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ACCOUNTING FOR SRI LANKA'S EXPENDITURE INEQUALITY 1980–2002: REGRESSION-BASED DECOMPOSITION APPROACHES

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Sri Lanka liberalized its economy in 1977, paving the way for more rapid economic growth and higher rates of job creation. But tensions over distributional issues still plague the body politic. This paper investigates the evolution of Sri Lanka's expenditure distribution in the period 1980–2002 and uses three decomposition methodologies—the Fields, the Shapley value decomposition, and Yun's unified method—to determine underlying causes. The study finds that while average adjusted expenditure rose across strata, the rich experienced more rapid expenditure growth leading to greater inequality. Inequality change was driven by differential access to infrastructure, education, and occupation status. Demographic factors, including ethnicity, and spatial factors contributed very little. The study recommends policies that ensure more equitable access to income earning assets such as education and infrastructure services, and that contain the rise in inequality along sectoral, regional, and ethnic fault lines.

1. Introduction

This paper traces the evolution of expenditure distribution in Sri Lanka after economic liberalization in 1977 and investigates the underlying causes. The analysis meets an obvious gap in the literature that has significant policy implications: Sri Lanka has long experienced violent social unrest related to distribution issues, but rigorous empirical evidence on inequality trends and determinants has been piecemeal. Earlier analyses covered different periods and followed different methodologies (see Glewwe, 1985, 1986; Gunewardena, 1996; Lakshman, 1997; Dunham and Jayasuriya, 2000). None extended beyond the mid-1990s. Analyses of the determinants of inequality (for example, Glewwe, 1986; Gunewardena, 1996) explained differences in income distribution between distinct groups of income recipients and between recipients with different sources of income. However, these methods did not permit the simultaneous decomposition of inequality by population subgroups and by income components. Nor did they enable the researchers to quantify the contributions of many other factors to total inequality.

In contrast, the present study applies three key regression-based methodologies to examine the progress of inequality and its causes during the full sweep of 1980 to 2002. Thus, it is able to take advantage of the greater availability of data as well as of innovations in methodology that have emerged since the last rigorous assessment of inequality in Sri Lanka. A comparison of results derived from

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applying the Fields and Shapley value decomposition methodologies to disaggregate total inequality and its changes into contributory factors is a key contribution of this paper. The analysis also applies the method proposed by Yun (2006) to decompose factor contributions into characteristics (quantity), coefficients (price), and non-observable effects (residuals).

An analysis of Sri Lanka's experience can add further insights to the growing body of country-specific evidence that illuminates "the rich texture of relationships" that exists between economic growth and income distribution (Kanbur, 2000, p. 797). Note that in the mid-1970s, Sri Lanka had "one of the most regulated economies outside the centrally planned economies" (Cuthbertson and Athukorala, 1991, as cited in Athukorala and Jayasuriya, 2000). But inherent contradictions in the import substituting strategy resulted in a stagnant economy, high unemployment, and the rationing of consumer goods. These economic ills were exacerbated by the first oil price shock of 1973 which paved the way for a landslide victory of the right-of-centre United National Party at the General Elections of 1977. The party had campaigned on a platform of liberalizing the economy and revitalizing the private sector. Thus, Sri Lanka became the first country in South Asia to liberalize its economy and dismantle the import substituting policy framework that had been in place since the late 1950s. A further, more intensive wave of reforms in the early 1990s left Sri Lanka one of the most open economies of the developing world by the end of the decade (Athukorala and Rajapatirana, 2000).

Economic liberalization was primarily aimed at generating export-oriented industrialization and a higher rate of economic growth and employment creation. In contrast to the preoccupation with social welfare issues of earlier governments, the government of the time was never directly concerned with the distributive effects of economic liberalization, looking instead to higher economic growth to translate into greater social welfare. For example, the government allowed the real value of the targeted food stamps program to erode and froze its coverage to cut back expenditure on welfare. As expected, economic growth rates picked up, light industrial goods began to claim a bigger share of the country's exports, and unemployment rates began to decline.

Economic growth rates averaging 2.9 percent each year between 1970 and 1976, surged to at least 5 percent after liberalization in all but a few years marked by political instability. While agriculture accounted for 31 percent of GDP in 1977, industry for 27 percent, and services for 42 percent, by 2002 agriculture's share had dropped to 20 percent, industry remained steady at 27 percent, and services accounted for 53 percent. Structural change in the composition of exports was more dramatic: agriculture's share in total exports declined sharply from 79 percent in 1977 to 19 percent in 2002, while manufacturing's share rose from 14 to 77 percent. The labor market transformed more slowly. In 1980 agriculture accounted for 46 percent of all employed (all island), but by 2002 this share had dropped to 34.5 (excluding the north and east). Unemployment declined from 14.6 percent of the labor force in 1978 (all island) to 9.8 percent (excluding the north and east) in 2002 (Central Bank of Sri Lanka, Annual Report, various years).

Nevertheless, the post-liberalization era of higher economic growth and lower unemployment levels also saw continuing social conflict and greater political instability related to distributional issues. Sri Lanka's twin political conflicts of the

early 1970s, the first involving ethnic Sinhalese youth and the second involving ethnic Tamil youth, stemmed from state policies that aimed to achieve redistributive justice in an economy made stagnant by a restrictive trade regime (Abeyratne, 2004). The shortage of resources ensured that poverty rather than wealth was shared and masses of rural youth remained outside the economic mainstream (Abeyratne, 2004). Thus, a fertile ground was created for the eruption and sustenance of social conflict.

Economic liberalization exacerbated rather than mitigated these tensions. Some economic liberalization measures negatively affected segments of the population engaged in the production of certain import substituting agricultural and industrial goods (Gunasinghe, 1986). Other measures are likely to have increased returns to those with certain endowments of income generating assets such as education and urban residence (Lakshman, 1997; Dunham and Jayasuriya, 2000).

Encouraged by sub-continental geopolitical forces in the early 1980s, disaffected Tamil youths in the northeast launched a violent insurrection against the state in a bid to secede. By the late 1980s Sinhalese youth in the rural south had also revolted. Thanks to the lack of external support for the latter movement, the government reasserted control with a mixture of brute force, more rapid economic reform, and an industrial and welfare policy that targeted areas outside the urban metropolis (Dunham and Kelegama, 1997). A targeted income transfer program, *Janasaviya* (converted into the *Samurdhi* program in 1995 to include pro-poor credit and community infrastructure components), replaced universal food subsidies and the ineffective food stamps scheme. Village reawakening and garment factory programs sought to bridge the development gap between urban and rural areas. But while targeting of the income transfer program was unsatisfactory (World Bank, 2007), transport infrastructure constraints impeded the integration of rural and urban markets and exacerbated spatial disparities. Pronounced imbalances between the economically dynamic southwest, the conflict-affected northeast, and remaining slow growing regions emerged. And 30 years after economic liberalization, Sri Lankan society remains politically volatile.

Thus, issues relating to consumption distribution continue to be of enormous economic and political significance in Sri Lanka. Critical questions remain about the evolution of consumption distribution and its underlying causes after economic liberalization, and a long-term analysis of these issues such as the present study can contribute much to policy making.

This paper is organized as follows. Section 2 discusses the data used and presents the findings of the analysis of inequality trends in Sri Lanka over the reference period. Section 3 introduces the decomposition methodologies used to identify the causes of inequality and presents the results of the analysis. Section 4 concludes by drawing out the policy implications of the study's findings.

2. Data, Variables, and Overview of Income Distribution in Sri Lanka

2.1. *Data*

The analysis in this paper uses consumption expenditure as proxy for income. This is because consumption expenditure is a more accurate measure of individual

and household welfare in developing countries (Deaton and Zaidi, 2002). Large informal sectors made up of self-employment, small business, and subsistence agriculture make the gathering of accurate income data difficult in developing countries, while means-tested income support programs can encourage under-reporting of income. Moreover, consumption expenditure is a direct measure of individual and household welfare, whereas income streams exhibit transitory fluctuations.

Data on household expenditure and demographic and other characteristics of households were drawn from the 1980/81 and 1985/86 Labor Force and Socio-Economic Surveys (LFSS), and the 1990/91, 1995/96, and 2002 Household Income and Expenditure Surveys (HIES) conducted by the Department of Census and Statistics, Sri Lanka. Despite the difference in name, the surveys are broadly comparable in design and methodology. Nevertheless, where it has been necessary to identify the principal income earner, as in the presentation of descriptive statistics in Table 1, we have used 1985 as the start period rather than 1980 because the income definitions of the 1980 survey are different from those of subsequent surveys. More importantly, the 1990/91, 1995/96, and 2002 HIES excluded the administrative districts in the Northern and Eastern Provinces as the conflict situation prevailing there precluded data collection. Hence the present analysis relates only to the seven provinces outside the Northern and Eastern Provinces, which account for roughly 85 percent of Sri Lanka's population of around 19 million people.

The analysis takes into account only households with positive expenditure. We also excluded households that box plot analyses of consumption data revealed as outliers. Household expenditure data were then adjusted to take into account equivalence scales and temporal and spatial differences in the cost of living. Details of how we adjusted the data are as follows.

Individual expenditure was adjusted to take into account the different costs of children relative to adults and the economies of scale in consumption within a household by using equivalence scales. If household i-th consumption expenditure is y_i and the adult equivalent size of the household is m_i, then the unit of analysis that we use is per adult equivalent consumption or y_i/m_i, where m_i is calculated as follows:

$$m_i = \left(\phi_1 n_{a,i} + \phi_2 n_{c,i}\right)^{\theta}. \tag{1}$$

In the formulation above, the number of adults is $n_{a,i}$ and the number of children is $n_{c,i}$. The term θ is a measure of economies of scale within the household and can take any value $0 \leq \theta \leq 1$. The term ϕ_1 is the cost of an adult member. We follow Deaton and Zaidi (2002), who use this formula for the setting of equivalence scales in developing countries, and set its value as unity. The term ϕ_2 is the cost of a child relative to an adult and can take any value $0 \leq \phi_2 \leq 1$. In this paper we arbitrarily set ϕ_2 and θ as 0.6 and 0.9, respectively. There are several reasons for this. Families are having fewer children than they did two decades ago and aspirations for their children's future have also increased. As a result parents spend more on each child than they did earlier. Hence the costs of children relative to adults have increased. The scope for economies of scale has also increased as the budget share on food has declined.

TABLE 1

Mean Adjusted Expenditure by Population Group, Sri Lanka, 1985, 2002 (Rupees)

	Mean Adjusted Expenditure		% Change	Share of Population (%)	
	1985	2002	1985–2002	1985	2002
Ethnicity					
Sinhalese	385.95	614.40	159.19	84.45	83.96
Sri Lankan Tamil	385.12	560.03	145.42	4.45	4.50
Indian Tamil	373.64	437.97	117.22	4.51	4.96
Moor	363.44	563.83	155.14	5.91	6.09
Other	547.45	879.13	160.59	0.68	0.49
Education of main income earner					
Primary or less	292.44	404.38	138.28	37.12	31.76
Secondary	359.54	525.29	146.10	41.61	39.71
GCE O levels	546.44	784.12	143.50	15.74	15.73
GCE A levels	670.05	1,021.37	152.43	3.25	9.75
University	840.96	1,359.69	161.68	2.28	3.05
Occupation of main income earner					
Managerial	649.11	1,071.77	176.29	17.70	9.24
Clerical	537.74	878.97	165.11	6.94	2.91
Service	447.32	595.14	163.46	6.53	2.99
Farmers	327.90	521.28	133.05	14.17	33.22
Production workers	355.29	502.53	158.98	37.95	15.41
Elementary	326.25	575.16	141.44	16.70	36.23
Infrastructure					
No access to any amenity	312.99	372.92	119.15	72.02	29.36
Access to vehicle	697.27	1,017.09	145.87	8.15	16.04
Access to electricity	582.67	701.42	120.38	23.51	66.63
Access to telephone	1,222.26	1,057.09	86.49	1.09	21.43
Region					
Western	462.25	764.28	165.34	24.90	28.35
Central	378.31	566.75	149.81	16.43	17.84
Southern	358.12	552.28	154.22	15.79	13.86
North Western	359.14	531.39	147.96	11.93	12.17
North Central	372.69	602.21	161.59	9.43	7.21
Uva	351.66	490.63	139.52	9.46	8.68
Sabaragamuwa	332.20	474.54	142.85	12.07	11.89

Given the arbitrary nature of setting equivalence scales, we tested the sensitivity of the Gini coefficient to different values of ϕ_2 and θ, including those suggested by Deaton and Zaidi (2002). We found that for a given year, there was little significant difference between the estimates (see Gunatilaka, 2005).

Data on household expenditure were adjusted for temporal and spatial differences in the cost of living using the set of regional price indices for the five survey years developed by Gunatilaka (2005). The price indices were constructed by applying the Country Product Dummy (CPD) method developed by Summers (1973) and Rao (2003).

Major population surveys have many sampling units which have different probabilities of being selected and most analyses of survey data use these sampling weights to adjust the data. But though sampling weights yield more accurate estimates of descriptive statistics, they can bias Ordinary Least Squares estimates (Deaton, 1997). Hence we calculated summary inequality measures and estimated

income generating functions both with and without population weights. There was little difference in the results. Nevertheless, we decided against using sampling weights in this analysis in order to avoid any possibility of bias in the regression-based decomposition analysis which forms the core of this paper.

2.2. *Overview of Consumption Distribution*

Since this paper looks at how consumption distribution has changed in Sri Lanka and at the factors underlying the changes, we first look at changes in mean adjusted expenditure by population group between 1985 and 2002 (Table 1). The population groups are defined according to the characteristics that are likely to determine income earning capacity and the distribution of consumption, and the table also sets out the share of the total population accounted for by people who have these group characteristics in each year. These attributes are ethnicity, education, and occupation of principal income earner, infrastructure, and region. We especially include infrastructure because of its potential positive impact on productivity and access to markets.

Table 1 shows that while all groups have experienced substantial mean expenditure growth over the period, some interesting similarities and differences are apparent. Mean expenditure as well as expenditure growth increases monotonically with education levels. Similar trends are apparent in mean expenditure by occupation of principal income earner. But ethnic differences have widened over the period while Western Province has pulled ahead of the rest. The relative premium on access to telephones appears to have contracted as more people have got access, unlike in the case of access to electricity and/or vehicles.

We take an overview of changes in the distribution as a whole from 1980 to 2002 in Table 2. The table sets out changes in mean expenditure per quintile of expenditure distribution for each survey year as percentage changes. It is clear that mean expenditure in Sri Lanka grew significantly across quintiles over the reference period. But variations in the rates of expenditure growth between quintiles are

TABLE 2

Changes in Mean Adjusted Expenditure in Sri Lanka, 1980–2002 (Rupees)

Quintile of Expenditure Distribution	Percentage Change in Mean Adjusted Expenditure				
	1980–85	1985–90	1990–95	1995–2002	1980–2002
1	5.3	19.8	7.7	10.3	49.9
	[4.170]	[22.731]	[9.576]	[11.799]	[34.304]
2	6.7	18.1	7.0	14.3	54.1
	[6.322]	[25.594]	[11.257]	[19.903]	[44.294]
3	9.1	16.4	7.9	18.9	62.8
	[9.492]	[23.835]	[11.923]	[23.314]	[51.293]
4	11.2	15.1	11.3	23.1	75.4
	[9.761]	[20.015]	[14.481]	[23.369]	[48.657]
5	13.0	11.8	19.9	24.1	88.0
	[5.165]	[7.730]	[13.045]	[14.631]	[30.010]

Notes: z-statistics in square brackets are derived from 1,000 bootstrap samples and show the significance of the change in mean income during the period indicated. The 5 percent critical values for the z-statistic are as follows: 1.96 for a two-tailed test; 1.65 for a one-tailed test.

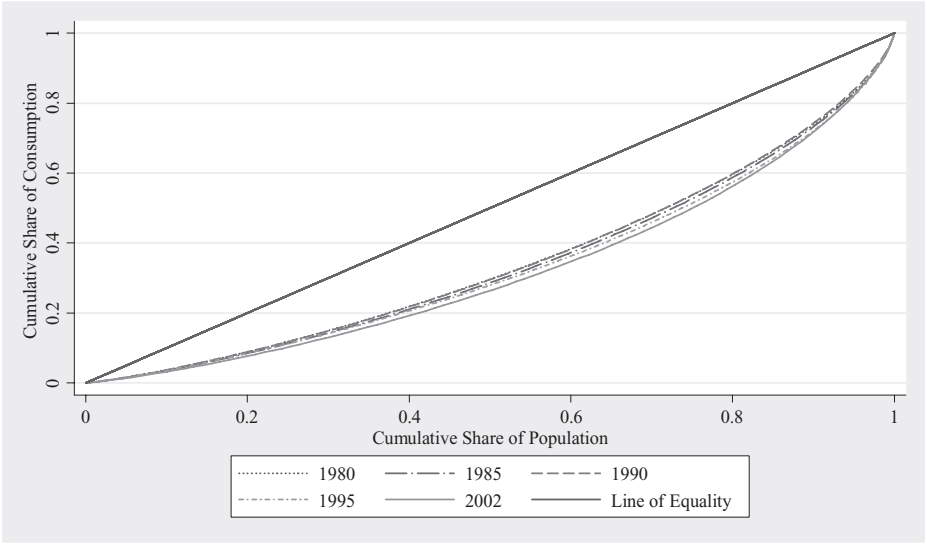

Figure 1. Lorenz Curves, 1980–2002

marked, with average consumption expenditure in the higher quintiles growing faster than those in the lower quintiles in all sub-periods other than the period 1985–90 when expenditure in the lower quintiles grew faster. Considering the period as a whole, mean expenditure among the poorest quintile of consumption distribution grew by 50 percent, while the top most quintile experienced a substantially higher mean expenditure growth rate of 88 percent.

The impact of these changes on the distribution can be seen in the movements in the Lorenz curve in Figure 1. The Lorenz curve represents the functional relationship between the cumulative proportion of expenditure and the cumulative proportion of expenditure units, assuming that expenditure units are arranged in ascending order of expenditure. Apart from a decline in inequality in 1990, the long-term trend has been for inequality to rise over the period. For a clearer representation of the extent to which the Lorenz curve has moved away from the line of equality over the reference period, we plot the transformed Lorenz curves in Figure 2 as differences between the line of equality and the associated Lorenz curves. While the general shape of the transformed Lorenz curve remains the same for each distribution, the 1990 and 1980 distributions appear the most equal. The 1995 distribution is more unequal than the 1985 distribution, and the 2002 distribution is the most unequal.

Nevertheless, Lorenz curves only provide a partial ranking of distributions. When two Lorenz curves map each other along some segments like the 1980 and 1990 distributions, it is hard to say whether they even intersect. Therefore, it is difficult to say which curve is more equal.

To provide a complete ordering of distributions and to assess the robustness of the trend to different inequality measures, we plot expenditure inequality measured by several indices in Figure 3. The figure presents standardized (with

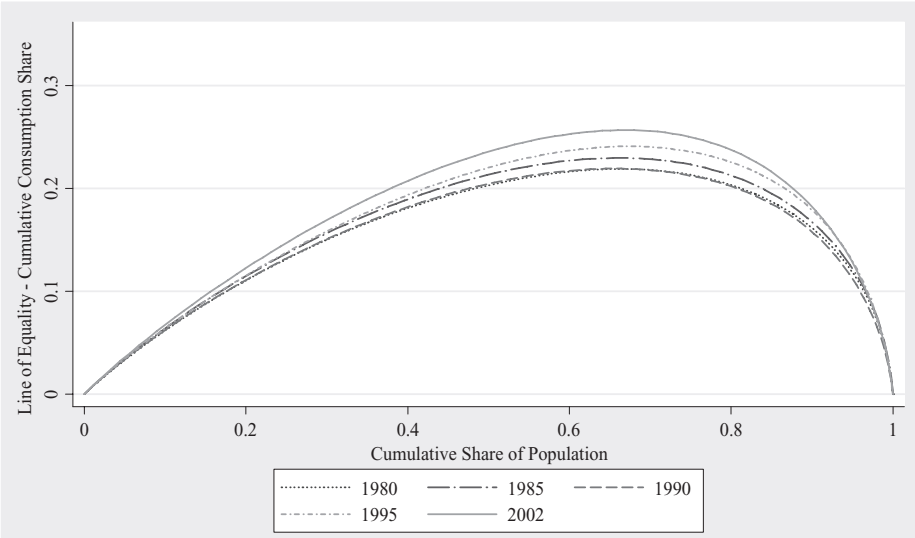

Figure 2. Transformed Lorenz Curves, 1980–2002

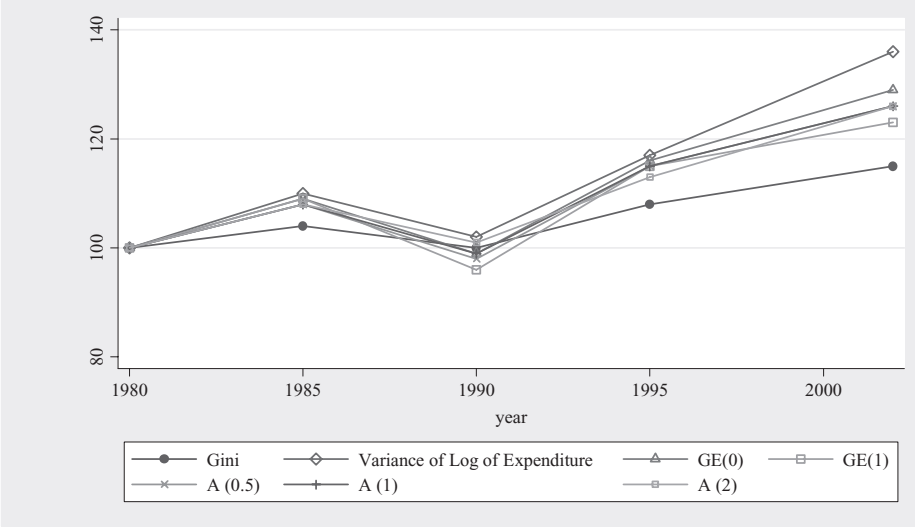

Figure 3. Standardized Inequality Indices, 1980–2002

1980 = 100) inequality indices for comparison purposes as in Karoly (1992) and Yun (2006), and include the following measures: the Gini coefficient, the variance of log of expenditure, two Generalized Entropy Indices including the Theil index, and the Atkinson index for three different values of inequality aversion. The values on which the plots are based are presented in the Appendix. All indices suggest that the long-term trend has been for inequality to increase in Sri Lanka except for a

TABLE 3

Adjusted Expenditure Inequality and Changes in Sri Lanka, 1980–2002

	1980	1985	1990	1995	2002
Gini coefficient	0.310	0.323	0.309	0.336	0.355
Variance of log of adjusted expenditure	0.281	0.310	0.287	0.329	0.382
	Percentage change				
	1980–85	1985–90	1990–95	1995–2002	1980–2002
Gini coefficient	4.5	–4.5	8.6	5.7	14.6
Variance of log of adjusted expenditure	10.3	–7.5	15.0	16.15	36.2

Notes: Gini coefficient and variance of log of adjusted expenditure calculated using expenditure per adult equivalent as the unit of analysis. All estimates of Gini coefficient and variance of log of adjusted expenditure and their changes are significant at the 5 percent level for both one-tailed and two-tailed tests. The standard errors and z-statistics (not reported here) are derived from 1,000 bootstrap samples.

brief reversal around 1990. In what follows we concentrate on the Gini coefficient and the variance of log of expenditure for further analysis.

Table 3 presents the Gini coefficient and the variance of log of expenditure for the five survey years along with percentage changes between survey years. All the changes are significant and the general trend confirms that inequality in Sri Lanka rose during the reference period apart from the sub-period 1985–90. The decline in inequality in 1990 also coincided with much slower consumption growth than in any other period, particularly for the top quintiles (see Table 2). The circumstances behind this were exceptional. In 1985 the country was sliding toward economic and political crises, the situation reaching its nadir in 1989. Recovery followed in 1990 only with further economic liberalization measures, politically eased in through a targeted income support program. The latter is likely to have pushed up real wage expectations among low skilled workers and so caused a rise in real wages and incomes among lower income groups as is evident by trends in consumption expenditure in Table 2. Hence the period 1985–90 must be regarded as a temporary reversal in a long-term trend of rising consumption disparities following economic liberalization. The largest and most significant increase in inequality during the 1980–2002 period occurred between 1990 and 1995.

We combine these two phenomena—rising mean expenditure and rising inequality—and examine their impact on social welfare narrowly defined to include just these two components, by using generalized Lorenz curve analysis. The generalized Lorenz curve enables the comparison of different distributions with different means and thus different aggregates and is obtained by scaling up the Lorenz curve by its mean (Shorrocks, 1983). Figure 4 plots the generalized Lorenz curves for the five survey years. It can be seen that by and large, the ranking of the distributions in terms of equality alone which we derived from the Lorenz curve analysis in Figure 1, has been almost totally reversed in terms of social welfare in the generalized Lorenz curves. The most unequal distribution, the 2002 distribution, emerges unambiguously as the most desirable in terms of welfare. The

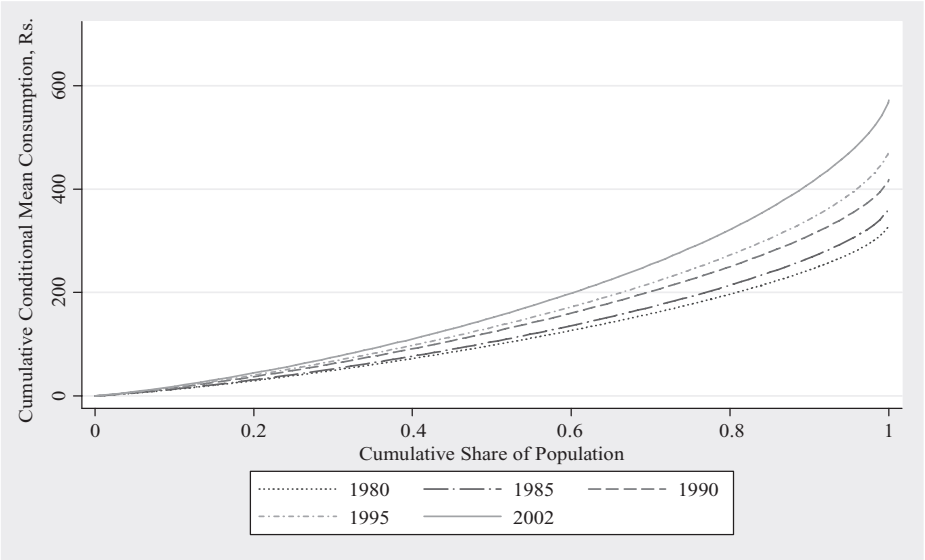

Figure 4. Generalized Lorenz Curves, 1980–2002

1980 distribution, which vied with the 1990 distribution as being most equitable, emerges as the least desirable.

To sum up the findings on inequality trends, we note that growth rates of mean expenditure by quintile revealed that all groups experienced consistent increases in mean consumption over the survey years. Consumption inequality rose between 1980 and 1985, declined between 1985 and 1990, and rose steadily thereafter. Generalized Lorenz curve analysis showed that due to the growth in mean expenditure, welfare narrowly defined to include only notions of levels and spread, appears to have progressively increased in Sri Lanka with every survey year.

What factors gave rise to these far reaching changes in the dispersion of consumption in Sri Lanka? In the sections to follow we use the regression-based, Fields and Shapley value decomposition methodologies and Yun's unified technique to decompose inequality into its contributory factors and the contributory factors into their price and quantity effects.

3. Regression-Based Decomposition

Unlike traditional methods of decomposition by population subgroups and decomposition by income source, regression-based approaches have the advantage of enabling analysts to include any mix of explanatory factors including economic, social, demographic, and policy variables. They also enable researchers to include continuous variables.

There have been many recent innovations in such methodologies, for example Shorrocks (1999), Bourguignon *et al.* (2001), Morduch and Sicular (2002), and

Fields (2003). All approaches begin with an income generating function, which, in linear form can be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon, \tag{2}$$

where y measures income for different income units. The variables x_k represent exogenous household endowments of resources that determine income. The term $\beta_k x_k$ can be regarded as the share of a household's income that flows from its endowment of x_k. The term ε is a random error.

The results of the estimation of the income generating function are then used to quantify the contribution of any number of factors to total inequality. The Fields method, for example, manipulates the equation so that it can be written in terms of covariances. The contribution of the independent variables to distributional change is then expressed as a function of the size of the coefficients of the income equation and the magnitude of the change in the variable relative to the variation in income. In the Morduch and Sicular method, the resulting coefficients are regarded as estimates of the income flows attributed to household variables. This permits the application of decomposition by income source or factor income to apportion inequality to any number of explanatory variables. This is in contrast to the method proposed by Bourguignon *et al.* (2001), which can be used to decompose differences in income distribution into just three broad components: price effects, participation effects, and population effects. Or for that matter, the Juhn, Murphy, and Pierce (1993) method, which decomposes total inequality into coefficient or price effects, characteristics or quantity effects, and residual effects.

Nevertheless, the Morduch and Sicular method has been criticized on the basis that although the methodology requires the inclusion of an error term into the original income generating equation it does not make any contribution toward overall inequality (see Wan, 2004). In contrast, Fields' decomposition methodology accounts for the contribution of the regression error to total inequality, but at times this tends to be large, leaving unexplained the major proportion of inequality.

In Sections 3.1 and 3.2 we set out the Fields and the Shapley value decomposition methodology which we use to disaggregate total inequality into its constituent factors. However, neither of these methods can be used to decompose each factor into its characteristics (quantity) or coefficient (price) effects. For this we use Yun's (2006) unified method which we set out in Section 3.3. The method is based on the Fields (2003) and the Juhn, Murphy, and Pierce (1993) methods. Section 3.4 defines the variables used for the analysis.

In the rest of this section and in the application to follow the y in the income generating function (2) is the log of income. We use the variance of log of income, σ_y^2, to measure inequality. This is because the Yun (2006) method which we also use can be applied only to this measure.

3.1. *Fields Method*

Given an income generating model such as in equation (2), Fields (2003) defines the contribution of the flow of income from any endowment, x_k, to total inequality as:

$$s_k = \frac{\mathrm{cov}(\beta_k x_k, y)}{\sigma_y^2}. \tag{3}$$

The term s_k is also known as the "factor inequality weight." The sign of s_k indicates whether the income flow from x_k is inequality increasing or decreasing. If $s_k = 0$, the distribution of income from factor k is as equal or as unequal as the distribution of total income. As a result, factor k has no impact on total inequality. The regression error shows how much of total income inequality remains unaccounted for by the income flows from endowments denoted by the explanatory variables.

It is also possible to calculate the contribution of x_k to total change in inequality between two time periods or to the difference in inequality between two datasets. Using variance of log of income, σ_y^2, to measure inequality, the contribution of x_k to the change in total inequality between two years, A and B, is expressed as:

$$\gamma_k \equiv \frac{s_{kB}\sigma_{yB}^2 - s_{kA}\sigma_{yA}^2}{\sigma_{yB}^2 - \sigma_{yA}^2}. \tag{4}$$

Like all regression-based decomposition methods, Fields' method has the advantage of enabling analysts to include any mix of explanatory factors including economic, social, demographic, and policy variables. And the procedure naturally decomposes total income into components from different sources, making it easy to measure the contribution from each to total inequality. Nevertheless, the Fields' method has some limitations which Wan (2004) has highlighted in some detail. The serious ones are: (i) the functional form for the income generating function must be log-linear; and (ii) the constant term in the income generating function does not contribute to inequality.

3.2. *Shapley Approach to Decomposition*

In contrast to other regression-based methods, the Shapley value decomposition methodology decomposes inequality completely into its contributory factors as it accounts for all parts of the income-generating equation (Shorrocks, 1999). Starting with an income generating function, the method can be applied to decompose any inequality index using an income generating model of any functional form.

Shorrocks' (1999) general application of the Shapley value method to decompose income inequality derives from Shapley's (1953) solution to the problem of calculating the real power of any given voter in a coalition voting game with transferable utility, when all orders of coalition formation are equally probable. As Shorrocks (1999) puts it, the Shapley value decomposition procedure is a solution to the "general decomposition problem" which yields "an exact additive decomposition" of the inequality index into the contributory factors (Shorrocks, 1999, p. 3). All factors are treated even-handedly and therefore the Shapley decomposition is symmetric in all variables.

While the Shapley value has been used in a number of cost allocation models since 1953 (see Albrecht *et al.*, 2002), its application to decompose income is

relatively recent. Rongve (1995), Chantreuil and Trannoy (1997), Sastre and Trannoy (2001a, 2001b), and Wan (2004) apply it to the decomposition of income. Devicienti (2008) applies the methodology to decompose wage income. In contrast, Kolenikov and Shorrocks (2005), and D'Ambrosio *et al.* (2004) use the procedure to decompose poverty.

To demonstrate the Shapley value decomposition, we begin by estimating an income generating model as represented by equation (2) with the dependent variable y as the log of income. Predicted $\hat{y}$ is then used to calculate $\hat{\sigma}^2_y$ which is total predicted income inequality, in turn determined by the distribution of incomes attributable to $x_1, x_2, \ldots, x_k$. In the case of Shapley value decomposition, both the income variable and the functional form can take any form but in this paper we use a linear functional form so that we can compare the results with the method by Fields.[1] The Shapley value decomposition aims to measure the contribution of x_k to total inequality. Decomposition can be carried out in two ways (Sastre and Trannoy, 2001a, 2001b). The first approach is known as *zero income decomposition*. According to this approach, the Shapley decomposition is obtained by calculating the extent by which $\hat{\sigma}^2_y$ would change if income flows from x_k, that is $\hat{\beta}_k x_k$, were to be removed from total income y. The second approach is known as *equalized income decomposition*. According to this approach, the Shapley decomposition is obtained from the change in $\hat{\sigma}^2_y$ after eliminating the inequality in x_k. That is the change in $\hat{\sigma}^2_y$ after replacing x_k by its sample mean. Chantreuil and Trannoy (1999) point out that the theoretical basis for choosing one approach over the other is inconclusive. We have opted for the *zero income decomposition* which is used in Shorrocks (1999).

Let $\hat{y}_k = \hat{y} - \hat{\beta}_k x_k$ be estimated total income after removing income flow from x_k. Let $\hat{\sigma}^2_{y_k}$ be the inequality in $\hat{y}_k$. The difference, $\hat{\sigma}^2_y - \hat{\sigma}^2_{y_k}$ represents the contribution to total inequality from x_k. This difference is known as the "first-round marginal effect" (Shorrocks, 1999). In the first round we remove the effect of one x at a time. One can perform a second-round effect by removing two x's simultaneously and then calculating $\hat{y}_{kj} = \hat{y} - \hat{\beta}_k x_k - \hat{\beta}_j x_j$. The change in inequality, $\hat{\sigma}^2_{y_j} - \hat{\sigma}^2_{y_{kj}}$ represents the contribution of x_k in the second round. Similarly, the effect of the third round can be obtained as $\hat{\sigma}^2_{jl} - \hat{\sigma}^2_{kjl}$. When the income generating function includes several x's there would be many sequences in which x_k can be removed in each round. Hence the total contribution of x_k to inequality is the average of the contributions in all sequences in each round and then the average for all such rounds. This makes sure that the estimated contribution of each variable to total inequality does not depend on the order in which it is eliminated. For details of the procedure see Shorrocks (1999) and Kolenikov and Shorrocks (2005). See also Sastre and Trannoy (2001a, 2001b) for a more mathematical exposition and the exact decomposition formulae.

The Shapley decomposition methodology also permits one to calculate the proportion of total inequality that is not explained, that is $\sigma^2_y - \hat{\sigma}^2_y$, where σ^2_y is inequality calculated using actual income data.

[1]It should be noted that equation (2) is a rather rigid specification imposing a constant "price" of characteristics x and the same functional form is applied across all sectors of the economy. However, this specification is required for the Fields method.

The Shapley value decomposition results can also be applied to equation (4) to calculate how much of the difference in income inequality between two time periods is accounted for by the explanatory factors. Here, s_{kt} would be the contribution of x_k to total inequality obtained using Shapley decomposition in year t as averaged across all possible eliminating sequences in each round and these round-based averages averaged again for all rounds.

3.3. *Yun's Unified Method*

Yun (2006) suggested a more comprehensive method to decompose the change in inequality between two time periods. The technique unifies the decomposition methods of Fields (2003) and Juhn, Murphy, and Pierce (1993) in order to investigate the contribution of factors at aggregate level as well as at the level of each variable. Note that these contributions derive from the statistical relationship between parameters as in the Fields (2003) and Juhn, Murphy, and Pierce (1993) methods. Hence the Shapley decomposition cannot be extended in the same way as it is based entirely on the mechanism or procedure of elimination rather than on statistical parameters. In what follows we present Yun's (2006) method by using his own clear notation.

Consider comparing two time periods, A and B. Let y_A and y_B be two vectors of the log of individual income for the two time periods. The income generating functions for the two time periods can be written as:

$$\begin{aligned} y_A &= \beta_{0A} + \beta_{1A}x_{1A} + \beta_{2A}x_{2A} + \cdots + \beta_{KA}x_{KA} + \varepsilon_A \\ y_B &= \beta_{0B} + \beta_{1B}x_{1B} + \beta_{2B}x_{2B} + \cdots + \beta_{KB}x_{KB} + \varepsilon_B, \end{aligned} \tag{5}$$

where x_{kA} and x_{kB} are the k-th exogenous variable in each time period. The specification assumes a constant "price" of characteristics x_k and the same functional form across all sectors of the economy. The difference in inequality between the two time periods can be measured by the difference in the variance of log of income as $\sigma^2_{yA} - \sigma^2_{yB}$.

Let y^* be defined as:

$$y^* = \beta_{0B} + \beta_{1B}x_{1A} + \beta_{2B}x_{2A} + \cdots + \beta_{KB}x_{KA} + \varepsilon_A. \tag{6}$$

The unified method decomposes the difference in inequality, $\sigma^2_{yA} - \sigma^2_{yB}$, into the characteristics, coefficients, and residuals effects as follows:

$$\sigma^2_{yA} - \sigma^2_{yB} = \sum_{k=1}^{K}\left(s_{ky^*}\sigma^2_{y^*} - s_{kyB}\sigma^2_{yB}\right) + \sum_{k=1}^{K}\left(s_{kyA}\sigma^2_{yA} - s_{ky^*}\sigma^2_{y^*}\right) + \left(\sigma^2_{eA} - \sigma^2_{eB}\right). \tag{7}$$

In this equation, s_{ky^*}, s_{kyA} and s_{kyB} are relative factor inequality weights for a factor k using the income definitions y^*, y_A and y_B, respectively. Using s_{kyA} as an example, it is defined as $s_{kyA} = (\beta_k\sigma_{xA,k}\rho_{xk,yA})/\sigma_{yA}$ where $\rho_{xk,yA}$ is the correlation coefficient between x_k and y_A.

In equation (7), the first, second, and third terms on the right hand side are the characteristics, the coefficients, and the residuals effects, respectively. The characteristics effect or quantity effect denotes the contribution to the change in total

inequality of a change in the number of individuals with that particular attribute. The coefficient effect or price effect denotes the contribution to the change in inequality of a change in returns to that factor. The residual effect denotes the contribution to the change in inequality, at aggregate level, of changes in factors unexplained by the model.

3.4. *Variables*

The dependent variable used in the regression-based decomposition analysis is the log of real consumption expenditure per adult equivalent. The independent variables $x_1, \ldots, x_k$ influence the level of household consumption. They are classed as five groups: demographic, education, occupation, infrastructure, and spatial characteristics. Infrastructure variables are included in the equation because they are income generating factors that represent the availability of productive economic infrastructure in the local environment due to infrastructure investment by service providers. In Sri Lanka, these services have largely been provided by the public sector. We include only provincial dummies as spatial variables and exclude rural and urban dummies. This is because the rural–urban definitions in the surveys are based on administrative definitions rather than on settlement characteristics.

The income generating equation includes 24 variables (see Table 4 for the list and the definitions). But in the decomposition analysis, inequality is decomposed only into seven as ethnicity, education, occupation, infrastructure, and spatial variables are treated as groups rather than separately.

4. Results

4.1. *Regression Results*

Table 4 sets out the regression coefficients for all five survey years, estimated using *Stata*. The regressions appear to perform well. R^2 varies from 0.34 to 0.48, which is reasonable for cross-sectional regressions of this sort. Almost all of the included regressors are significant and have the expected signs. We discuss them under each group of variables in what follows.

As far as demographics are concerned, the results show that per adult equivalent consumption increases with the proportion of adults in the household, more so for males than for females other than in 1995.

Coefficients of the ethnic dummies are interesting. They show that Sri Lankan Tamils are better-off on average than the Sinhalese (reference group) but the results are significant only for 1985 and 1995. It should be recalled that the data relate to the provinces outside the conflict areas of the north and the east where a little more than half of the Sri Lankan Tamil population reside.

Indian Tamils are on average better off than the majority Sinhalese community. The positive sign and significance of the coefficient on the "ethnic other" dummy other than for 1980 reveals that on average they, too, are better off than the majority Sinhalese. This is to be expected since they include small groups such as the Borahs and the Sindhis who are mercantile communities and well represented in the business sector, as well as the Burgher community, descendants

TABLE 4

Regression Results (dependent variable: log of expenditure per equivalent adult)

	1980	1985	1990	1995	2002
Demography					
Adult males, share	0.3450**	0.3719**	0.2982**	0.3385**	0.1724**
	(0.0318)	(0.0160)	(0.0168)	(0.0171)	(0.0185)
Adult females, share	0.2231**	0.2939**	0.2857**	0.3385	0.1209**
	(0.0358)	(0.0171)	(0.0174)	(0.0178)	(0.0194)
Sri Lankan Tamil dummy	0.0032	0.0817**	0.0212	0.0695**	0.0279
	(0.0293)	(0.0158)	(0.0149)	(0.0137)	(0.0169)
Indian Tamil dummy	0.0800**	0.2284**	0.23**	0.1427**	0.0669**
	(0.0277)	(0.0166)	(0.0176)	(0.0150)	(0.0171)
Ethnic Moor dummy	–0.0083	–0.0632**	–0.0886**	–0.1001**	–0.0333*
	(0.0331)	(0.0136)	(0.0135)	(0.0156)	(0.0148)
Ethnic other dummy	0.1200	0.1555**	0.2089**	0.1992**	0.1659**
	(0.0696)	(0.0359)	(0.0346)	(0.0458)	(0.0468)
Education					
Secondary education, share	0.2134**	0.1940**	0.1647**	0.1088**	0.1951**
	(0.0211)	(0.0104)	(0.0111)	(0.0114)	(0.0121)
GCE O level, share	0.4421**	0.4688**	0.3786**	0.3448**	0.4067**
	(0.0308)	(0.0148)	(0.0143)	(0.0145)	(0.0152)
GCE A level, share	0.5598**	0.5862**	0.5289**	0.5471**	0.6001**
	(0.0664)	(0.0296)	(0.0270)	(0.0226)	(0.0197)
University, share	0.7508**	0.7127**	0.8012**	0.7729**	0.8863**
	(0.1201)	(0.0460)	(0.0500)	(0.0470)	(0.0385)
Occupation					
Unemployed, share	–0.2318**	0.0489**	–0.3830**	–0.3997**	–0.2986**
	(0.0322)	(0.0144)	(0.0223)	(0.0235)	(0.0199)
Managers, share	0.3384**	0.5254**	0.3692**	0.4232**	0.3165**
	(0.0651)	(0.0298)	(0.0303)	(0.0299)	(0.0242)
Clerical, share	0.4308**	0.4874**	0.3062**	0.3426**	0.2617**
	(0.0700)	(0.0295)	(0.0308)	(0.0314)	(0.0359)
Service workers, share	0.2847**	0.3990**	0.2544**	0.2747**	0.0427
	(0.0428)	(0.0193)	(0.0194)	(0.0198)	(0.0369)
Farmers, share	0.0381	0.2137**	0.2130**	0.1400**	0.0708**
	(0.0298)	(0.0136)	(0.0128)	(0.0122)	(0.0135)
Infrastructure					
Vehicle, dummy	0.3698**	0.3306**	0.3699**	0.3587**	0.2818**
	(0.0282)	(0.0122)	(0.0107)	(0.0105)	(0.0103)
Electricity dummy	0.2507**	0.2588**	0.2251**	0.2165**	0.1964**
	(0.0213)	(0.0090)	(0.0084)	(0.0081)	(0.0083)
Telephone dummy	0.3851**	0.4740**	0.2979**	0.3761**	0.3983**
	(0.0701)	(0.0316)	(0.0222)	(0.0815)	(0.0097)
Spatial					
Central Province	–0.1407**	–0.0843**	–0.0551**	–0.085**	–0.0929**
	(0.0204)	(0.0105)	(0.0105)	(0.0108)	(0.0108)
Southern Province	–0.1138**	–0.0952**	–0.0260*	–0.0635**	–0.1189**
	(0.0209)	(0.0103)	(0.0104)	(0.0111)	(0.0116)
North Western Province	–0.0437*	–0.0206	–0.0598**	–0.0753**	–0.1129**
	(0.0213)	(0.0115)	(0.0119)	(0.0122)	(0.0123)
North Central Province	0.1005**	–0.0052	–0.0082	0.0283	0.0099
	(0.0322)	(0.0133)	(0.0135)	(0.0147)	(0.0151)
Uva Province	–0.2339**	–0.0573**	–0.0474**	–0.1651**	–0.1296**
	(0.0282)	(0.0128)	(0.0132)	(0.0135)	(0.0147)
Sabaragamuwa Province	–0.0409	–0.1140**	–0.0209	–0.0801**	–0.1472**
	(0.0225)	(0.0115)	(0.0117)	(0.0119)	(0.0124)
Constant	5.3539**	5.1237**	5.3565**	5.4404**	5.6339**
	(0.0351)	(0.0171)	(0.0160)	(0.0172)	(0.0191)
Observations	4,514	19,470	18,459	19,747	16,922
R-squared	0.37	0.38	0.34	0.36	0.48

Notes:

1. Standard errors in parentheses; *significant at 5%; **significant at 1%.

2. Variable definitions:

Adult males, share and *Adult females, share* are the proportions of adult male and female members of working age (more than 16 years of age) in a household.

The education variables denote the proportion of household members of working age who have completed the four levels of education. *Secondary education* denotes between 6 and 10 years of schooling. *GCE O level* and *GCE A level* denote success at the 10th and 12th year qualifying examinations.

Variables for occupation and employment status denote the proportion of household members of working age in five categories. Managers, clerks, and service sector workers in the 2002 survey are salaried employees only whereas the earlier surveys included salaried and self-employed workers.

Of the infrastructure dummies, *Vehicle* denotes access to motorable roads by bicycle, scooter, motorbike, car, or van. Where the surveys do not contain explicit information, evidence of expenditure on these items or ancillaries within the survey reference period is inferred as access.

3. The reference categories in the dummy variable analyses are: majority Sinhalese ethnic group; share of household members of working age with only primary education or less; share of household working members employed; share of household workers who are product workers and in occupations not classified elsewhere; household has no vehicle; no electricity; no telephone; resident in Western Province.

of Portuguese and Dutch colonialists and settlers. In contrast, ethnic Moors have been consistently worse off than the Sinhalese.

Education increases expenditure and increasingly so for higher levels. Over the years, however, returns to the proportion of household workers with only secondary education have declined somewhat. Even so, returns to the proportion of workers educated up to GCE A levels and more have increased. Unemployment has a decreasing, significant effect on income other than in 1985, when, surprisingly, it is associated with higher expenditure. More skilled occupation status is associated with higher expenditure and the results are significant. For example, the share of managers in a household is associated with a larger coefficient than the share of service sector workers, who in turn are associated with higher expenditure than households with a larger share of adult members engaged in farming.

All three infrastructure-related dummies have positive and significant coefficients, denoting that ownership of vehicles, and access to electricity and telephones are associated with higher expenditure.

The possible presence of endogeneity cautions against giving too much weight to the precise magnitudes of the contributions of these variables to consumption, particularly in the case of infrastructure. Even so, it is well known that efficient transport, electricity, and telecommunications services raise productivity levels, integrate markets, and enable factors of production to flow to areas and sectors with the best possible returns. Hence it is plausible that such factors raise the income-generating capacity of individuals who have access to them.

All regional dummies other than for North Western Province for 1985, North Central Province for 1985, 1990, 1995, and 2002, and Sabaragamuwa Province for 1990, are negative and significant, denoting that on average, residents living in these provinces are worse off than those living in Western Province (reference group). This is to be expected as Western Province with its metropolitan hub of Colombo, is the most favored region in terms of both infrastructure development and economic activity. The positive coefficients on the North Central Province dummy for 1980, 1995, and 2002 are puzzling, for, as in all other provinces, one would expect consumption in this province for these years to be lower on average than consumption in Western Province. Nevertheless, other than for 1980, the results are not significant.

4.2. *Results of Fields and Shapley Value Decompositions*

We use the regression results to calculate inequality weights using the Fields and Shapley procedures in order to decompose the level of inequality in each survey year by each factor. Recall that inequality is decomposed into only seven components as we group the ethnicity, education, occupation, infrastructure, and spatial variables.

The results of both decomposition procedures of the variance of log of expenditure, σ_y^2 in terms of the percentage share of total inequality explained by each factor are presented in Table 5.[2] The panel with the Shapley value decomposition

[2]Estimation was carried out using *Stata*. Kolenikov's (2000) Shapley.ado program was extensively modified and adapted for this purpose.

TABLE 5

Factor Contribution to Inequality Level Using Fields and Shapley Value Decomposition Methodologies (%)

	Fields Decomposition Methodology					Shapley Value Decomposition Methodology				
	1980	1985	1990	1995	2002	1980	1985	1990	1995	2002
Adult males	2.36	2.16	1.32	1.18	0.30	2.13	2.05	1.22	1.22	0.29
Adult females	0.21	0.74	0.74	1.20	0.29	0.63	1.16	1.01	1.49	0.41
Ethnicity	–0.11	0.31	0.58	–0.14	–0.13	–0.06	0.29	0.57	–0.14	–0.14
Education	11.62	12.46	10.82	11.66	15.14	11.11	11.78	10.33	11.13	14.17
Occupation	6.47	6.72	4.85	5.30	4.02	5.58	6.02	4.44	5.00	3.85
Infrastructure	12.93	14.89	15.05	14.70	25.60	13.84	15.57	15.08	14.86	25.76
Spatial	3.13	1.19	0.46	1.96	2.30	3.20	1.21	0.46	1.98	2.32
$\hat{\sigma}^2_y$						36.42	38.08	33.12	35.54	46.64
Residual	63.39	61.53	66.19	64.15	52.47	63.58	61.92	66.88	64.46	53.36
σ^2_y	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

results also contains the contribution of the estimated variance of log of expenditure, $\hat{\sigma}_y^2$, of the saturated model (or the model that includes all explanatory variables in its calculation of predicted expenditure) to total inequality calculated on original expenditure data. Note that the five values of σ_y^2 decomposed using the two methods are those presented in Table 3. We present the contributions to total inequality of the residual in order to indicate the extent to which the explanatory variables together account for total inequality.

It can be seen that the two methods yield remarkably similar results, in terms of both magnitude and direction. Hence, in what follows we discuss the results from the Shapley value decomposition only. While income flows from all groups of endowments appear to have contributed positively to increase inequality, income flows from access to infrastructure accounted for the largest share of total inequality. Its contribution to total inequality increased progressively over the years from 14 percent in 1980 to 26 percent of inequality in 2002. This is followed by education which accounts for between 11 and 14 percent. No clear trend is visible. Income flows from occupation endowments contributed between 4 and 6 percent over the period, but its contribution to inequality appears to be declining slightly. The contribution to inequality from demographic characteristics has been minimal. The contribution of spatial factors has decreased during the 1980s and increased thereafter. The contribution of unidentified factors (denoted by the residual) has been stable until 1995 after which it declined.

Table 6 sets out the factor contributions to the change in inequality using the factor inequality weights produced by the Fields and Shapley decomposition methods. Again, as expected, both methods yield very similar results. Recall that the change in inequality decomposed here is the change in the variance of log of expenditure calculated using original expenditure and it is apparent that σ_y^2 rose consistently during all sub-periods other than the period 1985–90. Also note that a positive contribution denotes that the factor or group of factors acted to intensify the change in inequality in whichever direction the change took place.

In terms of groups of factors, infrastructure, occupation, and education helped increase inequality in the three sub-periods when inequality rose. They also helped decrease inequality in the period 1985–90. It is apparent that the main drivers of inequality increase over the period have been infrastructure and education: education consistently so, with a marked spurt toward the end of the period; infrastructure more spectacularly, again in the last sub-period. Note how the contribution to inequality of income from ethnic endowments has reversed gear—from pushing the increase in inequality in the 1980s, to mitigating it, however weakly, from then onwards. Income from spatial endowments reduced the rise in inequality only in the 1980s, but contributed positively toward its rise between 1990 and 2002.

Thus, the Fields and Shapley value decompositions show that income flows associated with access to infrastructure, education, and occupation were the principal determinants of inequality and the main drivers of the change in expenditure dispersion in Sri Lanka during the reference period. In fact, the contribution of income flows from education and infrastructure to total inequality increased drastically between 1990 and 2002. The contribution from income flows associated with occupation endowments has declined slightly during this period. In contrast,

TABLE 6

Factor Contribution to Inequality Changes Using Fields and Shapley Value Decomposition Methodologies (%)

	Fields Decomposition Methodology				Shapley Value Decomposition Methodology			
	1980–85	1985–90	1990–95	1995–2002	1980–85	1985–90	1990–95	1995–2002
Adult males	0.13	12.53	0.25	−5.11	1.33	12.31	1.25	−5.48
Adult females	5.93	0.81	4.33	−5.34	6.29	3.07	4.68	−6.28
Ethnicity	4.40	−3.01	−4.97	−0.06	3.67	−3.23	−4.88	−0.18
Education	20.65	32.74	17.26	36.67	18.36	29.71	16.44	32.99
Occupation	9.25	29.94	8.34	−3.89	10.37	25.63	8.78	−3.26
Infrastructure	33.91	12.84	12.34	93.13	32.35	21.56	13.37	93.23
Spatial	−17.74	10.21	12.01	4.46	−18.19	10.38	12.18	4.37
Residual	12.44	−8.50	20.64	−149.42	45.82	0.56	48.18	−15.39
Change in σ_y^2	10.30	−7.49	14.92	16.15	10.30	−7.49	14.92	16.15

TABLE 7
DECOMPOSITION OF INEQUALITY CHANGES USING YUN'S UNIFIED METHOD (%)

	1980–85		1985–90		1990–95		1995–2002	
Decomposition	Char	Coeff	Char	Coeff	Char	Coeff	Char	Coeff
Adult males, share	–0.42	0.55	4.68	7.84	–2.03	2.28	–0.45	–4.66
Adult females, share	0.38	5.55	–6.44	7.26	1.50	2.83	0.64	–5.98
Ethnicity	–3.85	8.25	6.35	–9.36	–2.95	–2.01	0.25	–0.31
Education	18.87	1.77	–12.36	45.09	16.32	0.94	28.59	8.08
Occupation	12.78	–3.53	77.46	–47.52	1.80	6.55	10.08	–13.97
Infrastructure	35.80	–1.89	–31.50	44.34	10.16	2.17	113.23	–20.10
Spatial	0.43	–18.17	–1.16	11.37	3.91	8.10	2.11	2.35
Total	63.99	–7.47	37.04	59.02	28.71	20.86	154.45	–34.59
Residuals	43.47		3.94		50.44		–19.86	
Change in σ_y^2	–10.30		7.49		–14.92		–16.15	

Note: Char and Coeff denote characteristics and coefficient effects.

demographic factors, including income flows from ethnicity, and spatial factors contributed relatively little.

While this analysis decomposes the variance of log of expenditure, σ_y^2, elsewhere we have applied the Shapley value method to decompose inequality as measured by the Gini coefficient (see Gunatilaka, 2005). While the percentage contributions to inequality for different factors using the variance of log of expenditure are much smaller in magnitude than when using the Gini coefficient, whether calculated on expenditure (Gunatilaka, 2005) or on log of expenditure (not reported), the directions of change remain the same. In contrast, the Fields decomposition method will yield the same percentage contribution of each variable no matter what inequality index it is applied to, so long as the inequality index to be decomposed is based on the logarithm of income (or expenditure) (Fields, 2003).

Both the Fields and Shapley decomposition methods yielded similar results when applied to σ_y^2 because both methods used the same framework of identical income generating function and inequality index. However, the Shapley decomposition method is to be preferred because: (i) it takes into account different sequences of considering the variable x; and (ii) it is a more general approach in the sense that the income generating function can be of any form and it can be applied to any inequality measure.

4.3. *Decomposition of Change in Inequality Using Yun's Unified Method*

Decomposition using the unified method enables the decomposition of the changes in income inequality into characteristics or quantity effects and coefficients or price effects of the different factors. It also decomposes overall change in inequality to the effect of factors unexplained by the model.

Table 7 shows the results of decomposing the differences in expenditure inequality using the unified method. The contributions of total characteristics, coefficients, and residuals to overall inequality change for each of the time periods are all set out at the bottom of the table. Note that a negative change in variance

of log of adjusted expenditure during a sub-period denotes an increase in inequality as measured by the index. It can be seen that throughout the period total characteristics have contributed positively to the change in inequality, when inequality rose in the 1980–85, 1990–95, and 1995–2002 periods, as well as when inequality declined in the 1985–90 period. In contrast, coefficients or price effects worked to mitigate the rise in inequality during the first sub-period and the last sub-period only. The contribution of residuals to total inequality change has been positive in all the sub-periods other than in 1995–2002 when it worked to mitigate the rise in inequality.

Education, occupation, and access to infrastructure are the main determinants of inequality change. In each sub-period, education's quantity effect has worked to increase inequality. Note that even when inequality declined in 1985–90, the quantity effect of education worked to reduce the decline. In contrast, the coefficient effect or price effect has been generally small other than in 1985–90 when it worked to reduce inequality during that sub-period. The contribution of quantity and price effects of occupation has been greatest in the 1985–90 period when quantity effects of occupation contributed to decrease inequality and price effects worked to increase inequality. The characteristics effects of infrastructure access, like education, have worked to increase inequality during each sub-period, especially in the last. The price effects of infrastructure access have also worked to increase inequality other than in the first and last sub-periods.

In the next section we draw the policy implications of these results.

5. Conclusions and Policy Implications

This study showed that income inequality in Sri Lanka rose after economic liberalization, even as all income groups ended the period enjoying higher levels of income than they had at its beginning. The principal determinants of inequality change were access to education, occupation, and infrastructure.

The findings suggest a growth-equity trade off: economic liberalization and concomitant economic growth has caused inequality to rise in a stereotypical Kuznets-like phenomenon. Forces of economic growth unleashed by economic liberalization appear to have increased returns to certain income-earning assets of households such as education and infrastructure, as shown by the contribution of coefficients of the unified method. The ability to access such assets shown by the quantity effects has influenced household income and in turn, contributed to the dispersion of household income.

Thus, the macroeconomic policy framework that favored trade liberalization and economic growth, and sectoral policies investing in education and infrastructure services, have caused incomes to rise across the board, though proportionately more for the higher income ranges. The Sri Lankan case appears to be a clear example of how these policies complement each other and lead to greater income prosperity.

However, inequality also increased. And given that 23 percent of the population were found to be below the official poverty line in 2002 and that poverty has declined only marginally since 1990 (Narayan and Yoshida, 2004), the analysis

suggests that the government urgently needs to undertake pro-poor investments in education and infrastructure provision.

But this needs a well-calibrated approach. For example, it is not enough to merely build roads in rural areas where many of the poor reside. Rather, the emphasis should be on investing in regional growth centers, increasing connectivity, and integrating communities with markets. Government will also need to provide a public transport service where it is unviable for private transport service providers to do so. Restoring the rural transport services which became the casualties of an ideologically-driven, ill-planned privatization of the system would enable those at the bottom end of the income distribution to benefit from the economic liberalization process.

While such investments would enable those in the lowest income strata to move up along the income distribution and out of poverty, they may not succeed in narrowing income gaps: trade liberalization and technological change can increase returns to some factors and exacerbate income differentials. A practical approach to the problem would be to contain the social tensions that would inevitably arise with increasing inequality, a flashpoint for social conflict in diverse societies like Sri Lanka's. Policies need to be designed and targeted in such a way that the stresses generated by rising inequality do not occur along sectoral, regional, and ethnic fault lines. That is, the government needs to be vigilant and design and implement policies that mitigate the rise of inequality between population groupings that can mobilize along any of these attributes, cite that attribute as being a cause for discrimination or neglect, and mount a violent protest against the rest of society and the state.

Appendix

TABLE A1

Consumption Inequality Measures

Inequality Measure	1980	1985	1990	1995	2002
Gini	0.310	0.323	0.309	0.336	0.355
Variance of log of income	0.281	0.310	0.287	0.329	0.382
Generalized entropy					
GE ($a = 0$)	0.158	0.172	0.156	0.183	0.204
GE ($a = 1$) (Theil)	0.184	0.200	0.177	0.212	0.227
Atkinson					
A ($\varepsilon = 0.5$)	0.081	0.088	0.079	0.094	0.102
A ($\varepsilon = 1$)	0.146	0.158	0.144	0.167	0.184
A ($\varepsilon = 2$)	0.246	0.267	0.248	0.278	0.309

Notes: All inequality measures except variance of log of adjusted expenditure generated using Jenkins' (2006) INEQDECO: Stata module to calculate inequality indices with decomposition by subgroup, http://econpapers.repec.org/software/bocbocode/s366002.htm

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