementing with microeconomic information gathered from household survey data, these models could be used to compute poverty indicators under different policy simulations. Although it is simple, this disaggregation procedure has proved to be effective in some cases and has provided valuable insights into a variety of policy scenarios. Despite the higher level disaggregation of different income groups, as a means of preserving the heterogeneity of the population, the major drawback in computing the poverty measurements is the assumption of zero intra-group variation. For instance, Coxhead and Warr (1995) have used a CGE model comprising seven representative households, four sectors and three commodities, to investigate the impact

[2] For examples of CGE models with multiple households where each group is represented by a representative agent see Coxhead and Warr, 1995; Horridge, *et al.*, 1995; Sapkota, 2000; Humphreys, 2000).

of technical change in agriculture on income distribution, poverty and aggregated economic welfare in Philippines. In this study they have adopted Foster, Greer and Thorbecke's (1984) (FGT) poverty measurement in measuring headcount ratio, poverty gap and squired poverty gap while real gross national product has been used to measure the aggregated economic welfare. However, the major drawback in this analysis is the lack of information on income distributions within the household groups. A study by Löfgren (1999) adopted a similar approach in capturing income distribution and poverty consequences of trade policy simulations in Morocco. He investigated the short run impact of reduced agricultural and industrial protection on representative Moroccan households in general and the rural sector in particular within a multi-sector, single-region, comparative static CGE framework. In this model, activities, factors and households are explicitly separated into rural and urban sectors. Households have been disaggregated into four representative household groups, i.e., rural poor, rural non-poor, urban poor, urban non-poor. However, this study too did not model the within group income distribution. Several other researchers have adopted more or less similar versions of representative household agent based CGE models in addressing income distribution and poverty issues. The main features and policy conclusions of these studies are summarised in Table 3.1 (see Horridge, *et al.*, 1995; Coxhead and Warr, 1995; Dorosh and Sahn, 2000; Humphreys, 2000; Sapkota, 2000).

3.4.1.2 *Representative Households extended with income distribution functions*

There are several criticisms on the adoption of representative agents in economic models (see for instance Kirman, 1992). Hence, this second approach attempts to partially endogenise the within group income distribution using more realistic distribution functions such as lognormal, Pareto and more flexible beta distribution.

These models further assume that the mean of the income distribution could well be determined endogenously while its variance remains fixed or determined exogenously. The main advantage of this approach over the previous approach is the specification of income distribution using more disaggregated household survey data. These representative household distributions are estimated using the base year household survey data. Once a comparative static simulation has been carried out, a new mean income for each representative household would be generated within the CGE model. However, the variation of the distribution has been assumed to be constant (or determined exogenously). Therefore, the household income distribution would shift to right or left depending on the change in mean income while maintaining the same shape of the distribution as the variance is fixed. Unlike the first approach, this approach partially captures the intra-group income distribution as well as the inter-group income distribution. Thus, they could be used effectively in capturing absolute poverty. Pioneering attempts to capture the intra-group income distribution go back to the work of Adelman and Robinson (1979), in which they used the lognormal distribution function in specifying income distribution of various representative household groups in Korea. Later, de Janvry *et al.* (1991) and Chia *et al.* (1992) used Pareto and lognormal distribution functions, respectively, in specifying the income distribution of representative household groups.

Despite the simplicity, the second approach noted above suffers from various limitations. As Decaluwe *et al.* (2001) points out, none of those studies satisfactorily justifies why distribution functions such as lognormal and Pareto were preferred to other more flexible functional forms, such as the beta function. As the beta function could adopt fairly well under asymmetric situations by generating skewed distributions, it is more flexible in terms of utilising socio-economic information in forming household income distributions. Furthermore, in those studies, the poverty line, which is used as a reference point in measuring poverty, was determined exogenously. As prices of different commodities are generated from the model, treating poverty line (which is determined based on the prices of a distinctive basket of commodities) as exogenous is somewhat misleading.

An innovative development in specifying intra-group income distribution has been proposed by Decaluwe *et al.* (1998) for an archetypical African country. In this model, the income distributions of different household groups have been estimated using beta functional form. Moreover, the poverty line has been determined endogenously. Hence, once a simulation has been conducted the model would generate a new set of mean incomes for each household group and also generate a new value for the poverty line based on the changes in commodity prices. However, this model also assumes that the within group variation is fixed; thus, depending on the direction and the magnitude of the income change, the mean of the distribution remains constant or shifts to right or left while keeping the shape of the distribution unaffected. Additionally, the poverty line too shifts to either direction depending on the changes occurring on prices of basic needs commodities. This process therefore would capture the changes in poverty line as well as income in computing poverty measurements. Furthermore, they have used the FGT poverty measure to compute headcount ratio and income poverty gap. Although, this approach maintains some flavour of the assumption of representative households, it turns out to be a better framework for capturing poverty compared to previous models. More explanations on the methodology and archetypical applications of this approach can be found in Decaluwe, *et al.* (1999a, 1999b, 2001); Thorbecke, 2001; Boccanfuso, *et al.* (2003). Several other researches have adopted this approach in their applications within the developing country context (Colatei & Round, 2000; Pradhan & Sahoo, 2000; Fane and Warr, 2002). Table 3.1 summarises the main characteristics and policy conclusions of these studies.

3.4.1.3 *Microsimulation models*

Micro simulation models, which are popular in household level income distribution studies, do not rely on RHs assumption. As individual households are taken into account, these models are more reliable in capturing the individual heterogeneity. Moreover, these models allow researchers to completely endogenise the within group income distribution together with the within group variation. Pioneering work on microsimulation models were carried out by Orcutt (1957). Since then microsimulation models have been widely used in addressing distributive questions related to welfare programs, tax policy, fiscal reforms, health care and demographic issues (Cogneau and Robillard, 2000). These models are heavily dependent on micro level data such as household income or consumption survey data. The majority of these models are, however, partial equilibrium models. Early work on incorporating microsimulation models into CGE framework was carried out by Meagher (1993) and Dixon, *et al.* (1996) for Australia. Few others have also adopted a microsimulation approach by attempting to fully integrate individual households into a CGE model (Tongeren, 1994; Cogneau, 1999; Cogneau and Robillard, 2000; Cockburn, 2001).

We can identify two approaches in incorporating individual households into a CGE model, i.e., integrated micro simulation models and micro-macro models. These different approaches can be identified on the basis of how individual households are incorporated into a CGE model and the coupling mechanism adopted in linking microsimulation and CGE model.

In the first approach, the integrated microsimulation models attempt to incorporate individual household information that is generally found in income and expenditure based household surveys into CGE framework. Data for these models come in the form of disaggregated SAM account. Labor is categorised into several occupation categories and the household sector consists of individual households whose income generation has been mapped based on wage income of different occupation categories in various industrial sectors, profit income, government transfers, rest of the world transfers and other income. Using the base year disaggregated SAM, initial income distributions can be estimated for different household groups which represent different socioeconomic or geographical features. Hence, the SAM will contain different household groups as well as individuals within these groups. Once a counterfactual simulation has been carried out, individual household incomes would be modified basically through the adjustments in product prices, factor prices and government transfers. Using these newly generated individual incomes, new income distributions for various households groups can be estimated. Thus, in this process we could completely endogenise the household income distributions by estimating new mean incomes and variances. Depending on the income shock the mean of the distribution could shift to right or left. At the same time, the shape of the distribution also gets adjusted depending on the changes that occur to the variance. Therefore, this approach would capture the within group income variability explicitly. This mechanism provides a better tool for CGE modellers to investigate the issues related to absolute poverty within a general equilibrium framework.

Cogneau & Robilliard (2000) carried out the pioneering application of an integrated microsimulation CGE model in addressing poverty issues in Madagascar. In this model they have incorporated 4,508 actual households based on a survey data into a SAM based CGE model. Using those individual households, results are given for 14 household groups, thus endogenising both the within group mean and the variance. However, their model contains only 3 sectors. Hence, it provides limited information on sectoral implications. The model has been used to analyse the impact of different growth strategies on income distribution and poverty. The results indicate a significant change in relative mean income and prices, yet the impact of various growth shocks on poverty and inequality appears to be relatively small.

Cockburn (2001) carried out a microsimulation analysis based on a CGE model to look into the impacts of macroeconomic policies such as fiscal and trade reforms on income distribution and poverty in Nepal. In this model, similar to the approach proposed by the Cogneau and Robilliard study, 3,373 individual households whose information was gathered form survey data have been incorporated into a SAM based CGE model. The results suggest that impact of trade liberalisation on income distribution and poverty is quite complex and fully disaggregated models are necessary in understanding the linkage. More recently, Rutherford, *et al.* (2004) investigated the household and poverty effects of Russia's accession to world trade organisation by using a similar approach.

The second approach, the micro–macro model, is a different version of integrating a microsimulation model with a CGE model. In this approach, there are two distinct models: a household level microsimulation model and a multi-sector CGE model. Both these models are treated separately. Linking of the two is done in a sequential basis. The CGE model generates values for macro and mieso variables such as total employment, prices of commodities and wages etc. Microeconomic features of the labour market and household consumption and income behaviours are modelled using a microsimulation model based on household survey data. Moreover, parameters of the microsimulation model are estimated econometrically. Linking of the two models is done by allowing selected parameters of the microsimulation model to be modified according to certain variables generated by the CGE model. However, the microsimulation model is solved in such a way that results are consistent with the aggregated variables generated by the CGE model. This approach differs from the previous microsimulation approach in several ways. In the previous method, the household sector is disaggregated into individual households in order to capture micro level complexities, whereas in this approach, a separate model is developed encompassing other socio-economic and demographic features, which enables researchers to capture the interactions explicitly. However, due to the sequential fashion in generating results from CGE model to microsimulation model, this can be considered as the “top-down” approach. Thus, no feed back effects are transmitted from microsimulation model to CGE model.

Original work in terms of linking a CGE model with a microsimulation model in a sequential fashion to address the income distribution issue has been attempted by Meagher (1993) and Dixon *et al.* (1996). For instance, Dixon *et al.* have integrated a microsimulation model with a CGE model – MONASH dynamic model of the Australian economy – to examine the possible impacts of microeconomic reforms on the economy, especially on the distribution of income. Here they link the microsimulation model and CGE model into a single integrated system with the help of some common interface variables. This system can be considered to be superior to many other microsimulation based CGE models, as this model can be run in a dynamic mode.

Later Robilliard *et al.* (2001) developed a detailed model for Indonesia to investigate the distributional impacts of the financial crisis. They have used a 38 sector and 15 factors of production SAM based CGE model and microsimulation model estimated based on a sample survey of around 10,000 households for the year 1996. Two models are linked using the variable such as wages in various markets, prices of commodities produced by self employed, consumption prices and total employment for various sectors including self-employment, which are generated by the CGE model. The microsimulation model explicitly captures the labour market interactions and determines occupational choice by individuals; household level consumption price index; profit functions for self employed workers and the income generation mechanism for labour taking into account features such as different skill levels, location and gender. The microsimulation model is solved in such a way that changes in average income and number of wage and self employed workers, and the changes in the consumption prices are consistent with the CGE results. They concluded that the model produces relatively unbiased results compared to models with RHs assumption, which tend to produce underestimated inequality and poverty estimations.

An improved version of linking a CGE model with a Microsimulation model was carried out for Brazil by Filho and Horridge (2004). In their model they have investigated the trade and poverty relationship using a CGE model and a Microsimulation model by linking them in such a way that in addition to the ‘top down’ approach, feedback effects are taken into consideration. This model first communicates the changes in variables such as wages and employment into the Microsimualtion model and then simulates the Microsimulation model. Next, the feedback effects coming from the Microsimulation model are communicated back into the CGE model and solved iteratively until the two models converge.

A few other researchers developed micro-macro version of microsimulation models using multi-country or global CGE framework. These studies are briefly outlined in the next section.

3.4.2 Multi-Country Models

These models consist of multiple countries or the total global economy. In these analysis, the assumption of exogenous global or trading partner effects embodied in single country models are no longer maintained. Thus, implications coming from other countries or the rest of the world have been endogenized. Any policy induced or other shock occurring outside the country would have direct as well as indirect effects transmitting via various channels. This transmission mechanism is explicitly captured in these models. Thereby, these models could be comfortably used in multilateral trade liberalisation policy experiments. The most widely known general equilibrium global modelling system is the global trade analysis project (GTAP) model. There have been a few attempts in the recent CGE literature to address poverty issues using the GTAP model. This section intends to briefly scrutinise the methodology of some of the interesting poverty focussed multi-country/global CGE applications.

Evans (2001), for instance, investigated the effect of trade liberalisation on poverty in Zambia with the help of a case study and the GTAP model. The GTAP database for 1997 has been extended in order to analyse income poverty impact for four household classes for Zambia. Here they have utilised both the case study and the multi-country CGE analysis results in a complementary manner to discover winners and losers of unilateral and multilateral trade reforms and make inferences about poverty. The study concludes that global trade reforms have a favourable impact on income distribution and poverty while regional trade reforms create neutral or negative effects.

Friedman (2000) explores the differential impact of commodity price changes due to trade reforms on the poor and non-poor in Indonesia. A five-region GTAP model consisting 22 tradable and non-tradable goods with five factor inputs has been used along with detailed household consumption and income data provided by the 1996 Indonesian National Socio-economic survey. In this analysis, price changes due to trade reforms has been generated from the CGE model and then the price data are matched with household consumption data in order to estimate measures for compensating variations. The results suggest that under these trade shocks few or no households are made worse off; nevertheless it is observed that the gains from trade liberalisation tend to be biased towards urban households and wealthy households.

Several other researches have investigated the poverty and distributional impacts of various policy shocks based on multi-country or global CGE models (for details see Ianchovichina, *et al.* (2000); Hertel, *et al.* (2001); de Janvry and Sadoulet (2002); and Hertel, *et al.* (2003). Table 3.1 summarises the main features and policy conclusions of these studies.

3.5 CONCLUDING REMARKS

Quantifying the impacts of trade reforms on poverty and inequality is a growing area of concern in the current literature. Although the analysis based on CGE models is limited in this area, due to the usefulness of CGE model based counterfactual analysis in understanding the trade poverty linkage, it was necessary to evaluate the current state of the art with respect to poverty focussed trade related CGE analysis in developing countries. However, there are few studies which investigate the trade poverty linkage within the CGE framework. Therefore, this survey reviews the methods currently adopted by various researchers within the CGE framework in capturing poverty of different policy induced or natural shocks. Moreover, we classify the poverty focussed CGE models into several broad categories based on the methodology adopted in specifying the household sector. In addition, a comprehensive list of references of different poverty focussed CGE applications is provided. The trend suggests that there is growing interest among researchers in deviating from traditional representative agent based household specification into more realistic individual household specification. This may be carried out in several ways, such as estimating empirical income distribution functions for various household groups, fully integrating individual households into a CGE model to carry out microsimulation analysis within a CGE framework or linking CGE and microsimulation models sequentially within single-country or multi-country/global modelling system.

In this study, we adopt a method which extends the representative households based CGE model with empirically estimated best-fit income distribution functions. This is a simple and practical method of estimating poverty measurements within a CGE framework with a notable departure from the more restrictive representative agent hypothesis. Given that there are limitations with respect to accessibility of data and the unavailability of an econometrically estimated microsimulation model for Sri Lanka, this method provides a better analytical capability within the scope of this study. In the next chapter we develop the CGE model for the Sri Lankan economy, while Chapter 5 will discuss the empirical fitting of best-fit income distribution functional forms for Sri Lanka and the procedure of linking them with the CGE model.

Table 3.1
Summary of Poverty Focussed General Equilibrium Applications in Developing Countries

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
	<u>Representative households models</u>				
Horridge, *et al*, (1995)	Multi-household CGE model with 24 household groups.	Income distribution is measured using real consumption by household	South Africa	Macroeconomic, industry and distributional effects of increase in government spending	Expansion of GDP and real consumption is observed under no constraints on government or foreign borrowing. The income distribution effects are less significant. If taxes are used to finance the increase in government spending, distribution of income is markedly affected, particularly for income *vs* consumption taxes.
Coxhead & Warr (1995)	Four sector 3 commodities CGE model. Linear in proportional changes of variables (Johansen class). Seven representative agent households. It focuses only on inter group comparisons rather than intra-group variations.	FGT poverty measure and aggregate economic welfare measured using real gross national product	Philippine	Impact of technical change in agriculture on income distribution, poverty and economic welfare	Estimated impacts of technical change on poverty and economic welfare are more sensitive to structural features of the model rather than distribution sensitivity of poverty or welfare measurement Changes in poverty and welfare are mainly influenced by distributional consequences of changes in factor prices rather than commodity prices
Dorosh and Sahn (2000)	Multi-household country specific CGE models with each having 4 or 5 household groups	Household level real income	Cameroon, Gambia, Madagascar and Niger	Effects of imposing import quotas, real devaluation and real devaluation with reduction in government spending on income distribution.	Import quotas are favourable to urban high-income households. Real devaluation favours low-income households. Urban households are affected most by the reduction in government spending

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Kemal, *et al*. (2001)	13 sector CGE model where representative households are divided into 2 categories, i.e., urban and rural. In the rural sector, households are further disaggregated based on land holding. In the urban sector, households are disaggregated based on employment status.	Poverty line is endogenised. Percentage below the poverty line under different representative households has been used to measure poverty.	Pakistan	Effects of reduction in non-tariff barriers on poverty and income distribution	Increase in non-tariff barriers – quota on consumer goods imports – tends to reduce real income and aggravates poverty
Sapkota (2000)	Standard neo-classical CGE model with 15 production sectors, 15 commodity sectors, 5 factors of production and 10 representative households based on location, land tenure, and rural urban criteria.	Welfare effects of different policies on various households were estimated using computing equivalent variations	Nepal	Liberalisation of imports and domestic tax reforms	Simulation results are not robust
Humphreys (2000)	Standard CGE model with three household groups	Real household income	South Africa	Effects of gradual reduction in the tariff rates in protected sectors	Trade liberalisation favours poor and non-poor. However, it is bad for inequality. Reduction in government transfers would affect negatively on very poor households
Löfgren *et al.* (2001)	Thirty three sector CGE model with 14 households	Per capita household consumption is used to measure income distribution	Malawi	Effects of external shocks and domestic policy shifts targeted at poverty alleviation	External shocks are unfavourable to non-agricultural population. Real depreciation has a pro-rural bias while real appreciation favours urban population. Expanded public works programme favours rural poor but shows a negative consequence on non-agricultural households

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Löfgren (2001)	Dynamic recursive CGE model which encompasses two sub models – static model with nine sectors, four labour categories, two other institutions and six representative households; dynamic model with endogenous capital accumulation and exogenous updating of certain parameters.	Income distribution is measured by Theil index. Poverty is measured using real household consumption of representative household groups.	Egypt	Simulated the ex post, economic performances in Egypt during the period 1979–1997. Different scenarios for price policies, asset distribution, trade transaction costs and productivity growths are investigated.	The results indicate that there is no contradiction between fast productivity growth and welfare improvements of poor. Further, pro-poor land and human capital assets redistribution could have been more effective in combating poverty and inequality.
Coxhead and Jayasuriya (2004)	Standard Johansen class CGE model (Agricultural Policy Experiment – APEX model) with five household groups	Change in real household income	Philippines	Effects of protection policy on poverty and deforestation	In the short run trade liberalisation tends to increase the depth and severity of poverty among lower income groups. The environmental consequences of poverty changes are ambiguus.
	<u>Representative households extended with income distribution functions</u>				
Chia, Wahba & Whalley (1992)	Classical real sector CGE model in the public finance tradition. Seven household types based on representative agents. Lognormal income distribution has been assumed to each household. Three labour categories.	Welfare impacts are measured using Hicksian Equivalent Variations expressed as a proportion of the base case household gross income Poverty is measured using FGT indices	Cote d' Ivoire	Incidence of taxes and the effectiveness of poverty reducing targeting programs	Urban employees and export food croppers are largely affected by income tax and export tax respectively. Inter-household transfers play a crucial role in transmitting impact from one household group to a another due to second round effects. Budget neutral targeting programs are not effective in elimination of poverty while small transfers are relatively more effective than large target programs.

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Chia, Wahba & Whalley. (1994)	Classical real sector CGE model in the public finance tradition. Seven household types based on representative agents. Lognormal income distribution has been assumed to each household. Three labour categories.	FGT poverty measure	Cote d' Ivoire	Effectiveness of poverty reducing targeting programs	Budget neutral targeting programs are not effective in elimination of poverty while small transfers are relatively more effective than large target programs Inter-household transfers play a crucial role in transmitting impact from one household group to a another due to second round effects
Decaluwe *et al.* (1999a)	Used three approaches: traditional CGE model with multiple households; a CGE model with estimated beta distribution functions to determine poverty; a CGE model integrating individual households in the form of a microsimulation model	Poverty line has been endogenised FGT poverty measures are used to measure poverty. Gini coefficient and Theil index are used to determine income distribution.	Archetype African economy	Illustrative simulations on an increase in the unskilled labour supply and combine effect of an increase in world agricultural commodity prices with the elimination of customs duties for industrialised goods.	Intra group distributional effects are well captured in the CGE micro simulation approach. Hence this method is more useful in analysing poverty and inequality.
Decaluwe, *et al.* (1999b)	Six sector CGE model with six household income groups. The income distribution of these groups is assumed to follow beta distribution.	Poverty line has been endogenised FGT poverty measures are used to measure poverty.	Archetype African economy	Impacts of fall in the export crop prices and import tariff reforms on household poverty	Fall in the export prices causes an increase in headcount index for all household groups except for the rural households. However, poverty gap measurement increases in all groups. Import tariff reforms tend to reduce poverty in all low-income household groups.

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Colatei & Round (2000)	Standard CGE model with 10 household groups. Household income distributions are assumed to follow lognormal distribution.	Headcount index is used to measure poverty.	Ghana	Examined the effects of poverty-alleviating transfers on the economy. Also investigated the sensitivity on different closures.	The model results are somewhat sensitive to the closure rule. The simulated reduction in poverty is much pronounced in the fixed price input-output closure than that of the structuralist closure.
Pradhan & Sahoo (2000)	A 23-sector CGE model with 9 household groups The income distribution of these groups is assumed to follow lognormal distribution.	Poverty line is endogenised and FGT poverty indices are used to measure poverty	India	Impact of international oil price shocks on the welfare and poverty of households	Oil shock reduces welfare and increases poverty
Croser (2002)	82 industry and commodity categories with 10 broad household groups. The income distribution of these groups is assumed to follow beta distribution.	FGT poverty measures with endogenous monetary poverty line. Compensating variation (CV) to determine the within group income distribution	Indonesia	Impact of further trade liberalisation on poor households. Simulations carried out on complete removal of tariffs and tariff equivalent import licences	Trade liberalisation reduces poverty but widens the gap between rich and poor households.
Fane and Warr (2002)	Sixty-five sector CGE model with four mobile factors and two types of labour categories. Linear in proportional changes of variables. Ten representative household groups – seven rural and three urban – based on socio-economic characteristics. These groups are assumed to be distributed based on log normal distribution. However, the variance of these distributions assumed to be constant.	Inequality is measured by Gini coefficient while headcount rate and poverty gap are used in measuring poverty.	Indonesia	Investigates the impact of Hicks neutral productivity increase in various sectors and the accumulation of physical and human capital	Technical progress in services and manufacturing is more pro-poor than the technical progress in agriculture Education – modelled as shift of unskilled labour into skilled labour is pro-poor

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
	<u>Microsimulation models</u>				
Mujeri and Khandaker (1998)	CGE model with 14 sectors where 7 manufacturing sectors (excluding export sectors) are treated having non-competitive market structure with increasing returns to scale. Other sectors are treated as competitive. Comprises 8 representative household groups. Impact of macro policies on household nutrition status is estimated using a linked micro simulation model	SAM based multipliers and FGT poverty measure. Household welfare is measured using equivalent variation (EV)	Bangladesh	Distributional effects of tariff reforms with combine effects with domestic tax adjustments Simulating nutrition effects of price and income change	Observed Evs are lower for the worker household groups compared to agricultural household groups. Under tariff liberalisation percentage change in protein and calorie availability is large for high-income household groups compared to low-income groups. Positive distributional and poverty effects are largest for the social sectors followed by services and agricultural sectors
Cogneau and Robilliard (2000)	A 3 sector CGE model is integrated with a microsimulation model. In this model they have incorporated 4,508 actual households, based on a survey data, into a SAM based CGE model. Using those individual households, results are given for 14 household groups.	Per capita income measure and Theil index are used to measure poverty and inequality	Madagascar	The model has been used to analyse the impact of different growth strategies on income distribution and poverty.	The results indicate a significant change in relative mean income and prices, yet the impact of various growth shocks on poverty and inequality appears to be relatively small.
Robilliard *et al.* (2001)	A standard CGE model with 38 sectors is sequentially linked to a microsimulation model	Real household income is estimated using the microsimulation model headcount index, poverty gap index and poverty severity index are used to measure poverty. Theil index and Gini index are used to measure inequality.	Indonesia	Quantifying the effects on poverty and inequality of the 1997 financial crisis and evaluating the impacts of alternative social policy packages during the crisis.	El Nino drought effects and financial crisis shock equally contributed to increase in poverty during this period. Household transfer programmes are more efficient in alleviating poverty.

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Cockburn (2001)	A CGE model which explicitly integrates all households (3373 households) from a national household survey.	Poverty and income distribution analysis is carried out using DAD software. Distribution of income variations, equivalent variation, Atkinson index and Gini index are used to measure income distribution. FGT indices are used in the measurement of poverty.	Nepal	An illustrative simulation of reduction in all import tariffs	The results suggest that the impact of trade liberalisation on income distribution and poverty is quite complex and fully disaggregated models are necessary in understanding the linkage. Trade liberalisation favours urban households. Poverty reduces in urban areas and seems to increase in rural areas
Bussolo and Lay (2003)	A 36 sector standard CGE model and a microsimulation model are sequentially linked	Poverty head count, poverty severity , per capita income, general entropy and Gini coefficient are used to measure poverty and inequality	Colombia	Impact of trade liberalisation on poverty and income distribution	Trade liberalisation substantially reduces poverty. Income distribution differs between rural and urban areas
Rutherford, Tarr and Shepotylo (2004)	CGE model that endogenises 55 098 households based on Russian budget survey data. Moreover, it incorporates liberalisation of services and endogenises productivity gains of trade liberalisation.	Factor income shares by income decile and aggregate welfare measure of equivalent variation as a % of consumption and as a % of GDP	Russia	Effect of Russia's accession to the WTO on income distribution and the poor	All households gain in the medium term; however, many households are likely to lose in the short run due to the adjustment costs
Filho. and Horridge (2004)	A CGE model with 42 sectors, 52 commodities and 27 regions is integrated with a household level microsimulation (MS) model. It includes a mechanism that communicates income and expenditure changes from CGE to MS and feedback effect coming back to CGE until two models converge.	FGT poverty indices and Gini coefficient are used to measure poverty and income distribution, respectively.	Brazil	100% cut in all tariffs between Brazil and other trading partners. The shocks are generated using a previous study – linked Brazilian CGE model with GTAP model	The impact of the tariff cut on the economy as a whole as well as on the poverty and income distribution is not significant. Brazilian economy is less sensitive to tariff reforms as the domestic market is much bigger than the external market Liberalisation increases employment of lower-paid workers thus reducing poverty
	<u>Multi-country models</u>				
Friedman (2000)	Five region GTAP model consisting 22 tradable and non-tradable goods with five factor inputs has been used along with detailed household consumption and income data provided by the 1996 Indonesian National Socio-economic survey.	Measures of changes in compensating variation has been calculated in this study	Indonesia	Unilateral trade liberalisation based on GTAP model	The results suggest that under these trade shocks few or no households are made worse off. Nevertheless it is observed that the gains from trade liberalisation tend to be biased towards urban households and wealthy households

Authors/Year	Notes on Methodology	Poverty Measure	Country	Policy Issue(s)	Summary of conclusion
Evans (2001)	12 region GTAP model consisting of 10 sectors and 5 factors of production has been used including an extension for Zambia in order to analyse income poverty within 4 classes of households.	Change in headcount and elasticity of headcount wrt income are used to measure poverty	Zambia	The impact of unilateral tariff reforms (post Uruguay round), regional tariff reforms (SADC free trade agreement) and global tariff reforms (WTO millennium round) on income poverty	Possible global welfare gains from trade reforms were evident. Unilateral and regional tariff reforms were income improving but neutral on household income distribution. Based on poverty headcount changes, these tariff reforms were biased towards metropolitan sectors. Global tariff reforms showed a little bias towards non-metropolitan households while headcount effects showed the opposite
Hertel, *et al.* (2001)	Simulations done on GTAP model and price changes are then used in conjunction with information on factor income and expenditure at 5 strata.	Poverty is measured using headcount ratio and FGT poverty indices.	Brazil, Chile, Indonesia, Philippines, Thailand, Uganda, an d Zambia	Impact of trade liberalisation on household poverty, specifically on marginal households	In general trade liberalisation tends to reduce poverty in all 7 countries. The impact on particular groups within countries show mixed results.
Ianchovichina, *et al.*. (2000)	GTAP model is used to determine the price changes and the Mexican household data are used to asses the poverty and income distribution effects.	FGT poverty indices are used to measure poverty and Gini coefficient and Theil index are used to measure income distribution	Mexico	Effects on differential tariff structure on poverty and income distribution	Tariff reforms showed a positive welfare effect on all income deciles. Under non-homothetic individual preferences, poorer deciles were benefited most.
De Janvry and Sadoulet (2002)	Multi-country stranded CGE model with multiple social groups	Real incomes of different social groups are computed using social group specific consumer price indices.	Archetype models for Africa, Asia and Latin America	Direct and indirect effects of agricultural technology on poverty	Major effect flowing from technology on poverty: direct effects in Africa, indirect agricultural employment effects in Asia and linkage effects with the rest of the economy in Latin America.
Hertel, *et al.* (2003)	Eleven sector GTAP model is used in the simulation. The impacts on households are measured using a post-simulation income and expenditure system.	Poverty is measured using FGT indices and compensating variation	Multiple countries	Explores the relationship between trade regimes and vulnerability of poor in the presence of volatile staple grain prices	Trade liberalisation tends to reduce the variability of grain prices. Impact of grain price volatility on poverty is relatively small.

CHAPTER 4

THE THEORETICAL STRUCTURE AND THE IMPLEMENTATION OF THE SRI LANKAN GENERAL EQUILIBRIUM MODEL FOR POVERTY ANALYSIS (*SLGEM–P*)

4.1 INTRODUCTION

The aim of this chapter is to present the main features of the CGE model developed in this study to evaluate the impacts of trade reforms on poverty and income distribution of the Sri Lankan economy. As discussed in Chapter 3, there are limitations in partial equilibrium analytical approaches in tracking down the empirical relationship between trade policy and poverty. Hence, it is vital to adopt a better experimental design in order to isolate trade shocks from numerous other policy-induced or natural shocks while tracing different channels through which this trade impulse transmission mechanism is operated. The counterfactual analysis within a general equilibrium framework provides an ideal experimental setting to investigate this relationship. The general equilibrium framework not only allows analysts to capture the direct as well as the indirect interactions among different agents and markets; it also provides a convenient framework in which to carryout controlled policy experiments where the impact of trade reforms could be isolated from other shocks.

Sri Lanka has a long history of applying CGE models to analyse various issues related to the economy. The availability of quality data has been one of the main reasons for this trend. In fact, Sri Lanka is the first developing country for which a Social

Accounting Matrix (SAM) was developed in the early 1970s (Pyatt and Roe, 1977). This has influenced the wide adoption of the CGE framework in economic policy analysis of the country. De Melo (1978) developed the pioneering CGE model for Sri Lanka. Since then, several studies have developed CGE models for the Sri Lankan economy.[1] Bandara (1989) developed the first CGE model of the Johansen class (with linearized system of equations) following the *ORANI* model (Dixon *et al.*, 1982) of the Australian economy. This model contained a limited income distribution component without any reference to poverty measurements. However, no study has attempted to build a poverty focussed, multi-sectoral, SAM based CGE model to focus on poverty issues within the general equilibrium framework for Sri Lanka.

The main purpose of this chapter is to develop a comparative static multi-sectoral SAM based CGE model (Sri Lankan Poverty-Focussed Computable General Equilibrium Model – *SLGEM–P*) following the approach proposed by Decaluwe *et al.* (1998) to capture the link between trade reforms and absolute poverty within the Sri Lankan context. As noted in Chapter 3, developing a CGE model with a full-blown micro simulation model for Sri Lanka is beyond the scope of this thesis, as there is no readily available micro simulation model for Sri Lanka and developing such a model is constrained by the availability of time and data.

In terms of the modelling technique, the *SLGEM–P* belongs to the *ORANI* family of general equilibrium models dating back to the seminal work of Dixon *et al.* (1982). The starting point of the present model was the *IDCGEM* model, a SAM based CGE model of the South African economy (Horridge *et al.*, 1995), which was based on the

[1] See Blitzer & Eckaus (1986); Jayawardena *et al.* (1987); Bandara (1989); CIE (1992); Herath (1994); Somaratne (1998); Bandara & Coxhead (1999); Kandiah (1999). For a comprehensive survey of CGE applications for the Sri Lankan economy see Bandara (1990). In addition to country specific CGE analysis, few studies have been attempted on the implications of regional trade agreements on Sri Lanka using the Global Trade Analysis Project (GTAP) model (see for example Siriwardena, 2000; 2004; and Bandara and Yu, 2003)

Australian *ORANI-F* model (Horridge *et al.*, 1993). The model developed in this chapter is an extension of the *IDCGEM* model with several new features to accommodate socio-economic structure of Sri Lanka – particularly with respect to household income groups, different types of occupational labour, industry structure and more importantly the change in poverty line. Moreover, due to lack of reliable data on margins, the model does not include trade and transport margins. It therefore follows *ORANIG-NM* (the *ORANI* based CGE model without margins) version (Horridge, 2002) in which margins are modelled as direct flows. Furthermore, *SLGEM–P* is a single country comparative static CGE model which does not contain any recursive dynamic component or any regional extension,[2] basically due to the lack of reliable data.

The *SLGEM–P* is a system of m equations in n variables with $n > m$ which can be depicted as:

$$F(X) = 0, \qquad (4.1)$$

the above system of equations is linearised by logarithmic differentiation, where X is a (n x 1) vector of variables and F is a vector of m differentiable functions. In order to solve the model, (n-m) variables should be treated as exogenous. This can be given as:

$$F(X_1, X_2) = 0, \qquad (4.2)$$

where the vectors X_1 and X_2 consist of endogenous and exogenous variable respectively. Thus, the solution of the model can be given as:

$$X_1 = H(X_2), \qquad (4.3)$$

[2] Regional extension could not be attempted due to lack of input-output and other relevant data with respect to different regions. Lack of reliable estimates on industry level capital stocks prevented us incorporating recursive dynamic component into the model. As data on these areas become available, the present model could be extended to a recursive dynamic regional model.

where H is a vector of m differentiable functions. This yields a set of simultaneous equations that are linear in percentage changes in the model's variables. The linearisation of equations in (4.1) is done by using total differentiation of each equation, which can be depicted as:

$$\delta F_i dX = 0, \quad i = 1, \ldots\ldots., m, \tag{4.4}$$

where δF_i is the vector of first order partial derivatives of F_i. Assuming that zero is not a possible value of any of the variables, the equation (4.4) can be rewritten as:

$$\delta F_i \underset{\sim}{X} x = 0, \quad i = 1, \ldots\ldots.., m. \tag{4.5}$$

where x is the vector of percentage changes of the elements in vector X while $\underset{\sim}{X}$ is the diagonal matrix derived from the vector X. Thus, the equation (4.5) can be presented in matrix form as:

$$Ax = 0, \tag{4.6}$$

where A is a (m x n) matrix and x is a (n x 1) vector of percentage changes of the variables in the model.

The *SLGEM–P* is implemented using *GEMPACK* software suite (Harrison and Pearson, 1994a) – a flexible system for solving CGE models. In this chapter, we present the theoretical structure of the *SLGEM–P* organised around the *TABLO* file, which implements the model in *GEMPACK*. The *TABLO* representation of the model is close enough to ordinary algebraic representation of the model. Presenting the model in *TABLO* language is appropriate as it is the main language which communicates the *SLGEM–P* theory to computers. Moreover, in order to present the model theory and the computer implementation in a consistent manner, we document the model by discussing different blocks of equations with the help of Excerpts from the *TABLO* file. A complete explanation of *TABLO* language is given in *GEMPACK* manuals (Harrison and Pearson, 1994a, 1994b, 1998).

The remainder of this chapter is organised as follows. Section 4.2 presents the dimensions of the model. Overviews of variables and coefficients and of the model's equations are presented in Sections 4.3 and 4.4 respectively. Section 4.5 outlines the model closure. The procedure of model solution is described in Section 4.6. Section 4.7 explains the procedure of systematic sensitivity analysis. The final Section, 4.8, presents concluding remarks.

4.2 DIMENSIONS OF THE MODEL

SLGEM–P consists of 38 industries, which produce 38 commodities. These are listed under '*IND4'* and '*COM1'* statements respectively under '*SET'* statement given in Excerpt 4.1 of the *TABLO* code of the model. In addition, commodities come from two sources – domestic (*dom*) and imported (*imp*) which are given under '*SRC'* statement. There are 8 occupational labour types which are given under '*OCC8'* statement 1.Professional, technical and related workers (*PTW*); 2. Administrative and managerial workers (*AMW*); 3. Clerical & related workers (*CLW*); 4. Sales workers (*SALW*); 5.Service workers (*SERW*); 6 .Agricultural, animal husbandry, fisheries and forestry workers (*AGW*); 7. Production and related transport equipment operators & labourers (*LPW*); 8. Other workers (*OW*). Moreover, 5 household groups can be identified (1.Urban low-income households; 2. Rural low-income households; 3. Estate low-income households; 4. Urban high-income households; and 5. Rural high-income households) by '*HH5'* statement. In addition, there are two other sets, which denote traditional export commodities by 'TRADEXP' and non-traditional export commodities by '*NTRADEXP*' statement (refer to Excerpt 4.1 for details).

Excerpt 4.1: Sets and Subsets in *SLGEM–P*

```
!Definitions of sets !

Set
 COM4 # Commodities #
        (Teagrow, Rubgrow, Cocgrow, Paddy, Mexcrop,
Tobacco, Othe_agri, Livestock, Firewood, Forestry, Fishing, Mining, Teapro,
Rubpro, Cocopro, Milling, Foodbev, Textile, Garments, Wood, Paper, ChmFerti,
Petroleum, RubProduct, NMOminpr, Base_metal, Feb_metal, Othe_Manu,
Electricity, Construct, Trade, Hotels, Transport, Commun, Banking, Dwellings,
Pubadmin, Other_serv);
Set
 IND4 # Industries #
        (Teagrow, Rubgrow, Cocgrow, Paddy, Mexcrop,
Tobacco, Othe_agri, Livestock, Firewood, Forestry, Fishing, Mining, Teapro,
Rubpro, Cocopro, Milling, Foodbev, Textile, Garments, Wood, Paper, ChmFerti,
Petroleum, RubProduct, NMOminpr, Base_metal, Feb_metal, Othe_Manu,
Electricity, Construct, Trade, Hotels, Transport, Commun, Banking, Dwellings,
Pubadmin, Other_serv);
Set
 SRC # Source of Commodities # (dom,imp); ! s !
Set
 OCC8 # Occupations #
(PTW, AMW, CLW, SALW, SERW, AGW, LPW, OW);

Set
 HH5 # Income groupings #    (ULIHH, RLIHH, EHH, UHIHH, RHIHH);   ! h !

Mapping COM2IND from COM4 to IND4;
Formula (All,c,COM4) COM2IND(c) = $POS(c);
Mapping IND2COM from IND4 to COM4;
Formula (All,i,IND4) IND2COM(i) = $POS(i);
Set TRADEXP # Traditional Export Commodities #
 (Mexcrop,Mining, Teapro,Rubpro, Cocopro,Garments,RubProduct,
Othe_Manu);

Set NTRADEXP # Non-Traditional Export Commodities #
 ( Teagrow, Rubgrow, Cocgrow, Paddy,
Tobacco, Othe_agri, Livestock, Firewood, Forestry, Fishing,
 Milling, Foodbev, Textile,  Wood, Paper, ChmFerti,
Petroleum,  NMOminpr, Base_metal, Feb_metal,
Electricity, Construct, Trade, Hotels, Transport, Commun, Banking, Dwellings,
Pubadmin, Other_serv);
                                   ! c !
Subset TRADEXP is subset of COM4;
Subset NTRADEXP is subset of COM4;
```

Note: Table 4.1 provides a detailed description of 38 industries and commodities and shows how they are related to definitions of Tablo Excerpt 4.1.

4.3 VARIABLES AND COEFFICIENTS

The variables contained in the *SLGEM–P* are presented in table 4.2. Except for a few variables such as *Balance of Trade/GDP* and *Stocks/GDP*, which are reported as changes in the level values, all other variables are reported as percentage changes within the equations of the model.

Variable names follow a naming convention that contains a particular order. For instance, the first letter of a variable name is '*x*', it refers to a change in quantity while '*p*' refers to prices. Similarly, '*v*' refers to values, '*a*' refers to technical or taste changes, and '*f*' refers to shift expressions. Moreover, a variable name includes a number that refers to the type of sale. For instance, number 1 refers to intermediate inputs to production, number 2 refers to investment purchases, number 3 refers to household purchases, number 4 refers to exports, while number 5 refers to government purchases.

Table 4.3 presents the list of coefficients in the *SLGEM–P*. Coefficients are extracted directly from the database and some are calculated within the model using a 'Formula' statement. Moreover, coefficients are updated based on 'update' statements.[3]

4.4 OVERVIEW OF THE MODEL'S EQUATIONS

Many of the model equations are derived using the behavioural rules such as utility maximising consumers and profit maximising producers based on neo-classical assumptions.

[3] The 'update' statements fulfill two purposes. First, they would allow the model to generate solutions from multistep shocks – which allows modellers to simulate relatively large shocks within the linearised models while minimising the linearisation errors (Hertel, Horridge and Pearson, 1992). Second, as a by-product of the update command, a new database can be created which includes the changes as a result of the simulation.

Table 4.4 presents the list of equations of the *SLGEM–P*. There are several blocks of equations dealing with production, investment, household consumption, exports, and government expenditure which are described in this section. Subsequent parts cover prices, primary factor prices, market clearing equations, zero pure profit conditions, income distribution and the equations describing the poverty line.

The derivation of equations of CGE models of *ORANI* family has widely been documented (see for example Dixon, *et al.*, 1982). Therefore, it is not intended to document the details of derivation of equations of *SLGEM – P* model in this chapter. Rather a simple illustration of the derivation of percentage change equations of the Constant Elasticity of Substitution (CES) production nest is presented in Appendix B. The following sections will present a brief overview of the model equations within different blocks.

4.4.1 Structure of Production

As noted earlier, the model contains 38 industries, each of which produces one of 38 products. Thus, the model shows one to one relationship between industries and commodities and there are no multi-product industries as in *ORANI* model (the industry and commodity classification is given in Table 4.1). These 38 industries can be broadly categorised into four main sectors – Agriculture, Mining, Manufacturing and Services.

Table 4.1

Industry and Commodity Classifications in the *SLGEM – P* Model

	Industries	Description	Commodities
Agricultural Industries			
1	**Teagrow**	Tea growing	**Teagrow**
2	*Rubgrow*	Rubber growing	*Rubgrow*
3	*Cocgrow*	Coconut growing	*Cocgrow*
4	*Paddy*	Paddy growing	*Paddy*
5	*Mexcrop*	Minor export crops	*Mexcrop*
6	*Tobacco*	Tobacco growing	*Tobacco*
7	*Othe_agri*	Other agricultural crops	*Othe_agri*
8	*Livestock*	Livestock and poultry	*Livestock*
9	*Firewood*	Firewood	*Firewood*
10	*Forestry*	Forestry	*Forestry*
11	*Fishing*	Fisheries	*Fishing*
Mining Industry			
12	*Mining*	Mining	*Mining*
Manufacturing Industries			
13	*Teapro*	Tea processing	*Teapro*
14	*Rubpro*	Rubber processing	*Rubpro*
15	*Cocopro*	Coconut processing	*Cocopro*
16	*Milling*	Grain milling	*Milling*
17	*Foodbev*	Food and beverage industry	*Foodbev*
18	*Textile*	Textile industry	*Textile*
19	*Garments*	Garments industry	*Garments*
20	*Wood*	Wood products, furniture and fittings	*Wood*
21	*Paper*	Paper and printing	*Paper*
22	*ChmFerti*	Chemicals and fertilizer	*ChmFerti*
23	*Petroleum*	Petroleum products	*Petroleum*
24	*RubProduct*	Rubber products	*RubProduct*
25	*NMOminpr*	Non-metallic mineral products	*NMOminpr*
26	*Base_metal*	Basic metal products	*Base_metal*
27	*Feb_metal*	Fabricated metal products	*Feb_metal*
28	*Othe_Manu*	Other manufacturing industries	*Othe_Manu*
Service Industries			
29	**Electricity**	Electricity and water	*Electricity*
30	*Construct*	Construction	*Construct*
31	*Trade*	Whole sale and retail trade	*Trade*
32	*Hotels*	Hotels, bars and restaurants	*Hotels*
33	*Transport*	Transport	*Transport*
34	*Commun*	Communication	*Commun*
35	*Banking*	Banking and insurance	*Banking*
36	*Dwellings*	Ownership of dwellings	*Dwellings*
37	*Pubadmin*	Public administration and defense	*Pubadmin*
38	*Other_serv*	Personal, social and community services	*Other_serv*

The structure of production in the model is explained using a composite production function, which is separated into a sequence of nests. Figure 4.1 summarises the structure of production within the model. Separability assumptions keep the production specification of the model manageable.

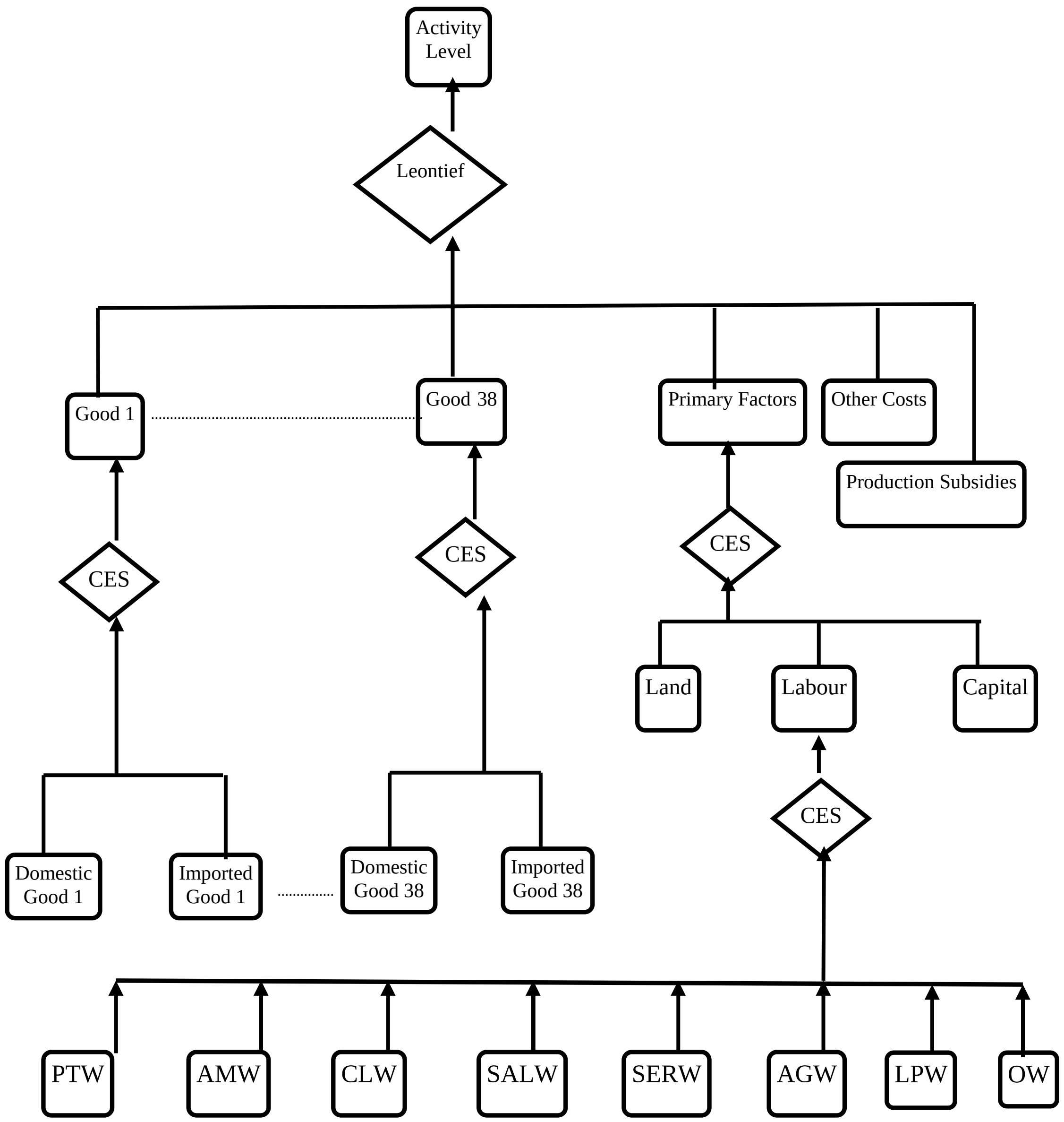


Figure 4.1: Production Function Tree of the Model

At the top of Figure 4.1, we assume input-output separability. The producers are assumed to choose their inputs using a cost minimisation decision rule subject to three-level, constant returns to scale industry production functions. Moreover, producers are considered to be price takers in input as well as output markets.

The top-level nests indicate that industries combine fixed ratios of effective inputs such as intermediate inputs (commodity composites), primary factors (labour, capital and land) and production subsidies and other costs (labelled as other cost tickets) based on a *Leontief* production function. This further suggests that the proportions of each composite input demanded remain unchanged as a result of change in composite price of each input, for a given technology. The *Leontief* production function can be given by:

$$x1tot(i) = \frac{1}{a1tot(i)} \times \min\left[All, c, COM4 : x1\_s(c,i), \frac{x1prim(i)}{a1prim(i)}, \frac{x1oct(i)}{a1oct(i)}, x1sub(i) \right] \quad (4.7)$$

The *Leontief* production function assumes zero substitution elasticity between intermediate, primary and other inputs. Thus, it is assumed that no substitution is taking place between primary factors and intermediate inputs or between intermediate inputs of different input-output classes. Each input category – the commodity composites ($x1\_s(c,i)$), primary factors ($x1prim(i)$), other cost tickets ($x1oct(i)$) and production subsidies ($x1sub$(i)) – is demanded in direct proportion to industry activity level ($x1tot(i)$) with $a1tot$(i), Hicks-neutral technical-change term that affects all inputs equally. This is given in Excerpt 4.2.

Excerpt 4.2: Top Nest of Industry Input Demands

```
! Top nest of industry input demands

Equation E_x1_s # Demands for Commodity Composites #
(all,c,COM4)(all,i,IND4)
 x1_s(c,i) - a1tot(i) = x1tot(i);

Equation E_x1prim # Demands for primary factor composite #
(all,i,IND4)
 x1prim(i) - a1prim(i) - a1tot(i) = x1tot(i);

Equation E_x1oct # Demands for other cost tickets #
(all,i,IND4) x1oct(i)
 - a1oct(i) - a1tot(i) = x1tot(i);

Equation E_x1sub # Demands for production subsidies #
(all,i,IND4) x1sub(i) = x1tot(i);
```

4.4.1.1 Demands for Intermediate Inputs

The next level of nest, which describes the demand for intermediate inputs from two sources – domestic and imported – is assumed to be derived by adopting a cost minimisation decision rule subject to a constant elasticity of substitution (*CES*) production function in which the substitution between imported and domestically produced inputs is allowed following the Armington (1969) assumption of imperfect substitutability. The commodity composites are aggregated from domestic and imported sources using a *CES* production function, given in percentage change form:

$$x1(c,s,i) = x1\_s(c,i) - SIGMA1(c)\left[p1(c,s,i) - p1\_s(c,i)\right], \qquad (4.8)$$

where, the demand for intermediate input, c, from source, s, (domestic or imported) by each industry, i, $x1(c,s,i)$, depends on the total output (scale effects) $x1\_s(c,i)$, the relative prices of commodities from different sources and the ability to substitute commodities from different sources ($SIGMA1(c)$, Armington elasticity). Thus it suggests that for given values of $x1\_s(c,i)$, when the weighted average price of imports and domestic commodities (*p1_s(c,i)*) becomes cheaper than the price of domestic commodities, industries will reduce their demand for domestic inputs in favour of imported inputs. However, this substitution is controlled by the Armington elasticity. The import/domestic composition of intermediate demand is given in Excerpt 4.3.

Excerpt 4.3: The Import /Domestic Composition of Intermediate Demand

```
! Import/domestic composition of intermediate demands !

Coefficient (all,c,COM4) SIGMA1© # Armington elasticities: Intermediate #;
Read SIGMA1 from file BASEDATA header "1ARM";

Equation E_x1 # Source - Specific Commodity Demands #
(all,c,COM4)(all,s,SRC)(all,i,IND4)
 x1(c,s,i) = x1_s(c,i) - SIGMA1©*{p1(c,s,i) - p1_s(c,i)};

Equation E_p1_s # Effective Price of Commodity Composite #
(all,c,COM4)(all,i,IND4)
 p1_s(c,i) = sum{s,SRC, S1(c,s,i)*{p1(c,s,i)}};
```

4.4.1.2 Demands for Primary Factors

The equations of demand for primary factors are the flows of value added components of costs that are described within a nest. The levels of industry output and the relative prices of primary factors determine the demand for primary factors. Looking at the bottom of the right hand side of Figure 4.2, one could identify the first problem the producers face, choosing a right combination of labour types to minimise the total labour cost. This is solved using a *CES* function in which substitutability is allowed between different types of labour categories (including eight categories of labour, which were classified based on occupational labour types, i.e., Professional, technical and related workers; Administrative and managerial workers; Clerical & related workers; Sales workers; Service workers; Agricultural, animal husbandry, fisheries and forestry workers; Production and related transport equipment operators & labourers and Other workers). The demand for labour by industry and skill group is given by:

$$x1lab(i,o) = x1lab\_o(i) - SIGMA1LAB(i)\left[p1lab(i,o) - p1lab\_o(i)\right], \qquad (4.9)$$

where the occupational labour demand, $x1lab(i,o)$, depends on the total labour demand in the economy, the relative wage rates between occupations and the ability to substitute labour among different occupational categories ($SIGMA1LAB(i)$). Thus it suggests that at given level of demand for effective labour ($x1lab\_o(i)$), when the wage rate of occupation o increases relative to overall wage rate of effective labour ($p1lab\_o(i)$), industries will reduce their demand for that particular occupation in favour of other occupations. However, this substitution is controlled by $SIGMA1LAB(i)$, CES substitution between skill types. This is given in Excerpt 4.4.

Excerpt 4.4: The Occupational Composition of Labour Demand

```
!Occupational composition of labour demand !

Coefficient (all,i,IND4) SIGMA1LAB(i) # CES substitution between skill types #;
Read SIGMA1LAB from file BASEDATA header "SLAB";

Equation E_x1lab # Demand for labour by industry and skill group #
(all,i,IND4)(all,o,OCC8)
 x1lab(i,o) = x1lab_o(i) - SIGMA1LAB(i)*{p1lab(i,o) - p1lab_o(i)};

Equation E_p1lab_o # Price to each industry of labour composite #
(all,i,IND4)
 {TINY + V1LAB_O(i)}*p1lab_o(i) = sum{o,OCC8,V1LAB(i,o)*p1lab(i,o)};

Equation E_employ_i # Total Demand for labour of each skill #
(all,o,OCC8)
 {TINY + V1LAB_I(o)}*employ_i(o) = sum{i,IND4,V1LAB(i,o)*x1lab(i,o)};

Equation E_person_i # Total Demand (Persons) for labour of each skill #
(all,o,OCC8)
0 = sum{i,IND4,PERSON(i,o)*[person_i(o) - x1lab(i,o)]};

Equation E_employ_o # employment by industry #
(all,i,IND4)[TINY + V1LAB_O(i)]*employ_o(i) = sum{o,OCC8,V1LAB(i,o)*x1lab(i,o)};
```

At the next level, the primary factor costs – composite bundle of land, labour and capital – are minimised for a given primary input requirement. The composite labour, capital and land are assumed to have *CES* substitution possibilities. Thus, producers will minimise the total cost by selecting the appropriate composition of primary factors by substituting each other. Hence, demand equations for primary factors include parameters specifying substitution prospects between land, labour, and capital and between the different types of labour. For example, for a given level of demand for effective primary inputs (*x1prim*(*i*)), when the price of labour (*p1lab_o*(*i*)) is more expensive than the weighted average cost of primary factors (*p1prim*(*i*)), the industries will reduce their demand for labour in favour of other primary factors such as capital and/or land. This imperfect substitution is governed by *SIGMA1PRIM*(*i*), *CES* substitution for primary factors. Similar mechanism is applied to all other factors in the nested production structure. The shifters *a1lab_o*(*i*) and *a1lab_io* denote productivity of effective labour, while shifters *a1cap*(*i*) and *a1lnd*(*i*) denote capital technical change and productivity of land respectively. Excerpt 4.5 presents the industry demands for primary factors.

Excerpt 4.5: The Industry Demands for Primary Factors

```
! Primary factor proportions !
Coefficient (all,i,IND4) SIGMA1PRIM(i) # CES substitution, primary factors #;
Read SIGMA1PRIM from file BASEDATA header "P028";

Equation E_x1lab_o # Industry demands for effective labour #
(all,i,IND4) x1lab_o(i) - a1lab_o(i) - a1lab_io =
 x1prim(i) - SIGMA1PRIM(i)*{p1lab_o(i) + a1lab_o(i) + a1lab_io - p1prim(i)};

Equation E_p1cap # Industry demands for capital #
(all,i,IND4) x1cap(i) - a1cap(i) =
 x1prim(i) - SIGMA1PRIM(i)*{p1cap(i) + a1cap(i) - p1prim(i)};

Equation E_p1lnd # Industry demands for land #
(all,i,IND4) x1lnd(i) - a1lnd(i) =
 x1prim(i) - SIGMA1PRIM(i)*{p1lnd(i) + a1lnd(i) - p1prim(i)};

Equation E_p1prim # Effective price term for factor demand equations #
(all,i,IND4)[TINY + V1PRIM(i)]*p1prim(i) =
 V1LAB_O(i)*{p1lab_o(i) + a1lab_o(i) + a1lab_io}
 + V1CAP(i)*{p1cap(i) + a1cap(i)} + V1LND(i)*{p1lnd(i) + a1lnd(i)};
```

4.4.2 Demands for Investment Inputs

Capital is assumed to be created by domestically produced and imported commodities. The nesting structure for the production of capital goods is given in Figure 4.2. It is assumed that all industries in a given sector adopt common technology in capital creation and also produce homogenous capital goods. Unlike in the structure of input demands to the production nest, demands for investments require only commodity inputs. Hence, primary factors such as capital, labour and land are not required. However, they are indirectly involved in capital creation through the intermediate inputs. At the top level of the nesting structure, units of fixed capital are created by combining the effective units of produced inputs, independent of relative prices, using the *Leontief* technology, given by:

$$x2tot(i) = Leontief\ x2\_s(c,i), \tag{4.10}$$

where $x2tot(i)$ is the number of units of fixed capital created for industry i and $x2\_s(c,i)$ is the effective input of good i.

At the bottom level, the effective units of produced inputs are assumed to be created using *CES* production functions, given by:

$$x2(c,s,i) = x2\_s(c,i) - SIGMA2(c)\left[p2(c,s,i) - p2\_s(c,i)\right], \tag{4.11}$$

where the demand for inputs for capital creation from a particular source (domestic or imported) by each industry, $x2(c,s,i)$, depends on the total units of fixed capital created by each industry (scale effects) and the relative prices of commodities from different sources. The $SIGMA2(c)$ is the substitution elasticity, which governs the ability of substitution between domestic and imported inputs for capital creation. Thus, similar to the source specific demands for intermediate inputs in the production nest, industries would demand more of a domestic commodity when the domestic price of that commodity (*p*2(*c,s,i*)) is cheaper than the weighted average price of imports and domestic commodities (*p*2_*s*(*c,i*)). Excerpt 4.6 presents equations for the investment demands.

Excerpt 4.6: Investment Demands

```
Investment demands !
Coefficient (all,c,COM4) SIGMA2(c) # Armington elasticities: Investment #;
Read SIGMA2 from file BASEDATA header "2ARM";

Equation E_x2 # Source - Specific Commodity Demands #
(all,c,COM4)(all,s,SRC)(all,i,IND4)
x2(c,s,i) - x2_s(c,i) = - SIGMA2(c)*{p2(c,s,i) - p2_s(c,i)};

Equation E_p2_s # Effective Price of Commodity Composite #
(all,c,COM4)(all,i,IND4)
p2_s(c,i) = sum{s,SRC, S2(c,s,i)*{p2(c,s,i)}};
! Investment top nest !
Equation E_x2_s # Demands for Commodity Composites #
(all,c,COM4)(all,i,IND4)
 x2_s(c,i) - {a2tot(i)} = x2tot(i);
```

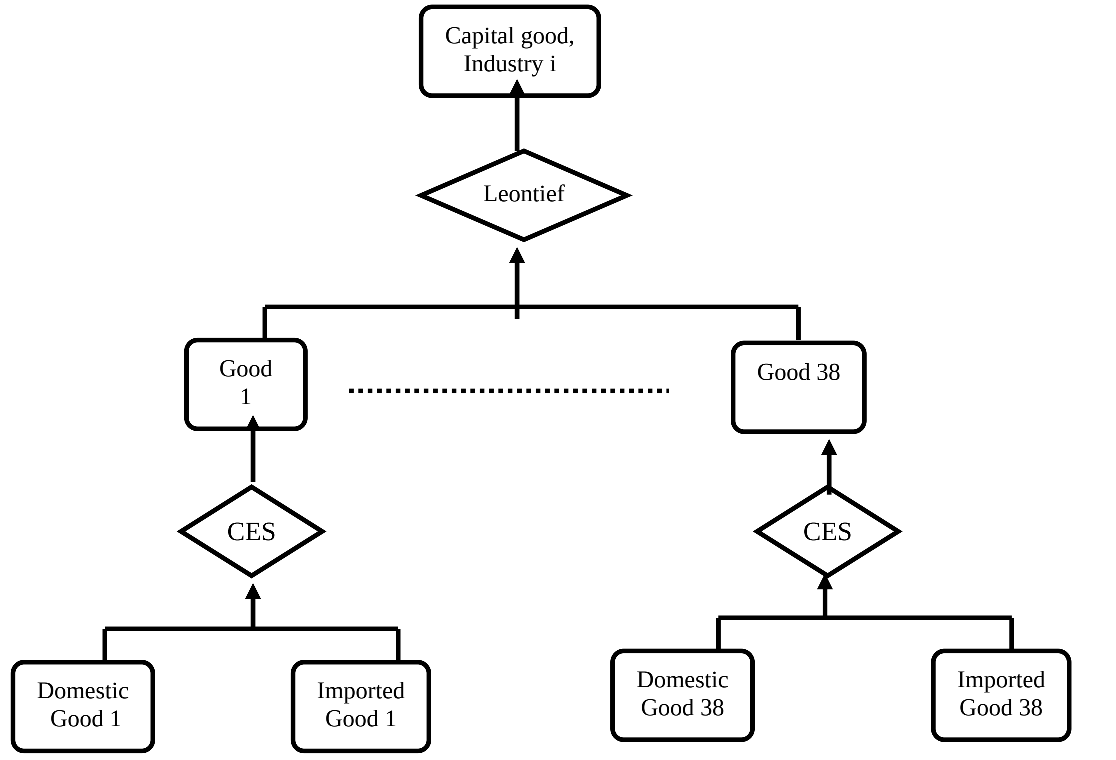


Figure 4.2: Structure of Investment Demand

4.4.3 Household Demands

There are five household groups in the model that can be defined on the basis of geographical area (such as rural, urban and estate) and household income levels (such as low-income and high-income): (1) Urban low-income households; (2) Rural low-income households; (3) Estate low-income households; (4) Urban high-income households; (5) Rural high-income households. Consumers in each household group behave as price takers. A utility maximising model expresses household demands in the model. Here the consumers choose their purchases to maximise their utility using an additive nested utility function subject to an aggregate expenditure constraint. Figure

4.3 shows the nesting structure of household demand. This is similar to the structure of investment demand but instead of the *Leontief* function, adopts the *Klein-Rubin* utility function where each representative household determines the optimal composition of its consumption bundle subject to a budget constraint in order to maximise utility. This would lead to a linear expenditure system (*LES*[4]).

The household demand is given by Excerpt 4.7. Equation $x3\_s(c,h)$ determines total household demand for composite commodities. The *Klein-Rubin* utility function could be used to derive the allocation of household expenditure between commodity composite:

$$UTILITY\ per\ household = \frac{1}{Q_{(h)}}\prod_{c}\left[X3\_S(c,h) - X3SUB(c,h)\right]^{S3LUX(c,h)} \qquad (4.12)$$

where $X3SUB$ and S3LUX are behavioural coefficients. $S3LUX$ must sum to unity and Q is the number of households (block letters are the level versions of the corresponding percentage change variables given in the *TABLO* code). The following demand equations can be derived from this utility function.

$$X3\_S(c,h) = X3SUB(c,h) + S3LUX(c,h) \text{ x } V3LUX/P3\_S(c,h), \qquad (4.13)$$

$$\text{Where, } V3LUX = V3TOT - \sum X3SUB(c,h) \text{ x } P3\_S(c,h), \qquad (4.14)$$

The expenditure on each composite commodity can be given by a linear expenditure system (*LES*), which is a linear function of prices ($P3\_S(c,h)$) and expenditure ($V3TOT$). The form of the demand function leads to the following interpretation. The X3SUB and the $V3LUX$ are considered to be the ‘subsistence’ component – purchased regardless of price – and the ‘luxury’ component or ‘supernumerary’ expenditure respectively.

[4] See Chung (1994) for details.

Luxury expenditure is obtained by subtracting subsistence expenditure from the total household expenditure. *S3LUX(c,h)* is the marginal budget shares of each commodity, which allocates the luxury component among each commodity.

Excerpt 4.7: Household Demands

```
!Commodity composition of household demand !
Equation E_x3sub # Subsistence Demand for composite commodities #
(all,c,COM4)(all,h,HH5)
 x3sub(c,h) = q(h);

Equation E_x3lux # Luxury Demand for composite commodities #
(all,c,COM4)(all,h,HH5)
 x3lux(c,h) + p3_s(c,h) = w3lux(h);

Equation E_x3_s # Total Household demand for composite commodities #
(all,c,COM4)(all,h,HH5)
 x3_s(c,h) = B3LUX(c,h)*x3lux(c,h) + {1 - B3LUX(c,h)}*x3sub(c,h);

Equation E_utility # Change in utility disregarding taste change terms #
(all,h,HH5)
 utility(h) + q(h) = sum{c,COM4, S3LUX(c,h)*x3lux(c,h)};

! Addups of Consumption !

Equation E_x3_h # Total Consumption Demands #
(all,c,COM4)(all,s,SRC)[TINY + V3BAS_H(c,s)]*x3_h(c,s) =
 sum{h,HH5, V3BAS(c,s,h)*x3(c,s,h)};

! Import/domestic composition of household demands !

Equation E_x3 # Source - Specific Commodity Demands #
(all,c,COM4)(all,s,SRC)(all,h,HH5)
x3(c,s,h) = x3_s(c,h) - SIGMA3(c)*{p3(c,s,h) - p3_s(c,h)};

Equation E_p3_s # Effective Price of Commodity Composite #
(all,c,COM4)(all,h,HH5)
 p3_s(c,h) = sum{s,SRC, S3(c,s,h)*{p3(c,s,h)}};
```

Equation *x3sub(c,h)* denotes that the percentage changes in subsistence demands equate with the percentage changes in the number of households (*q*). Equation *x3lux(c,h)* indicates that percentage changes in luxury expenditures on each commodity (*x3lux(c,h)*

+ $p3\_s(c,h))$ would be a function of percentage changes of nominal supernumerary household expenditure ($w3lux(h)$).

Once the households determine the total composite commodities they will choose the sources of commodities to minimise costs based on a *CES* nest. Hence, the bottom level of the nesting structure is specified by *CES* functions, which accommodate the substitution between domestic and foreign sources of consumer goods by each category of households. Equations $x3(c,s,h)$, the source specific commodity demands, are analogous with the equations for intimidate and investment demands. The demand for household commodities from a particular source (domestic or imported) by each industry, $x3(c,s,i)$, depends on the total household demand for composite commodities, $x3\_s(c,i)$, the relative prices of household commodities from different sources and the ability to substitute commodities from different sources ($SIGMA3(c)$, household *Armington* elasticity). Thus, it suggests that for given values of $x3\_s(c,i)$, when the weighted average price of imports and domestic commodities ($p3\_s(c,i)$) become cheaper than the price of domestic commodities, households will reduce their demand for domestic commodities in favour of imported commodities. However, this substitution is controlled by the household *Armington* elasticity.

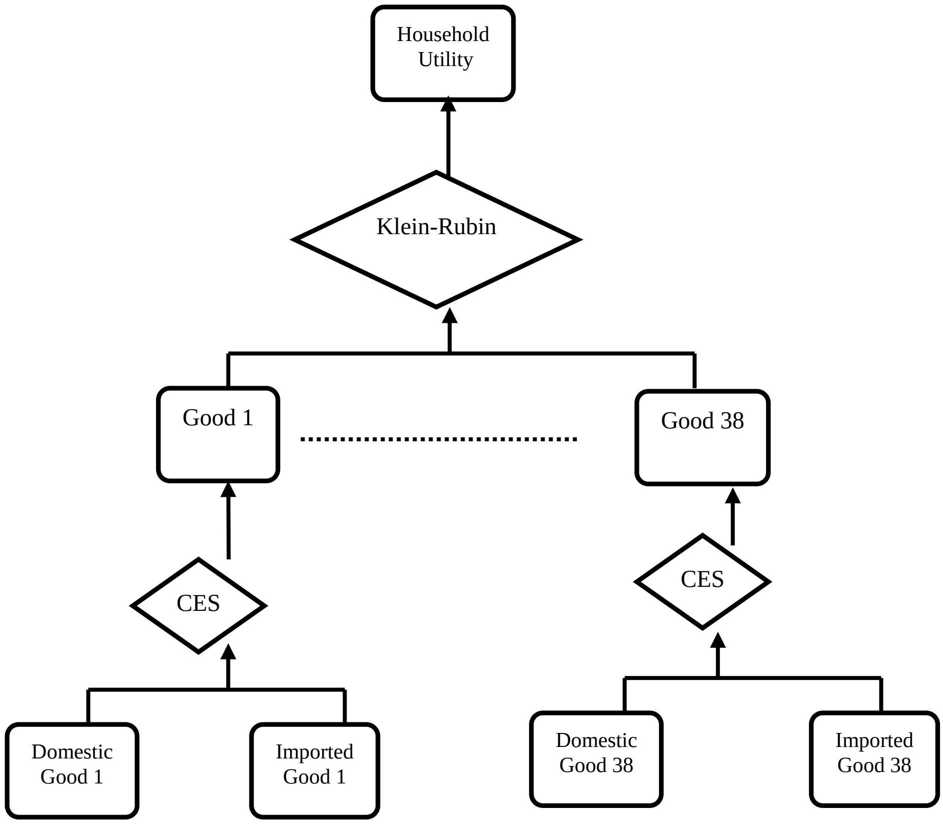


Figure 4.3: Structure of Consumer Demand

4.4.4 Export Demands

Foreign demands for Sri Lankan exports are given by export demand functions. These demand functions are flexible in handling the demand for Sri Lankan exports. In order to model export demands, commodities in *SLGEM–P* are separated into two groups: (1) *individual export commodity* in which export demand is inversely related to that commodity's price (these commodities are identified in the set *TRADEXP* – traditional export commodities); (2) remaining commodities, identified as *collective export commodities* in which export demand is inversely related to the average price of all collective export commodities (these are identified in the set *NTRADEXP* – non-traditional export commodities). The traditional and non-traditional exports industries are listed in Section 4.2.

The foreign demand for traditional export commodities, which is a downward sloping demand function, can be given in the levels form as:

$$X4(c) = F4Q(c)\left[\frac{P4(c)}{PHI \times F4P(c)}\right]^{EXP\_ELAST(c)}, \qquad (4.15)$$

where, $F4Q$ (c) and $F4P$ (c) are horizontal (quantity) and vertical (price) shifters respectively of the demand equation. $EXP\_ELAST(c)$ is the constant commodity specific export demand elasticity – which is a negative parameter. The export volumes, $X4$ (c), are declining functions of their foreign currency prices, ($P4$ (c)/PHI), where PHI is the exchange rate.

The non-traditional export commodities have an exogenous commodity composition by specifying the collective exports as a *Leontief* aggregate. Total demand for non-traditional exports, *E_x4_ntrad*, is given as a function of average price of non-traditional export commodities *via* a constant elasticity demand curve, similar to those for traditional exports. Excerpt 4.8. presents the export demands.

Excerpt 4.8: Export Demands

```
Coefficient (All,c,COM4) EXP_ELAST(c)
 # Export Demand Elasticities: #;
Read EXP_ELAST From File BASEDATA Header "P018";


Equation E_x4_A  # Traditional export demand functions #
(All,c,TRADEXP) x4(c) - f4q(c) = EXP_ELAST(c)*[p4(c) - phi - f4p(c)];

Equation E_x4_B  # Non-Traditional export demand functions #
(All,c,NTRADEXP) x4(c) = x4_ntrad;

Equation E_p4_ntrad  # Average Price of Non-Traditional exports #
    V4NTRADEXP*p4_ntrad = Sum(c,NTRADEXP, V4PUR(c)*p4(c));

Coefficient EXP_ELAST_NT # Non-Traditional Export Demand Elasticity #;
Read EXP_ELAST_NT From File BASEDATA Header "EXNT";

Equation E_x4_ntrad # Demand for Non-Traditional export aggregate #
     x4_ntrad    = EXP_ELAST_NT*[p4_ntrad - phi - f4_ntrad];
```

4.4.5 Government Demands

Excerpt 4.9 describes the government demand. The demand for both imported and domestically produced goods and services by the government is represented by government demand, $x5(c,s)$. The aggregate real government demand is driven by aggregate real household consumption. Government demands by commodities are assumed to move in line with the aggregated real government demand. The model permits to implement exogenous shocks to specific government demand categories *via* shift variables i.e., overall shift term for government demands ($f5tot$), government demand shift ($f5(c,s)$) and $f5tot2$ (ratio between $f5tot$ and $x3tot\_h$ – real household consumption).

Excerpt 4.9: Government Demands

```
! Other final demands !

Equation E_x5 # "Other" demands #
(all,c,COM4)(all,s,SRC) x5(c,s) = f5(c,s) + f5tot;

Equation E_f5tot # Overall "Other" demands shift #
 f5tot = x3tot_h + f5tot2;
```

4.4.6 The Price System and Zero Pure Profits condition

The current model, following the *ORANIG-NM* (*No Margins*) version (Horridge, 2002), assumes that the prices received by producers – the basic value of commodities – can be derived by subtracting sales taxes from the purchaser's price – the prices paid by consumers. Thus, we assume that there are no trade and transport margins in *SLGEM–P* model. This assumption was necessary, as there were no reliable data on margins for the 1995 *I-O* industries. Moreover, this assumption would not restrict our analysis, as we do not intend to carry out any simulation with regard to margins. The price system is defined, based on perfectly competitive markets under constant return to scale production technology, where profits can only be collected by the factors of production. Furthermore, the price system would explain the relationship between sets of domestic prices, together with their relation to the foreign currency prices of imports and exports. In setting out the price system, two main assumptions are made:

(1) the zero pure profit condition – The price system of the Sri Lankan model represents zero pure profit conditions for all economic activities such as current production, capital creation, international trading, etc. This assumption indicates that revenue per unit of output equates cost per unit of output in each activity. Thus there are no pure profits in these activities.

(2) basic prices are identical across users and producing industries with respect to domestic commodities and across importers with respect to imported commodities. The equations of price system and zero pure profits are given in Excerpt 4.10.

Excerpt 4.10: Price System and Zero Pure Profit Conditions

```
Equation E_p1 # purchasers prices - producers #
(All,c,COM4)(All,s,SRC)(All,i,IND4)
{TINY + V1PUR(c,s,i)}*p1(c,s,i) = {V1BAS(c,s,i) + V1TAX(c,s,i)}*{p0(c,s)
 + t1(c,s,i)} ;

Equation E_p2 # purchasers prices - capital creators #
(All,c,COM4)(All,s,SRC)(All,i,IND4)
{TINY + V2PUR(c,s,i)}*p2(c,s,i) = {V2BAS(c,s,i) + V2TAX(c,s,i)}*{p0(c,s)
 + t2(c,s,i)} ;

Equation E_p3 # purchasers prices - households #
(All,c,COM4)(All,s,SRC)(All,h,HH5)
{TINY + V3PUR(c,s,h)}*p3(c,s,h) = {V3BAS(c,s,h) + V3TAX(c,s,h)}*{p0(c,s)
 + t3(c,s)} ;
Equation E_p1tot # Zero pure profits in production #
(all,i,IND4)
 [TINY + V1TOT(i)]*{p1tot(i) - a1tot(i)} = sum{c,COM4, V1PUR_S(c,i)*{p1_s(c,i)}}
 + V1PRIM(i)*{p1prim(i) + a1prim(i)} + V1OCT(i)*{p1oct(i) + a1oct(i)}
 - V1SUB(i)*{p1sub(i) - a1tot(i)} ;

Equation E_p2tot # Zero pure profits in investment #
(all,i,IND4)[TINY + V2TOT(i)]*[p2tot(i) - a2tot(i)] =
 sum{c,COM4, V2PUR_S(c,i)*{p2_s(c,i)}};

Equation E_p4 # Zero pure profits in Exporting #
(all,c,COM4)
{TINY + V4PUR(c)}*p4(c) = {TINY + V4BAS(c) + V4TAX(c)}*{p0(c,"dom") + t4(c)}

Equation E_p5 # Zero pure profits in distribution of other#
(all,c,COM4)(all,s,SRC)
{TINY + V5PUR(c,s)}*p5(c,s) = {V5BAS(c,s) + V5TAX(c,s)}*{p0(c,s) + t5(c,s)}

Equation E_p0_A # Zero pure profits in importing #
(all,c,COM4)
 p0(c,"imp") = pf0cif(c) + phi + t0imp(c);
```

4.4.7 Market-Clearing Equations

The *SLGEM–P* model as other standard economy-wide CGE models assumes that prices adjust in a way that demand equates with supply, which clears all markets. Hence, under this assumption there is no excess supply or demand observed in the model. The market-clearing equations for the domestic goods market guarantee that the total supply of domestic goods equals the total domestic absorption of commodities from domestic sources and exports. A similar set of equations applies for imported commodity markets. The market clearing equation for primary production factors ensures that the supply of primary factors equates the demand. Excerpt 4.11 presents the market clearing conditions.

Excerpt 4.11: Market Clearing Conditions

```
!Market clearing equations!

Equation E_p0_B # Demand equals supply for commodities #
(all,c,COM4)
 {TINY +SALES(c)}*x0dom(c) =
 sum{i,IND4, V1BAS(c,"dom",i)*x1(c,"dom",i) + V2BAS(c,"dom",i)*x2(c,"dom",i)}
 + V3BAS_H(c,"dom")*x3_h(c,"dom") + V4BAS(c)*x4(c) + V5BAS(c,"dom")*x5(c,"dom")
 + 100*P0LEV(c,"dom")*delx6(c,"dom");

Equation E_x0imp # Import volumes #
(all,c,COM4)
 [TINY + V0IMP(c)]*x0imp(c) =
 sum{i,IND4,V1BAS(c,"imp",i)*x1(c,"imp",i) + V2BAS(c,"imp",i)*x2(c,"imp",i)}
 + V3BAS_H(c,"imp")*x3_h(c,"imp") + V5BAS(c,"imp")*x5(c,"imp")
 + 100*P0LEV(c,"imp")*delx6(c,"imp");
```

4.4.8 The Poverty Line

The main objective of developing the *SLGEM–P* is to quantify different policy implications on income distribution in general and on absolute poverty in particular, for Sri Lanka. Hence, in this study, an attempt was made to measure income poverty within five household groups. Excerpt 4.12 presents the *TABLO* code used in incorporating percentage change of the poverty line into the CGE model that would be finally used to calculate the post-shock poverty measures outside the model (i.e., within the income distribution functions).

As the general equilibrium framework permits endogenisation of relative prices, the change in monetary poverty line during a simulation can be endogenised within the CGE model. A recent development introduced by Decaluwe *et al.* (2001) demonstrates that a basket of commodities (volume) which reflect the basic needs of average households can be defined within the CGE model. Moreover, while keeping the volume fixed at the base year level, post shock values of this commodity basket could be obtained by multiplying with respective post simulation prices, which are endogenously determined in the model. Thus, similar to a price index, the percentage change of basic-needs commodity prices at each household group level can be determined. This in turn provides the percentage change in monetary poverty line for different household groups.

Although the current study adopts a variant of the approach described by Decaluwe *et al.* (2001), it keeps the conceptual basis intact. We estimate the base year poverty line per household by multiplying the 1995 basic needs per person monetary poverty line of Rs.791.67/person/month estimated in World Bank (2000) with the 1996/97 average household size of 4.61 found in the CFS (1999). This base year poverty line is denoted by the coefficient *BPOVLINE* in the TABLO Excerpt 4.12. Assuming that the quantity of basic needs commodities consumed by households remains constant during simulations, the new value of poverty line was computed by taking basic needs commodity price changes into account. Hence a price index has been defined which reflects the price changes of commodity groups that encompass the basic needs goods. The set *PCOM* in Excerpt 4.12 depicts the commodities used in computing the change of poverty line.

Thus, in this model, changes of monetary poverty lines of low-income household groups, *pline*(*ph*), have been endogenised. In computing the percentage change in the national monetary poverty line, *pline_ph*, changes of poverty lines of respective low-income groups were taken into account (the set *PHG* in Excerpt 4.12 depicts the household groups used in computing the *pline*(*ph*)). Thus, percentage changes of poverty lines in urban low-income, rural low-income and estate low-income groups were aggregated to obtain the percentage change in the national monetary poverty line.

Excerpt 4.12: Incorporation of a New Poverty Line

```
! Incorporation of a  poverty line!
Set
PCOM # commodities used in computing poverty line#

( Cocgrow, Mexcrop, Tobacco, Othe_agri, Livestock, Firewood, Forestry,
Fishing, Teapro, Milling, Foodbev, Garments, Petroleum, ChmFerti,
Electricity );!pc!

PHG # household groups used in computing poverty line#
 ( ULIHH, RLIHH, EHH);!ph!
Subset PHG is subset of HH5;
Subset PCOM is subset of COM4;
Variable
(all, ph,PHG) pline(ph)# poverty line#;
Equation
E_pline # poverty line  #
(all,ph,PHG) V3TOT(ph)*pline(ph) = sum{pc,PCOM, sum{s,SRC, V3PUR(pc,s,ph)*
 p3(pc,s,ph)}};
Coefficient
V3TOT_ph;
Formula
V3TOT_ph = sum{ph,PHG,V3TOT(ph)};
Variable
pline_ph;
Equation
E_pline_ph #aggregate poverty line#
V3TOT_ph*pline_ph = sum{ph, PHG,V3TOT(ph)*pline(ph)};
Coefficient
BPOVLINE # base year poverty line#;
Read
BPOVLINE from file BASEDATA header "NPOV";
Update
 BPOVLINE =pline_ph;
```

```
! Calculation of income change for poverty measurements!

Set ULN # number of households in ULH# (u1-u151);!u!
 RLN #number of households in RLH# (r1-r984); !r!
 ELN #number of households in ELH# (e1-e89); !e!
 UHN #number of households in UHH# (z1-z90); !z!
 RHN #number of households in RHH# (f1-f165); !f!

Coefficient
(all,u,ULN) ULH(u) # urban low base income#;
(all,r,RLN) RLH (r) # rural low base income #;
(all,e,ELN)ELH(e) # estate low base income#;
(all,z,UHN)UHH (z) #urban high base income#;
(all,f,RHN)RHH (f) # rural high base income#;

Read
 ULH from file BASEDATA header "NULH";
 RLH from file BASEDATA header "NRLH";
 ELH from file BASEDATA header "NELH";
 UHH from file BASEDATA header "NUHH";
 RHH from file BASEDATA header "NRHH";

Update
 (all,u,ULN)ULH(u) = wdispinc ("ULIHH");
(all,r,RLN)RLH(r) = wdispinc ("RLIHH");
(all,e,ELN)ELH(e) = wdispinc ("EHH");
(all,z,UHN)UHH(z) = wdispinc ("UHIHH");
(all,f,RHN)RHH(f) = wdispinc ("RHIHH");
```

Moreover, the calculation of percentage changes in the average income of different household groups was also carried out within the model, which are subsequently used in estimating poverty and inequality estimates outside the CGE model (i.e., within the income distribution functions). The percentage change in nominal post tax income of different household groups, *wdispinc*(*h*), is used in calculating the percentage change in average income of respective household groups. The CGE model and the income distribution functions are linked in “top down” fashion to calculate the changes in poverty and inequality that would arise from trade policy shocks.

A detailed discussion of empirical estimation of base year income distribution functional forms for different household groups, estimation of base year absolute poverty and inequality measurements and the mechanism involved in linking the CGE model and the income distribution functions will be presented in Chapter 5.

4.4.9 Income Distribution

This section explains how the main features of income distribution are incorporated in the model. Income distribution aspects have been added into the model by defining a set of variables and coefficients that link *SLGEM–P* with the SAM database developed for Sri Lanka for the base year 1995. A detailed description of the Sri Lankan SAM database is given in Chapter 6. The model contains four groups, which receive income, i.e., household groups, firms, government and the rest of the world.

There are five household groups defined based on the geographical location and the income level. These households provide different types of labour (as described in Section 4.4.3) to different industries as specified in the model. Excerpt 4.13 presents the model equations related to income distribution. The labour income to households, *w1labinc*(*o,h*), is given as a function of population growth (*q*(*h*)), total wage bill (*w1lab_i*(*o*)) and employment rate (*labslack*(*o*)). Moreover, households receive income from government in the form of transfer payments, *wgovhou*(*h*). In particular, rural low-income households receive the welfare payment, known as *Samurdi* payment, that is especially targeted towards very low-income households, as a means of alleviating poverty. The government transfer payments to households are set to move according to the government income, *wincgov*. They also receive gross operating surplus generated by different industries as a share of profit income. Gross operating surplus to households, *wgoshou*(*h*), is set to move according to total post-tax gross operating surplus, *wgos_posttax*. In addition, households receive income in the form of private transfers from rest of the world, *wrowhou*(*h*). A substantial amount of *wrowhou*(*h*) is generating from the Sri Lankan migrant labour population located in the middle eastern countries. The rest of the world transfer payments are set to move according to nominal

GDP from expenditure side, *w0gdpexp.* Finally, the households are allowed to generate income from inter-household transfers, *whouhou*. These income components would makeup the pre-tax total household income, *whousinc* (*h*). The proportion of income received by each household group will be estimated using the SAM database for the Sri Lankan economy. The post-tax household income, *wdispinc* (*h*), can be derived by subtracting income taxes and other transfers paid to government by households, *whougov* (*h*), from the *whousinc* (*h*).

Excerpt 4.13: The Model Equations Related to Income Distribution

```
!Income distribution!
Equation E_x1lab_i # Total Demand for labour of each skill/source #
(all,o,OCC8)
[TINY+V1LAB_I(o)]*x1lab_i(o) = sum{i,IND4,V1LAB(i,o)*x1lab(i,o)};
Equation E_wgovgos # interest on public debt # wgovgos = w0gdpexp;
Equation E_wrowgos # GOS from ROW # wrowgos = w0gdpexp;
Equation E_wgos # GOS from income side #
VGOS*wgos = V1CAP_I*w1cap_i + V1LND_I*w1lnd_i
 + V1OCT_I*w1oct_i + VROWGOS*wrowgos + VGOVGOS*wgovgos;
Equation E_wgos_posttax # VGOS less VGOSTAX #
VGOS_POSTTAX*wgos_posttax = VGOS*wgos - VGOSTAX*wgostax;
Equation E_wgostax # corporation tax # wgostax = fgostax + wgos;
Equation E_wgosgov # GOS to gov # wgosgov = wgos_posttax;
Equation E_wgosrow # GOS to ROW # wgosrow = wgos_posttax;
Equation E_wgoshou # GOS to households #
(all,h,HH5) wgoshou(h) = wgos_posttax;
Equation E_wgossav # find VGOSSAV as residual #
VGOS*wgos = sum{h,HH5, VGOSHOU(h)*wgoshou(h)} +
 VGOSGOV*wgosgov + VGOSTAX*wgostax + VGOSROW*wgosrow + VGOSSAV*wgossav;
Equation E_wgoshou_h # total GOS to households #
VGOSHOU_H*wgoshou_h = sum{h,HH5, VGOSHOU(h)*wgoshou(h)};
Equation E_w1lab_i # all-industry labour bills #
(all,o,OCC8) [TINY+V1LAB_I(o)]*w1lab_i(o) =
 sum{i,IND4, V1LAB(i,o)*{p1lab(i,o)+x1lab(i,o)}};
Equation E_w1labinc # labour income to households #
(all,o,OCC8)(all,h,HH5)
w1labinc(o,h) = q(h) + w1lab_i(o) + labslack(o);
Equation E_wlabrow # wages to ROW #
 (all,o,OCC8) wlabrow(o) = w1lab_i(o);
Equation E_wlabrow_o # wages to ROW #
 VLABROW_O*wlabrow_o = sum{o,OCC8, VLABROW(o)*wlabrow(o)};
Equation E_labslack # adding up constraint #
(all,o,OCC8)[TINY+V1LAB_I(o)]*w1lab_i(o) = VLABROW(o)*wlabrow(o)
 + sum{h,HH5, V1LABINC(o,h)*w1labinc(o,h)};
Equation E_q # rule of population growth #
(all,h,HH5) q(h) = q_h;
Equation E_w1labinc_o # total labour income to households #
(all,h,HH5)
[TINY+V1LABINC_O(h)]*w1labinc_o(h) =
 sum{o,OCC8, V1LABINC(o,h)*w1labinc(o,h)};
```

```
Equation E_wincgov # government income #
VINCGOV*wincgov = V0TAX_CSI*w0tax_csi + VGOSGOV*wgosgov + VGOSTAX*wgostax
- V1SUB_I*w1sub_i
 + sum{h,HH5, VHOUGOV(h)*whougov(h)} + VROWGOV*wrowgov;
Equation E_whousinc # pre-tax household income #
(all,h,HH5)
VHOUSINC(h)*whousinc(h) = VGOSHOU(h)*wgoshou(h)
 + V1LABINC_O(h)*w1labinc_o(h)
 + sum{hfrom,HH5, VHOUHOU(h,hfrom)*whouhou(h,hfrom)}
 + VGOVHOU(h)*wgovhou(h) + VROWHOU(h)*wrowhou(h);

Equation E_whousinc_h # total pre-tax household income #
sum{h,HH5, VHOUSINC(h)*{whousinc(h) - whousinc_h}} = 0;
Equation E_wgovhou # gov transfers to households #
(all,h,HH5) wgovhou(h) = wincgov;
Equation E_wrowhou # ROW transfers to households #
(all,h,HH5) wrowhou(h) = w0gdpexp;
Equation E_whouhou # inter-household transfers #
(all,hto,HH5)(all,hfrom,HH5)
 whouhou(hto,hfrom) = wdispinc(hfrom);
Equation E_wdispinc # post-tax household income #
(all,h,HH5) VDISPINC(h)*wdispinc(h) =
 VHOUSINC(h)*whousinc(h) - VHOUGOV(h)*whougov(h);
Equation E_wdispinc_h # total post-tax h'hold income #
sum{h,HH5, VDISPINC(h)*{wdispinc(h) - wdispinc_h}} = 0;
Equation E_avetax_h # average tax factor #
 wdispinc_h = whousinc_h + avetax_h;
Equation E_whougov # households to gov: income taxes and transfers #
(all,h,HH5) whougov(h) = whousinc(h)
 + f_inctaxrate(h) + f_inctaxrate_h;
Equation E_f_gosinctax # fgostax - f_inctaxrate_h #
 f_gosinctax = fgostax - f_inctaxrate_h;
Equation E_whourow # household transfers to ROW #
(all,h,HH5) whourow(h) = wdispinc(h);
Equation E_whousav # household saving #
(all,h,HH5) VHOUSAV(h)*whousav(h) =
 VHOUSINC(h)*whousinc(h) - V3TOT(h)*w3tot(h)
 -sum{hto,HH5, VHOUHOU(hto,h)*whouhou(hto,h) }
 - VHOUGOV(h)*whougov(h) - VHOUROW(h)*whourow(h);
Equation E_wrowgov # transfers from ROW to gov #
 wrowgov = w0gdpexp;
Equation E_wgovcur # current gov expenditure #
VGOVCUR*wgovcur = V5TOT*w5tot + VGOVGOS*wgovgos + VGOVROW*wgovrow
+ sum{h,HH5, VGOVHOU(h)*wgovhou(h)};
Equation E_wgovrow # GOV transfers to ROW #
wgovrow = w0gdpexp;
Equation E_wgovcap # investment gov expenditure #
VGOVCAP*wgovcap =
 sum{i,IND4, GOVSHRINV(i)*V2TOT(i)*{s2gov(i) + p2tot(i) + x2tot(i)} };
Equation E_wGOVEXP # total gov expenditure #
VGOVEXP*wgovexp = VGOVCUR*wgovcur + VGOVCAP*wgovcap;
Equation E_wgovsav # gov (income - expenditure) #
 VGOVSAV*wgovsav = VINCGOV*wincgov - VGOVEXP*wgovexp;
Equation E_delsgovsav # gov (income - expenditure)/GDP #
 100*V0GDPEXP*delsgovsav = VGOVSAV*wgovsav - V0GDPEXP*w0gdpexp;
```

```
Equation E_realgovsav # real gov (income - expenditure)#
 realgovsav = wgovsav - p0gdpexp;
Equation E_wprivcap # investment private expenditure #
 VPRIVCAP*wprivcap = V2TOT_I*w2tot_i - VGOVCAP*wgovcap
 + V6TOT*w6tot;
Equation E_wrowexp # total ROW expenditure #
VROWEXP*wrowexp = V4TOT*w4tot + VROWGOV*wrowgov + VROWGOS*wrowgos
 + sum{h,HH5, VROWHOU(h)*wrowhou(h)};
Equation E_wincrow # total ROW income #
VINCROW*wincrow = sum{h,HH5, VHOUROW(h)*whourow(h)}
+ VGOVROW*wgovrow + V0CIF_C*w0cif_c + VGOSROW*wgosrow + VLABROW_O*wlabrow_o;
Equation E_wrowsav # ROW (income - expenditure) #
 VROWSAV*wrowsav = VINCROW*wincrow - VROWEXP*wrowexp;


Equation E_wsamcheck # Global (income - expenditure) #
V0GDPEXP*wsamcheck = sum{h,HH5, VHOUSAV(h)*whousav(h)}
+ VGOSSAV*wgossav + VGOVSAV*wgovsav - VPRIVCAP*wprivcap + VROWSAV*wrowsav;
! household consumption function !
Equation
E_f3tot # consumption function #
(All,h,HH5)
 w3tot(h) = f3tot(h) + f3tot_h + wdispinc(h);
```

The structure of expenditure of different household groups can be traced by looking at the outgoing expenditure of the households. There are three main components of household expenditure: (1) the household consumption expenditure, *w3tot* (*h*), is the major expenditure component of households, which can be specified with the help of a consumption function, where *w3tot* (*h*) is allowed to vary based on post-tax household income and two consumption shifters, *f3tot*(*h*) and *f3tot_h*.;(2) The household transfers to rest of the world, *whourow* (*h*), which is set to vary according to the post-tax household income, *wdispinc* (*h*); (3) The household transfer payments to other households – inter-household transfers, *whouhou* (*hto,h*). Finally, the household savings, *whousav* (*h*), can be derived as a residual.

The gross operating surplus from the income side, *wgos*, can be obtained by adding aggregate payments to capital (*w1cap_i*), aggregate payments to land (*w1lnd_i*), aggregate other cost ticket payments (*w1oct_i*), transfers coming from rest of the world (*wrowgos*) and interest on public debt coming from the government (*wgovgos*).

Moreover, *wgovgos* and *wrowgos* are set to move with the nominal GDP from the expenditure side (*w0gdpexp*). The post-tax gross operating surplus income, *wgos_posttax*, can be derived by subtracting corporation taxes, *wgostax*, from gross operating surplus from income side, *wgos*.

Gross operating surplus, in turn, is distributed among different economic agents within the economy. For instance, as described earlier, households receive a gross operating surplus, *wgoshou*(*h*), which is allowed to vary according to post-tax gross operating surplus income, *wgos_posttax*. Similarly, government receives a gross operating surplus as the corporation tax, *wgostax,* and other income and transfers to government, *wgosgov*, while the rest of the world receive a gross operating surplus, *wgosrow*, which is also allowed to fluctuate according to post-tax gross operating surplus income, *wgos_posttax.* Finally, the retained earnings, *wgossav*, can be derived as a residual.

The government income, *wincgov*, can be derived by subtracting *w1sub_I*, aggregate subsidy payments, from the total government income – calculated as an aggregation of aaggregate revenue from all indirect taxes (*w0tax_csi*), gross operating income and transfers coming to government (*wgosgov*), corporation tax (*wgostax*), transfers from rest of the world to government (*wrowgov*) and total income tax and household transfers to government (*whougov*).

The total Government expenditure, *wgovexp*, can be divided into two components: current government expenditure (*wgovcur*) and government investment expenditure (*wgovcap*). The current government expenditure is specified as an aggregation of an aggregate nominal value of government demands (*w5tot*), interest on public debt (*wgovgos*), government transfers to rest of the world (*wgovrow*) and total government transfers to households (*wgovhou*). The investment government expenditure is specified as a function of exogenously given government share of investment by industry (*s2gov*(*i*)), cost of units of capital (*p2tot*(*i*)) and investment by using industry (*x2tot*(*i*)). The government savings, *wgovsav*, therefore, can be derived by the difference between government income (*wincgov*) and the expenditure (*wgovexp*). Finally, real government savings, *realgovsav*, is obtained by deflating government savings by expenditure side GDP price index, *p0gdpexp*.

Rest of the world income, *wincrow*, is given as an aggregation of total household transfers (*whourow*), government transfers (*wgovrow*), gross operating surplus income (*wgosro)* to rest of the world, *CIF* value of imports (*w0cif_c*) and wages paid to rest of the world (*wlabrow_o*), whereas rest of the world expenditure, *wrowexp*, can be given as an aggregation of border price of exports (*w4tot*), *wrowgov*, *wrowgos* and total *wrowhou*. Finally, rest of the world savings, *wrowsav*, can be obtained by the difference between *wincrow* and *wrowexp*.

4.4.10 Other Equations

In this section, we present the rest of *SLGEM–P* equations that are not described in previous sections. Some of these equations are used to determine the income and expenditure side of GDP; consumer price index; equations related to tax rate; trade balance and other aggregates; investment equations; indexing equations; results decomposition equations such as fan decomposition which explains the local market effects, export effects and domestic share effects of output change and rule for stocks. The Excerpt 4.14 presents these other equations. Since these equations are not significantly different from standard Australian *ORANI* family CGE models,[5] detailed description of these equations are not given in this chapter.

[5] For detailed description of other equations see Dixon, *et al.* (1982); Horridge (2001)

Excerpt 4.14: Other Equations

```
!Tax rate equations !
Equation
E_t1 # power of tax on sales to intermediate #
(All,c,COM4)(All,s,SRC)(All,i,IND4) t1(c,s,i) = f0tax_s(c) + f1tax_csi;
E_t2 # power of tax on sales to investment #
(All,c,COM4)(All,s,SRC)(All,i,IND4) t2(c,s,i) = f0tax_s(c) + f2tax_csi;
E_t3 # power of tax on sales to households #
(All,c,COM4)(All,s,SRC) t3(c,s) = f0tax_s(c) + f3tax_cs;
E_t4 # power of tax on sales to exports #
(All,c,COM4) t4(c) + f4t(c) = f0tax_s(c) + f4tax;
E_t5 # power of tax on sales to other #
(All,c,COM4)(All,s,SRC) t5(c,s) = f0tax_s(c) + f5tax_cs;
! Indirect tax revenue !
Equation
E_w1tax_csi # revenue from indirect taxes on flows to intermediate #
 {TINY + V1TAX_CSI}*w1tax_csi = Sum(c,COM4, Sum(s,SRC, Sum(i,IND4,
 V1TAX(c,s,i)*{p0(c,s) + x1(c,s,i)}
 + {V1TAX(c,s,i) + V1BAS(c,s,i)}*t1(c,s,i))));

E_w2tax_csi # revenue from indirect taxes on flows to investment #
 (TINY + V2TAX_CSI)*w2tax_csi = Sum(c,COM4, Sum(s,SRC,Sum(i,IND4,
V2TAX(c,s,i)*{p0(c,s) + x2(c,s,i)} + {V2TAX(c,s,i) + V2BAS(c,s,i)}*t2(c,s,i))));

E_w3tax_csh # revenue from indirect taxes on flows to households #
 (TINY + V3TAX_CSH)*w3tax_csh = Sum(c,COM4, Sum(s,SRC,Sum(h,HH5,
 V3TAX(c,s,h)*{p0(c,s) + x3(c,s,h)} + (V3TAX(c,s,h) + V3BAS(c,s,h))*t3(c,s))));

E_w4tax_c # revenue from indirect taxes on exports #
 (TINY + V4TAX_C)*w4tax_c = Sum(c,COM4,
 V4TAX(c)*{p0(c,"dom") + x4(c)} + (V4TAX(c) + V4BAS(c))*t4(c));

E_w5tax_cs # revenue from indirect taxes on flows to "Other" #
 (TINY + V5TAX_CS)*w5tax_cs = Sum(c,COM4, Sum(s,SRC,
 V5TAX(c,s)*{p0(c,s) + x5(c,s)} + (V5TAX(c,s) + V5BAS(c,s))*t5(c,s)));

Equation
E_w0tar_c # tariff revenue #
 (TINY + V0TAR_C)*w0tar_c = Sum(c,COM4,
 V0TAR(c)*{pf0cif(c) + phi + x0imp(c)} + V0IMP(c)*t0imp(c));
! Factor incomes and GDP from income side !
Equation
E_w1lnd_i # aggregate payments to land #
 {TINY + V1LND_I}*w1lnd_i = Sum(i,IND4,V1LND(i)*{x1lnd(i) + p1lnd(i)});
E_w1lab_io # aggregate payments to labour #
 V1LAB_IO*w1lab_io =Sum(i,IND4,Sum(o,OCC8,V1LAB(i,o)*{x1lab(i,o)
+ p1lab(i,o)}));
E_w1cap_i # aggregate payments to capital #
 V1CAP_I*w1cap_i = Sum(i,IND4,V1CAP(i)*{x1cap(i) + p1cap(i)});
E_w1oct_i # aggregate other cost ticket payments #
 {TINY + V1OCT_I}*w1oct_i = Sum(i,IND4,V1OCT(i)*{x1oct(i) + p1oct(i)});
E_w1sub_i # aggregate subsidies #
 {TINY + V1SUB_I}*w1sub_i = Sum(i,IND4,V1SUB(i)*{x1sub(i) + p1sub(i)});
E_w0tax_csi # aggregate value of indirect taxes #
 V0TAX_CSI*w0tax_csi = V1TAX_CSI*w1tax_csi + V2TAX_CSI*w2tax_csi
+ V3TAX_CSH*w3tax_csh + V4TAX_C*w4tax_c + V5TAX_CS*w5tax_cs + V0TAR_C*w0tar_c;
E_w1prim_i # aggregate factor payments #
 V1PRIM_I*w1prim_i =V1LND_I*w1lnd_i +V1CAP_I*w1cap_i + V1LAB_IO*w1lab_io;
```

```
E_w0gdpinc # aggregate nominal GDP from income side #
 V0GDPINC*w0gdpinc =V1LND_I*w1lnd_i +V1CAP_I*w1cap_i + V1LAB_IO*w1lab_io
 + V1OCT_I*w1oct_i - V1SUB_I*w1sub_i + V0TAX_CSI*w0tax_csi;

! GDP expenditure aggregates !
E_x2tot_i # total real investment #
 V2TOT_I*x2tot_i = Sum(i,IND4,V2TOT(i)*x2tot(i));
E_p2tot_i # investment price index #
 V2TOT_I*p2tot_i = Sum(i,IND4,V2TOT(i)*p2tot(i));
E_w2tot_i # total nominal investment #
 w2tot_i = x2tot_i + p2tot_i;
E_x3tot # real consumption #
(All,h,HH5) V3TOT(h)*x3tot(h) = Sum(c,COM4, Sum(s,SRC, V3PUR(c,s,h)*x3(c,s,h)));
E_p3tot # consumer price index #
(All,h,HH5) V3TOT(h)*p3tot(h) = Sum(c,COM4, Sum(s,SRC, V3PUR(c,s,h)*p3(c,s,h)));
E_w3tot # household budget constraint #
(All,h,HH5) w3tot(h) = x3tot(h) + p3tot(h);
E_x3tot_h # real consumption #
 V3TOT_H*x3tot_h = Sum(h,HH5, V3TOT(h)*x3tot(h));
E_p3tot_h # consumer price index #
 V3TOT_H*p3tot_h = Sum(h,HH5, V3TOT(h)*p3tot(h));
E_w3tot_h # nominal consumption #
 w3tot_h = x3tot_h + p3tot_h;
E_x4tot # export volume index #
 V4TOT*x4tot = Sum(c,COM4,V4PUR(c)*x4(c));
E_p4tot # exports price index, Rand #
 V4TOT*p4tot = Sum(c,COM4,V4PUR(c)*p4(c));
E_w4tot # Rand Border value of exports #
 w4tot = x4tot + p4tot;
E_x5tot # aggregate real "Other" demands #
 V5TOT*x5tot = Sum(c,COM4,Sum(s,SRC,V5PUR(c,s)*x5(c,s)));
E_p5tot # 'other' demands price index #
 V5TOT*p5tot = Sum(c,COM4,Sum(s,SRC,V5PUR(c,s)*p5(c,s)));
E_w5tot # aggregate nominal value of "Other" demands #
 w5tot = x5tot + p5tot;
variable (change) delx6tot # inventories volume change: base period prices #;
 equation
E_delx6tot # inventories volume change: base period prices #
 delx6tot = Sum(c,COM4,Sum(s,SRC,delx6(c,s)));

Variable (change) delw6tot # inventories value #;
Equation
E_delw6tot # inventories volume index: base period prices #
 100*delw6tot = 100*Sum(c,COM4,Sum(s,SRC,P0LEV(c,s)*delx6(c,s)))
 + Sum(c,COM4,Sum(s,SRC,V6BAS(c,s)*p0(c,s)));
E_x6tot # inventories volume index: base period prices #
 V6TOT*x6tot = 100*Sum(c,COM4,Sum(s,SRC,P0LEV(c,s)*delx6(c,s)));
E_p6tot # inventories price index #
 V6TOT*p6tot = Sum(c,COM4,Sum(s,SRC,V6BAS(c,s)*p0(c,s)));
E_w6tot # aggregate nominal value of inventories #
 w6tot = x6tot + p6tot;

Equation
E_delStokShr # V6TOT/GDP #
 100*V0GDPEXP*delStokShr = V6TOT*{w6tot - w0gdpexp};
E_x0cif_c # CIF Import volume index, CIF weights #
```

```
 V0CIF_C*x0cif_c = Sum(c,COM4,V0CIF(c)*x0imp(c));
E_p0cif_c # Rand CIF imports price index #
 V0CIF_C*p0cif_c = Sum(c,COM4,V0CIF(c)*{phi + pf0cif(c)});
E_w0cif_c # Rand CIF value of imports #
 w0cif_c = x0cif_c + p0cif_c;
E_x0gdpexp # real GDP,expenditure side #
 V0GDPEXP*x0gdpexp = V3TOT_H*x3tot_h + V2TOT_I*x2tot_i + V5TOT*x5tot
 + 100*delx6tot + V4TOT*x4tot - V0CIF_C*x0cif_c;
E_w0gdpexp # nominal GDP from expenditure side #
 V0GDPEXP*w0gdpexp = V3TOT_H*w3tot_h + V2TOT_I*w2tot_i + V5TOT*w5tot
 + 100*delw6tot + V4TOT*w4tot - V0CIF_C*w0cif_c;
E_p0gdpexp # price index for GDP,expenditure side #
 p0gdpexp = w0gdpexp - x0gdpexp;

! Trade balance and other aggregates !
Equation
E_delB # (balance of trade)/GDP #
 100*V0GDPEXP*delB = V4TOT*w4tot - V0CIF_C*w0cif_c - (V4TOT - V0CIF_C)*w0gdpexp;

Equation
E_x0imp_c # import volume index, duty paid weights #
 V0IMP_C*x0imp_c = Sum(c,COM4,V0IMP(c)*x0imp(c));
E_p0imp_c # duty paid imports price index #
 V0IMP_C*p0imp_c = Sum(c,COM4,V0IMP(c)*p0(c,"imp"));
E_w0imp_c # value of imports (duty paid) #
 w0imp_c = x0imp_c + p0imp_c;

Equation
E_x1prim_i # aggregate output: value - added weights #
 V1PRIM_I*x1prim_i = Sum(i,IND4,V1PRIM(i)*x1tot(i));
E_x1cap_i # aggregate usage of capital,rental weights #
 V1CAP_I*x1cap_i = Sum(i,IND4,V1CAP(i)*x1cap(i));
E_p1cap_i # average capital rental #
 V1CAP_I*p1cap_i = Sum(i,IND4,V1CAP(i)*p1cap(i));
E_employ_io # aggregate employment,wage bill weights #
 V1LAB_IO*employ_io = Sum(i,IND4,V1LAB_O(i)*employ_o(i));
E_person_io # aggregate employment,persons weights #
 0 = Sum(i,IND4, Sum(o,OCC8, person_io - PERSON(i,o)*x1lab(i,o)));
E_p1prim_i # primary factor cost deflator #
 p1prim_i = w1prim_i - x1prim_i;
E_p0toft # terms of trade #
 p0toft = p4tot - p0cif_c;

E_p0realdev # real devaluation #
 p0realdev = p0cif_c - p0gdpexp;

E_avewage # average money wage (pre - tax) #
 Sum(i,IND4, Sum(o,OCC8, V1LAB(i,o)*{avewage - p1lab(i,o)})) = 0;

E_avewager # average real wage (pre - tax) #
 avewager = avewage - p3tot_h;


 !Investment equations!
Equation E_r1cap # definition of rates of return to capital #
(All,i,IND4) r1cap(i) = 2.0*(p1cap(i) - p2tot(i));
Equation E_finvDPSV # investment rule #
(All,i,IND4)
x2tot(i) - x1cap(i) = finvDPSV(i) + 0.33*{r1cap(i) - omega};
```

```
! Indexing equations !
Equation E_p1lab # flexible setting of money wages #
(All,i,IND4)(All,o,OCC8) p1lab(i,o) =
p3tot_h + f1lab_io + f1lab_o(i) + f1lab_i(o) + f1lab(i,o);

Equation E_p1oct # Indexing of prices of "Other Cost" tickets #
(All,i,IND4) p1oct(i) = p0gdpexp + f1oct(i); ! assumes full indexation !

Equation E_p1sub # Setting of subsidy rates #
(All,i,IND4) p1sub(i) = p1tot(i) + f1sub(i); ! ad valorem on output cost !

! Fan's decomposition !
Equation E_fanloc # growth in local market effect #
(all,c,COM4)SALES(c)*fanloc(c) = DOMSALES(c)*x0dom(c) + V0IMP(c)*x0imp(c);

Equation E_fanimp # import leakage effect - via residual #
(all,c,COM4)x0dom(c) = fanloc(c) + fanimp(c) + fanexp(c);

Equation E_fanexp # export effect #
(all,c,COM4)SALES(c)*fanexp(c) = V4BAS(c)*x4(c);
! rule for stocks !
Equation E_delx6 # rule for stocks #
(All,c,COM4)(All,s,SRC)
100.0*P0LEV(c,s)*delx6(c,s) = STOKRAT(c)*{
 ISDOM(s)*{V6BAS(c,s)*x0dom(c) + Sales(c)*delfstock}
 + {1.0 - ISDOM(s)}*{V6BAS(c,s)*x0imp(c) + V0IMP(c)*delfstock}} + f6(c,s);
```

4.5 SELECTION OF EXOGENOUS VARIABLES AND MODEL CLOSURE

Similar to any other CGE model, the number of variables exceeds the number of equations in this model. In order to solve the model some variables need to be declared as exogenous. In CGE modelling literature, the classification of variables into exogenous and endogenous variables is known as the “closure” or “economic environment”. This section defines a standard short-run and long run macro closures used in policy simulation with this model. Model closure has fundamental implications for the simulation results. Hence the choice of exogenous variables for the model closure depends on the nature of the problem that is investigated by the model user. In the present study, simulation experiments are carried out to identify the short run and long run impact of tariff cuts on macro variables, industry level variables and the household level absolute and relative poverty. Similarly, the study sought to ascertain the differential impacts of tariff cuts in manufacturing industries, agricultural industries and the across the board case.

These experiments are carried out within two different macro closures or environments, representing the short run and long run effects. In brief, under the short run closure we assume a slack labour market within a fixed capital stock while under the long run closure we allow capital stock to vary under full employment. Details of the model closures adopted in the policy simulations will be discussed in Chapter 7.

The *SLGEM–P* model was solved using the *GEMPACK* software suite (Harrison & Pearson, 1998) similar to any CGE model of the *ORANI* family. Hence, the next section will briefly discuss the procedure involved in solving the model and subsequently carrying out a systematic sensitivity analysis to check the robustness of results under varying parameter values.

4.6 SOLUTION METHODS AND THE USE OF GEMPACK

To solve the model, The General Equilibrium Modelling Package (*GEMPACK*)[6] (Harrison & Pearson, 1998) developed at the Centre of Policy Studies of Monash University was used. This is a general purpose modelling software system that could be used in policy simulations in general equilibrium and partial equilibrium models. The simulations were carried out using the *WINGEM* version 2.61 and *RUNGEM* version 2.5 August (2002) in *GEMPACK* version 7. The simulation procedure using the *WINGEM* program is illustrated in Figure 4.4.

[6] GEMPACK (including major program components) is fully explained and documented in a comprehensive set of user manuals [see Harrison and Pearson (1994a and 1994b)]. See Pearson, (1988); Codsi and Pearson, (1988); and Harrison and Pearson, (1996) for further information on GEMPACK software and computing solutions.

In *GEMPACK*, model details are written in a *TABLO* input file. Excerpts presented in the previous sections are from this TABLO input file. Generally in large models, the *TABLO* input file cannot be run directly using the *TABLO* program. Therefore, the size of the model has to be reduced through condensation.[7] The information on condensation is given to the program using a stored-input file (*STI* file). The model simulation procedure can be listed as follows.

Firstly, we create the respective *FORTRAN* program (*FOR* file) by running the *TABLO* program. Secondly, using this *FOR* file we run the *COMPILE & LINK* program to create the executable image of the *TABLO* generated executable file in extension *EXE*. Thirdly, this *EXE* file is used to solve the model by running *RUN TG PROGRAME* with the respective command file (*CMF* file), which specifies the model closure, database, solution method and shocks. Finally, the solutions can be viewed using either the *GEMPIE* program or the *VIEW SOL* program.

The files in the *SLGEM–P* have been denoted as *SL.TABLO*, *SL.STI*, *SL.FOR*, *SL.EXE* and *SL.CMF* in the illustration. The simulations are experimented using two methods: (1) running the executable image file using the *SL.CMF* command file (as illustrated in Figure 4.4); and (2) using executable image file and the model data files (*SL.MDF*) and specifying the closures, solution methods and the shocks in the *RUNGEM* program (as illustrated in Figure 4.5). A Systematic Sensitivity Analysis (*SSA*) was also carried out using the *RUNGEM* program.

[7] For details on model condensation, see Dixon *et al*. (1982), Harrison and Pearson (1994a) and Harrison and Pearson (1996).

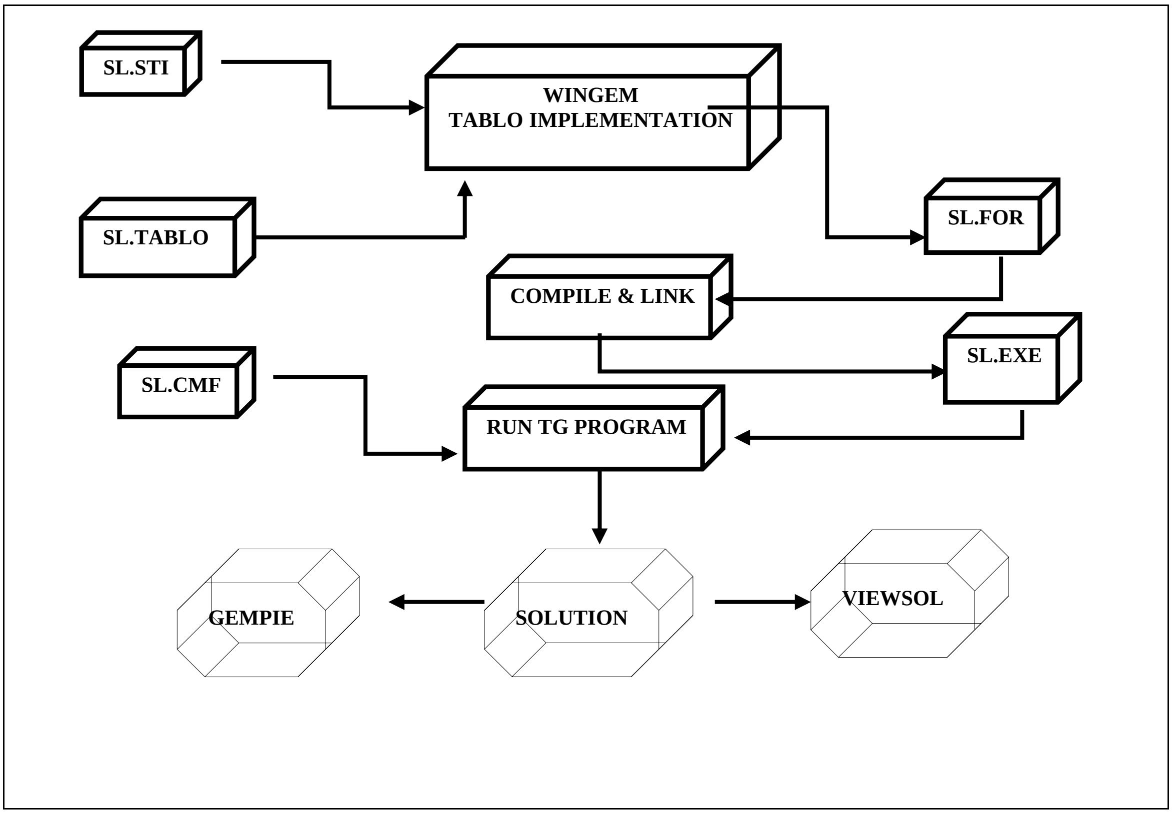


Figure 4.4: Simulation Procedure using WINGEM Program of GEMPACK

Many of the *SLGEM–P* equations are in non-linear form. However, using the Johansen linearisation approach (Johansen, 1960), one could generate a model solution by representing those equations as a set of linear equations involving percentage changes or changes in the logarithms in model variables. Generally, the Johansen one-step simulation experiments in comparative static CGE analysis would lead to linearisation errors (see Harris,1988), particularly, this would give rise to a linearisation error when dealing with relatively large changes of model variables. Hence, under such instances, the model may generate inaccurate projections.[8] This could be minimised by solving the model using a multistep solution process – a solution is obtained by dividing the solution process into sufficiently many steps and moving from one solution to another

[8] For detailed explanation on Johansen procedure and the associated linearization errors, see Dixon *et al*. (1992) and Horridge, *et al.* (1993).

using differential equations. The *SLGEM–P* is therefore solved using a multistep procedure known as *Gragg 2-4-6.*[9] In this procedure, after dividing all the shocks into two equal instalments, we use *Gragg 2-4-6* multistep procedure to generate the outcome for the first instalments, then repeat it with the updated database, which can be used to compute the effects of the second instalment using the *Gragg 2-4-6* method. By compounding the change results of both computations we derive the total results.[10]

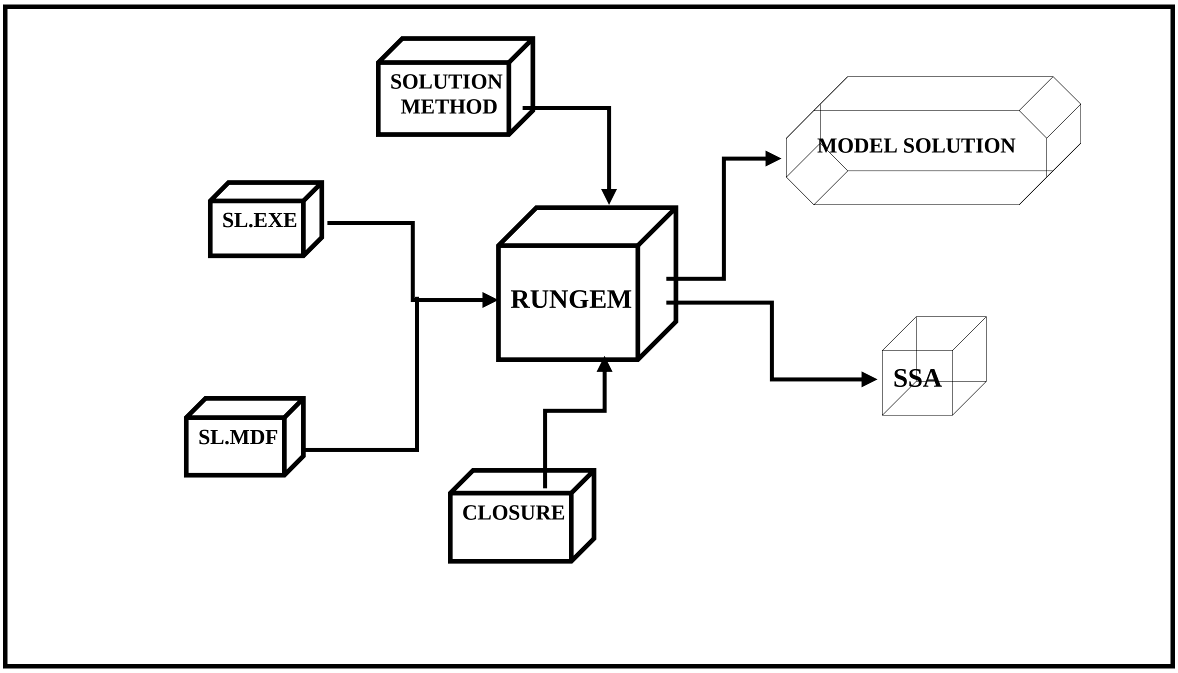


Figure 4.5: Simulation Procedure using RUNGEM Program.

4.7 SYSTEMATIC SENSITIVITY ANALYSIS (*SSA*)

A very important area of any CGE analysis is to examine the sensitivity of the results. It is well accepted in traditional econometrics that the model outcomes can be sensitive to the specification of the functional form and the parameter values. Several researchers

[9] For a detailed explanation of Grag 2-4-6 method see Harrison & Pearson (1996). Similarly, there are two other methods known as Euler method, one of the simplest numerical integration techniques, which allows multi-step solution, and the Mid point method. Moreover, the accuracy of the multi-step solution can be enhanced by extrapolation in the form of repeating the solution using several steps such as 4-steps, 8-steps, 16-steps and 32-steps etc (see Dixon *et al*. (1992) for details).

[10] Experience of Sri Lankan CGE modelling indicates that no attempt has been made in the past to solve the CGE models developed for the Sri Lankan economy, following the Australian *ORANI* model tradition, using multi-step solution methods. Thus, all the previous simulations carried out using these *ORANI* tradition models are subjected to linearization errors.

have questioned the empirical validity of CGE results (see, for example, McKitrick, (1998)). Generally in CGE models, parameters are either calibrated or taken from literature. Even the estimates generated by CGE models do not come with standard deviations, as the calibration procedure leaves zero degrees of freedom. Sensitivity analysis addresses, in particular, the question of reliability of results in a simulation experiment. It identifies whether the simulation results are sensitive to different parameter values and shocks. Parameters of *SLGEM–P* are largely gathered from the existing literature and some are "guestimates". Particularly, the values of Armington elasticities play a crucial role in trade liberalisation simulations. This is more important in terms of analysing the trade liberalisation effects at the household level as the value of this parameter determines the substitution of domestic and imported commodities that may finally affect the welfare of households employed in domestic industries. Hence, in this study we subject the simulations carried out with *SLGEM–P* to a sensitivity analysis, particularly with respect to Armington elasticities.[11]

In most CGE studies sensitivity analyses are performed on an *ad hoc* basis, if they are performed at all. However, in systematic sensitivity analysis (*SSA*) we evaluate the effects of independent uncertainties about the values of several parameters and shocks. This may involve a large number of simulations that produce massive amounts of results such as in *Monte Carlo* simulations. Thus it becomes an exceedingly difficult task to work with fairly large models. However, the method known as *Gaussian Quadrature* (Arndt, 1996a) views main exogenous variables as random variables with associated distributions. Thus the computation of some statistical measures, such as mean and standard deviation, on the probability distributions of each simulation acts to

[11] Moreover, many experiments conducted with *ORANI* tradition Sri Lankan models have never been subjected to sensitivity analysis to identify the sensitivity of the model results to different parameter values. Hence, the present study makes a significant contribution to the literature via its attempt to carry out a systematic sensitivity analysis with respect to parameters.

reduce the number of simulations to a manageable level and also help to summarise the results for easy interpretation.

The *RUNGEM* program of *GEMPACK* software offers the programming and optimisation technique known as *Gaussian quadrature*[12] to determine the optimum level of simulations. There are two *Gaussian quadratures* in *RUNGEM*, *Stroud's quadrature* by Stroud (1957) and *Liu's quadrature* by Liu (1997). These methods assume that (1) the simulation results are well approximated by a third-order polynomial; (2) shocks or parameters have a symmetric distribution; (3) shocks and parameters do not vary at the same time; and (4) shocks or parameters either vary quite independently (zero correlated) or the variations are perfectly correlated within a user specified group. In this study we adopt the *Stroud's quadrature* method. The *SSA* simulation results for the policy experiments are presented and discussed in Chapter 7.

4.8 CONCLUDING REMARKS

This chapter describes the basic structure of the *SLGEM–P*, which is a single country comparative static CGE model of *ORANI* tradition specifically focussed on poverty and inequality issues. The model incorporates multi-households and poverty lines, which make it more suitable for absolute poverty measurements. The next chapter will discuss how this model can be linked up with empirically estimated income distribution functional forms to estimate poverty and inequality measures for Sri Lanka. Furthermore, this model is implemented using a SAM database that reflects the socio-economic structure of the Sri Lankan economy. Therefore, Chapter 6 will discuss the construction of SAM database, other parameters and coefficients for successful implementation of *SLGEM–P*.

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[12] For detailed discussion on *SSA* see Harrison & Vinod (1992), Arndt (1996b) and Arndt & Pearson (1998).

Table 4.2: List of Variables in *SLGEM–P*

Variable	Set elements	Description
x1(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Intermediate basic demands
x2(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Investment basic demands
x3_h(c,s)	c ∈ COM4 s ∈ SRC	Household demand agg. over type
x3(c,s,h)	c ∈ COM4 s ∈ SRC h ∈ HH5	Household basic demands
x4(c)	c ∈ COM4	Export basic demands
x5(c,s)	c ∈ COM4 s ∈ SRC	Government basic demand
delx6(c,s)	c ∈ COM4 s ∈ SRC	Inventories demands
p0(c,s)	c ∈ COM4 s ∈ SRC	Basic price of commodity c, source s
f5(c,s)	c ∈ COM4 s ∈ SRC	Government Demand Shift
t1(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Power of tax on Intermediate
t2(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Power of tax on Investment
t3(c,s)	c ∈ COM4 s ∈ SRC	Power of tax on Household
t4(c)	c ∈ COM4	Power of Export Tax (B)
t5(c,s)	c ∈ COM4 s ∈ SRC	Power of tax on Government
p1(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Purchaser’s price, Intermediate
p2(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Purchaser’s price, Investment
p3(c,s,h)	c ∈ COM4 s ∈ SRC h ∈ HH5	Purchaser’s price, Household
p4(c)	c ∈ COM4	Purchaser’s price, Exports
p5(c,s)	c ∈ COM4 s ∈ SRC	Purchaser’s price, Government
x1lab(i,o)	i ∈ IND4 o ∈ OCC8	Employment by industry and occupation
p1lab(i,o)	i ∈ IND4 o ∈ OCC8	Wages by industry and occupation
f1lab(i,o)	i ∈ IND4 o ∈ OCC8	Wage Shift variable
x1cap(i)	i ∈ IND4	Current Capital Stock
p1cap(i)	i ∈ IND4	Rental Price of Capital
a1cap(i)	i ∈ IND4	Capital Augmenting Technical Change
x1lnd(i)	i ∈ IND4	Use of Land
p1lnd(i)	i ∈ IND4	Rental Price of Land
a1lnd(i)	i ∈ IND4	Land Augmenting Technical Change
x1oct(i)	i ∈ IND4	Demand for "Other Cost" Tickets
p1oct(i)	i ∈ IND4	Price of "Other Cost" Tickets
a1oct(i)	i ∈ IND4	"Other Cost" Ticket Augmenting Technical Change
f1oct(i)	i ∈ IND4	Shifts in Price of "Other Cost" Tickets
x1sub(i)	i ∈ IND4	Demand for Subsidy Units

(Table 4.2 Continued)

p1sub(i)	$i \in$ IND4	Price of Subsidy Units
f1sub(i)	$i \in$ IND4	Shifts in Subsidy Rate
t0imp(c)	$c \in$ COM4	Power of Tariffs
x1_s(c,i)	$c \in$ COM4 $i \in$ IND4	Intermediate use of imp/dom composite
x2_s(c,i)	$c \in$ COM4 $i \in$ IND4	Investment use of imp/dom composite
x3_s(c,h)	$c \in$ COM4 $h \in$ HH5	Household use of imp/dom composite
x3lux(c,h)	$c \in$ COM4 $h \in$ HH5	Household – Supernumerary demands
x3sub(c,h)	$c \in$ COM4 $h \in$ HH5	Household – Subsistence demands
p1_s(c,i)	$c \in$ COM4 $i \in$ IND4	Price, intermediate imp/dom composite
p2_s(c,i)	$c \in$ COM4 $i \in$ IND4	Price, investment imp/dom composite
p3_s(c,h)	$c \in$ COM4 $h \in$ HH5	Price, household imp/dom composite
employ_i(o)	$o \in$ OCC8	Employment by Occupation
q(h)	$h \in$ HH5	Number of H'holds
utility(h)	$h \in$ HH5	Utility per Household
w3lux(h)	$h \in$ HH5	Nominal Supernumerary Expenditure
w3tot(h)	$h \in$ HH5	Nominal Household Consumption
f3tot(h)	$h \in$ HH5	Shift Term For Consumption
p3tot(h)	$h \in$ HH5	Consumer Price Index
x3tot(h)	$h \in$ HH5	Real Household Consumption
f0tax_s(c)	$c \in$ COM4	General Sales Tax Shifter
f4t(c)	$c \in$ COM4	Export Tax Shift Variable
f4p(c)	$c \in$ COM4	Price (upward) Shift in Export Demand Schedule
f4q(c)	$c \in$ COM4	Quantity (right) Shift in Export Demands
pf0cif(c)	$c \in$ COM4	C.I.F. Foreign Currency Import Prices
x0dom(c)	$c \in$ COM4	Total Supplies of Domestic Goods
x0imp(c)	$c \in$ COM4	Total Supplies of Imported Goods
a1prim(i)	$i \in$ IND4	All Factor Augmenting Technical Change
a1tot(i)	$i \in$ IND4	All Input Augmenting Technical Change
a2tot(i)	$i \in$ IND4	Neutral Technical Change – Investment
employ_o(i)	$i \in$ IND4	Employment by Industry (B)
p1prim(i)	$i \in$ IND4	Effective Price of Primary Factor Composite
p1tot(i)	$i \in$ IND4	Average Input/Output Price
p2tot(i)	$i \in$ IND4	Costs of Units of Capital
a1lab_o(i)	$i \in$ IND4	Labour Tech Change
f1lab_o(i)	$i \in$ IND4	Industry – Specific Wage Shifter
p1lab_o(i)	$i \in$ IND4	Price of Labour Composite (B)
x1lab_o(i)	$i \in$ IND4	Effective Labour Input

(Table 4.2 Continued)

f1lab_i(o)	$o \in$ OCC8	Occupation – Specific Wage Shifter
person_i(o)	$o \in$ OCC8	Aggregate Employment (Persons)
x1prim(i)	$i \in$ IND4	Primary Factor Composite
x1tot(i)	$i \in$ IND4	Activity Level or Value-Added
x2tot(i)	$i \in$ IND4	Investment by Using Industry
p3tot_h		Consumer Price Index
x3tot_h		Real Household Consumption
w3tot_h		Nominal Total Household Consumption
avewage		Average Money Wage (Pre-Tax)
avewager		Average Real Wage (Pre-Tax)
delStokShr		(Stocks)/GDP
a1lab_io		Uniform Labour Augmenting Technical Change
f1lab_io		Overall Wage Shifter
w1lab_io		Aggregate Payments to Labour
f1tax_csi		Uniform % Change in Powers of Taxes on intermediate Usage
f2tax_csi		Uniform % Change in Powers of Taxes on investment
f3tax_cs		Uniform % Change in Powers of Taxes on Household Usage
f4tax		Uniform % Change in Powers of Taxes on exports
f5tax_cs		Uniform % Change in Powers of Taxes on government Usage
delB		(Balance of Trade)/GDP
f3tot_h		Overall Shift Term For Consumption
f4q_c		Uniform Quantity (right) Shift in Export Demands
f5tot		Overall Shift Term For Government Demands
f5tot2		Ratio between f5tot and x3tot
p0cif_c		Imports Price Index, CIF, Rand
p0gdpexp		GDP Price Index, Expenditure Side
p0imp_c		Duty-paid Imports Price Index, Rand
x1prim_i		Aggregate Output: Primary Factor Cost Weights
p0realdev		Real Devaluation
p0toft		Terms of Trade
p1prim_i		Primary Factor Cost Deflator

(Table 4.2 Continued)

w1prim_i	Aggregate Primary Factor Payments
employ_io	Aggregate Employment – Wage Bill weights
person_io	Aggregate Employment (Persons)
x1cap_i	Aggregate Capital Stock, Rental Weights
p1cap_i	Average Capital Rental
p2tot_i	Aggregate Investment Price Index
phi	Exchange Rate, Rand/$world
p4tot	Exports Price Index
p5tot	Government Price Index
p6tot	Inventories Price Index
w0cif_c	CIF Rand Value of Imports
w0gdpexp	Nominal GDP from Expenditure Side
w0gdpinc	Nominal GDP from Income Side
w0imp_c	Value of Imports plus Duty
w0tar_c	Aggregate Tariff Revenue
w0tax_csi	Aggregate Revenue from All Indirect taxes
w1cap_i	Aggregate Payments to Capital
w1lnd_i	Aggregate Payments to Land
w1oct_i	Aggregate Other Cost Ticket Payments
w1sub_i	Aggregate Subsidy Payments
w1tax_csi	Aggregate Revenue from Indirect Taxes on Intermediate
w2tax_csi	Aggregate Revenue from Indirect Taxes on Investment
w3tax_csh	Aggregate Revenue from Indirect Taxes on Households
w4tax_c	Aggregate Revenue from Indirect Taxes on Export
w5tax_cs	Aggregate Revenue from Indirect Taxes on Government
w2tot_i	Aggregate Nominal Investment
w4tot	Rand Border Value of exports
w5tot	Aggregate Nominal Value of Government Demands
w6tot	Aggregate Nominal Value of Inventories
x0cif_c	Import Volume Index, CIF Weights

(Table 4.2 Continued)

x0gdpexp		Real GDP from Expenditure Side
x0imp_c		Import Volume Index, Duty - Paid Weights
x2tot_i		Aggregate Real Investment Expenditure
x4tot		Export Volume Index
x5tot		Aggregate Real Government Demands
x6tot		Aggregate Real Inventories
q_h		Total Number of H'holds
delx6tot		Inventories volume change: base period prices
delw6tot		inventories value
omega		Slack variable for aggregate investment or bond rate
r1cap(i)	$i \in$ IND4	Current Rates of Return on Fixed Capital
finvDPSV(i)	$i \in$ IND4	Investment shifter
fanloc(c)	$c \in$ COM4	Growth in local market effect (B)
fanimp(c)	$c \in$ COM4	Import leakage effect – *via* residual (B)
fanexp(c)	$c \in$ COM4	Export effect (B)
delfstock		Stock shifter
f6(c,s)	$c \in$ COM4 $s \in$ SRC	Stock shifter
x1lab_i(o)	$o \in$ OCC8	Employment by OCC8.
w1labinc(o,h)	$o \in$ OCC8 $h \in$ HH5	Labour income from OCC8 (o) to households (h)
w1lab_i(o)	$o \in$ OCC8	Total Labour Bill (o)
w1labinc_o(h)	$h \in$ HH5	Total Wages to Households (h)
avetax_h		Average Tax Factor: avedispwager – avewager
wgosgov		GOS income to gov + GOS transfers to gov
wgosrow		GOS income to ROW + GOS transfers to ROW
wgostax		Corporation tax
wgovgos		Interest on public debt
wgovrow		GOV transfers to ROW
wrowgos		GOS from ROW
wrowgov		Transfers from ROW to gov
wgossav		Retained earnings
wgoshou(h)	$h \in$ HH5	GOS to households
wgovhou(h)	$h \in$ HH5	Gov transfers to households

(Table 4.2 Continued)

whougov(h)	$h \in HH5$	Income tax + h'hold transfers to gov
whourow(h)	$h \in HH5$	Household transfers to ROW
wrowhou(h)	$h \in HH5$	ROW transfers to households
whouhou(hto,hfrom)	$hto \in HH5$ $hfrom \in HH5$	Intra-h'hold trnsfrs
s2gov(i)	$i \in IND4$	Gov share of investment by industry
wgos		Total GOS
wgos_posttax		VGOS less VGOSTAX
fgostax		Ad valorem rate of corporation tax
wgoshou_h		Total GOS to households
labslack(o)	$o \in OCC8$	Employment rate
wlabrow(o)	$o \in OCC8$	Wages to ROW
wlabrow_o		Wages to ROW
wincgov		Government income
whousinc(h)	$h \in HH5$	Pre-tax h'hold income
whousinc_h		Total pre-tax h'hold income
wdispinc(h)	$h \in HH5$	Post-tax h'hold income
wdispinc_h		Total post-tax h'hold income
f_inctaxrate(h)	$h \in HH5$	Income tax shifter: by income
f_inctaxrate_h		Income tax shifter: overall
f_gosinctax		fgostax – f_inctaxrate_h
whousav(h)	$h \in HH5$	Household saving
wgovcur		Current Gov expenditure
wgovcap		Investment Gov expenditure
wgovexp		Total Gov expenditure
wgovsav		Gov (income – expenditure)
delsgovsav		Gov (income – expenditure)/GDP
realgovsav		Real Gov (income – expenditure)
wprivcap		Investment private expenditure
wrowexp		Total ROW expenditure
wincrow		Total ROW income
wrowsav		ROW (income – expenditure)
wsamcheck		Global (income – expenditure)
pline(ph)	$ph \in PHG$	Poverty line
pline_ph		

Source: *SLGEM–P*

Table 4.3: List of Coefficients in *SLGEM–P*

Coefficient	Set elements	Description
V1BAS(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Intermediate basic flows
V2BAS(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Investment basic flows
V3BAS(c,s,h)	$c \in COM4$ $s \in SRC$ $h \in HH5$	Households basic flows
V4BAS(c)	$c \in COM4$	Export basic flows
V5BAS(c,s)	$c \in COM4$ $s \in SRC$	Government Demand
V6BAS(c,s)	$c \in COM4$ $s \in SRC$	Inventories basic flows
P0LEV(c,s)	$c \in COM4$ $s \in SRC$	Levels basic prices
V1TAX(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Taxes on intermediate
V2TAX(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Taxes on investments
V3TAX(c,s,h)	$c \in COM4$ $s \in SRC$ $h \in HH5$	Taxes on households
V4TAX(c)	$c \in COM4$	Taxes on exports
V5TAX(c,s)	$c \in COM4$ $s \in SRC$	Taxes on Government
V1CAP(i)	$i \in IND4$	Capital rentals
V1LAB(i,o)	$i \in IND4$ $o \in OCC8$	Wage bill matrix
PERSON(i,o)	$i \in IND4$ $o \in OCC8$	Persons labour matrix
V1LND(i)	$i \in IND4$	Land rentals
V1OCT(i)	$i \in IND4$	Other cost tickets
V1SUB(i)	$i \in IND4$	Industry Subsides
V0IMP(c)	$c \in COM4$	Total basic value imports of good c
V0TAR(c)	$c \in COM4$	Tariff revenue
V1LAB_I(o)	$o \in OCC8$	OCC8 labour bill
V1LAB_IO		Total labour bill
V3BAS_H(c,s)	$c \in COM4$ $s \in SRC$	Households : Agg. basic flows
V1PUR(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Intermediate purch. value
V2PUR(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	Investment purch. value
V3PUR(c,s,h)	$c \in COM4$ $s \in SRC$ $h \in HH5$	Households purch. value
V4PUR(c)	$c \in COM4$	Export purch. value
V5PUR(c,s)	$c \in COM4$ $s \in SRC$	Government purch. value
V1PUR_S(c,i)	$c \in COM4$ $i \in IND4$	Dom + imp intermediate purch. value
V2PUR_S(c,i)	$c \in COM4$ $i \in IND4$	Dom + imp investment purch. value
V3PUR_S(c,h)	$c \in COM4$ $h \in HH5$	Dom + imp household purch. value
S1(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	
S2(c,s,i)	$c \in COM4$ $s \in SRC$ $i \in IND4$	
S3(c,s,h)	$c \in COM4$ $s \in SRC$ $h \in HH5$	
V1LAB_O(i)	$i \in IND4$	Total labour bill in industry i
V1PRIM(i)	$i \in IND4$	Total factor input to industry i

(Table 4.3 Continued)

V1TOT(i)	i ∈ IND4	Total cost in each industry
V2TOT(i)	i ∈ IND4	Total capital created for each industry
DOMSALES(c)	c ∈ COM4	Total domestic sales of domestic commodity c
SALES(c)	c ∈ COM4	Total sales of domestic commodity c
V0CIF(c)	c ∈ COM4	Total ex-duty imports of good c
V1TAX_CSI		Aggregate Indirect Tax Revenue from Intermediate
V2TAX_CSI		Aggregate Indirect Tax Revenue from Investment
V3TAX_CSH		Aggregate Indirect Tax Revenue from Households
V4TAX_C		Aggregate Indirect Tax Revenue from Export
V5TAX_CS		Aggregate Indirect Tax Revenue from Government
V0TAR_C		Aggregate Tariff Revenue
V0TAX_CSI		Aggregate Indirect Tax Revenue
V1CAP_I		Total payments to capital
V1LND_I		Total payments to land
V1OCT_I		Total other cost ticket payments
V1SUB_I		Total subsidies
V1PRIM_I		Total primary factor payments
V0GDPINC		Nominal GDP from income side
V0CIF_C		Total Rand import costs, excluding tariffs
V0IMP_C		Total basic value imports (includes tariffs)
V2TOT_I		Total investment usage
V3TOT(h)	h ∈ HH5	Total purchases by households
V3TOT_H		Total purchases by households
V4TOT		Total export earnings
V5TOT		Total value of Government demands
V6TOT		Total stocks
V0GDPEXP		Nominal GDP from expenditure side
TINY		
ISDOM(s)	s ∈ SRC	1 for dom, 0 for imp, used for twists
SIGMA1LAB(i)	i ∈ IND4	CES substitution between skill types
SIGMA1PRIM(i)	i ∈ IND4	CES substitution, primary factors
SIGMA1(c)	c ∈ COM4	Armington elasticities: Intermediate

(Table 4.3 Continued)

SIGMA2(c)	$c \in COM4$	Armington elasticities: Investment
SIGMA3(c)	$c \in COM4$	Armington elasticities: Households
NUMCOM		Number of goods
V3LUX(c,h)	$c \in COM4$ $h \in HH5$	Supernumerary expenditure commodity c
B3LUX(c,h)	$c \in COM4$ $h \in HH5$	Supernumerary expenditure commodity c/total expenditure commodity c
V3LUX_C(h)	$h \in HH5$	Total supernumerary expenditure
S3LUX(c,h)	$c \in COM4$ $h \in HH5$	Marginal household budget shares
EXP_ELAST(c)	$c \in COM4$	Export Demand Elasticities: Typical Value - 20.0
STOKRAT(c)	$c \in COM4$	Inventories/sales
V1LABINC(o,h)	$o \in OCC8$ $h \in HH5$	Labour income from OCC8 (o) to households (h)
V1LABINC_H(o)	$o \in OCC8$	Subtotal labour income to households (o)
V1LABINC_O(h)	$h \in HH5$	Total wage income to h'lds (h)
VGOSSAV		Capital Account: Gov
VGOSGOV		GOS income to gov + GOS transfers to gov
VGOSROW		GOS income to ROW + GOS transfers to ROW
VGOSTAX		Corporation tax
VGOVGOS		Interest on public debt
VGOVROW		GOV transfers to ROW
VROWGOS		GOS from ROW
VROWGOV		Transfers from ROW to gov
VGOSHOU(h)	$h \in HH5$	GOS to households
VGOVHOU(h)	$h \in HH5$	Gov transfers to households
VHOUGOV(h)	$h \in HH5$	Income tax + h'hold transfers to gov
VHOUROW(h)	$h \in HH5$	Household transfers to ROW
VROWHOU(h)	$h \in HH5$	ROW transfers to households
VHOUHOU(hto,hfrom)	$hto \in HH5$ $hfrom \in HH5$	Intra-h'hold trnsfrs
GOVSHRINV(i)	$i \in IND4$	Gov share of investment by industry
VGOS		Total GOS
VGOS_POSTTAX		VGOS less VGOSTAX
GOSTAXRATE		Ad valorem GOS Tax
VGOSHOU_H		Total GOS to households
VLABROW(o)	$o \in OCC8$	Wages to ROW
VLABROW_O		Wages to ROW

(Table 4.3 Continued)

VINCGOV		Government income
VHOUSINC(h)	$h \in$ HH5	Pre-tax h'hold income
VDISPINC(h)	$h \in$ HH5	Post-tax h'hold income
VHOUSAV(h)	$h \in$ HH5	Household saving
VGOVCUR		Current gov expenditure
VGOVCAP		Investment gov expenditure
VGOVEXP		Total gov expenditure
VGOVSAV		Gov (income – expenditure)
VPRIVCAP		Investment private expenditure
VROWEXP		Total ROW expenditure
VINCROW		Total ROW income
VROWSAV		ROW (income – expenditure)
VSAMCHECK		Global (income – expenditure)
INCTAXRATE(h)	$h \in$ HH5	Tax rates
PURE_PROFITS(i)	$i \in$ IND4	PURE_PROFITS, should be zero
EXPGDP(e)	$e \in$ EXPMAC	Expenditure Aggregates
INCGDP(i)	$i \in$ INCMAC	Income Aggregates
TAX(t)	$t \in$ TAXMAC	Tax Aggregates
COSTMAT(i,co)	$i \in$ IND4 $co \in$ COSTCAT	
SALEMAT(c,sa)	$c \in$ COM4 $sa \in$ SALECAT	
TARRATE(c)	$c \in$ COM4	av rate of tariff
PRVSHRINV(i)	$i \in$ IND4	
DOMINV(i)	$i \in$ IND4	Investment use of dom goods
DOMUSE(u)	$u \in$ USER	
IMPUSE(c,u)	$c \in$ COM4 $u \in$ USER	Imports at basic prices
IMPDUTY(u)	$u \in$ USER	Duty paid, by user
IMPCIF(u)	$u \in$ USER	Imports CIF
V2TAX_CS(i)	$i \in$ IND4	
SAM(i,j)	$i \in$ CASHDEST $j \in$ SPENDER	
INCTOT(i)	$i \in$ CASHDEST	Row totals
EXPTOT(j)	$j \in$ SPENDER	Expenditure totals
V3TOT_ph		
TARFRATE(c)	$c \in$ COM4	Ad valorem tariff rate
PW0TAR(c)	$c \in$ COM4	Base power of tariff
SPW0TAR(c)	$c \in$ COM4	Shock of power of tariff
NTARRATE(c)	$c \in$ COM4	New tariff rate
NPW0TAR(c)	$c \in$ COM4	New power of tariff
TRATE(c)	$c \in$ COM4	Ad valorem tariff rate percentage

(Table 4.3 Continued)

ULH(u)	$u \in ULN$	Urban low base income
RLH(r)	$r \in RLN$	Rural low base income
ELH(e)	$e \in ELN$	Estate low base income
UHH(z)	$z \in UHN$	Urban high base income
RHH(f)	$f \in RHN$	Rural high base income
BPOVLINE		Base year poverty line

Source: *SLGEM–P*

Table 4.4: List of Equations in *SLGEM–P*

Equations	Set elements	Description
E_x1lab(i,o)	i ∈ IND4 o ∈ OCC8	Demand for labour by industry and skill group
E_p1lab_o(i)	i ∈ IND4	Price to each industry of labour composite
E_employ_i(o)	o ∈ OCC8	Total Demand for labour of each skill
E_person_i(o)	o ∈ OCC8	Total Demand (Persons) for labour of each skill
E_employ_o(i)	i ∈ IND4	Employment by industry
E_x1lab_o(i)	i ∈ IND4	Industry demands for effective labour
E_p1cap(i)	i ∈ IND4	Industry demands for capital
E_p1lnd(i)	i ∈ IND4	Industry demands for land
E_p1prim(i)	i ∈ IND4	Effective price term for factor demand equations
E_x1(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Source-Specific Commodity Demands
E_p1_s(c,i)	c ∈ COM4 i ∈ IND4	Effective Price of Commodity Composite
E_x1_s(c,i)	c ∈ COM4 i ∈ IND4	Demands for Commodity Composites
E_x1prim(i)	i ∈ IND4	Demands for primary factor composite
E_x1oct(i)	i ∈ IND4	Demands for other cost tickets
E_x1sub(i)	i ∈ IND4	Demands for other cost tickets
E_p1tot(i)	i ∈ IND4	Zero pure profits in production
E_x0dom(c)	c ∈ COM4	Quantity of dom output
E_x1tot(c)	c ∈ COM4	Map industry commodity prices
E_x2(c,s,i)	c ∈ COM4 s ∈ SRC i ∈ IND4	Source - Specific Commodity Demands
E_p2_s(c,i)	c ∈ COM4 i ∈ IND4	Effective Price of Commodity Composite
E_x2_s(c,i)	c ∈ COM4 i ∈ IND4	Demands for Commodity Composites
E_p2tot(i)	i ∈ IND4	Zero pure profits in investment
E_x3(c,s,h)	c ∈ COM4 s ∈ SRC h ∈ HH5	Source - Specific Commodity Demands

(Table 4.4 Continued)

E_p3_s(c,h)	$c \in COM4$ $h \in HH5$	Effective Price of Commodity Composite
E_x3sub(c,h)	$c \in COM4$ $h \in HH5$	Subsistence Demand for composite commodities
E_x3lux(c,h)	$c \in COM4$ $h \in HH5$	Luxury Demand for composite commodities
E_x3_s(c,h)	$c \in COM4$ $h \in HH5$	Total Household demand for composite commodities
E_utility(h)	$h \in HH5$	Change in utility disregarding taste change terms
E_x3_h(c,s)	$c \in COM4$ $s \in SRC$	Total Consumption Demands
E_x4(c)	$c \in COM4$	Export demand functions
E_x5(c,s)	$c \in COM4$ $s \in SRC$	Government demands
E_f5tot		Overall Government demands shift
E_p1(c,s,I)	$c \in COM4$ $s \in SRC$ $I \in IND4$	Purchasers prices – producers
E_p2(c,s,I)	$c \in COM4$ $s \in SRC$ $I \in IND4$	Purchasers prices – capital creators
E_p3(c,s,h)	$c \in COM4$ $s \in SRC$ $h \in HH5$	Purchasers prices – households
E_p4(c)	$c \in COM4$	Zero pure profits in Exporting
E_p5(c,s)	$c \in COM4$ $s \in SRC$	Zero pure profits in distribution of Government
E_p0_A(c)	$c \in COM4$	Zero pure profits in importing
E_p0_B(c)	$c \in COM4$	Demand equals supply for commodities
E_x0imp(c)	$c \in COM4$	Import volumes
E_t1(c,s,I)	$c \in COM4$ $s \in SRC$ $I \in IND4$	Power of tax on sales to intermediate
E_t2(c,s,I)	$c \in COM4$ $s \in SRC$ $I \in IND4$	Power of tax on sales to investment
E_t3(c,s)	$c \in COM4$ $s \in SRC$	Power of tax on sales to households
E_t4(c)	$c \in COM4$	Power of tax on sales to exports
E_t5(c,s)	$c \in COM4$ $s \in SRC$	Power of tax on sales to Government
E_w1tax_csi		Revenue from indirect taxes on flows to intermediate
E_w2tax_csi		Revenue from indirect taxes on flows to investment
E_w3tax_csh		Revenue from indirect taxes on flows to households

(Table 4.4 Continued)

E_w4tax_c		Revenue from indirect taxes on exports
E_w5tax_cs		Revenue from indirect taxes on flows to Government
E_w0tar_c		Tariff revenue
E_w1lnd_i		Aggregate payments to land
E_w1lab_io		Aggregate payments to labour
E_w1cap_i		Aggregate payments to capital
E_w1oct_i		Aggregate other cost ticket payments
E_w1sub_i		Aggregate subsidies
E_w0tax_csi		Aggregate value of indirect taxes
E_w1prim_i		Aggregate factor payments
E_w0gdpinc		Aggregate nominal GDP from income side
E_x2tot_i		Total real investment
E_p2tot_i		Investment price index
E_w2tot_i		Total nominal investment
E_x3tot(h)	$h \in HH5$	Real consumption
E_p3tot(h)	$h \in HH5$	Consumer price index
E_w3tot(h)	$h \in HH5$	Household budget constraint
E_x3tot_h		Real consumption
E_p3tot_h		Consumer price index
E_w3tot_h		Nominal consumption
E_x4tot		Export volume index
E_p4tot		Exports price index, Rand
E_w4tot		Rand Border value of exports
E_x5tot		Aggregate real Government demands
E_p5tot		'Government demands price index
E_w5tot		Aggregate nominal value of Government demands
E_delx6tot		Inventories volume change: base period prices
E_delw6tot		Inventories volume index: base period prices
E_x6tot		Inventories volume index: base period prices
E_p6tot		Inventories price index
E_w6tot		Aggregate nominal value of inventories

(Table 4.4 Continued)

E_delStokShr		V6TOT/GDP
E_x0cif_c		CIF Import volume index, CIF weights
E_p0cif_c		Rand CIF imports price index
E_w0cif_c		Rand CIF value of imports
E_x0gdpexp		Real GDP, expenditure side
E_w0gdpexp		Nominal GDP from expenditure side
E_p0gdpexp		Price index for GDP, expenditure side
E_delB		(Balance of trade)/GDP
E_x0imp_c		Import volume index, duty paid weights
E_p0imp_c		Duty paid imports price index
E_w0imp_c		Value of imports (duty paid)
E_x1prim_i		Aggregate output: value-added weights
E_x1cap_i		Aggregate usage of capital, rental weights
E_p1cap_i		Average capital rental
E_employ_io		Aggregate employment, wage bill weights
E_person_io		Aggregate employment, persons weights
E_p1prim_i		Primary factor cost deflator
E_p0toft		Terms of trade
E_p0realdev		Real devaluation
E_avewage		Average money wage (pre-tax)
E_avewager		Average real wage (pre-tax)
E_r1cap(i)	$i \in IND4$	Definition of rates of return to capital
E_finvDPSV(i)	$i \in IND4$	Investment rule
E_p1lab(i,o)	$i \in IND4$ $o \in OCC8$	Flexible setting of money wages
E_p1oct(i)	$i \in IND4$	Indexing of prices of "Other Cost" tickets
E_p1sub(i)	$i \in IND4$	Setting of subsidy rates
E_fanloc(c)	$c \in COM4$	Growth in local market effect
E_fanimp(c)	$c \in COM4$	Import leakage effect – *via* residual
E_fanexp(c)	$c \in COM4$	Export effect
E_delx6(c,s)	$c \in COM4$ $s \in SRC$	Rule for stocks
E_x1lab_i(o)	$o \in OCC8$	Total Demand for labour of each skill/source

(Table 4.4 Continued)

E_wgovgos		Interest on public debt
E_wrowgos		GOS from ROW
E_wgos		GOS from income side
E_wgos_posttax		VGOS less VGOSTAX
E_wgostax		Corporation tax
E_wgosgov		GOS to gov
E_wgosrow		GOS to ROW
E_wgoshou(h)	$h \in HH5$	GOS to households
E_wgossav		Find VGOSSAV as residual
E_wgoshou_h		Total GOS to households
E_w1lab_i(o)	$o \in OCC8$	All-industry labour bills
E_w1labinc(o,h)	$o \in OCC8$ $h \in HH5$	Labour income to households
E_wlabrow(o)	$o \in OCC8$	Wages to ROW
E_wlabrow_o		Wages to ROW
E_labslack(o)	$o \in OCC8$	Adding up constraint
E_q(h)	$h \in HH5$	Rule of population growth
E_w1labinc_o(h)	$h \in HH5$	Total labour income to households
E_wincgov		Government income
E_whousinc(h)	$h \in HH5$	Pre-tax household income
E_whousinc_h		Total pre-tax household income
E_wgovhou(h)	$h \in HH5$	Gov transfers to households
E_wrowhou(h)	$h \in HH5$	ROW transfers to households
E_whouhou(hto,hfrom)	$hto \in HH5$ $hfrom \in HH5$	Inter-household transfers
E_wdispinc(h)	$h \in HH5$	Post-tax household income
E_wdispinc_h		Total post-tax h'hold income
E_avetax_h		Average tax factor
E_whougov(h)	$h \in HH5$	Households to gov: income taxes and transfers
E_f_gosinctax		fgostax – f_inctaxrate_h
E_whourow(h)	$h \in HH5$	Household transfers to ROW
E_whousav(h)	$h \in HH5$	Household saving
E_wrowgov		Transfers from ROW to gov
E_wgovcur		Current gov expenditure
E_wgovrow		GOV transfers to ROW
E_wgovcap		Investment gov expenditure
E_wGOVEXP		Total gov expenditure
E_wgovsav		Gov (income - expenditure)
E_delsgovsav		Gov (income - expenditure)/GDP
E_realgovsav		Real gov (income - expenditure)

(Table 4.4 Continued)

E_wprivcap		Investment private expenditure
E_wrowexp		Total ROW expenditure
E_wincrow		Total ROW income
E_wrowsav		ROW (income - expenditure)
E_wsamcheck		Global (income - expenditure)
E_f3tot(h)	$h \in HH5$	Consumption function
E_pline(ph)	$ph \in PHG$	Poverty line
E_pline_ph		Aggregate poverty line

Source: *SLGEM–P*

CHAPTER 5

EMPIRICAL ESTIMATION OF INCOME DISTRIBUTION FUNCTIONAL FORMS FOR SRI LANKA AND POVERTY AND INEQUALITY MEASUREMENTS

5.1 INTRODUCTION

The objective of this chapter is to explain the methodology involved in estimating income distribution functional forms of different household groups in the *SLGEM–P* developed in Chapter 4 in order to measure poverty and inequality indices for the base-case scenario. In this chapter we extend the different aggregated household groups in the *SLGEM–P* into empirically estimated income distribution functions based on household survey data. These distribution functions in turn would be used to estimate various poverty and inequality indices for the base year: using a “top down” approach we estimate the post simulation poverty and inequality estimates.

The empirical estimation of best-fit income distribution functions for different household groups has never been carried out for Sri Lanka. Moreover, linking of household level income distribution functions with a national CGE model and estimating different poverty and inequality indices within a general equilibrium framework has never been attempted for Sri Lanka. Interestingly, there are hardly any studies available within the context of CGE models which investigate the linkage between trade reforms and poverty by incorporating empirically fitted best-fit income distribution functions. This study seeks to shed more light on the current debate on the trade–poverty linkage by attempting to fill the gaps in the above areas. Therefore, this chapter attempts to fit the most suitable income distribution functional forms empirically and link them with the CGE model to measure the poverty and distributional consequences of trade reforms. Moreover, we estimate the base case estimates of poverty and inequality indices, which are necessary for the simulation experiments described in Chapter 7.

This chapter is organised as follows. Section 5.2 briefly discusses the available income distribution functions within CGE models. The empirical procedure of estimating the income distribution functions for different household groups in Sri Lanka is described in Section 5.3. Section 5.4 discusses the poverty and inequality indices used in the study and presents the results of base year poverty and inequality estimates. The linking of income distribution models with the CGE model is briefly explained in Section 5.5 and Section 5.6 presents the concluding remarks.

5.2 INCOME DISTRIBUTION FUNCTIONS WITHIN CGE MODELS

As discussed in Chapter 3, there are three approaches to specifying households in a CGE model: using a single aggregated representative agent household; using multiple households to represent different income groups where each group is denoted by a representative agent household; using multiple households where each income group is represented by a distribution of households rather than a single representative agent household. Among the above three approaches discussed in Chapter 3, the first two approaches strongly hold the representative agent hypothesis by identifying a single representative household to denote the aggregated household sector or different household subsectors (groups), respectively. In contrast, the third approach relaxes this hypothesis to certain extent by specifying the representative household agent within a probability distribution. Therefore, the shape of the probability distribution could well express the distribution of the income of the individual households represented by the agent.

As noted in Chapter 3 the models based on the third approach can be considered to have partially endogenised the income distribution of different household groups as they allow the mean of the income distribution to be determined endogenously while keeping the variance fixed or determined exogenously. Thus, after a simulation, the distribution curve could shift to right or to left depending on the generated post simulation mean value while maintaining the same shape of the distribution. Moreover, these models can be used to specify the poverty line within the income distribution curve and allow the change of poverty line to be accommodated too. Thus, CGE models, which adopt the third approach, can effectively be used in estimating the change in absolute poverty within different household groups as they partially capture the intra-group income distribution as well as the inter-group income distribution.

However, the majority of CGE modellers who adopt the third approach in specifying the household sector rely on a few standard probability distribution functions. Among them the most commonly used distributional functional forms are lognormal[1], Pareto[2] and more flexible beta distribution function[3]. As noted in Boccanfuso *et al.* (2003), these studies neither give any detailed justification on the use of standard distributions nor seem to utilise the fast expanding body of literature on probability distribution functions on income distribution. For instance, there is a growing body of literature on fitting different types of distribution functions to represent income distributions in various household groups in different economies (see McDonald, 1984; Bordley *et al.*, 1996;

[1] See Adelman and Robinson (1979).
[2] See de Janvry *et al.,* (1991) and Chia *et al.,* (1992).
[3] See Decaluwe, *et al.,* (1998, 1999a, 1999b, 2001); Thorbecke (2001); Boccanfuso, *et al.,* (2003); Colatei and Round (2000); Pradhan and Sahoo (2000); Bussolo and Round (2003).

Bandourian, 2000; Bandourian *et al.,* 2002; Griffith *et al*., 2002; and Chotikapanich *et al*., 2004. Moreover, Boccanfuso *et al.* (2003) further suggested that a single functional form may not always be suitable for all household groups and the best-fit functional forms should be selected by giving due consideration to the characteristics of sample and subgroups. They further highlighted the importance of identifying appropriate distributions since the income effect at household level under CGE policy simulations are often very small.

Interestingly, empirical fitting of most suited distributional functional forms and testing using goodness-of-fit statistical tests have hardly been attempted in poverty focussed CGE literature. The only available illustrative study on this is Boccanfuso *et al.* (2003), which carried out an illustrative simulation using the multi household CGE model for Senegal and experimented Foster, Greer and Thorbecke's (FGT) poverty measure within seven income distribution functions, i.e., beta, lognormal, gamma, displaced lognormal, Champernowne, Singh-Maddala, Dagum and non-parametric DAD. The study observed a relatively significant variation in poverty measurement under different functional forms. Moreover, it concluded that there is no single functional form that fits well within all household groups and most flexible functional forms often perform well.

This study therefore will focus on this direction by empirically fitting the best-fit distributional functional forms and evaluating those using statistical and graphical goodness-of-fit tests to find the most suitable functional forms which will subsequently be used in the *SLGEM–P*. Hence, the next section will discuss the procedure of empirical fitting of distributional functional forms for the Sri Lankan data.

5.3 EMPIRICAL ESTIMATION OF INCOME DISTRIBUTION FUNCTIONAL FORMS FOR SRI LANKA

As discussed in the previous section, empirical fitting of the best suited distributional functional form and testing using the goodness-of-fit statistical tests have hardly been attempted in poverty focussed CGE literature. Hence, this study aims to fill that gap by empirically estimating a number of popular distribution functions found in the income distribution literature, using 1996/97 CFS data for Sri Lanka in order to link them with the CGE model in estimating poverty measures.

In this study, we fitted 9 functional forms[4], i.e, beta general, lognormal, chi-square, Pareto, exponential, inverse gaussian, triangular, uniform and pearson type 5, for the five household groups described in the *SLGEM–P* model. The selection of different functional forms for empirical fitting was guided mainly by the shapes of relative frequency histograms drawn for different household groups and the past literature on commonly used income distributional functional forms in CGE based studies. The identification of the best-fit functional form was based on some graphical and statistical goodness-of-fit tests which will be discussed in Section 5.3.2. The respective functional forms, parameters and restrictions of the above functions are given in Table 5.1. The next section will briefly describe the database used for estimation.

[4] Distribution fitting was carried out using *BestFit* - probability distribution fitting for Microsoft Windows version 4.5.2 (2002).

Table 5.1: Density functions, parameters and constraints of selected probability distributions

Function name	Probability Density Function	Mean	Variance	Parameters and constraints
Uniform	$f(x)=\frac{1}{\max-\min}$	$\frac{\max-\min}{2}$	$\frac{(\max-\min)^2}{12}$	*min* and *max* – continuous boundary parameters *min*<*max*
Triangular	$f(x)=\frac{2(x-\min)}{(m.likely-\min)(\max-\min)}$	$\frac{\max+m.likely+\max}{3}$	$\frac{\max^2+m.likely^2+\max^2-(\max)(m.likely)-(m.likely)(\min)-(\max)(\min)}{18}$	*min* and *max* are continuous boundary parameters while *m.likely* is a continuous mode parameter where *max* > *min*, *min* <= *m.likely* <= *max* and *m.likely* <= *x* <= *max*
Lognormal	$f(x)=\frac{1}{x\sqrt{2\pi\sigma'}}e^{-\frac{1}{2}\left[\frac{\ln x-\mu'}{\sigma'}\right]^2}$	μ	σ^2	μ and σ are continuous parameters, where μ > 0 and σ > 0 $\mu'\equiv\ln\left[\frac{\mu^2}{\sqrt{\sigma^2+\mu^2}}\right]$ and $\sigma'\equiv\sqrt{\ln\left[1+\left(\frac{\sigma}{\mu}\right)^2\right]}$
Exponential	$f(x)=\frac{e^{-\frac{x}{\beta}}}{\beta}$	β	β^2	β is a continuous scale parameter where β >0

Table 5.1: Density functions, parameters and constraints of selected probability distributions (continued)

Chi-Squared	$f(x)=\frac{1}{2^{\upsilon/2}\tau(\upsilon/2)}e^{-x/2}x^{(\upsilon/2)-1}$	υ	2υ	υ is a discrete shape parameter where $\upsilon > 0$ and τ is the Gamma function
Beta	$f(x/p,q)=\frac{1(x-a)^{p-1}(b-x)^{q-1}}{B(p,q)(b-a)^{p+q-1}}$ where, $B(p,q)=\int_a^b\frac{(x-a)^{p-1}.(b-x)^{q-1}}{(b-a)^{p+q-1}}dx$	$\mu_x=a+\frac{p}{p+q}[b-a]$	$\sigma_Y^2=\frac{pq}{(p+q)^2(p+q+1)}[b-a]^2$	ρ and q are continuous shape parameters where $\rho >$ 0 and $q > 0$ a and b are continuous boundary parameters where $a < b$
Pearson Type V	$f(x)=\frac{1}{\beta\tau(\alpha)}.\frac{e^{-\beta/x}}{(x/\beta)^{\alpha+1}}$	$\frac{\beta}{\alpha-1}$ for $\alpha > 1$	$\frac{\beta^2}{(\alpha-1)^2(\alpha-2)}$ for $\alpha > 2$	α is a continuos shape parameter and β is a continuos scale parameter where $\alpha > 0$ and $\beta > 0$ τ is the Gamma function
Inverse Gaussian	$f(x)=\sqrt{\frac{\lambda}{2\pi x^3}}e^{-\left[\frac{\lambda(x-\mu)^2}{2\mu^2 x}\right]}$	μ	$\frac{\mu^3}{\lambda}$	μ and λ are continuos parameters where $\mu > 0$ and $\lambda > 0$
Pareto	$f(x)=\frac{\theta a^{\theta}}{x^{\theta+1}}$	$\frac{a\theta}{\theta-1}$ for $\theta > 1$	$\frac{\theta a^2}{(\theta-1)^2(\theta-2)}$ for $\theta > 2$	θ is a continuos shape parameter while a is a continuos scale parameter where $\theta > 0$ and $a > 0$

Source: Best-fit (2002) Palisade Corporation..

5.3.1 Database

The main data source used in this chapter was the household income and expenditure survey known as *Consumer Finance Survey*[5] conducted by the *Central Bank of Sri Lanka* for the years 1996/97 (CFS, 1999). The household income data of three main sectors – *rural*, *urban* and *estate* – of the *1996/97 Consumer Finance Survey* of Sri Lanka were defined based on the geographical location and the economic activity of households. This survey was used as the first step in defining the five household groups used in the study. In the *1996/97 CFS* the *urban* sector consists of the households residing in the municipal and urban council areas and the *estate* sector consists of the households in tea, rubber and coconut estates with 20 or more acres and with 10 or more resident workers. The *rural* sector consists of the households not included in the urban or estate sectors. In the present study we divide the households in *rural* and *urban* sectors into low- and high-income groups based on the monthly income per household thus making altogether five household groups. Accordingly, low-income groups are defined based on whose income falls below Rs.15,000 /household/ month. In order to estimate the income distribution functional forms as well as poverty and inequality measures, a total sample of 1479 households (comprising of 151 urban low-income households (*ULIHH*), 984 rural low-income household (*RLIHH*), 89 estate low-income households (*ELIHH*), 90 urban high-income households (*UHIHH*) and 165 rural high-income households (*RHIHH*) based on their relative proportions) were randomly selected. These samples were used in empirically estimating the income distribution

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[5] The Central Bank of Sri Lanka conducted the first household income and expenditure survey in 1953. Since then the Bank has conducted similar surveys in 1963, 1973, 1978/79, 1981/82 and 1986/87. The 1996/97 survey conducted by it's Statistics Department was the most recent consumer finance survey. In this survey a random sample of 8,880 households was selected for enumeration and a stratified three-stage sample design was adopted. In this survey, a household has been defined to consist of either a person living alone or a group of persons living together and sharing common cooking. However, the North and Eastern Province was not covered under this survey for security reasons (as in the previous survey of 1986/87).

functions for different household groups, estimating the base year poverty measures for each group and measuring the overall income inequality for the base year. The next section will explain the procedure adopted in fitting best-fit distributional functional forms and relevant goodness-of-fit statistics.

5.3.2 Goodness-of-Fit Test Results

This section explains the procedure involved in evaluating the best-fit empirical income distribution functions for five household groups described in the previous section. The goodness-of-fit of the nine functional forms fitted for different household groups can be assessed using two methods, i.e., using statistical goodness-of-fit tests and graphical goodness-of-fit tests. The most suitable functional form is identified on the basis of how close the theoretical distribution is to the empirical distribution.

5.3.2.1 Statistical goodness-of-fit tests[6]

We use three statistical goodness-of-fit tests, namely the *Anderson-Darling test* (Stephens, 1974), *Kolmogorov-Smirnov test* (Chakravart *et al.*, 1967) and the *Chi-squared test* (Snedecor and Cochran, 1989) for each of the five household groups in order to identify how close the empirical distributions are to the theoretical distributions.

Chi- squared (χ^2) goodness-of-fit test

The c*hi-squared* statistic is the most commonly used goodness-of-fit statistic. This test can be performed for both continuous and discrete sample data. When calculating this we need to break the data into several 'bins' or classes. This test is based on the

[6] The goodness-of-fit test statistics presented in this section are based on the *Bestfit* (2002) user manual and START (2003).

probability density functions (PDF). Thus, this test is in the category of "area tests" (START,2003).

The *Chi-squared* test statistic can be defined as:

$$x^2 = \sum_{i=1}^{K} \frac{(N_i - E_i)^2}{E_i} \tag{5.1}$$

where

K= the number of bins

N_i = the observed number of observations in the ith bin

E_i = the expected number of observations in the ith bin

This test could be applied to any univariate distribution for which a PDF can be calculated; however, there are some disadvantages. The dependence of the value of the *Chi-squared* statistic to the binning process and the requirement of a sufficiently large sample size for the validity of the test are some of the major drawbacks of this test (*NIST/SEMATECH e-Handbook of Statistical Methods*, 2003). The null hypothesis (H_0) of this test is that the empirical data follows a specific probability distribution and the alternative hypothesis (H_A) is that empirical data does not follow a specific probability distribution. In the present study this test is used to rank the best-fit models based on the lowest value of the test statistic – the *Chi squared* statistic. To do this we use the Sri Lankan data and calculate the data-based values of the *Chi-squared* statistics and their ranking for different functional forms fitted for urban, rural and estate household groups for the low-income and high-income households.

Kolmogorov-Smirnov(K-S) goodness-of-fit test

The Kolmogorov-Smirnov test is restricted to sample data of continuous distributions. Unlike the *Chi-squared* statistic this statistic is not sensitive to the binning process, as this does not require binning. Hence it is a less arbitrary measure than the *Chi-squared* statistic. Similarly, unlike the *Chi-squared* test which is based on the PDF, the *Kolmogorov-Smirnov(K-S)* test and *Anderson-Darling (A-D)* test are based on the cumulative distribution function (CDF), and therefore, belong to the class of "distance tests" (START, 2003), where the test is based on maximum distance between the theoretical CDF and the empirical step function CDF. However, this statistic does not detect deviations in the tails of the distribution and it is more sensitive near the center of the distribution. Moreover, it is essential that the distribution be fully specified. If the location, scale or shape parameters are estimated from the data, instead of determining them by simulation, the critical regions of the *K-S* test can no longer be valid. In other words, the K-S test is distribution free as the critical values do not depend on the specific distribution being tested. Thus, it may not allow a more sensitive test. These can be considered as the major weaknesses of this test (*NIST/SEMATECH e-Handbook of Statistical Methods*, 2003). The *K-S* test statistic can be defined as:

$$D = \max_{x_i}\left\{\left|F_n(x_i) - F_0(x_i)\right|\right\} \tag{5.2}$$

where,

$$F_n(x_i) = \frac{number\ of\ x's \le x_i}{n}$$

$F_0(x_i)$ = is the hypothesised or theoretical CDF being tested

$F_n(x_i)$ = is the empirical CDF of the sample

n = the number of sample

The *K-S* test statistic *D* is the largest absolute deviation between $F_0(x_i)$ and $F_n(x_i)$ over the range of the random variable. The null hypothesis (H_0) of this test is that the empirical data follow a specific probability distribution and the alternative hypothesis (H_A) is that the empirical data do not follow a specific probability distribution. In the present study this test is used to rank the best-fit models based on the lowest value of the *K-S* test statistic. According to Oakshott (1997), for a large[7] sample size (n), the approximate critical value at 5 percent significance level can be calculated using the following formula:

$$\frac{1.36}{\sqrt{n}} \tag{5.3}$$

Therefore, based on the sample size given in Section 5.2.1, approximate critical values for the *K-S* test can be calculated for different household groups. For instance, critical values for *ULIHH*, *RLIHH*, *ELIHH*, *UHIHH* and *RHIHH* are 0.110, 0.043, 0.144, 0.143 and 0.105, respectively. We also calculate the data-based value of the *K-S* test statistics and their rankings for various functional forms fitted for urban, rural and estate household groups for the low-income and high-income households.

Anderson-Darling (A-D) goodness-of-fit test

This test is similar to the *K-S* test and can be performed only for sample data of continuous distributions. Similarly the *A-D* statistic is also not sensitive to the binning process, as this does not require binning. However, unlike the *K-S* test, the *A-D* test detects the deviations in the tails and gives more weight to the tails of the distribution. Furthermore, the *A-D* test makes use of the exact distribution being tested in calculating the critical values. Therefore, the A-D test is a more sensitive test compared to the other two tests (*NIST/SEMATECH e-Handbook of Statistical Methods*, 2003). Due to these advantages *A-D* statistic is more preferred to other statistics in determining the goodness of fit of a distribution. However, the main disadvantage of this test is that the critical values need to be estimated for each distribution. The *A-D* statistic can be defined as:

$$A_n^2 = n\int_{-\infty}^{+\infty}\left[F_n(x)-\hat{F}(x)\right]^2\psi(x)\hat{f}(x)dx \qquad (5.4)$$

where

n = total number of data points

$$\psi^2 = \frac{1}{\hat{F}(x)\left[1-\hat{F}(x)\right]}$$

$\hat{f}(x)$ = the hypothesised density function

$\hat{F}(x)$ = the hypothesised cumulative distribution function

$$F_n(x) = \frac{N_x}{n}$$

N_x = the number of x_i's less than x

In the present study this test is used to rank the best-fit models based on the lowest value of the *A-D* statistic. To do this we calculate the data-based value of the *A-D*

[7] For a sample size over 30

statistics and their rankings for numerous functional forms fitted for urban, rural and estate household groups for low-income and high-income households respectively.

The distribution fitting was conducted using the statistical package *BestFit* (probability distribution fitting for Microsoft Windows Version 4.5.2, 2002). We carried out the above three statistical goodness-of-fit tests. The *BestFit* produces fitness statistics that measure how good the distribution fits the input data. Accordingly, we calculated the *Chi-squared*, *A-S* and *A-D* statistics for each income distributional functional form under five household groups. The best-fit models were ranked based on the lowest value for the above three tests.

Table 5.2 presents the data-based value of the three test statistics and their rankings under the different functional forms for low-income household groups. For instance, the lowest values for *Chi-squared*, *K-S* and *A-D* test statistics in urban low-income households are 16.51, 0.05 and 0.46, respectively. Similarly, in rural low-income and estate low-income household groups, the lowest values for the above test statistics are 217.6, 0.04, 1.81 and 7.6, 0.10, 1.07, respectively. According to all three statistical tests, based on the lowest value of the goodness-of-fit test statistic, the beta general distribution was ranked as the best-fit functional form in describing the income distribution of all low-income household groups. Moreover, according to the *K-S* test statistic values presented in columns (4), (10) and (16) of Table 5.2, we could observe that the test statistics for beta distribution under low-income household groups are smaller than the critical values at 5 per cent significance level. Thus, the null hypothesis that the empirical data follow a specific probability distribution is not rejected. The outcome of these statistical tests is further justified by the graphical goodness-of-fit tests described in Section 5.3.2.2. According to the second lowest values of the *Chi-squared*, *K-S* and *A-D* test statistics (16.99, 0.07 and 0.76, respectively) the triangular distribution was ranked as the next best distribution for urban low-income households. In contrast, lognormal distribution was ranked as the next best distribution based on all statistical tests for the estate low-income group and based on *K-S* and *A-D* tests for the rural low-income group. However, according to the value of the *Chi-squared* statistic, 293.4, the triangular distribution could be ranked as the next best distribution for the rural low-income household group.

Table 5.3 presents the results of the goodness-of-fit test statistic under urban and rural high-income household groups. According to the *K-S* and *A-D* test statistics, 0.095 and 1.39, respectively, observed for the urban high-income household group, exponential distribution is ranked as the best fit distribution while lognormal distribution is ranked the second best. Moreover, in both distributions we do not reject the null hypothesis at 5 per cent significance level under *K-S* test. However, when we look at the *Chi-squared* test statistic values and their ranking, the beta distribution is ranked number one while the triangular distribution is ranked second. In contrast, for the rural high-income household group, inverse Gaussian distribution is ranked number one based on *K-S* and *A-D* statistics while beta and exponential distributions are ranked as the best and the second best distributions, respectively. Furthermore, in both distributions we do not reject the null hypothesis at 5 per cent significance level under the *K-S* test.

Table 5.2
Goodness-of-Fit Statistics for Fitted Income Distributional Functional Forms for Low-Income Households, Sri Lanka

Distribution	Urban Low-income Households						Rural Low-income Households						Estate Low-income Households					
	Chi-squared Test		K-S Test		A-D Test		Chi-squared Test		K-S Test		A-D Test		Chi-squared Test		K-S Test		A-D Test	
(1)	Test Statistic (2)	Rank (3)	Test Statistic (4)	Rank (5)	Test Statistic (6)	Rank (7)	Test Statistic (8)	Rank (9)	Test Statistic (10)	Rank (11)	Test Statistic (12)	Rank (13)	Test Statistic (14)	Rank (15)	Test Statistic (16)	Rank (17)	Test Statistic (18)	Rank (19)
BetaGeneral	16.51	1	0.05	1	0.46	1	217.6	1	0.04	1	1.81	1	7.6	1	0.10	1	1.07	1
Chi-Sq.	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.71*	8	+Infinity	8
Exponential	28.79	4	0.17*	4	6.02	4	343.6	4	0.16*	4	36.50	4	33.9	6	0.29*	6	8.15	5
InvGauss	37.75	5	0.18*	5	7.69	5	496.2	5	0.19*	5	55.49	5	15.9	3	0.19*	3	4.15	3
Lognormal	19.2	3	0.10	3	2.49	3	343.4	3	0.10*	2	15.03	2	9.5	2	0.13	2	2.31	2
Pearson5	57.76	7	0.18*	6	9.16	6	-	-	-	-	-	-	25.5	5	0.21*	4	5.68	4
Triangular	16.99	2	0.07	2	0.76	2	293.4	2	0.13*	3	25.06	3	22.1	4	0.27*	5	9.76	6
Uniform	49.42	6	0.25*	7	15.80	7	832.8	6	0.36*	6	252.50	6	83.4	7	0.44*	7	27.23	7

* Significant at 5 per cent significance

Table 5.3
Goodness-of-Fit Statistics for Fitted Income Distributional Functional Forms for High-Income Households, Sri Lanka

Distribution	Urban High-income Households						Rural High-income Households					
	Chi-squared Test		K-S Test		A-D Test		Chi-squared Test		K-S Test		A-D Test	
(1)	Test Statistic (2)	Rank (3)	Test Statistic (4)	Rank (5)	Test Statistic (6)	Rank (7)	Test Statistic (8)	Rank (9)	Test Statistic (10)	Rank (11)	Test Statistic (12)	Rank (13)
BetaGeneral	18.74	1	0.136	6	-	6	43.20	1	0.147*	6	-	6
Exponential	66.89	4	0.095	**1**	1.39	**1**	71.34	2	0.124*	5	3.29	4
InvGauss	85.56	5	0.109	3	1.87	3	84.26	5	0.082	**1**	2.11	**1**
Lognormal	86.90	6	0.101	2	1.69	2	87.21	6	0.087	2	2.16	2
Pareto	90.82	7	0.111	5	-	7	79.04	3	0.091	4	-	7
Pearson5	98.92	8	0.109	4	2.02	4	107.40	7	0.090	3	2.36	3
Triangular	49.19	2	0.165*	7	-	8	83.05	4	0.255*	7	-	8
Uniform	53.61	3	0.287*	8	11.65	5	184.20	8	0.384*	8	51.86	5

* Significant at 5 per cent significance

5.3.2.2 Graphical goodness-of-fit tests[8]

The results of the statistical goodness-of-fit tests discussed above are further verified by using a range of graphical tests which are complementary to these tests. This section intends to scrutinise these graphical tests.

Comparison graphs

The comparison graphs display the input data and the fitted distribution on the same graph. Thus, it allows us to visually compare the PDF or the CDF and determine the accuracy of the fit. Similarly, it allows us to detect the match around specific areas such as the mid section or the tails. Figures 5.1 to 5.5 present the comparison graphs for different household groups. The outputs of the comparison graphs drawn under all household groups further justify the conclusions suggested by the goodness-of-fit statistical tests.

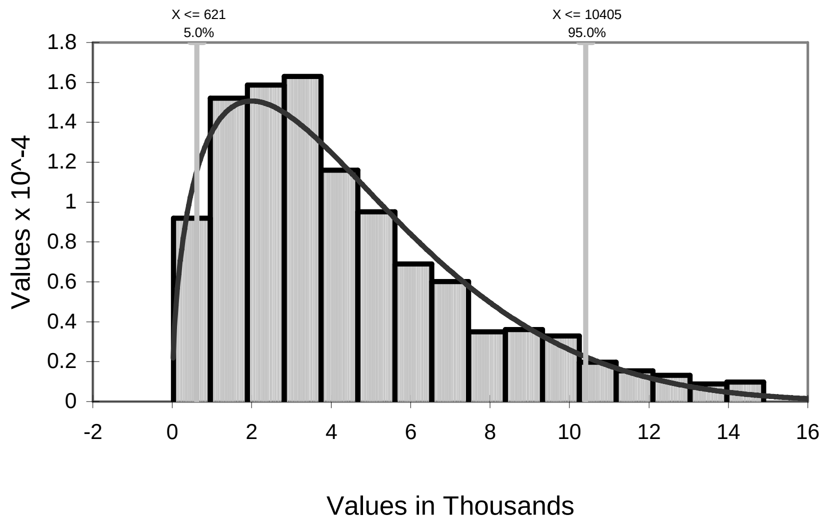

Figure 5.1: Beta Distribution for Rural Low-Income Households

[8] The overview of graphical goodness-of-fit tests is based on the *Bestfit* (2002) user manual and *NIST/SEMATECH e-Handbook of Statistical Methods* (2003).

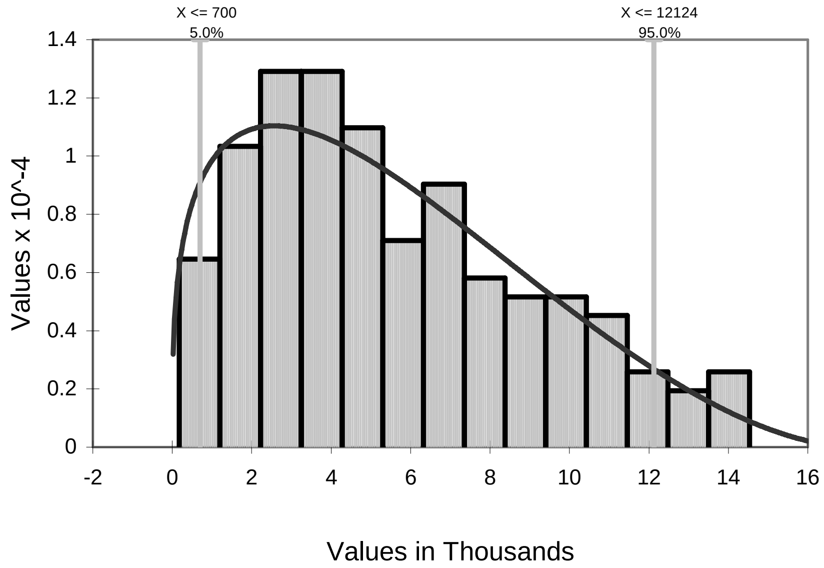

Figure 5.2: Beta Distribution for Urban Low-Income Households

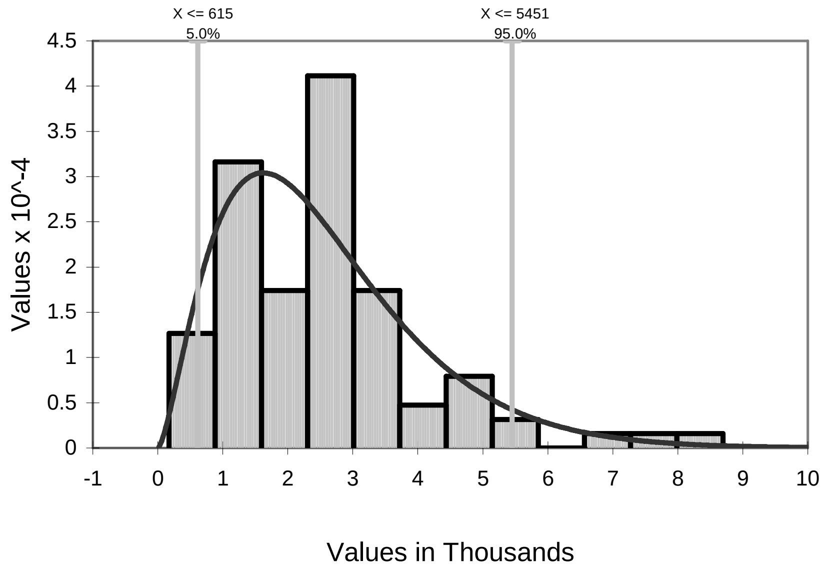

Figure 5.3: Beta Distribution for Estate Low-Income Households

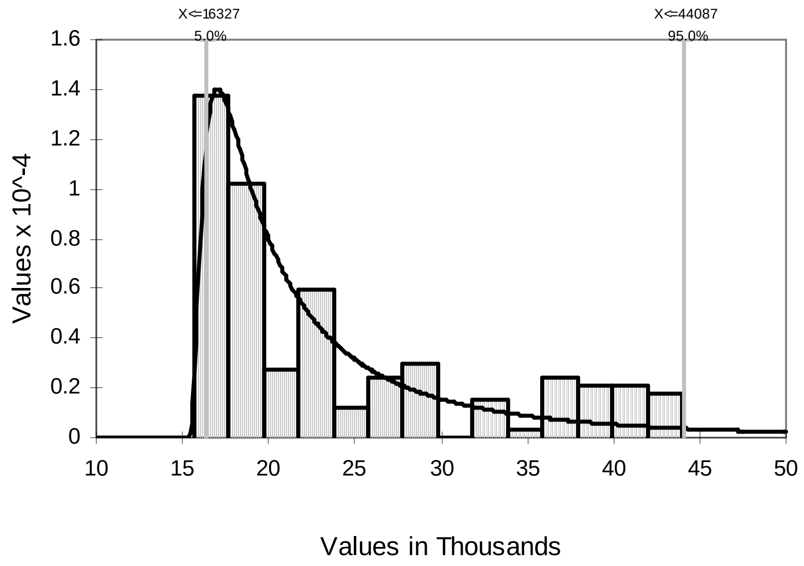

Figure 5.4: Inverse Gaussian Distribution for Rural High-Income Households

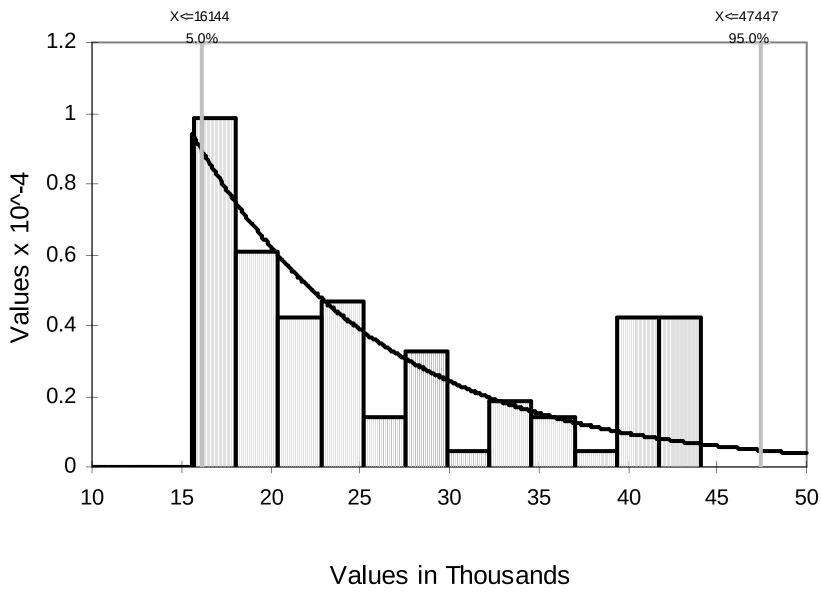

Figure 5.5: Exponential Distribution for Urban High-Income Households

Difference graphs

The difference graphs depict the absolute error between the input data and the fitted distribution. If the error closely fluctuates around zero, the model fits well. If it shows a significant departure from zero, it suggests a mismatch between the input data and the fitted distribution. Figures 5.6 to 5.10 present the difference graphs for different household groups.

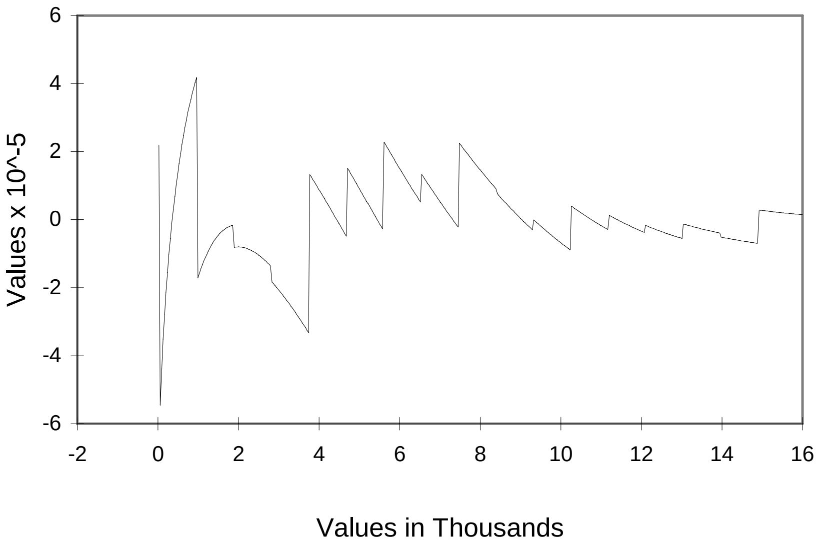

Figure 5.6: Difference Graph for Rural Low-Income Households (RLIH)

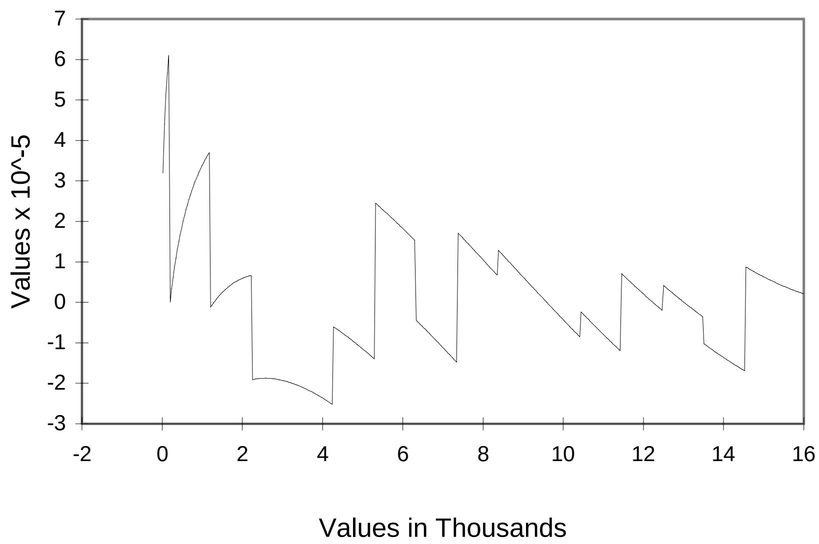

Figure 5.7: Difference Graph for Urban Low-Income Households

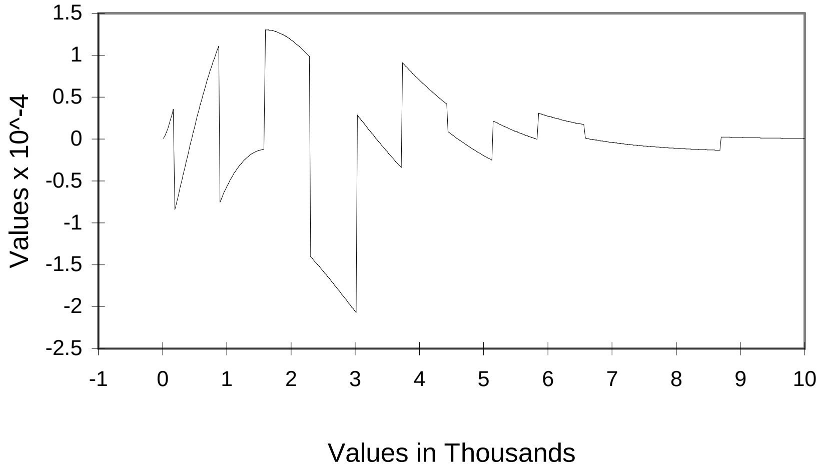

Figure 5.8: Difference Graph for Estate Low-Income Households

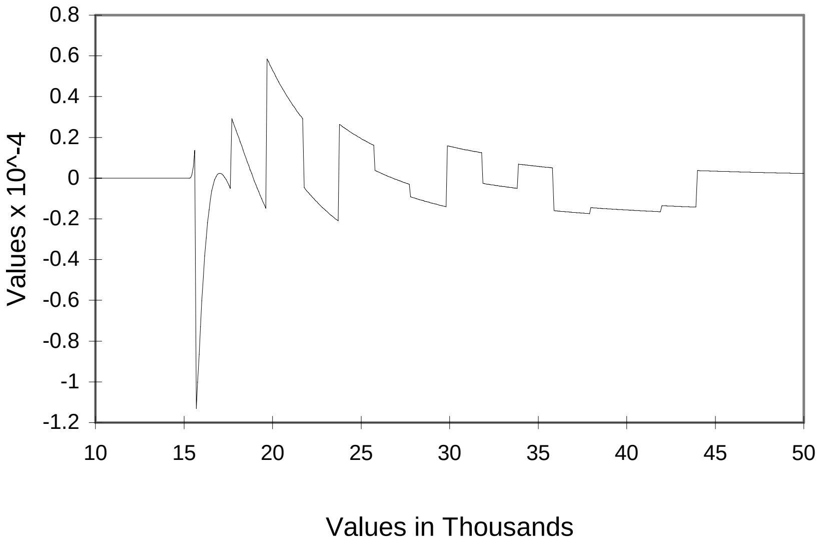

Figure 5.9: Difference Graph for Rural High-Income Households

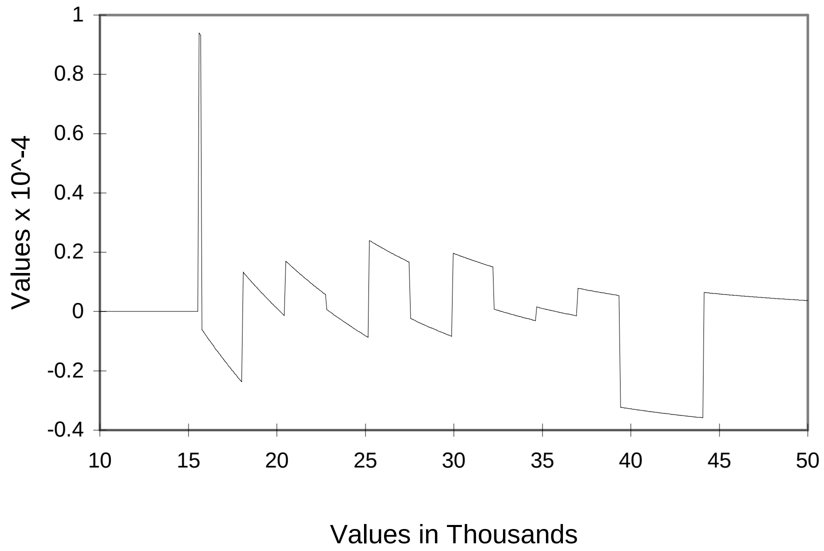

Figure 5.10: Difference Graph for Urban High-Income Households

It can be observed that the difference graphs drawn for low-income household groups tend to fluctuate closer to zero compared to those drawn for high-income household groups. Thus, it suggests that the fitted distributions on low-income household groups are much more reliable.

Probability–Probability (P–P) graphs

The probability plot (Chambers *et al.*, 1983) is another graphical tool that is used to judge whether a data set follows a particular probability distribution. In this, we plot the empirical cumulative distribution function against the theoretical cumulative distribution function. If the empirical distribution fits well with the theoretical distribution, then all points in this plot should fall approximately on the diagonal line. Any deviation from this straight line implies the departure of the empirical distribution from the theoretical distribution. Figures 5.11 to 5.15 present the P–P graphs for different household groups.

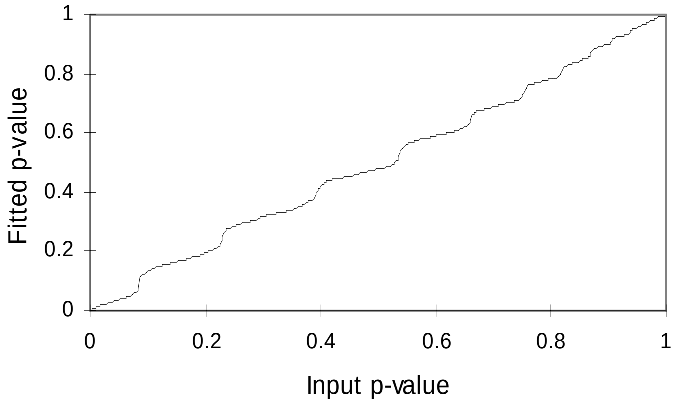

Figure 5.11: Probability–Probability Graph for Rural Low-Income Households

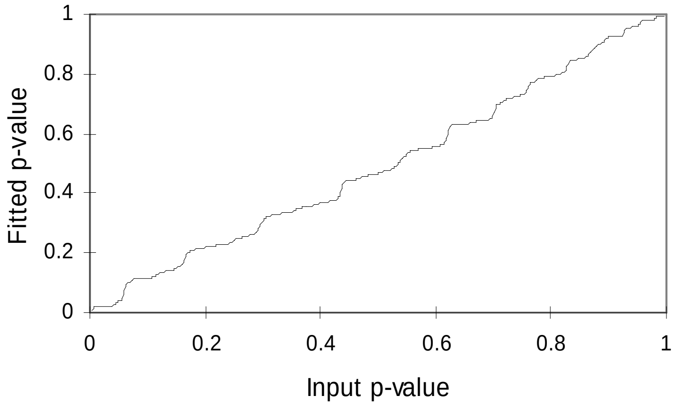

Figure 5.12: Probability–Probability Graph for Urban Low-Income Households

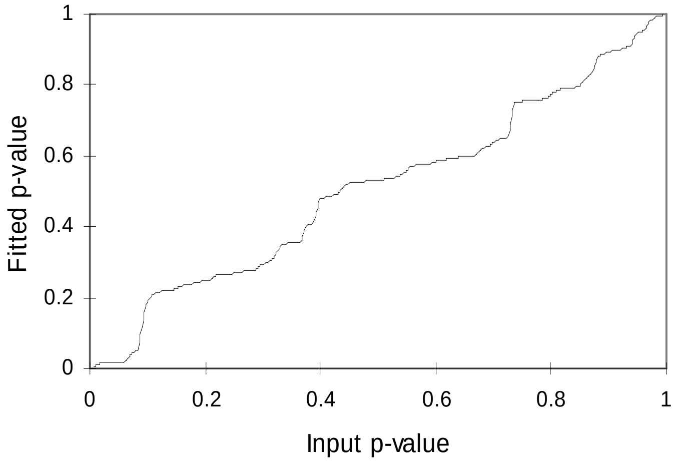

Figure 5.13: Probability–Probability Graph for Estate Low-Income Households

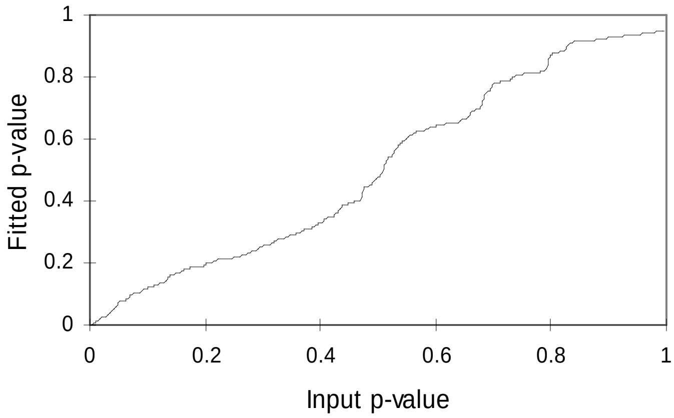

Figure 5.14: Probability–Probability Graph for Rural High-Income Households

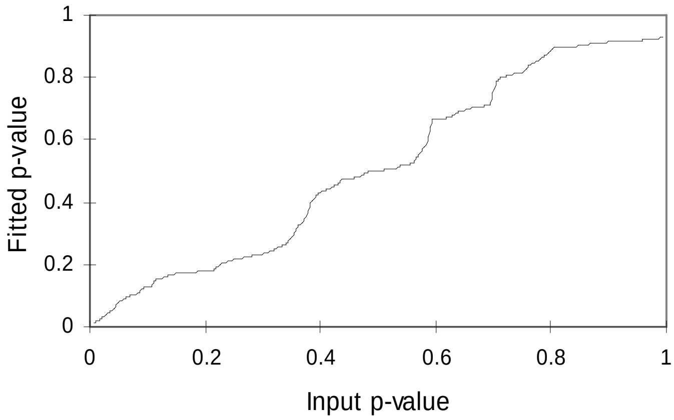

Figure 5.15: Probability–Probability Graph for Urban High-Income Households

Quantile–Quantile (Q–Q) graphs

The quantile–quantile plot is a graphical technique similar to the *P–P* graphs, which can be used to find the ideal probability distribution for a given set of data. In this, we plot the quantiles of the empirical distribution against that of the theoretical distribution. Just as the *P–P* plots, we can identify a good fit of the theoretical distribution to the empirical distribution by observing whether the data points fall onto a straight line. A significant departure from the straight line implies a bad fit. Figures 5.16 to 5.20 present the *Q–Q* graphs for different household groups.

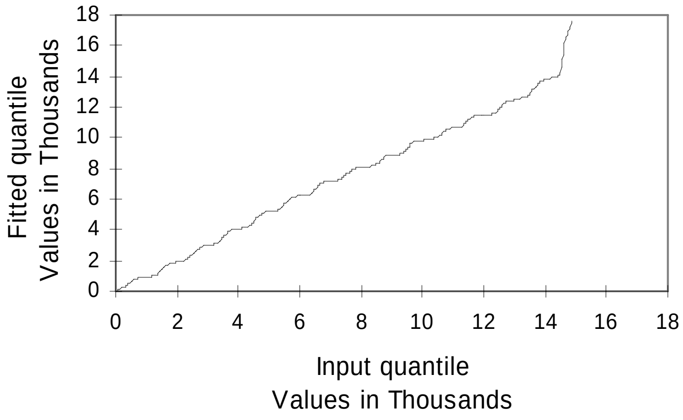

Figure 5.16: Quantile–Quantile Graph for Rural Low-Income Households

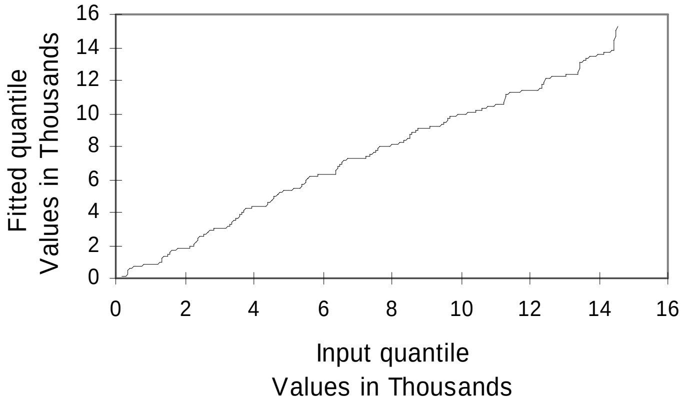

Figure 5.17: Quantile–Quantile Graph for Urban Low-Income Households

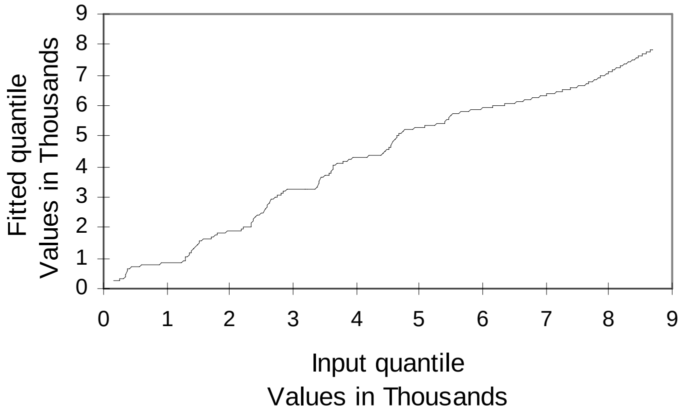

Figure 5.18: Quantile–Quantile Graph for Estate Low-Income Households

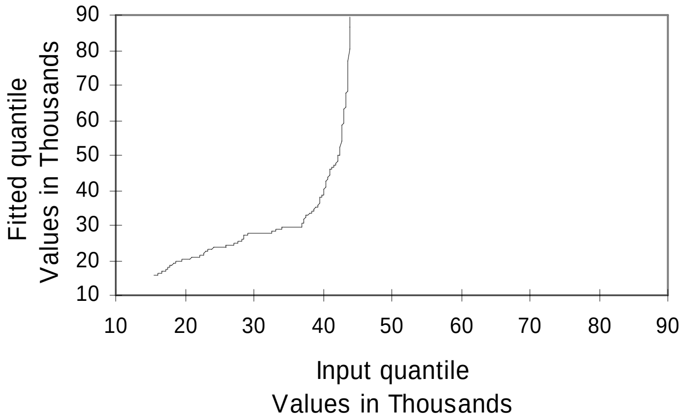

Figure 5.19: Quantile–Quantile Graph for Rural High-Income Households

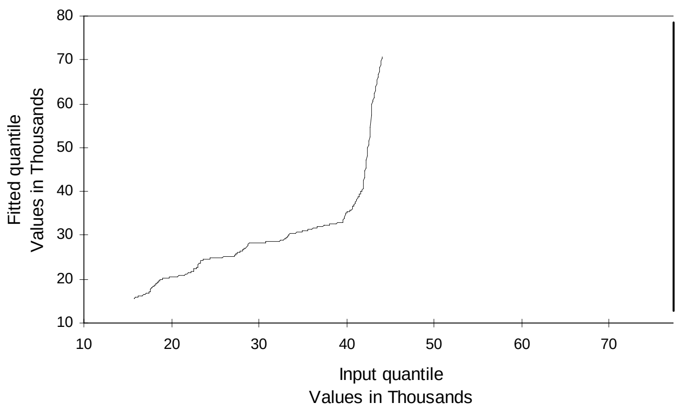

Figure 5.20: Quantile–Quantile Graph for Urban High-Income Households

The above graphical plots drawn for low-income household distributions further justify the conclusions suggested by the statistical goodness-of-fit tests. Therefore, we could conclude that the empirical income distribution functions of all low-income household groups – *RLIHH*, *ULIHH* and *ELIHH* – follow the beta general probability distribution function.[9] Moreover, we could observe that the beta distribution is skewed to the right in all three cases, suggesting that the income of the majority of households within each household group fall below the median of respective group. Hence, these low-income

[9] Several earlier researchers have also found beta general distribution or different versions of beta distribution as the best-fit income distribution functional form for various economies. For details see Thurow (1970); McDonald (1984); McDonald and Xu (1995); Bordley *et al.* (1996); and Bandourian (2000).

household groups can be considered to contain individual households which are highly vulnerable to negative economic shocks. When we observe the graphical plots on high-income household groups, particularly by looking at the *Q–Q* plots, it is evident that a weaker fit exists between the empirical and theoretical probability distribution functions. However, as we are mainly focussing in this study on the impact of trade reforms on the absolute poverty, we do not intend to find the most suitable probability distribution function for high-income household groups as the income of households in these groups are well above the poverty line. Therefore, we focus on the income distribution patterns of the low-income household groups. The next section intends to scrutinise the characteristics of the beta general probability distribution function and the procedure involved in estimating the parameters of these distributions.

5.3.3 Beta Income Distribution Function

This section will briefly present the main features of the beta general income distribution functional form and the process involved in estimating parameters. Beta distribution function is a more flexible functional form for income distribution analysis compared to other popular distributions. Its main strength lies in its flexibility in specifying asymmetric – left or right skewed – as well as symmetric distributions.[10] The flexible functional forms are more appropriate for specifying income distributions in many economies (Bordley *et al.*, 1996).

Beta distributions can be defined for random variables whose values occur in the interval between 0 and 1 (Derman *et al.*, 1973). As income vectors can not be observed between 0 and 1 it is important to transform the data using the following formula in order to estimate the parameters of the beta distribution.

$$Y = \frac{X - a}{b - a} \qquad (5.5)$$

where

X = random variable of interest (household income)

Y= transformed random variable

a = minimum value

b = maximum value

Thus, the possible values of the transformed variable would come within the range of 0 and 1. For instance, if the values for a = 0 and b = 1, no transformation is required for the random variable.

The beta distribution depicts a set of curves that are nonzero only for the random variable values between 0 and 1. The general form of the PDF of the beta distribution function could be expressed using the mathematical definition

$$y = f(x|p,q) = \frac{1(x-a)^{p-1}(b-x)^{q-1}}{B(p,q)(b-a)^{p+q-1}} \qquad \text{for } a < x < b \qquad (5.6)$$

where

$$B(p,q) = \int_a^b \frac{(x-a)^{p-1}(b-x)^{q-1}}{(b-a)^{p+q-1}} \, dx \qquad (5.7)$$

ρ = parameter influencing the shape of the distribution

q = parameter influencing the skewness of the distribution

[10] For a detailed review on the characteristic of beta probability distribution function see Johnson and Kotz (1970) and Derman *et al.* (1973).

a = minimum income within a particular household income group

b = maximum income within a particular household income group

in the above given beta distribution function, b and a are the maximum and minimum incomes, respectively, within a particular household income group. The parameters p and q, respectively, influence the shape and the skewness of the distribution. We estimate p and q using the maximum likelihood (ML) method.[11] Table 5.4 presents the estimated beta distribution parameters for the low-income household groups.

Table 5.4
Parameters for the Beta Income Distribution Function, Sri Lanka

Parameter	Urban low-income households	Rural low-income households	Estate low-income households
p	1.035	1.190	1.799
q	1.672	2.703	4.739
b	14531	14889	8694.30
a	172.51	31.88	172.72

[11] Maximum Likelihood Estimation (MLE)
If x is a continuous random variable whose probability density function can be defined as:

$$f(x;\phi_1,\phi_2,......,\phi_k)$$

the MLEs of the distribution function are, $\phi_1,\phi_2,......,\phi_k$, unknown constant parameters of that function which maximise the likelihood of the distribution for a given set of observations. Thus, in order to estimate these parameters, N independent observations of x ($x_1, x_2, ..., x_N$) could be obtained by conducting an experiment. The likelihood function for these data can be given as:

$$L(x_1, x_2,....,x_N \mid \phi_1,\phi_2,.....,\phi_k) = L = \prod_{i=1}^{N} f(x_i;_2\ \phi_1,\phi_2,......,\phi_k)$$

where i= *1,2,...,N*
the logarithmic function of the above likelihood function can be defined as:

$$\Lambda = \ln L = \sum_{i=1}^{N} \ln f(x_i;\phi_1,\phi_2,.....,\phi_k)$$

the ML estimators can be obtained by maximising either the above likelihood function (L) with respect to ϕ_j or the logarithmic function Λ with respect to ϕ_j

thus solve for ϕ_j such that,

$$\frac{\partial(L)}{\partial\phi_j} = 0 \quad \text{or} \quad \frac{\partial(\Lambda)}{\partial\phi_j} = 0\,, \quad j = 1, 2, \ldots.., k$$

For a detailed explanation of MLE method see (Myung, 2001). In this study, the ML parameter estimation was carried out using the *MATLAB* statistical tool kit (1998).

The parameter values suggest that all three low-income distributions having positively skewed income distributions. This suggests that the majority of households in all three income groups are low-income households. Thus, the large segment of these three household groups is comprised of individual households which are highly vulnerable to negative income shocks. Moreover, it can also suggest that there is notable within group income inequality in all three groups. When compared among three household groups, it can be observed that as the parameter value q is largest (4.739) in *ELIHH*, it is more positively skewed compared to the other two groups, suggesting that it is the most vulnerable household group for negative income shocks. *RLIHH* stands next in terms of skewness, so does the vulnerability. A large number of households belong to this income group. Therefore, any shock which affects the income of this group will be of grave concern. In contrast, *ULIHH* seems to be less vulnerable compared to the other two household groups, though this group is positively skewed too.

The next section describes the estimation of the various poverty measures for Sri Lanka within the above low-income household groups, particularly the FGT poverty measure. Furthermore, it also presents other important poverty and inequality indices estimated for the base year.

5.4 POVERTY AND INEQUALITY INDICES

This section illustrates the estimation of base year household group level poverty indices and inequality indices for Sri Lanka. The year 1995 has been selected as the base year for the simulations that are carried out with the *SLGEM–P* and income distribution functions. Therefore, this section will outline the procedure adopted in estimating a range of household level indices of absolute poverty and overall income inequality for Sri Lanka for the year 1995. These values in turn will be used as the base case scenario in the trade policy shock simulations conducted in Chapter 7.

5.4.1 Estimation of Poverty Indices

In this study, we estimate several poverty indices to verify the robustness of the estimates.[12] The importance of multiple poverty measures has been highlighted by Zheng (1997). Moreover, in the present study, poverty indices are mainly computed for different household groups. As the high-income household groups, *UHIHH* and *RHIHH*, contain individual households with an income well above the poverty line, only the low-income household groups, *ULIHH*, *RLIHH* and *ELIHH*, are used in estimating poverty indices.

As detailed in Section 4.4.8 of Chapter 4, the base year poverty line per household is estimated by multiplying the 1995 basic needs per person monetary poverty line of Rs. 791.67/person/month (estimated by World Bank, 2000) by the 1996/97 average household size of 4.61 (estimated in the CFS, 1999). Thus, the basic needs monetary poverty line can be estimated as Rs. 3649.6/month/household for the base year.

We adopt two approaches in estimating poverty within different low-income household groups, (1) estimate the FGT poverty indices within the empirically estimated beta probability density function, and (2) estimate a range of other poverty indices adopting the *DAD* approach (Duclos *et al.*, 2002). The following sections will discuss these approaches in detail.

[12] For detailed discussion on various poverty measures see Ravallion (1994); Zheng (1997); Duclos and Gregoire (2003) and Duclos and Araar (2004).

FGT Poverty Index

The main poverty measurements used in the study are the most popular money-metric poverty indices of FGT. The FGT P_α measure consists of a class of additively decomposable poverty measures and can be mathematically expressed in terms of the beta distribution function as:

$$P_\alpha = \int_a^z \left(\frac{z-y}{z}\right)^\alpha I(y; p, q)dy \qquad (5.8)$$

where z is the poverty line, *a* is the minimum income, *p* and *q* are the parameters of the beta distribution function and α is the ethical parameter or poverty aversion parameter which differentiates members within the distribution. For α=0, P_α becomes the standard headcount ratio i.e., the proportion of households below the poverty line. However, Watts (1968) and Sen (1976) criticised the headcount ratio on the grounds that it fails to capture the income distribution of the poor. For α=1, P_α becomes the income poverty gap in which relative importance is given to all individuals below the poverty line based on their income. In other words it measures the average shortfall of income from the poverty line. However, this measure has a disadvantage, as it does not take the inequality among the poor into consideration. Thus, when calculating the income poverty gap it gives the same weight to those who are just below and those far away from the poverty line (Boccanfuso and Savard, 2001). Moreover, as Zheng (1997) pointed out, the usefulness of anti-poverty policies cannot be captured fully using the above given headcount ratio and income poverty gap. They often record those policies which leads to poverty elimination rather than poverty alleviation. In contrast, as the value for α increases, more importance is assigned to the poorest households, which measures the severity of poverty. In this study we have set α=2, in measuring the severity of poverty. As noted by Duclos and Gregoire (2003), the FGT class of poverty indices has several advantages: (1) flexibility with respect to ethical considerations, which can be seized from the parameter α; (2) ability to decompose across subgroups; and (3) ease of calculation and understanding.

In this study, the FGT indices are estimated using a MATLAB program. Appendix C presents the MATLAB code used in estimating ML estimators of beta PDF parameters, base case FGT indices, and post simulation FGT indices. Moreover, it also contains the code used to plot the pre- and post-simulation beta distribution along with the pre- and post simulation poverty line.

Table 5.5 presents the FGT poverty indices computed for different low-income household groups for the year 1995. It can be observed that the FGT head count ratio calculated for the urban low income, rural low-income and estate low-income households are 35.70, 45.42 and 79.17, respectively. Also, the FGT poverty gap and the poverty severity indices are 17.24 and 10.99 for urban low-income households, 22.23 and 14.37 for the rural low-income households and 36.58 and 21.58 for the estate low-income households, respectively. The values for all three measures – headcount ratio, poverty gap and poverty severity – show that the estate low-income group have the highest incidence of poverty. This result further confirms the outcome of the human poverty index compiled by the UNDP (1998) at regional and district level.[13] In that study, using a multidimensional poverty index they have found that human poverty is worst in the *Nuwara Eliya* district where 31% of the population suffer poverty related deprivation and the *Monaragala* district, which is ranked next with 29%. Interestingly, a large number of estate low-income households live in these districts, particularly in the

[13] Sri Lanka is administratively divided into nine regions/provinces which include twenty five districts.

Nuwara Eliya district. The high incidence level of income poverty among estate workers could be attributed to the fact that they depend solely on labour wages for their income whereas other sources of income such as migrant remittence, government transfer payments and shares of gross operating profits from economic activates do not form a major component of their income sources.

The second highest incidence of income poverty can be observed among the rural low-income households. This group comprises peasants mainly involved in agricultural activities. Lack of infrastructure facilities and poor performance of agricultural activities along with high production costs may be responsible for the outcome. In contrast, the urban low-income households are found to have the lowest incidence of poverty among all low-income household groups. Many of them in this group are employed in manufacturing and service activities, which perform relatively well compared to agricultural activities. Moreover, due to the presence of high regional disparities in Sri Lanka, urban areas are comparatively better equipped with infrastructure facilities, thus creating more economic activities in these areas. Overall, these factors allow urban households to generate income from different sources. In the next section we employ a range of other well known poverty indices to ascertain poverty among low-income households using the same sample data, in order to asses the robustness of the FGT poverty indices.

Table 5.5
Base Year (1995) Estimates of FGT Poverty Indices (in percentages) in Sri Lanka

Poverty Index	Urban low income households	Rural low income households	Estate low-income households
FGT index			
Head count ratio (α =0)	35.70	45.42	79.17
Poverty gap (α =1)	17.24	22.23	36.58
Poverty severity (α =2)	10.99	14.37	21.58

Base poverty line = Rs.3649.6/month/household

Other Poverty Indices

In order to verify the robustness of the FGT poverty indices, a range of other popular poverty indices was computed using the sample representing *RLIHH*, *ULHH* and *ELIHH*. We employ following poverty indices to compute poverty: (1) Watts index (Watts, 1968); (2) single parameter Gini index; (3) Sen index (Sen,1976); and (4) Clark, Hemming and Ulph's (CHU) index (Clark *et al.*, 1981). The functional forms, parameters and restrictions of these poverty indices are given in Table 5.6. These indices are computed using the DAD/distributional analysis software (Duclos *et al.*, 2002) specifically developed for poverty and inequality estimations. In these calculations the DAD approach adopts a non-parametric density estimation method known as the Kernel method.[14]

[14] For details of the Kernel method used in the DAD approach see Boccanfuso and Savard (2001) and Duclos and Araar (2004).

Table 5.6
Other Poverty Indices

Poverty Index	Functional form	Parameters and Restrictions
S-Gini Index	$P(z;\rho) \equiv P(z;\rho,\varepsilon=0) = z - \int_0^1 Q^*(p;z)\omega(p;\rho)dp$	$Q^*(p;z)$ = the distribution of income censored at the poverty line, z. ρ = 2
Watts Index	$PW(z) = \int_0^1 \ln\left(\frac{z}{Q^*(p;z)}\right)dp$	$Q^*(p;z)$ = the distribution of income censored at the poverty line, z.
Sen Index	$S = H\left[I + (1-I)G_p\left(\frac{q}{q+1}\right)\right]$	H = headcount poverty ratio, I = ratio of average income shortfall to the poverty line, G_p = Gini coefficient of income among the poor and q = number of people below the poverty threshold
CHU Index	$P(z;\varepsilon) = \begin{cases} z - \left(\int_0^1 Q^*(p;z)^{(1-\varepsilon)}dp\right)^{\frac{1}{1-\varepsilon}}, & when \quad \varepsilon \neq 1, \\ z - exp\left(\int_0^1 ln(Q^*(p;z))dp\right), & when \quad \varepsilon = 1. \end{cases}$	$Q^*(p;z)$ = the distribution of income censored at the poverty line, z.

Sources: Duclos and Araar (2004)

The computed values for other poverty indices mentioned above are given in Table 5.7. These results further confirm the outcome of FGT poverty measures, suggesting that *ELIHH* had the highest incidence of poverty, *RLIHH* ranked next and *ULIHH* had the lowest incidence of poverty. Moreover, these results suggest that FGT poverty measures are robust estimators.

Table 5.7
Base Year (1995) Estimates of Poverty Indices (in percentages) in Sri Lanka

Poverty Index	Urban low income households	Rural low income households	Estate low-income households
Watts Index	0.2908	0.3854	0.6102
S-Gini Index (rho=2.0)	0.2905	0.3649	0.5261
Sen Index	0.2281	0.2982	0.4844
CHU Index (epsilon=0.5)	47.426	60.535	100.594

Base poverty line = Rs.3649.6/month/household

5.4.2 Estimation of Inequality Indices

In this section a range of inequality measures are estimated to ascertain the underlying income inequality present in the economy at the base year. We estimate three popular income inequality indices,[15] the Atkinson index (Atkinson, 1970), the S-Gini index, and the Entropy index (Theil, 1967) using the DAD approach. As in the previous case the DAD approach adopts the Kernel non-parametric density estimation method in specifying the PDF. The functional forms, parameters and restrictions of these inequality indices are given in Table 5.8. These inequality indices are estimated at household level for the aggregated sample as well as for the aggregated low-income groups separately.

Unlike poverty measurements, inequality measurements do not depend on any poverty line. Furthermore, inequality indices can be calculated for different household groups or

[15] For detailed discussion on various inequality measures see Duclos and Gregoire (2003) and Duclos and Araar (2004).

for the entire population. In this study, we calculate the inequality indices separately for the total low-income households group and for the entire population. Table 5.9 presents the computed indices for the above two categories for the year 1995. The values of all three inequality indices suggest that the total low-income household group is relatively homogenous compared to the entire population. For instance, the Gini index for the total low-income household group is estimated as 0.3889 whereas the same index for the entire population can be estimated as .5306. This kind of information is valuable in designing policy interventions.

5.5 LINKING THE INCOME DISTRIBUTION FUNCTIONS WITH THE CGE MODEL

This section briefly explains the steps involved in linking the *SLGEM–P* developed in Chapter 4 and the income distribution functions developed earlier in this chapter to carry out policy experiments on trade reforms, to be discussed in the Chapter 7. The *SLGEM–P* model and the income distribution functions for the five income groups have been linked in a "top down" fashion. As described in Chapter 4 the *SLGEM–P* generates the percentage change in disposable (post tax) income from the base case for all five household groups. The post-simulation individual household income in each household income group is obtained by multiplying the base case individual income of each group with the post-simulation percentage change in income obtained from the *SLGEM–P* for the respective group. Here it is assumed that the variance of the probability distribution remains the same for the simulation. Therefore, depending on the direction of the change in income, the mean income of the respective household distributions would shift to the right or the left, without changing the shape of the probability distribution. In the case of low-income household groups in Sri Lanka, these probability distributions are beta distributions that have been estimated in this chapter.

Table 5.8
Inequality Indices

Name of the Inequality Index	Functional form	Parameters and Restrictions
Single parameter Gini Index(*S-Gini Index*)	$I(\rho)=\int_0^1 (p-L(p))k(p;\rho)dp$ $where \quad k(p;\rho) = \rho(\rho-1)(1-\rho)^{(\rho-2)}$	$p-L(p)$ = the deficit between population shares, p, and shares in income, $L(p)$. When ρ =2 , $I(\rho)$ is the standard Gini index.
Atkinson Index	$I(\varepsilon)=I(\rho=1,\varepsilon)=\begin{cases} 1-\dfrac{\left(\int_0^1 Q(p)^{(1-\varepsilon)}dp\right)^{\frac{1}{1-\varepsilon}}}{\mu}, when \quad \varepsilon \neq 1, \\ 1-\dfrac{exp\left(\int_0^1 ln(Q(p))dp\right)}{\mu}, when \quad \varepsilon = 1. \end{cases}$	$Q(p)$ = income and ε = the Atkinson parameter of relative inequality aversion.
Entropy Index	$I(\theta)=\begin{cases} \dfrac{1}{\theta(\theta-1)}\left(\int_0^1 \left(\dfrac{Q(p)}{\mu}\right)^{\theta} dp-1\right), & if \quad \theta \neq 0{,}1 \\ \int_0^1 ln\left(\dfrac{\mu}{Q(p)}\right)dp, & if \quad \theta = 0 \\ \int_0^1 \dfrac{Q(p)}{\mu} ln\left(\dfrac{Q(p)}{\mu}\right)dp, & if \quad \theta = 1 \end{cases}$	$Q(p)$ = income, μ = mean and when θ = 1, it gives the *Theil index of inequality*

Sources: Duclos and Araar (2004)

Table 5.9
Estimates of the Inequality Indices (Base year = 1995), Sri Lanka

Inequality Index	Total households	Total low-income households
Atkinson Index (epsilon=0.5)	.2281	0.1299
S-Gini Index (rho=2.0)	.5306	0.3889
Entropy Index (theta=1.0)	.4900	0.2481

Similarly, as described in Chapter 4, the *SLGEM–P* model generates the percentage change in the national poverty line over the base year poverty line. This percentage change in poverty line and the respective shift in mean of the beta income distribution functions – that measures the change in income – would be used to estimate FGT poverty measures for different household groups. Thus, FGT poverty measures were computed not only for the base case but also for the post-simulation case; the percentage change in these measures is reported. Similarly, the post-simulation income of individual households can be fed into the DAD program to generate a range of poverty and inequality indices. Finally, the percentage change in the values of these indices with respect to base case scenario will be reported.

The linking of the *SLGEM–P* model and the beta income distribution functions is essentially a top down process, as no feedback has been allowed from the beta income distribution function to the *SLGEM–P* model. Figure 5.21 presents the major components of the *SLGEM–P* model and their relationships. It also presents software packages used in implementing the different components of the model.

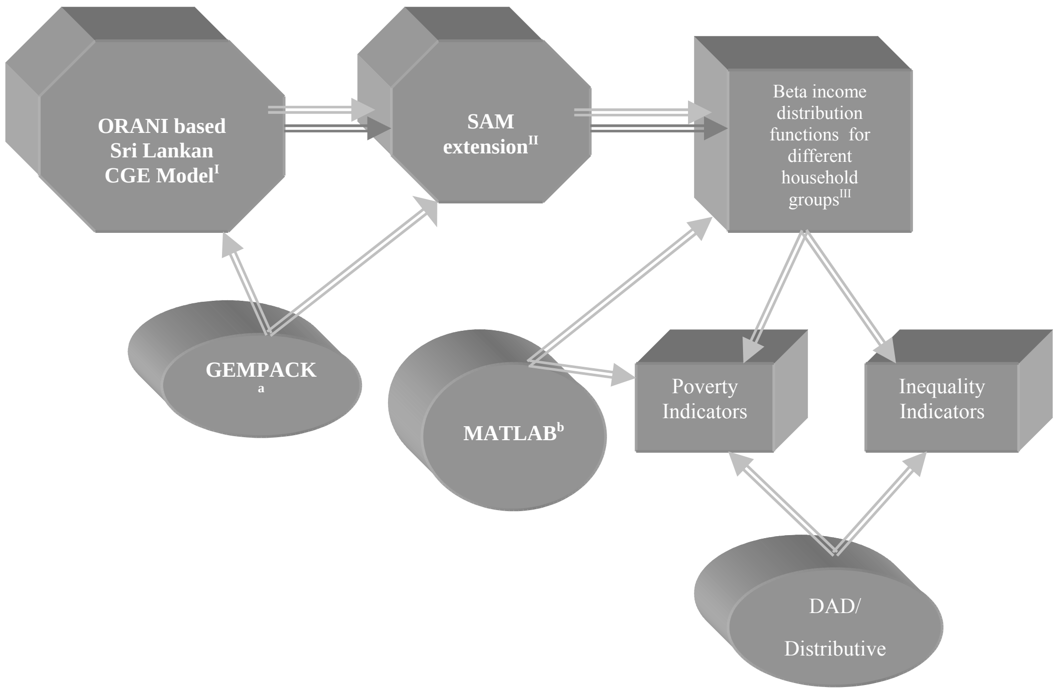

Figure 5.21: Major components and the linking process of the *SLGEM–P* model with beta income distribution functions along with associated computational software

I Orani based comparative static Sri Lankan CGE model
II SAM extension which links the CGE model to a SAM database
III Empirically estimated beta income distribution models for different households which generate poverty and inequality indicators
a GEMPACK software suite has been used to solve the CGE model with the SAM extension
b MATLAB – Statistical Toolbox has been used to estimate the parameters of the Beta distribution models and computation of FGT poverty indicators.
c DAD/Distributive Analysis software has been used to compute other poverty and inequality measures.

5.6 CONCLUDING REMARKS

This chapter explained the methodology involved in empirically estimating the best-fit income distribution functions for the different household groups in the *SLGEM–P* model for Sri Lanka. The empirical estimation of best-fit income distribution functional forms for different household groups and the linking of household level income distribution functions with a national CGE model was carried out for the first time in the Sri Lankan context. The results suggest that the income distribution of all low-income household groups follow the beta general probability distribution function. These distribution functions in turn were used to estimate various poverty and inequality indices for the base year. The next chapter presents the SAM database along with other parameters and coefficients necessary for the successful implementation of the *SLGEM–P* model in trade policy simulation.

CHAPTER 6

SOCIAL ACCOUNTING MATRIX (SAM) FOR SRI LANKA AND OTHER DATA FOR *SLGEM–P*

6.1 INTRODUCTION

The objective of this chapter is to describe the structure and procedure of compilation of the database used in implementing the *SLGEM–P* model developed in Chapter 4. To implement a CGE model with an income distribution component, two types of databases are required, namely a Social Accounting Matrix (SAM) including an Input-Output (IO) database and different elasticity estimates. Even though there are several recently developed SAMs available for many developing countries (for example, see Warr and Azis, 1997 for Indonesia; Pradhan *et al*., 2001 for India; Nielsen, 2001 for Vietnam), there is no available SAM recently developed for Sri Lanka. The latest published disaggregated SAM for Sri Lanka is for the base year 1980 compiled by Mertens (1984). This lack of a recent SAM for Sri Lanka posed a major obstacle to the implementation of the model. In order to overcome this problem we developed a disaggregated SAM using available macro and micro data for the base year 1995.

This chapter focuses on the development of the disaggregated SAM for Sri Lanka (*SL-SAM95*), the input-output data matrices and other miscellaneous data such as various elasticities required for the implementation of the model.

The remainder of this chapter is organised as follows. Section 6.2 presents a brief introduction of SAM databases and a historical overview of the construction of SAMs in Sri Lanka. Section 6.3 describes the macroeconomic accounting framework of the 1995 SAM. Construction methodology by major blocks is illustrated in Section 6.4. Section 6.5 explains the procedure used in compiling other miscellaneous data required for the *SLGEM–P* model. Section 6.6 presents a summary of the chapter.

6.2 A BRIEF INTRODUCTION AND HISTORICAL OVERVIEW OF SAMS WITHIN THE SRI LANKAN CONTEXT

The motivation of constructing a Social Accounting Matrix (SAM) basically emerged from the need to reconcile the Input-Output (*I-O*) data and the national income accounts within a unified statistical framework (Robinson, 1989).[1] A SAM is a structured data matrix which depicts different activities within and outside the economy. As King (1985) notes, the principle behind SAM is similar to double entry book keeping in accounting. A SAM consists of a set of accounts, in each of which the income and the expenditure should balance. What should be an income to one industry must be an expenditure from another industry. Thus, it resembles traditional national accounts; nevertheless it contains much more information. For example, Pyatt (1988) describes the SAM as follows:

> There is only one fundamental law of economics: for every income there is a corresponding outlay or expenditure. The law is the equivalent for economists of the physicists' law of energy conservation. It plays a similar role in defining the completeness of a model or analytic formulation: no theory or model can be correct unless it is complete in the sense that all incomes and outlay are fully accounted for. A social accounting matrix, or SAM, is a simple and efficient way of representing this fundamental law. (p.329)

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[1] See Pyatt and Round (1977, 1979, 1985); Pyatt (1985, 1988, 1991); Thorbecke (1985); King (1985); Reinert and Roland-Holst (1997) and Chulu and Wobst (2001) for a detailed discussion on SAMs.

In line with the above fundamental law in economics, Pyatt and Roe (1977) noted that SAM framework should satisfy two basic rules:

(a) A SAM matrix has an equal number of rows and columns and the system is complete only if the row and column totals are equal.

(b) Every entry is considered as a receipt when it is read along the row, while it is treated as an expenditure in its column context.

Therefore, SAMs satisfy a variant of Walras's law wherein the system will be balanced when all but one account is balanced (Reinert and Roland-Holst, 1997).

There are two types of SAMs based on the level of aggregation of various accounts within the SAM, i.e., *Macro-SAM* and *Micro-SAM*. *Macro-SAM* provides a highly aggregated version of all accounts without detailing sectoral and institutional breakdowns. Moreover, there are different ways of structuring *Macro-SAM*s[2]. In contrast, *Micro-SAM* provides comprehensive details of the socioeconomic structure of the economy, particularly with detailed representation of sectors and institutions. However, the level of disaggregation is largely dependent on the availability of data and the area of focus.

Sri Lanka was the first developing country for which a SAM was developed (Pyatt and Roe, 1977). This SAM consisted of 48 sectors, with the year 1970 considered as the base year. Unfortunately Sri Lankan policy analysts did not update this at regular intervals. However, a few attempts have been made to construct SAMs for Sri Lanka in later years. Mertens (1984) constructed a 20-sector SAM for the base year of 1980, which has subsequently been used in Gutkind (1988). This SAM closely followed the general outline specified in the pioneering 1970 SAM. Maasaland (1990) and Herath

[2] For example, see Rutayisire and Vos. (1991) and Chulu & Wobst (2001).

(1994) constructed highly aggregated SAMs consisting of 4 and 6 sectors respectively. Both these SAMs were constructed for CGE models and the year 1981 was considered as the base year[3]. However, there are several drawbacks in using these SAMs for the current study. In particular, (a) the Sri Lankan economy has undergone significant changes following the liberalisation process initiated in November 1977: the full effects of this liberalization process had not been felt by the economy in 1981; (b) the level of disaggregation in terms of industries and commodities in the previous SAMs, particularly the ones that were produced during the early 1980s, were inadequate in analysing industry level effects; and (c) the economy has evolved over time and the socio-economic structure has changed substantially during the process of liberalization, thus yielding notable changes to inter-industry transactions, technological coefficients, composition of occupational labour categories and income distribution. Therefore, construction of a SAM for a base year which reflects a reasonable level of impact of the liberalisation process, especially the second wave of liberalisation in the early 1990s, is essential to carry out the analysis set out in this study. However, no attempt had been made before this study to construct a disaggregated SAM for Sri Lanka which could capture the socio-economic structure of the post-liberalisation economy. Hence, this study attempts to bridge the gap by constructing a 38-sector SAM for Sri Lanka for the base year 1995. The choice of 1995 as the base year for the SAM was largely due to the availability of a most recent disaggregated *I-O* table (DCS, 1998a) and the availability of comprehensive household level income and expenditure survey data (CFS, 1999) for Sri Lanka.

[3] Bandara and Kelegama (2005) present a historical overview of the construction of SAMs for Sri Lanka.

6.3 THE MACROECONOMIC ACCOUNTING FRAMEWORK

As noted in the previous section, a SAM is a square matrix which presents monetary flows that reflect payments and receipts of all transactions between various agents in the economy. Moreover, it follows a macroeconomic accounting framework which enables us to compute various macro identities that are consistent with available national accounts. The macroeconomic accounting framework can be expressed in the form of algebraic equations which could be used in computing various macro identities[4]. In specifying the macroeconomic framework we divide all agents in the economy into four sectors,

household (*h*),

commercial enterprises (*e*),

government (*g*) and

the rest of the world (*r*).

Let Y_i be income, E_i be expenditure and S_i be savings in sector *i*. Furthermore, all transactions between different sectors will be denoted by T_{ij} which indicates the direction of flow from sector $_i$ to sector $_j$. For example, T_{hg} denotes the total transfers from household sector *h* to government sector *g*, while T_{gh} denotes the total transfers from government sector *g* to the household sector *h*.

The macroeconomic identities are derived by taking into account the budget constraints of all agents. However, in the enterprises sector we assume that their income is equal to the expenditure, as all net revenue would be allocated to owners of factors of production. Thus, there will be zero savings in the enterprises sector. In the following subsection we consider the four sectors individually.

[4] This study adopts the structure of a macroeconomic accounting framework presented by Warr and Azis (1997).

6.3.1 Sectorwise Accounts: Income, expenditure and savings

The household sector

The household sector consists of three main accounts, household income, household expenditure and household savings, denoted by Y_h, E_h and S_h, respectively. The households derive their income mainly from labour income (Y_f) and distributed profits and other transfers from the enterprises (T_{eh}), which are generated within the production activities. In addition to these incomes, they also receive other incomes such as transfers from the government (T_{gh}) and transfers from the rest of the world (T_{rh}). The total net transfers received by the household sector is denoted by $\check{T}_h$. Thus, household income can be algebraically expressed by the following identity:

$$Y_h = Y_f + T_{eh} + T_{gh} + T_{rh} \tag{6.1}$$

and household expenditure can be represented by

$$E_h = C + T_{hg} + T_{hr} \tag{6.2}$$

where C = Consumption.

Household savings can be written as

$$S_h = Y_h - E_h \tag{6.3}$$

Substituting (6.1) and (6.2) in (6.3), we have

$$S_h = Y_f - C + \check{T}_h \tag{6.4}$$

where

$$\check{T}_h = (T_{gh} - T_{hg}) + (T_{rh} - T_{hr}) + T_{eh}$$

Hence, three main accounts of the household sector can be expressed by equations (6.1), (6.2) and (6.4).

The Commercial enterprise sector

The commercial enterprise sector consists of two main accounts, i.e., enterprise income and expenditure. In contrast to the household sector, we assume that their income is equal to the expenditure, thus having zero savings in the enterprises sector. The commercial enterprise sector income and the expenditure are denoted by Y_e and E_e, respectively. The commercial enterprises derive their income mainly from operating surplus which is generated by deducting the consumption of fixed capital (depreciation) (S_D) from the total capital income (Y_{os}) within the production activities. The interest payments by the government, T_{ge}, and transfers from the rest of the world, T_{re}, are the other components of their income. Thus, commercial enterprise income and expenditure could be algebraically expressed by the following identity:

$$Y_e = Y_{os} - S_D + T_{ge} + T_{re} \tag{6.5}$$

and

$$E_e = T_{eh} + T_{eg} + T_{er} \tag{6.6}$$

According to the assumption stated above:

$$Y_e = E_e \tag{6.7}$$

Hence, the commercial enterprise income and expenditure can be expressed by equations (6.5) and (6.6), respectively.

Government sector

Similar to the household sector, the government sector has three accounts: total government receipts (income), total government outlays (expenditure) and government savings. Total government receipts are denoted by Y_g while total government outlays and savings are denoted by E_g and S_g, respectively. The total government receipts are derived mainly from indirect taxes denoted by I_t, income tax from the households (T_{hg})

and profit taxes and transfers from the enterprises (T_{eg}). The total net transfers received by the government sector is denoted by $\check{T}_g$. Thus, government income and expenditure could be algebraically expressed as:

$$Y_g = I_t + T_{hg} + T_{eg} \qquad (6.8)$$

and

$$E_g = G + T_{gh} + T_{ge} \qquad (6.9)$$

Where G = government consumption expenditure.

Government savings can be written as

$$S_g = Y_g - E_g \qquad (6.10)$$

Substituting equations (6.8) and (6.9) in (6.10), we have

$$S_g = I_t - G + \check{T}_g \qquad (6.11)$$

where

$$\check{T}_g = (T_{hg} - T_{gh}) + (T_{eg} - T_{ge})$$

Hence, total government receipts, outlays and savings can be defined by equations (6.8), (6.9) and (6.11), respectively.

Rest of the world sector

The rest of the world sector consists of three main accounts, i.e., total receipts of foreigners from domestic agents, total payments from foreigners to domestic agents and foreign savings. Total receipts of foreigners from domestic agents are denoted by Y_r while total payments from foreigners to domestic agents and foreign savings are denoted by E_r and S_r, respectively. Total receipts of foreigners from domestic agents are mainly derived through imports, M, transfers from the enterprises (T_{er}) and transfers from the households (T_{hr}). The total net transfers received by the rest of the world sector is denoted by $\check{T}_r$. Thus, total income of foreigners from domestic agents could be algebraically expressed by the following identity:

$$Y_r = M + T_{er} + T_{hr} \tag{6.12}$$

and foreigners' payments to domestic agents can be defined as

$$E_r = X + T_{rh} + T_{re} \tag{6.13}$$

where M = total imports, and X = total exports.

Foreign savings can be written as

$$S_r = Y_r - E_r \tag{6.14}$$

Substituting equations (6.12) and (6.13) in (6.14), we have

$$S_r = M - X + \check{T}_r \tag{6.15}$$

where

$$\check{T}_r = (T_{er} - T_{re}) + (T_{hr} - T_{rh})$$

Hence, total receipts of foreigners from domestic agents, total payments from foreigners to domestic agents and foreign savings can be defined by equations (6.12), (6.13) and (6.15), respectively.

6.3.2 The Macro Aggregates

In this section, we derive some macro aggregates, namely, GDP factor cost (Y^{FC}), GDP at market price (Y) from the income side as well as from the expenditure side and investment and savings equilibrium. The macro aggregates can be obtained as follows. By summing the equations (6.4), (6.11), and (6.15) we obtain

$$S_h + S_g + S_r = Y_f - C + I_t - G + M - X + T_{er} - T_{re} + T_{eh} + T_{eg} - T_{ge} \tag{6.16}$$

Since, by definition the commercial enterprise income equals expenditure, $Y_e = E_e$,

or

$$Y_{os} - S_D + T_{ge} + T_{re} = T_{eh} + T_{eg} + T_{er} \tag{6.17}$$

and by rearranging the above equation we can obtain the following equation

$$Y_{os} - S_D = T_{er} - T_{re} + T_{eh} + T_{eg} - T_{ge} \tag{6.18}$$

Thus, by substituting $Y_{os} - S_D$ in to the right hand side of equation (6.16) and rearranging we can obtain the following equation

$$S_h + S_g + S_r + S_D = Y_f - C + Y_{os} + I_t - G + M - X \tag{6.19}$$

Since, GDP at factor cost (Y^{FC}) can be defined as follows

$$Y^{FC} = Y_f + Y_{os} \tag{6.20}$$

and

GDP at market price (Y) can be given, on the income side, by

$$Y = Y^{FC} + I_t \tag{6.21}$$

and by substituting GDP at market price (Y) in the right hand side of equation (6.19) we can obtain the following equation

$$S_h + S_g + S_r + S_D = Y - C - G + M - X \tag{6.22}$$

As the definition of GDP at market price, on the expenditure side, can be given as

$$Y = C + I + G + X - M \tag{6.23}$$

and by rearranging the above equation we obtain the following equation

$$I = Y - C - G + M - X \tag{6.24}$$

Thus, by substituting I into the right hand side of equation (6.22) we can obtain the following equation

$$S_h + S_g + S_r + S_D = I, \tag{6.25}$$

where I denotes the total value of gross investment at market prices. Thus, equation (6.25) presents the investment and savings equilibrium.

The macroeconomic framework described in this section would form the basis of constructing the *Macro-SAM*, which is described in the following section. The following section also explains details of various macro accounts in the SAM including data sources and compilation methodology.

6.4 CONSTRUCTION METHODOLOGY BY MAJOR BLOCKS

As noted in Section 6.2, there are two types of SAMs based on the level of aggregation of various accounts within the SAM. The *Macro-SAM* presents the highly aggregated version of all accounts where sectoral and institutional details are absent. In contrast, the *Micro-SAM* presents a more disaggregated version of accounts, particularly with detailed representation of sectors and institutions. In this section, we develop a *Macro-SAM* in the first instance and then create a 95 x 95 *Micro-SAM* by disaggregating the various accounts in the *Macro-SAM*.

6.4.1 Structure of the 1995 *Macro-SAM*

The 1995 *Macro-SAM* for Sri Lanka is a square matrix comprising of 9 sectors which represent separate accounts in the economy. The 9 sectors used are activities, commodities, factors, households, enterprises, government, savings/investment, rest of the world and the total. In line with the macroeconomic framework discussed above, the schematic structure of the 1995 *Macro-SAM* of Sri Lanka is presented in Table 6.1. As noted in Section 6.2 there are different ways of structuring the *Macro-SAM*s. The *Macro-SAM* structure considered in this thesis (given in Table 6.1) is the most widely used structure and is derived from modifying the schematic *Macro-SAM* structures developed by Nielsen (2001) for Vietnam and Pradhan *et al*. (2001) for India.

Activities

Following through the accounts in Table 6.1 by reading along columns (1) and (2), one may observe that the activities account which describes the production activities purchase intermediate inputs from commodities account and factors such as labour and capital from factor account. Moreover, producers must pay indirect taxes (turnover taxes, import duties etc.) to the government account (here we refer to net indirect taxes which can be derived by deducting government subsidies).

Commodities

The commodities account in column 2 reveals that producers must pay for the activities on domestically produced commodities and also for the rest of the world on imported commodities. The ultimate destinations of the output of these production activities are given along raw 2 of the commodities account. Thus, the output is sold domestically as intermediate inputs, final private consumption by households, final government consumption and investment purposes. Furthermore, the output is sold in the foreign market in the form of exports.

Table 6.1
Schematic Structure of the 1995 *Macro-SAM* for Sri Lanka

	Activities (1)	**Commodities (2)**	**Factors (3)**	**Households (4)**	**Enterprises (5)**	**Government (6)**	**Savings/investment (7)**	**Rest of the world (8)**	**Total (9)**
(1) Activities		Sales							**Gross output**
(2) Commodities	Intermediate inputs			Final private consumption (C)		Final government consumption (G)	Investment expenditure (I)	Exports (X)	**Demand**
(3) Factors	Value added (Y^{FC})								**Factor income**
(4) Households			Factor income (Y_f)		Distributed profits, other transfers (T_{eh})	Transfers (T_{gh})		Foreign transfers (T_{rh})	**Household income**
(5) Enterprises			Factor income (Y_{os})			Interest payments (T_{ge})		Foreign transfers (T_{re})	**Enterprise income**
(6) Government	Taxes on intermediate, import duties (I_t)			Income tax (T_{hg})	Profits taxes, transfers (T_{eg})				**Government revenue**
(7) Savings/ investment			Depreciation (S_D)	Household savings (S_h)		Government savings (S_g)		Foreign savings (S_r)	**Savings**
(8) Rest of the world		Imports (M)		Transfers to rest of world (T_{hr})	Transfers to rest of world (T_{er})				**Foreign exchange outflow**
(9) Total	**Cost of production**	**Supply**	**Factor expenditure**	**Household expenditure**	**Enterprise expenditure**	**Government expenditure**	**Investment**	**Foreign exchange inflow**	

Factors

The factor account in column 3 is related to two factors of production, labour and capital.[5] The factor income is generated through two main sources, namely, labour income created by wages and capital income formed by operating surplus of different industries. Furthermore, the factor income could be allocated to three accounts: as wages into household account, as operating surplus into enterprises account and as consumption of fixed capital (depreciation) into savings/investment account.

Households

The household account in column 4 is spent on final private consumption, as income tax paid to government and transfers to rest of the world. The household income is mainly generated through factor income, distributed profits and other transfers from enterprises, government transfers such as *Samurdi* welfare payments and foreign transfers mainly in the form of migrant remittances.

Enterprises sector

The enterprise income mainly flows from the income generated through the gross operating surplus, government interest payments and foreign transfers, whereas the enterprise expenditure takes the form of distributed profits and other transfers to households, cooperate or profits taxes to government and transfer payments to rest of the world.

[5] Although at this stage SAM does not distinguish land as another factor of production, in the SLGEM–P database it clearly identifies land as a factor in agricultural industries. Thus, land rent would be allocated to agricultural industries by splitting the capital based on the shares of a previous Sri Lankan IO database (CIE, 1992).

Government sector

Government income is mainly created through indirect taxes from production activities, income tax from households and cooperate or profit taxes from enterprise. This income is then distributed to households in the form of transfer payments, to enterprises as interest payments and to the commodities account as final government consumption.

Rest of the world sector

The rest of the world account generates income through payments on imported goods and services and transfer payments from households and enterprises. This income in turn would be spent on exports and foreign transfers to households and enterprises.

Savings/Investment

Household savings and government savings together form total domestic savings, whereas if depreciation and foreign savings are added into that, it becomes total savings. These savings are sufficient to finance the investment in various production sectors. Thus, total savings equals total investment expenditure in the economy. Warr and Azis (1997) note that this reflects a counterpart of Walres's law within a SAM.

6.4.2 Numerical construction of the 1995 *Macro-SAM*

Following the schematic *Macro-SAM* structure described above, a numerical *Macro-SAM* was compiled by integrating two main statistical data sources, the Sri Lankan *input-output* (*I-O*) data (DCS, 1998a) and the *National Accounts* for the year 1995 (DCS, 1998b). Hence, this framework not only utilises a more comprehensive set of data but also helps in reconciling these two data sources. The numerical *Macro-SAM* for the base year 1995 is presented in Table 6.2. For example, values for intermediate inputs, factor income for households, factor income for enterprises (gross operating surplus) and the total sales have been taken from the 1995 *I-O* data table. However, household savings and profit taxes and transfers were estimated as residuals while distributed profits and other transfers from enterprises to households, income tax, government transfers to households and interest payments have been estimated using data from *National Accounts* for the year 1995. The rest of the data are directly taken from the *National Accounts* for the year 1995. Moreover, the numerical values used in the *Macro-SAM* are all in market prices.

As the *I-O* data tables and the *National Accounts* come from the same government statistical department (the *Department of Census and Statistics*, Sri Lanka) there are no major problems regarding balancing the *Macro-SAM*. The *Macro-SAM* was balanced after eliminating minor discrepancies by adjusting residually estimated household savings and profit taxes and transfers cells.

Table 6.2
1995 *Macro-SAM* of Sri Lanka (Rs Million)

	Activities (1)	Commodities (2)	Factors (3)	Households (4)	Enterprises (5)	Government (6)	Savings/ investment (7)	Rest of world (8)	Total (9)
(1) Activities		**1227493**							**1227493**
(2) Commodities	**565109**			**468496**		**97244**	**160452**	**237735**	**1529036**
(3) Factors	**570675**								**570675**
(4) Households			**221927**		**294080**	**39230**		**40891**	**596128**
(5) Enterprises			**315075**			**6399**		**10868**	**332342**
(6) Government	**91709**			**27166**	**20312**				**139187**
(7) Savings/investment			**33673**	**94394**		**-3686**		**36071**	**160452**
(8) Rest of world		**301543**		**6072**	**17950**				**325565**
(9) Total	**1227493**	**1529036**	**570675**	**596128**	**332342**	**139187**	**160452**	**325565**	

Source: Data compiled based on 1995 *I-O* table (DCS,1998a) and *National Accounts of Sri Lanka* (DCS, 1998b)

Numerical *Macro-SAM* would elicit valuable information regarding the static macro economic structure of a given economy. For example, as can be seen in Table 6.2, the third cell in column (1) of the Sri Lankan *Macro-SAM* provides the value added component of the economy or the GDP at factor cost, which is Rs.570675 million. This comprises total labour payments or factor income of households (Rs.221927 million), capital payments or factor income of the enterprises (Rs.315075 million) and depreciation or capital consumption (Rs.33673 million). This decomposition of value added components is given along the third column. Similarly GDP at market price from expenditure side (Rs.662384 million) can be obtained by subtracting total imports (Rs.301543 million), found on the penultimate cell in the second column, from the summation of values in the second row across all columns except column one: household consumption (Rs.468496 million), government consumption (Rs.97244 million), total investment (Rs.160452 million) and exports (Rs.237735 million).

It is important to check the balance of the matrix as well as to compute macro identities described in Section 6.2 in order to verify the consistency of the values in *Macro-SAM* with the 1995 *National Accounts* published by the *Department of Census and Statistics*, Sri Lanka. These macro identities, computed based on numerical values in the *Macro-SAM*, are presented in Table D6.1 of Appendix D. They are consistent with those from the *National Accounts*. Furthermore, for the purpose of comparison, Table D6.2 in Appendix D provides numerical values of the various income and expenditure balance sheets for 1995 as given in the *Consolidated Accounts, National Accounts of Sri Lanka* (DCS, 1998b).

6.4.3 Structure of the 1995 *Micro-SAM*

After constructing the 1995 *Macro-SAM* for Sri Lanka, the next step was to construct the *Micro-SAM* for the same base year. This was achieved by disaggregating the main accounts in the *Macro-SAM* and the non-zero data entries in that matrix to provide a detailed view of all flows in the economy. Carrying out this operation required more detailed disaggregated data regarding many accounts which could clearly represent the socio-economic structure of the country in that base year. New information was gathered using relevant disaggregated input-output accounts, household income and expenditure surveys, labour forces surveys and various other industry surveys. In this process, non-zero entries in the *Macro-SAM* served as control totals in the disaggregation procedure. Moreover, numerical values in the *Micro-SAM* are all in market prices.

The level of disaggregation is determined by several factors: among them the objective of the analysis and the availability of data play a crucial role. In this study, the main purpose of building a *Micro-SAM* is to address the issue of income distribution and poverty within a CGE model. Hence, more emphasis was given to disaggregating the factor account in terms of different occupational labour categories and household account in terms of different household income groups. Furthermore, as the study is aimed at looking into the implications at industry level, highly disaggregated industry and commodity accounts are required.

The 1995 *Micro-SAM* can be viewed as a matrix which contains income and expenditure flows of 94 economic agents in the economy. Theoretically, a large number of agents who make choices with respect to their economic behaviour. However, in this

Micro-SAM we simplify them into 94 representative agents who make economic decisions with respect to the Sri Lankan economy. These agents are:

- 38 industries producing 38 commodities (one-to-one relationship between commodities and industries);
- 5 households who are the owners of factors of production. They also receive and dispatch transfer payments to and from government and the rest of the world;
- 8 occupational labour categories;
- 38 importers who import commodities from rest of the world;
- 1 exporter who exports Sri Lankan products to rest of the world;
- 1 investor who makes capital;
- 1 enterprise which represents commercial firms;
- 1 government;
- 1 rest of the world which trades with Sri Lanka and also makes and receives transfer payments.

Micro-SAM at 1995 prices (in millions of rupees) for the Sri Lankan economy is presented in Table D6.3 in Appendix D. Below we shall review the disaggregation procedure and relevant data sources in compiling *Micro-SAM* which comprises 94 economic agents.

Disaggregation of activities and commodities accounts were carried out based on the 1995 *I-O* table. An *I-O* table can be defined as a matrix that shows the flow of goods and services produced from each sector (industry) of the economy to different sectors (industries) of the economy within a specified period of time such as a year. Along the columns we show the cost of production of a particular industry which includes different types of raw material inputs, labour inputs, capital inputs and net indirect taxes etc. The rows give the destination of the gross output produced by an industry. The portion of gross output is utilised as intermediate inputs to other industries and the balance is directly used by final users. These final users can be subdivided into different categories based on private consumption, government consumption, investment and exports.

The original 1995 *I-O* table consisted of 47 industries. However, for the current analysis, these are aggregated to 38 industries, including 11 agricultural industries, 16 manufacturing industries, 1 mining industry and 10 services industries. Moreover, these activities produce 38 commodities; thus there are no multi-product industries and multi-industry commodities. The main purpose of aggregation was to overcome the data limitation with respect to different labour categories and household expenditure patterns of some industries and commodities. For instance, in the original *I-O* table, there were 3 industries to represent the tea growing industry, i.e., tea growing-high elevation, tea growing-medium elevation and tea growing-low elevation. These were aggregated to represent a single tea growing industry. Similarly industries such as vegetables, fruits, highland crops, potato, betel, arecanuts and miscellaneous agricultural products were aggregated to a single industry called other agricultural crops. Furthermore, two milling industries, rice milling and flour milling, were aggregated to a single milling industry. However, the plantation developments industry which was present in the original *I-O* table was split into three, among the three plantation agricultural industries tea growing, rubber growing and coconut growing, according to their share of gross output. The industry on tourist shops and travel agents was aggregated with the wholesale and retail industry. In the original *I-O* table, there was only a single sector to represent the textile and garments industries. Since these two industries are key industries within the Sri

Lankan manufacturing sector and since a substantial number of rural and urban low-income households were employed in these industries, they were treated as two separate industries by disaggregating based on the information drawn from various *industry surveys* and the unpublished *1994 I-O table* (Ministry of Finance, 2001). Table 6.3 presents the different activities and commodities in the 1995 *Micro-SAM*.

The aggregated 1995 *I-O* database consists of several matrices and vectors. They include the domestic flow matrix, which presents the inter-industry transactions of intermediate commodities and shows the flow of domestic commodities into various industries for current production (a 38 × 38 matrix); the household consumption vector, which describes the flow of commodities into the single households sector; the investment vector, which presents the commodities utilised in capital creation; the government consumption vector, which describes the commodities consumed by the government; the exports vector, which presents the commodities exported from Sri Lanka; and other vectors such as for wages, gross operating surplus, indirect taxes, subsidies, imports, import duties and stock adjustments.

Table 6.3

Activities and Commodities in the 1995 *Micro-SAM*

	Activities	Description	Commodities
Agricultural Industries			
1	*Teagrow*	Tea growing	*Teagrow*
2	*Rubgrow*	Rubber growing	*Rubgrow*
3	*Cocgrow*	Coconut growing	*Cocgrow*
4	*Paddy*	Paddy growing	*Paddy*
5	*Mexcrop*	Minor export crops	*Mexcrop*
6	*Tobacco*	Tobacco growing	*Tobacco*
7	*Othe_agri*	Other agricultural crops	*Othe_agri*
8	*Livestock*	Livestock and poultry	*Livestock*
9	*Firewood*	Firewood	*Firewood*
10	*Forestry*	Forestry	*Forestry*
11	*Fishing*	Fisheries	*Fishing*
Mining Industry			
12	*Mining*	Mining	*Mining*
Manufacturing Industries			
13	*Teapro*	Tea processing	*Teapro*
14	*Rubpro*	Rubber processing	*Rubpro*
15	*Cocopro*	Coconut processing	*Cocopro*
16	*Milling*	Grain milling	*Milling*
17	*Foodbev*	Food and beverage industry	*Foodbev*
18	*Textile*	Textile industry	*Textile*
19	*Garments*	Garments industry	*Garments*
20	*Wood*	Wood products, furniture and fittings	*Wood*
21	*Paper*	Paper and printing	*Paper*
22	*ChmFerti*	Chemicals and fertilizer	*ChmFerti*
23	*Petroleum*	Petroleum products	*Petroleum*
24	*RubProduct*	Rubber products	*RubProduct*
25	*NMOminpr*	Non-metallic mineral products	*NMOminpr*
26	*Base_metal*	Basic metal products	*Base_metal*
27	*Feb_metal*	Fabricated metal products	*Feb_metal*
28	*Othe_Manu*	Other manufacturing industries	*Othe_Manu*
Service Industries			
29	*Electricity*	Electricity and water	*Electricity*
30	*Construct*	Construction	*Construct*
31	*Trade*	Whole sale and retail trade	*Trade*
32	*Hotels*	Hotels, bars and restaurants	*Hotels*
33	*Transport*	Transport	*Transport*
34	*Commun*	Communication	*Commun*
35	*Banking*	Banking and insurance	*Banking*
36	*Dwellings*	Ownership of dwellings	*Dwellings*
37	*Pubadmin*	Public administration and defense	*Pubadmin*
38	*Other_serv*	Personal, social and community services	*Other_serv*

Source: Compiled based on 1995 *I-O* table (DCS, 1998a).

6.4.4 Numerical construction of the 1995 Micro-SAM

The principal data source used in disaggregating other accounts, mainly the household account and the factor account, was *Consumer Finance Survey*, conducted by the *Central Bank of Sri Lanka* for the years 1996/97 (CFS, 1999). This survey was carried out using a sample of 8880 households within a stratified 3 staged sampling design. Households are divided into 13 strata using 3 sectors – rural, urban and estate – and 5 zones. Direct personal interviews of household members were carried out to gather data which encompasses a wide array of vital socio-economic information.

The original 1995 *I-O* table presents a single vector for the wage bill of each industry. However, when constructing the *Micro-SAM* it is necessary to disaggregate this wage bill into different occupational labour categories found in the economy. Therefore, the present study disaggregates labour into the following 8 occupational labour categories distinguished by main occupations in line with the *international standard classification of occupations* (*ISCO-68*) (ILO, 1968):

- Professional, technical and related workers (*PTW*);
- Administrative and managerial workers (*AMW*);
- Clerical & related workers (*CLW*);
- Sales workers (*SALW*);
- Service workers (*SERW*);
- Agricultural, animal husbandry, fisheries and forestry workers (*AGW*);
- Production and related transport equipment operators & labourers (*LPW*);
- Other workers (*OW*).

Hence, in order to create the wage matrix (of order 8×38), it is necessary to allocate the total wage bill among 8 occupational labour categories. This is achieved by utilising data from different sources such as the *Labour Force Surveys* (DCS, various issues), *CFS 1996/97* and *Industry surveys* (DCS, various issues). Information on employed population within 23 industries with respect to the above given occupational categories was available in the *CFS* 1996/97. Based on that information, proportions for employed population by industry and occupation were compiled. Table 6.4 presents the estimated proportion of employed population by industry and occupation for 23 industries. Furthermore, using the information from labour force surveys, industry surveys and also the industry-wise wage bill shares in the 1995 *I-O* table, proportions of employed population by industry and occupation for 38 industries were generated by disaggregating the proportions compiled for 23 industries.

Using the *Consumer Finance Survey* for the years 1996/97 (CFS, 1999), households have been categorised into five socio-economic groups, i.e., urban low-income households, rural low-income households, estate low-income households, urban high-income households and rural high-income households. These household groups are defined based on two factors: firstly, on the basis of geographical location (rural, urban and estate workers involved in tea, rubber and coconut plantations) and secondly, on the basis of income level (low-income groups are defined based on whose income falls below Rs.15, 000 /household/ month). Figure 6.1 illustrates the disaggregation approach of the household groups.

Table 6.4
Proportion of Employed Population by Industry and Occupation – All Sectors

Industry	PTW	AMW	CLW	SALW	SERW	AGW	LPW	*OW*
Agriculture	0.003	0.000	0.006	0.002	0.007	0.935	0.011	0.037
Forestry and Logging	0.029	0.000	0.029	0.086	0.057	0.343	0.400	0.057
Fishing	0.000	0.006	0.006	0.039	0.000	0.910	0.006	0.032
Crude Petroleum and Natural Gas Production	0.125	0.000	0.125	0.125	0.125	0.000	0.500	0.000
Mining	0.000	0.000	0.017	0.051	0.006	0.006	0.809	0.112
Manufacture of Food, Beverages & Tobacco	0.004	0.008	0.021	0.080	0.059	0.067	0.653	0.107
Textile, Wearing apparel & Leather Industries	0.008	0.015	0.028	0.017	0.024	0.005	0.869	0.032
Manufacture of Wood and Furniture	0.000	0.006	0.006	0.010	0.003	0.081	0.829	0.065
Manufacture of Paper & Paper Products	0.016	0.032	0.079	0.048	0.016	0.000	0.683	0.127
Manufacture of Chemicals Rubber and Plastic	0.045	0.082	0.100	0.045	0.091	0.009	0.491	0.136
Manufacture of Non Metallic Minerals	0.010	0.000	0.031	0.015	0.010	0.000	0.800	0.133
Basic Metal Industries	0.000	0.000	0.034	0.000	0.000	0.000	0.897	0.069
Manufacture of Fabricated Metal Products	0.055	0.000	0.047	0.094	0.024	0.000	0.756	0.024
Other Manufacturing Industries	0.032	0.021	0.021	0.021	0.000	0.000	0.842	0.063
Electricity, Gas and Steam	0.071	0.010	0.141	0.040	0.071	0.020	0.576	0.071
Construction	0.022	0.004	0.005	0.009	0.025	0.010	0.809	0.115
Trade	0.008	0.005	0.038	0.848	0.024	0.012	0.038	0.028
Restaurants and Hotels	0.038	0.000	0.051	0.127	0.658	0.006	0.082	0.038
Land Transport and Storage	0.016	0.009	0.193	0.022	0.043	0.006	0.617	0.094
Communication	0.108	0.000	0.708	0.000	0.031	0.000	0.138	0.015
Banking	0.152	0.085	0.436	0.170	0.060	0.004	0.071	0.021
Public Administration and Defence	0.068	0.043	0.427	0.002	0.327	0.002	0.064	0.066
Other Services	0.384	0.003	0.071	0.019	0.157	0.007	0.127	0.234

Source: Compiled based on the CFS 1996/97 (1999) survey data on employed population by industry and occupation – all sectors.

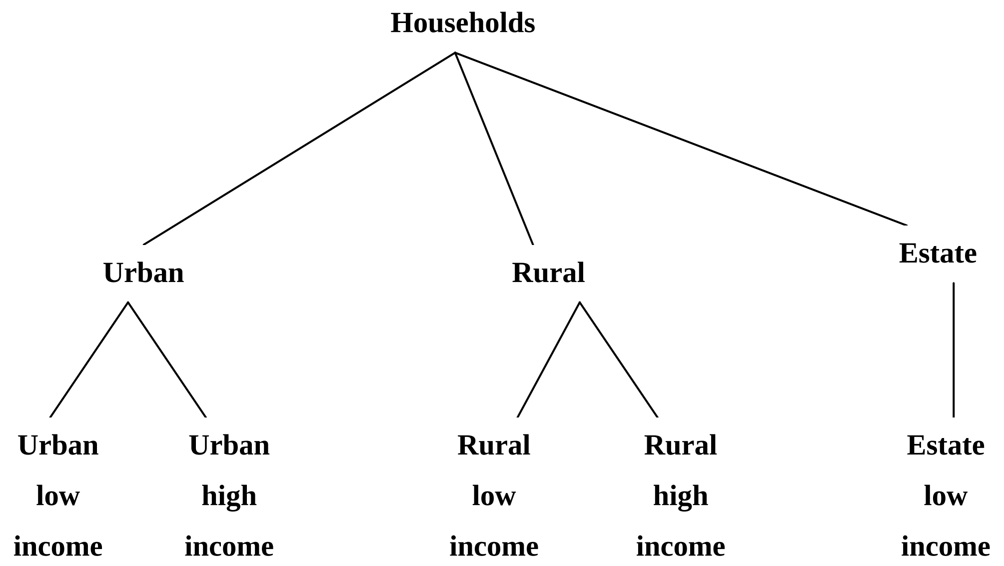

Figure 6.1 Schematic View of Household Disaggregation

The *CFS 1996/97* has categorised the households listed in the sampling frame into three sectors – urban, rural and estate, where households residing in the municipal and urban council areas are grouped under urban households, the estate sector consists of households in the tea, rubber and coconut plantation areas, and the rural sector consists of households which do not belong to either the urban or estate sectors. Furthermore, the *CFS 1996/97* data provide information on the income generation as well as the expenditure patterns of the above three sectors. Moreover, data give information on various socio-economic factors at different household income levels within the three sectors, i.e., for instance, income levels have been defined on the basis of income classes ranging from Rs.0-250/household /month being the first group and over Rs.35,000/household/month as the last group. Furthermore, there are about 25 income classes falling in between. Thus, in this study we have divided each of the three sectors, Urban, Rural and Estate, into two groups taking income class of Rs.0–15,000/household/month as the low-income group and the income class of Rs.15,001–

over 35,000/household/month as the high-income group. In this demarcation, Rs.15,000/household/month was taken as the cut-off line on the basis of rough estimations of average cost of living of a household that was prevailing in the year 1995. However, in the estate sector, the high-income group was aggregated with the urban high-income group, as high-income estate sector workers mainly come from the estate management and in most cases they and their families reside in urban areas. Finally, this household classification yields 5 household groups based on geographic location and the household monthly income level: urban low-income households (*ULIHH*), rural low-income households (*RLIHH*), estate low-income households (*ELIHH*), urban high-income households (*UHIHH*) and rural high-income households (*RHIHH*).

Once the different household groups have been defined, the next task is to allocate the income generated by different sources into relevant households. This was carried out based on the information gathered from the *CFS 1996/97*. Thus, wage income received by 8 occupational labour categories within 38 industries has been allocated among 5 household groups based on the proportions estimated from CFS data. Moreover, gross operating surplus generated by different industries has been allocated among 5 household groups in a similar manner based on the proportions obtained from *CFS* data. Government transfer payments such as *Samurdi* payments and transfers from the rest of the world mainly consisting of migrant remittance have also been allocated to different household groups based on the proportions calculated from *CFS* data.

The next step is to outline the expenditure patterns of the different household groups, including the spending on private consumption – of 38 commodities, income tax payments to government and the transfer payments to rest of the world. Allocation of household expenditure by different household groups on 38 commodities was carried out based on the budget shares calculated from the data on food, non food and consumer durables expenditure patterns found in the *CFS* data. Income taxes and rest of the world transfers were also allocated based on proportions estimated from *CFS* data.

Let Y^F = wage income;

C_{si} = private consumption of the i^{th} household group on commodities produced by s industry;

T_{gi} = transfers from the government g to the i^{th} household sector;

T_{ig} = transfers from the i^{th} household sector to the government g;

Y_i = income of the i^{th} household group; and

E_i = expenditure of the i^{th} household group

where household sectors i = 1,…,m; occupational labour categories n = 1,…,h; industries s = 1,…,k; government g = 1; enterprises e = 1; and rest of the world r =1. Then the income and expenditure mapping of different household groups can be expressed as follows:

$$Y_i = \sum_{s=1}^{k} \sum_{n=1}^{h} Y_{sni}^F + T_{ei} + T_{gi} + T_{ri} \tag{6.26}$$

$$E_i = \sum_{s=1}^{k} C_{si} + T_{ig} + T_{ir} \tag{6.27}$$

Thus, aggregated household income and aggregated household expenditure can be written as

$$Y = \sum_{i=1}^{m} Y_i \tag{6.28}$$

$$E = \sum_{i=1}^{m} E_i \tag{6.29}$$

Aggregated household savings is given by

$$S = Y - E \tag{6.30}$$

In the *Micro-SAM* compilation process, we have used *Macro-SAM* values as control totals. There were no major discrepancies found in the balancing process. The minor imbalances were eliminated by using a biproportional matrix balancing technique known as RAS[6] – an iterative algorithm of biproportional adjustment, which is a widely used methodology to balance or update SAMs.

6.5 *I-O* DATABASE AND OTHER MISCELLANEOUS DATA

Two main types of data are required to implement the *SLGEM–P* described in Chapter 4, i.e., *I-O* data along with other data matrices and vectors in the *Micro-SAM* and various elasticity estimates. Since previous sections have scrutinised the main features of the SAM database, we focus mainly in this section on other associated *I-O* data matrices and elasticity estimates required to implement the model. The schematic representation of the I-O database of the SLGEM–P model is presented in Figure D6.1 in Appendix D.

6.5.1 *I-O* data matrices

As a precondition to implementing the model, *I-O* data matrices and vectors should be valued in basic prices. Since 1995 *I-O* table was valued in producer's prices – as they exclude trade and transport margins but include sales taxes – it is necessary to convert data matrices into basic prices. This would be achieved by subtracting taxes from each data point in the *I-O* table. Thus, as the first step, tax matrices were constructed by splitting the indirect tax row of the original *I-O* table valued at producer's price into various categories of sale taxes on intermediate inputs and final consumption. Since there are no published data on sales taxes of intermediate inputs and consumer goods of

[6] For description of RAS method in comparison with other widely used matrix balancing techniques, see McDougall (1999).

each industry, the tax matrix was estimated by taking into account shares of intermediate inputs by each industry and final consumption. This was further complemented by other information drawn from various statistical sources such as *Central Bank Annual Reports* and a previous *I-O* database (CIE, 1992). Subsequently separate indirect tax matrices were constructed following this disaggregation procedure. Finally, *I-O* table for the year 1995 valued at basic prices was derived by subtracting the tax matrices from the original 1995 *I-O* table valued at producer's prices.

The original *I-O* data tables do not provide information on trade and transport margins. Furthermore, there were no readily available published data on margins with respect to intermediate commodities and final demand commodities. As we do not intend in this study to carryout simulations regarding margins, the model does not include trade and transport margins and we follow the *ORANIG-NM* (No Margins) version (Horridge, 2002) in which margins are modelled as direct flows. Thus, the need did not arise to construct separate margin matrices and vectors.

Another important data matrix is *import matrix*, which describes in detail the allocation of imports to various industries and final demand sectors. However, the entries in the original *import matrix* of *I-O* 1995 seemed to represent the imports inadequately as some entries were nonsensical and also lacked details with respect to many industries. Thus, in consultation with other databases such as *National Accounts of Sri Lanka* (DCS, various issues), *Central Bank Annual Reports* (CBSL, various issues) and an unpublished *1994 input-output table* (Ministry of Finance, 2001), a new import matrix was constructed. The 1995 *I-O* data table and the newly constructed import *matrix* for 1995 are presented in Tables D6.4 and D6.5 respectively, of Appendix D.

The original 1995 *I-O* database contains two column vectors that represent domestic and imported capital formation. Using these two vectors, it was decided to construct a total capital flow matrix, which includes both imported and domestic inputs. However, there were no readily available published data on investment with respect to different industries. *National Accounts of Sri Lanka* (DCS, 1998b) provides information on gross fixed capital formation by type for some aggregated sectors and purchasers – both private and government. It was decided to estimate the domestic and imported capital flow matrices using the available information. As a result domestic and imported capital flow matrices were created using the information obtained from *National accounts of Sri Lanka* (DCS, 1998b) along with the shares obtained from a previous CGE database (CIE, 1992). In addition to the above matrices, an import duty matrix and a government subsidy matrix were created using information obtained from the original 1995 *I-O* database, *Central bank Annual Reports* (CBSL, various issues) and previous CGE database (CIE, 1992).

6.5.2 Elasticity estimates

In CGE modelling, a successful implementation of the model depends on the availability of a wide range of elasticity parameters. CGE modellers use various methods to gather elasticity parameters. The econometric estimation of elasticity parameters using cross sectional or time series data would be the most ideal method. However, due to constraints with respect to time series and cross sectional data, time and other resources, the econometric estimation of elasticities was not possible in this study. Therefore, this study employs other popular methods such as adopting plausible values from available literature and making a good guess – 'guesstimation'. Hence, this section explains the procedure of assembling different elasticity parameters for the *SLGEM–P*.

Substitution elasticities between domestic and imported commodities (Armington Elasticities[7])

In the *SLGEM–P*, it is assumed that in production, investment and consumption, the elasticities of substitution between domestic and imported commodities are imperfect. The intensity of commodities substituted for each other from two sources could be captured by the Armington elasticity. When the value of Armington elasticities are higher, imported goods become better substitutes for domestic goods; when these Armington elasticity values are lower, they become weak substitutes for domestic goods. However, within the context of developing countries, one could rarely observe empirical estimates of Armington elasticities due to the unavailability of time series data on import prices and quantities, domestic prices and quantities, quantitative restrictions and other variables such as seasonal fluctuations. Nevertheless, CGE models developed for developing countries rely on literature surveys to find Armington elasticities which are estimated for other countries. For example, Table 6.5 presents the Armington elasticities adopted in selected countries. In the case of Sri Lanka, no empirical estimates are available for Armington elasticities. Therefore, this study adopts Armington elasticities compiled by CIE (1992) based on literature surveys. These values were further adjusted by the characteristics of various commodities. Table D6.6 of Appendix D presents the Armington elasticities used in this study.

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[7] See Armington (1969) and Kapuscinski and Warr (1996) for theoretical explanation on Armington elasticities.

Table 6.5
Armington (Import Substitution) Elasticities in Selected Countries

Source	Armington Elasticity	Country
Stern *et al*. (1976)	1.0	Not Available
Alaouze *et al.* (1977)	2.0	Australia
Vincent (1986)	2.0	Chile
Vincent (1986)	0.5-5.0	Colombia
Vincent (1986)	2.0	Ivory Coast
Vincent (1986)	0.5-5.0	Kenya
Vincent (1986)	0.5-5.0	India
Vincent (1986)	0.20-2.0	Turkey
Vincent (1986)	2.0	South Korea
Kapuscinski and Warr (1992)	2.0 <	Philippines
Comber (1995)	1.64 - 3.5	New Zealand
Kapuscinski and Warr (1996)	0.04 - 3.8	Philippines

Source: Somaratne (1998).

Substitution elasticities between primary factors

Substitution elasticities between primary factors (labour, capital and land) form another important set of parameters in the successful implementation of CGE models. Unfortunately, as in the case of other elasticity parameters, there are no readily available econometric estimates for elasticities of substitution between primary factors for Sri Lanka. Therefore, this study will adopt the primary factors substitution elasticity values from previous studies Bandara (1989) and CIE (1992). A value of 0.5 is assumed as the elasticity of substitution between primary factors for all industries.

Substitution elasticities between different occupational type of labour

There are 8 occupational labour categories identified in the model. These categories are defined based on skill level. As in the case of other elasticity parameters, no study has been carried out to econometrically estimate the elasticity between these occupational labour categories within the Sri Lankan context. Hence, for the implementation purpose of the *SLGEM–P*, based on Bandara (1989) and CIE (1992), a default value of 0.5 was set as the substitution elasticity of different occupational groups in Sri Lanka.

Household elasticities and price elasticities of demand

It is important to find estimates of expenditure elasticites of demand, own and cross price elasticities of demand for the *SLGEM–P*. Unlike other elasticity parameters there have been several attempts to econometrically estimate expenditure and price elasticity of demand for Sri Lanka (Alderman and Timmer, 1980; Dissanayake and Giles, 1988; Sahn, 1984, 1988; Pradhan and Tudawe, 1997). These elasticities are however related to aggregated level food demand in the economy. Hence, there are no studies carried out to estimate expenditure elasticities for 38 commodities within different household groups identified in this study. This study therefore would adopt expenditure elasticity estimates used by Bandara (1989).

For instance, Bandara (1989) has estimated expenditure elasticities for seven broad commodity groups in Sri Lanka and has then derived separate estimates for 24 commodities based on the method proposed by Tulpule and Powell (1978). Bandara has estimated expenditure elasticities within three socio-economic groups – urban, rural and estate. These estimates for 24 commodities were first mapped into 38 commodities by disaggregating commodity groups while replicating elasticity values of commodities which come from the same group. The next step was to assign elasticity estimates of 38 commodities to different household income groups. Here we assume that all urban income groups and rural high-income group adopt expenditure elasticity estimates of urban group while estate low-income group and rural low-income group adopt expenditure elasticity estimates of the estate and rural groups, respectively.

Finally, adopting the Frisch formula (Frisch, 1959) along with the expenditure elasticities, commodity level supernumerary expenditure within different household groups, cross and own price elasticities of demand could be estimated. The price elasticities can be estimated as

$$\eta_{ijh} = -\sigma_{ih} W_{jh}\left[1+\frac{\sigma_{jh}}{\omega_h}\right]+\theta_{ij}\frac{\sigma_{ih}}{\omega_h} \quad , \qquad i, j = 1,\ldots.k, \qquad h = 1,\ldots.m \qquad (6.31)$$

where η_{ijh} is the price elasticity of commodity *i* with respect to the price of commodity *j* in household group *h*; σ_{ih} is the expenditure elasticity of commodity *i* in household group *h*; W_{jh} is the household budget share for commodity *j* in household group *h*; θ_{ij} has a value 1 for $i = j$ and zero otherwise; and ω_h is the Frisch parameter.

The above formula requires budget shares, expenditure elasticities and the Frisch parameter value to calculate the price elasticities. Budget shares have been estimated using the *I-O* database while expenditure elasticties and value for the Frisch parameter have been taken from Bandara (1989)[8]. Tables D6.7 and D6.8 in Appendix D present estimates of expenditure elasticities for 38 commodities and commodity level supernumerary expenditure within different household groups.

Export demand elasticities

Export demand elasticity is another important parameter for the successful implementation of the *SLGEM–P* for policy analysis purposes. The export demand elasticity would determine the market power of a particular commodity in the world market. Except for the commodity tea, Sri Lanka's other export commodities hold rather insignificant market share in the world market, which makes the small country assumption more appropriate for the country's exports (Athukorala and Bandara, 1984; CIE, 1992). Accordingly, it is assumed that Sri Lanka cannot influence world prices

[8] Frisch parameter values are estimated as -4.57, -5.45 and -6.43 for the urban, rural and estate sectors, respectively.

except for Sri Lankan tea, which maintains an export share of around 17.6% of the world tea market (Ministry of Public Administration, Parliamentary Affairs and Plantation Industries, 1994). Therefore, this study adopts a value of 0.05 assumed in Bandara (1989) and CIE (1992) as the reciprocal of the export demand elasticity for each commodity except tea, whereas a value of 0.6 as suggested by Vincent (1986) for India has been taken as the reciprocal export demand elasticity for tea.

6.6 SUMMARY

In this chapter, compilation of the Sri Lankan database necessary for implementing *SLGEM–P* is described. A CGE model with an income distribution component requires basically two types of databases, i.e., SAM including an I-O database and different elasticity estimates. However, there was no readily available SAM recently developed for Sri Lanka. This posed a major problem in implementing the model. In this chapter, we overcome this problem by developing a disaggregated SAM using available macro and micro data for the base year 1995. As a SAM would have numerous other potential uses, it could be considered as another important contribution of the study. The complete database includes a SAM for Sri Lanka for the base year 1995 (that is, 9×9 *Macro-SAM* as well as 95×95 *Micro-SAM*), *I-O* database for the base year 1995 including supplementary matrices such as import matrix, tax matrix, domestic and imported capital formation matrix, import duty matrix and government subsidy matrix. In addition, the database includes a range of elasticity parameters such as household expenditure elasticities and price elasticities, import and domestic substitution elasticities (Armington elasticities), substitution elasticities between occupational labour, substitutional elasticities between primary factors and export demand elasticities. These databases serve the purpose of calibration of the *SLGEM–P* described in Chapter 4, for the base year 1995. The next chapter willl demonstrate a set of policy experiments conducted using the *SLGEM–P* and the empirically fitted income distribution functions to identify the poverty and inequality consequences of trade policy reforms.

CHAPTER 7

APPLICATIONS OF *SLGEM–P*: THE EFFECTS OF TRADE LIBERALISATION WITH SPECIAL REFERENCE TO POVERTY AND INEQUALITY[1]

7.1 INTRODUCTION

The aim of this chapter is to carry out a set of simulation experiments using the *SLGEM-P* model developed in Chapter 4, the income distribution functions presented in Chapter 5 and the database outlined in Chapter 6. The main objective of the simulation experiments is to identify and quantify the impacts of trade liberalisation on some key variables of the Sri Lankan economy in general and on the household level poverty and inequality in particular. Therefore, a set of simulations is carried out to quantify the short run and long run impacts of tariff reductions on the Sri Lankan economy at macro level, industry level and household level. This chapter is organised as follows. Section 7.2 presents the details of the policy experiments. The model closure is described in Section 7.3. The results of the policy experiments with respect to macro variables and sectoral variables as well as to household level poverty and inequality, are given in Section 7.4. The sensitivity of the model outcomes for different parameter values under the Systematic Sensitivity Analysis is illustrated in Section 7.5. The final section presents a summary of the chapter.

[1] The preliminary results of the policy experiments outlined in this chapter were presented at the PhD conference in Economics and Business (Perth, November 2003). The feedback I received from my discussant at the conference, Professor Rod Tyers from Australian National University and from Professor Peter Dixon from the Center of Policy Studies, Monash University is greatly acknowledged.

7.2. POLICY EXPERIMENTS

As described in Chapter 2, there is growing concern among the policy makers of Sri Lanka about the distributional and poverty implications of the trade reform process. In the latter part of 1977, Sri Lanka underwent a radical shift in trade policy towards a more liberalised export oriented policy regime. During the policy reform, several measures, such as "Tariffication" of quantitative import restrictions, elimination of export taxes and reduction of tariff rates for different commodities in the economy, were taken.

As noted in Chapter 2, a descriptive analysis of the general trend of the incidence of poverty among households suggests that this had declined towards the early 1990s except for the households in the estate sector. While urban poverty seems to have declined towards 1995, poverty among households in the rural and estate sectors has risen since 1990. As the rural population in Sri Lanka comprises around 70 per cent of the total population (DCS, 2001), the current trend in poverty incidence attracts serious concern, particularly as along with the adoption of long-standing welfare policies by successive Sri Lankan governments, a massive government poverty reduction program has also been in operation since 1989. Similarly, as described in Chapter 2, careful observation of the trend of income inequality suggests that the gap between rich and poor in the society widened around the late 1980s under the liberalised policy regime, resulting in an increase in relative poverty.

The above observations suggest that trade liberalisation might be suspected to be one of the main causal factors that exacerbate poverty and inequality within Sri Lanka. However, pro-liberalisation analysts at international organisations such as the World Bank and IMF advocate further trade liberalisation and market oriented reforms to alleviate poverty. Since there have been hardly any empirical investigations carried out on the link between trade reforms and poverty in Sri Lanka, it is hard to make any judgment on either of the above hypotheses. Empirical investigation on this issue would shed more light on this controversy.

As discussed in Chapter 3, the CGE framework can be considered as an ideal tool in analysing trade and poverty linkage within developing countries. Interestingly, there are no CGE studies which investigate the trade and poverty link in the Sri Lankan context. In this chapter, our attention is focussed on that aspect through conducting a set of simulation experiments. These simulations are counterfactual simulations. In other words, we try to answer “what if” types of questions. Amongst the few policy instruments available in shaping up the trade policies, tariff reforms can be considered as one of the most widely adopted policy instruments in many countries. Therefore, in this study, we limit our focus to tariff reforms.

The following section outlines a set of simulation experiments designed to identify the short run and long run impacts of reduction in import tariffs on macro variables, industry level variables and household level absolute poverty and income inequality. In this study, the attention is particularly focused on the differential impacts likely to occur in tariff reduction in agricultural sectors and in that of manufactured product sectors. As the main focus of this study is to ascertain the impacts of trade reforms on absolute poverty and income inequality at the household level, variables which affect household income, such as labour wages and the flow of gross operating surplus to households, have been endogenised. The following simulation experiments were carried out with the intention of quantifying the direction and magnitude of the short run and long run impacts of trade reforms on the economic variables within the Sri Lankan economy, in order to shed some light on the continuing debate over the relationship between trade and poverty.

(1) A 100 per cent reduction in prevailing tariffs in the manufactured products sectors (Simulation 1).

(2) A 100 per cent reduction in prevailing tariffs in the agricultural sectors (Simulation 2).

(3) A 100 per cent reduction in prevailing tariffs across the board (Simulation 3).

The next section describes the economic environment or "closure" in which these policy shocks are implemented.

7.3 MODEL CLOSURE

As noted in Chapter 4 Section 4.5, these simulations are conducted in two different economic environments or closures – short run and long run closures – which represent the short run and long run effects respectively. The assumptions involved in these settings will determine the expected time period of the solution. The set of assumptions used in the above economic environments are given below.

Short Run Closure

The assumptions of this closure are made to retain the realities of the Sri Lankan labour market and other macro constraints in the short run. Figure 7.1 shows the schematic representation of the short run closure. On the supply side of the economy, both the physical capital stocks and the real wages have been exogenised. The physical capital stock is fixed in each industry, assuming that the industry level output can be changed only through the changes in labour input. Though the capital stock is fixed, we allow the rate of return on the capital stock within each industry to be determined endogenously. In spite of a given total investment budget, the industry level investment is also allowed to vary according to the rate of return on the capital of respective industries. However, the above assumption asserts that the period of concern is too small for the investment to be realised into a productive capital stock due to the gestation lag on capital creation.

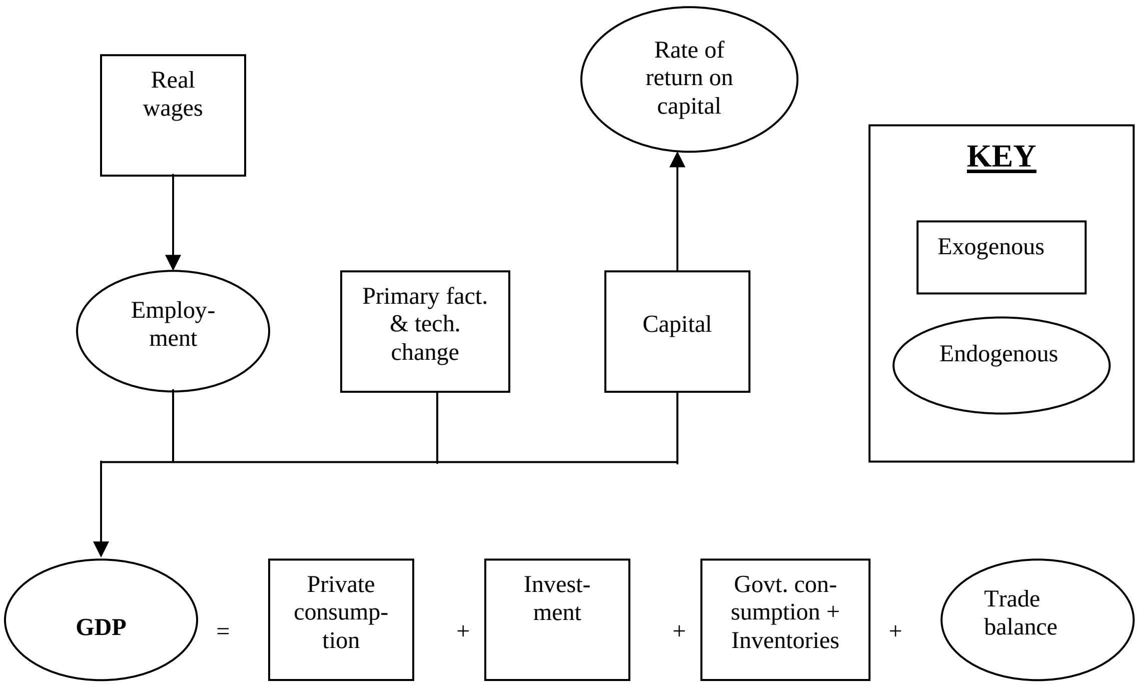


Figure 7.1

The Schematic Representation of the Short Run Closure

Similarly, we assume that in the short run, the economy faces a slack labour market, thus allowing the aggregate employment as well as the employment levels of various categories of labour to be determined endogenously. Real wages on the other hand are considered to be fixed and are allowed to vary only in the long run. Moreover, we assume that other primary factors such as land are fixed and that the technical changes in the production process are also constant during the projection period.

On the demand side of the economy, in line with the standard short run closure, various components of domestic absorption such as real private consumption expenditure, real investment expenditure, real government expenditure and real demands for inventories are set to be exogenously determined. However, the balance of trade is allowed to be determined endogenously. As noted by Dixon, *et al.* (1982), the rationale for this assumption is based on the fact that the tariff policy is operated as an expenditure-switching instrument. Moreover, it is assumed that the other macroeconomic policy instruments that are not modelled could be used independently from tariff policy to influence the different components of domestic absorption.

Furthermore, as production technologies and household consumption preferences are usually expected to change over a long period of time, we set them to be exogenous in the short run. Similarly agricultural land, the number of households, the foreign prices of imports, the real unit cost of "other cost tickets" and subsidies, all tax rate variables, and the demand curves of exports are assumed to be determined exogenously. Additionally, the nominal exchange rate is fixed and is considered to be the *numeraire*. Hence, changes in domestic price indices can be interpreted as changes in domestic prices relative to world prices. In line with many other CGE simulations, the short run solution period is assumed as 1 to 2 years.

Long Run Closure

The assumptions of this closure are made to retain the realities of the macroeconomic environment of the Sri Lankan economy in the long run. Figure 7.2 shows the schematic representation of the long run closure.

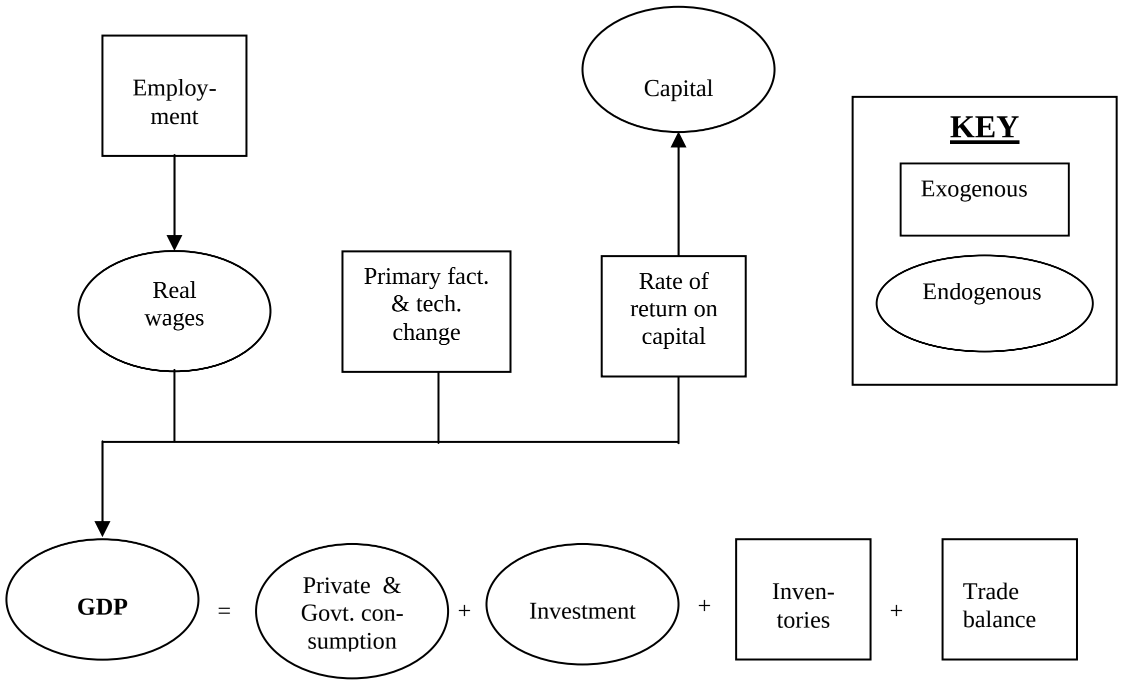


Figure 7.2

The Schematic Representation of the Long Run Closure

On the supply side of the economy, both the rate of return on capital and aggregate employment are allowed to be determined exogenously in the long run. Thus, we assume that the industry level capital stock can vary over a long period, thereby allowing it to be determined endogenously. In other words the producers are allowed to relocate the industry capital stock in order to attain the exogenously given rate of return on capital.

Aggregate employment is regarded as to be fixed in the long run, thus assuming that the economy is in full employment at the long run equilibrium. Therefore, we allow real wages to be determined endogenously. However, labour is allowed to be mobile among different occupational labour categories as well as among industries.

On the demand side of the economy, we assume that some components of real domestic absorption are determined endogenously. For instance, we allow real private consumption expenditure to be determined endogenously while allowing real government consumption expenditure to follow private consumption. Thus, both the overall shift term for consumption and the ratio between the overall shift term for government demand and that for consumption are exogenised. Furthermore, aggregate investment is allowed to be determined by industry specific rules. The demand for inventories, however, is set to be fixed. In contrast to the short run closure, the balance of trade is determined exogenously.

Similar to the short run closure, production technologies, agricultural land, the number of households, the foreign prices of imports, the real unit cost of "other cost tickets" and subsidies, all tax rate variables, and the demand curves of exports are assumed to be determined exogenously. Additionally, the nominal exchange rate is fixed and is considered to be the *numeraire*.

7.4 SIMULATION RESULTS

This section presents the possible effects of trade liberalisation under the short run and long run closures. The macroeconomic effects, industry effects and household level effects including the impacts on absolute poverty and inequality are presented in different subsections.

7.4.1 Macroeconomic Effects

This section presents the expected macroeconomic implications of the trade policy shocks. As detailed in Chapter 4, the simulation results, except for a few variables, are reported as the percentage changes of respective endogenous variables with respect to their base values. The possible effects on important macro variables such as aggregate employment, the consumer price index, real GDP, real wages and the poverty line for the simulation experiments presented in Section 7.2 are summarised in Table 7.1.

Table 7.1
Projections of Percentage Change in Macro Variables under Different Policy Experiments

Macro Variable	**Simulation 1** 100% cut in prevailing tariffs in manufacturing industries		**Simulation 2** 100% cut in prevailing tariffs in agricultural industries		**Simulation 3** 100% cut in prevailing tariffs in all sectors	
	SR	LR	SR	LR	SR	LR
Aggregate Employment (*employ_io*)	2.24	Exogenous	0.3	Exogenous	2.56	Exogenous
Real Wages (*f1lab_io*)	Exogenous	14.45	Exogenous	0.56	Exogenous	15.2
Real GDP (*x0gdpexp*)	0.73	3.77	0.1	0.01	0.84	3.84
Ordinary Change to Nominal Trade Balance to GDP Ratio (*delB*)	0.003	Exogenous	0.00	Exogenous	0.004	Exogenous
Ordinary Change in the Real Trade Balance*	4444.56	Exogenous	641.23	Exogenous	5107.89	Exogenous
Real Devaluation (*p0realdev*)	3.62	-0.04	0.69	0.38	4.35	0.32
Consumer Price Index (*p3tot_h*)	-2.67	0.25	-0.77	-0.51	-3.44	-0.25
Poverty Line (*pline_ph*)	-2.44	0.39	-0.88	-0.62	-3.31	-0.23
Import Volume Index, CIF Weights (*x0cif_c*)	2.02	10	0.16	0.14	2.19	10.45
Export Volume Index (*x4tot*)	4.43	12.27	0.48	0.29	4.93	12.96
Aggregate real household consumption (*x3tot_h*)	Exogenous	3.32	Exogenous	-0.03	Exogenous	3.33

Notes: SR = short run effects & LR = long run effects.
* In Rs Millions
Model variables in Tablo codes are given in parenthesis.

When analysing the macro results it is important to identify the implications on the key variables such as real GDP and aggregate employment. Real GDP can be determined from the income or supply side as well as from the expenditure side components of GDP. The results presented in Table 7.1 reveal that all simulations yielded a positive increase in real GDP. For instance, in the short run, simulations 1 and 3 yielded a 0.73 and

0.84 per cent increase of real GDP respectively, while simulation 2 produced a 0.1 per cent increase of real GDP compared to the base case. In the case of the long run, simulations 1 and 3 produced 3.77 and 3.84 per cent increase of real GDP respectively, while simulation 2 yielded a marginal increase of 0.01 per cent. Overall these results substantiate the widely held notion of the growth stimulation effects of trade liberalisation as established in the literature on the link between trade and growth (for a detailed survey see Andrew and Krueger, 2003).

In the short run, when we look from the supply side, it is evident that under the short run closure all components of GDP other than aggregate employment have been fixed. Hence, components such as capital stock, technology and real wages are unaffected while the aggregate employment is expected to change, as it is determined within the model. Furthermore, since we assume unemployment in the short run, we see a change in aggregate employment following a policy shock. Table 7.1 presents the short run results of aggregate employment under the above simulations. For instance, aggregate employment has shown increases of 2.24 and 2.56 per cent under simulations 1 and 3 respectively. Simulation 2 increases aggregate employment, though at a lesser degree of 0.3 per cent. Thus, all simulations suggest a positive impact on aggregate employment.

The underlying mechanism of the above results of aggregate employment can be explained through the implications on different industries in the economy. A detailed analysis of industry results is given in Section 7.4.2. When there is a tariff cut, the price of imported goods will be reduced. This in turn makes the imported inputs as well as the imported consumer goods relatively cheaper than their domestic counterparts. Thus, the prices of domestic commodities that compete with these imports will decline in order to be competitive in the economy. Consequently, this will have a declining effect on the consumer price index, which represents the relative price effects of domestic prices relative to world prices. Furthermore, in the model, nominal wages are allowed to be fully indexed to the consumer price index. Thus a reduction in the consumer price index will lead to a proportional decline in nominal wages. The overall net effect of these changes on the industries can be observed in terms of a reduction in the cost of production. The industries that are selling their products mainly to export markets will benefit due to the increase in profits, as the output prices are determined by the global markets. Hence, these industries expand. Depending on the structure and the composition of the industrial sector in the economy, we could expect an increase in demand for labour by those industries. As a slack labour market is allowed, aggregate employment would be increased. In the above results it is evident that aggregate employment is increased under all simulations, although in different magnitudes. This will explain the increase in real GDP from the supply side.

Further examination of the results of short run real GDP and aggregate employment reveals that simulations 1 and 3 produce the highest positive impacts while simulation 2 produces marginal results. Close examination of industry level results shed more light on the possible reasons for the above divergence.

As described in detail in the next section, manufacturing industries, which are predominantly catering to the export market, are expanded. Some of these industries, such as garment and textile industries, are labour intensive industries thus contributing to the expansion of aggregate employment. Moreover, the border protection on manufacturing industries could be seen to have a negative impact on other export-oriented industries such as the agricultural export industries. Higher protection would hamper the efficient use of limited primary resources thus restricting them into those unproductive industries. Tariff cuts in turn reduce the prices of imported manufactured goods that are used as inputs and bring down both the consumer price index and nominal wages. This would lead to an overall reduction in the cost of production in export industries including those of agricultural export industries. Since global markets determine the export prices in those industries, increase in profits can be seen to play a key role in the expansion of export agricultural industries leading to an increase in derived demand for labour. These impacts predominantly contribute to the expansion of real GDP from the supply side under simulations 1 and 3.

In contrast, the agricultural trade liberalisation, simulation 2, produces marginal results. In other words, it can be seen that the impacts of agricultural border protection are trivial by comparison with those of manufacturing industries. This may be due to several reasons. Firstly, the agricultural trade liberalisation has a relatively limited impact on domestic price distortions as agricultural goods play a comparatively minor role in stimulating the output of other industries through the inter-sectoral linkages – being intermediate inputs or inputs to capital creation. Secondly, as the relative import shares of agricultural commodities in the base year are very small in comparison to those of manufacturing goods, tariff reduction is expected to have a marginal impact on their activity levels. For instance, there are no imports recorded for commodities such as Tea, Rubber, Coconut and Minor export crops in the base year. Lastly, due to above reasons agricultural trade liberalisation is projected to have a relatively marginal effect on the terms of trade.

Moreover, the reduction of agricultural import prices causes less impact on the consumer price index compared with that of manufactured products. Therefore, agricultural trade liberalisation seems to play a less important role in the short run in achieving growth objectives in Sri Lanka. However, since non tariff barriers such as quantity restrictions are in operation in some agricultural imports which can not be captured by the current database, care must be exercised in drawing conclusions (Table E 7.1 in Appendix E presents the base period tariff rates).

The increase in GDP from the supply side is matched by the changes in variables in the expenditure side of GDP as given by the GDP identity. However, the domestic absorption has been set to be determined exogenously thus the only variable that is allowed to be adjusted is the balance of trade. In this case an improvement in the balance of trade can be observed. For instance, we can observe ordinary changes (0.003 and 0.004 respectively) of the nominal trade balance to GDP ratio under simulations 1 and 3. Moreover, these two simulations produce Rs. Million 4444.56 and Rs. Million 5107.89 worth of ordinary change in the real trade balance respectively. In simulation 2, Rs Million 641.23 real trade balance is evident. Though trade liberalisation mainly stimulates exports, it also promotes imports. This can be further verified by observing the reported import and export volume indices. A careful observation of total exports and total imports reveals that balance of trade improvement has come from the increase in exports relative to imports.

Observing the impact on other relevant macro variables can further substantiate the above macroeconomic mechanism. For instance, it is revealed that under all simulations, real devaluation is expected to occur. This was more significant in simulations 1 and 3. This suggests that the country would experience an increase in its competitiveness in the export market as a result of the reduction in production costs. Interestingly, it is revealed that trade liberalisation tends to reduce inflation in the economy, which could be observed by the percentage change of the consumer price index as well as that of the poverty line. When the prices of basic needs commodities, especially manufactured food products, petroleum products, garments and other agricultural imports, are reduced due to tariff cuts, the money metric poverty line shifts to the left, thus making the basic needs commodities cheaper in the market. Thus, the reduction in the consumer price index and the aggregate poverty line suggest that tariff cuts are expected to play a positive role in bringing down the cost of living.

In the long run simulations, it is observed that most macro variables show a direction of change similar to that of the short run. However, the change of magnitudes shows a significant difference: the impacts are more pronounced in the long run than in the short run. For instance, the percentage changes of long run real GDP under simulations 1 and 3 were 3.77 and 3.84 respectively, which is much higher than those under the short run closure. The large effects can be attributed to sizeable expansions in the manufacturing industries. The tariff reduction increases the output of industries which are heavily dependant on imported inputs thus adjusting the relative prices favourable to those industries. Since we allow primary factors such as labour and capital to be mobile between industries in the long run, productive industries will attract resources from other unfavourable industries and grow further in the long run generating higher GDP.

In the long run simulation we assume that the aggregate employment is fixed and thus the economy is in full employment. However, labour is allowed to be mobile between industries as well as between different labour categories. Implications of the above simulations on these labour movements are presented in Section 7.4.3. In contrast to the short run case, we assume real wages are determined endogenously. According to Table 7.1, simulations 1 and 3 record the highest percentage change of real wages, 14.45 and 15.2 respectively. This increase in real wages is due to the increase in derived demand for labour as a result of considerable expansions in activities of manufacturing industries. Real GDP from the supply side is mainly determined by real wages.

As in the short run case, this increase in GDP from the supply side is matched by the changes in variables in the expenditure side of GDP. In contrast to the short run case, the components of domestic absorption have been set to be determined endogenously except for the demand for inventories. The results reveal that real aggregate private consumption increases in both simulations 1 and 3, with percentage changes of 3.32 and 3.33 respectively. This can also be considered as a measure that indicates the aggregate welfare effects on trade liberalisation. Therefore, the above increase of the real consumption suggests a positive aggregate welfare improvement. Similarly aggregate investment, another endogenous component of domestic absorption, predicts increases of 8.4 and 8.5 per cent respectively in simulations 1 and 3. The government consumption demand is expected to increase by 3.32 and 3.3 per cent respectively.

As the balance of trade is set to be exogenous in the long run, the increase in the supply side of real GDP is matched by the increase in domestic absorption. Moreover, imports are expected to have increased. This could be attributed to the expansion of consumption and investment demand in the economy. It is observed that real devaluation occurs in simulation 3, which suggests an improvement in competitiveness leading to an increase in exports. Despite the fact that a slight over-valuation takes place in simulation 1, the exports are expected to have increased. Moreover, as the balance of trade is set to be fixed in the long run, we could see the exports being adjusted in order to match that constraint.

However, the agricultural trade liberalisation, implemented by the second simulation yielded a trivial increase in GDP compared to simulations 1 and 3. As in the case of the short run, this may be due to the fact that agricultural trade liberalisation has a relatively limited impact on domestic price distortions. However, due to the caveat mentioned before, care has to be exercised in drawing conclusions.

The overall macro results reveal that in both the short run and the long run, reduction in tariff tends to stimulate the economy. However, the results also indicate that in both runs trade liberalisation in manufacturing industries stimulates the economy more positively than it does in agricultural industries. This suggests that agricultural trade liberalisation plays a less important role in achieving growth objectives in Sri Lanka.

Having discussed the macro economic implications of the simulation experiments, we trace the industry level effects in detail in the next section.

7.4.2 Industry Level Effects

One of the main advantages of the general equilibrium framework is its capacity to trace the sectoral implications of any policy shock. In this subsection, we present the sectoral impacts of the previously discussed simulation experiments on variables such as output by industry (*x1tot*) and employment by industry (*employ_o*). Table 7.2 presents the industry results.

Under the first simulation, which consisted of 100 per cent import tariff cut in all manufacturing sectors within the fixed sectoral capital and slack labour market (short run closure), some industries have shown an expansion while others have either shown a contraction or remained neutral. The industry level output effects are depicted by Figures 7.3 and 7.4. These varied effects can be attributed to different reasons as explained below.

Firstly, the tariff cut leads to a reduction in prices of imported inputs in manufacturing industries, which tends to lower the cost of production of those industries. Secondly, as described in the previous section, tariff cuts will lead to a reduction in the consumer price index. As the nominal wages are fully indexed to the price index that would lead to a decrease in the labour cost resulting in a drop in the cost of production. Due to both of these reasons the cost of production of industries will fall. This can lead to an expansion of industries that are significantly catering to the export market. Since the global markets largely determine the output prices of export industries, we would expect an expansion of activities of such industries due to the generation of relatively higher profits. Therefore, compared to the base year, the export industries have shown positive growth in terms of output and employment generation. For instance manufacturing export industry groups such as Textiles, Garments, Fabricated metal products, Other manufacturing and Plastic and rubber products have shown an expansion in terms of output as well as employment.

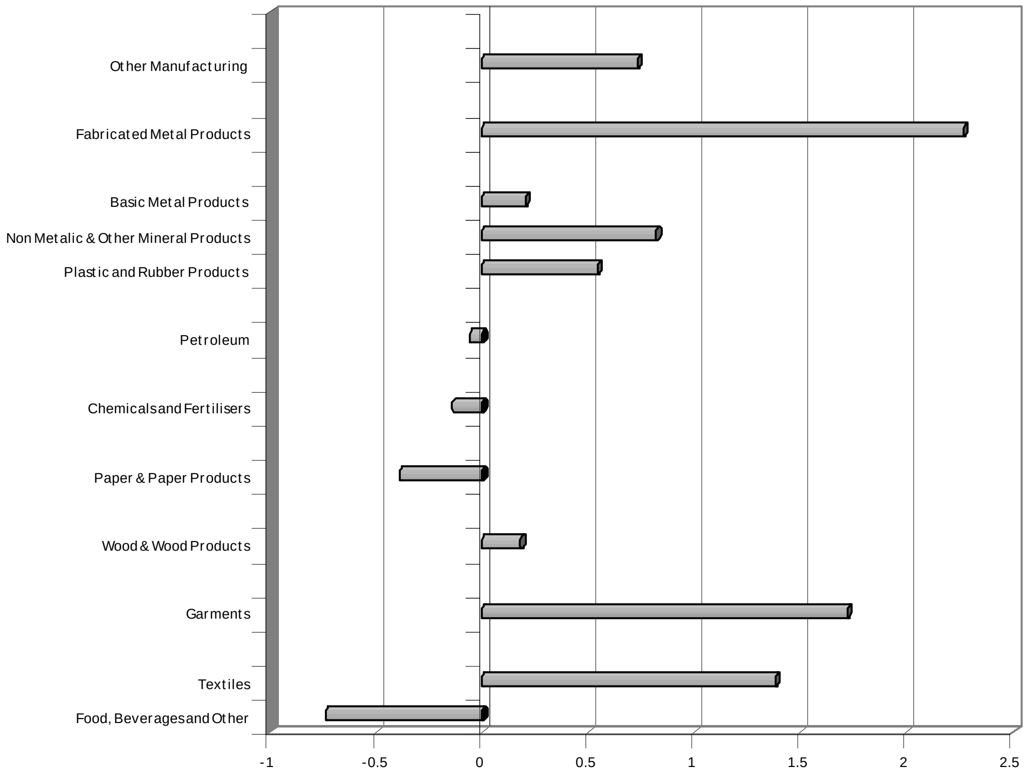


Figure: 7.3: Short Run Output Effects on Manufacturing Industries under Simulation 1

Table 7.2: Projections of Percentage Change in Industry Effects under Different Policy Experiments

Industry	Simulation 1 100% cut in prevailing tariffs in manufacturing industries				Simulation 2 100% cut in prevailing tariffs in agricultural industries				Simulation 3 100% cut in prevailing tariffs in all industries			
	Output level		Employment		Output level		Employment		Output level		Employment	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
Tea Growing	1.12	-7.49	2.14	-12.1	0.27	-0.02	0.51	-0.03	1.38	-7.56	2.64	-12.2
Rubber Growing	0.55	-3.91	1.62	-9.34	0.19	-0.01	0.55	-0.02	0.74	-3.97	2.17	-9.46
Coconut Growing	0.19	-3.82	0.59	-9.52	0.13	-0.01	0.41	-0.03	0.32	-3.88	1	-9.65
Paddy	-0.02	0.58	-0.09	-1.97	-0.15	-0.24	-0.59	-0.56	-0.16	0.34	-0.65	-2.53
Minor Export Crops	0.07	0.05	1.39	-6.41	0.02	0	0.4	-0.02	0.09	0.04	1.8	-6.49
Tobacco	0.23	-0.99	1.42	-7.06	1.51	4.21	9.74	12.04	1.73	3.22	11.32	4.05
Other Agriculture	0.04	1	0.41	-2.14	-0.2	-0.4	-1.88	-1.22	-0.16	0.63	-1.5	-3.28
Livestock	0.23	1.13	2.04	0.42	0.06	0.04	0.51	0.14	0.29	1.12	2.59	0.33
Firewood	-0.04	0.76	-0.24	-2.4	0.02	0.03	0.12	0.06	-0.02	0.78	-0.1	-2.37
Forestry	0.2	2.15	0.82	-0.89	0.05	-0.07	0.2	-0.16	0.25	2.07	1.02	-1.09
Fisheries	0.44	1.64	5.98	1.08	0.08	0.07	1.06	0.25	0.51	1.65	7.08	1.07
Mining and Quarrying	0.58	-2.49	1.96	-7.84	0.16	-0.01	0.53	-0.02	0.74	-2.44	2.51	-7.78
Tea Processing	1.33	-7.63	6.65	-13.1	0.26	-0.02	1.24	-0.03	1.58	-7.69	8	-13.2
Rubber Processing	0.84	-6.36	3.2	-11.6	0.18	-0.04	0.67	-0.05	1.03	-6.44	3.92	-11.7
Coconut Processing	1.3	-11.2	3.17	-15	0.3	-0.08	0.73	-0.09	1.61	-11.3	3.94	-15.2
Milling	-0.02	0.58	-0.15	-9.97	-0.15	-0.24	-0.94	-0.26	-0.16	0.34	-1.03	-10.2
Food, Beverages and Other	-0.74	-3.21	-7.41	-9.84	0.09	0.16	0.94	0.15	-0.64	-3.08	-6.48	-9.76
Textiles	1.38	7.02	3.93	1.75	0.2	0.26	0.56	0.24	1.58	7.08	4.52	1.77

Table (continued)

Industry	Simulation 1 100% cut in prevailing tariffs in manufacturing industries				Simulation 2 100% cut in prevailing tariffs in agricultural industries				Simulation 3 100% cut in prevailing tariffs in all industries			
	Output level		Employment		Output level		Employment		Output level		Employment	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
Garments	1.72	2.51	5.16	-2.47	0.21	0.11	0.6	0.1	1.93	2.35	5.79	-2.66
Wood & Wood Products	0.18	3.49	1.03	-3.61	0.08	-0.05	0.48	-0.06	0.26	3.43	1.53	-3.71
Paper & Paper Products	-0.39	2.93	-1.13	-2.14	0.22	0.03	0.66	0.01	-0.18	2.8	-0.54	-2.3
Chemicals and Fertilisers	-0.14	8.45	-0.78	1.7	0.7	0.94	4.14	0.92	0.59	9.58	3.47	2.71
Petroleum	-0.06	2.21	-0.9	-9.64	0.11	0.07	1.67	0.05	0.05	2.22	0.75	-9.7
Plastic and Rubber Products	0.54	26.36	4.4	17.94	0.06	0.41	0.49	0.39	0.6	26.61	4.91	18.12
Non Metalic & Other Mineral Products	0.82	17.82	4.3	10.77	0.08	0	0.43	-0.02	0.9	17.69	4.78	10.6
Basic Metal Products	0.2	25.36	0.2	25.36	0.16	0.07	0.16	0.07	0.36	25.44	0.36	25.44
Fabricated Metal Products	2.27	88.55	12.48	77.24	0.09	0.05	0.43	0.03	2.35	89.5	12.99	78.05
Other Manufacturing	0.73	26.13	2.85	16.21	0.18	0.6	0.68	0.59	1.4	36.28	5.55	25.5
Electricity, Gas and Water	0.34	3.14	1.66	-3.17	0.07	0.01	0.32	-0.01	0.41	3.17	2	-3.19
Construction	-0.01	7.73	-0.02	5.22	-0.01	0.01	-0.01	0	-0.03	7.78	-0.04	5.25
Wholesale and Retail Trade	1.93	5.55	5.96	-2.62	0.27	0.13	0.8	0.12	2.2	5.7	6.81	-2.52
Hotels and Restaurants	0.07	4.19	0.11	-0.34	0.07	0.01	0.11	0.01	0.15	4.26	0.23	-0.3
Transport	1.08	4.67	3.75	-0.83	0.15	0.05	0.52	0.03	1.23	4.74	4.3	-0.8
Post and Communication	-0.18	1.52	-0.18	1.52	0.02	-0.15	0.02	-0.15	-0.16	1.39	-0.16	1.39
Banking Insurance and Real Estate	2.26	2.54	2.98	-0.5	0.3	0.07	0.4	0.06	2.55	2.4	3.36	-0.66
Ownership of Dwellings	0	3.54	0	0	0	-0.13	0	0	0	3.42	0	0
Public Administration and Defence	0.11	3.35	0.11	3.35	0.01	-0.02	0.01	-0.02	0.12	3.35	0.12	3.35
Other Personal Services	0.08	2.59	0.1	0.83	0	-0.1	0	-0.1	0.09	2.51	0.1	0.74

Notes: Projections are in percentage changes from the base solution

Similarly, the manufacturing industries which rely heavily on imported inputs while having a moderate export volume (such as non metallic and other mineral products and basic metal products) have also shown an modest expansion. In addition, other export industries such as Wood and wood products and Mining and quarrying have also shown a moderate growth.

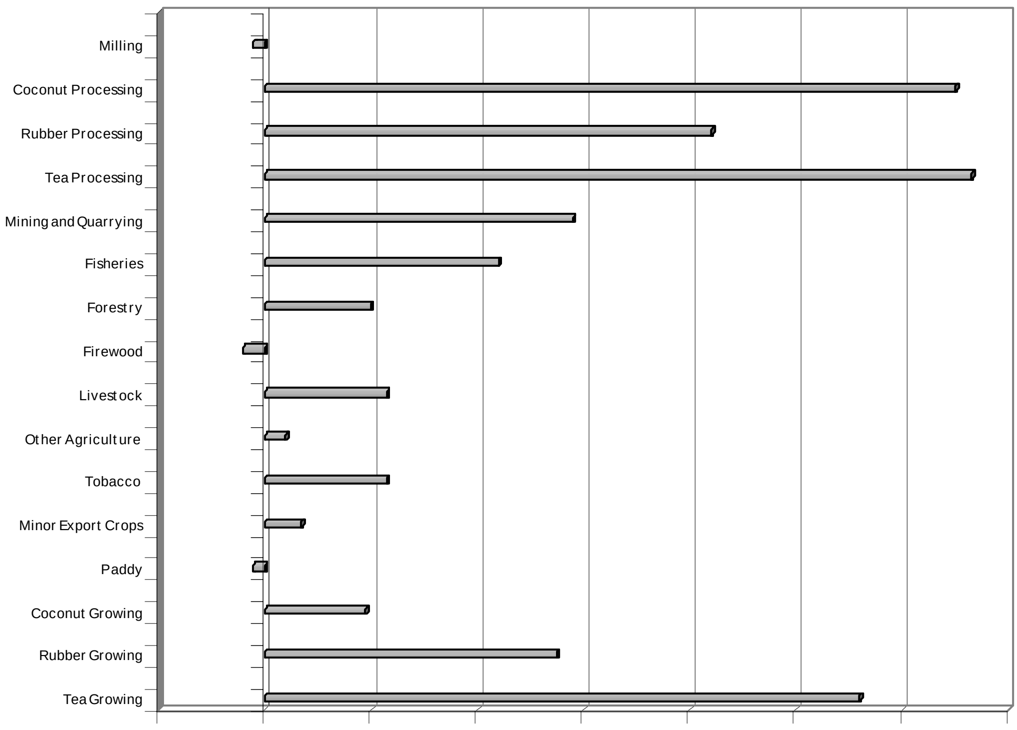


Figure: 7.4: Short Run Output Effects on Agricultural Industries under Simulation 1

By the same token the agricultural export industries such as Tea processing, Rubber processing and Coconut processing have shown a significant expansion mainly due to the reduction in labour cost, while Minor export crops and Tobacco industries revealed a modest increase. Furthermore, due to inter-industry linkages the main suppliers of intermediate goods to the above agricultural export industries have also revealed an expansion. Thus, agricultural industries such as Tea growing, Rubber growing and Coconut growing have been stimulated.

In contrast, the import substituting industries, which are mainly directed at the final consumption, are badly hit due to the competition coming from cheaper imports. For instance, the Food, beverage and other industry, in which 68 per cent of total imports have been used in final consumption, has shown a contraction in output as well as in employment. Similarly, industries mainly catering to the domestic market in terms of intermediate goods such as Paper and paper products and Chemicals and fertilisers have shown a contraction due to the competition coming from imports.

Amongst the agricultural industries that are catering mainly to the domestic market, the Paddy industry has revealed a slight negative growth. This may be due to the relative attractiveness of other export oriented agricultural industries over the Paddy industry. The contraction of the Paddy industry in turn has affected the Milling industry, which is primarily dependent on the Paddy industry for its intermediate inputs.

The service industries mainly linked with those expanding industries seem to have been stimulated. For instance, service industries such as Wholesale trade and retail trade, Transport and Banking insurance and real estate have shown significant growth. However, the Construction industry, which is strongly linked to domestic import competing industries, has demonstrated a slight decline.

Overall most industries are either slightly benefited or unaffected by this shock. Although the slack labour market would supply enough labour to all industries to meet the new labour demand or to replace outgoing labour, positive output effects are less pronounced due to the capital constraint in the short run.

Under the long run closure of full employment and mobile capital, the manufacturing industries are expected to expand significantly. In particular, industries such as Fabricated metal products, Plastic and rubber products, Other manufacturing, Basic metals products, Non metallic and other mineral products, Chemicals and fertilisers, along with Textile and Garments, have shown a marked increase in output. The Food, beverages and other industry has shown a contraction as a result of the competition coming from cheaper imports. In contrast to the short run case, export agricultural industries and the mining industry are expected to contract. Particularly, industries such as Tea processing, Rubber processing and Coconut processing have shown a significant contraction. This in turn has led to a contraction of Tea growing, Rubber growing and Coconut growing industries which are mainly supplying intermediate goods to the above export agricultural industries.

The reason behind the contraction of export agricultural industries could be viewed as a consequence of the attraction of resources to more profitable manufacturing industries, such as the mobility of labour from export agricultural industries to more attractive manufacturing industries. In the long run, although we keep the aggregate labour fixed assuming full employment, we allow the mobility of labour between industries. As the relative growth of manufacturing industries is very high compared to agricultural industries, rural labour would be attracted to these growing manufacturing industries, which are mainly situated in urban areas. This in turn would cause a resource constraint to those export agricultural industries, thus forcing them to contract their activities.

In contrast, the domestic agricultural industries that are mainly catering to the domestic market seen to have either slightly benefited or been unaffected by the policy shock. For instance, the industries such as Paddy, Other agriculture, Livestock and Fisheries have shown a moderate expansion. This possibly occurs because of the domestic consumption effect results from higher real wages of labour, which can also be seen from the increase in aggregate real household consumption as explained in Section 7.4.1.

Mobility in capital in addition to labour has made the positive impacts on manufacturing industries more pronounced in the long run. Moreover, along with the expansion of most of the manufacturing industries, some service sectors that supply inputs to those industries (such as retail and wholesale trade, transport and electricity, gas and water) have been stimulated. In addition, the Construction industry exhibits positive growth due to the improvement shown in the real domestic absorption.

Under the second simulation, which implemented 100 per cent tariff cut in agricultural industries, a majority of industries were unaffected or marginally benefited while paddy, other agriculture and milling industries were contracted in the short run. These results are consistent with the proposition that previously heavily protected industries suffer when trade is liberalised. As the above industries are mainly supplying to the domestic market, they tend to suffer heavily from the competition coming from cheaper imports. The reason for the contraction of the milling industry can be attributed to the negative effects felt by the Paddy industry, which is the main supplier of domestic intermediate goods to the Milling industry. Furthermore, the Construction industry, which is strongly linked to domestic industries, is also seen to have suffered. In the long run, in addition to the domestic agricultural industries, other export-oriented agricultural industries such as Tea processing, Rubber processing and Coconut processing have also shown a marginal contraction. This contraction results from the marginal drop in the output of major intermediate input supplying industries such as Tea growing, Rubber growing and Coconut growing. These three tree crops are perennial crops, so any competition coming from cheaper imports may be felt in the long run as farmers may tend to reallocate their resource from these industries to more other profitable industries. This may occur as reduction in replanting and less application of fertiliser, which may ultimately result in a drop in output per unit land area. In addition, we can also observe a slight drop in output in the mining and forestry industries.

On the other hand, manufacturing industries as a whole have benefited. Relocation of resources from unprofitable agricultural industries into relatively profitable manufacturing industries might be the reason for this long run growth. However, the Wood and wood products industry, which utilises inputs from the Forestry industry, has shown a marginal contraction. The services industries, except for a few services industries (Other personal services, Public administration and defence, Post and communication), have been marginally stimulated. All in all, it can be observed that agricultural trade liberalisation yields relatively low stimulus at the industry level in both the short run and the long run, suggesting the relative importance of liberalising the manufacturing industries.

The third simulation of 100 percent across the board tariff cut (both in the short run and the long run) revealed more or less similar results as in simulation 1. However, the previously protected Other agriculture industry category has shown a decline in output in the short run. A close examination of simulation results reveals that industry effects are a combination of the outcome of both the previous simulations. However, impacts on manufacturing tariff cuts are more prominent due to the fact that agricultural tariff cuts alone may not be sufficient enough to distort the domestic prices in order to stimulate the economy.

7.4.3 Household Level Effects

The impact of trade policy shocks at household level can be traced from the CGE results, whereas the effects on poverty and inequality could be tracked from income distribution models. This is the main focus of the model. The CGE model captures the changes that occur among the occupational labour categories through the differential impacts observed at industry level and the associated derived demand for occupational labour categories. Similarly, the household income flows are determined by taking into account the changes of wage income, government transfers, other transfers, gross operating surplus and other sources of household income. Moreover, taking into account the household tax payments generates the change in disposable income for different household groups over the base case. Tables 7.3 and 7.4 present the projection of aggregate employment among different occupational groups and post tax income among different household groups respectively.

The short run results of simulations 1 and 3 indicate an overall increase in derived demand for occupational labour categories following industry expansion due to a slack labour market. Furthermore, these results revealed an increase of 5.38 and 6.17 per cent of Sales workers followed by an increase of 2.04 and 2.35 per cent of Administrative and managerial workers, as well as an increase of 1.67 and 2 per cent of Production and related transport equipment operators & labourers as a result of an expansion of both the trading industries and the manufactured product industries under simulations 1 and 3 respectively. The long run results revealed that the demand for unskilled labour particularly that of the Production and related transport equipment operators & labourers, has markedly increased, while the demand for skilled and semi skilled labour categories (Service workers, Clerical & related workers and Professional, technical and related workers) have also increased marginally by placing them next in line. However, unskilled agricultural labour is expected to contract due to the migration of labour from backward domestic agricultural industries into expanded manufacturing industries. In contrast, the trade reforms in agricultural imports (simulation 2) revealed an insignificant increase in derived demand for occupational labour categories, as this shock yielded a relatively low stimulus at the industry level.

Table 7.3
Projections of Percentage Change in Aggregate Employment by Different Occupational Groups

Occupational group	**Simulation 1** 100% cut in prevailing tariffs in manufacturing industries		**Simulation 2** 100% cut in prevailing tariffs in agricultural industries		**Simulation 3** 100% cut in prevailing tariffs in all sectors	
	SR	LR	SR	LR	SR	LR
Professional, technical and related workers	1.5	1.42	0.21	0	1.72	1.4
Administrative and managerial workers	2.04	0.96	0.3	0.04	2.35	0.96
Clerical & related workers	1.7	1.17	0.24	0.01	1.95	1.13
Sales workers	5.38	-2.19	0.73	0.11	6.17	-2.12
Service workers	0.88	1.97	0.14	0	1.03	1.96
Agricultural, animal husbandry, fisheries and forestry workers	1.46	-6.81	-0.07	-0.31	1.39	-7.17
Production and related transport equipment operators & labourers	1.67	2.22	0.29	0.05	2	2.37
Other workers	1.28	0.94	0.2	-0.01	1.51	0.97

SR = short run effects & LR = long run effects.

Table 7.4
Projections of Percentage Change on Post Tax Income among Different Household Groups

Household group	Simulation 1 100% cut in prevailing tariffs in manufacturing industries		Simulation 2 100% cut in prevailing tariffs in agricultural industries		Simulation 3 100% cut in prevailing tariffs in all sectors	
	SR	LR	SR	LR	SR	LR
Urban low-income households	-1.01	12.83	-0.47	-0.03	-1.47	12.95
Rural low-income households	-2.32	3.71	-0.56	-0.35	-2.87	3.42
Estate low-income households	-0.88	10.6	-0.51	-0.09	-1.38	10.61
Urban high-income households	0.56	6.44	-0.36	-0.16	0.24	6.37
Rural high-income households	0.2	7.66	-0.38	-0.13	-0.15	7.61

SR = short run effects & LR = long run effects.

The industry expansions and contractions affect the derived demand for primary factor inputs; so does the factor income. The short run results of simulations 1 and 3 revealed a contraction of nominal post tax income in all low-income household groups. It further showed a comparatively marked decline in the income of rural low-income households. The main reasons for this decline in income are the reduction of government transfer payments to low-income households following the reduction of government revenue as a result of tariff cut and the reduction in output and employment in the paddy sector. Although the import tariff rates of manufactured products were moderate in size, the total revenue loss was significant due to high import volume. Interestingly, the rural low-income households, which suffered most under these shocks, received approximately 83 per cent of government transfer payments. The high-income households, however, have benefited, as the expansion of manufacturing industries has contributed to the expansion of the gross operating surplus of those industries. More importantly, service industries such as retail and wholesale trade and transport, which accounted for a sizeable portion of gross operating surplus, form a significant income source of high-income groups. In contrast, long run effects of these shocks benefited low-income groups, particularly urban low-income households, as these households form the main labour component of the manufactured product industries. However, it is revealed that, similar to the short run scenario, the high-income groups receive moderately high benefits in terms of income, mainly due to the expansion of service industries and manufactured product industries, leading to an increase in demand for skilled labour categories such as Administrative and managerial workers and Professional, technical and related workers, as discussed in the previous section.

Simulation 2 revealed a rather neutral effect on income with respect to high-income groups in both the short run and the long run. This may be due to less involvement of high-income groups in the activities of heavily protected domestic agricultural industries. In contrast to the previous simulations, low-income groups experienced a marginal negative effect in both the short run and the long run, suggesting that agricultural trade reforms are moderately income-neutral compared to those of manufacturing industries.

7.4.4 Absolute Poverty

As discussed in Chapters 4 and 5, absolute poverty is captured by linking the CGE outputs of percentage change in the poverty line and percentage change in the average income of different household groups with the beta income distribution functions of the respective household group. Graphical presentation of pre and post simulation beta income distribution functions and money metric poverty lines for different household groups are given in Figures 7.5, 7.6 and 7.7. The continuous line depicts the base case beta income distribution, whereas the dotted line depicts the post simulation beta income distribution. Similarly, the continuous straight line represents the base case money metric poverty line while the dotted straight line portrays the post simulation money metric poverty line.

By examining the graphical presentations of pre and post simulation beta income distribution functions, the following observations can be made. In the urban and estate low-income household groups, a significant change in the post simulation beta income distribution functions is evident in long run simulations 1 and 3. The above change in beta income distribution functions under the same simulation experiments is less pronounced in the rural low-income group. However, in all simulations in all low-income household groups the change in the poverty line is less prominent. As the post simulation changes are rather modest in magnitude, it is necessary to go beyond the graphical analysis and closely examine the numbers in detailed.

In Table 7.1 we observe a decline in the post simulation poverty line under all simulation experiments except the short run scenario of simulation 1, where it was observed to be increasing slightly. When the prices of basic needs commodities, especially manufactured food products, petroleum products, garments and other agricultural imports, are reduced due to tariff cuts, the money metric poverty line declines thus making basic needs commodities cheaper in the market. With the changes in post tax nominal household income distribution and the new money metric poverty line, the beta income distribution models for different household groups would generate income poverty measures based on the FGT P_α indices, which are discussed in Chapter 6. The FGT P_α results of all simulations under the short and long run cases are presented in Tables 7.5 and 7.6 respectively.

Table 7.5
FGT Poverty Indices (%) under Different Policy Experiments
(Short Run Results)

Policy Experiment	**Urban low-income households**			**Rural low-income households**			**Estate low-income households**		
	Before	*After*	**% Change**	*Before*	*After*	**% Change**	*Before*	*After*	**% Change**
Simulation 1									
Head count ratio (α =0)	35.70	35.19	-1.43	45.42	45.37	-0.11	79.17	78.21	-1.21
Poverty gap (α =1)	17.24	16.97	-1.57	22.23	22.20	-0.13	36.58	35.90	-1.86
Poverty severity (α =2)	10.99	10.81	-1.64	14.37	14.35	-0.14	21.58	21.11	-2.18
Simulation 2									
Head count ratio (α =0)	35.70	35.55	-0.28	45.42	45.28	-0.31	79.17	78.94	-0.29
Poverty gap (α =1)	17.24	17.16	-0.46	22.23	22.16	-0.31	36.58	36.42	-0.44
Poverty severity (α =2)	10.99	10.93	-0.55	14.37	14.32	-0.35	21.58	21.47	-0.51
Simulation 3									
Head count ratio (α =0)	35.70	35.04	-1.85	45.42	45.22	-0.44	79.17	77.97	-1.52
Poverty gap (α =1)	17.24	16.89	-2.03	22.23	22.12	-0.49	36.58	35.74	-2.30
Poverty severity (α =2)	10.99	10.75	-2.18	14.37	14.30	-0.49	21.58	20.99	-2.73

Base poverty line = Rs.3649.6/month/household. Percentage change in poverty line under different simulation experiments: simulation 1= -2.44, simulation 2= -0.88, simulation 3= -3.31

The FGT indicators are estimated and compared with the base case and the percentage changes from the base case are reported in the tables. Thus, a negative change of the FGT index denotes a reduction in absolute poverty. Furthermore, three types of FGT indices capturing headcount ratio, poverty gap and poverty severity are reported. In the short run case, under simulations 1 and 3, the headcount ratio, poverty gap and poverty severity are expected to decline among all household groups. However, the rural low-income households group showed a comparatively low improvement over the other groups. As discussed earlier, reduction in government transfers following government revenue loss due to tariff cuts, particularly import tariffs of manufactured products, seems to be the causal factor that reduces the potential benefits accruing to the rural low-income households in the short run. In contrast, under simulation 2, all indicators show a reduction within all groups, suggesting that agricultural trade reforms are comparatively poverty neutral in the short run.

Figure 7.5: Change in Absolute Poverty within Rural Low-income Households

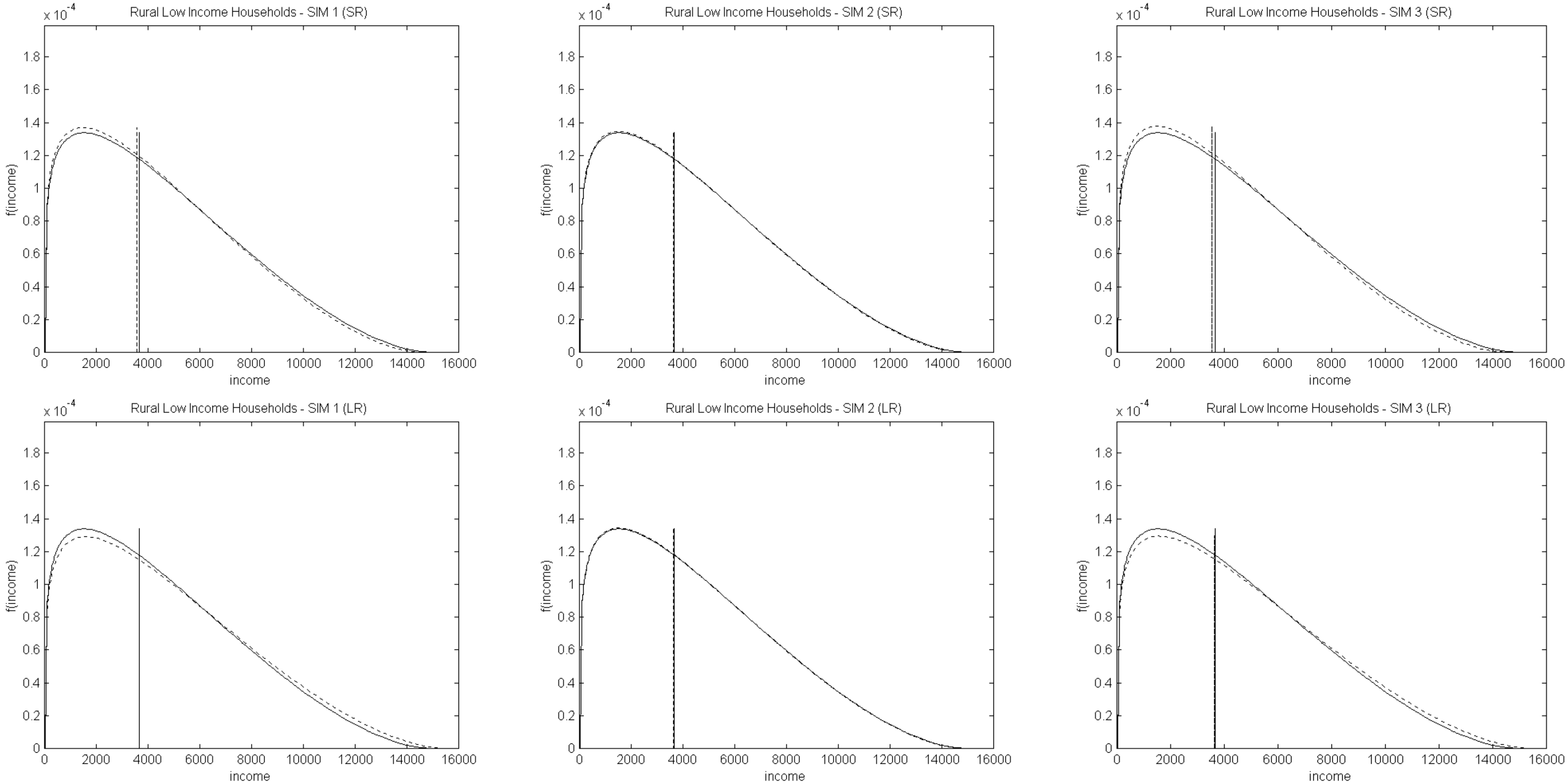


Figure 7.6: Change in Absolute Poverty within Urban Low-income Households

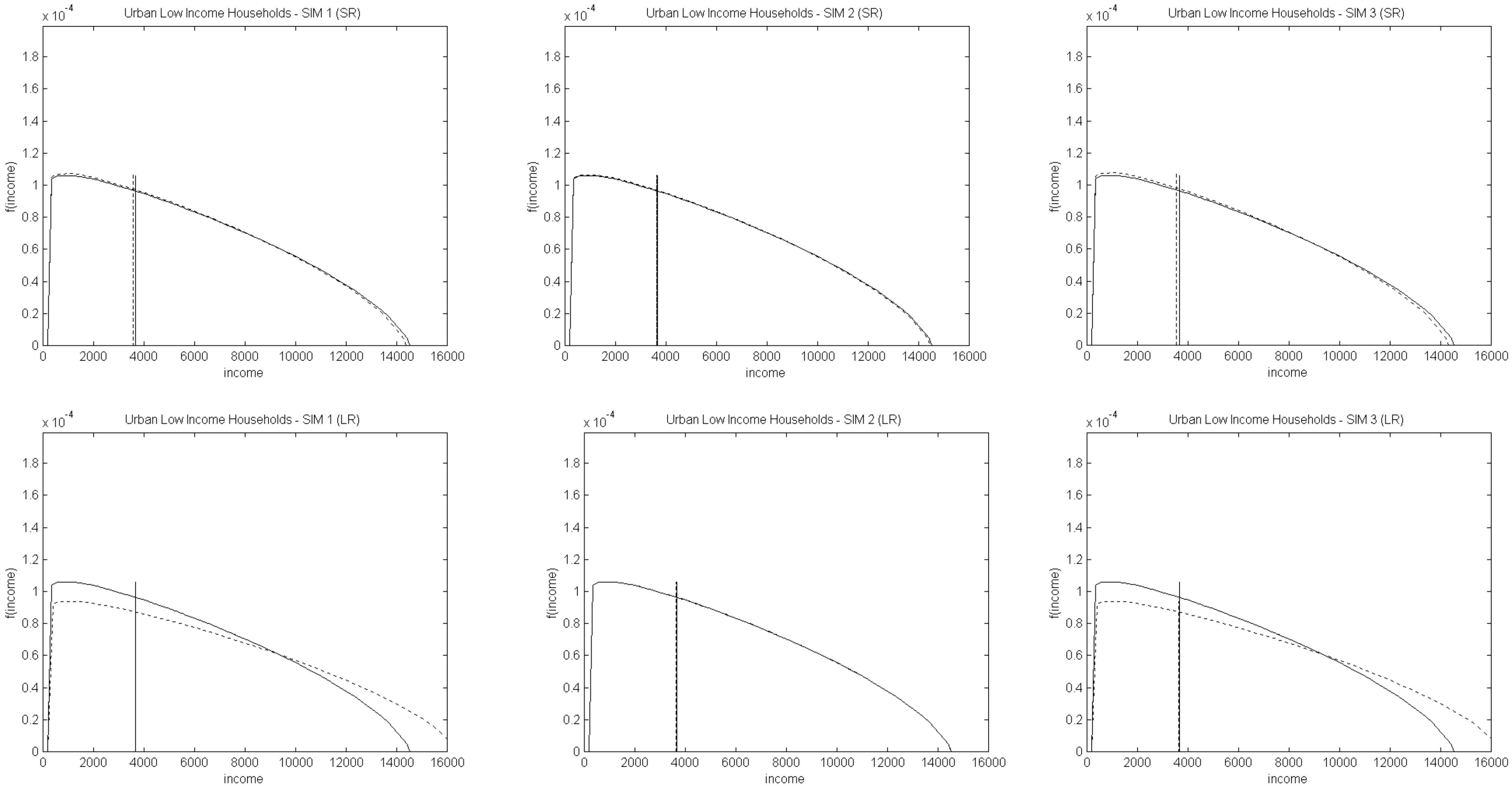
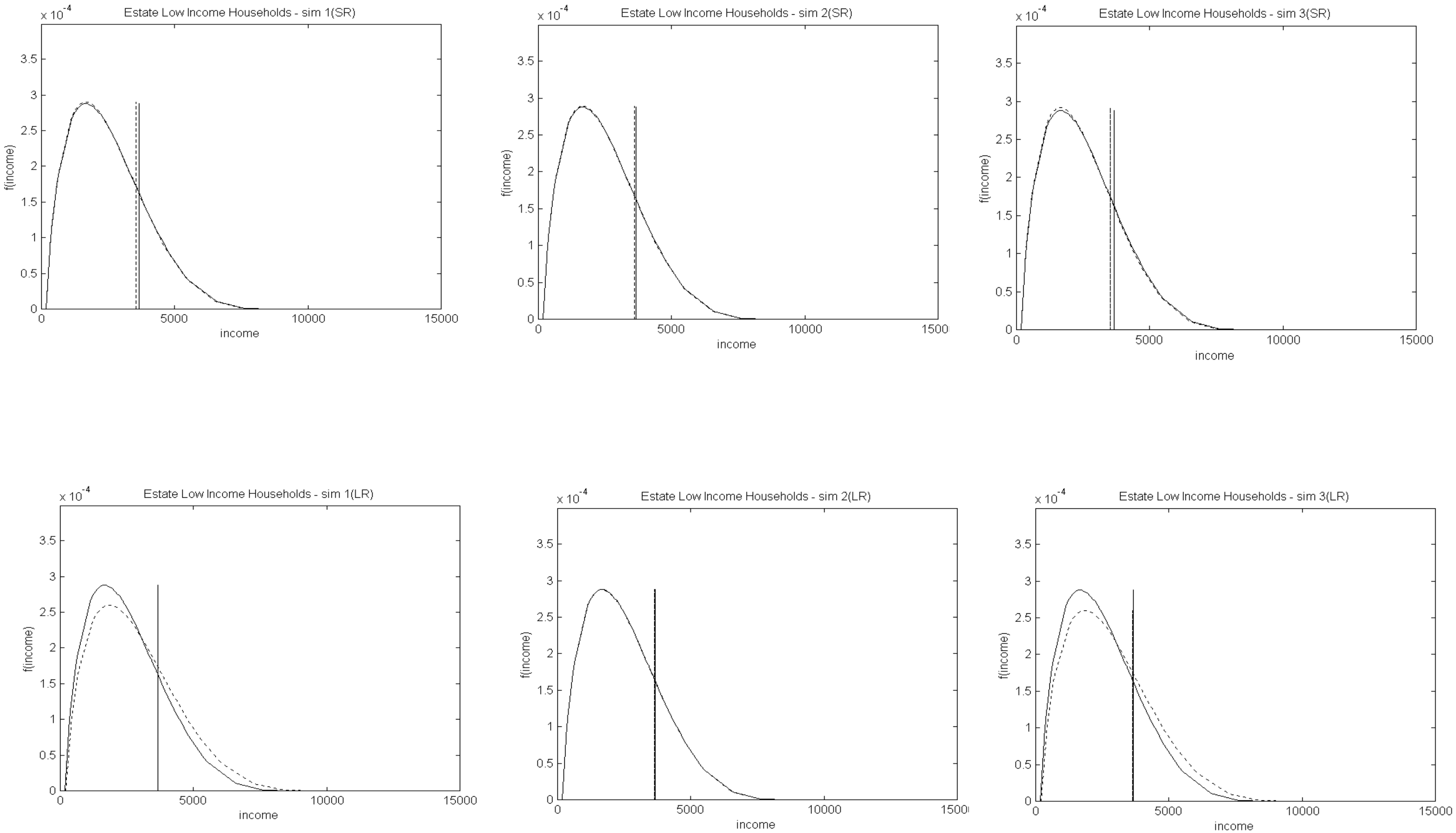


Figure 7.7: Change in Absolute Poverty within Estate Low-income Households



In the long run, under all simulations, all household groups show a reduction in absolute poverty in terms of headcount ratio, poverty gap and poverty severity. However, it is striking to note that simulations 1 and 3 substantially reduce poverty among all household groups. Trade liberalisation in manufacturing industries remarkably stimulated the manufactured product industries and attracted labour from the low productive sectors, which would ultimately improve the nominal income of a sizeable portion of low-income households, particularly the urban low-income group. This in turn along with the decline in the poverty line, has resulted in a substantial drop in absolute poverty among all income groups in the long run. In contrast, agricultural trade liberalisation (simulation 2) demonstrates a marginal improvement in absolute poverty in all household groups, suggesting that trade reform in the manufacturing industries is more pro-poor than that of the agricultural industries, at least in the long run.

Table 7.6
FGT Poverty Indices (%) under Different Policy Experiments
(Long Run Results)

Policy Experiment	**Urban low-income households**			**Rural low-income households**			**Estate low-income households**		
	Before	*After*	**% Change**	*Before*	*After*	**% Change**	*Before*	*After*	**% Change**
Simulation 1									
Head count ratio (α =0)	35.70	31.78	-10.98	45.42	44.03	-3.06	79.17	73.17	-7.58
Poverty gap (α =1)	17.24	15.19	-11.89	22.23	21.48	-3.37	36.58	32.54	-11.04
Poverty severity (α =2)	10.99	9.60	-12.65	14.37	13.86	-3.55	21.58	18.80	-12.88
Simulation 2									
Head count ratio (α =0)	35.70	35.49	-0.59	45.42	45.31	-0.24	79.17	78.85	-0.40
Poverty gap (α =1)	17.24	17.13	-0.64	22.23	22.17	-0.27	36.58	36.35	-0.63
Poverty severity (α =2)	10.99	10.91	-0.73	14.37	14.33	-0.28	21.58	21.42	-0.74
Simulation 3									
Head count ratio (α =0)	35.70	31.55	-11.62	45.42	43.89	-3.37	79.17	72.77	-8.08
Poverty gap (α =1)	17.24	15.07	-12.59	22.23	21.41	-3.69	36.58	32.29	-11.73
Poverty severity (α =2)	10.99	9.52	-13.38	14.37	13.81	-3.90	21.58	18.62	-13.72

Base poverty line = Rs.3649.6/month/household. Percentage change in poverty line under different simulation experiments: simulation 1= 0.39, simulation 2= -0.62, simulation 3= -0.23.

In order to evaluate the robustness of the FGT poverty measures, a range of popular poverty measures (Watts index, S-Gini index, Sen index and CHU index) are computed, based on the changes in nominal income distributions and poverty lines generated from the CGE model. Interestingly, both the short and long run results are consistent with the FGT measures, which suggests that poverty measures calculated in this study are robust estimates. The short run and long run estimates of these poverty measures are given in Tables 7.7 and 7.8. Furthermore, the conclusions drawn from the poverty results generated under the present study are to some extent consistent with the previous CGE analysis carried out for Nepal by Cockban (2001), in which poverty reduces among urban household groups. However, contrary to that study, rural low-income households have shown a marginal improvement in absolute poverty.

7.4.5 Income Inequality

In order to evaluate the inequality or relative poverty among total households, a range of inequality measures (Atkinson index, S-Gini index and Entropy index) are computed, based on the changes in nominal income distributions generated from the CGE model. Interestingly, both the short and long run results revealed an increase in inequality estimates under all three simulations. Contrary to the Stolper-Samuelson theory (Stolper and Samuelson, 1941), which postulates that most abundant factors would benefit by trade reforms, inequality is expected to increase, suggesting that the gap between poor and rich households is expected to widen. Despite the benefits accruing to the most abundant factor in Sri Lanka – labour – the increase in gross operating surplus, in the light of the expansion of manufacturing industries and linked services sectors, accrued benefits to high-income households. One possible reason for this outcome is the expansion observed in service industries such as retail and wholesale trade and transport, which generate a notable amount of gross operating surplus that forms a vital source of

Table 7.7

Poverty Indices (other than FGT) under Different Policy Experiments (Short Run Results)

Policy Experiment	Urban low-income households			Rural low-income households			Estate low-income households		
	Before	After	%change	Before	After	%change	Before	After	%change
Simulation 1									
Watts Index	0.2908	0.285	-1.98	0.3854	0.3848	-0.15	0.6102	0.597	-2.16
S-Gini Index (rho=2.0)	0.2905	0.2855	-1.74	0.3649	0.3644	-0.14	0.5261	0.519	-1.35
Sen Index	0.2281	0.2239	-1.83	0.2982	0.2977	-0.17	0.4844	0.4685	-3.28
CHU Index (epsilon=0.5)	47.426	46.055	-2.89	60.535	59.663	-1.44	100.594	95.379	-5.18
Simulation 2									
Watts Index	0.2908	0.2891	-0.57	0.3854	0.3838	-0.41	0.6102	0.6071	-0.51
S-Gini Index (rho=2.0)	0.2905	0.289	-0.50	0.3649	0.3636	-0.35	0.5261	0.5244	-0.32
Sen Index	0.2281	0.2274	-0.33	0.2982	0.2959	-0.77	0.4844	0.4831	-0.27
CHU Index (epsilon=0.5)	47.426	47.214	-0.45	60.535	59.544	-1.64	100.594	100.14	-0.45
Simulation 3									
Watts Index	0.2908	0.2834	-2.55	0.3854	0.3831	-0.59	0.6102	0.5938	-2.68
S-Gini Index (rho=2.0)	0.2905	0.284	-2.24	0.3649	0.3631	-0.50	0.5261	0.5172	-1.69
Sen Index	0.2281	0.2198	-3.65	0.2982	0.2951	-1.05	0.4844	0.4672	-3.56
CHU Index (epsilon=0.5)	47.426	44.298	-6.60	60.535	58.56	-3.26	100.594	94.944	-5.62

Base poverty line = Rs.3649.6/month/household. Percentage change in poverty line under different simulation experiments: simulation 1= -2.44, simulation 2= -0.88 , simulation 3= -3.31

Table 7.8

Poverty Indices (other than FGT) under Different Policy Experiments (Long Run Results)

	Urban low-income households			Rural low-income households			Estate low-income households		
Policy Experiment	**Before**	**After**	**%change**	**Before**	**After**	**%change**	**Before**	**After**	**%change**
Simulation 1									
Watts Index	0.2908	0.2497	-14.12	0.3854	0.3696	-4.11	0.6102	0.5339	-12.50
S-Gini Index (rho=2.0)	0.2905	0.2546	-12.34	0.3649	0.3525	-3.39	0.5261	0.4826	-8.28
Sen Index	0.2281	0.1852	-18.82	0.2982	0.2826	-5.24	0.4844	0.417	-13.91
CHU Index (epsilon=0.5)	47.426	36.451	-23.14	60.535	56.649	-6.42	100.594	87.358	-13.16
Simulation 2									
Watts Index	0.2908	0.2884	-0.83	0.3854	0.3841	-0.34	0.6102	0.6057	-0.73
S-Gini Index (rho=2.0)	0.2905	0.2884	-0.72	0.3649	0.3638	-0.30	0.5261	0.5237	-0.46
Sen Index	0.2281	0.2254	-1.20	0.2982	0.296	-0.73	0.4844	0.4825	-0.39
CHU Index (epsilon=0.5)	47.426	46.491	-1.97	60.535	59.622	-1.51	100.594	100.28	-0.32
Simulation 3									
Watts Index	0.2908	0.2475	-14.88	0.3854	0.368	-4.52	0.6102	0.5294	-13.25
S-Gini Index (rho=2.0)	0.2905	0.2528	-12.99	0.3649	0.3513	-3.73	0.5261	0.4798	-8.80
Sen Index	0.2281	0.1843	-19.20	0.2982	0.2816	-5.55	0.4844	0.4151	-14.31
CHU Index (epsilon=0.5)	47.426	36.336	-23.38	60.535	56.351	-6.91	100.594	87.084	-13.43

Base poverty line = Rs.3649.6/month/household. Percentage change in poverty line under different simulation experiments: simulation 1= 0.39, simulation 2= -0.62, simulation 3= -0.23.

income for high-income groups. Moreover, as evident from the derived demand for different labour categories under the above simulations, the demand for skilled labour categories, particularly those of Administrative and managerial workers and the Professional, technical and related workers, has also increased along with that of unskilled labour, thus contributing to widening the gap between rich and poor. This evidence on the widening of the gap between rich and poor under trade reforms is consistent with recent CGE analysis carried out for South Africa (Humphreys, 2000) and for Indonesia (Croser, 2002). However, when inequality measures were estimated for households in the total low-income groups (total of urban low-income, rural low-income and estate low-income household groups), a significant drop in inequality is evident under simulation 3 in both the short and the long run. This suggests that across the board trade liberalisation causes a more equitable distribution of income among low-income groups. The short run and long run estimates of inequality indicators among total households and total low-income households are given in Table 7.9.

7.5 RESULTS OF THE SYSTEMATIC SENSITIVITY ANALYSIS

As described in Chapter 4 Section 4, a SSA was carried out to check the robustness of simulation results under different parameter values, particularly the values of the Armington elasticities. As we assume under the assumption of imperfect substitutability of Armington elasticities that imported goods are not complete substitutes for domestically produced goods, then competition coming from the imported goods due to tariff reduction might not be intensive enough to completely shut down the domestic import competing industries. This assumption is debatable under the circumstance where the parameter values are assumed rather than econometrically estimated. More importantly, SSA was never carried out to any of the ORANI tradition CGE models previously developed for Sri Lanka.

In this study, therefore, we carried out the simulations by varying the Armington elasticity values systematically and investigated the results. All three Armington elasticities, namely, the Intermediate Armington, investment Armington and the household Armington, were allowed to vary by 100 per cent from the original values based on a Triangular distribution and carried out simulations using *Stroud's quadrature* (Stroud, 1957). The short run and the long run industry results for simulation 3 are reported in Table E7.2 in Appendix E.

The results reveal that in the long run as well as in the short run, the SSA mean values are not significantly different from the original simulation results. Furthermore, by looking at the values of standard deviations reported in the SSA results, it is revealed that deviations from the mean are significantly low among many endogenous variables. Thus, according to Chebyshev's inequality, [2] which states that we can be 75 per cent confidant that the actual value would fall within two standard deviations plus or minus the mean, we can specify a confidence interval estimate for each and every endogenous variable taking into account the mean value and the standard deviation. A relatively low standard deviation values suggest that the confidence intervals are rather narrow, thus

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[2] Assume an endogenous variable Z with mean M and standard deviation D.
Chebyshev's inequality states that, irrespective of the distribution of the variable in question, for each positive real number k, the probability that the value of Z does not lie within k standard deviations of the mean M is no more than $1/(k^2)$. For example,
If (k=2) the probability that its value does not lie within 2 standard deviations of the mean is no more than 0.25 [$=1/(2^2)$]. Hence, you can be 75% sure that the value does lie between M-2D and M+2D. (based on RunGEM help menu)

Table 7.9
Inequality Measures under Different Policy Experiments

Policy Experiment	Total households						Total low-income households					
	Short run			Long run			Short run			Long run		
	Before	After	%Change	Before	After	%Change	Before	After	%Change	Before	After	%Change
Simulation 1												
Atkinson Index (epsilon=0.5)	.2281	0.2327	2.00	.2281	0.2318	1.63	0.1299	0.1254	-3.46	0.1299	0.1259	-3.07
S-Gini Index (rho=2.0)	.5306	0.5353	0.89	.5306	0.5344	0.71	0.3889	0.3845	-1.13	0.3889	0.3855	-0.88
Entropy Index (theta=1.0)	.4900	0.4967	1.38	.4900	0.4944	0.90	0.2481	0.2414	-2.71	0.2481	0.2427	-2.18
Simulation 2												
Atkinson Index (epsilon=0.5)	.2281	0.2292	0.49	.2281	0.2292	0.48	0.1299	0.1254	-3.45	0.1299	0.1254	-3.45
S-Gini Index (rho=2.0)	.5306	0.5313	0.14	.5306	0.5313	0.13	0.3889	0.3845	-1.13	0.3889	0.3845	-1.13
Entropy Index (theta=1.0)	.4900	0.488	-0.40	.4900	0.488	-0.42	0.2481	0.2414	-2.71	0.2481	0.2414	-2.72
Simulation 3												
Atkinson Index (epsilon=0.5)	.2281	0.233	2.14	.2281	0.2321	1.74	0.1299	0.1254	-3.46	0.1299	0.1259	-3.04
S-Gini Index (rho=2.0)	.5306	0.5357	0.96	.5306	0.5347	0.77	0.3889	0.3845	-1.13	0.3889	0.3855	-0.87
Entropy Index (theta=1.0)	.4900	0.4976	1.54	.4900	0.4951	1.03	0.2481	0.2414	-2.71	0.2481	0.2428	-2.15

indicating that the results are generally robust with respect to different Armington elasticity values. However, as observed from Table A7.1, in some industries such as the Food and beverage industry, Paper and printing, Petroleum products, Non-metallic mineral products and Basic metal products, the values for standard deviations for outputs and employments are greater than one. This suggests that, as industry results for the above industries are sensitive to Armington elasticity values, an empirical estimation of the above elasticities for those industries would shed more light on the behaviour of the said industries under trade policy shocks.

7.6 CONCLUDING REMARKS

In this chapter, the poverty-focussed SAM based CGE model for the Sri Lankan economy developed in this thesis was used to analyse the effects of further trade liberalisation on absolute poverty and income distribution. Simulation experiments were conducted in relation to 100 per cent tariff cuts in manufacturing industries, agricultural industries and the across the board case. It is noteworthy that the results of the simulation experiments carried out with the model have shed considerable light on the implications of trade reforms at macro level, sectoral level and, more importantly, at household level absolute poverty and inequality. Moreover, income distribution models have been empirically estimated and linked to the CGE model within a "top down" approach while allowing the change of poverty line to be determined within the CGE model. Furthermore, a SSA was carried out with respect to Armington elasticities in order to check the robustness of results.

The overall results of the SSA reveal a very low level of standard deviation values for most of the endogenous variables, which indicates that the model produces a rather robust set of results. The simulation results suggest that in the short run, trade liberalisation of manufacturing industries tends to increase the economic growth and reduce absolute poverty in low-income household groups. However, the improvement of absolute poverty seems to have been felt at a lessor degree by the rural low-income group. Reduction in the flow of government transfers to households following the loss of tariff revenue may be blamed for this negative consequence. Nevertheless, long run results indicate that trade liberalisation reduces absolute poverty in all groups. It further reveals that in the long run, trade liberalisation of manufacturing industries is more pro poor than that of agricultural industries. However, overall results suggest that trade reforms may widen the income gap between rich and poor thus promoting relative poverty. This may warrant active interventions with respect to poverty alleviation activities following the trade shocks.

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

This thesis has attempted to contribute to the on-going debate about the trade and poverty linkage using Sri Lanka as a case study within a general equilibrium framework. In order to examine the trade and poverty link, a multi-household CGE model (*SLGEM–P*), which has the capabilities of capturing poverty, was developed for Sri Lanka. As a methodological enhancement, the *SLGEM–P* model was linked with a sub model that was developed by empirically fitting the best-fit income distribution functional forms for different households groups in Sri Lanka. This methodological development aimed to control the limitation of the representative agent hypothesis. Moreover, a disaggregated Social Accounting Matrix (SAM) was constructed for Sri Lanka for the base year 1995 along with other data matrices necessary in implementing the *SLGEM–P* for trade policy simulations. This was another contribution in this thesis considering the unavailability of a SAM for decades in Sri Lanka. Finally, a set of simulation experiments were carried out using *SLGEM–P* with respect to 100 per cent reduction in existing tariffs in the manufacturing products sectors, agricultural products sectors and the across the board case in order to identify the implications on macro economic variables, sectoral variables and household level variables, particularly on absolute poverty and inequality.

The thesis was presented through eight chapters. The first chapter introduced the research problem and specified the objectives of the study. The second and third chapters reviewed the background of the trade and poverty experience in Sri Lanka and the applications of poverty focussed CGE models in developing countries, respectively. In the fourth chapter we developed the Sri Lankan poverty focussed general equilibrium model, *SLGEM–P*. The fifth chapter illustrated the procedure in empirically fitting the best-fit income distribution functional forms for different household groups in Sri Lanka and the estimation of poverty and inequality indices for the base case scenario. The database for the model, which included a Sri Lankan disaggregated SAM for the base year 1995, was constructed in the sixth chapter. The seventh chapter presented the results and discussion on the trade policy simulation experiments carried out using the *SLGEM–P* to understand the link between trade policy, poverty and inequality within the Sri Lankan context.

The objective of this final chapter is to summarise the main findings, highlight the limitations of this study and shed some light on future directions of research. The chapter is structured as follows. Section 8.2 presents a summary of research findings. The limitations of the study are discussed in Section 8.3. Section 8.4 highlights suggestions for further research and the final section presents concluding observations.

8.2 SUMMARY OF RESEARCH FINDINGS

This section intends to summarise the major findings of the study starting from the descriptive analysis of the trade liberalisation, inequality and poverty experience of Sri Lanka and extending it to the core analysis of the trade policy shocks on macro, industry level and household level variables emanating from the *SLGEM–P* model. It further summarises results of empirical fitting of best-fit income distributional functional forms as well as the results of the systematic sensitivity analysis.

A descriptive analysis of the trade liberalisation experience within the Sri Lankan context reveals that Sri Lanka's trade liberalisation process has yielded positive results with respect to macro indicators such as economic growth, unemployment rate and the flow of FDI. In contrast, the inflation rate, budget deficit and current account deficit seemed to have worsened in the post-liberalisation period. Most analysts believe that the worsening of the budget deficit may be due to the escalation of the defence budget. However, the data reveal that successive governments have failed to control inflation during the post-liberalisation period.

The descriptive analysis of the inequality and poverty situation in Sri Lanka reveals that, on the basis of the trends in the Gini coefficient, there is clear evidence that the inequality has increased in Sri Lanka during the post-liberalisation period with weak trickledown effect of economic growth. The analysis of the income shares of the poorest 40 per cent and the richest 20 per cent of spending units further confirmed that Sri Lanka is facing a considerable degree of income inequality. However, the general trend suggested that the incidence of poverty, as a whole, declined towards the early 1990s, though there were disparities of income poverty among the urban, rural and estate sectors. The urban poverty seemed to have declined over time towards 1995; however, poverty among rural and estate sector households has fluctuated.

According to the literature survey on the methods for capturing poverty currently adopted by various researchers within the CGE framework, we could classify poverty focussed CGE models into several broad categories based on the methodology adopted in specifying the household sector. Moreover, the present trend suggests that there is growing interest among researchers in deviating from the traditional representative agent based household specification into more realistic individual households specifications.

The results of the empirical fitting of the best-fit income distribution functional form for low-income household groups in Sri Lanka suggest that all low-income household groups – *RLIHH*, *ULIHH* and *ELIHH* – follow the beta general probability distribution function. This was concluded on the basis of three goodness-of-fit statistical test results. The outcome of these statistical tests is further justified by the graphical goodness-of-fit tests. Moreover, we could observe that the beta distribution is skewed to the right in all three cases, suggesting that the income of the majority of households within each household group falls below the median of each respective group. Hence, these low-income household groups can be considered to contain individual households which are highly vulnerable to negative economic shocks.

The short run macro results of the simulation experiments reveal that all simulations, particularly simulation 1 (reduction of import tariffs in manufacturing industries) and simulation 3 (across the board import tariff reduction), are expected to yield a positive increase in real GDP. Furthermore, the results suggest that tariff reduction is likely to have a positive impact on aggregate employment as well as on the balance of trade. It is also observed that the country's export competitiveness is likely to be improved as a result of the possible real devaluation. Interestingly, it was revealed that trade liberalisation tends to reduce the inflation in the economy: this was observed from the decline in the percentage change of the consumer price index as well as that of the poverty line. This further suggests that tariff cuts are likely to play a positive role in bringing down the cost of living.

Long run macro results of the simulation experiments indicate that simulations 1 and 3 are expected to stimulate the real GDP substantially. The large effects can be attributed to sizeable expansions in the manufacturing industries. The results further reveal that real wages as well as real aggregate private consumption are expected to increase. Thus, the above increase of the real consumption suggests a positive aggregate welfare improvement of trade liberalisation.

In contrast to simulation 1, the agricultural trade liberalisation, simulation 2, produces marginal results in the short run as well as in the long run. In other words, it can be seen that the likely impacts of agricultural border protection are trivial by comparison to that of manufacturing industries. Therefore, agricultural trade liberalisation seems to play a less important role in achieving growth objectives in Sri Lanka. However, since the non tariff barriers such as quantity restrictions in operation in some agricultural imports can not be captured by the current database, care has to be exercised in drawing conclusions.

The implications at industry level demonstrate that as the tariff cuts tend to reduce the cost of production of industries that are significantly catering to the export market, export industries are likely to be expanded (as the global markets largely determine the output prices of such industries). Thus, under simulations 1 and 3, in the short run, the manufacturing export industries such as Textiles, Garments, Fabricated metal products, Other manufacturing and Plastic and rubber products have shown a likely expansion in terms of output as well as the employment. Similarly, manufacturing industries such as non metallic and other mineral products and basic metal products, which heavily rely on imported inputs while having a moderate export volume have also shown a tendency towards a modest expansion. In addition, other export industries such as Wood and wood products and Mining and quarrying have also shown a likely moderate growth. By the same token, the agricultural export industries have shown a tendency of significant expansion mainly due to the reduction in labour cost. Furthermore, due to inter-industry linkages the industries that are mainly supplying intermediate goods to the above agricultural export industries have also revealed a likely expansion.

It can be observed under simulation 1 and 3, in the short run, the import substituting industries that are mainly feeding into final consumption are likely to be badly hit due to the competition coming from the cheaper imports. For instance, the Food, beverage and other industry, in which 68 per cent of total imports have been used in final consumption, has shown a tendency of a contraction in output as well as the employment. Similarly, industries mainly catering to the domestic market in terms of intermediate goods such as Paper and paper products and Chemicals and fertilisers have shown a possible contraction due to the competition coming from imports. Correspondingly, the agricultural industries that are mainly catering to the domestic market, the Paddy industry for instance, have revealed a possible slight negative growth. This may be due to relative attractiveness of other export oriented agricultural industries over the Paddy industry. The contraction of the Paddy industry in turn is likely to affect the Milling industry, which is primarily dependent on the Paddy for its intermediate inputs.

Observations on the short run implications at the service industries, under simulation 1 and 3, revealed that service industries with links mainly with those expanding industries are likely to be expanded. For instance, service industries such as Wholesale trade and retail trade, Transport and Banking insurance and real estate have shown a significant growth. Meanwhile the Construction industry, which is strongly linked to domestic import competing industries, has demonstrated a possible slight decline.

In the long run, under simulations 1 and 3, the industries such as Fabricated metal products, Plastic and rubber products, Other manufacturing, Basic metals products, Non metallic and other mineral products, Chemicals and fertilisers along with Textile and Garments have shown a marked possible increase in output. The Food, beverages and other industry has shown a likely contraction as a result of the competition coming from the cheaper imports. In contrast to the short run case, export agricultural industries and the mining industry have shown a tendency towards a possible contraction as a consequence of the attraction of resources to more profitable manufacturing industries. Particularly, industries such as Tea processing, Rubber processing and Coconut processing have shown a significant contraction. This in turn has led to a possible contraction of Tea growing, Rubber growing and Coconut growing industries which are mainly supplying intermediate goods to the above export agricultural industries.

In the long run, under simulations 1 and 3, the domestic agricultural industries that are mainly catering to the domestic market are expected to be either slightly benefited or unaffected by the policy shock. For instance, the industries such as Paddy, Other agriculture, Livestock and Fisheries have shown a possible moderate expansion. A plausible reason for this could be the domestic consumption effect resulting from higher real wages for labour, which can also be seen from the increase in aggregate real household consumption.

In the short run under the second simulation, agricultural trade liberalisation, a majority of industries were projected to be unaffected or marginally benefited while paddy, other agriculture and milling industries shown a possible contraction. These results are consistent with the proposition that previously heavily protected industries suffer when trade is liberalised. The reason for the contraction of the milling industry can be attributed to the negative effects felt by the Paddy industry, which is the main supplier of domestic intermediate goods to the Milling industry. Furthermore, the Construction industry, which is strongly linked to domestic industries, is also shown a possible decline.

In the long run under the second simulation, the domestic agricultural industries as well as other export oriented agricultural industries such as Tea processing, Rubber processing and Coconut processing have also shown a possible marginal contraction. The reason for this contraction can be identified as a result of the marginal drop in output of major intermediate input supplying industries such as Tea growing, Rubber growing and Coconut growing industries. These three tree crops are perennial crops, thus any competition coming from cheaper imports may be felt in the long run, as farmers may tend to reallocate their resource from these industries to more profitable other industries. This may happen in terms of reduction in replanting as well as less application of fertiliser, which may ultimately result in a drop in output per unit land area. On the other hand, manufacturing industries as a whole are likely to be benefited. Relocation of resources from unprofitable agricultural industries into relatively profitable manufacturing industries might be considered as one of the possible reasons. However, it can be observed that agricultural trade liberalisation is likely to yield a relatively low stimulus at the industry level both in the short run and the long run, suggesting the relative importance of liberalising the manufacturing industries.

In the sort run, under simulations 1 and 3, the post-tax income of all low-income household groups is expected to be decreased. On the other hand, the high-income households are expected to benefit as the expansion of manufacturing industries has contributed through expanding the gross operating surplus of those industries. Furthermore, the expansion of service industries such as retail and wholesale trade and transport, which form a significant income source for high-income groups, contributes towards this. In contrast, long run effects of these shocks show potential benefits towards low-income groups, particularly the urban low-income households, as they form the main labour component of the manufactured product industries. However, it is revealed that, similar to the short run scenario, the high-income groups also tend to receive moderately high benefits in terms of income mainly due to the expansion of service industries as well as the manufactured product industries, leading to an increase in demand for skilled labour categories such as Administrative and managerial workers and Professional, technical and related workers

In the short run case, under simulations 1 and 3, despite the reduction of post-tax income of all low income household groups, the FGT poverty indices, which describe the headcount ratio, poverty gap and poverty severity, have shown a possible decline among all household groups (this indicates a decrease in poverty). The overall potential reduction in the poverty line due to the decline of the prices of basic need commodities has contributed towards this. However, the rural low-income households group showed a comparatively low improvement over other groups. The reduction in government transfers following government revenue loss due to tariff cuts, particularly import tariffs of manufactured products, seems to be the causal factor that reduces the potential benefits accruing to the rural low income households. This operates through the potential reduction in post-tax income. In contrast, under simulation 2, all FGT indices show a marginal reduction within all groups, suggesting that agricultural trade reforms are comparatively poverty neutral in the short run.

In the long run, under all simulations, all household groups show a possible reduction in absolute poverty in terms of headcount ratio, poverty gap and poverty severity. However, it is striking to note that simulations 1 and 3 tend to substantially reduce poverty among all household groups. Trade liberalisation in manufacturing industries tends to remarkably stimulate the manufactured product industries, which in turn attract labour from the low productive sectors, ultimately improving the nominal income of a sizeable portion of low income households, particularly the urban low income group. This in turn, along with the decline in poverty line, has resulted in a potentially substantial drop in absolute poverty among all income groups in the long run. In contrast, agricultural trade liberalisation (simulation 2) demonstrates a marginal improvement in absolute poverty in all household groups, suggesting that trade reform in the manufacturing industries is more pro poor than that of agricultural industries, at least in the long run.

In order to evaluate the robustness of the FGT poverty measures, a range of popular poverty measures i.e., Watts index, S-Gini index, Sen index and CHU index, were computed using the changes in nominal income distributions and poverty lines generated from the CGE model. Interestingly, in all simulations, both the short and long run results of these poverty measurers are consistent with the FGT poverty indices, which suggest that poverty measures calculated in this study are robust estimates.

In all simulations, both the short and long run results revealed a possible increase in inequality or relative poverty, which is evaluated using a range of inequality measures i.e., Atkinson index, S-Gini index and Entropy index, suggesting that the gap between the poor and the rich households has widened. This evidence is contrary to the Stolper-Samuelson theory, which postulates that most abundant factors would be benefited by trade reforms. Despite the benefits accruing to the most abundant factor in Sri Lanka – labour – the increase in gross operating surplus in the light of expansion of manufacturing industries and the linked services sectors, accrued benefits to high-income households. One possible reason for this outcome could be the expansion observed in service industries such as retail and wholesale trade and transport, which generate a notable amount of gross operating surplus that form a vital source of income for high income groups. Moreover, as evident from the derived demand for different labour categories under above simulations, the demand for skilled labour categories, particularly, the Administrative and managerial workers and Professional, technical and related workers has also increased along with that of unskilled labour thus contributing to widening the gap between the rich and the poor.

Overall, the absolute poverty story in all three trade liberalization simulations suggests that trade reforms, particularly tariff reduction, are expected to have a positive impact on reduction in absolute poverty. Hence, this evidence supports the view of proponents of globalisation in the current trade and poverty debate. However, in terms of income inequality, the simulation results contradict the popularly known story of trickling down effects of trade induced growth within the developing country context. Hence, it highlights the importance of redistribution along with liberalisation.

Finally, the results for the SSA carried out for Armington elasticites reveal that, in the long run as well as in the short run, the SSA mean values are not significantly different from the original simulation results. Furthermore, by looking at the values of standard deviations reported in the SSA results, it is revealed that deviations from the mean are significantly low among many endogenous variables. A relatively low standard deviation values suggest that confidence intervals are rather narrow, thus indicating the results are generally robust with respect to different Armington elasticity values. However, in some industries such as Food and beverage industry, Paper and printing, Petroleum products, Non-metallic mineral products and Basic metal products, the values for standard deviations for outputs and employment are greater than one. This suggests that as industry results for the above industries are sensitive to Armington elasticity values, an empirical estimation of above elasticities for those industries would shed more light on the behaviour of the said industries under trade policy shocks.

8.3 LIMITATIONS OF THE STUDY

Similar to many empirical studies, this study was constrained by various factors which could be considered as limitations. In common with most other studies which adopt CGE models, the first and the most important limitation is the database. The elasticity parameters used in the model are not econometrically estimated using Sri Lankan data but have been ‘borrowed’ from other studies. Although a reasonable level of confidence can be attached to the conclusions of the model simulations, as the results were robust with different Armington parameter values tested under SSA, it was noted that some industry results were sensitive to parameter values assumed in the model. Similarly, a better understanding of implications at industry level could have been gathered had we been able to use more disaggregated data at industry level, as the current database permits only a disaggregation of industries and commodities up to 38 sectors.

Another limitation of the study was that, as the current model could only be simulated to carry out comparative statics results, it misses out the dynamics, which could be used in understanding the path that changes the income and expenditure of households over time. Given the nature of the underlying research problem, it would have been ideal to use a recursive dynamic model to track the policy implications, more importantly, the long run effects. However, construction of a recursive dynamic CGE model for Sri Lanka was severely constrained by relevant data such as capital stock at industry level and other time series forecasts for exogenous variables.

As can be seen from the nature of the poverty and inequality situation in Sri Lanka, it can be considered that the quite substantial Sri Lankan regional disparities play a vital role in determining poverty and inequality in the country. Therefore, it is important to take these regional disparities into account and look into the regional development aspects with respect to trade policy in analysing the linkage of trade, inequality and poverty. It would have been ideal if we had analysed the trade policy issues using a regional CGE model. However, the limitation in gathering reliable regional level data is a major constraint in constructing a regional CGE model for Sri Lanka.

Given that linking of the CGE model with an econometrically estimated household level microsimulation model would be an ideal way to elicit poverty and inequality impacts of trade policy effects, the current model may have some limitations in generating more accurate results at household level.

Despite the above limitations, the current *SLGEM–P* model, along with the newly constructed SAM and the other database, generated plausible empirical results in analysing the trade policy, poverty and inequality linkage within the Sri Lankan context.

8.4 SUGGESTIONS FOR FURTHER RESEARCH

The areas of further research that can be identified with respect to the current study are directly or indirectly associated with some of the limitations of the study disclosed above. Below are some of the recommendations for further extension of the study.

First, it would be appropriate to divert more resources, time and effort into constructing a comprehensive database for a recent base year. Moreover, the database should encompass some of the key features such as more disaggregation with respect to industries and commodities in the IO database, regional level industry and macro data – regional IO tables, industry level capital stocks data and time series forecasts for various exogenous variables in the current model. In particular, the regional IO database would help to analyse how regional disparities contribute to poverty and inequality in the context of trade liberalisation. Moreover, this kind of analysis would shed some light on poverty implications of the long lasting civil conflict in Sri Lanka. It is also important to estimate elasticity parameters econometrically in the current model using Sri Lankan economic data.

Second, it is ideal to extend the current CGE model, *SLGEM–P*, to incorporate features such as recursive dynamics in making conditional forecasts, regional extensions in tracking regional disparities (this is very important in the context of North and South conflict), further disaggregation of the number of industries and the commodities to understand the industry level linkages in detail and incorporating features of imperfect competition in some of the markets, in order to better capture the ground realities in Sri Lankan markets. This will ensure more realistic simulation results with respect to trade policy, inequality and poverty linkage, particularly in terms of implications in the long run within the Sri Lankan context.

Third, the analysis undertaken in this study regarding the general equilibrium impacts of poverty and inequality stem from a linked model, which links a CGE model and a set of income distribution models in a "top down" mode. If we could develop an econometrically estimated microsimulation model which could capture multidimensional features of poverty in more detail, and which could link with the CGE model while allowing feedback effects, the trade policy implications on poverty could be better understood.

8.5 CONCLUDING OBSERVATIONS

Despite some limitations, the *SLGEM-P* model developed in this study produces plausible results that would help to shed some light on the current debate about the trade and poverty linkage. Construction of a recent SAM for the Sri Lankan economy and empirical estimation of income distribution functional forms have greatly improved the reliability of model outcomes.

The results of trade policy simulations suggest that in the short run, trade liberalisation of manufacturing industries tends to increase the economic growth and to reduce absolute poverty in the urban low-income household group and the estate low-income household group. However, the rural low-income households group shows a comparatively low improvement over other groups. The reduction in government transfers following government revenue loss due to tariff cuts, particularly import tariffs of manufactured products, seems to be the causal factor that reduces the potential benefits accruing to the rural low-income households. In contrast, long run results indicate that trade liberalisation reduces absolute poverty in substantial proportion in all groups. It further reveals that in the long run, trade liberalisation of manufacturing industries are more pro poor than that of agricultural industries.

Therefore, empirical evidence in terms of the effects on absolute poverty coming from this study supports the overall view of proponents of globalisation, the pro poor effects of trade liberalisation (see Bautista and Thomas, 1997; Dollar and Kraay, 2000; 2001; 2002; 2004; Case, 2000; Ianchovichina and Soloaga, 2000; Hertel *et al*., 2001). The conclusions drawn from the poverty results generated under the present study with respect to urban household groups are consistent with the previous CGE analysis carried out for Nepal by Cockban (2001).

However, in terms of relative poverty or inequality, overall results suggest that trade reforms may widen the income gap between the rich and the poor thus promoting relative poverty. Hence the results contradict the popularly known story of the trickling down effects of trade-induced growth within the developing country context. This evidence on the widening of the gap between rich and poor under trade reforms is consistent with recent CGE analysis carried out for South Africa (Humphreys, 2000) and for Indonesia (Croser, 2002).

Hence this study highlights the importance of implementation of some redistribution measures with trade liberalisation in developing countries.

APPENDIX A

Table A 2.1
Estimates of the Proportion of Population in Poverty
(in percentages)

Base Year		Households			
		Urban	Rural	Estate	Total
Income/ Expenditure based poverty line					
1969/70	(1)	5.0	12.8	11.1	11.2
1973	(3)	22.7	31.6	8.1	27.6
	(4)	6.4	26.1	1.7	19.1
1978/79	(3)	24.4	23.8	8.9	22.7
	(5)	16.0	22.7	5.9	19.5
1980/81	(1)	16.9	25.9	25.0	24.1
1981/82	(3)	19.6	23.2	13.8	21.9
	(4)	17.7	26.1	12.3	23.6
Dietary energy based poverty line					
1969/70	(2)	58.3	52.3	38.5	52.0
1980/81	(6)	49.0	42.9	32.6	-
1985/86	(5)	12.3	32.4	5.9	27.4
1986/87	(8)	10.5	28.7	11.1	24.1
1990/91	(7)	18.2	34.7	20.5	30.4
Rs 791.67/person/ month at 1995/96 prices taken as poverty line					
1985/86	(9)	18.4	35.6	20.5	30.9
1990/91	(9)	15.0	22.0	12.4	19.9
1995/96	(9)	14.7	27.0	24.9	25.2
Poverty head count index based on national poverty line					
2002	(10)	8.6	31.3	28.0	28.1

Sources: This table heavily draws from Tudawe (2000) and Gunathileka (2000).
(1) Bhalla & Glewwe (1986); (2) Visaria (1981); (3) Anand & Harris (1990); (4) Marga (1981); (5) Gunaratne (1985); (6) Sahn (1987); (7) DCS (1993); (8) Edirisinghe (1990); (9) Gunathileka (2000).
(10) DCS (2003).

APPENDIX B

Illustration of Deriving Percentage Change Equation of the Production Nest[1]

Following the neoclassical assumption on behaviour of firms, we assume that firms seek to maximise profits from producing given level of output subject to price of inputs. Thus, the cost minimisation problem can be presented as a constrained optimisation problem where firms choose inputs $X_i(i = 1,....K.....n)$, to minimise the total cost of inputs $\sum_{i=1}^{n} P_i X_i$ of producing given output, *Y*, subject to following *CES* production function:

$$Y = \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho}\right)^{-1/\rho} \tag{1}$$

The Lagrangian equation for the above problem can be set up as:

$$L = \sum_{i=1}^{n} P_i X_i + \Lambda\left[Y - \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho}\right)^{-1/\rho}\right] \tag{2}$$

The first order conditions are as follows:

$$\frac{\partial L}{\partial X_k} = P_k - \Lambda\left(\sum_{i=1}^{n} \delta_i X_i^{-\rho}\right)^{-(1+\rho)/\rho} \delta_k X_k^{-(1+\rho)} \tag{3}$$

$$\frac{\partial L}{\partial \Lambda} = Y - \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho}\right)^{-1/\rho} \tag{4}$$

since,

$$\frac{\partial Y}{\partial X_k} = \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho}\right)^{-(1+\rho)/\rho} \delta_k X_k^{-(1+\rho)} \tag{5}$$

[1] This section is heavily drawn from Horridge, *et al.* (1993).

$$P_k = \Lambda \frac{\partial L}{\partial X_k} = \Lambda \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho} \right)^{-(1+\rho)/\rho} \delta_k X_k^{-(1+\rho)} \tag{6}$$

hence,

$$\frac{P_k}{P_i} = \frac{\Lambda \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho} \right)^{-(1+\rho)/\rho} \delta_k X_k^{-(1+\rho)}}{\Lambda \left(\sum_{i=1}^{n} \delta_i X_i^{-\rho} \right)^{-(1+\rho)/\rho} \delta_i X_i^{-(1+\rho)}} \tag{7}$$

or

$$\frac{P_k}{P_i} = \frac{\delta_k}{\delta_i} \left(\frac{X_i}{X_k} \right)^{1+\rho} \tag{8}$$

by rearranging the above equation we could obtain an equation for $X_i^{-\rho}$ as follows:

$$\frac{P_k}{P_i} = \frac{\delta_k (X_k)^{-(1+\rho)}}{\delta_i (X_i)^{-(1+\rho)}} \tag{9}$$

$$X_i^{-(1+\rho)} = \frac{P_i \, \delta_k}{P_k \, \delta_i} \cdot X_k^{-(1+\rho)} \tag{10}$$

$$X_i^{-\rho} = \left(\frac{P_i \, \delta_k}{P_k \, \delta_i} \right)^{-\left(\frac{\rho}{\rho+1}\right)} \cdot X_k^{-\rho} \tag{11}$$

using the production function given by equation (1) and substituting the equation (11) back into the production function we obtain:

$$Y = X_k \left(\sum_{i=1}^{n} \delta_i \left(\frac{P_i \, \delta_k}{P_k \, \delta_i} \right)^{\frac{-\rho}{(\rho+1)}} \right)^{\frac{-1}{\rho}} \tag{12}$$

or

$$Y = X_k \left(\sum_{i=1}^{n} \delta_i \left(\frac{P_k \, \delta_i}{P_i \, \delta_k} \right)^{\frac{\rho}{(\rho+1)}} \right)^{\frac{-1}{\rho}} \tag{13}$$

by rearranging the equation (13) we can obtain the input demand function as:

$$X_k = \frac{Y}{\left(\sum_{i=1}^{n} \delta_i \left(\frac{P_k \, \delta_i}{P_i \, \delta_k} \right)^{\rho/(\rho+1)} \right)^{-1/\rho}} \tag{14}$$

or

$$X_k = Y \left(\sum_{i=1}^{n} \delta_i \left(\frac{P_k \, \delta_i}{P_i \, \delta_k} \right)^{\rho/(\rho+1)} \right)^{1/\rho} \tag{15}$$

the above equation can also be presented as follows

$$X_k = Y \, \delta_k^{1/(\rho+1)} \left(\frac{P_k}{P_{ave}} \right)^{-1/(\rho+1)} \tag{16}$$

where

$$P_{ave} = \left(\sum_{i=1}^{n} \delta_i^{1/(\rho+1)} P_i^{\rho/(\rho+1)} \right)^{(\rho+1)/\rho} \tag{17}$$

the equations (16) and (17) can be transformed into linear percentage form as follows[2]

$$x_k = z - \sigma \left(p_k - p_{ave} \right), \tag{18}$$

and

$$p_{ave} = \sum_{i=1}^{n} s_i \, p_i \tag{19}$$

where

---

[2] Percentage change transformation can be carried out based on following rules:

levels form	percentage change form
$Y = 3X$	$y = x$
$Y = XZ$	$y = x + z$
$Y = X / Z$	$y = x - z$
$Y = X^{\alpha}$	$y = \alpha x$ (α assumed constant)

for further details see Horridge, *et al.* (1993).

$\sigma = 1 / (\rho + 1)$ (substitution elasticity between two inputs)

$$s_i = \delta_i^{1/(\rho+1)} p_i^{\rho/(\rho+1)} \Big/ \sum_k \delta_k^{1/(\rho+1)} p_k^{\rho/(\rho+1)}$$

APPENDIX C Matlab Code For FGT Poverty Measurement

```
% Beta parameter estimation, FGT poverty measure, sensitivity analysis and plots base and sim%

XX=wk1read('ruralbase');
XY=wk1read ('ruralsim');
bp=wk1read ('blp')
sp=wk1read ('slp')
s=wk1read ('s')
XX=sort(XX);
ymin_a=min(XX);
ymax_a=max(XX);
n=length(XX);
XXbeta=(XX-ymin_a)/(ymax_a-ymin_a);
XXbeta=XXbeta(2:n-1,:);
XY=sort(XY);
ymin_b=min(XY);
ymax_b=max(XY);
mb=length(XY);
XYbeta=(XY-ymin_b)/(ymax_b-ymin_b);
XYbeta=XYbeta(2:mb-1,:);
[phat_base]=betafit(XXbeta)
[phat_simb]=betafit(XYbeta)
z_a=bp;
z_b=sp;
v1=((s)-(s*(10/100)));
z_n10=((bp)+(bp*(v1/100)));
z_n10;
v2=((s)-(s*(20/100)));
z_n20=((bp)+(bp*(v2/100)));
z_n20;
v3=((s)-(s*(30/100)));
z_n30=((bp)+(bp*(v3/100)));
z_n30;
v4=((s)-(s*(40/100)));
z_n40=((bp)+(bp*(v4/100)));
z_n40;
v5=((s)-(s*(50/100)));
z_n50=((bp)+(bp*(v5/100)));
z_n50;
v75=((s)-(s*(75/100)));
z_n75=((bp)+(bp*(v75/100)));
z_n75;
v100=((s)-(s*(100/100)));
z_n100=((bp)+(bp*(v100/100)));
z_n100;

vp1=((s)+(s*(10/100)));
z_p10=((bp)+(bp*(vp1/100)));
z_p10;
vp2=((s)+(s*(20/100)));
z_p20=((bp)+(bp*(vp2/100)));
z_p20;
vp3=((s)+(s*(30/100)));
z_p30=((bp)+(bp*(vp3/100)));
z_p30;
vp4=((s)+(s*(40/100)));
z_p40=((bp)+(bp*(vp4/100)));
z_p40;
vp5=((s)+(s*(50/100)));
z_p50=((bp)+(bp*(vp5/100)));
z_p50;
```

```
vp75=((s)+(s*(75/100)));
z_p75=((bp)+(bp*(vp75/100)));
z_p75;
vp100=((s)+(s*(100/100)));
z_p100=((bp)+(bp*(vp100/100)));
z_p100;

p_a=phat_base(1,1);
q_a=phat_base(1,2);
p_b=phat_simb(1,1);
q_b=phat_simb(1,2);

for alpha = 1:3;
  if ymin_a>z_a
    FGT_baseza(alpha)=0;
  else
    FGT_baseza(alpha)=quad8('fgtbeta',ymin_a,z_a,[],[],z_a,alpha,p_a,q_a,ymin_a,ymax_a);
  end
  if ymin_b>z_b
    FGT_simbzb(alpha)=0
  else
    FGT_simbzb(alpha)= quad8('fgtbeta',ymin_b,z_b,[],[],z_b,alpha,p_b,q_b,ymin_b,ymax_b);
  end
  if ymin_b>z_n100
    FGT_simbzbn100(alpha)=0
  else
    FGT_simbzbn100(alpha)=
quad8('fgtbeta',ymin_b,z_n100,[],[],z_n100,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_n10
    FGT_simbzbn10(alpha)=0
  else
    FGT_simbzbn10(alpha)=
quad8('fgtbeta',ymin_b,z_n10,[],[],z_n10,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_n20
    FGT_simbzbn20(alpha)=0
  else
    FGT_simbzbn20(alpha)=
quad8('fgtbeta',ymin_b,z_n20,[],[],z_n20,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_n30
    FGT_simbzbn30(alpha)=0
  else
    FGT_simbzbn30(alpha)=
quad8('fgtbeta',ymin_b,z_n30,[],[],z_n30,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_n40
    FGT_simbzbn40(alpha)=0
  else
    FGT_simbzbn40(alpha)=
quad8('fgtbeta',ymin_b,z_n40,[],[],z_n40,alpha,p_b,q_b,ymin_b,ymax_b);
  end
     if ymin_b>z_n50
    FGT_simbzbn50(alpha)=0
  else
    FGT_simbzbn50(alpha)=
quad8('fgtbeta',ymin_b,z_n50,[],[],z_n50,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_n75
```

```
    FGT_simbzbn75(alpha)=0
  else
    FGT_simbzbn75(alpha)=
quad8('fgtbeta',ymin_b,z_n75,[],[],z_n75,alpha,p_b,q_b,ymin_b,ymax_b);
  end


  if ymin_b>z_p100
    FGT_simbzbp100(alpha)=0
  else
    FGT_simbzbp100(alpha)=
quad8('fgtbeta',ymin_b,z_p100,[],[],z_p100,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_p10
    FGT_simbzbp10(alpha)=0
  else
    FGT_simbzbp10(alpha)=
quad8('fgtbeta',ymin_b,z_p10,[],[],z_p10,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_p20
    FGT_simbzbp20(alpha)=0
  else
    FGT_simbzbp20(alpha)=
quad8('fgtbeta',ymin_b,z_p20,[],[],z_p20,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_p30
    FGT_simbzbp30(alpha)=0
  else
    FGT_simbzbp30(alpha)=
quad8('fgtbeta',ymin_b,z_p30,[],[],z_p30,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_p40
    FGT_simbzbp40(alpha)=0
  else
    FGT_simbzbp40(alpha)=
quad8('fgtbeta',ymin_b,z_p40,[],[],z_p40,alpha,p_b,q_b,ymin_b,ymax_b);
  end
     if ymin_b>z_p50
    FGT_simbzbp50(alpha)=0
  else
    FGT_simbzbp50(alpha)=
quad8('fgtbeta',ymin_b,z_p50,[],[],z_p50,alpha,p_b,q_b,ymin_b,ymax_b);
  end
   if ymin_b>z_p75
    FGT_simbzbp75(alpha)=0
  else
    FGT_simbzbp75(alpha)=
quad8('fgtbeta',ymin_b,z_p75,[],[],z_p75,alpha,p_b,q_b,ymin_b,ymax_b);
  end

end
FGT_baseza =FGT_baseza*100
FGT_simbzb =FGT_simbzb*100
FGT_simbzbn10=FGT_simbzbn10*100;
FGT_simbzbn20=FGT_simbzbn20*100;
FGT_simbzbn30=FGT_simbzbn30*100;
FGT_simbzbn40=FGT_simbzbn40*100;
FGT_simbzbn50=FGT_simbzbn50*100;
FGT_simbzbn75=FGT_simbzbn75*100;
FGT_simbzbn100=FGT_simbzbn100*100;
```

```
FGT_simbzbp10=FGT_simbzbp10*100;
FGT_simbzbp20=FGT_simbzbp20*100;
FGT_simbzbp30=FGT_simbzbp30*100;
FGT_simbzbp40=FGT_simbzbp40*100;
FGT_simbzbp50=FGT_simbzbp50*100;
FGT_simbzbp75=FGT_simbzbp75*100;
FGT_simbzbp100=FGT_simbzbp100*100;

FGT_basezchange=((FGT_simbzb)-(FGT_baseza))
FGT_simbzbn10change=((FGT_simbzbn10)-(FGT_baseza));
FGT_simbzbn20change=((FGT_simbzbn20)-(FGT_baseza));
FGT_simbzbn30change=((FGT_simbzbn30)-(FGT_baseza));
FGT_simbzbn40change=((FGT_simbzbn40)-(FGT_baseza));
FGT_simbzbn50change=((FGT_simbzbn50)-(FGT_baseza));
FGT_simbzbn75change=((FGT_simbzbn75)-(FGT_baseza));
FGT_simbzbn100change=((FGT_simbzbn100)-(FGT_baseza));

FGT_simbzbp10change=((FGT_simbzbp10)-(FGT_baseza));
FGT_simbzbp20change=((FGT_simbzbp20)-(FGT_baseza));
FGT_simbzbp30change=((FGT_simbzbp30)-(FGT_baseza));
FGT_simbzbp40change=((FGT_simbzbp40)-(FGT_baseza));
FGT_simbzbp50change=((FGT_simbzbp50)-(FGT_baseza));
FGT_simbzbp75change=((FGT_simbzbp75)-(FGT_baseza));
FGT_simbzbp100change=((FGT_simbzbp100)-(FGT_baseza));


M=[FGT_baseza
   FGT_simbzb
   FGT_simbzbn10
   FGT_simbzbn20
   FGT_simbzbn30
   FGT_simbzbn40
   FGT_simbzbn50
   FGT_simbzbn75
   FGT_simbzbn100
   FGT_simbzbp10
   FGT_simbzbp20
   FGT_simbzbp30
   FGT_simbzbp40
   FGT_simbzbp50
   FGT_simbzbp75
   FGT_simbzbp100];

wk1write ('FGT',M)

C=[FGT_basezchange
FGT_simbzbn10change
FGT_simbzbn20change
FGT_simbzbn30change
FGT_simbzbn40change
FGT_simbzbn50change
FGT_simbzbn75change
FGT_simbzbn100change
FGT_simbzbp10change
FGT_simbzbp20change
FGT_simbzbp30change
FGT_simbzbp40change
FGT_simbzbp50change
```

```
FGT_simbzbp75change
FGT_simbzbp100change];

wk1write('FGTchange',C)



densite_a = ((((ymax_a-ymin_a)^(p_a+q_a-1)).*beta(p_a,q_a)).^(-1)).*((XX-ymin_a).^(p_a-1).*(ymax_a-XX).^(q_a-1));
densite_b = ((((ymax_b-ymin_b)^(p_b+q_b-1)).*beta(p_b,q_b)).^(-1)).*((XY-ymin_b).^(p_b-1).*(ymax_b-XY).^(q_b-1));
for i=1:length(XX)
  z_abeta(i)=z_a;
end;
for i=1:length(XY)
  z_bbeta(i)=z_b;
end

plot (XX,densite_a,'r',z_abeta,densite_a,'r')
hold on
plot(XY,densite_b,'b:',z_bbeta,densite_b,'b:')
hold off
axis ([0 16000 0 0.000199])
  title ('Rural Low Income Households');
  xlabel('income')
  ylabel('f(income)')

  print basesim1 -depsc
```

Matlab code for FGT function

```
% FGT function%

function [y]=fgtbeta(revenu,z,alpha,p,q,ymin,ymax)
if nargin ==0, revenu=0.5:.05:1;
end

y=(((-revenu+z)/z).^(alpha-1)).*(1/beta(p,q)).*((revenu-ymin).^(p-1)).*((ymax-revenu).^(q-1))/((ymax-ymin).^(p+q-1));


end
```

Matlab code was taken originally from Boccanfuso and Savard (2001) and modified in order to incorporate sensitivity analysis

APPENDIX D

Table D 6.1
Values for Macro Economic Identities Based on Data from the Numerical Macro-SAM for Sri Lanka for the Year 1995

Macro identity	Numerical Values (Rs. Million)
Household income	
$Y_h = Y_f + T_{eh} + T_{gh} + T_{rh}$	*596128 = 221927 + 294080 + 39230 + 40891*
Household expenditure	
$E_h = C + T_{hg} + T_{hr}$	*501734 = 468496 + 27166 + 6072*
Household savings	
$S_h = Y_h - E_h$	*94394 = 596128 – 501734*
or	
$S_h = Y_f - C + \check{T}_h$	*94394 = 221927 - 468496 + 340963*
where	
$\check{T}_h = (T_{gh} - T_{hg}) + (T_{rh} - T_{hr}) + T_{eh}$	*340963= (39230 – 27166) + (40891 – 6072) + 294080*
Commercial enterprise sector income	
$Y_e = Y_{os} - S_D + T_{ge} + T_{re}$	*332342= 348748 - 33673 + 6399 + 10868*
Commercial enterprise expenditure	
$E_e = T_{eh} + T_{eg} + T_{er}$	*332342 = 294080 + 20312 + 17950*
Total Government receipts	
$Y_g = I_t + T_{hg} + T_{eg}$	*139187 = 91709 + 27166 + 20312*
Government expenditure	
$E_g = G + T_{gh} + T_{ge}$	*142873 = 97244 + 39230 + 6399*
Government savings	
$S_g = Y_g - E_g$	*-3686 = 139187 - 142873*
or	
$S_g = I_t - G + \check{T}_g$	*-3686 = 91709 - 97244 + 1849*
where	
$\check{T}_g = (T_{hg} - T_{gh}) + (T_{eg} - T_{ge})$	*1849= (27166 -39230) + (20312 - 6399)*
Total receipts of foreigners	
$Y_r = M + T_{er} + T_{hr}$	*325565 = 301543 + 17950 + 6072*
Foreigners' payments	
$E_r = X + T_{rg} + T_{rh} + T_{re}$	*289494 = 237735 + 40891 + 10868*
Foreign savings	
$S_r = Y_r - E_r$	*36071 = 325565 – 289494*
or	
$S_r = M - X + \check{T}_r$	*36071= 301543 – 237735 + (-27737)*
where	
$\check{T}_r = (T_{er} - T_{re}) + (T_{hr} - T_{rh})$	*-27737 = (17950 – 10868) + (6072- 40891)*
$S_h + S_g + S_r + S_D = Y_f - C + Y_{os} + I_t - G + M - X$	*[94394 + (-3686) + 36071+ 33673] = [221927 – 468496 + 348748 + 91709 – 97244 + 301543 – 237735]*
GDP at factor cost	
$Y^{FC} = Y_f + Y_{os}$	*570675 = 221927 + 348748*
GDP at market price (income side)	
$Y = Y^{FC} + I_t$	*662384 = 570675 + 91709*
$S_h + S_g + S_r + S_D = Y - C - G + M - X$	*[94394 + (-3686) + 36071 + 33673]=[662384 – 468496 – 97244 + 301543 –237735]*
GDP at market price (expenditure side)	
$Y = C + I + G + X - M$	662384 = 468496 + 160452 + 97244 + 237735 – 301543
$I = S_h + S_g + S_r + S_D$	*160452 = 94394 + (-3686) + 36071+33673*

Table D6.2
Sri Lanka National Accounts Balance Sheet for 1995 (Rs. Million)

Gross Domestic Product	Income		Expenditure
Value-added at factor costs	570675	Private final consumption	468496
Indirect taxes	95944	Government final consumption	97244
Less: Subsidies	4235	Gross fixed capital formation plus changes in stocks	168363
		Increase in Stocks	-7911
		Exports of goods and services	237735
		Less: Imports of goods and services	301543
Total (GDP at market price)	662384	Total (GDP at market price)	662384

National Disposable Income	Income		Expenditure
Compensation of employees and operating surplus	537002	Private final consumption	468496
Indirect taxes	95944	Government final consumption	97244
Net compensation of employees/ property and entrepreneurial income from rest of the world	-7082	Net domestic savings	90709
Less: Subsidies	4235		
Net Current Transfers from rest of the world	34820		
Total (Disposable income)	656449	Total (Disposable income)	656449

Table C6.2 (Continued)

Capital accounts	Income		Expenditure
Net domestic savings	90709	Gross fixed capital formation	168363
Consumption of fixed capital	33673	Increase in stocks	-7911
Foreign savings	36070		
Total	160452	Total	160452

Rest of the world	Income		Expenditure
Imports of goods and services	301543	Exports of goods and services	237735
Net compensation of employees/ property and entrepreneurial income from abroad	7082	Foreign savings	36071
Net Current Transfers from abroad	-34819		
Total	273806	Total	273806

Source: *National Accounts of Sri Lanka* (DCS, 1998)

Table D 6.3
1995 Micro-SAM for Sri Lanka (Rs Million)

	Activities												
	1 Teagrow	2 Rubgrow	3 Cocgrow	4 Paddy	5 Mexcrop	6 Tobacco	7 Othe_agri	8 Livestock	9 Firewood	10 Forestry	11 Fishing	12 Mining	13 Teapro
Activities													
1 Teagrow													
2 Rubgrow													
3 Cocgrow													
4 Paddy													
5 Mexcrop													
6 Tobacco													
7 Othe_agri													
8 Livestock													
9 Firewood													
10 Forestry													
11 Fishing													
12 Mining													
13 Teapro													
14 Rubpro													
15 Cocopro													
16 Milling													
17 Foodbev													
18 Textile													
19 Garments													
20 Wood													
21 Paper													
22 ChmFerti													
23 Petroleum													
24 RubProduct													
25 NMOminpr													
26 Base_metal													
27 Feb_metal													
28 Othe_Manu													
29 Electricity													
30 Construct													
31 Trade													
32 Hotels													
33 Transport													
34 Commun													
35 Banking													
36 Dwellings													
37 Pubadmin													
38 Other_serv													
Commodities													
1 Teagrow	71.9	0	0	0	0	0	0	0	0	0	0	0	13258
2 Rubgrow	0	86.2	0	0	0	0	0	0	0	0	0	0	0
3 Cocgrow	0	0	239.7	0	0	0	0	0	0	0	0	0	0
4 Paddy	0	0	0	1243.9	0	0	0	0	0	0	0	0	0
5 Mexcrop	0	0	0	0	153.6	0	0	0	0	0	0	0	0
6 Tobacco	0	0	0	0	0	227.9	0	0	0	0	0	0	0
7 Othe_agri	1.9	1.2	1.7	0	0	27.3	2463.5	1292.1	0	0	0	0	0
8 Livestock	79	0	97.8	541.1	0	0	396.2	62.2	0	0	0	0	0
9 Firewood	0	0	0	0	0	0	0	0	0	0	0	0	147.2
10 Forestry	23.2	5.8	8.1	0	0	0	55	8	65	0	0	0	0
11 Fishing	0	0	0	0	0	0	0	0	0	0	96.5	0	0
12 Mining	51.2	32	132.8	0	0	0	0	0	0	0	0	0	0
13 Teapro	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Rubpro	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Cocopro	0	0	0	0	0	0	0	539.8	5	0	0	0	0
16 Milling	0	0	0	0	0	0	0	39.6	0	0	0	0	0
17 Foodbev	0	0	0	0	0	0	0	1011.1	0	0	0	0	0
18 Textile	0	0	0	0	0	0	0	0	0	0	1337	0	0
19 Garments	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Wood	4.9	3.2	4.4	8.9	0	0	0	0	0	0	48	25	11
21 Paper	0.3	0	0	1.7	0	7.1	0	0	0	0	0	3	9
22 ChmFerti	1720	224.4	467.3	3935.6	93.8	18.8	1830.5	356.1	0	0	0.2	0	0
23 Petroleum	131.8	63.4	106	42	0	0	103	0	0	0	2803	196.4	639.5
24 RubProduct	0	0	0	0	0	0	0	0	0	0	1.3	0	0
25 NMOminpr	0	0	18	0	0	0	0	0	0	0	8.1	0	0
26 Base_metal	0	20	0	0	0	0	0	0	0	0	0	0	7.8
27 Feb_metal	200.2	179.4	155.9	384.2	15.3	3.2	123	0	0	11	701	20.8	158.5
28 Othe_Manu	194.9	92.4	108.4	0	6.9	4.5	190.3	27.1	33.4	3.3	14	109.3	998.7
29 Electricity	51.7	9.8	13.7	0	0	0	0	66.2	0	0	0	98	406.6
30 Construct	514.4	303.9	439.2	140	5	0	276.8	0	0	0	0	20.4	232.9
31 Trade	340	270.3	501.4	381.3	180	115	3281	889.2	145	89	1005	654	1875
32 Hotels	0	0	0	0	0	0	0	0	0	0	0	0	0
33 Transport	250	106.3	142.8	357	165	85	2206	502	95	65	615	150	1400
34 Commun	17	0	0	0	0	0	0	0	0	0	0	13.8	0
35 Banking	309.9	207.6	306.1	138	3.2	0	839.2	5.4	2	0.4	307.5	50	321.2
36 Dwellings	0	0	0	0	0	0	0	0	0	0	0	0	0
37 Pubadmin	0	0	0	0	0	0	0	0	0	0	0	0	0
38 Other_serv	0	0	0	0	0	0	0	0	0	0	0	0	0
factors													
Labour													
1 PTW	75.2	31.7	45.7	0	1.7	1.3	0	0	92.4	12.1	0	0	0
2 AMW	11.1	4.7	6.8	0	0.3	2.9	0	0	0	0	0	0	0
3 CLW	50.1	21.1	30.4	0.1	1.2	2.2	43.3	0	30.8	4	0	61.4	0
4 SALW	13.4	5.6	8.1	9.8	0.3	8.3	11.6	0	92.4	12.1	0	184.2	0
5 SERW	56.8	23.9	34.5	41.6	1.3	6.2	49.1	0	61.6	8	0	20.5	0
6 AGW	5387.8	2268.3	3271.1	3985.6	125.3	4.7	4673.7	0	246.5	32.2	0	13.6	0
7 LPW	63.5	26.7	38.6	46.5	1.5	45.4	54.9	0	287.5	37.6	0	1965.3	0
8 OW	141.1	59.4	85.7	103.4	3.3	5	122	0	27.4	3.6	0	182	0
Capital	5167.2	4645.8	7298.3	12971	2562.6	378	43354	6450	4403	328.6	13368.4	5636.6	2239.6
Households													
1 ULIHH													
2 RLIHH													
3 EHH													
4 UHIHH													
5 RHIHH													
Enterprises													
Government	346.4	170.75	51.25	0	-23.5	333.6	1019	70	0	0	101.2	141.6	8.5
Savings/Investment													
Rest of the World													
Total	15274.9	8863.9	13613.8	24331.7	3296.8	1276.4	61092.1	11318.8	5587.0	606.9	20406.2	9545.9	21713.5

Table D 6.3: (Continued)

14 Rubpro	15 Cocopro	16 Milling	17 Foodbev	18 Textile	19 Garments	20 Wood	21 Paper	22 ChmFerti	23 Petroleum	24 RubProduct	25 NMOminpr	26 Base_metal	27 Feb_metal	28 Othe_Manu
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7025	0	0	0	0	0	0	0	0	0	542	0	0	0	0
0	4745	0	1205.6	0	0	0	0	0	0	0	0	0	0	0
0	0	22859.6	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	110	0	0	0	0	0	0	0	0	0	0	0
0	0	0	262	0	0	0	0	0	0	0	0	0	0	0
0	0	3554.3	3781 2	0	0	0	0	897 7	0	0	0	0	0	77 9
0	0	0	3176.8	155.1	4217.6	0	0	0	0	0	0	0	0	31 7
93.5	33.5	65	950	0	0	0	0	0	0	0	135	0	0	43.6
0	0	0	1.4	0	0	302	0	0	0	0	0	0	0	0
0	0	0	45	0	0	0	0	0	0	0	0	0	0	4.6
0	0	0	0	0	0	0	0	51	2370.1	56.5	477.1	87	0	7854.7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1508.4	0	0	0	0
0	3005.5	0	0	0	0	0	0	0	0	0	0	0	0	17.4
0	0	9561 5	12189.4	0	0	0	0	0	0	0	0	0	0	0
0	0	0	6768.8	0	0	0	0	169 5	0	0	0	0	0	0
0	0	0	850	0	57378	0	252.5	78.9	0	0	0	0	0	396.2
0	0	0	0	7844 2	8871.7	0	257.8	0	0	0	0	0	19.8	406.8
0	0	0	2.9	0	10.3	844	89.4	0.5	0	58	4.6	0	1 3	15.9
2.3	0.9	1 3	0.8	0	802.3	0	8707.4	761 1	0	14	4.6	0	1 3	19 2
105.6	0	0	623.3	9614.2	808.9	0	531 3	12230.4	0	757.6	139.1	174	56.9	1380.7
72.6	104.6	117.4	483.4	220.4	43.6	16.3	13.8	105	20073	29 5	191	26	36.3	17.1
0	0	0	0	0	0	0	0	68.9	0	797.4	0	0	67.1	182 3
0	0	0	0	0	0	0	0	102.5	0	0	723.3	3.4	58	339.1
0	0	0	0	0	0	2 2	0	0	0	0	3527	4458.6	1616.1	0
124 2	3.1	458.4	236.7	240.4	1500.8	15.4	127.6	375 7	129.6	118.5	11 9	93	6923.9	3468 9
24.9	48.1	26.7	37 1	89	2705.2	84	178.1	305.2	0	58	93.5	0	236.5	3091.5
124.9	53 2	218.5	1326.8	422.4	105.6	32.8	27 5	24.1	160.2	59	382.1	14.3	72 7	34.2
93.7	88.6	6.7	90.1	21 1	267 9	14.5	2.8	15	18	38.4	48	18	11.4	11.1
1250	1350	5300	3523	7052 5	4322.5	235	1143	1753	3426	805.8	1243	1369	1489	2540
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
780	1075	3952	2123	3151.5	3573.5	185	775	1589	2713	610	825	575	950	1450
0	20.6	0	0	0	0	0	0	0	211	0	0	0	0	0
36.7	37	130	240	10.2	38.9	0	49.3	0	450	45.2	78	35	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1.8	0	0	0	0	0	0	0	0
0	0	14 5	49.3	122.1	242.3	0	2.8	14.4	118 7	32 5	34.7	0	160	137.7
0	0	32 3	109.5	254.3	504.9	6.5	6.2	28 9	0	65.1	0	0	0	102
0	0	24.2	82.1	142.4	282 7	1 9	4.7	10.6	39.6	23.9	34.7	2 9	45.7	30.6
0	0	92 1	312	86.5	171 7	2 9	2.8	4.8	39.6	10.8	17.3	0	91.5	30.6
0	0	67.9	229.9	122.1	242.3	1	0.9	9.6	39.6	21 7	11.6	0	22 9	0
0	0	51 7	175.2	17	33.7	16.2	0	0.6	0	1.4	0	0	0	0
0	0	501.1	1696.9	2909.5	5775.6	166.8	26.8	34.6	105.5	78.1	601	49.6	487.8	816.2
0	0	55	186.1	72.3	143.6	8.7	3.3	6.4	0	14.5	66.8	2 5	10.2	40.8
1557.4	4261	4649.3	27755.3	6655.5	14013.7	989	91 5	522.3	4744.3	1700.4	3141.6	-53.5	3273.6	3252
0	0	498.5	7134.288	280.56161	1264.6044	155.7	868.4	536.062	7209.3	921.2	549 1	726.1	5645	927 1
11290.8	14826.1	52238.0	75757.9	39483.3	107321.9	3081.7	13162.9	19695.8	41847.5	8367.9	12340.0	7580.9	21277.0	26719.9

Table D 6.3: (Continued)

29 Electricity	30 Construct	31 Trade	32 Hotels	33 Transport	34 Commun	35 Banking	36 Dwellings	37 Pubadmin	38 Other_serv	1 Teagrow	2 Rubgrow	3 Cocgrow	4 Paddy	5 Mexcrop	6 Tobacco
										Commodities					
										15275.063					
											8863.95				
												13613.654			
													24331.7		
														3296.8	
															1276.3
0	0	0	0	0	0	0	0	0	0						
0	0	0	0	0	0	0	0	0	0						
0	0	0	5	0	0	0	0	0	0						
0	0	0	0	0	0	0	0	0	0						
0	0	97.8	6	0	0	0	0	0	0						
0	0	0	167.1	0	0	0	0	0	0						
0	0	0	2530.5	0	0	0	0	0	0						
0	0	0	2176	0	0	0	0	5	0						
0	0	0	363	0	0	0	0	0	0						
0	15	0	0	81	0	0	0	0	0						
0	0	0	401.2	0	0	0	0	0	0						
0	312.4	0	16.7	0	0	0	149	0	0						
0	0	3.1	269.5	9	0	0	0	0	0						
0	0	0	0	0	0	0	0	0	0						
0	956.9	0	7.9	0	0	0	0	0	0						
0	0	0	74	0	0	0	0	0	0						
0	0	805	3476.2	0	0	0	0	0	0						
0	0	6225.9	13.2	20	0	0	0	867.2	89.8						
0	0	0	0	0	0	0	0	0	0						
0	889.1	706	0	40.3	0	0	35.2	0	0						
2.1	187.6	1617.2	0.4	5	10	119.4	0	441.9	126.1						
10	1786.8	4	0	30.5	0	0	65.9	0	1588.9						
221.8	503.4	10086.3	93	6414.2	15	0	0	6113.3	165						
0	479.7	701.9	0	2846.3	5	38	26.3	0	0						
0	10176.2	753	14.4	147.9	0	0	33	0	78						
35.5	1906.4	50.9	0	16.8	0	0	0	0	0						
1151.5	1102.6	2066.8	234	5430.7	415	119.4	0	855.2	1559.1						
1.3	1140.3	1592.2	110.7	2170	0	0	79	845	725.7						
68.8	935.5	2960.5	57.9	155	45	81.4	0	0	208.1						
1.3	985	245.4	3	0	0	27.1	469.2	0	3300						
575	8070	12839.7	1650	3725	1025	1520	161	0	950						
0	0	0	0	0	0	0	0	0	0						
425	2838	7575	1100	2300	325	695	135	2925	1025						
0	85.5	0	0	0	0	70.5	0	0	0						
11.9	2264	6593.6	77.1	0	65	185	135	977	158						
0	0	0	0	0	0	0	0	0	0						
0	0	0	0	0	0	0	0	11176.2	0						
0	7.3	59.9	0	1762.1	0	0	49.7	0	115						
694.2	2789	984.3	39	1095.2	1119	10488.6	0	7057.3	6314.1						
110.2	590.3	625	0	663.7	0	6504.6	0	4900.9	49.8						
462.8	221.3	1523.4	17.3	4314.3	2451.1	10000.8	0	14702.7	391.1						
132.2	398.4	34334	43.3	497.8	0	3902.7	0	73.5	101.5						
231.4	1062.5	960.9	225.3	962.4	106.6	1382.2	0	11247.5	859.8						
44.1	295.1	312.5	1.4	88.5	0	54.2	0	49	23.9						
1256.2	23020.4	1015.6	18.8	9181.8	319.7	1084.1	0	1470.3	463.7						
102.8	2184	510.4	5.8	929.2	23.7	216.8	0	1012.8	569.2						
11547	14017.5	79103	185	42552	0	10381	4078	0	1529						
265	3352.5	36482	485	-119.5	0	424	0	14411	7473						
										0	0	0	308.5	0	1102
17350.1	82572.7	210835.3	13867.7	85319.2	5925.1	47294.8	5416.3	79130.8	27863.8	15275.1	8864.0	13613.7	24640.2	3296.8	2378.3

Table D 6.3: (Continued)

7 Othe_agri	8 Livestock	9 Firewood	10 Forestry	11 Fishing	12 Mining	13 Teapro	14 Rubpro	15 Cocopro	16 Milling	17 Foodbev	18 Textile	19 Garments	20 Wood	21 Paper	22 ChmFerti
61092 2															
	11318.8														
		5587.016													
			606.9												
				20406.191											
					9545.86										
						21713.5									
							11290.8								
								14826 1							
									52238.2						
										75757 904					
											39483.27				
												107321 94			
													3081 7		
														13163	
															19695 9
5271.8	244.9	43.6	82.4	3498.1	8111.7	79.1	5.1	17.4	11170.2	23084.5	48178.1	8205.4	815.8	6031.4	38808.4
66364.0	11563.7	5630.6	689.3	23904.3	17657.6	21792.6	11295.9	14843.5	63408.4	98842.4	87661.4	115527.3	3897.5	19194.4	58504.3

Table D 6.3: (Continued)

23 Petroleum	24 RubProduct	25 NMOminpr	26 Base_metal	27 Feb_metal	28 Othe_Manu	29 Electricity	30 Construct	31 Trade	32 Hotels	33 Transport	34 Commun	35 Banking	36 Dwellings	37 Pubadmin
41847.5														
	8368													
		12339 9												
			7580.89741											
				21277										
					26719.9									
						17350.2								
							82572.6							
								210835.3						
									13867.8					
										85319 2				
											5925			
												47294.8		
													5416.3	
														79130.8
20093.4	2681.7	11169.8	7081.3	59191.4	11043.5	0	0	9538	0	8132.4	0	15990.9	0	1563
61940.9	11049.7	23509.7	14662.2	80468.4	37763.4	17350.2	82572.6	220373.3	13867.8	93451.6	5925.0	63285.7	5416.3	80693.8

Table D 6.3: (Continued)

	factors	Labour							Capital	Households					Enterprise
38															
Other_serv	1 PTW	2 AMW	3 CLW	4 SALW	5 SERW	6 AGW	7 LPW	8 OW		1 ULIHH	2 RLIHH	3 EHH	4 UHIHH	5 RHIHH	
27863.7															
										0	0	0	0	0	
										0	0	0	0	0	
										1215.1	1588.9	1528.5	703.8	461.8	
										0	0	0	0	0	
										201.6	248.8	292.3	108.2	74	
										165	153.4	499	127.7	44.5	
										11131.2	12193.8	12233.9	7265.3	4969.8	
										1667	1233	1742.8	1474.1	771.5	
										653.3	1055.6	1369.4	383.9	228.8	
										4.2	9.2	6.1	1.2	1.3	
										5917.3	5202.9	3142.1	3596.2	2551.5	
										20.7	267.9	402.7	144.1	250.1	
										919.4	1005.9	18.4	341.5	341.5	
										0	0	0	0	0	
										1145.2	1345.1	1939.3	653.6	318.7	
										5793	8304.4	13126.2	4085.4	2176.5	
										23603.9	19587.9	14675.1	14081.8	9989.7	
										1629.7	1744.5	2892.3	3236.2	1973.9	
										2435.4	2369.6	3311	3019.2	2330.5	
										597.5	472.7	254.7	373.5	538.3	
										715	736.8	432.7	1028	695.8	
										3641.5	4330.3	2808.3	2573	2066.9	
										1054	1045.5	1487.5	2490.5	2422.5	
										85.2	525.1	177.1	609.5	278.5	
										607.4	397.2	736.8	341.3	229.4	
										355.4	412.2	330.4	755.3	216.9	
										209.4	878.2	605.3	2103.4	1008.7	
										1122	1096.4	2119.1	2225.2	2059	
										2191.3	925.9	138.9	2870.4	1589.5	
										0	0	0	0	0	
										16493.1	9891.6	5084.2	12093.2	12934.8	
										5394.6	2718.1	1109.4	3092.6	1553.2	
										6380.4	4606.2	2968.4	16787	3377.9	
										583.6	368.6	380.9	2948.6	1861.3	
										2606.6	6977.9	621.9	7396.4	9501	
										1397.3	742	303.3	2074.3	899.1	
										1160.9	1081.7	560.7	2770.3	1022.4	
										4539.3	4304.5	3548	8478.6	5217.6	
	0	0	10516.7	12207.6	5433.5	2117.3	32188.6	2759.1							8633.8381
	0	0	7011.1	8138.4	3622.3	14821.3	16094.3	2759.1							98016.099
	0	0	3505.6	4069.2	1811.2	4234.7	5364.8	689.8							4742.6322
	19061.9	8747.9	3505.6	4069.2	1811.2	0	0	0							112670.63
	12708	5831.9	10516.7	12207.6	5433.5	0	0	689.8							70016.096
									348749						
										3195.1336	1638.6664	0	12780.33	6554.87	15028.484
										-28727.7	93213.932	-54610.87	36335.005	51181.626	38958
0										401.4	205.8	0	3612.2	1852.6	17949.133
27863.7	31769.9	14579.8	35055.7	40692.0	18111.7	21173.3	53647.7	6897.8	348749.0	80505.3	192880.2	26235.8	162960.8	133546.0	366014.9

Table D 6.3: (Continued)

Governme	Savings/In	Rest of the	Total
			15275.1
			8864.0
			13613.7
			24331.7
			3296.8
			1276.3
			61092.2
			11318.8
			5587.0
			606.9
			20406.2
			9545.9
			21713.5
			11290.8
			14826.1
			52238.2
			75757.9
			39483.3
			107321.9
			3081.7
			13163.0
			19695.9
			41847.5
			8368.0
			12339.9
			7580.9
			21277.0
			26719.9
			17350.2
			82572.6
			210835.3
			13867.8
			85319.2
			5925.0
			47294.8
			5416.3
			79130.8
			27863.7
0	1945.2	0	15275.1
0	1210.8	0	8864.0
0	1726.5	193.8	13613.7
0	536.7	0	24640.2
0	16.5	1987.9	3296.7
0	-694.6	1426.3	2378.3
0	3066.9	873.9	66364.1
78	-6377.4	36.1	11563.6
0	108.8	0	5630.6
0	99.5	3.3	689.3
311	40.1	2595.8	23904.2
18.3	1668.9	3294.1	17657.3
85	-3374.8	22174.2	21792.7
0	5556.4	4231.1	11295.9
125	21.2	4762.8	14843.4
608	7450.4	0	63408.4
1376	-734.7	4032	98842.3
75	267.8	8333.3	87661.4
0	402.7	84258.7	115527.4
45	-2409.7	1222.7	3897.6
2657	-2431.6	2514.6	19194.3
3552	-49.8	1027.1	58504.1
2052.5	-1772.8	3914.1	61940.9
348	-2641.7	6453.6	11049.5
1297	5296.2	2149.6	23509.8
1005.7	-1105.5	1050.4	14662.1
3102.5	33125.9	10720.1	80468.4
3471.3	588.7	9656.4	37763.3
1363	54.7	0	17350.2
5823	69040.5	0	82572.4
0	57059.8	29773.1	220373.5
0	-0.2	0	13867.7
4932	-11229.5	15820.1	93451.6
1363.9	-2000.3	0	5925.0
6175	1665.4	14234	63285.6
0	0.3	0	5416.3
56700	5226.7	995	80693.9
680	-900.1	0	27863.7
			31769.8
			14580.0
			35055.4
			40691.8
			18111.6
			21173.3
			53647.6
			6897.8
			348749.0
3358.9		3289.8	80505.3
32827		9590.6	192880.2
1182.4		635.5	26235.8
519.6		12574.8	162960.8
1342.1		14800.3	133546.0
6399		10868	366015.0
		8282	139187.2
-3686		27789.833	160453.8
			325564.9
139187.2	160453.9	325564.9	

Source : Compiled by the author

Table D 6.4

A 38 Sector Input-Output Table for the Year 1995 - Sri Lanka

(At Producers' Price; Values in Rupees Million)

Selling Sectors \ Buying Sectors	1 Teagrow	2 Rubgrow	3 Cocgrow	4 Paddy	5 Mexcrop	6 Tobacco	7 Othe_agri	8 Livestock	9 Firewood	10 Forestry	11 Fishing	12 Mining
1 Teagrow	71.9	0	0	0	0	0	0	0	0	0	0	0
2 Rubgrow	0	86.2	0	0	0	0	0	0	0	0	0	0
3 Cocgrow	0	0	239.7	0	0	0	0	0	0	0	0	0
4 Paddy	0	0	0	1127	0	0	0	0	0	0	0	0
5 Mexcrop	0	0	0	0	153.6	0	0	0	0	0	0	0
6 Tobacco	0	0	0	0	0	110	0	0	0	0	0	0
7 Othe_agri	1.9	1.2	1.7	0	0	5.4	2391.2	1292.1	0	0	0	0
8 Livestock	79	0	97.8	541.1	0	0	396.2	56.5	0	0	0	0
9 Firewood	0	0	0	0	0	0	0	0	0	0	0	0
10 Forestry	23.2	5.8	8.1	0	0	0	55	8	65	0	0	0
11 Fishing	0	0	0	0	0	0	0	0	0	0	96	0
12 Mining	51.2	32	132.8	0	0	0	0	0	0	0	0	0
13 Teapro	0	0	0	0	0	0	0	0	0	0	0	0
14 Rubpro	0	0	0	0	0	0	0	0	0	0	0	0
15 Cocopro	0	0	0	0	0	0	0	539.8	5	0	0	0
16 Milling	0	0	0	0	0	0	0	39.6	0	0	0	0
17 Foodbev	0	0	0	0	0	0	0	667.6	0	0	0	0
18 Textile	0	0	0	0	0	0	0	0	0	0	1250	0
19 Garments	0	0	0	0	0	0	0	0	0	0	0	0
20 Wood	4.9	3.2	4.4	8.9	0	0	0	0	0	0	48	25
21 Paper	0.3	0	0	1.7	0	0	0	0	0	0	0	3
22 ChmFerti	322	43.7	103	1160.5	18.8	18.8	398.8	16.3	0	0	0	0
23 Petroleum	131.8	63.4	106	42	0	0	103	0	0	0	2803	196.4
24 RubProduct	0	0	0	0	0	0	0	0	0	0	0	0
25 NMOminpr	0	0	18	0	0	0	0	0	0	0	8.1	0
26 Base_metal	0	20	0	0	0	0	0	0	0	0	0	0
27 Feb_metal	200.2	179.4	155.9	384.2	15.3	0	115	0	0	11	701	20.8
28 Othe_Manu	194.9	92.4	108.4	0	6.9	4.5	190.3	27.1	33.4	3.3	14	109.3
29 Electricity	51.7	9.8	13.7	0	0	0	0	66.2	0	0	0	98
30 Construct	514.4	303.9	439.2	140	5	0	276.8	0	0	0	0	20.4
31 Trade	340	270.3	501.4	381.3	180	115	3281	889.2	145	89	1005	654
32 Hotels	0	0	0	0	0	0	0	0	0	0	0	0
33 Transport	250	106.3	142.8	357	165	85	2206	502	95	65	615	150
34 Commun	17	0	0	0	0	0	0	0	0	0	0	13.8
35 Banking	309.9	207.6	306.1	138	3.2	0	839.2	5.4	2	0.4	307.5	50
36 Dwellings	0	0	0	0	0	0	0	0	0	0	0	0
37 Pubadmin	0	0	0	0	0	0	0	0	0	0	0	0
38 Other_serv	0	0	0	0	0	0	0	0	0	0	0	0
Local Intermediate Inputs	2564.3	1425.2	2379	4281.7	547.8	338.7	10252.5	4109.8	345.4	168.7	6847.6	1340.7
Imports	1398	180.75	364.25	2892	75	150	1512	689	0	0	89	0
Total Intermediate Inputs	3962.3	1605.95	2743.25	7173.7	622.8	488.7	11764.5	4798.8	345.4	168.7	6936.6	1340.7
Gross Operating Surplus less Indirect Taxes	5167.22976	4645.75	7298.254	12971	2562.625	378	43354.036	6450	4402.9574	328.65	13368.391	5636.56
Compensation of Employees	5799.13344	2441.5	3520.9	4187	134.875	76	4954.664		838.65856	109.55		2427
Value Added at Factor Cost Price,(1+2)	10966.3632	7087.25	10819.154	17158	2697.5	454	48308.7	6450	5241.616	438.2	13368.391	8063.56
Import Duty, plus	0	0	0	0	0	211	250	71	0	0	0	0
Other Indirect Taxes, plus	478	253	166.4	0	0	0	0	0	0	0	0	0
Less Subsidies	131.6	82.25	115.15	0	23.5	0	15.8	1	0	0	59.5	0
Value Added at Producers' Price,(3+4+5-6)	11312.7632	7258	10870.404	17158	2674	665	48542.9	6520	5241.616	438.2	13308.891	8063.56
Gross Output (50+7)	15275.0632	8863.95	13613.654	24331.7	3296.8	1153.7	60307.4	11318.8	5587.016	606.9	20245.491	9404.26

Selling Sectors \ Buying Sectors	13 Teapro	14 Rubpro	15 Cocopro	16 Milling	17 Foodbev	18 Textile	19 Garment	20 Wood	21 Paper	22 ChmFer	23 Petroleu	24 RubProduct
1 Teagrow	13258	0	0	0	0	0	0	0	0	0	0	0
2 Rubgrow	0	7025	0	0	0	0	0	0	0	0	0	542
3 Cocgrow	0	0	4745	0	1205.6	0	0	0	0	0	0	0
4 Paddy	0	0	0	22668	0	0	0	0	0	0	0	0
5 Mexcrop	0	0	0	0	110	0	0	0	0	0	0	0
6 Tobacco	0	0	0	0	262	0	0	0	0	0	0	0
7 Othe_agri	0	0	0	3554.3	3776.3	0	0	0	0	0	0	0
8 Livestock	0	0	0	0	3140	0	4202	0	0	0	0	0
9 Firewood	147.2	93.5	33.5	65	950	0	0	0	0	0	0	0
10 Forestry	0	0	0	0	0	0	0	302	0	0	0	0
11 Fishing	0	0	0	0	45	0	0	0	0	0	0	0
12 Mining	0	0	0	0	0	0	0	0	0	0	2370.1	56.5
13 Teapro	0	0	0	0	0	0	0	0	0	0	0	0
14 Rubpro	0	0	0	0	0	0	0	0	0	0	0	1503.3
15 Cocopro	0	0	3005.5	0	0	0	0	0	0	0	0	0
16 Milling	0	0	0	0	10706.8	0	0	0	0	0	0	0
17 Foodbev	0	0	0	0	2173.6	0	0	0	0	0	0	0
18 Textile	0	0	0	0	850		10695.7	0	0	0	0	0
19 Garments	0	0	0	0	0	7805.7	5249	0	0	0	0	0
20 Wood	11	0	0	0	2.9	0	10.3	844	25	0.5	0	58
21 Paper	9	2.3	0.9	1.3	0.8	0	10.3	0	5705	0.5	0	14
22 ChmFerti	0	105.6	0	0	0	326	314.5	0	0	3478.2	0	234.8
23 Petroleum	639.5	72.6	104.6	117.4	483.4	220.4	43.6	16.3	13.8	57.3	1539.6	29.5
24 RubProduct	0	0	0	0	0	0	0	0	0	0	0	353.9
25 NMOminpr	0	0	0	0	0	0	0	0	0	0.2	0	0
26 Base_metal	7.8	0	0	0	0	0	0	2.2	0	0	0	0
27 Feb_metal	158.5	124.2	3.1	56.5	91	0	216.2	15.4	25.2	15.4	30	79
28 Othe_Manu	998.7	24.9	48.1	26.7	0	0	0	84	0	0.3	0	58
29 Electricity	406.6	124.9	53.2	218.5	1326.8	422.4	105.6	32.8	27.5	24.1	160.2	59
30 Construct	232.9	93.7	88.6	6.7	90.1	21.1	267.9	14.5	2.8	15	18	38.4
31 Trade	1875	1250	1350	5300	3523	7052.5	4322.5	235	1143	1753	3426	805.8
32 Hotels	0	0	0	0	0	0	0	0	0	0	0	0
33 Transport	1400	780	1075	3952	2123	3151.5	3573.5	185	775	1589	2713	610
34 Commun	0	0	20.6	0	0	0	0	0	0	0	211	0
35 Banking	321.2	36.7	37	130	240	10.2	38.9	0	49.3	0	450	45.2
36 Dwellings	0	0	0	0	0	0	0	0	0	0	0	0
37 Pubadmin	0	0	0	0	0	0	0	0	0	0	0	0
38 Other_serv	0	0	0	0	0	0	0	1.8	0	0	0	0
Local Intermediate Inputs	19465.4	9733.4	10565.1	36096.4	31100.3	19009.8	29050	1733	7766.6	6933.5	10917.9	4487.4
Imports	0	0	0	10155	6927.0042	9811.2	55596.8	0	4389	11594	18633	1011
Total Intermediate Inputs	19465.4	9733.4	10565.1	46251.4	38027.304	28821	84646.8	1733	12155.6	18527.5	29550.9	5498.4
Gross Operating Surplus less Indirect Taxes	2239.6	1557.4	4261	4649.3	27755.312	6655.4933	14013.741	989	91.462	522.338	4744.3	1700.4
Compensation of Employees				839	2841	3726.215	7396.795	204	47.538	110	343	248
Value Added at Factor Cost Price,(1+2)	2239.6	1557.4	4261	5488.3	30596.312	10381.708	21410.536	1193	139	632.338	5087.3	1948.4
Import Duty, plus	0	0	0	450	567	185.4	1050.6	0	355	1295	4642	85
Other Indirect Taxes, plus	0	0	0	0	4548	94.47	187.53	86	370	586	2246.8	469.6
Less Subsidies	0	0	0	0	135.712	6.10839	12.12561	0	0	1344.938	0	0
Value Added at Producers' Price,(3+4+5-6)	2239.6	1557.4	4261	5938.3	35575.6	10655.47	22636.54	1279	864	1168.4	11976.1	2503
Gross Output (50+7)	21705	11290.8	14826.1	52189.7	73602.904	39476.47	107283.34	3012	13019.6	19695.9	41527	8001.4

Table D 6.4 (Continued)

25 NMOmi	26 Base_m	27 Feb_met	28 Othe_M	29 Electrici	30 Constru	31 Trade	32 Hotels	33 Transpo	34 Commu	35 Banking	36 Dwellin	37 Pubadm	38 Other_serv	Total Inter-..mediate Inputs	Pivate Consumptio Expenditure 1	Governmen Consumptio Expenditure 2	Fixed Capital Formation 3	Change in Stocks 4	Exports FOB.Value 5	Final Demand 6	Gross Output/ Grand Total 7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	13329.9	0	0	1966	-20.8368	0	1945.1632	15275.063
0	0	0	0	0	0	0	0	0	0	0	0	0	0	7653.2	0	0	1228.75	-18	0	1210.75	8863.95
0	0	0	0	0	0	0	5	0	0	0	0	0	0	6195.3	5498.0714	0	1720.25	6.2468571	193.78571	7418.354	13613.654
0	0	0	0	0	0	0	0	0	0	0	0	0	0	23795	0	0	0	536.7	0	536.7	24331.7
0	0	0	0	0	0	97.8	6	0	0	0	0	0	0	367.4	925	0	0	16.542857	1987.8571	2929.4	3296.8
0	0	0	0	0	0	0	0	0	0	0	0	0	0	372	50	0	0	-694.5857	1426.2857	781.7	1153.7
0	0	0	0	0	0	0	2530.5	0	0	0	0	0	0	13554.6	42812	0	0	3066.9241	873.87586	46752.8	60307.4
0	0	0	0	0	0	0	2176	0	0	0	0	5	0	10693.6	6888.4615	78	0	-6377.404	36.142857	625.2	11318.8
135	0	0	0	0	0	0	363	0	0	0	0	0	0	1787.2	3691	0	0	108.816	0	3799.816	5587.016
0	0	0	0	0	15	0	0	0	0	0	0	0	0	482.1	22	0	0	99.514286	3.2857143	124.8	606.9
0	0	0	0	0	0	0	401.2	0	0	0	0	0	0	542.2	16756.296	311	0	40.14855	2595.8462	19703.291	20245.491
423	87	0	836.7	0	284.5	0	0	0	0	0	149	0	0	4422.8	0	18.3	3111	-1441.914	3294.0741	4981.46	9404.26
0	0	0	0	0	0	3.1	269.5	9	0	0	0	0	0	281.6	2539	85	0	-3374.8	22174.2	21423.4	21705
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1503.3	0	0	0	5556.3889	4231.1111	9787.5	11290.8
0	0	0	0	0	956.9	0	7.9	0	0	0	0	0	0	4515.1	5402	125	0	21.2	4762.8	10311	14826.1
0	0	0	0	0	0	0	74	0	0	0	0	0	0	10820.4	33310.909	608	0	7450.3909	0	41369.3	52189.7
0	0	0	0	0	0	805	1200	0	0	0	0	0	0	4846.2	64083.448	1376	0	-734.7441	4032	68756.704	73602.904
0	0	0	0	0	0	6225.9	13.2	20	0	0	0	867.2	89.8	20011.8	10788.606	75	0	267.78416	8333.28	19464.67	39476.47
0	0	0	0	0	0	0	0	0	0	0	0	0	0	13054.7	9567.2542	0	0	402.66584	84258.72	94228.64	107283.34
4.6	0	1.3	15.5	0	835	706	0	40.3	0	0	35.2	0	0	2684	1470	45	0	-2409.727	1222.7273	328	3012
4.6	0	1.3	15.5	2.1	185	1617.2	0.4	5	10	119.4	0	441.9	126.1	8277.6	2002	2657	0	-2431.6	2514.6	4742	13019.6
85	0	0	45	10	1468.7	0	0	0	0	0	65.9	0	0	8215.6	9920	583	0	-49.84286	1027.1429	11480.3	19695.9
191	26	36.3	17.1	221.8	500	9859.6	93	6414	15	0	0	6113.3	165	30435.7	8500	450	0	-1772.8	3914.1	11091.3	41527
0	0	0	0	0	35	650	0	2515.3	5	38	26.3	0	0	3623.5	218	348	0	-2641.671	6453.5714	4377.9	8001.4
0	3.4	0	74	0	2784.5	733.5	14.4	0	0	0	33	0	78	3747.1	521	576	3025	2271.0704	2149.6296	8542.7	12289.8
3527	779.6	1454.2	0	0	1349.2	50.9	0	0	0	0	0	0	0	7190.9	108	74	0	-1105.493	1050.39	126.89741	7317.7974
3.4	48	16.7	3326.7	300	488.2	1638	0	3098	415	119.4	0	255.2	895.7	13201.6	380	176	0	-7466.68	10720.08	3809.4	17011
93.5	0	236.5	2935	1.3	1140.3	1592.2	24.7	2170	0	0	79	703	419	11419.7	4090	175	0	588.67143	9656.4286	14510.1	25929.8
382.1	14.3	72.7	34.2	68.8	935.5	2960.5	57.9	155	45	81.4	0	0	208.1	8216.5	7716	1363	0	54.7	0	9133.7	17350.2
48	18	11.4	11.1	1.3	985	245.4	3	0	0	27.1	469.2	0	3300	7708.9	0	5823	74182.05	-5141.35	0	74863.7	82572.6
1243	1369	1489	2540	575	8070	12839.7	1650	3725	1025	1520	161	0	950	77043.7	46959	0	13997	43062.5	29773.1	133791.6	210835.3
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13868	0	0	-0.2	0	13867.8	13867.8
825	575	950	1450	425	2838	7575	1100	2300	325	695	135	2925	1025	49809.1	34120	4932	11760	-32878.5	15820.1	33753.6	83562.7
0	0	0	0	0	85.5	0	0	0	0	70.5	0	0	0	418.4	6143	1363.89	0	-2000.29	0	5506.6	5925
78	35	0	0	11.9	2264	6593.6	77.1	0	65	185	135	977	158	14107.4	16497	2457	0	-0.6	14234	33187.4	47294.8
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5416	0	0	0.3	0	5416.3	5416.3
0	0	0	0	0	0	0	0	0	0	0	0	11176.2	0	11176.2	6596	55137	5226	0.6	995	67954.6	79130.8
0	0	0	0	0	7.3	59.9	0	1762.1	0	0	49.7	0	115	1995.8	26088	680	0	-900.1	0	25867.9	27863.7
7043.2	2955.3	4269.4	11300.8	1617.2	25227.6	54253.3	10066.8	22213.7	1905	2855.8	1338.3	23463.8	7529.7	397500.1	392946.05	79516.19	116216.05	-7909.975	237734.13	818502.45	1216002.5
840	3897.9974	7271	10082	887	9414	731	2780	2940	0	0	0	742	2559	167611.0016	70048	16702	47182	0	0	133932	301543
7883.2	6853.2974	11540.4	21382.8	2504.2	34641.6	54984.3	12846.8	25153.7	1905	2855.8	1338.3	24205.8	10088.7	565111.1016	462994.05	96218.19	163398.05	-7909.975	237734.13	952434.45	1517545.5
3141.6	-53.5	3273.6	3252	11547	14017.5	79103	185	42552	0	10381	4078	0	1529	348748.9992						0	348749
766	55	818	1158	3034	30561	40266	351	17733	4020	33634	0	40514	8773	221927.829						0	221927.83
3907.6	1.5	4091.6	4410	14581	44578.5	119369	536	60285	4020	44015	4078	40514	10302	570676.8282							570676.83
0	407	761	50	265	2095	177	485	35	0	0	0	91	541	14069	5502	1026	4965			11493	25562
499	56	618	87	0	1379	36305	0	187	0	424	0	14408	6932	70380.8						0	70380.8
0	0	0	0	0	121.5	0	0	2098	0	0	0	88	0	4235.184						0	4235.184
4406.6	464.5	5470.6	4547	14846	47931	155851	1021	58409	4020	44439	4078	54925	17775	650891.4442							650891.44
12289.8	7317.7974	17011	25929.8	17350.2	82572.6	210835.3	13867.8	83562.7	5925	47294.8	5416.3	79130.8	27863.7	1216002.546	468496.05	97244.19	168363.05	-7909.975	237734.13	963927.45	2179930

Source: Aggregated by the author based on 1995 I-O Table (DCS, 1998)

Table D 6.5

Import Matrix Table for the year 1995 - Sri Lanka

(C.I.F Value; Values in Rupees Million)

	Selling Sectors \ Buying Sectors	Tea Growing 1	Rubber Growing 2	Coconut and Toddy 3	Paddy 4	Minor Export Crops 5	Tobacco 6	Other Agri. Products 7	Livestocks 8	Firewood 9	Forestry 10	Fisheries 11	Mining and Quarrying 12	Tea Processing 13	Rubber Processing 14	Coconut Processing 15	Milling 16	Food & Beverages Other 17	Textiles & 18	garments 19	Wood& Wood Products 20	Paper & Paper Products 21	Chemicals &Fertilizer 22
1	Tea Growing																	0	0	0			
2	Rubber Growing																	0	0	0			
3	Coconut and Toddy																	0	0	0			
4	Paddy				116.94616												191.6318582	0	0	0			
5	Minor Export Crops																	0	0	0			
6	Tobacco						117.88914											0	0	0			
7	OtherAgri. Products						21.874469	72.285358										4.941207508	0	0			897.70727
8	Livestocks								5.7238406									36.77936532	155.11114	15.601038			
9	Firewood																	0	0	0			
10	Forestry																	1.356501306	0	0			
11	Fisheries											0.5315063						0	0	0			
12	Mining and Quarrying																	0	0	0			50.986994
13	Tea Processing																	0	0	0			
14	Rubber Processing																	0	0	0			
15	Coconut Processing																	0	0	0			
16	Milling																9561.464674	1482.558036	0	0			
17	Food, Beverages and Other								343.49799									4595.248398	0	0			169.48351
18	Textiles											86.981173						0	0	46682.331		252.46944	78.93957
19	garments																	0	38.488617	3622.6817		257.81258	
20	Wood and Wood Products																	0	0	0		64.435174	
21	Paper and Paper Products						7.0558168											0	0	791.97502		3002.4084	760.62136
22	Chemicals and Fertilizer	1398	180.75	364.25	2775.0538	75		1431.6956	339.77817			0.180973						623.3379886	9288.2287	494.40971		531.33112	8752.1796
23	Petroleum Industry																	0	0	0			47.749724
24	Plastic and Rubber Products											1.2647731						0	0	0			68.854231
25	Non Metalic & Other Mineral Products																	0	0	0			102.27281
26	Basic Metal Products																	0	0	0			
27	Febricated Metal Products						3.1805711	8.0190522				0.0415749					401.9034681	145.7049533	240.35823	1284.5664		102.39868	360.27907
28	Other Manufacturing																	37.07770237	89.013309	2705.2351		178.14466	304.92588
29	Electricity, Gas and water																	0	0	0			
30	Construction																	0	0	0			
31	Wholesale and Retail Trade																	0	0	0			
32	Hotels and Restaurants																	0	0	0			
33	Transport																	0	0	0			
34	Post and Communication																	0	0	0			
35	Banking insuranceand Real Estate																	0	0	0			
36	Owership of Dwellings																	0	0	0			
37	Public Administration and Defence																	0	0	0			
38	Other Personal Services																	0	0	0			
	Total Imports Including Non- factor Services	1398	180.75	364.25	2892	75	150	1512	689	0	0	89	0	0	0	0	10155	6927.004152	9811.2	55596.8	0	4389	11594
	Import Duty	0	0	0	0	0	211	250	71	0	0	0	0	0	0	0	450	567	185.4	1050.6	0	355	1295
	Total Imports including duty, (48+49)	1398	180.75	364.25	2892	75	361	1762	760	0	0	89	0	0	0	0	10605	7494.004152	9996.6	56647.4	0	4744	12889

Table D 6.5 (continued)

Petroleum Industry 23	Plastic & Rubber Products 24	Other Mineral Products 25	Basic Metal Products 26	Fabricated Metal Products 27	Other Manufac..turing 28	Electricity & Gas & Water 29	Cons..truction Industry 30	Wholesale & Retail Trade 31	Hotels & Restaurents 32	Transport Industry 33	Post & Commun..nication 34	Banking, Insurance & Real Est. 35	Ownership of Dwelling 36	Public Administr.tion 37	Other Personal Services 38	Total Inter..mediate Inputs	Pivate Consumption Expenditur	Government Consumption Expenditure	Capital Transport	Machinery	Fixed Capital Formation	Change in Stocks	Exports FOB.Value	Final Demand	Gross Output/ Grand Total
																0	0	0	0	0	0			0	0
																0	0	0	0	0	0			0	0
																0	0	0	0	0	0			0	0
																308.57802	0	0	0	0	0			0	308.57802
																0	0	0	0	0	0			0	0
									167.13427							285.02341	817	0	0	0	0			817	1102.0234
					77.918244											1074.7265	4197	0	0	0	0			4197	5271.7265
					31.664192											244.87958	0	0	0	0	0			0	244.87958
					43.623936											43.623936	0	0	0	0	0			0	43.623936
										80.963813						82.320315	0	0	0	0	0			0	82.320315
					4.6262619											5.1577682	3493	0	0	0	0			3493	3498.1578
		54.054965			7017.9964		27.881958		16.713427							7167.6337	944	0	0	0	0			944	8111.6337
																0	79	0	0	0	0			79	79
	5.1481211															5.1481211	0	0	0	0	0			0	5.1481211
					17.374183											17.374183	0	0	0	0	0			0	17.374183
																11044.023	126	0	0	0	0			126	11170.023
									2276.2096							7384.4395	15700	0	0	0	0			15700	23084.439
					396.23933											47496.961	681.15	0	0	0	0			681.15	48178.111
				19.824087	406.80263											4345.6096	3859.85	0	0	0	0			3859.85	8205.4596
					0.3855218		54.093945									118.91464	697	0	0	0	0			697	815.91464
					3.6838752		2.586817									4568.3313	1463	0	0	0	0			1463	6031.3313
	522.82218	54.054965	174.00313	56.896576	1335.6669		318.12937	4.0268621		30.462359					1588.8709	30339.129	5500	2969	0	0	0			8469	38808.129
18533.438							3.3563132	226.73174		0.1835082						18811.459	0	1282	0	0	0			1282	20093.459
	443.51741			67.139021	182.29471		444.67056	51.91256		331.04877						1590.702	1091	0	0	0	0			1091	2681.702
		723.34989		58.018012	265.09337		7391.6985	19.547262		147.8709						8707.8508	1756	706	0	0	0			2462	11169.851
			3678.9919	161.90636		35.467001	557.22985			16.790999						4450.3861	1784	847	0	0	0			2631	7081.3861
99.561992	39.512295	8.5401804	45.002358	6907.2159	142.15142	851.533	614.35266	428.78157	233.98798	2332.6796				600.03067	663.39183	15513.194	3636	2658	7974	29410	37384			43678	59191.194
					156.47902				85.954767					141.96933	306.73731	4005.5371	4079	2959	0	0	0			7038	11043.537
																0	0	0	0	0	0			0	0
																0	0	0	0	0	0			0	0
																0	9538	0	0	0	0			9538	9538
																0	0	0	0	0	0			0	0
																0	0	0	8132	0	8132			8132	8132
																0	0	0	0	0	0			0	0
																0	10607	3718	1666	0	1666			15991	15991
																0	0	0	0	0	0			0	0
																0	0	1563	0	0	0			1563	1563
																0	0	0	0	0	0			0	0
18633	1011	840	3897.9974	7271	10082	887	9414	731	2780	2940	0	0	0	742	2559	167611	70048	16702	17772	29410	47182	0	0	133932	301543
4642	85	0	407	761	50	265	2095	177	485	35	0	0	0	91	541	14069	5502	1026	1688	3277	4965			11493	25562
23275	1096	840	4304.9974	8032	10132	1152	11509	908	3265	2975	0	0	0	833	3100	181680	75550	17728	19460	32687	52147	0	0	145425	327105

Source: compiled by the author

Figure D 6.1 The I-O Database of the *SLGEM – P* Model

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Households	Exports	Government	Change in inventories
	size	← I →	← I →	← H →	← 1 →	← 1 →	← 1 →
Basic Flows	↑ CxS ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Sales Taxes	↑ CxS ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labour	↑ O ↓	V1LAB					
Capital	↑ 1 ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Other Costs	↑ 1 ↓	V1OCT					
Industry Subsidies	↑ 1 ↓	V1SUB					

I = Number of Industries
C = Number of Commodities
S = 2: Domestic, Imported
O = Number of Occupation Types
H = Number of Household Groups

Table D 6.6
Estimates of Armington Elasticities for 38 Commodities

	Commodities	Armington elasticities
1	*Teagrow*	0
2	*Rubgrow*	0
3	*Cocgrow*	0
4	*Paddy*	0
5	*Mexcrop*	2
6	*Tobacco*	0
7	*Othe_agri*	0.5
8	*Livestock*	0
9	*Firewood*	0
10	*Forestry*	0
11	*Fishing*	0
12	*Mining*	0
13	*Teapro*	0
14	*Rubpro*	0
15	*Cocopro*	0
16	*Milling*	5
17	*Foodbev*	2
18	*Textile*	2
19	*Garments*	2
20	*Wood*	2
21	*Paper*	2
22	*ChmFerti*	2
23	*Petroleum*	5
24	*RubProduct*	2
25	*NMOminpr*	2
26	*Base_metal*	2
27	*Feb_metal*	2
28	*Othe_Manu*	2
29	*Electricity*	0
30	*Construct*	0
31	*Trade*	0
32	*Hotels*	0
33	*Transport*	0
34	*Commun*	0
35	*Banking*	0
36	*Dwellings*	0
37	*Pubadmin*	0
38	*Other_serv*	0

Sources: compiled by the author based on CIE (1992).

Table D 6.7
Estimates of Expenditure Elasticities for 38 Commodities

	Commodities	Expenditure elasticities		
		Urban sector	Rural sector	Estate sector
1	*Teagrow*	-	-	-
2	*Rubgrow*	-	-	-
3	*Cocgrow*	0.36	0.62	0.63
4	*Paddy*	-	-	-
5	*Mexcrop*	0.36	0.62	0.63
6	*Tobacco*	0.36	0.62	0.63
7	*Othe_agri*	0.36	0.62	0.63
8	*Livestock*	0.36	0.62	0.63
9	*Firewood*	0.36	0.62	0.63
10	*Forestry*	0.36	0.62	0.63
11	*Fishing*	0.36	0.62	0.63
12	*Mining*	-	-	-
13	*Teapro*	0.36	0.62	0.63
14	*Rubpro*	-	-	-
15	*Cocopro*	0.36	0.62	0.63
16	*Milling*	0.36	0.62	0.63
17	*Foodbev*	0.36	0.62	0.63
18	*Textile*	0.57	1.9	2.47
19	*Garments*	0.57	1.9	2.47
20	*Wood*	2.53	2.38	0.47
21	*Paper*	2.53	2.38	0.47
22	*ChmFerti*	2.53	2.38	0.47
23	*Petroleum*	0.35	0.45	0.48
24	*RubProduct*	2.53	2.38	0.47
25	*NMOminpr*	2.53	2.38	0.47
26	*Base_metal*	-	-	-
27	*Feb_metal*	2.53	2.38	0.47
28	*Othe_Manu*	2.53	2.38	0.47
29	*Electricity*	0.35	0.45	0.48
30	*Construct*	-	-	-
31	*Trade*	0.69	0.94	1.02
32	*Hotels*	0.69	0.94	1.02
33	*Transport*	0.69	0.94	1.02
34	*Commun*	0.69	0.94	1.02
35	*Banking*	0.69	0.94	1.02
36	*Dwellings*	0.69	0.94	1.02
37	*Pubadmin*	-	-	-
38	*Other_serv*	0.69	0.94	1.02

Sources: compiled by the author based on Bandara (1989).

Table D 6.8
Commodity Level Supernumerary Expenditure within Different Household Groups

	Commodities	Supernumerary expenditure				
		ULIHH	RLIHH	EHH	UHIHH	RHIHH
1	*Teagrow*	0	0	0	0	0
2	*Rubgrow*	0	0	0	0	0
3	*Cocgrow*	95.72	180.76	149.76	55.44	36.38
4	*Paddy*	0	0	0	0	0
5	*Mexcrop*	15.88	28.30	28.64	8.52	5.83
6	*Tobacco*	13.00	17.45	48.89	10.06	3.51
7	*Othe_agri*	876.86	1387.18	1198.66	572.32	391.49
8	*Livestock*	131.32	140.27	170.76	116.12	60.77
9	*Firewood*	51.46	120.09	134.17	30.24	18.02
10	*Forestry*	0.33	1.05	0.60	0.09	0.10
11	*Fishing*	466.13	591.89	307.86	283.29	200.99
12	*Mining*	0	0	0	0	0
13	*Teapro*	72.43	114.43	1.80	26.90	26.90
14	*Rubpro*	0	0	0	0	0
15	*Cocopro*	90.21	153.02	190.01	51.49	25.11
16	*Milling*	456.34	944.72	1286.08	321.83	171.45
17	*Foodbev*	1859.39	2228.35	1437.84	1109.29	786.93
18	*Textile*	203.27	608.17	1111.04	403.64	246.20
19	*Garments*	303.76	826.10	1271.88	376.57	290.68
20	*Wood*	330.78	206.43	18.62	206.77	298.01
21	*Paper*	395.83	321.76	31.63	569.11	385.20
22	*ChmFerti*	2015.97	1891.03	205.27	1424.44	1144.26
23	*Petroleum*	80.72	86.33	111.04	190.74	185.53
24	*RubProduct*	47.17	229.31	12.94	337.47	154.16
25	*NMOminpr*	336.26	173.46	53.86	188.95	127.00
26	*Base_metal*	0	0	0	0	0
27	*Feb_metal*	115.93	383.51	44.24	1164.46	558.43
28	*Othe_Manu*	621.15	478.79	154.90	1231.89	1139.88
29	*Electricity*	167.82	76.45	10.37	219.83	121.73
30	*Construct*	0	0	0	0	0
31	*Trade*	2490.21	1706.07	806.51	1825.89	1952.96
32	*Hotels*	814.50	468.81	175.99	466.94	234.51
33	*Transport*	963.34	794.46	470.88	2534.58	510.01
34	*Commun*	88.11	63.58	60.42	445.19	281.03
35	*Banking*	393.56	1203.53	98.65	1116.74	1434.51
36	*Dwellings*	210.97	127.98	48.11	313.19	135.75
37	*Pubadmin*	0	0	0	0	0
38	*Other_serv*	685.36	742.43	562.82	1280.14	787.78

Source: compiled by the author

APPENDIX E

Table E 7.1: Base year (1995) Commodity Tariff rates

Commodity	Tariff Rate
Tea Growing	0.00%
Rubber Growing	0.00%
Coconut and Toddy	0.00%
Paddy	21.74%
Minor Export Crops	0.00%
Tobacco	28.68%
OtherAgri. Products	17.67%
Livestocks	10.09%
Firewood	2.06%
Forestry	5.10%
Fisheries	4.85%
Mining and Quarrying	2.07%
Tea Processing	10.76%
Rubber Processing	11.65%
Coconut Processing	9.78%
Milling	3.20%
Food, Beverages and Other	13.23%
Textiles	1.00%
garments	1.00%
Wood and Wood Products	12.89%
Paper and Paper Products	11.07%
Chemicals and Fertilizer	5.23%
Petroleum Industry	25.01%
Plastic and Rubber Products	18.24%
Non Metalic & Other Mineral Products	15.88%
Basic Metal Products	11.20%
Febricated Metal Products	10.34%
Other Manufacturing	10.29%
Electricity, Gas and water	0.00%
Construction	0.00%
Wholesale and Retail Trade	0.00%
Hotels and Restaurants	0.00%
Transport	21.60%
Post and Communication	0.00%
Banking Insuranceand Real Estate	0.00%
Owership of Dwellings	0.00%
Public Administration and Defence	0.00%
Other Personal Services	0.00%

Source:*SLGEM-P* database

Table E 7.2: SSA Projections of Percentage Change in Industry Effects under Simulation 3

Industry	Short Run Effects						Long Run Effects					
	Output level			Employment			Output level			Employment		
	Original value	Mean	Standard deviation	Original value	Mean	Standard deviation	Original value	Mean	Standard deviation	Original value	Mean	Standard deviation
Teagrow	1.38	1.36	0.06	2.64	2.61	0.12	-7.56	-7.56	0.07	-12.2	-12.2	0.1
Rubgrow	0.74	0.73	0.04	2.17	2.14	0.13	-3.97	-3.97	0.04	-9.46	-9.46	0.08
Cocgrow	0.32	0.32	0.03	1	0.98	0.08	-3.88	-3.88	0.05	-9.65	-9.66	0.11
Paddy	-0.16	-0.16	0.02	-0.65	-0.64	0.08	0.34	0.34	0.45	-2.53	-2.52	1
Mexcrop	0.09	0.09	0	1.8	1.78	0.1	0.04	0.04	0	-6.49	-6.49	0.03
Tobacco	1.73	1.73	0.02	11.32	11.3	0.11	3.22	3.22	0.01	4.05	4.04	0.03
Othe_agri	-0.16	-0.15	0.07	-1.5	-1.44	0.66	0.63	0.63	0.28	-3.28	-3.26	0.83
Livestock	0.29	0.29	0.01	2.59	2.59	0.12	1.12	1.12	0.18	0.33	0.33	0.73
Firewood	-0.02	-0.01	0.01	-0.1	-0.09	0.07	0.78	0.78	0.31	-2.37	-2.36	0.78
Forestry	0.25	0.25	0.02	1.02	1.01	0.08	2.07	2.07	0.36	-1.09	-1.1	0.78
Fishing	0.51	0.5	0.03	7.08	6.95	0.39	1.65	1.65	0.04	1.07	1.07	0.15
Mining	0.74	0.73	0.04	2.51	2.48	0.13	-2.44	-2.44	0.02	-7.78	-7.77	0.05
Teapro	1.58	1.57	0.06	8	7.9	0.31	-7.69	-7.69	0.07	-13.18	-13.18	0.07
Rubpro	1.03	1.02	0.04	3.92	3.88	0.15	-6.44	-6.44	0.03	-11.7	-11.7	0.04
Cocopro	1.61	1.59	0.07	3.94	3.89	0.18	-11.34	-11.33	0.41	-15.24	-15.24	0.4
Milling	-0.16	-0.16	0.02	-1.03	-1.02	0.12	0.34	0.34	0.45	-10.24	-10.24	0.38
Foodbev	-0.64	-0.61	0.12	-6.48	-6.22	1.12	-3.08	-3.09	1.99	-9.76	-9.77	1.84
Textile	1.58	1.57	0.04	4.52	4.5	0.11	7.08	7.08	0.29	1.77	1.77	0.29
Garments	1.93	1.91	0.05	5.79	5.75	0.16	2.35	2.35	0.79	-2.66	-2.66	0.76
Wood	0.26	0.25	0.03	1.53	1.51	0.19	3.43	3.42	0.6	-3.71	-3.72	0.56
Paper	-0.18	-0.2	0.87	-0.54	-0.53	2.54	2.8	2.8	0.83	-2.3	-2.3	0.79
ChmFerti	0.59	0.6	0.08	3.47	3.54	0.46	9.58	9.58	0.33	2.71	2.71	0.3
Petroleum	0.05	0.09	0.34	0.75	1.57	5.27	2.22	2.23	0.54	-9.7	-9.68	0.48
RubProduct	0.6	0.6	0.01	4.91	4.89	0.11	26.61	26.6	0.36	18.12	18.11	0.34
NMOminpr	0.9	0.91	0.11	4.78	4.81	0.6	17.69	17.75	2	10.6	10.66	1.89
Base_metal	0.36	0.35	0.59	0.36	0.35	0.59	25.44	25.47	1.07	25.44	25.47	1.07
Feb_metal	2.35	2.35	0.04	12.99	12.97	0.26	89.5	89.49	0.63	78.05	78.04	0.6
Othe_Manu	1.4	1.4	0.05	5.55	5.53	0.21	36.28	36.27	0.42	25.5	25.49	0.39
Electricity	0.41	0.4	0.01	2	1.98	0.07	3.17	3.17	0.17	-3.19	-3.18	0.14
Construct	-0.03	-0.03	0	-0.04	-0.04	0.01	7.78	7.78	0.09	5.25	5.25	0.09
Trade	2.2	2.17	0.09	6.81	6.71	0.31	5.7	5.7	0.14	-2.52	-2.53	0.15
Hotels	0.15	0.14	0.02	0.23	0.22	0.03	4.26	4.26	0.07	-0.3	-0.3	0.06
Transport	1.23	1.21	0.05	4.3	4.24	0.19	4.74	4.74	0.04	-0.8	-0.8	0.05
Commun	-0.16	-0.16	0.01	-0.16	-0.16	0.01	1.39	1.39	0.14	1.39	1.39	0.14
Banking	2.55	2.51	0.13	3.36	3.31	0.17	2.4	2.4	0.17	-0.66	-0.66	0.17
Dwellings	0	0	0	0	0	0	3.42	3.43	0.15	0	0	0
Pubadmin	0.12	0.12	0.01	0.12	0.12	0.01	3.35	3.35	0.09	3.35	3.35	0.09

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