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Assessing the Impacts of Globalization on Poverty Using Decomposition Methods

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Abstract

The objective of this study is to assess the determinants of poverty in Sri Lanka from 1977 to 2000. A general equilibrium model is developed for the Sri Lankan economy considering two sectors, two factors and two households assuming it is a small open economy. A specific factors model is used treating labor as the mobile factor. Three data sets are developed and used for calibration for the years 1977, 1994 and 2000. Models are used to assess the contribution of technological change, trade, government transfers, labor endowment and changes in tastes on poverty. Results reveal that technological change mainly explains the changes in relative and absolute poverty from 1977 to 1994. Changes in absolute poverty from 1977 to 1994 is mainly due to change in labor endowment.

Key words: General Equilibrium model, Decomposition, Double Calibration, Poverty and Sri Lanka.

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Non-Technical Summary

The objective of this study is to assess the respective roles of technology, trade and government transfers in explaining the change in poverty in Sri Lanka. A general equilibrium model, incorporating a specific-factors trade model, is used for this purpose. A stylized economy is considered with a high degree of aggregation. Model developed consists of two sectors, agriculture (the exportable sector) and rest of the economy (the importable sector). Two factors are considered; labor is treated as the mobile factor and non-labor input, i.e., capital is treated as the specific factor. Two income groups, the rich and the poor are considered. The rich household group owns capital and the poor owns labor. Government transfers, funded through import tariff, export tax and domestic tax revenues are shared between the two groups. Poor gets the transfer payments specifically designed for households.

Three consistent data sets are developed to reflect some elements of Sri Lankan economy in 1977, 1994 and 2000. The difference among the baseline equilibrium values for these years are due to differences in import tariffs and export taxes, world market prices of the products, labor endowments, changes in technology and tastes, and changes in government revenue.

Baseline equilibrium values indicate a rise in the income levels of both owners of labor and owners of capital from 1977 to1994 and from 1994 to 2000. The ratio of the incomes of the owners of capital relative to labor, an indicator of relative poverty, has however increased from 2.002 in 1977 to 2.952 in 1994 and to 3.758 in 2000. Per capita income of the labor owners, an indicator of absolute poverty, has first increased and then decreased. They are 24.719 units in 1977, 51.120 in 1994 and 44.315 units in 2000.

The general equilibrium model is calibrated to the equilibrium in years 1977, 1994 and 2000 and technological and taste parameters are obtained through this calibration process and are used to assess the impacts of technological change and changes in tastes respectively. Impacts of trade are obtained by changing import tariff, export tax and relative export price. Impacts of transfer payments are assessed using the changes in government revenue and household transfer payments. Finally impacts of changes in labor endowments are assessed.

First, model calibrated for the year 1977 is used to assess the impacts of different shocks, which are set at 1994 levels. The resulting changes in poverty measures are compared with 1994 values to evaluate relative contribution. It is found that while technological change mostly explains the changes in relative poverty, both technological change and government transfers explain the changes in absolute poverty from 1977 to 1994.

The experiments conducted using the model calibrated for 1994, with shocks as in 2000 yield different results. They indicate that the changes in relative poverty is due to technological change, yet the changes in absolute poverty is due to changes in endowment from 1994 to 2000.

The changes in relative poverty as modeled in this study are due to relative changes in returns to labor and capital. The changes in absolute poverty are due to the changes in return to labor and household transfer payments.

Technological change is such that sector specific technological progress is very prominent especially in rest of the economy according to the parameter values, both from 1977 to 1994 and from 1994 to 2000. This has increased the return to specific factor used in the sectors, i.e., income of the capital owners, leading to a rise in relative poverty. Labor usage in the rest is

rising over the years, yet a reduction in share of labor in the rest is observed. This too shows a rising return to the specific factor. Technological change from 1994 to 2000 too has the same impacts as from 1977 to 1994.

Technological change also improved the wage rate. This created a higher income for the labor owners. Of the changes considered—this is the only factor contributed to increase in wage rate. All other factors either reduced wage rate or did not make any changes (tastes and transfers).

Transfers have increased the per capita income. A significant rise in both government revenue and household transfer payments from 1977 to 1994 is observed. Increased government revenue is considered to be obtained through a high domestic rate. Transfers to households and high government revenue both worked in the same direction and increased per capita income. With such changes, no impact is observed on the production side. Increase in labor endowment decreased the wage rates and hence income of the labor owners from 1994 to 2000. This can explain the reduction in per capita income.

1. INTRODUCTION

Many countries in the world consider poverty as a major obstacle for development. To alleviate poverty, government transfer programs are conducted and to achieve growth objectives technological transfers are encouraged and trade is enhanced. Identifying the roles of technology, trade and government transfers in explaining absolute and relative poverty is of concern among many policy makers and economists.

This paper decomposes the change in absolute and relative poverty into three components: technology, trade and government transfers. It conducts an ex-post decomposition analysis using a general equilibrium model double calibrated to the Sri Lankan economy in 1977, 1994 and 2000. It concludes that from 1977 to 1994 increase in relative poverty in Sri Lanka is mainly explained by the technological change, and decrease in absolute poverty is explained by technological change and government transfers. From 1994 to 2000, change in relative poverty is due to technological change, but the change in absolute poverty is due to changes in labor endowment.

François (1998) argued that the neoclassical, general equilibrium model (more specifically Hecksher-Ohlin model) is a useful framework for discussing and evaluating the impact of international trade and wages. The majority opinion regarding income distribution is that technology rather than trade influenced it. Leamer (1998 and 2000) criticized this view and argued that recent changes in the distribution of income primarily reflect trade rather than technology. However, according to Krugman (2000) the factor bias of technological change is not immaterial, except in the case where such change takes place in a small open economy.
Few studies have been conducted recently to assess the impact of government transfers/spending on poverty. According to Chia *et al.* (1992), given a budget neutral targeting program, it is impossible to completely eliminate poverty when general equilibrium effects are taken into account. Small transfers generally have a greater relative effect than larger targeting programs. Colatei and Round (2000) analyzed a range of revenue-neutral redistributive policies (increasing income taxes, domestic commodity taxes, and import duties) on poverty in Ghana. Results indicate that structural adjustment may not be benefiting to all segments of the society.

Abrego and Whalley (2000) developed a technique for performing ex-post decomposition analysis using general equilibrium models. They capture separate influences of trade, technology and demographics underlying changes in wage inequality. This technique can be used to decompose poverty into different components.

This paper focuses on factors contributed to changes in poverty in Sri Lanka. Some argue that changes in poverty in Sri Lanka are effected by processes of globalization such as increased trade and technological change while others argue that it is linked to changes in domestic policies such as government transfer programs. The purpose of this study is to assess the roles of technology, trade and government transfers in explaining absolute and relative poverty in Sri Lanka.

The paper is organized as follows. The next section presents a background to the study showing policy framework in Sri Lanka since 1977, trade pattern and changes in poverty. It is followed by a section that presents the structure of the general equilibrium model, which is developed to assess the impacts of technological change, trade and transfers on poverty. Data and calibration procedure are discussed in the next section. The results are discussed next and the paper ends with some concluding remarks.

2. BACKGROUND

2.1 Policy Framework

A series of economic policy measures aimed at creating an economy driven by market forces was introduced to Sri Lanka in 1977. Prior to this, the trade was regulated by a series of complex tariff and non-tariff measures. The import tariff structure had more than 19 major tariff bands and tariff rates ranging from 10% to 500%. Export licensing requirements and export duties played a prominent role. Since 1977 changes were introduced to reduce the complexity of trade regulations.

Trade liberalization launched in 1977, apart from relaxing export, import and exchange controls also led to a gradual reduction of tariffs on both exports and imports. In 1978 six bands of tariff rates of 0-5-12.5-25-50-100 per cent were introduced with the higher rates designed to protect domestic agriculture and industry. A four band tariff structure was introduced in 1987 with a maximum of 60 per cent and a minimum of 5 per cent for tariff free imports such as fertilizer, books and dried fish. Import duties were reduced further under four bands of duties with a maximum of 50 per cent in 1993; this was reduced to 45 per cent under a 4 band scheme of 10, 20, 35 and 45 per cent in 1994, and to 35 per cent in 1995 under a three band scheme of 35, 20 and 10 per cent (Kelegama, 1996).

Export duties on all minor agricultural commodities and marine products were abolished in 1988. Export duties on tea, rubber and coconut were removed in 1992. By 1994 export licensing was limited to four items with the objective of environmental protection and preservation of antiques. Successive governments have placed high priority on improving the quality of life in terms of nutrition, health, education, housing and public amenities. Free public health services, and free education facilities up to the tertiary level have been provided. Social welfare programs aimed at improving nutritional standards covered the entire population for many years, and since 1977 these programs have been targeted to serve the most vulnerable segments of the society (Table 1).

Table 1: Government social expenditure in selected years (as a percentage of GDP)

Item	1990	1995	1999
Education	3.0	2.8	2.6
Health	1.5	1.8	1.4
Transfers to households and other sectors	4.7	4.5	3.3
Subsidies/transfers	1.7	2.0	1.6

Source: Central Bank of Sri Lanka

2.2 Trade Pattern

The trade sector became a dynamic force in the economy of Sri Lanka, encouraging the growth of income and employment opportunities since 1977. The export structure became diversified

and industrial exports led by textile and garment became the largest contributor to export earnings. The composition of imports also changed drastically from consumer goods to growth oriented intermediate and investment goods. It's imports and exports in 1996 accounted for 68% of GDP compared to 35% in 1977. Table 2 shows the changes in price indices, trade volumes and trade values for the period 1975-2000.

Table 2: Trade Indices 1975-2000 (1990=100)

Year	Prices		Volume		Value	
	Exports	Imports	Exports	Imports	Exports	Imports
1975	9.5	6.6	65.2	29.2	6.4	5.0
1980	41.6	29.3	60.3	78.5	23.8	30.4
1985	60.4	46.8	74.5	88.6	45.0	41.4
1990	100.0	100.0	100.0	100.0	100.0	100.0
1995	174.2	140.2	140.9	176.7	245.5	247.8
2000	265.8	199.1	198.7	244.7	527.8	487.5

Source: Central Bank of Sri Lanka

2.3 Poverty and Income Distribution

According to evidences from household-income and expenditure and consumer surveys, absolute poverty in Sri Lanka has declined from 1985/86 to 1990/91 in all three sectors, *i.e.,* urban, rural and estate and increased in 1995/96 (Table 3).

Table 3: Poverty in Sri Lanka by Sector measured in Head Count Indices

Measure	1978/79*	1985/86**	1990/91**	1995/96**
Urban	24.4	18.4	15.0	14.7
Rural	23.8	35.6	22.0	27.0
Estate	8.9	20.5	12.4	24.9
Sri Lanka		30.9	19.9	25.2

Reference poverty line is *Rs. 70.00 and ** Rs. 791.67 per person per month

Source: Department of Census and Statistics; World Bank Sri Lanka Poverty Assessment

The economic liberalization policies generated a wide range of new economic activities, resulting in an accumulation of profits in the upper income deciles in the early years of liberalization. The expansion in economic activities resulted in a higher rate of labor absorption and hence a rise in the wage level. However, domestic wage increase could not keep pace with

the much higher earnings in the form of profits. As a result, the relative share of the lower income deciles decreased showing an increase in income inequality since 1977 (Table 2).

Table 4: Income distribution (percentage of income received by spending units)

Income group	1978/79	1981/82	1986/87	1996/97
Poorest 40%	16.06	15.25	14.14	15.30
Middle 40%	34.07	32.79	33.56	34.80
Richest 20%	49.87	51.96	52.30	49.90
Gini ratio	0.43	0.45	0.46	0.43

Source: Consumer Finance and Socio-economic Survey series of the Central Bank of Sri Lanka.

3. STRUCTURE OF THE GENERAL EQUILIBRIUM MODEL

In order to achieve the stated objectives, a general equilibrium model is used as the analytical model. More specifically, the Ricardo-Viner model with two sectors (agriculture and rest of the economy) and two factors (labor and capital which includes all non-labor factors) is used in the study. Capital is considered as the specific factor. Labor is mobile between sectors. There are two types of consumers as the rich and the poor. The poor own labor and obtain income from wages and from government transfers. The rich own the capital and receive income from capital rents.

There are many reasons that made us to construct the stylized economy in the above manner. Firstly, the usability of the same theoretical structure as in many other studies that have analyzed similar policy issues. Secondly, as the data, on which numerical specifications are based come in a form consistent with two factor models. Finally, due to the partition between goods and factors that can be used in applied models to simplify computations and significantly reduce the costs of repeated equilibrium solutions (Shoven and Whalley, 1992, pp. 92).

Characteristic features of the Ricardo-Viner model are due to factor specificity. The model is an appropriate tool to analyze the structure in Sri Lanka as it can capture the asset specificity in the short run. This model predicts that "a relative price increase of a good benefits the specific factor used in that industry, reduces the real income of the other specific factor, and has an ambiguous effect on the mobile factor". The economic intuition behind the impacts of commodity price

changes on the prices of the specific factors is straightforward. A rise in product prices in one sector induces firms in that sector to wish to produce. This leads to a rising demand for specific factors used in that sector. As additional supplies of specific factors are available, the factor experiences a substantial rise in its real price. In effect, owners of specific factors gain both from the influx of labor and from receiving a share of the higher price. Although the returns to the specific factors are unambiguously related to commodity price changes, such is not the case for the return to labor, (the mobile factor). Whether labor loses or gains from an increase in output price is ambiguous.

The model developed in this study consists of six blocks, *i.e*., production, consumption, equilibrium conditions, price linkages, government revenue and poverty measures. The following section describes the structure of the model.

3.1 Production

It is considered that production functions posses Cobb-Douglas production technology as given in equation (1). Y denotes production and L denotes labor. Subscript *i* indicates the two sectors; agriculture and rest of the economy.

$$Y_i = A_i \cdot L_i^{\alpha i} \qquad (1)$$

Parameter A_i incorporates the specific factor used in the i^{th} industry and the scale parameter of the respective industry. The above production function implies that the entire available stock of the specific factor is used to produce commodity *Y*. It is also assumed that all factors of production are fully employed. The return to labor (the wage rate) denoted as *w*, is the same in both sectors by virtue of the free mobility of workers (Markusen *et al*., 1995).

Demand for labor can be derived from the above production function assuming profit maximization as the objective of the producers. The factor markets are considered to be perfectly competitive, implying that firms pay each factor the value of its marginal product.

$$Max\ \Pi_i = P_i \cdot Y_i - W_L \cdot L_i \qquad (2)$$

The first order condition of the above maximization problem is,

$$\partial \Pi_i / \partial L_i = P_i \cdot \partial Y_i / \partial L_i - W_L = 0 \quad (3)$$

Where, P_i denotes output price and W_L denotes wage rate. Expression (3) is equivalent to the following expression showing that the exponent of L in (1) is labor share as the Cobb-Douglas function is used.

$$\alpha i = \frac{W_L \cdot L_i}{P_i \cdot Y_i} \quad (4)$$

3.2 Consumption

Both labor owners and capital owners derive utility by consuming agricultural product and the products produced by the rest of the economy. The consumer demand function (5) is derived by assuming utility maximization as the behavioral assumption of the consumers.

$$Max\, U_t = D_{1t}^{\beta} \cdot D_{2t}^{1-\beta} \quad s.t. \quad I_t = P_1 \cdot (1+vat) \cdot D_{1t} + P_2 \cdot (1+vat) \cdot D_{2t} \quad (5)$$

Where, *U* is the utility, *D* is demand and *I* is income. Consumer prices are different from producer prices due to domestic taxes (*vat*). Subscripts *i* and *t* show the sector and type of consumer, (labor owners or capital owners) respectively. The solutions to above problem are given by equations (6) and (7),

$$D_{1t} = \frac{\beta \cdot I_t}{P_1 \cdot (1+vat)} \quad (6)$$

$$D_{2t} = \frac{(1-\beta) \cdot I_t}{P_2 \cdot (1+vat)} \quad (7)$$

Income of labor owners comprises of, wages, a part of government revenue *(GR)* and transfers to households (*HHTRA*) while that of capital owners include returns on the fixed factors *(K)* and rest of the government revenue[1].

$$I_L = W_L \cdot L + HHTRA + 0.5(GR - HHTRA) \quad (8)$$

[1] Note that this apportioning of government revenue between the two income groups is bit arbitrary.

$$I_K = K_1 + K_2 + 0.5(GR - HHTRA) \quad (9)$$

3.3 Equilibrium conditions

Factor market clearing conditions are given by equation (10).

$$L = L_1 + L_2 \quad (10)$$

Good market clearing conditions are given by equation(11).

$$Y_i = D_{iL} + D_{iK} + EXP_i \quad (11)$$

Where, *EXP* is net exports. *EXP* will carry a positive sign for exports and a negative sign for imports. Since sector 1 has net exports EXP_1 is positive and since sector 2 has net imports EXP_2 is negative. Assuming perfectly competitive markets, zero profit conditions determine the return to fixed factors in each sector as in equation (12).

$$P_i \cdot Y_i = W_L \cdot L_i + K_i \quad (12)$$

Where, K is the return to fixed factors. At the equilibrium, trade balances and trade balance condition is given by,

$$P_1^w \cdot EXP_1 = P_2^w \cdot (-EXP_2) \quad (13)$$

Where, P^w is the world market price. Note that in the above expression, negative of EXP_2 is used to show imports of sector 2.

3.4 Price linkage equations

Assuming a small open economy, markets are linked with the rest of the world as follows.

$$P_1^d = P_1^w(1 + tariff) \quad (14)$$

$$P_2^d = P_2^w(1 - tax) \quad (15)$$

Where, P^d is the domestic price. Import tariff rate and export tax rates are denoted respectively by *tariff* and *tax.* Both tariff and tax rates are included as positive values. Domestic price rises with an import tariff and falls with an export tax. Therefore, a negative sign is used in equation (15).

3.5 Government Revenue

Government earns revenue from import tariffs, export taxes, and domestic taxes.

$$GR = P_2^w \cdot EXP_2 \cdot tax - P_1^w \cdot EXP_1 \cdot tariff + P_1 \cdot D_1 \cdot \frac{vat}{lap} + P_2 \cdot D_2 \cdot \frac{vat}{lap} \qquad (16)$$

Where, $lap = \dfrac{\sum_{i=1}^{i=2} Pd_i^1 \cdot Y_i^0}{\sum_{i=1}^{i=2} Pd_i^0 \cdot Y_i^0}$

Superscript 0 indicates the first period and superscript 1 indicates the second period.
In the above equation too, negative EXP_1 s are used to show imports in sector 1.

3.6 Poverty Measures

Poverty measures can be obtained by using the income levels of the labor owners and the capital owners. Two indices, Per capita income (17) and Ratio of Income (18) are used to measure the impact of different policies on the relative and absolute poverty. Their definitions are as follows.

i. Per capita income of labor owners (PCI): This is obtained by dividing income of labor owners by the number of laborers. Higher the per capita income, lower the absolute poverty.

$$PCI = \frac{I_L}{L \cdot lap} \qquad (17)$$

ii. Ratio: This is obtained by dividing income of capital owners by income of labor owners. A higher ratio implies a higher disparity between the two groups, and is an indication of high incidence of relative poverty.

$$Ratio = \frac{I_K}{I_L} \qquad (18)$$

Endogenous variables of the model are the production, demand, domestic price, trade, labor usage, utility levels, government revenue, income levels and poverty measures. Impact on poverty due to changes in exogenous variables of the model such as labor endowment, world market price, tariff rate and tax rate can be evaluated using this model.

4. DATA AND CALIBRATION

4.1 National Income Data: Changes since 1977

The experiments are conducted to assess the roles of different factors in explaining changes in poverty from 1977 to 2000. The selection of years, 1977 and 2000 are to represent the status of the economy before and after the period during which trade liberalization took place. Input-output table is available for 1994 and is also a suitable period to be included as a middle year in the liberalization process. Throughout this period changes in world market prices, import tariff rates and export tax rates, labor endowments, government revenues, changes in technology and tastes are observed to have occurred.

In order to conduct experiments, it is necessary to calibrate models for the years under consideration. Calibration requires the construction of equilibrium data sets depicting base values of endogenous and exogenous variables. These data sets should also meet the equilibrium conditions for the general equilibrium model. For the model used in the study, restrictions which, need to be satisfied are,

(i) demand equals supply for all commodities (equation 11)
(ii) non-positive profits are generated in all industries (equation 12)
(iii) all consumers have demands that satisfy their budget constraint (equations 6 and 7)
(iv) the economy is in external sector balance (equation 13)

As the model is developed for two sectors and two factors, a dis-aggregation in national data is done to reflect production, consumption and trade levels of agricultural sector and rest of the economy. More specifically, base data for the following variables requires to be calibrated.

(i) Production levels, consumption levels (or trade levels), and domestic prices (or world market prices) of agricultural goods and goods produced by the rest of the economy.
(ii) Labor usage in the agricultural sector and in the rest of the economy
(iii) Average wage rate
(iv) Labor endowment
(v) Government revenue
(vi) Import tariff rate, export tax rate and domestic tax rate

Most of the variables listed above cannot be directly observed. Some related variables as presented in national income accounts are presented in Table 5. This set of data has to be transformed into constant prices to reflect the real changes in monetary values. GDP and contribution of GDP by agriculture and rest are obtained directly from National Accounts as such values in constant prices in 1996 are also given. Trade values, export and import price indices and nominal wage indices in 1977, 1994 and 2000 are converted into real indices using GDP deflator. Import price indices are set as one and relative export price indices are obtained. Using the percentage wage bill as given by input-output table for 1994, employment and value of production in 1994 and wage rate for 1994 is obtained. Real wage rate indices are used to obtain real wage rates for 1977 and 2000. Table 6 shows data sets in real terms.

Table 5: Comparison of 1977, 1994 and 2000 (market prices and nominal indices)

Variable	Units	Year		
		1997	**1994**	**2000**
GDP	Billion Rs.	34.68	523.30	1125.25
Agric. production[2]	Billion Rs.	10.64	124.37	218.41
Agric. net exports[3]	Billion Rs.	2.62	16.00	33.31
Tariff rate[4]	%	8.62	9.6	4.5
Tax rate[5]	%	9.34	0.0	0.0
Wage bill[6]	%	n.a.	0.20	n.a.
Agric export price	Index	18.1	151.7	265.8
Rest import price	Index	7.3	121	199.1
Nominal Wage Rate[7]	Index	72.15	685.65	999.95
Intermediate input usage	Billion Rs.	2.65	119.97	287.19
Intermediate inputs in agriculture	Billion Rs.	0.05	3.10	6.06
Total Employment	‘000	4647	5281	6343
Employment in agriculture	‘000	2415	2085	2265
Transfers to household	Billion Rs.	0.19	28.27	41.61
Government revenue	Billion Rs.	6.69	118.76	221.32
GDP deflator	Index	12.83	82.29	126.28

Table 6: Comparison 1977, 1994 and 2000 (in 1996 constant prices)

Variable	Units	Year		
		1977	**1994**	**2000**
GDP	Billion Rs.	270.34	653.92	891.08
Agric production	Billion Rs.	82.96	151.14	172.96
Agric.net exports	Billion Rs.	20.42	19.44	26.38
Agric export price	Index	141.08	184.35	210.48
Rest import price	Index	56.90	147.04	157.67
Wage rate	Index	562.35	833.21	791.85
Intermediate input usage	Billion Rs.	20.64	145.79	227.43
Intermediate inputs in agriculture	Billion Rs.	0.40	3.76	4.80
Transfers to household	Billion Rs.	1.54	34.36	32.95
Government revenue	Billion Rs.	52.11	144.31	175.26
Relative wage rate	Billon Rs /Unit	18.98	28.12	26.73
Relative export price	Billon Rs /Unit	2.48	1.25	1.33

It was necessary to make some important assumptions when constructing required base values using the data presented in table 6. GDP was considered as depicting the sum of the value added in each sector. Gross value of production is assumed as the sum of value added and the value of

[2] Includes the production category “agriculture, forestry and fishing” in national accounts.
[3] Agricultural exports net of “food, beverages and tobacco” imports
[4] Import tariff revenue divided by value of imports
[5] Export tax revenue divided by value of exports
[6] Percentage wage bill for 1994 was found from the Input-output table, by dividing wages paid by value of total output and by multiplying by 100.
[7] Nominal wage rate for observed values

intermediate inputs used. Fertilizer is considered as the only intermediate input used in agricultural sector. Textile and clothing, chemicals, and petroleum are considered as the intermediate inputs used in the rest of the economy. Value added is divided by domestic price and intermediate inputs are divided by their world prices and summed up to obtain quantity of gross production in each sector. Value of net exports of agricultural products is obtained by deducting value of food imports by total value of agricultural exports. It is considered same as the value of imports by the rest of the economy to retain the trade balance. Values of imports/exports are divided by the world price levels to obtain the quantities traded. Quantities traded and quantities produced are used to obtain quantities consumed. Number of workers in the agricultural sector is obtained from "employment in agriculture, hunting and forestry". This is deducted from total employment to obtain the number of workers in rest of the economy.

4.2 Calibration and parameters

Production functions and utility functions are considered as of Cobb-Douglas type and hence the base values can determine all parameters of the model. Production side parameters include shares of labor and scale parameters. Consumption side parameters include only consumption shares. Their definitions are as follows,

(i) Share of labor

Share of labor is obtained by multiplying wage rate by employment in the sector and dividing by gross value of production in that sector (equation 4).

(ii) Scale parameter

The above is obtained using production, labor usage and share of labor (equation 1).

(iii) Consumption shares

Consumption share of agricultural products by both groups is obtained by dividing value of consumption of agricultural goods by total consumption expenditure assuming both consumer groups have the same taste.

Table 7 shows parameters for three periods, obtained using equilibrium data sets. It is clear that over the years the values of scale parameter have increased. This indicates that there is a sector

specific technological progress in both sectors. From 1977 to 1994 and from 1994 to 2000 this progress is particularly significant in the rest of the economy compared to that of agricultural sector. Share of labor has been declining in both sectors over the years, showing that the technology becomes more and more labor saving. It should be noted that employment in agriculture has declined from 1977 to 1994 and it has increased from 1994 to 2000. Employment in the rest of the economy has been rising over the years.

Table 7: Parameters of the models

	1977		1994		2000	
	Agriculture	**Rest**	**Agriculture**	**Rest**	**Agriculture**	**Rest**
Scale	22.85	163.90	93.56	496.44	100.56	774.41
Share of labor	0.549	0.202	0.379	0.140	0.341	0.115
Consumption share	0.219	0.781	0.170	0.830	0.134	0.866

Taste parameters reflect the expenditure share of each good in consumption. Over the years proportion of expenditure on agricultural goods has been declining, indicating a shift in tastes and preferences of the consumers towards non-agricultural goods.

It is clear from the above discussion that technology parameters and tastes parameters are different from year to year. Calibration to multiple years consists of choosing values for the model parameters such that the model gives equilibrium solutions consistent with data in all periods. As we consider a small open economy in this study and as goods are treated as homogenous, the demand and production side of the model are separable (Abrego and Whalley, 2000). Following section shows how parameters are obtained separately for production side and consumption side.

Production functions used in all three periods are of the Cobb-Douglas form. Hence, elasticity of substitution is equal to one in all periods. The parameters in the production functions are scale (A) and share of labor (α). Changes in scale represent sector specific (Hicks-neutral) technical change, while changes in share of labor represent factor-specific (factor-biased) technological change.

The requirement that these parameters are consistent with the model equilibrium conditions in each time period implies that the values chosen for them must ensure that respective equations for production function (1) and factor demand functions (4) are satisfied. It is allowed for the technical change to be both sector specific and factor-specific, allowing scale parameters and labor share parameters to change over time. This allows exact identification of parameter values from model equilibrium values.

One could restrict the labor share parameters to be equal across time periods. With such a restriction, only Hicks neutral technological change is allowed. Alternatively, one could restrict the scale parameter to be equal across time periods, allowing only factor-specific technological change to be present. Such restrictions will lead to inexact calibration of the models to different time periods. This study conducts only exact calibration procedures.

4.3 Decomposition Experiments

Following experiments are conducted to decompose the poverty measures into technology, trade and transfer components. During the calibration procedures, other factors which affect relative and absolute poverty over time, such as changes in labor endowment and taste parameters are captured. These also enter the decomposition analysis and results.

(i) Technology shock:
Technological shocks are captured through changes in scale parameters and share parameters.

(ii) Trade shock:
Trade shocks are captured through changes in relative world market price for exportable products, import tariff rates and export tax rates.

(iii) Transfer shock:
Transfer shock is captured through government revenue and transfers to households

(iv) Taste shock:

Taste shock is captured through changes in consumption shares[8].

(v) Endowment shock:

Endowment shock is captured through changes in employment.

To analyze the contribution to relative and absolute poverty by each of these components, the equilibrium of year 1977 is taken as the base model solution. The model is then solved by considering one shock at a time, setting the value of shock at 1994 value. Considering all the shocks together as consistent with the equilibrium in year 1994, calculations are done of the portions of the total change in poverty measures attributable to each component. The same procedure is followed considering 1994 as the base equilibrium and shocking with 2000 values. This allows decomposition of poverty measures from 1994 to 2000. Table 8 shows the levels of shocks as compared to 1977 values.

Table 8: Experiments: Levels of shocks

Shock	Parameter/variable	1977	1994	2000
Technology	Scale for agriculture	22.85	93.56	100.56
	Scale for rest	163.90	496.44	774.41
	Share of Labor in agriculture	0.202	0.140	0.115
	Share of Labor in rest	0.549	0.379	0.341
Trade	Relative export price	2.48	1.25	1.33
	Import tariff rate	8.62	9.6	4.5
	Export tax rate	9.34	0.00	0.00
Transfers	Government revenue	52.11	144.31	175.26
	Transfers to households	1.54	34.36	32.95
Labor endowment	Total employment	4.647	5.281	6.343
Taste	Share of agriculture	0.219	0.170	0.134
	Share of rest	0.781	0.830	0.866

5. RESULTS AND DISCUSSION

Base values used in the analysis for different years are presented in Table 9. The changes in these base values under different scenarios are presented in the following sections.

[8] This will not however affect production side.

Table 9: Baseline equilibrium values

Variable	Year		
	1977	1994	2000
Production of agricultural goods	37.0710	123.773	133.119
Production of rest	192.766	583.939	910.376
Wage	18.9470	28.103	26.802
Labor usage of agricultural goods	2.415	2.0930	2.261
Labor usage of rest	2.232	3.1880	4.082
Demand by labor owners of agricultural goods	9.618	27.351	23.843
Demand by labor owners of rest	70.987	152.751	196.840
Demand by capital owners of agricultural goods	19.255	80.729	89.606
Demand by capital owners of rest	142.701	450.862	739.798
Utility of labor owners	45.821	114.023	148.142
Utility of capital owners	91.729	336.551	557.526
Income of labor owners	114.876	237.746	274.110
Income of capital owners	229.956	701.736	1030.207
Welfare	137.550	450.574	705.868
Price of agricultural goods	2.248	1.254	1.335
Price of rest	1.086	1.096	1.045
VAT	0.164	0.179	0.154
Exports of agricultural goods	8.198	15.693	19.672
Exports of rest	-20.327	-19.674	-26.262
Returns to capital of agricultural goods	37.583	96.363	117.114
Return to capital of rest	167.087	550.397	841.938

5.1 Trade shock

We consider trade shock as a composite shock, which is effected by three different policy variables, i.e., relative export price, import tariff and export taxes (table 8).

(a) From 1977 to 1994

The first experiment is to apply trade shock to 1977 equilibrium. The shock incorporates a decrease in relative export price, a decrease in export taxes and an increase in import tariffs. A decrease in per capita income and wage rate and an increase in ratio are observed when trade shock is applied at 1994 levels. These results indicate an increase in relative and absolute poverty (Table 10). From year 1977 to 1994, it is observed that relative poverty is increased while absolute poverty is in decrease. The results of the decomposition experiment indicate that 46.21 per cent of the increase in relative poverty is explained by trade shock. However, neither the changes in absolute poverty, nor the changes in wage rates can be explained by the trade shock, as wage rate determine the absolute poverty level.

Table 10: Impacts of different shocks on poverty and wage (Base year 1977)

Shock	Ratio	PCI	Wage
Base	2.002	24.719	18.947
Trade	2.441	22.33	13.892
	(46.21)	(-9.05)	(-55.21)
Endowment	1.973	22.697	17.621
	(-3.05)	(-7.66)	(-14.48)
Taste	2.002	24.716	18.947
	(0.00)	(-0.01)	(0.00)
Transfers	1.464	38.166	18.947
	(-56.63)	(50.93)	(0.00)
Technology	n.a.	n.a.	n.a.
	(137.37)	(65.90)	(167.34)
Compound w/o technology	1.647	33.722	12.781
	(-37.37)	(34.10)	(-67.34)
All	2.952	51.12	28.103
	(100.00)	(100.00)	(100.00)

Figures in parenthesis are the percentage contribution.

Table 11 shows detailed results of the trade shock experiment. The trade shock has decreased domestic price of agricultural goods and has marginally increased the prices of the goods in the rest of the economy. As a result, a drop in production of agricultural goods and a rise in the production of rest of the economy are observed. It causes to attract labor into the rest of the economy from agricultural sector. These changes made the economy a net importer of agricultural goods and a net exporter of products from the rest of the economy. Wage rate declines, lowering income of labor owners. As the returns to capital i.e., the specific factors of the agricultural sector decreases significantly, capital owners' income drops. Theses changes have increased the wellbeing of capital owners and decreased that of labor owners (Table 12),

Table 11: Impacts on other variables (base year 1977)

Variable	Year		Trade	Labor	Taste	Transfers	Compounds
	1977	1994					
Production of agricultural goods	37.0710	123.773	26.570	40.495	37.071	37.071	29.408
Production of rest	192.766	583.939	208.993	196.340	192.766	192.766	213.450
Labour usage of agricultural goods	2.415	2.0930	1.316	2.836	2.415	2.415	1.584
Labour usage of rest	2.232	3.1880	3.331	2.445	2.232	2.232	3.697
Demand by labour owners of agricultural goods	9.618	27.974	13.553	10.123	7.536	11.718	14.777
Demand by labour owners of rest	70.987	156.231	55.288	74.711	76.147	86.485	82.529
Demand by capital owners of agricultural goods	19.255	82.569	33.088	19.973	15.087	17.153	24.337
Demand by capital owners of rest	142.701	461.135	134.976	147.407	152.441	126.595	135.918
Utility of labour owners	45.821	116.621	40.636	48.225	51.391	55.826	61.605
Utility of capital owners	91.729	344.220	99.206	95.150	102.879	81.716	101.458
Income of labour owners	114.870	237.746	91.382	119.879	114.870	177.380	156.832
Income of capital owners	229.956	701.736	223.095	236.524	229.956	259.646	258.287
Price of agricultural goods	2.248	1.254	1.254	2.248	2.248	2.248	1.254
Price of rest	1.086	1.096	1.096	1.086	1.086	1.086	1.096
VAT	0.164	0.152	0.178	0.154	0.153	0.475	0.439
Exports of agricultural goods	8.198	13.230	-20.071	10.399	14.448	8.200	9.706
Exports of rest	-20.327	-33.427	18.729	-25.778	-35.819	-20.314	-4.998
Return to capital of agricultural goods	37.583	96.363	15.023	41.054	37.583	37.583	16.628
	167.087	550.397	182.787	170.185	167.087	167.087	186.685
Return to capital of rest	1.000	0.881	0.881	1.000	1.000	1.000	0.881
LAP	24.719	51.120	22.330	22.697	24.719	38.166	33.732
PCI							

Table 12: Impacts of different shocks on equivalent variation (base year 1977)

Shock	Labor owners	Capital owners	Both groups
Trade	-13.000	18.745	5.745
Endowment	6.027	8.576	14.603
Taste	13.963	27.953	41.916
Transfers	25.079	-25.100	-0.021
Compound w/o technology	39.568	24.389	63.957
All	177.487	632.972	810.459

The contribution of different types of trade policy variables on poverty measures is presented in Appendix (Table A.1). Ratio increases and wage rate and per capita income decrease are observed only when relative export price is changed to 1994 level. Changing import tariff only to 1994 level causes increases in the ratio, per capita income and wage rate. A change in export tax to 1994 level causes a decrease in the ratio with increases in per-capita income and wage rate.

It is clear that the impacts of relative export price and export tax work in opposite directions. Drop in export tax rate is very small when compared with the rise in relative export price and therefore the impact of relative export price effect dominates. These were incorporated in the experiment and it is true in actual case too. Impact of an increase in import tariff rate is similar to a decrease in export tax rate as far as wage rate is concerned. Therefore, impacts of import tariff on per capita income and wages are same as that of a decrease in export tax rate. This impact too is rather small and hence relative export price effect dominates.

(b) From 1994 to 2000

From 1994 to 2000, a slight rise in relative export price and a reduction in import price are observed. Import tariffs declines and export taxes remain the same. When these shocks are applied, the solution becomes infeasible. In order to understand the impact of trade shock as the residual, except for trade shocks, all the other shocks are applied. These changes lead to a reduction in ratio and a rise in per capita income and wage rate (Table 13). However, from 1994 to 2000 a rise in ratio and a reduction in per capita income and wage rates are observed and hence decomposition experiment concludes that trade cannot explain the changes in poverty from 1994 to 2000. Detailed impacts are presented in Table 14 and welfare impacts are presented in Table 15.

Table 13: Impacts of different shocks on poverty and wage (base year 1994)

Shock	Ratio	PCI	Wage
Base	2.952	45.019	28.103
Compound w/o trade	3.882	43.285	26.870
	(115.38)	(246.31)	(94.77)
Trade	n.a.	n.a.	n.a.
	(-15.38)	(-146.31)	(94.77)
Endowment	2.950	38.605	24.520
	(-0.25)	(911.22)	(275.40)
Transfers	2.843	47.818	28.103
	(-13.52)	(-397.59)	(0.00)
Technology	4.042	48.021	31.102
	(135.24)	(-426.42)	(-230.51)
Compound w/o taste	3.758	44.315	26.802
	(100)	(256.25)	(100)
Taste	n.a.	n.a.	n.a.
	(0.00)	(-156.25)	(0.00)
All	3.758	44.315	26.802
	(100)	(100)	(100)

Figures in parenthesis are the percentage contribution

Table 14: Impacts on other variables (base year 1994)

Variable	Year		Compound w/o trade	Endowment	Technology	Transfers	Compound w/o taste
	1994	2000					
Production of agricultural goods	123.773	133.119	128.692	134.517	119.311	123.773	133.119
Production of rest	583.939	910.376	915.729	597.050	898.487	583.939	910.376
Labour usage of agricultural goods	2.0930	2.261	2.048	2.607	1.640	2.093	2.261
Labour usage of rest	3.1880	4.082	4.295	3.736	3.641	3.188	4.082
Demand by labour owners of agricultural goods	27.351	23.936	25.518	28.343	30.395	28.124	30.319
Demand by labour owners of rest	152.751	197.622	188.642	158.292	169.753	157.068	189.110
Demand by capital owners of agricultural goods	80.729	89.961	99.054	83.625	122.863	79.958	113.951
Demand by capital owners of rest	450.862	742.736	732.262	467.034	686.174	446.552	710.745
Utility of labour owners	114.023	148.931	114.285	118.159	126.714	117.245	138.537
Utility of capital owners	336.551	559.740	560.077	348.624	512.203	333.334	520.673
Income of labour owners	237.746	274.110	274.541	244.862	253.587	252.516	274.110
Income of capital owners	701.736	1030.207	1065.700	722.458	1025.045	717.916	1030.207
Price of agricultural goods	1.254	1.335	1.254	1.254	1.254	1.254	1.335
Price of rest	1.096	1.045	1.096	1.096	1.096	1.096	1.045
VAT	0.179	0.149	0.179	0.171	0.131	0.218	0.151
Exports of agricultural goods	15.693	19.222	4.121	22.549	-33.948	15.691	-11.151
Exports of rest	-19.674	-29.981	-5.175	-28.276	42.560	-19.680	10.521
Return to capital of agricultural goods	96.363	117.114	106.324	104.728	98.573	96.363	117.114
	550.397	841.938	808.221	562.755	871.497	550.397	841.938
Return to capital of rest	1.000	0.975	1.000	1.000	1.000	1.000	0.975
LAP	45.019	44.315	43.285	38.605	48.021	47.818	44.315
PCI							

Table 15: Impacts of different shocks on equivalent variation (base year 1994)

Shock	Labor owners	Capital owners	Both groups
Technology	26.465	366.254	392.719
Compound w/o trade	63.099	466.067	529.166
Endowment	8.624	25.171	33.796
Transfers	6.719	-6.708	0.011
Compound w/o taste	51.114	435.021	435.021
All	72.788	465.364	538.152

From 1994 to 2000, there is no change in export tax rates. A rise in export price and a drop in import tariff are observed. These two shocks work in opposite directions and the impact of export price dominates as reflected in wage rate and per capita income (Table A.1). The impact on ratio is negative in both instances and trade shock too shows such an impact.

5.2 Technology shock

Production function parameters exhibit sector specific as well as factor specific technological change. Sector specific technological progress is observed overtime and it is labor saving.

(a) From 1977 to 1994

An increase in per capita income, wage rate and ratio is observed from 1977 to 1994. When technology parameters are set at 1994 levels model becomes infeasible. When all the other shocks are applied simultaneously except for technology shock, per capita income increases and the ratio and wage rate decrease. This implies that technological change helped to increase ratio and wage rates. The impact of all the other shocks on per capita income is not as high as the level in 1994. This too implies that technological change has helped to increase the wage rate up to 1994 levels. Decomposition results indicate that technological change explains 137.37, 65.90 and 167.34 per cent of the changes in the ratio, per capita income and wage rate respectively.

(b) From 1994 to 2000

An increase in ratio and decreases in per capita income and wage rate are observed from 1994 to 2000. Technology shock in 2000 resulted in a higher ratio, per capita income and wage rate. This result suggests that the rise in ratio is explained by technological change. Decomposition results indicate that technological change explains 135.24 per cent of the changes in ratio.

These impacts are due to the change in production technology, which in this case is a sector specific progress mainly in the rest of the economy in this case and is labor saving. It increases the production in the rest of the economy and decreases the production of agricultural goods, making the country an importer of agricultural goods and a net exporter of other goods. Allocation of labor between the two sectors changes with technological progress showing an

increase in labor usage in the rest of economy. It increases wage rate and hence increases the income of labor owners. Returns on fixed factors increase leading to increase capital owners' income. The ratio between income of capital owners and that of labor owners however increases. Overall, it increases the welfare of both groups and hence the welfare in the overall economy (Table 15).

To assess the impact of factor specific technological change, share parameters are set at the level of year 2000, while keeping the scale parameters at 1994 levels. Impacts of that on poverty measures and other variables are presented in Table A.2. It decreased the production in both sectors with an increase in labor usage in the agricultural sector. Wage rate and per capita income decrease. Returns to capital in the agricultural sector rises and that in the rest of the economy drops. Capital owners' income increases, widening the income gap between capital owners and labor owners.

Similarly, to assess the impact of sector specific technological change, scale parameters are set at the level of year 2000, while keeping the share parameters at 1994 levels. Impacts of that on poverty measures and other variables are presented in Table A.2. It increased the wage rate, per capita income and the ratio.

5.3 Transfer shock

The experiment is conducted by changing the government revenue and portion of the revenue that goes to labor owners, i.e., transfers to households (Table 8). As government revenue is an exogenous variable, domestic taxes, i.e. VAT, becomes endogenous, allowing government to maintain the same revenue with changes in other border charges. The following experiments are conducted to assess the impacts of changes in government revenue alone.

(a) From 1977 to 1994

When government revenue and transfers to households increase, it is found that per capita income of laborers rises and the ratio declines, however there is no impact on wage rates (Table 10). This suggests that transfers decrease both absolute poverty and relative poverty. As

increases in per capita income and in the ratio are observed from 1977 to 1994, it is clear that though transfers can explain absolute poverty, it cannot explain relative poverty. Decomposition experiment suggests that 50.93 per cent of the increase in absolute poverty is due to transfers. Results show that transfer shock has no impact on the production side of the model. Changes in poverty levels are due to changes in consumption side of the model.

When transfers to households increase while keeping government revenue at the same level, it is found that per capita income rises and the ratio drops. When government revenue increases while keeping the same level of transfers to households, a similar result is obtained (Table A.3). Both these impacts do not change the wage level.

(b) From 1994 to 2000

Transfer shock cannot explain the changes in poverty from 1994 to 2000 as the resulting impacts on poverty measures are opposite to the actual changes.

When transfers to households are increased while keeping government revenue at the same level, it is found that per capita income drops and ratio rises. When government revenue is increased while keeping the same level of transfers to households, per capita income increases with a simultaneous drop in the ratio (Table A.5). This implies that two impacts work in opposite direction from 1994 to 2000. Both these impacts do not affect the wage level. Impacts of transfers to households is towards the same direction as that of the actual changes from 1994 to 2000, indicating that they could partly explain changes in poverty from 1994 to 2000.

Furthermore, transfers cannot change the welfare of the economy significantly, as it can only transfer income from one group to another group as a lump-sum payment. This is true with all types of transfer shocks, change in government revenues, change in transfer payments to households and simultaneous change in both.

5.4 Taste shock

Expenditure shares on different goods show a change in tastes and preferences over time. Consumers spend relatively lesser on agricultural goods in the latter period than the former.

(a) From 1977 to 1994

Changes in tastes have the impact on the consumption pattern. Consumers with new tastes need more goods from the rest of the economy. They now need less agricultural goods. Production, labor usage, wage rates and returns on specific factors do not change with changes in tastes, as consumption and production sides are independent due to small country assumption. As a result, exports of agricultural goods and imports of goods in the rest of the economy increase. Government now has to collect less domestic taxes to maintain the same revenue due to rise in import tariff revenue (Table 11). Consumers of both income groups are better-off as shown by the equivalent variation (Table 12). As changes in tastes do not change poverty measures that derive from wage rate and income of the two groups of consumers, there is no change in absolute and relative poverty levels. As a result, decomposition experiment show that changes in tastes cannot explain the changes in poverty measures.

(b) From 1994 to 2000

When the model with the year 1994 as the base is run with year 2000, solution for taste parameters became infeasible[9]. When the model is run with all other shocks as in 2000, it is observed that production side variables, such as production levels, labor usage, wage rate and return on specific factor are similar to year 2000 levels. This indicates that the change in tastes does not change the production side variables. Therefore, changes in tastes do not change poverty measures that derive from wage rate and income of the two groups of consumers. As a result, decomposition experiment show that changes in tastes cannot explain the changes in poverty measures.

[9] This is a technical problem which could not be solved. Appendix B shows the codes written in GAMS for 1977 and 1994 respectively.

5.5 Endowment shock

Number of workers in the labor force has been increasing over the years. The labor force was 4.647, 5.281 and 6.343 million in 1977, 1994 and 2000 respectively (Table 8).

(a) From 1977 to 1994

Increase in workforce has effected a drop in the wage rate, reducing the per capita income of workers along with a drop in the ratio (Table 10). Actual data show an increase in wage rate, per capita income and the ratio from 1977 to 1994. Therefore, the decomposition experiment concludes that change in endowment does not explain the changes in poverty (Table 10).

(b) From 1994 to 2000

Increase in workforce from 1994 to 2000 too has lead to drop the wage rate, reducing the per capita income of the workers along with a drop in the ratio (Table 13). Actual data show a decrease in wage rate and per capita income, and an increase in the ratio from 1994 to 2000. It can be concluded that the change in endowment explains the changes in wage rates and absolute poverty by 275.4 and 911.22 per cent respectively, however it does not explain the changes in relative poverty (Table 13).

With increase in labor endowment labor usage in both sectors rises, which lead to an increase in production in both sectors. Although this results in a drop in the wage rate, it increases the income of labor owners as a rise in employment is observed. Income of capital owners also rises, due to a rise in returns on specific factors. Exports of agricultural goods and imports in goods in the rest of the economy rise. Government now has to collect less domestic taxes to maintain the same revenue due to rise in import tariff revenue (Table 14). Consumers of both income groups are better-off as shown by the equivalent variation (Table 15).

6. CONCLUSIONS AND POLICY IMPLICATIONS

It can be concluded that technological change explains mostly the change in absolute and relative poverty from 1977 to 1994 and relative poverty from 1994 to 2000. Trade and transfers rank as the second most important factors in explaining the changes in relative and absolute poverty

respectively from 1997 to 1994. Changes in wage rate and absolute poverty are solely explained by the change in endowment level from 1994 to 2000. This finding is consistent with most of the previous studies, which concluded that income distribution is determined by technological change rather than trade. (Krugman, 2000).

The implication of this study is that two main poverty determinants i.e., technological change and changes in endowments, are not directly controllable. Transfers, for which the government has a direct control seem to have a direct impact on reducing poverty. Trade liberalization from 1977 to 1994 increased per capita income and decreased ratio, indicating trade liberalization in that period is pro-poor in Sri Lanka. However, trade liberalization from 1994 to 2000 drops per capita income and the ratio, indicating that it is anti-poor during 1994 to 2000 despite the general belief.

7. LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The results obtained using this model should be considered as suggestive and not as conclusive. The model could be extended to incorporate different consumer groups based on the ownership of resources. Accurate apportioning of government revenue is required among such consumer groups.

Omission of the non- tradable sector may have biased the results to a certain degree. To maintain the equality between the value of imports and the value of exports as required by the model, the value of exports is considered as the value of imports. However, the years under consideration 1977, 1994 and 2000 incur a trade balance, which is not captured by this model.
Inexact calibration procedure can be extended to assess different types of technological change with different restrictions on technological parameters.

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APPENDIX

Table A.1: Poverty impacts due to different trade shocks

Base year	Trade shock	Ratio	PCI	Wage
1977	Base	2.002	24.719	18.947
	Trade	2.441	22.330	13.892
	Export price	2.492	22.189	13.296
	Import tariff	2.011	24.616	19.005
	Export tax	1.925	25.269	20.241
1994	Base	2.952	45.019	28.103
	Compound w/o trade	3.882	43.285	26.870
	Export price	2.918	45.321	28.976
	Import tariff	2.885	46.064	27.421

Table A.2: Impacts due to Factor and Sector Specific Technological Change (base year 1994)

Variable	1994 Base	2000 sector specific	2000 factor specific
Production of agricultural goods	123.773	159.070	123.341
Production of rest	583.939	1000.282	563.985
Labour usage of agricultural goods	2.0930	1.743	2.249
Labour usage of rest	3.1880	3.538	3.032
Demand by labour owners of agricultural goods	27.351	38.789	24.424
Demand by labour owners of rest	152.751	216.633	136.405
Demand by capital owners of agricultural goods	80.729	136.645	80.660
Demand by capital owners of rest	450.862	763.141	450.475
Utility of labour owners	114.023	161.708	101.821
Utility of capital owners	336.551	569.656	336.263
Income of labour owners	237.746	318.401	213.149
Income of capital owners	701.736	1121.644	703.921
Price of agricultural goods	1.254	1.254	1.254
Price of rest	1.096	1.096	1.096
VAT	0.179	0.113	0.183
Exports of agricultural goods	15.963	-16.364	18.257
Exports of rest	-19.674	20.508	-22.896
Return to capital of agricultural goods	96.363	123.844	101.903
Return to capital of rest	550.397	942.826	547.042
Ratio	2.952	3.523	3.302
PCI	45.019	60.295	40.363
Wage	28.103	43.375	23.445

Table A. 3: Poverty impacts due to different types of transfer shocks

Year	Shock	Ratio	PCI	Wage
1977	Base	2.002	24.719	18.947
	Transfer	1.464	38.166	18.947
	Government revenue	1.715	34.635	18.947
	Household transfers	1.627	28.247	18.947
1994	Base	2.952	45.019	28.103
	Transfer	2.843	47.818	28.103
	Government revenue	2.832	47.952	28.103
	Household transfers	2.963	44.888	28.103

Appendix B.1: Code for 1977 base

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*=================
*$TITLE Cobb-Douglas Example of G.E. with 2 HH 1 mobile and 2 specific
*factors
* Jeevika Weerahewa: Absolute Poverty Model:
* Decomposition experiment
* Calibrated for 1977; IN 1996 CONSTANT FACTOR PRICES
*=============
* JULY 2002 *
*=============

$OFFSYMXREF
OPTION NLP = CONOPT2;

SET
G       sectors         /G1,G2/

ALIAS  (G,GG);

PARAMETER

ALPHA (G)       Production shares
       /G1 0.202
        G2 0.549/

ELASDL (G)      expenditure shares in consumption
       /G1 0.781
        G2 0.219/

ELASDK (G)      expenditure shares in consumption
       /G1 0.781
        G2 0.219/


TARIFF (G)      rate of tariff
       /G1 0.0862
        G2 0.000/

TAX (G)      rate of tax
       /G1 0.0
        G2 0.0934/

PRICE (G)       output prices in the world market
       /G1 1.0
        G2 2.4795/
```

```
SCALE (G)
       /G1 163.901
        G2 22.848/
PDO(G)
       /G1 1.086
        G2 2.248/

PDNO(G)
       /G1 192.766
        G2 37.071/;

PARAMETER
LABOR
TR
HHTRA;

LABOR=4.647;
TR=52.11;
HHTRA=1.54;

VARIABLES
PDN(G)
INCL
INCK
LAB(G)
DMDL(G)
DMDK(G)
WAGE
RET(G)
PD(G)
UTIL
UTIK
WEL
VAT
LAP
EXP(G)
PCI
RATIO
DMY
;

EQUATIONS
PDNDEF(G)
INCDEF
INCDEF1
LABDEF
```

```
DMDDEF(G)
DMDDEF1 (G)
EXDEM(G)
ZERODEF (G)
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
TRDEF
TRDEF1
LABCLEAR
WELDEF
INDEX
PCIDEF
PCIDEF1
RATIODEF
DMYDEF
;

PDNDEF(G)..
PDN(G) =E= SCALE(G)*LAB(G)**ALPHA(G);

LABDEF (G)..
LAB(G) =E= PDN(G)*PD(G)*ALPHA(G)/WAGE;

INCDEF..
INCL =E= LABOR*WAGE + HHTRA + (TR-HHTRA)*0.5 ;

INCDEF1..
INCK =E=  SUM(G, RET(G))+ (TR-HHTRA)*0.5  ;

TRDEF..
TR =E= SUM(G, (-TARIFF(G)*PRICE(G)*EXP(G) + TAX(G)*PRICE(G)*EXP(G))) +
     SUM(G, DMDL(G)*PD(G)*VAT) +  SUM(G, DMDK(G)*PD(G)*VAT);

TRDEF1..
TR =E= SUM(G, (-TARIFF(G)*PRICE(G)*EXP(G) + TAX(G)*PRICE(G)*EXP(G))) +
     SUM(G, DMDL(G)*PD(G)*(VAT/LAP)) +  SUM(G, DMDK(G)*PD(G)*(VAT/LAP));

DMDDEF(G)..
DMDL(G) =E= ELASDL(G)*INCL/(PD(G)*(1+VAT));

DMDDEF1(G)..
DMDK(G) =E= ELASDK(G)*INCK/(PD(G)*(1+VAT));

ZERODEF(G)..
```

```
PD(G) =E= (WAGE*LAB(G) + RET(G))/PDN(G);

PDDEF1..
PD("G1") =E= PRICE("G1")*(1+TARIFF("G1"));

PDDEF2..
PD("G2") =E= PRICE("G2")*(1-TAX("G2"));

UTIDEF..
UTIL =E= PROD(G, DMDL(G)**ELASDL(G)) ;

UTIDEF1..
UTIK =E= PROD(G, DMDK(G)**ELASDK(G)) ;

EXDEM(G)..
PDN(G)=E=DMDL(G)+DMDK(G)+EXP(G);

LABCLEAR..
LABOR =E=  SUM(G, LAB(G));

WELDEF..
WEL=E=UTIL+UTIK;

INDEX..
LAP =E= SUM(G,PD(G)*PDNO(G))/SUM(G,PDO(G)*PDNO(G));

PCIDEF..
PCI =E= INCL/LABOR;

PCIDEF1..
PCI =E= INCL/(LAP*LABOR);

RATIODEF..
RATIO =E= INCK/INCL;

DMYDEF..
DMY =E= SUM(G, PDN(G));

MODEL DFID /
PDNDEF
INCDEF
INCDEF1
LABDEF
DMDDEF
DMDDEF1
EXDEM
```

```
ZERODEF
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
WELDEF
TRDEF
LABCLEAR
PCIDEF
RATIODEF
DMYDEF
/;

MODEL DFID1 /
PDNDEF
INCDEF
INCDEF1
LABDEF
DMDDEF
DMDDEF1
EXDEM
ZERODEF
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
WELDEF
TRDEF1
LABCLEAR
INDEX
PCIDEF1
RATIODEF
DMYDEF
/;

PDN.LO(G) = .001;
WAGE.LO =0.001;
LAB.LO(G) = 0.001;
DMDL.LO (G) = .001;
DMDK.LO (G) = .001;
PD.LO(G) =.001;
WEL.LO = .001;
INCL.LO = .001;
INCK.LO = .001;
VAT.LO = 0;
LAP.LO = 0;
```

```
EXP.LO(G)=-40;

PDN.L("G1")=910;
PDN.L("G2")=130;
WAGE.L=28;
LAB.L("G1")=3.28;
LAB.L("G2")=2.095;
DMDL.L("G1")=0.7*114/(0.38*1.35);
DMDL.L("G2")=0.3*114/0.76;
DMDK.L("G1")=0.7*165/(0.38*1.35);
DMDK.L("G2")=0.3*114/0.76;
INCL.L=114;
INCK.L=165;
VAT.L=0.00;
PD.L("G1")=0.52;
PD.L("G2")=0.76;
EXP.L("G1")=-33;
EXP.L("G2")=25;
LAP.L=1.00;

SOLVE DFID USING NLP MINIMIZING DMY;

PARAMETER
REPPDN(G)
REPLAB
REPWAGE
REPUTIL
REPUTIK
REPINCL
REPDMDL
REPDMDK
REPINCL
REPINCK
REPPD(G)
REPVAT
REPLAP
REPEXP(G)
REPRET(G)
REPRATIO
REPPCI
;

REPPDN(G)=PDN.L(G);
REPLAB(G)=LAB.L(G);
REPWAGE=WAGE.L;
REPUTIL=UTIL.L;
```

```
REPUTIK=UTIK.L;
REPINCL=INCL.L;
REPINCK=INCK.L;
REPDMDL(G)=DMDL.L(G);
REPDMDK(G)=DMDK.L(G);
REPINCL=INCL.L;
REPINCK=INCK.L;
REPPD(G)=PD.L(G);
REPVAT=VAT.L;
REPLAP=LAP.L;
REPEXP(G)=EXP.L(G);
REPRET(G)=RET.L(G);
REPRATIO=RATIO.L;
REPPCI=PCI.L;

DISPLAY PDN.L, WAGE.L, LAB.L, DMDL.L, DMDK.L, UTIL.L, UTIK.L,
INCL.L, INCK.L, WEL.L, PD.L, VAT.L, LAP.L, EXP.L, RET.L;

*$EXIT

* 1994 SHOCKS
*TARIFF("G1") = 0.096;TAX("G2")=0.00;PRICE("G2") = 1.2537;
*LABOR = 5.281;
*SCALE("G1")=496.443; SCALE("G2")=93.557;ALPHA("G1")=0.140; ALPHA("G2")=0.379;
*ELASDL("G1")=0.83;ELASDL("G2")=0.17;ELASDK("G1")=0.83;ELASDK("G2")=0.17;
*TR=144.31;
HHTRA=34.36;

SOLVE DFID1 USING NLP MINIMIZING DMY;

PARAMETER
EVL
EVK
EV
;
EVL=(UTIL.L-REPUTIL)/REPUTIL*REPINCL;
EVK=(UTIK.L-REPUTIK)/REPUTIK*REPINCK;
EV=EVL+EVK;
DISPLAY
REPDMDL, DMDL.L, REPDMDK, DMDK.L, REPPDN,PDN.L, REPLAB,
LAB.L,REPEXP,EXP.L,
REPUTIL, UTIL.L, REPUTIK, UTIK.L, REPINCL, INCL.L, REPINCK, INCK.L,
REPPD, PD.L, REPVAT, VAT.L, REPLAP, LAP.L, REPRET, RET.L,REPWAGE, WAGE.L,
EVL,EVK,EV;

DISPLAY REPRATIO, RATIO.L, REPPCI, PCI.L;
```

Appendix B.2: Code for 1994 base

```
*=================
*$TITLE Cobb-Douglas Example of G.E. with 2 HH 1 mobile and 2 specific
*factors
* Jeevika Weerahewa: Absolute Poverty Model:
* Decomposition experiment
* Calibrated for 2000; IN 1996 CONSTANT FACTOR PRICES
*=============
* JULY 2002 *
*=============

$OFFSYMXREF
OPTION NLP = CONOPT2;

SET
G       sectors          /G1,G2/

ALIAS  (G,GG);

PARAMETER

ALPHA (G)        Production shares
       /G1 0.140
        G2 0.379/

ELASDL (G)       expenditure shares in consumption
       /G1 0.83
        G2 0.17/

ELASDK (G)       expenditure shares in consumption
       /G1 0.83
        G2 0.17/


TARIFF (G)       rate of tariff
       /G1 0.096
        G2 0.000/

TAX (G)       rate of tax
       /G1 0.0
        G2 0.0/

PRICE (G)        output prices in the world market
       /G1 1.0
        G2 1.2537/
```

```
SCALE (G)
      /G1 496.443
       G2 93.557/

PDO(G)
      /G1 1.096
       G2 1.254/

PDNO(G)
      /G1 583.939
       G2 123.773/;


PARAMETER
LABOR
TR
HHTRA;

LABOR=5.281;
TR=144.31;
HHTRA=34.36;

VARIABLES
PDN(G)
INCL
INCK
LAB(G)
DMDL(G)
DMDK(G)
WAGE
RET(G)
PD(G)
UTIL
UTIK
WEL
VAT
LAP
PCI
RATIO
EXP(G)
DMY
;

EQUATIONS
PDNDEF(G)
INCDEF
```

```
INCDEF1
LABDEF
DMDDEF(G)
DMDDEF1 (G)
EXDEM(G)
ZERODEF (G)
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
TRDEF
TRDEF1
LABCLEAR
WELDEF
INDEX
PCIDEF
PCIDEF1
RATIODEF
DMYDEF
;

PDNDEF(G)..
PDN(G) =E= SCALE(G)*LAB(G)**ALPHA(G);

LABDEF (G)..
LAB(G) =E= PDN(G)*PD(G)*ALPHA(G)/WAGE;

INCDEF..
INCL =E= LABOR*WAGE + HHTRA + (TR-HHTRA)*0.5 ;

INCDEF1..
INCK =E=  SUM(G, RET(G))+ (TR-HHTRA)*0.5  ;

TRDEF..
TR =E= SUM(G, (-TARIFF(G)*PRICE(G)*EXP(G) + TAX(G)*PRICE(G)*EXP(G))) +
     SUM(G, DMDL(G)*PD(G)*VAT) +  SUM(G, DMDK(G)*PD(G)*VAT);

TRDEF1..
TR =E= SUM(G, (-TARIFF(G)*PRICE(G)*EXP(G) + TAX(G)*PRICE(G)*EXP(G))) +
     SUM(G, DMDL(G)*PD(G)*(VAT/LAP)) +  SUM(G, DMDK(G)*PD(G)*(VAT/LAP));

DMDDEF(G)..
DMDL(G) =E= ELASDL(G)*INCL/(PD(G)*(1+VAT));

DMDDEF1(G)..
DMDK(G) =E= ELASDK(G)*INCK/(PD(G)*(1+VAT));
```

```
ZERODEF(G)..
PD(G) =E= (WAGE*LAB(G) + RET(G))/PDN(G);

PDDEF1..
PD("G1") =E= PRICE("G1")*(1+TARIFF("G1"));

PDDEF2..
PD("G2") =E= PRICE("G2")*(1-TAX("G2"));

UTIDEF..
UTIL =E= PROD(G, DMDL(G)**ELASDL(G)) ;

UTIDEF1..
UTIK =E= PROD(G, DMDK(G)**ELASDK(G)) ;

EXDEM(G)..
PDN(G)=E=DMDL(G)+DMDK(G)+EXP(G);

LABCLEAR..
LABOR =E=  SUM(G, LAB(G));

WELDEF..
WEL=E=UTIL+UTIK;

INDEX..
LAP =E= SUM(G,PD(G)*PDNO(G))/SUM(G,PDO(G)*PDNO(G));

PCIDEF..
PCI =E= INCL/LABOR;

PCIDEF1..
PCI =E= INCL/(LAP*LABOR);

RATIODEF..
RATIO =E= INCK/INCL;

DMYDEF..
DMY =E= SUM(G, PDN(G));

MODEL DFID /
PDNDEF
INCDEF
INCDEF1
LABDEF
DMDDEF
```

```
DMDDEF1
EXDEM
ZERODEF
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
WELDEF
TRDEF
LABCLEAR
PCIDEF
RATIODEF
DMYDEF
/;

MODEL DFID1 /
PDNDEF
INCDEF
INCDEF1
LABDEF
DMDDEF
DMDDEF1
EXDEM
ZERODEF
PDDEF1
PDDEF2
UTIDEF
UTIDEF1
WELDEF
TRDEF1
LABCLEAR
INDEX
PCIDEF1
RATIODEF
DMYDEF
/;



PDN.LO(G) = .001;
WAGE.LO =0.001;
LAB.LO(G) = 0.001;
DMDL.LO (G) = .001;
DMDK.LO (G) = .001;
PD.LO(G) =.001;
WEL.LO = .001;
```

```
INCL.LO = .001;
INCK.LO = .001;
VAT.LO = 0;
LAP.LO=0;
EXP.LO(G)=-40;

PDN.L("G1")=344;
PDN.L("G2")=130;
WAGE.L=30;
LAB.L("G1")=3;
LAB.L("G2")=2;
DMDL.L("G1")=0.7*114/(0.38*1.35);
DMDL.L("G2")=0.3*114/0.76;
DMDK.L("G1")=739;
DMDK.L("G2")=89;
INCL.L=114;
INCK.L=165;
VAT.L=0.00;
LAP.L=1;
PD.L("G1")=0.52;
PD.L("G2")=0.76;
EXP.L("G1")=-33;
EXP.L("G2")=25;

SOLVE DFID USING NLP MINIMIZING DMY;
PARAMETER
REPPDN(G)
REPLAB
REPWAGE
REPUTIL
REPUTIK
REPINCL
REPDMDL
REPDMDK
REPINCL
REPINCK
REPPD(G)
REPVAT
REPLAP
REPEXP(G)
REPRET(G)
REPRATIO
REPPCI
;

REPPDN(G)=PDN.L(G);
```

```
REPLAB(G)=LAB.L(G);
REPWAGE=WAGE.L;
REPUTIL=UTIL.L;
REPUTIK=UTIK.L;
REPINCL=INCL.L;
REPINCK=INCK.L;
REPDMDL(G)=DMDL.L(G);
REPDMDK(G)=DMDK.L(G);
REPINCL=INCL.L;
REPINCK=INCK.L;
REPPD(G)=PD.L(G);
REPVAT=VAT.L;
REPLAP=LAP.L;
REPEXP(G)=EXP.L(G);
REPRET(G)=RET.L(G);
REPRATIO=RATIO.L;
REPPCI=PCI.L;


DISPLAY PDN.L, WAGE.L, LAB.L, DMDL.L, DMDK.L, UTIL.L, UTIK.L,
INCL.L, INCK.L, WEL.L, PD.L, VAT.L, LAP.L, EXP.L, RET.L, PCI.L, RATIO.L;

*$EXIT

* 2000 SHOCKS
*TARIFF("G1") = 0.045; TAX("G2")=0.00; PRICE("G2") = 1.3350;
*LABOR = 6.343;
*SCALE("G1")=774.410; SCALE("G2")=100.791; ALPHA("G1")=0.115;
ALPHA("G2")=0.341;
*ELASDL("G1")=0.866;ELASDL("G2")=0.134;ELASDK("G1")=0.866;ELASDK("G2")=0.134
;
*TR=175.26;
HHTRA=32.95;

*factor specific tech shock only
*SCALE("G1")=496.443; SCALE("G2")=93.557;  ALPHA("G1")=0.115;
ALPHA("G2")=0.341;
*sector specific tech shock only;
*SCALE("G1")=838.085; SCALE("G2")=128.879; ALPHA("G1")=0.140;
ALPHA("G2")=0.379;


SOLVE DFID1 USING NLP MINIMIZING DMY;

PARAMETER
EVL
```

```
EVK
EV
;
EVL=(UTIL.L-REPUTIL)/REPUTIL*REPINCL;
EVK=(UTIK.L-REPUTIK)/REPUTIK*REPINCK;
EV=EVL+EVK;

DISPLAY
REPDMDL, DMDL.L, REPDMDK, DMDK.L, REPPDN,PDN.L, REPWAGE, WAGE.L,
REPLAB, LAB.L,REPEXP,EXP.L,
REPUTIL, UTIL.L, REPUTIK, UTIK.L, REPINCL, INCL.L, REPINCK, INCK.L,
REPPD, PD.L, REPVAT, VAT.L, REPLAP, LAP.L, REPRET, RET.L, EVL,EVK,EV;

DISPLAY REPRATIO, RATIO.L, REPPCI, PCI.L;
```