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The Routledge Handbook of Environmental Economics in Asia, Edited by Shunsuke Managi
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Sri Lanka Journal of Economic Research

The International Journal of the Sri Lanka Forum of University Economists

Aims and Scope

Sri Lanka is currently facing many transitions: economic, epidemiological, demographic, technological and social. The world economy too is evolving, with technological progress, economic crises and social upheavals demanding more and alternative economic analyses. Both these factors make it imperative for economists in Sri Lanka and overseas, among the academic community as well as practitioners, to focus on economic research and its dissemination. The journal of the Sri Lanka Forum of University Economists seeks to fulfill this mandate.

The Sri Lanka Journal of Economic Research (SLJER) creates a space where research, particularly policy related research, can be disseminated and so contributes to the economic thinking in the country in this period. The critical evaluation of policy is essential if optimal use is to be made of the demographic window of opportunity. Equity and social welfare, the cornerstone of economic thinking in the country, and the challenges posed to such fundamentals by economic liberalization, globalization and technological progress make it vital to dwell on ideas and ideals, as well as to collate systematic evidence to support rational policy making. The aim of this journal then is to support such processes through dissemination and discussion.

The SLJER is a refereed tri-lingual journal. The journal will primarily provide an opportunity for authors presenting papers at the annual sessions of the Sri Lanka Forum of University Economists to disseminate their contributions. Apart from the research articles the journal carries a special section titled ’Perspectives’ which articulates alternative thinking and approaches to Economics. Book reviews are included as well.

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64, Sukhasthan Gardens, Ward Place,  
Colombo 7, Sri Lanka.  
Telephone: +94 112 69 39 74  
Fax: +94 112 69 39 75  
Email: info@ncas.ac.lk  
Web: www.ncas.ac.lk |

INQUIRIES

All inquiries to be directed to:

Secretariat of the SLJER (2012), Department of Economics, University of Colombo, Kumaratunga Munidasa Mawatha, Colombo 3, Sri Lanka.  
Telephone: +94 112 58 26 66  
Fax: +94 112 50 27 22  
Email: editor.sljer@gmail.com;

Secretariat (2013) of the Sri Lanka Forum of University Economists,  
Department of Economics and Statistics, University of Peradeniya, Sri Lanka;  
Telephone: +94 812 39 26 22  
Fax: 94 812 39 26 21  
Email: journalslerc@yahoo.com

Secretariat (2014) of the Sri Lanka Forum of University Economists,  
Department of Economics, University of Ruhuna, Sri Lanka;  
Telephone: +94 (0) 41 22 22 681/Ext 32 02  
Email: ruh2014slfue@gmail.com

Secretariat designate (2015) of the Sri Lanka Forum of University Economists, Department of Business Economics, University of Sri Jayawardenapura, Sri Lanka  
Telephone: +94 (0) 28 02 005  
Intercom: 8811  
Email: slfue@sjp.ac.lk
PANEL OF REVIEWERS

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RESEARCH ARTICLES
THE IMPACT OF CURRENCY DEPRECIATION AND TRADE LIBERALIZATION ON TRADE BALANCE OF SRI LANKA

Nandasiri Keembiyahetti
Athula Naranpanawa

Abstract

This study examines the impact of trade liberalization and currency depreciation on the trade balance of Sri Lanka. Using the bounds testing ARDL approach for co-integration, which is more suitable for small finite sample cases, we found that there was a long run co-integrating relationship between the trade balance and its determinants; particularly the Trade Openness and Real Exchange Rate. Our findings suggest that 1% increase in trade openness leads to 0.48% deterioration, while 1% depreciation of local currency leads to 0.45% improvement in the Trade Balance Ratio of Sri Lanka given all else remaining unchanged. These findings solve the fundamental dilemma, why Sri Lanka’s Trade Balance continued to deteriorate; despite of substantial currency devaluations/depreciations allowed during past five decades. Our findings conclude that a more powerful negative impact arising from trade openness fully offset the positive impact arising from currency depreciation; thereby leading the Trade Balance into deficit, eventually in the long run. Accordingly, we found trade liberalization and devaluation are counter-cyclical as policy tools.

Keywords: – Trade Liberalization, Trade Balance, Bounds Testing, ARDL, Sri Lanka JEL classification: C22; C51; F14

Nandasiri Keembiyahetti
Senior Lecturer, Department of Economics, Faculty of HSS, University of Ruhuna, Matara, Sri Lanka. Email; nandasiri2007@gmail.com

Athula Naranpanawa
Associate Professor, Department of Accounting, Finance and Economics, Griffith Business School, Gold Coast Campus, Griffith University, Queensland 4222, Australia. Tel: + 61 7 5552 8083 Fax: +61 7 5552 8068 E-mail address: a.naranpanawa@griffith.edu.au
INTRODUCTION

Trade Liberalization refers to the removal or reduction of artificial barriers to trade goods and services among nations. This includes the reduction or removal of tariff (import duties and surcharges) and non-tariff barriers (licensing, quotas, rules of origin, exchange restrictions). Trade liberalization on the one hand encourages countries to be specialized in producing the goods and services, for which they have comparative advantages. On the other hand the removal of barriers would result affordably low prices for consumers. Moreover, trade liberalization exposes local producers for greater competition emerging from other nations. This would stimulate to increase production efficiency, cost reduction or provide an incentive for an industry to move resources into new ventures, not vulnerable to competition. Trade Liberalization enables economies of scale and greater specialization, particularly for small economies, having geographical limitations in very own country.

Sometimes, Trade Liberalization might be threatening the balance of an economy. Some industries may grow faster, some might be sluggish or collapse; thereby causing structural unemployment. Trade Liberalization can often be painful to less developed countries, having a great deal of infant industries that cannot compete against foreign competition. On the top of all, Trade Liberalization may create or worsen the existing trade imbalances among nations.
The effect of Trade Liberalization on the trade balance is theoretically indeterminate. The Elasticity Approach suggests the effect will depend on the price elasticity of demand for imports and exports, as well as the extent to which the liberalization causes to change the relative price of export and import. Though the relative prices could be enormously changed due to tariff reduction under Trade Liberalization, it does not assure improvement in trade balance unless Marshall-learner (ML) condition; together with its assumptions is satisfied. Nevertheless, ‘Trade Openness’ is a broader concept beyond reduction of tariffs, which involves removal of non-tariff barriers and exchange controls as well. Hence, the Elasticity approach alone does not suffice to conclude whether openness improves or worsens the trade balance. The Absorption Approach to the balance of payments by Sydney Alexander (Haberler, 1976) suggests the effect of liberalization will depend on how real income is affected in relation to real absorption. A reduction in import duties will shift expenditure to imported goods, thereby raising foreign exchange outflows; but a reduction in export duties does the opposite. Yet, the balance of payments will not improve if the propensity to absorb is greater than unity.

Given this theoretical ambiguity, the impact of trade openness on the trade balance becomes an empirical issue. ‘Trade Openness’ has become an important policy variable for developing countries for the last few decades, its impact on trade balance has recently received a great deal of attention from researchers and policy makers alike; as
many developing countries continue to embark on Trade Liberalization entering into bilateral, regional, and multilateral trade agreements. This process was further encouraged by the World Bank and World Trade Organization (WTO)

The objectives of this study are as follows: (a) To examine whether long-run level relationship exists between trade balance of Sri Lanka and its determinants using recent bound testing techniques (b) To estimate the short-run and long-run elasticity of trade openness and to exchange rate with respect to the trade balance using ARDL and EC models (c) To evaluate trade openness and to exchange rate devaluation as policy tools to rectify the persistent balance of trade problem in Sri Lanka.

The remainder of this paper is organized as follows: beginning with a brief literature review on ‘Trade Openness’ and balance of trade nexus, it subsequently presents theoretical and econometric specification of the model, Then, it discusses the empirical results, and finally, concludes the findings and presents policy recommendations.

**BRIEF LITERATURE REVIEW**

Ostry and Rose (1992) using five different data sets (including one for developing countries) found no statistically significant effect of tariff changes on the real trade balance. Lutz and Singer (1994) addressed the question of the effect of Trade Liberalization on a country’s term
of trade, based on a sample of 91 countries for 1968-88 including both LDCs and industrialized countries. Their study conclude that liberalization is likely to lead to the deterioration of the term of ‘trade,’ if Trade Liberalization was aimed at raising the size of the tradable sector, either in absolute or relative terms. Santos-Paulino (2004) using dynamic panel data and time series/cross-section analysis on the trade balance and the current account balance of twenty two developing countries from Latin America, Africa, East Asia and South Asia; where significant trade reforms had been undertaken since the mid-1970s. It has been found that liberalization has worsened the balance of trade and the balance of payments; because imports have increased more rapidly than exports. Using Bounds Testing Approach and Auto-Regressive Distributed Lags (ARDL) model, Klasra (2011) tested the existence of long run equilibrium relationship between the determinants of growth during the period 1975–2004 for Pakistan and Turkey. The results concluded that there is bi-directional causal relationship between ‘Trade Openness’ and exports for Pakistan in the short run. Moreover, they found that openness-growth nexus holds true for Pakistan, and growth-driven exports hypothesis receives empirical support for Turkey in the long run. Allaro (2012) examined the impact of Trade Liberalization on the Ethiopia's trade balance, using the data over the period 1974 to 2009; and found evidence to substantiate the fact that Trade Liberalization led to deteriorate the trade balance due to speedy increase in imports. Islam (2004) applied the Bounds Test to determine the existence of a level relationship between government sizes, openness, terms of trade volatility, and external risk using time
series data from Australia, Canada, England, Norway, Sweden, and the US. Bounds Test results revealed that the existence of a long run relationship in the US and Canada; but not in any of the other countries.

Among the studies pertaining to Sri Lanka, Chowdhury and Saleh (2007) examined the long-run and short-run relationships between the current account deficit, budget deficit, savings and investment gap and ‘Trade Openness’ in Sri Lanka using the Auto-Regressive Distributive Lagged (ARDL) Approach. They found that ‘Trade Openness’ has a positive effect on the current account deficit, but is statistically insignificant. The result is not surprising, because the current account balance includes private remittances from abroad; which is exogenous to openness but helps in great deal to smooth the current account deficit in Sri Lanka. Weliwita and Tsujii (2000) examined the responsiveness of Sri Lanka’s trade deficit to currency devaluation during the post liberalization period. The findings revealed that devaluation of Sri Lankan rupee turned the trade deficit bad to worse, because trade volumes were not responsive to the changes in real exchange rates. De Silva and Zhu (2004) examined the effect of devaluation of rupee on the trade balance and GDP using VAR and ECM, supplemented by Variance Decomposition and Impulse Response Analysis. Their findings based on aggregate annual data for 1977-1997, revealed that the new exchange rate policy after 1977 has improved the trade balance, but has failed to stimulate real output at least in the short run.
A couple of fundamental macroeconomic problems that Sri Lanka has been facing since the 1950s is the declining terms of trade and widening trade gap. When the earnings from the traditional agricultural exports of tea, rubber, and coconut had been weakening in the international marketplace in the early 1960s, governments responded to this situation by introducing tight regulations over foreign exchange. Imports and exports were strongly regulated. This trend had been accelerated from 1970 to 1977, when a coalition headed by the Sri Lanka Freedom Party imposed direct controls over international trade, especially on imports. After its electoral victory in 1977, the United National Party (UNP) government made enormous effort to liberalize the economy and encouraged private enterprise, welcomed foreign direct investment (FDI) and slackened import controls in a platform called ‘Open Economic Policies.’ This is unambiguously accepted as the historic turning point in trade linearization in Sri Lanka. Following liberalization, Sri Lanka's economy became more diverse in the 1970s and 1980s. In 1986 textiles and garments surpassed tea for the first time as the country's ‘single largest export.’ Nevertheless, the performance of the traditional agricultural exports remained essential to the country's economic sustainability, while remittances from Sri Lankans working overseas, foreign aids, and tourism became the other important sources of foreign exchange.
From economic viewpoint, one of the most important benefits associated with trade openness is the achievement of a faster economic growth and development (Winters, 2004). The economic intuition behind this statement is that less developed countries require acquiring a huge amount of resources and exploring market opportunities for domestically produced goods and services from advanced economies. However, while Sri Lanka benefitted from Open Market Policies in many different ways, its trade balance continued to deteriorate year by year after introducing the ‘Open Economy’ in 1977.

As shown in Figure-1, starting from US Dollar 41 Million surplus in 1977, the trade balance reported historic lowest downturn of US Dollar 9,710 Million by 2011, which is almost equal to the entire export earnings of the country for that year. After three years later in 2014, it has very marginally improved to US Dollar -8,285 Million which is still as high as 74% of the total export earnings.
A careful study into the scatter plot depicted in Figure-2 would reveal that Sri Lanka’s trade balance and exchange rate behaviour is totally opposite to what is expected in ‘Economic Theory.’ Economic theory postulates that trade balance should improve while exchange rate continues to depreciate/devaluate given ML condition is satisfied. Nevertheless, in Sri Lankan context the opposite seems true as illustrated in Figure-2.

In this context, despite the studies so far done, we suspect that there could be countercyclical effects between Trade Liberalization and exchange devaluation on trade balance which offset the impact of each other. As such, we attempt to answer the empirical question ‘why the trade balance of Sri Lanka continued to deteriorate despite substantial currency devaluations/depreciations during past five decades.’
METHODOLOGY

Model
This study employs the standard “Two County” trade model as stipulated by many studies in literature (see Rose and Yellen (1989); Rose (1990); Bahmani-Oskooee (1991); Shirvani and Wilbratte (1997); and Wilson (1999)) with a slight modification to incorporate the ‘Trade Openness.’ The standard two country trade model assumes that the demand for imports by domestic residents ($D_m$) depends on the domestic income ($y$) and the relative price of imported goods to the domestically produced goods ($r p_m$) both expressed in home country currency terms. Additionally, we assume that the trade balance is affected by the degree of trade openness ($top$) of that economy. The supper script $f$ denotes the foreign counterpart of the analogous variables. Thus, the initial equations can be given as:

Import demand

$$D_m = D_m(y, r p_m, top)$$  \hspace{1cm} (1)

$$D_f = D_f(y_f, r p_f, top_f)$$  \hspace{1cm} (2)

$$r p_m = e . p / p = (e . p / p) . (p / p_f) = q . r p_x$$  \hspace{1cm} (3)

$$q = e . p / p \text{ (real exchange rate)}$$  \hspace{1cm} (4)

($e$- nominal exchange rate – the domestic currency price of foreign exchange)
Analogously,
\[ rp_m^f = (p_x/p^f \cdot e) = (p/p^f \cdot e) \cdot (p_x/p) = (1/q) \cdot r_p \]
\[ \] \hspace{1cm} (5)

\[ rp_m^f = r_p / q \]

**export supply**

\[ S_x = S_x(r_p, \text{top}) \]

\[ S_x^f = S_x^f(r_p^x, \text{top}^f) \] \hspace{1cm} (6)

**Equilibrium condition**

\[ D_m = S_x^f \quad \text{and} \quad D_m^f = S_x \] \hspace{1cm} (7)

\[ TB = \text{Real Trade balance of the domestic country} \]

\[ TB = r_p x S_x - r_p m D_m \] \hspace{1cm} (8)

\[ TB = r_p x D_m^f - q \cdot r_p x D_m \]

\[ TB = r_p x D_m^f(y^f, r_p^m, \text{top}^f) - q \cdot r_p x D_m(y, r_p m, \text{top}) \]

\[ TB = r_p x D_m^f(y^f, r_p / q, \text{top}^f) - q \cdot r_p x D_m(y, q \cdot r_p^f, \text{top}) \] \hspace{1cm} (9)

Assume, no tariffs on exports, and no taxes or subsidies on domestically trading goods; thus domestic price must be equal to export price in any country; it means always \( r_p x = r_p x^f = 1 \) in equation 9; so equation becomes

\[ TB = D_m^f(y^f, 1/q, \text{top}^f) - q \cdot D_m(y, q, \text{top}) \] \hspace{1cm} (10)

Now TB is a function of

\[ TB = TB(y^f, y, q, \text{top}, \text{top}^f) \]
Applying small country argument, we could ignore the impact of foreign country’s ‘Trade Openness’ on the trade balance of the domestic country, because a small country would demand (import) or supply (export) a negligibly small volume which could be exchangeable irrespective of the degree of trade openness of the rest of the world. Hence, we can reasonably omit \( (\text{top}_f) \) from the above function. Thus TB can be expressed as:

\[
TB=TB(y_f, y, q, \text{top})
\]  

(11)

This study applies the Bounds Testing Method, which is widely known as the Autoregressive Distributed Lagged (ARDL) co-integration procedure developed by Pesaran and Smith (2001) to analyse the long-run relationships and dynamic interactions among the variables of interest. ARDL procedure is more appropriate for this analysis due to following reasons. Firstly, the Bounds Testing procedure does not require the pre-testing of the variables in the model for unit roots. The bounds testing procedure is applicable irrespective of whether the regresses are integrated I(0), I(1) or mutually co-integrated, as long as they are not co-integrated I(2). Secondly, the bounds testing procedure is relatively more efficient in small or finite sample data, where the number of observations by nature is small as in our case. Thirdly, both short-run and long-run parameters can be estimated simultaneously. Furthermore, as opposed to other multivariate co-integration techniques such as Johansen and Juselius (1990), the Bounds Test procedure is simple because the co-integration relationship can be estimated using OLS; once the lag order of the model is defined by a suitable information criterion.
Now we rewrite the functional relationship denoted in Eq(11) as follows for notational convenience of the ARDL model.

\[ TB = f(GDP, GDPW, REX, TOP, OIL, T) \]  \hspace{1cm} (12)

TB is the ratio of real exports to real imports both measured in USD millions. Measuring TB as a ratio of exports to imports deserves at least three advantages. It becomes unit less, non-negative allowing for log transformation, and is normalized to one when trade is balanced.

GDP is Gross Domestic Product of home country and GDPW is the sum of GDPs of the top 20 export destinations of Sri Lanka\(^1\).

REX is the real exchange defined in terms of domestic currency price for one unit of US dollar. (Same as defined in Eq-4)

TOP is the sum of real exports and imports defined as a percentage of GDP which is a proxy variable, representing the degree of Trade Openness. Though it is subject to some limitations, this is the conventional measure used to measure Trade Openness in many empirical studies\(^2\). Many researchers use GDP in trade openness index to normalize cross-sectional heterogeneity, depending on country size which is not relevant to a single country case like ours. In our study, taking total trade as a percentage of GDP at least produces a

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\(^1\) U.S.A., U.K., India, Italy, Belgium, Germany, Russia, U.A.E., Japan, Iran, France, Netherlands, Canada, Turkey, Australia, China, Syria, Hong-Kong, Mexico, Singapore, Switzerland. These countries account for 80.77% of Sri Lanka’s total exports.

comparable measure for Trade Openness over time. Nevertheless, this measure as a proxy for Trade Openness is not free from errors. GDP includes government expenditure (G) which is exogenously determined, especially for country like Sri Lanka that had been undergoing three decades of civil war. Thus, any abnormal increase in G might erroneously means to suggest a reduction of Trade Openness, as GDP appears in the denominator.

Also we included OIL dummy to capture world oil price hike in 1973 and a time (T) dummy for de-trending data.

The equation (12) was then transformed to an Auto-Regressive Distributed Lag model (ARDL) to identify the existence of a long-run co-integration relationship. TB, GDP, REX, TOP were considered endogenous and GDPW and dummy variables were taken as exogenous variables. The ln notation stands for natural logarithm and \( e_t \) for the error term which is white noise.

\[
\begin{align*}
\ln TB_t &= \beta_{0TB} + \beta_{1TB}T_t + \beta_{2TB}OIL_t + \beta_{3TB}\ln GDPW_t + \\
\sum_{i=1}^{n} \alpha_{1TB} \ln TB_{t-i} + \sum_{i=0}^{n} \alpha_{2TB} \ln GDP_{t-i} + \sum_{i=0}^{n} \alpha_{3TB} \ln REX_{t-i} + \\
\sum_{i=0}^{n} \alpha_{4TB} \ln TOP_{t-i} + \epsilon_{TBt}
\end{align*}
\]

\[
\begin{align*}
\ln GDP_t &= \beta_{0GDP} + \beta_{1GDP}T_t + \beta_{2GDP}OIL_t + \beta_{3GDP}\ln GDPW_t + \\
\sum_{i=1}^{n} \alpha_{1GDP} \ln GDP_{t-i} + \sum_{i=0}^{n} \alpha_{2GDP} \ln TB_{t-i} + \\
\sum_{i=0}^{n} \alpha_{3GDP} \ln REX_{t-i} + \sum_{i=0}^{n} \alpha_{4GDP} \ln TOP_{t-i} + \epsilon_{GDPt}
\end{align*}
\]
The Impact of Currency Depreciation and Trade Liberalization

\[ \ln REX_t = \beta_{0REX} + \beta_{1REX}T_t + \beta_{2REX}OIL_t + \beta_{3REX}\ln GDPW_t + \]
\[ \sum_{i=1}^{n} \alpha_{1REX} \ln REX_{t-i} + \sum_{i=0}^{n} \alpha_{2REX} \ln GDP_{t-i} + \]
\[ \sum_{i=0}^{n} \alpha_{3REX} \ln TB_{t-i} + \sum_{i=0}^{n} \alpha_{4REX} \ln TOP_{t-i} + \epsilon_{REX_t} \]  \quad (15)  

\[ \ln TOP_t = \beta_{0TOP} + \beta_{1TOP}T_t + \beta_{2TOP}OIL_t + \beta_{3TOP}\ln GDPW_t + \]
\[ \sum_{i=1}^{n} \alpha_{1TOP} \ln TOP_{t-i} + \sum_{i=0}^{n} \alpha_{2TOP} \ln GDP_{t-i} + \]
\[ \sum_{i=0}^{n} \alpha_{3TOP} \ln REX_{t-i} + \sum_{i=0}^{n} \alpha_{4TOP} \ln TB_{t-i} + \epsilon_{TOP_t} \]  \quad (16)  

**Hypotheses**

In equation 13, where real trade balance is the dependent variable \( f_{TB}(TB|GDP,REX,TOP) \) the null hypothesis of no cointegration amongst the variables is \( H_0: \alpha_{1TB} = \alpha_{2TB} = \alpha_{3TB} = \alpha_{4TB} = 0 \) against the alternative hypothesis \( H_1: \alpha_{1TB} \neq \alpha_{2TB} \neq \alpha_{3TB} \neq \alpha_{4TB} \neq 0 \).

In equation 14, where GDP is the dependent variable, \( f_{GDP}(GDP|TB,REX,TOP) \) the null hypothesis of no cointegration is \( H_0: \alpha_{1GDP} = \alpha_{2GDP} = \alpha_{3GDP} = \alpha_{4GDP} = 0 \) against the alternative hypothesis \( H_1: \alpha_{1GDP} \neq \alpha_{2GDP} \neq \alpha_{3GDP} \neq \alpha_{4GDP} \neq 0 \).

In equation 15, where REX is the dependent variable, \( f_{REX}(REX|TB,GDP,TOP) \) the null hypothesis of no cointegration is \( H_0: \alpha_{1REX} = \alpha_{2REX} = \alpha_{3REX} = \alpha_{4REX} = 0 \) against the alternative hypothesis \( H_1: \alpha_{1REX} \neq \alpha_{2REX} \neq \alpha_{3REX} \neq \alpha_{4REX} \neq 0 \).
Similarly in equation 16, where TOP is the dependent variable, 
\[ f_{TOP}(TB, GDP, REX) \] the null hypothesis of no cointegration is 
\[ H_0: \alpha_{1TOP} = \alpha_{2TOP} = \alpha_{3TOP} = \alpha_{4TOP} = 0 \] against the alternative hypothesis 
\[ H_1: \alpha_{1TOP} \neq \alpha_{2TOP} \neq \alpha_{3TOP} \neq \alpha_{4TOP} \neq 0. \]

**Data**

This study uses annual data 1960-2014 from two sources. GDPW is from author’s calculation with GDP data from International Financial Statistics (IFS). All the other data are from the Annual Reports of the Central Bank of Sri Lanka. GDP and export import data series were rebased to 2005 constant price using relevant price indices.

**EMPIRICAL RESULTS**

The ARDL bounds test developed by Pesaran et al. (2001) can be used to establish the short-run and long-run relationships, irrespective of whether they are purely I(0), purely I(1), or mutually co-integrated. Nevertheless, this procedure requires the variables under consideration are not integrated at an order higher than one. In the presence of I(2) variables, the model crashes because the critical values provided by Pesaran et al. (2001) are no longer valid. Therefore, it is of crucial importance to test the order of integration of all variables and to verify none of them are of I(2). To test the null hypothesis of unit root against the alternative of stationary, we performed Augmented Dickey–Fuller (ADF) test for both “intercept only” and “intercept with liner trend” methods but reported only the latter for brevity. The latter is more
reliable, as all the variables are trending over time and we have no valid statistical reason to avoid intercept.

As per the ADF test results reported in Table-1, all the variables were found I(1) in levels, but I(0) in first difference and more importantly, no evidences were detected for I(2). Hence, the variables are qualified to be used in bounds testing.

### Table-1: Augmented Dickey-Fuller Unit Root Test (Intercept and Trend)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>First Differenced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-statistic</td>
<td>Probability</td>
</tr>
<tr>
<td>lnGDP</td>
<td>-2.070 (5)</td>
<td>0.5478</td>
</tr>
<tr>
<td>lnTB</td>
<td>-1.831 (0)</td>
<td>0.6745</td>
</tr>
<tr>
<td>lnTOP</td>
<td>-2.631 (0)</td>
<td>0.2689</td>
</tr>
<tr>
<td>lnGDPW</td>
<td>-2.396 (1)</td>
<td>0.3771</td>
</tr>
<tr>
<td>lnREX</td>
<td>-0.826 (2)</td>
<td>0.9558</td>
</tr>
</tbody>
</table>

For ADF test within brackets are lag length selected by AIC

*** Significant at 1% level

** Significant at 5% level

In the bounds testing approach to ARDL, $F$-statistic is used to test the existence of long-run relationship. The $F$-stat used for this procedure, however, does not follow standard $F$-distribution. Thus, the Pesaran et al. (1996) computed two sets of critical values for any given conventional significance level. One set assumes that all variables are integrated order I(0), and the other set assumes that they all are integrated order I(1). If the calculated $F$-statistics exceeds, the upper bound critical value, then the $H_0$ of no co-integration will be rejected favouring the alternative that co-integration among the variables. On the other hand, if the calculated $F$-statistic is less than the lower bound
critical value, then $H_0$ of no co-integration among the variables cannot be rejected. If $F$-statistic falls within the bounds, then the test result is inconclusive and existence of long-run relationship is indeterminate.

Table-2 shows the Result of Bound Testing for Co-integration in ARDL Model. The results indicate that the null hypothesis of no co-integration cannot be rejected for the models defined by Eq(14), Eq(15) and Eq(16). It reveals that the calculated $F$-statistic exceeds the upper bound critical value at 5% significant level only for model defined by Eq(13), leading to the concussion that there exists only one long run co-integrating relationship where TB appears being the dependent variable.

<table>
<thead>
<tr>
<th>ARDL Model</th>
<th>ARDL Lag Length</th>
<th>$F$-Statistics</th>
<th>Presence of Cointegration</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{TB}(TB</td>
<td>TOP,GDP,REX)$</td>
<td>1,2,2,1</td>
<td>6.6842**</td>
</tr>
<tr>
<td>$F_{TOP}(TOP</td>
<td>TB,GDP,REX,)$</td>
<td>1,0,2,1</td>
<td>1.6558*</td>
</tr>
<tr>
<td>$F_{GDP}(GDP</td>
<td>TOP,TB,REX)$</td>
<td>2,0,1,2</td>
<td>5.0474*</td>
</tr>
<tr>
<td>$F_{REX}(REX</td>
<td>GDP,TOP,TB)$</td>
<td>1,1,2,1</td>
<td>1.8186*</td>
</tr>
</tbody>
</table>

** Above the 95% Upper bound critical value
* Below the 95% Lower bound critical value

Note: The critical value bounds are computed by stochastic simulations using 20000 replications. For this analysis 95% critical bounds are 5.0376-6.2037

Having established the co-integrating relationship, the long run coefficients for Eq(13) was estimated using ARDL (1,2,2,1) selected based on Akaike Information Criterion. The estimated long run coefficients are reported in Table-3
The Impact of Currency Depreciation and Trade Liberalization

Table-3, The Estimated Long-run Coefficients

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-Ratio</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-16.3545</td>
<td>22.6664</td>
<td>-0.7215</td>
<td>0.4760</td>
</tr>
<tr>
<td>T</td>
<td>-0.0362</td>
<td>0.07406</td>
<td>-0.4899</td>
<td>0.6280</td>
</tr>
<tr>
<td>OIL</td>
<td>0.1966</td>
<td>0.17643</td>
<td>1.1141</td>
<td>0.2740</td>
</tr>
<tr>
<td>lnTOP</td>
<td>-0.4803 **</td>
<td>0.2281</td>
<td>-2.1055</td>
<td>0.0430</td>
</tr>
<tr>
<td>lnGDP</td>
<td>1.0655</td>
<td>1.4900</td>
<td>0.7151</td>
<td>0.4800</td>
</tr>
<tr>
<td>lnGDPW</td>
<td>0.0664</td>
<td>1.1923</td>
<td>0.0556</td>
<td>0.9560</td>
</tr>
<tr>
<td>lnREX</td>
<td>0.4596 ***</td>
<td>0.1015</td>
<td>4.5240</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

As shown in Table-3, all the variables take expected sign but only the Trade Openness (TOT) and Real Exchange Rate (REX) are significant in explaining long run variations in the Trade Balance (TB). The estimated coefficient for REX shows highly significant long run impact of Real Exchange Rate on the Trade Balance. The estimated coefficient indicates that 1 % depreciation of local currency leads to 0.45% improvement in the Trade Balance Ratio of Sri Lanka, given all else being equal. On contrary the Trade Openness is negatively significant at 5% level indicating that 1% increase in Trade Openness leads to deteriorate the Trade Balance Ratio by 0.48%. The underlining economic intuition is that the nature of Trade Openness in Sri Lanka can be regarded as more supportive to imports than to exports. These findings solve our basic puzzle that why Sri Lanka’s Trade Balance continuous to deteriorate in long term despite of substantial currency depreciation. It is proven in our findings that relatively a more powerful negative impact arising from Trade Openness fully offset the positive impact arising from currency depreciation ultimately leading the Trade Balance into deficit in the long run.
Table 4. Error Correction Representation ARDL(1,2,2,1) selected based on Akaike Information Criterion
Dependent variable is ΔlnLTB

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-Ratio</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔlnTOP</td>
<td>-0.07473</td>
<td>0.17983</td>
<td>-0.4156</td>
<td>0.680</td>
</tr>
<tr>
<td>ΔlnTOP1</td>
<td>0.44084</td>
<td>0.17988</td>
<td>2.4507</td>
<td>0.020</td>
</tr>
<tr>
<td>ΔlnGDP</td>
<td>-0.23013</td>
<td>1.01890</td>
<td>-0.2259</td>
<td>0.823</td>
</tr>
<tr>
<td>ΔlnGDP1</td>
<td>-2.23960</td>
<td>1.00130</td>
<td>-2.2368</td>
<td>0.032</td>
</tr>
<tr>
<td>ΔlnREX</td>
<td>-0.07579</td>
<td>0.15949</td>
<td>-0.4752</td>
<td>0.638</td>
</tr>
<tr>
<td>ΔT</td>
<td>-0.02230</td>
<td>0.04366</td>
<td>-0.5108</td>
<td>0.613</td>
</tr>
<tr>
<td>ΔOIL</td>
<td>0.12080</td>
<td>0.10365</td>
<td>1.1654</td>
<td>0.252</td>
</tr>
<tr>
<td>ΔlnGDPW</td>
<td>0.04078</td>
<td>0.73425</td>
<td>0.0555</td>
<td>0.956</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.61456</td>
<td>0.14476</td>
<td>-4.2453</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Notes, ΔlnLTB = lnTB-lnTBt-1
ΔlnTOP = lnTOP- TOPt-1
ΔlnTOP1 = lnTOPt-1 - lnTOPt-2
ΔlnLGDP= lnGDP- lnGDPt-1
ΔlnLGDP1= lnGDPt-1-lnGDPt-2
ΔlnREX = lnREX-lnREXt-1
ΔT = T-Tt-1
ΔOIL = OIL-OILT-1
ΔlnLGDPW= lnGDPW-lnGDPWt-1

R-Squared 0.54956
R-Bar-Squared 0.37520
S.E. of Regression 0.091253
F-Stat. F(9,34) 4.2025[.001]
Residual Sum of Squares 0.25814
DW-statistic 2.3615

The results of the Error Correction Model (ECM) denotes the short-run dynamics associated with the long run relationships are given in Table-4. The short run dynamics tabulated in Table-4 suggest neither Real Exchange Rate nor Trade Openness has significant influence on the Trade Balance in the short run. However, the Error Correction Term (ECM) estimated -0.61456 (0.000) is highly significant and negative in sign indicating fairly a higher speed of adjustment towards equilibrium after a short run shock. It is estimated approximately 61% of disequilibria from the previous year would converge back to long run equilibrium in the current year.
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Figure-3 depicts the dynamic forecast for the long run path of Real Trade Balance while Figure-4 and Figure-5 respectively depict the plot of cumulative sum of recursive residuals (CUSUM) and the plot of cumulative sum of squares recursive residuals (CUSUMQ).

![Dynamic forecasts for the level of LREALTB](image)

Both CUSUM and CUSUMQ moving within critical bounds at 5% significant level illustrate the model stability for the sample period.
Figure-4

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level.

Figure-5

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level.
CONCLUSION

Employing the Bound Testing (ARDL) approach, this study examined the short run and long run relationship between ‘Trade Openness’ and the ‘Trade Balance’ of Sri Lanka. The Bounds test reveals that there is a long run co-integrating relationship between the variables of interest, predominantly the Trade Openness and Real Exchange Rate. Our findings suggest that 1% increase in trade openness leads to 0.48% deterioration while 1% depreciation of local currency leads to 0.45% improvement in the Trade Balance Ratio of Sri Lanka, given all else remaining unchanged. These findings solve our basic dilemma, why Sri Lanka’s Trade Balance continued to deteriorate, despite the substantial currency depreciation allowed during last few decades. It is proven that relatively a more powerful negative impact arising from Trade Openness fully offset the positive impact arising from currency depreciation; thereby leading the Trade Balance into deficit eventually in the long run. Therefore, devaluing currency and liberalizing trade are countercyclical policies offsetting the impact of each other. It leads to the policy recommendation that government must allow further depreciation of local currency if liberalizing trade any longer, in order to prevent TB going bad to worse.

REFERENCES


EDUCATION, ATTITUDES AND AGRICULTURAL BIODIVERSITY: AN APPLICATION OF RANDOMISED CONTROL METHOD

P.P.A. Wasantha Athukorala

Abstract

The study attempts to investigate the role of education and environmental concerns in conserving ‘agricultural biodiversity’ of diverse farming systems in Sri Lanka. It analyses how farmers’ valuation of agricultural biodiversity alters with education on agricultural biodiversity and environmental concerns. The Choice Experiment (CE) Method, combined with Randomized Control Method (RCM) was used to collect data, while models such as Conditional Logit (CL) and Random Parameter (RP) Logit were used to analyse the collected data. The results clearly illustrate that farmers’ education level, as well as environmental concerns play a major role in the conservation of agricultural biodiversity. The overall findings of this study will help the policy makers to implement relevant policies in reducing degradation of agricultural biodiversity, which is increasingly posing a major impediment to agricultural growth, to the environmental protection and sustainable development.

Keywords: Agricultural Biodiversity, Education, Valuation

P.P.A. Wasantha Athukorala
Senior Lecturer, Department of Economics and Statistics, University of Peradeniya, Sri Lanka

1 Financial assistance received from the Peradeniya University Research Grant (RG/AF 2013/61/A) for this project is greatly appreciated
INTRODUCTION

‘Agricultural biodiversity’ is a sub-set of general biodiversity, which is essential for the global food production, livelihood security, environmental protection and sustainable agricultural development (FAO, 2007). The direct and indirect benefits of conserving farm level biodiversity can be explained on the basis of the Total Economic Value (TEV) framework. TEV consists of both ‘use’ and ‘non-use’ values. The benefits obtained by individuals using agricultural biodiversity are defined as ‘use values.’ ‘Use values’ include, direct, indirect, portfolio values and option values\(^2\) (Primack, 1993; Swanson, 1996; Evenson et al. 1998). On the other hand, bequest values, altruistic values, existence values and cultural values of agricultural biodiversity are considered under ‘non-use values’ (Brown, 1990; Primack, 1993; Evenson et al. 1998).

Some direct benefits that farmers can gain from maintaining a ‘diverse farming system’ can be summarised as follows. Firstly, a diverse farming system minimizes the external risk that farmers often faced. For example, if a farmer has both crops and livestock, this will minimize the risk of loss from drought or water shortage. That is, though crop harvests may be devastated by harsh climatic conditions, the farmers still can derive an income from livestock. Second, high levels of agricultural biodiversity provide fresh nutritional foods for

\(^2\) Option values can be placed under both use and non-use values. It includes future direct and indirect use values.
the members of their families. Third, a diverse farming system can help farm families to utilise family labour optimally (Brookfield et al. 2002). For example, crop diversity demands labour in different time periods and family labour can easily be distributed among different crops and/or livestock in order to obtain maximum benefits. Fourth, agricultural biodiversity is found to have positive impacts on the overall productivity and quality of soil (Karunarathna, 2013). In addition to providing direct benefits to farmers, agricultural biodiversity improves ecological processes through regulating climate, maintaining soil quality, providing protection from erosion, storing nutrients and breaking down pollution (Di Falco and Chavas, 2009). Despite all these benefits, the previous experience has shown that population growth, inequity, inadequate economic policies and institutional systems have mainly contributed towards the increasing loss of agricultural biodiversity in the world. Low levels of education and lack of integrated research on natural ecosystems and their innumerable components may exaggerate the process, especially in developing countries.

The overall aim of this study is to evaluate the farmers' preference of agricultural biodiversity in diverse agricultural systems in Sri Lanka. Accordingly, the study attempts to investigate the fact that how farmers’ valuation of agricultural biodiversity would change along with changes happened in relation to the discrepancies of their education and environmental concerns. The Choice Experiment (CE) method (combined with Randomized Control Method) is used to
estimate farmers’ preferences for agricultural biodiversity. Models such as Conditional Logit (CL) and Random Parameter (RP) Logit are used to analyse the data. The results are then used to estimate the likely welfare gains under different groups of farmers. The overall findings of this research will help for implementation of policies to reduce degradation of agricultural biodiversity in developing countries.

**LITERATURE REVIEW**

A number of studies have already been undertaken to investigate the various aspects of agricultural biodiversity (Kontoleon, 2003; Lusk et al. 2003; Birol, 2006; Ouma et al. 2007; Ruto et al. 2008; Roessler et al. 2008; Zander and Drucker, 2008; Kassie et al. 2009; Asrat et al. 2009). Brock and Xepapadeas (2003) developed a conceptual framework for valuing biodiversity from an economic perspective. This study illustrated that a more diverse system could attain a higher value, even though the genetic distance of the species in the more diverse system could be almost zero. Kontoleon (2003) investigated consumers’ perceptions of ‘Genetically Modified’ (GM) food and found that consumers across the European Union (EU) were willing to pay more to obtain information on the GM content in their food supplies.

Di Falco and Perrings (2003) investigated the impact of providing financial assistance to farmers in maintaining crop biodiversity in an uncertain setting. The findings reveal that risk aversion is an important
driving force for crop biodiversity conservation. This is because, risk averse farmers can hedge against uncertainty they face, by allocating land to different crop species. Van Dusen et al. (2005) carried out an empirical case study about farmer management of rice genetic resources in two communities of Nepal. In this study, the decision-making process of farm households is modelled and estimated in order to provide information for the design of community-based conservation programmes. The CE method was used to investigate farmers’ valuation of agricultural biodiversity of maize varieties, using 414 farm households from three States of Mexico by Birol et al. (2006). The results revealed that there was a considerable heterogeneity among the farmers’ preferences for *Milpa* diversity and GM maize across within the three States.

Poudel and Johnsen (2009) sought to advance the application of Contingent Valuation (CV) method to document the economic value of crop genetic resources, based on farmers’ willingness to pay for conservation. According to them, landholding size, household size, education level, socio-economic status, gender of the respondents, number of crop landraces grown, and the knowledge of biodiversity influence the willingness to pay for in situ conservation; whereas only landholding size and household size influence the willingness to pay for ex-situ conservation. The CE approach was employed to investigate Ethiopian farmers’ crop variety preferences and to estimate the mean willingness to pay for each crop variety attributes by Asrat et al. (2009). They also identified household-specific and institutional factors that
governed the preferences. Recently, a Choice Experiment method was used by Kikulwe et al. (2011) to estimate farmers’ valuation of agricultural biodiversity in the *milpa* system, and examined their interest in cultivating Genetically Modified (GM) maize.

Meanwhile, several studies have used econometric models to identify the determinants of diversity in livestock and crops in developing or transitional economies. Some studies, conducted in Peru (potato), Turkey (wheat), and Mexico (maize), have sought to identify some of the important factors that positively and negatively affected the conservation of agricultural biodiversity (Brush et al. 1992; Meng, 1997; Van Dusen, 2000; Smale et al. 2002). However, most of these studies (Brush et al. 1992; Franks, 1999; Bellon, 2004; Benin et al. 2004) concentrate on diversity within a single crop or animal bread. When analysing the multiple benefits of the farms under semi-subsistent rural areas, concentration on variety diversity, mix farming systems and organic farming are more important than considering a single crop.

Although these studies identified the importance of conserving agricultural biodiversity, literature on economic valuation of diverse farms in semi-subsistence economies are very limited in developing countries. This is because, assigning monetary values to diverse farming systems are complicated in subsistence farming systems (Gauchan, 2004; Diwakar and Johnsen, 2009); therefore, a challenging area of study. As a result, these studies have only provided limited
Education, Attitudes and Agricultural Biodiversity:

information on the value of the different attributes of agricultural biological diversity. This study is expected to fill this void in the literature by applying CE method to analyse farmer's preference for different aspects of agricultural biodiversity in Sri Lanka.

**CHOICE EXPERIMENT METHOD**

CE approach has a theoretical grounding in Lancaster’s Attribute Theory of Consumer Choice (Lancaster, 1966) and an econometric basis in models of random utility (McFadden, 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves, but from the attributes they provide. To illustrate, the basic model behind Choice Experiments, it is assumed that farm families have a utility function of the form:

\[ U_{ij} = U(X_{ij}, Z_i) \]

Where, for any farm family \( i \), a given level of utility will be associated with any alternative farm \( j \). Utility derived from any farm alternatives depend on the attributes of the farm \( X_{ij} \) and the social and economic characteristics of the farm family \( Z_i \), since different families may receive different levels of utility from these attributes. According to the ‘Random Utility Model’, the utility of a choice comprises of a systematic (deterministic) component, \( T_{ij} \) and an error (random)
component $e_{ij}$, which is independent of the deterministic part and follows a predetermined distribution (Hanemann et al. 1991):

$$U_{ij} = T_{ij} + e_{ij}$$

The systematic component can be explained as a function of the characteristics of the farm and of the social and economic characteristics of the farm family. Accordingly, Equation 2 can be expressed as:

$$U_{ij} = T(X_{ij}, Z_i) + e_i$$

Given an error part in the utility function, choices made among alternative farms will be a function of the probability that the utility associated with a particular farm option ($j$) is higher than that for the other alternative farm. Hence, the probability that farm family $i$ will choose farm $j$ over all other options $n$ is given by:

$$P_{ij} = \text{prob}\{T_{ij} + e_{ij} > T_{in} + e_{in}\} \quad \text{Where, } j \neq n.$$  

It is assumed that the relationship between utility and attributes follow a linear path in the parameters and variables. We further assume that the error terms are identically and independently distributed with a Weibull distribution\(^3\) (Greene, 1997). These assumptions ensure that the probability of any particular alternative $j$ being chosen can be

\(^3\)Weibull distribution is a continuous probability distribution. For further details about the basic properties of this distribution (1997).
expressed in terms of logistic distribution. This specification is known as the ‘CL Model’ (McFadden, 1974; Greene, 1997; Maddala, 1999) which has the following general form:

\[ P_{ij} = \frac{\exp(X_{ij}'\beta + Z_i'\alpha)}{\sum_{j=1}^{J} \exp(X_{ij}'\beta + Z_i'\alpha)} \] (3)

The components of \( X_{ij} \) are typically called the attribute of the choices. However, \( Z_i \) contains characteristics of the individual and is, therefore, the same for all the choices. Equation 3 is the probabilistic response function and it shows that, given all other options, the probability of farmer \( i \) selecting the option \( j \) type farm. The CL model generates results for a conditional indirect utility function of the form:

\[ T_{ij} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_m X_m + \alpha_1 Z_1 + \alpha_2 Z_2 + \ldots + \alpha_k Z_k \] (4)

Where, \( \beta \) is the alternative specific constant (ASC), that captures the effects in utility from any attributes, which are not included in choice specific attributes (Rolfe et al. 2000). The number of farm attributes considered is \( m \) and the number of social and economic characteristics of the farm family employed to explain the choice of the farm is \( k \). The vectors of coefficients are attached to the vector of attributes \( (X) \) and to a vector of socio-economic factors \( (Z) \) that influence utility, respectively. The CE method is consistent with Utility Maximization and Demand Theory. When parameter estimates are obtained, welfare
measures can be estimated from the CL model using the following formula:

$$\text{CS} = \frac{\ln \sum_i \exp(T_{i1}) - \ln \sum_i \exp(T_{i0})}{\delta} \quad (5)$$

Where CS is the compensating surplus welfare measure, δ is the marginal utility of income (generally represented by the coefficient of the monetary attribute in the CE) and $T_{i0}$ and $T_{i1}$ represent indirect utility functions of alternative i (with subscript 0 indicating the base situation and 1 indicate the changed situation) before and after the change under consideration. For the linear utility index, the marginal value of change within a single attribute can be represented as a ratio of coefficients, reducing Equation 5 to 6:

$$W = \left( \frac{\beta_{\text{attribute}}}{\beta_{\text{monetary variable}}} \right) \quad (6)$$

In addition to this, the following Equation 7 can be used to estimate the consumer surplus in different areas.

$$\text{CS} = \frac{-1}{\beta_{\text{costs}}} \left[ \Delta \beta_{\text{crops}} + \Delta \beta_{\text{mix}} + \Delta \beta_{\text{organic}} - \text{ASC} \right] \quad (7)$$
Using Equation 6, the implicit prices \((W)\) for the various farm attributes can be calculated. These demonstrate the marginal rate of substitution between cost and the attribute in question. This is the same as the marginal welfare measure (WTP or WTA) for a change in any of the attributes. An alternative model specification to the CL model is random parameter logit (RPL) model which is increasingly becoming popular in CE studies. The advantage of RPL model is that it accounts for consumers’ taste heterogeneities and also relaxes the Independence of Irrelevant Alternatives (IIA) assumption of the CL model. More importantly, preferences are in fact heterogeneous and accounting for this heterogeneity, enables estimation of unbiased estimates of individual preferences and enhances the accuracy and reliability of estimates of parameters of the model and total welfare (Greene, 1997).

**DESIGNING CE STUDY**

In this study the most important attributes of farms and their levels were identified through consultation with experts from the Department of Agriculture in Sri Lanka; drawing on the results of informal interviews and workshops with farmers in the study sites, focus group discussions and a thorough review of previous research in this area in the country. After identifying the attributes for the experiment, we assigned values or levels to each attribute. Selected attributes for this study, their definitions and the levels are given in Table 1.
Table 1: Identified Attributes of Agricultural Biodiversity in the Country

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Definition</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of species</td>
<td>This is measured by the total number of crops and animal species that are cultivated in the farm, in a given season</td>
<td>1, 4, 7, 10</td>
</tr>
<tr>
<td>Mixed farming system</td>
<td>This attribute investigates whether a farmer prefers an integrated crop and livestock production system to a system that is specialised in crops or livestock.</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Organic production</td>
<td>This attribute investigates whether a farmer prefers organic methods of production to a system using chemical fertiliser and pesticides</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Estimated costs in terms of additional labour days</td>
<td>This is defined as a percentage of additional labour requirements under different policy options. This is the monetary attributes of the CE study.</td>
<td>5 %, 10%, 15%</td>
</tr>
</tbody>
</table>

Note: i. Upper and lower bound of the crop species diversity and additional labour requirements are estimated using pilot survey information.

Table 1 shows the attributes that we used in the CE study. The first three attributes reflect the various attributes of a diverse farming system, found in the farms in Sri Lanka. The last factor is the monetary attribute in terms of additional labour costs\(^4\) that farmers have under different policy options. As compared to willingness to pay (WTP),

\(^4\)This indirect measure is preferred over a direct monetary attribute due to three reasons. First, most of the outputs and functions of the farms that are considered in this study are not traded in the markets, but consumed by the farm families themselves. Therefore, they are not likely to be familiar with a direct monetary measure. Second, the proxy monetary attribute can easily be converted into actual monetary units by using secondary data on labour costs. Third, it is obvious that a diverse farming system requires more labour than a specialised farming system. Therefore, monetary attribute that measure the additional labour costs that farmers have to allocate for receiving the benefits of agricultural biodiversity may work as a good proxy for measuring welfare changes in the community in this study.
willingness to accept is measured as a benefit rather than a cost (Freeman, 2003). In order to estimate this benefit, a monetary attribute in terms of additional labour costs that farmers are willing to offer is included. The size of the hypothetical farm is fixed at one acre in area in each case (this is the average farm size in study area). A large number of different types of farms (combinations of attributes) could be constructed from this number of attributes and levels. However, in this study we used 16 choice options and they were randomly blocked into 4 different versions (each has four options). Using the Doptimal procedure in Engine, an experimental design was undertaken to recover 16 pair wise comparisons of farm profiles. A sample choice set presented to respondents is given below.

Assuming that the following farms were the ONLY choices you have, which one would you prefer to cultivate?

<table>
<thead>
<tr>
<th>Farm Characteristics</th>
<th>Farm (A)</th>
<th>Farm (B)</th>
<th>Neither farm (A) nor farm (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of species</td>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mixed farming system</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Organic production</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Estimated costs in terms of additional labour days</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

I prefer to cultivate

Farm (A)....................
Farm (B)....................
Neither Farm ..............
(Please pick one option)
SURVEY METHOD, DATA CORDING AND ESTIMATION
PROCEDURE

This study employs Randomized Control Method (RCM) to collect the data. Firstly, 21 villages from Ampara district were selected purposively. Then, the villages were randomly divided into three groups: one control group and two treatment groups. Accordingly, randomisation to select households into different groups (two treatment and the control) was done at the village level and ‘village’ is the unit of randomisation in this study. Then, using the farmers’ list, 20 farmers were randomly selected from each village. The survey involved several steps. First, households for the survey from the district were selected. Second, based line survey was carried out covering all three groups. The main purpose of this survey is to understand their education and environmental attitudes on biodiversity and test whether there is any significant spill over effect among the respondents. This survey includes a set of simple questions related to agricultural biodiversity and environment concerns\(^5\). Third, one treatment group was educated using a formal educational programme (specially designed for this study) on agricultural biodiversity, while other treatment group was provided with information in order to improve their environmental concerns. Control group was not provided with

\(^5\) During the final survey, the same questions were asked. By comparing the information of those two surveys, spillover effects can be judged. For example, we can check whether there is a significant change of the knowledge on biodiversity/environmental concerns of the control group.
any information. Finally, CE survey\textsuperscript{6} covers all groups in the district. After one month of the formal educational programme, the final survey was conducted using structured questionnaire which was developed based on the results from six focus group discussions and a pre-test. A pre-test for 15 respondents was undertaken in February 2013. On the basis of the pre-test, only minor modifications to the questionnaire were required. In the questionnaire, respondents were said that the development of the Choice Experiment questionnaire was based on focus group studies. Six focus group discussions were conducted for both potential respondents (3) and for agricultural officers (3) to ensure that inputs for choice sets were correctly specified.

Education programme consisted with two steps. Firstly, we met the respondents of two control groups and explained the importance of agricultural biodiversity or environmental protection individually. Secondly, we provided leaflets (but not keep with them; they could read it in front of us or we can read it for them) showing the importance of maintaining diverse farming systems in their farms or the importance of protecting environment. Final survey was carried out by administering a questionnaire through a face-to-face interview with the Head or any other working member of the households. The final survey covered 420 households.

\textsuperscript{6} Before the interview it was confirmed whether the respondents were generally those responsible for farm production decision making.
Data coding is one of the important parts of the Choice Experiment Model. During this study, the data was coded according to the levels of the attributes. Attributes with 2 levels entered the utility function as binary variables that were effects coded (Louviere et al. 2000). Crops diversity variable is used as a continuous variable. Consequently, the crop species diversity attribute took levels 1, 4, 7 and 10. Estimated costs in terms of additional labour requirement were transformed into monetary values when estimating the models. The percentage values of additional labour requirements were given as 5, 10 and 15. On average, farm families need approximately 31 labour days per month for their one acre farm cultivation. Daily average wage rate per person was Rs.500\(^7\). Accordingly, value of the cost of accepting alternative farms can be expected as Rs. 2,500, Rs. 5,000 and Rs. 7,500 for the three levels respectively. In this way, the levels used for labour requirement variables were entered in a cardinal-linear form. The attributes for the ‘neither farm’ option were coded with zero values for all attributes. The alternative specific constants were equalled to 1, when either farm A or B was chosen and to 0 when the ‘neither farm’ alternative was chosen. Choice data were converted from wide to long format with a programme coded in LIMDEP 9.0 NLOGIT 4.0. This data conversion step was necessary in estimating models with multiple responses from each respondent; a format similar to panel data.

\(^7\) This varies between Rs. 600 and Rs. 400 depending on various factors (gender, period and area). For example, men wage rate is slightly higher than female. Wage rate in harvesting period is greater than other period.
First, we estimated the CLM. The IIA property of this model is tested using a procedure suggested by Hausman and McFadden (1984). This test involves constructing a likelihood ratio test around different versions of the model, where choice alternatives are excluded. If IIA holds, the model estimated on all choices (the full choice set) should be the same as that estimated for a sub-set of alternatives (Bateman et al. 2003). It is found that the IIA conditions have not violated any of the cases. We then included social and economic characteristics as interaction terms, and test whether there is an improvement of our result. It was found to not have any significant improvement in including any social-economic characteristics as the interaction term.

As the next step of the analysis, Random Parameter Logit (RPL) model was used in order to take into account the preference heterogeneity. We estimated the basic RPL model, which includes only attributes as well as extended RPL model that includes some socio-economic variables. When comparing with RPL results with CL results, it was found that basic CL results were better in terms of overall fit of the model and number of significant variables. Therefore, the result of the basic CL model was used to simulate welfare change of the society, when changing different attributes and their level.

**RESULTS AND DISCUSSION**

The descriptive statistics of the samples show the similar characteristics of all three groups. The mean values of age were 38, 40 years for two treatment groups and 37 years for the control group. The
average number of persons in the household was 5, 4 and 5 while the average education levels were 10, 9 and 9, respectively. Although agriculture was the dominant source of household income, monthly income from non-farm activities was approximately estimated as Rs. 1,350, Rs. 1,300 and Rs. 1,425 per household; which accounted for almost 5 percent of the total household income. The mean labour usage per season was 74 man-days for three samples. This is expected, given the tedious labour intensity for all agricultural work in semi-subsistence economy. Rice was cultivated by almost all households followed by various types of vegetables and cash crops. The maximum number of crop varieties cultivated by any household was seven. More details of the descriptive are given in Table 2. The comparison of descriptive statistics clearly indicate that there is no significant difference among different groups.

Before estimating any model, we explored a variety of different specifications of the utility functions to identify the best specification of the data. These tests include both formal statistical tests and informal judgments about the signs, magnitudes, or relative magnitudes of parameters based on our knowledge about the underlying behavioural relationships that influence different choice of farms.
Table 2: Descriptive Statistics of the Variables Used in the Study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>38.33</td>
<td>62.00</td>
<td>18.00</td>
</tr>
<tr>
<td>Household size</td>
<td>4.66</td>
<td>7.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Education level</td>
<td>9.33</td>
<td>12.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Farm income (Rs. per month)</td>
<td>26500.00</td>
<td>62450.00</td>
<td>6540.00</td>
</tr>
<tr>
<td>Off-farm income (Rs. per month)</td>
<td>1358.30</td>
<td>6500.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Labour days (per month)</td>
<td>24.66</td>
<td>45.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>

Note: As hypothetical scenarios are given in choice experiment, descriptive statistics of those variables are not recorded.

As a formal statistical process, different model specifications were compared according to higher log-likelihood value criterion in this study. Most appropriate specification was found to be the model with the linear version of the four attributes of the study. Accordingly, CL model is specified, so that the probability of selecting a particular alternative is a function of attributes of the alternatives and of the alternative specific constant. Indirect utility received by the farm attributes take the form:

\[ T_{ij} = \beta_0 + \beta_1 (X_{species}) + \beta_2 (X_{mix}) + \beta_3 (X_{organic}) + \beta_4 (X_{cons}) \]  

Where, \( \beta_0 \) refers to the alternative specific constant and \( \beta_{1-4} \) refers to the vector of coefficients associated with the vector of attributes describing farm characteristics. The results of the estimated basic CL model for the separate samples are presented in Table 3. All attributes
except the organic farms in the control group in the models were statistically significant at conventional levels, and their signs were as expected.

Table 3: Regression Results of the CL Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Education (biodiversity)</td>
<td>Education (Environment)</td>
<td>Control group</td>
</tr>
<tr>
<td>ASC</td>
<td>2.32 (0.009)*</td>
<td>3.028 (0.005)*</td>
<td>2.984 (0.029)**</td>
</tr>
<tr>
<td>Crop diversity</td>
<td>0.081 (0.000)*</td>
<td>0.119 (0.002)*</td>
<td>0.011 (0.076)**</td>
</tr>
<tr>
<td>Mix system</td>
<td>0.229 (0.001)*</td>
<td>0.446 (0.001)*</td>
<td>0.022 (0.008)*</td>
</tr>
<tr>
<td>Organic farms</td>
<td>0.196 (0.041)**</td>
<td>0.477 (0.020)**</td>
<td>0.034 (0.341)</td>
</tr>
<tr>
<td>Costs</td>
<td>-3.1E-04 (0.000)*</td>
<td>-2.5E-04 (0.000)*</td>
<td>-2.1E-04 (0.000)*</td>
</tr>
<tr>
<td>LR chi2(5)</td>
<td>956.24</td>
<td>1425.14</td>
<td>971.44</td>
</tr>
<tr>
<td>Prob &gt; chi²</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Pseudo $R^2$</td>
<td>0.228</td>
<td>0.321</td>
<td>0.120</td>
</tr>
<tr>
<td>N</td>
<td>1680</td>
<td>1680</td>
<td>1680</td>
</tr>
</tbody>
</table>

Note:  
i. P values are shown within parentheses  
ii. * denotes significant at 1% level while ** and *** indicates significant variables at 5% and 10% level respectively

All attributes in the first and second models were statistically significant at conventional levels (5 percent), and their signs were as expected. The overall fit of the model as measured by McFadden’s $R^2$ was also good by conventional standards used to describe probabilistic discrete choice models (Ben-Akiva and Lerman, 1985). When analysing the results of these two models, it is clear that all of the farm attributes are statistically significant at 5 percent level, implying that
any single attribute increases the probability that a farm is selected; whereas different socio-economics variables and preferences remain equal. Since the underlying samples is statistically significant (P<0.05), these parameters represent preference estimates of farm families for farms attributes among two treatment groups. Third model shows the situation of the control group. For this group, organic farm variable is not significant (P>0.01) even under ten percent level while all other attributes were significant at five or ten percent level. Relatively, significance of the attributes of this model is less when compared to other two models. The results clearly show that the education has some impact on farmers’ valuation of agricultural biodiversity in study area.

As the next step of the analysis, the IIA property of all models is tested using a procedure suggested by Hausman and McFadden (1984) and contained within NLOGIT 4.0. This test involves constructing a likelihood ratio test around different versions of the model where choice alternatives are excluded. If IIA holds, then the model estimated on all choices (the full choice set) should be the same as that estimated for a sub-set of alternatives (Bateman et al. 2003). It was found that the IIA property is not violated implying that the conditional logit estimates do not hold any bias that could have resulted from inclusion of the ‘neither’ option. However, CL model assumes homogeneous preferences across farm families in each district, though references across families are in fact heterogeneous. Accounting for this heterogeneity enables estimation of unbiased estimates of individual
preferences and enhances the accuracy and reliability of parameter estimates (Rolfe et al., 2000). Interaction of individual-specific social and economic characteristics with choice specific attributes or with ASC of the indirect utility function is a common solution to dealing with the heterogeneity. However, the main problem with this method is multi-collinearity, which occurs when too many interactions are included in the estimation. In this context, the model needs to be tested down, using the higher log-likelihood criteria (Bateman et al., 2003; Birol, 2004). Therefore, as the next step of the analysis, CL model is estimated using three socio-economic variables as interaction terms. They are; age of the respondent (age), education level of the respondent (education) and household size (hhs). Accordingly, indirect utility received by the farm attributes and interaction with socio-economic characteristics can be re-specified as Equation 9:

\[ T_y = \beta_0 + \beta_1(X \text{species}) + \beta_2(X \text{mix}) + \beta_3(X \text{organic}) + \beta_4(X \text{const}) + \alpha_1(X \text{species} \times Z \text{age}) + \alpha_2(X \text{species} \times Z \text{edu}) + \alpha_3(X \text{species} \times Z \text{hhs}) + \alpha_4(X \text{mix} \times Z \text{age}) + \alpha_5(X \text{mix} \times Z \text{edu}) + \alpha_6(X \text{mix} \times Z \text{hhs}) + \alpha_7(X \text{organic} \times Z \text{age}) + \alpha_8(X \text{organic} \times Z \text{edu}) + \alpha_9(X \text{organic} \times Z \text{hhs}) + \alpha_{10}(X \text{const} \times Z \text{age}) + \alpha_{11}(X \text{const} \times Z \text{edu}) + \alpha_{12}(X \text{const} \times Z \text{hhs}) \]

As it shown in equation 9, the total number of coefficients in the full model is 16. We tested various interactions of the four farm attributes with the household-level including other characteristics. An initial run

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8 Different socio-economic variables were tried and finally those three were found to be more appropriate.
Education, Attitudes and Agricultural Biodiversity:

of the model with all interaction terms reveal that a large number of variables are insignificant for all three models. Then we estimated the correlation matrix and it was revealed that there was a higher level of correlation and multi-collinearity among these household-level variables. Estimation of variance inflation factor further provided the evidence about the higher correlation among household level variables. To address this limitation (except age, education and household size) all other independent variables were eliminated based on variance inflation factors, which were calculated by running ordinary least square regressions between each independent variable\(^9\). The estimated results of the final models are reported in Table 4.

This specification of the model was not significantly different from the previous specification. In particular, the model did not reveal a significant higher level of parametric fit, compared with the first model. Most of the interaction terms of all three models are not significant. Further, including the interaction terms has reduced the significance of some of the attributes of the models.

Therefore, it can be concluded that the improvement in model fit was not significant.

\(^9\) Those independent variables for which \(VIF_j > 0.6\) indicate clear evidence that the estimation of the characteristic is being affected by multicollinearity (Maddala, 2000).
Table 4: CL Model Including Attributes and Socioeconomic Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Education (biodiversity)</td>
<td>Education (Environment)</td>
<td>Control group</td>
</tr>
<tr>
<td>ASC</td>
<td>1.42 (0.016)**</td>
<td>2.317 (0.004)*</td>
<td>2.984 (0.019)**</td>
</tr>
<tr>
<td>Crop diversity</td>
<td>0.136 (0.002)*</td>
<td>0.362 (0.008)*</td>
<td>0.019 (0.169)</td>
</tr>
<tr>
<td>Mix system</td>
<td>0.124 (0.016)**</td>
<td>0.219 (0.021)**</td>
<td>0.063 (0.192)</td>
</tr>
<tr>
<td>Organic farms</td>
<td>0.116 (0.042)**</td>
<td>0.192 (0.000)*</td>
<td>0.044 (0.041)**</td>
</tr>
<tr>
<td>Costs</td>
<td>-2.2E-4(0.000)*</td>
<td>-2.9E-05(0.000)*</td>
<td>-1.6E-04(0.000)*</td>
</tr>
<tr>
<td>Crops_age</td>
<td>0.026 (0.231)</td>
<td>0.051 (0.090)***</td>
<td>0.002 (0.201)</td>
</tr>
<tr>
<td>Crops_edu</td>
<td>0.002 (0.041)**</td>
<td>0.0160 (0.000)*</td>
<td>0.002 (0.131)</td>
</tr>
<tr>
<td>Crops_hhs</td>
<td>0.002 (0.620)</td>
<td>0.001(0.000)*</td>
<td>0.017 (0.870)</td>
</tr>
<tr>
<td>Mix_age</td>
<td>0.107 (0.821)</td>
<td>0.203 (0.141)</td>
<td>0.007 (0.121)</td>
</tr>
<tr>
<td>Mix_edu</td>
<td>0.001(0.060)***</td>
<td>1.425(0.059)***</td>
<td>0.074 (0.083)***</td>
</tr>
<tr>
<td>Mix_hhs</td>
<td>0.012(0.061)***</td>
<td>1.224 (0.587)</td>
<td>0.704 (0.065)***</td>
</tr>
<tr>
<td>Organic_age</td>
<td>0.003 (0.506)</td>
<td>0.029 (0.601)</td>
<td>0.043 (0.801)</td>
</tr>
<tr>
<td>Organic_edu</td>
<td>0.043 (0.018)**</td>
<td>1.098 (0.017)*</td>
<td>0.247 (0.060)***</td>
</tr>
<tr>
<td>Organic_hhs</td>
<td>0.01 (0.255)</td>
<td>0.051(0.401)</td>
<td>1.248 (0.294)</td>
</tr>
<tr>
<td>Costs_age</td>
<td>-0.073 (0.459)</td>
<td>-1.13 (0.410)</td>
<td>-0.233 (0.094)***</td>
</tr>
<tr>
<td>Costs_edu</td>
<td>-0.305 (0.129)</td>
<td>0.451 (0.016)**</td>
<td>1.324 (0.183)</td>
</tr>
<tr>
<td>Costs_hhs</td>
<td>-0.031(0.149)</td>
<td>-0.130 (0.40)</td>
<td>-0.203(0.840)</td>
</tr>
<tr>
<td>LR chi2</td>
<td>1276.23</td>
<td>1825.88</td>
<td>1141.64</td>
</tr>
<tr>
<td>Prob &gt; chi²</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Pseudo $R^2$</td>
<td>0.229</td>
<td>0.342</td>
<td>0.140</td>
</tr>
<tr>
<td>N</td>
<td>1680</td>
<td>1680</td>
<td>1680</td>
</tr>
</tbody>
</table>

Note:  
  i. *denotes significant at 1% level while ** and *** indicates significant variables at 5% and 10 % level.  
  ii. $P$ values are given in parenthesis.
The Hausman-McFadden test also revealed that CL model without interactions is a better fit for the data, than the CL model with interaction. Among the significant interactions, households with a higher education level in all samples had a higher preference for organic and mix farming practices. The overall model is significant at the one percent level. Compared to basic CL model, the explanatory power of the model has not changed significantly.

An alternative method to account for preference heterogeneity is the use of RPL model\(^{10}\). We next estimate the results using RPL model to investigate the fact that whether there is an observable improvement of the results. Running the RPL model requires an assumption to be made about the distribution of preferences for each attribute. The main candidate distributions are normal and log normal. The former allows preferences to range between positive and negative for a given attribute, the latter restricts the range to being of one sign only. Further, treating preference parameters as random variables require estimation by simulated maximum likelihood. This means that the maximum likelihood algorithm searches for a solution by simulating \(m\) draws from distributions with given means and standard deviations. Probabilities can be calculated by integrating the joint simulated distribution. In this study the RPL model was estimated using NLOGIT

\(^{10}\) RPL model is one of the fully flexible versions of the discrete choice models because its unobserved utility is not limited to the normal distribution. It decomposes the random parts of utility into two parts. One has the independent, identical type 1 extreme value distribution, and the other representing individual tastes can be any distribution. It is also characterized by accommodating heterogeneity as a continuous function of the parameters.
4.0. All the parameters were specified to be independently normally distributed and distribution simulations were based on 500 draws. The results of the RPL estimations for the separate districts are reported in Table 5

**Table 5: Regression Results of the RPL Model for Separate Districts and Pool Data**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Education (biodiversity)</td>
<td>Education (Environment)</td>
<td>Control group</td>
</tr>
<tr>
<td>ASC</td>
<td>1.838 (0.042)**</td>
<td>1.343 (0.007)*</td>
<td>2.428 (0.013)**</td>
</tr>
<tr>
<td>Crop diversity</td>
<td>0.0640 (0.009)*</td>
<td>0.126(0.009)*</td>
<td>0.015 (0.032)**</td>
</tr>
<tr>
<td>Mix system</td>
<td>0.178 (0.040)**</td>
<td>0.157 (0.001)*</td>
<td>0.135 (0.081)*****</td>
</tr>
<tr>
<td>Organic farms</td>
<td>0.147 (0.044)**</td>
<td>0.192 (0.036)**</td>
<td>0.184 (0.145)</td>
</tr>
<tr>
<td>Costs</td>
<td>-2.0E-04 (0.000)*</td>
<td>-2.3E-05 (0.000)*</td>
<td>-1.4E-04 (0.000)*</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-1722.65</td>
<td>-2943.43</td>
<td>-1647.32</td>
</tr>
<tr>
<td>Simulation</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>$\rho^2$</td>
<td>0.178</td>
<td>0.198</td>
<td>0.161</td>
</tr>
<tr>
<td>$N$</td>
<td>1680</td>
<td>1680</td>
<td>1680</td>
</tr>
</tbody>
</table>

Notes:  
- i. P values are shown in brackets.  
- ii. *denotes significant at 1% level while ** and *** indicates significant variables at 5% and 10% level respectively.

The results of the RPL model are quite similar in sign and magnitude to the CL model, where preferences are assumed to be homogenous. The crop diversity coefficient for the standard CL model is 0.081, whereas it is 0.064 for the RPL for Model 1. In this model coefficients of the mix farming systems are 0.229 and 0.178 for CL model and RPL model respectively. The CL model contains all positive and significant choice attributes, except organic farm in model three which is similar
to the RPL results. The major difference between the two models is that most coefficients of the CL models are highly significant, while RP models are relatively less significant. The Swait Louviere Log Likelihood ratio test results of the test cannot reject the null hypothesis that the RPL model and CL model estimates are equal. Hence no improvement in the model fit can be achieved with the use of a RPL model. Accordingly, it can be concluded that the CL model is sufficient for analysis of the data set presented in this study. Therefore, the results of the CL model reported in Table 2 can be used to calculate the value assigned by the farm families to farm attributes. Point estimates of the WTA, a change in one of the attributes in the choice sets can be found by estimating implicit prices. Implicit prices are the marginal rates of substitution between the attribute of interest and the monetary attribute. This is equal to the ratio of the coefficient of one of the non-monetary attributes and the monetary attributes. Equation 6 is used to estimate the implicit prices for each attribute. Estimates of implicit prices for each of the non-monetary attributes in the choice sets are reported in Table 6.
Table 6: Implicit Price Estimates for Attributes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Education (biodiversity) Rs.</th>
<th>Education (Environment) Rs.</th>
<th>Control group Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop diversity</td>
<td>261</td>
<td>476</td>
<td>86</td>
</tr>
<tr>
<td>Mix system</td>
<td>739</td>
<td>1784</td>
<td>105</td>
</tr>
<tr>
<td>Organic farms</td>
<td>632</td>
<td>1908</td>
<td>162</td>
</tr>
</tbody>
</table>

Note: all implicit prices are estimated using the result of the basic CLM.

These estimates indicate that, for example, farmers’ valuation of the additional benefits that farmers could obtain in increasing crop diversity by one per month is Rs. 86, 261 and 476 in control group, educated on biodiversity group and educated on environment group respectively. It is clear that farmers of ‘educated on environment’ group have placed relatively high values on all attributes. Interestingly, the highest valuation is given for organic farming when comparing with other attributes. This is expected as most farmers in these districts use their farm products for their own consumption.

These estimates of implicit prices are based on a ceteris paribus assumption, where we assume that all other parameters are held constant except the attribute for which the implicit price is being calculated. Implicit prices, however, do not provide estimates of compensating surplus. Estimating the overall WTA for a change from the current situation requires more substantial calculations. This is because, the attributes in the choice sets do not capture all of the
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reasons why respondents might choose to increase agricultural biodiversity. To estimate overall WTA, it is necessary to include the alternative specific constant. As discussed earlier, the alternative specific constant captures systematic but unobserved information about why respondents chose a particular option (unrelated to the choice set attributes). Therefore, as the final step of the analysis, consumer surpluses for different samples are estimated using Equation 7. Then changes of the CS relative to the control group are estimated. These changes are given in Table 7.

Table 7: Changes of the CS under Each Scenario

<table>
<thead>
<tr>
<th>Status quo</th>
<th>Crops diversity</th>
<th>Mix</th>
<th>Organic</th>
<th>Education (Biodiversity) ΔCS / Rs.</th>
<th>Education (Environment) ΔCS / Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>2,434</td>
<td>4,522</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>3,127</td>
<td>4,786</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>3,434</td>
<td>5,245</td>
</tr>
</tbody>
</table>

Note: After estimating the CS per farmer under each scenario, the deviation from the status quo were calculated. Then the changes of those two groups from the control group were estimated.

To illustrate this process, estimates are provided for three alternative scenarios. The status quo situation is identified as a farm with one crop variety and no mixed farming or organic farms. We changed these characteristics for the rest of the profile gradually and estimated change of the CS under each profile. Estimated change of CS in each sample is given in Table 7. The ΔCS values indicate that the value attached to deviation from control group to educated on biodiversity group were
Rs. 2,434, 3,127 and 3,434 respectively. Those values for educated on environment group were Rs. 4,522, 4,786 and 5,245 respectively. These are, the average benefits per household which can be obtained by increasing crop diversity, adopting mix farming practice and introducing organic farming practice in their farms. This shows that farmer welfare could be easily increased by shifting farming practice to more diverse systems in rural areas in Sri Lanka.

CONCLUSIONS AND POLICY IMPLICATIONS

This research is one of the first attempts to use choice modelling to investigate farmers’ preference for different attributes of agricultural biodiversity that can be seen in diverse farms in Sri Lanka. The study applied the choice modelling approach with RCM to identify question that whether farmers preferences on different attributes of agricultural biodiversity are affected by different types of education or not? The result of this study shows that agriculture based families in the study area have strong preferences to increase agricultural biodiversity. It is clear that all diversity components are valued highly by all types of households in the study area.

In general, the findings of the Choice Experiment support the assumption that diverse farms and their multiple attributes contribute positively and significantly to the utility of farm families in Sri Lanka. Furthermore, their valuation is highly affected by their education on biodiversity and environmental attitudes. The present study illustrates
the importance of education in determining farmers’ valuation of agricultural biodiversity. Therefore, designing formal and informal education programmes will improve farmers’ abilities to conserve agricultural biodiversity in the country. Moreover, a further initiative can be taken to strengthen the capacity of farmers through farmer-centred training workshops geared towards conserving agricultural biodiversity. This could be done in a collaborative manner involving the government, district assemblies and NGOs. The government also needs to intensify its agricultural extension service programmes by training and deploying qualified extension officers. The officers, in turn, should intensify farmer education on agricultural biodiversity.

The overall findings of this research will help to implement policies to reduce degradation of agricultural biodiversity that is increasingly posing a major impediment to agricultural growth, environmental protection and sustainable development. Further, the research findings will contribute to the sustainable use of agricultural biodiversity to improve farmers’ well-being and achieve an environmentally friendly farming system. It also helps to increase awareness and generates support for investment in conservation and development of agricultural biodiversity. Moreover, it will provide an opportunity to make necessary policies that provide incentives to protect biodiversity at farm level that generate regional as well as global benefits in the future.
REFERENCES


STANDARDIZATION AND CHARACTERIZATION OF VALUE ADDED WATERMELON JUICE (*Citrullus lanatus*) READY-TO-SERVE BEVERAGE

K. Saranyah  
T. Mahendran

Abstract

An experiment was conducted to study the feasibility of blending pineapple and watermelon juice in different ratio for preparation of blended RTS beverage. The formulated RTS beverages were evaluated for various chemical, organoleptic and microbial qualities. The titrable acidity, ascorbic acid, total soluble solids (TSS) and total sugars of freshly made RTS beverages increased while pH decreased with the increased concentration of pineapple juice from 10-30%. Tukey’s test results revealed that, the mean scores for all assessed organoleptic characters varying significantly (pH0.05) in the freshly made pineapple blend watermelon RTS beverages. The formulated beverage with 80:20 watermelon and pineapple juice was found to be superior in quality and could be stored at 30±1°C for a minimum period of three months without any significant changes in quality attributes.

**Keywords:** Pineapple, quality characteristics, Ready-To-Serve beverage, watermelon.

K. Saranyah  
Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University, Sri Lanka

T. Mahendran  
Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University, Sri Lanka
INTRODUCTION

Fruit and Vegetable sector has much potential to contribute to increase the level of national income, export revenue, generate new employment opportunities, increase farm income and enhance the nutrition and health of the people. The potential for cultivating fruit and vegetable crops for the domestic and export markets is high. Sri Lanka’s per capita consumption of fruits and vegetables remains far below the required average daily intake. According to Medical Research Institute (2011), the daily per capita requirement of fruits for a balanced diet should be 30-40g (edible portion), which is approximately equivalent to 25-40 kg fresh fruit per head per year. Consuming fruits and vegetables of all kinds has long been associated with a reduced risk of many lifestyle-related health conditions.

Watermelon (Citrullus lanatus) is an important cucurbitaceous crop, whose fruits serve as a dessert to the common people in summer. These fruits are available in May to June in the markets throughout Sri Lanka. Watermelon is consumed as a fresh fruit and for its dry seeds. The watermelon fruit contains 93% water, with small amounts of protein, fat, minerals, and vitamins. The major nutritional components of the fruits are carbohydrates, especially sugars (6.4g/100g), vitamin A (590 IU), and lycopene (4,100μg/100g, range 2,300–7,200), an anti-carcinogenic compound found in red flesh watermelon (USDA Nutrient Database, 2009). Only a few studies have dealt with drying of watermelon, mainly with osmotic dehydration of the pulp (Falade et al., 2007) and spray-drying of the juice (Quek et al., 2007).
Pineapple (*Ananas comusus*) belongs to the family of Bromeliaceae. The fibrous flesh of pineapple is yellow in colour and has a vibrant tropical flavour that balances the tastes of sweet and tart. It is an excellent source of vitamin C which is required for the collagen synthesis in the body. It is also available in the same season from May to June of which watermelon are available in Sri Lanka.

Juice blending is one of the best methods to improve the nutritional quality of the juice. It can improve the vitamin and mineral content depending on the kind and quality of fruits and vegetables used (De Carvalho *et al.*, 2007). Apart from nutritional quality improvement, blended juice can be improved in its effects among the variables, thus it cannot depict the net effects of various parameters on the reaction rate. Moreover, one could think of a new product development through blending in the form of a natural health drink, which may also be served as an appetizer. The watermelon fruit juice blend that could lower the risk of cardiovascular disease has been created by Cyril *et al.* (2009). Polyphenols are found in fruits as diverse in red watermelon. Their beneficial effect on health is well known, with a diet rich in polyphenols correlating with a reduced risk of cardiovascular disease.

According to the Sri Lanka Standard Institute specifications, RTS fruit beverage should not exceed its total acidity more than 1% (as anhydrous citric acid). The fruit and sugar content should not be less than 5% by mass and preservatives should not exceed the limit of Sulphur dioxide (70 ppm) and benzoic acid (120 ppm). Adding preservatives such as Sulphur dioxide and benzoic acid can increase
the shelf life of RTS beverages. Colouring matter and clarifying agents can be added to the product, to increase attractiveness and addition of flavouring ingredients is allowed only in the product prepared by using mango.

Therefore, this research was carried out to formulate an acceptable quality of RTS beverage using watermelon and pineapple at different combinations considering SLS requirements and to assess the chemical, organoleptic and microbial qualities of pineapple blend watermelon RTS beverage after formulation and during storage.

**MATERIALS AND METHODS**

Undamaged, disease free, healthy, mature and ripe watermelon (Variety - *Thillina*) and pineapple (Variety - *Mauritius*) fruits were purchased from the Commercial Horticultural Farms of the Department of Agriculture, Sri Lanka.

**Juice preparation**

Fruits were washed with clean running water to remove dust particles and to reduce the microbial load on the surface of the fruits. Peeled pineapples were crushed with mixer cum juicer for the extraction of juice. Watermelons were cut with the help of stainless steel knives into pieces and seeds were removed manually. The fleshes were passed through the juicer for extraction of juice. Six formulations were prepared by mixing watermelon juice and pineapple juice in different ratios with sugar, acidity as anhydrous citric acid and 70 ppm of potassium metabisulphite (KMS). The amount of added sugar, citric
acid and potassium metabisulphite were kept as same for each treatment.

The prepared beverages were filtered through the strainer (200 µm) to get a clarified juice and filled in previously sterilized glass bottles (200 ml) leaving 2.5 cm head space and sealed airtight by crown corking covered with aluminium foil. Then the bottled juice were sterilized at 105°C for 10 min and cooled to room temperature of 30±1°C.

The following treatment combinations were formulated:

T<sub>1</sub> - RTS beverage with 100% watermelon juice
T<sub>2</sub> - RTS beverage with 90% watermelon juice and 10% pineapple juice
T<sub>3</sub> - RTS beverage with 85% watermelon juice and 15% pineapple juice
T<sub>4</sub> - RTS beverage with 80% watermelon juice and 20% pineapple juice
T<sub>5</sub> - RTS beverage with 75% watermelon juice and 25% pineapple juice
T<sub>6</sub> - RTS beverage with 70% watermelon juice and 30% pineapple juice

Chemical Qualities
Chemical qualities of the RTS beverage were analysed using recommended standard AOAC methods (2002). The titrable acidity was determined by titrating the RTS beverages of various juice
combinations with 0.1N NaOH and the results were expressed as percentage of anhydrous citric acid.

Ascorbic acid content of beverages was titrimetrically estimated by indophenol dye method. The pH was determined by an Electronic pH meter (Mettler Toledo, UK). Lane-Eynon method was performed to determine the total sugar content of the formulated beverages.

Hand-held refractometer (ATAGO-S-28E model) was used to estimate the total soluble solids (TSS) and the values were expressed as °Brix. The analyses were replicated thrice.

**Microbial Test**
The prepared beverages were studied for microbial quality and safety. The total microbial load was calculated by standard plate count method. The standard plate count was done according to the method described by Arachchi (2003) in raw mango RTS beverages.

**Sensory Evaluation**
In sensory evaluation, the samples were subjected to nine-point hedonic scale test and the acceptability of samples was judged by 11 trained panelists to determine sensory preference. The sensory characteristics such as colour, flavour, taste, thickness and overall acceptability of the RTS beverages were judged by the panelists.

**Shelf Life Evaluation**
RTS beverages were subjected to storage studies at room temperature for a period of 3 months by drawing samples at bimonthly intervals to
evaluate changes in chemical, organoleptic parameters and microbial spoilage.

Statistical Analysis
Data obtained in chemical analysis were subjected to Analysis of Variance (ANOVA) and mean separation was done with Duncan’s Multiple Range Test (DMRT). Descriptive statistics was done on sensory attributes and the means were compared using the Tukey’s test (p<0.05).

RESULTS AND DISCUSSION
Titrable Acidity
According to the Sri Lanka Standard Institute Specifications, the limits of acidity for RTS preparation are 0.3-1% as anhydrous citric acid (SLS 729:1985). The titrable acidity of the RTS beverage samples varied significantly and increased from 0.16 to 0.42% with increase the concentration of pineapple juice from 10 to 30% as shown in Figure 1. This can be attributed partly to the contribution of the inherent acid naturally present in the pineapple juice. Pineapple is acidic, which 87 % is citric acid and 13 % is malic acid. According to Samson (1986), the fresh pineapple juice has 0.7-1.6 g citric acid /100 ml.
Ascorbic Acid is an essential nutrient for humans because it aids in the synthesis of collagen in addition to protecting against oxidative damage. Watermelon juice contains 5.81 mg/100 ml of ascorbic acid (Patil, 2000).
The ascorbic acid content increased significantly from 5.64 to 15.63 mg/100 ml with an increase in the concentration of pineapple juice from 10 to 30% in the RTS beverage formulations (Figure: 2). These findings are reported that maximum ascorbic acid (15.9 mg/100 ml juice) was recorded in RTS beverage with 70% watermelon juice and 30% pineapple juice.

**pH**

The presence of free hydrogen ions and buffering capacity of the juices influence the pH value of the beverage (Shubhangi, 2002). The pH of freshly made pineapple blend watermelon RTS beverages was below 5.25. According to DMRT, the pH reduced significantly (p<0.05) with the increasing concentration of pineapple juice in RTS beverages is shown in the Table 1. The highest pH value 5.22 was obtained in the treatment T\(_1\). The treatment T\(_6\) (RTS beverage with 70% watermelon juice and 30% pineapple juice) had the least mean value.

**Table 1: The pH and TSS of freshly made Pineapple blend Watermelon RTS Beverages**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>pH</th>
<th>TSS (°Brix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T(_1)</td>
<td>5.22±0.002(^a)</td>
<td>13.1±0.02(^a)</td>
</tr>
<tr>
<td>T(_2)</td>
<td>5.10±0.023(^b)</td>
<td>13.5±0.03(^b)</td>
</tr>
<tr>
<td>T(_3)</td>
<td>4.90±0.003(^c)</td>
<td>13.9±0.09(^c)</td>
</tr>
<tr>
<td>T(_4)</td>
<td>4.76±0.002(^d)</td>
<td>14.0±0.06(^d)</td>
</tr>
<tr>
<td>T(_5)</td>
<td>4.64±0.016(^e)</td>
<td>14.2±0.04(^e)</td>
</tr>
<tr>
<td>T(_6)</td>
<td>4.61±0.016(^f)</td>
<td>14.5±0.06(^f)</td>
</tr>
</tbody>
</table>

Note: The values are means of triplicates ± standard error
The results generally showed that the higher acidity, lower pH of pineapple RTS beverages. Similar study conducted by Awsi Jan and Dorcus (2012) found that there is a corresponding reduction in pH as the acidity increased in pineapple Juice blend with carrot and orange juice.

**Total Sugar**

Sugars, acids and their interactions are important to sweetness, sourness and overall acceptability in RTS beverages. The minimum total sugar content (as sucrose) for RTS preparation is 5% (SLS 729:1985). Sugars, acids and their interaction are important to sweetness, sourness and overall acceptability in RTS beverages. As shown in Figure: 3, the total sugar content of watermelon was 5.25%. Schmidt et al, (2005) found that the watermelon juice contained 32.2% fructose, 9.3% glucose, and 27.1% sucrose for a total of 68.6% of sugars on a dry matter basis.

![Figure 3: Total Sugar Content of Freshly Made RTS Beverages](image)

**Note:** The values are means of triplicates. Vertical bars indicate the standard errors.
According to DMRT, the total sugar significantly (p<0.05) differed between each treatment. The treatment T₆ had highest mean value and the treatment T₁ (RTS beverage with 100% watermelon juice) had a least mean value at 5% level of significance.

**Total Soluble Solids (TSS)**

TSS: Acid ratio is often better related to palatability of the fruits than either sugar or acid alone. The recommended TSS for commercial RTS production is 15°Brix (SLS 729: 1985). The TSS of RTS beverage formulation was adjusted initially. According to the DMRT, the TSS increased significantly (p<0.05) with the increasing concentration of pineapple juice in RTS beverages is shown in the Table 1. The highest TSS value 14.5 (°Brix) was obtained in the treatment T₆. The treatment T₁ (RTS beverage with 100% watermelon juice) had the least mean value of 13.1 (°Brix).

**Microbial Test for Freshly Made RTS Beverages**

In the freshly made beverages, no bacterial growth was observed immediately after formulation. Therefore, there was no total plate count in these samples. Carter *et al.* (2007) reported that many products that could safely be maintained sterile by pasteurization process alone could be doubly preserved by the addition of potassium metabisulphite. The sulphite inhibits yeasts, moulds and bacteria (Doughari and Elmahmood, 2007). Therefore, the heat treatment was sufficient to destroy initial microbial load in the formulated fruit drinks.
Sensory qualities of Freshly Made RTS Beverages

Sensory evaluation was made through panel of 11 trained judges. The panel evaluated colour, flavour, taste, thickness and overall acceptability. A 9-point hedonic scale was used for this purpose. As shown in Figure: 4, the sensory evaluation of the RTS beverage revealed that, there were significant differences between the treatments as the concentration of pineapple juice was increased from 10 to 30% for colour, flavour, taste, thickness and overall acceptability at 5% level of significance according to General Linear Models (GLM).

CONCLUSION

Based on the chemical analysis of the freshly made RTS beverages, there were significant increase in titrable acidity, ascorbic acid, total sugar and total soluble solids (TSS) and a significant decrease in pH with the increase in the concentration of pineapple juice from 10 to 30% in RTS beverages. According to the microbial test, the total plate
count was observed after three months of storage. Among the inoculated samples, there were shown some colony forming units (bacterial growth).

There was no drastic effect on the quality of the product due to microbial growth in three months at ambient temperature. Therefore, it is safe for consumption upon three months of storage. The sensory analysis revealed that, there were significant (p<0.05) differences for the organoleptic characters between the treatments. According to Tukey’s test, the highest overall acceptability was observed in the RTS beverage with 80% watermelon juice and 20% pineapple juice. The RTS beverage with 100% watermelon juice had low organoleptic characters and overall acceptability than the other RTS beverages. Therefore, the RTS beverage formulated with 80% watermelon juice and 20% pineapple juice is the best combination for the commercial preparation of pineapple blend watermelon RTS beverage without any significant changes in the nutritional, chemical and sensory characteristics with extended shelf life.

REFERENCES


THE SOLID WASTE MANAGEMENT FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF HAMBANTOTA MUNICIPAL COUNCIL AREA IN SRI LANKA

Asiri D. Vitharana

Abstract
The study explores the importance of Solid Waste Management (SWM) for Sound Environmental Development (SED) in Hambantota Municipal Council (HMC) area in Sri Lanka. Data for the study was collected using integrated research tools including Semi-structured interviews, self-completion questionnaires, focus group discussions and non-participatory observations. The ‘Random Sampling Method’ was used to select households and business population while ‘Purposive Sampling’ was used to select respondents for the interviews and focus groups. The study revealed that lack of awareness, little synergy between local authorities and the community and challenges of limited resources, facilities and funds and illegal dumping for proper SWM process were the dominant problems in SWM. In this regard, the paper suggests an integrated SWM process, with awareness programmes and cooperation between authorities and community for the process. Implementing SWM in to Development policies for Sustainable Development, has been further suggested.

Keywords: Sustainable Development, Solid Waste Management, Hambantota Municipal Council, Sri Lanka

Asiri D. Vitharana
University of Ruhuna, Matara, Sri Lanka
asiridvitharana@hotmail.com
INTRODUCTION

Over the time, countries experience the development with growth of industrialization, trade and internationalization. To some extent, a discussion has emerged whether this development is sustainable. Recently, most development practitioners have focused on ‘Sustainable Development’ (SD)\(^1\) as an environmental concept placing the emphasis on intergenerational equality (Carter, 2001). According to World Conservation Strategy (WCS), development depends on environmental conservation (Adams, 2009). However, the human way of life has put an immense pressure on the environment, because of high consumption patterns accelerating in parallel with the economic development.

Solid waste (SW) has become a major negative consequence of development in recent decades. SW largely affects the natural environment, and poses a serious threat in achieving Sound Environmental Development (SED) or so-called Sustainable Development (SD) (Anand, 2010). Therefore, sound SW management is one of the necessities in development process.

Sri Lanka may provide an example of this issue, with new development processes under the government’s major development plans, since the environment is challenged with rapidly generating SW. Consumer behaviour has generated a significant amount of SW in

\(^{1}\) As guided by the United Nations (UN) Brundtland Commission, sustainability is ‘a system which can be considered sustainable if it ensures that today’s economic development is not at the expense of tomorrow’s development perspectives’ (Malik et al, 2011).
recent years. According to the National Environmental Action Plan (NEAP), management of solid waste has been identified as one of the major challenges for sound environmental development in Sri Lanka. However, when considering the sound environmental development/Sustainable Development in Sri Lanka, it is important to assess the impact of development project on the environment, especially for the generation of Solid Waste, as it is the first and the most significant outcome of the development. Hambantota development projects were implemented during last few years. There are no proper research studies on the impact of Solid Waste Management for sound environmental development in the area. Even though the development projects have mentioned about sustainable development, there is no proper description and procedure or discussion on the importance of Solid Waste Management for sustainable development process.

As Hambantota district is being developed under a master development plan, it is important to direct this development towards SED/SD for future generations. Therefore, the research considers SWM practices and its impact on SED/SD in Hambantota Municipal council (HMC). The study further focuses on identifying the importance of SWM for the formulation of on-going development processes towards sustainability. The objective of this study is to explore the existing SWM practices, analysis their impact on sustainable development in the study area finally make recommendation to improve the SWM processes.
CONCEPTUAL FRAMEWORK

Figure 1 depicts a Conceptual Framework (CF) to explain the link among SWM, Environmental Conservation and Sustainable Development. The framework elaborates that development occurs with growing economy and increasing population generates solid waste, which in turn causes environmental pollution and degradation.

**Figure 1: Conceptual Framework**

![Conceptual Framework Diagram]

Source: Created by Author

Waste separation, recycling and composting can be used as methods for SWM with integrating of such measures as legal structure,
awareness raising, attitude change, and cooperation between authorities and community to mitigate the negative impacts on the environment. Integrated, sustainable SWM provides the ground for environmental conservation and in turn socio-economic development. Efficient waste management will facilitate steady state growth and to achieve the sustainable development/Sound Environmental Development at the end.

LITERATURE REVIEW

Over the past 30 years, most of countries in the world have achieved rapid economic development in term of improving the well-being of people and raising their living standards. Despite some remarkable progress, there are also pressing constraints on development with entrenched negative trends means that sustainability is remaining question (Dalal-Clayton, and Bass 2002). Development practitioners now recognize Sustainable Development as a matter of environmental conservation that should be followed by social and economic development. Environmental sustainability is a necessity for SD in order to balance the three pillars of economic and social development with environmental protection (Malik et al, 2011). The Recognition led to initiate discoureser and create the United Nations Environmental Programme (UNEP) and United Nations Environment Department (UNED). Since then, worldwide acceptance of the importance of the environmental issues has grown enormously (Dalal-Clayton and Bass 2002). Concurrently, the report of the World Commission on Environment and Development (WCED - the Brundtland commission)
was introduced in response to increasingly informed analysis of the link between environment and development (Dalal-Clayton and Bass 2002).

Focusing on environmental aspects of the Sustainable Development, the crucial condition appears to be that of reducing environmental degradation and resource consumption combined with economic development (Clini et al., 2010). However, accelerating environmental degradation indicates that the world is facing a stronger sustainability challenge than ever (Ayres, 2007). The achievement of sustainability in national development requires a strategic approach, which is both long term in its perspective and integrated or joined up in linking various development processes; so that they are as sophisticated as the challenges are complex (Dalal-Clayton and Bass, 2002). The important message is that environment and the socio-economic development are so intricately linked that development cannot be sustained without considering its environmental dimensions (UNEP, 2013). Therefore, to achieve Sustainable Development goals, countries should develop attentiveness towards sound environmental development and mitigate impacts on the environment.

Sustainable Development rejects the practices that support depletion of natural resources and that leaves future generations with poorer prospects (Repetto, 1986). Human actions have caused many challenges to the environment, especially with tremendous amount of waste generated due to population growth, industrialization and increasing consumption patterns. Unmanaged development influences
The Solid Waste Management for Sustainable Development: the production of wastes in different ways and strongly affects the environment all over the world. This cannot be avoided as long as waste generation is a necessary reality associated with economic development (Vallero and Letder, 2011). Waste is described as something that has ‘no value,’ something which is ‘useless’ and something that the owner wants to ‘discard.’ The words Rubbish, Garbage, Trash or refuse are often used as synonyms for waste. The UNEP (2009) classifies waste as; Municipal Solid Waste (MSW) including Plastic waste, Construction and Demolition waste (C&DW), Hazardous solid wastes (HW), Bio-Medical Waste (BMW) and Electronic waste (E-waste). Out of all these wastes, many countries are facing serious problems with the increasing amount of Solid Waste (SW) SW is viscid, dense, hard and substantial materials. SW has been further called ‘Municipal Solid Waste’ (MSW). The urban development process, population growth and consumption patterns have increased the generation of SW/MSW in many countries. The institutions both Government and non-government have responsibility to manage the waste in order to mitigate the possible impact on health and environment of the people.

According to the Schübeler, (1996) Solid Waste Management (SWM) is an essential task for ensuring public health and well-being, quality and sustainability of the urban environment and efficiency and productivity of the urban economy. As Chandrappa & Das (2012) described, SWM processes may vary due to different lifestyles of the inhabitants and type of the natural resources in the respected region.
Therefore, the strategy towards SWM should be differentiated accordingly.

The aim and purpose of Solid Waste Management is to ensure a sound environment and increase resilience. The underlying principle of the Basel Convention (1989), points out that the environmentally sound management is an approach that has the potential to bridge the makers to the breakers and thus contributing worldwide to the protection of human health and the environment. Therefore, Sound Environmental Waste Management should focus on integrating all practical steps to protect human health and the environment from the adverse effects of all kinds of wastes (Portas, 2003). The Integrated Solid Waste Management is a new, broad, international consensus on the Management of SW/MSW in sustainable ways and the concept was introduced by the organization WASTE first and was later developed and expanded by the Collaborative Working Group on Solid Waste Management in Low and Middle-Income Countries (UN Habitat, 2010). ‘Integrated Waste Management’ is a framework of reference for designing and implementing new waste management systems and for analysing and optimizing existing systems (UNEP, 2005).

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2 ‘Integrated Waste Management’ is a framework of reference for designing and implementing new waste management systems and for analysing and optimizing existing systems (UNEP, 2005).
According to McDougall et al (2001), ISWM uses a range of collection and treatment methods. All materials in the waste stream are handled in environmentally effective, economically affordable and socially acceptable ways. The Integrated Approach to Solid Waste Management can deliver both environmental and socio-economic sustainability. Countries that can achieve SW/MSW with ISWM may move towards sustainability.

A healthy environment has the ability to serve as a sink or waste repository. It can absorb, redistribute and transform waste, produced by human action or natural phenomenon, into harmless forms (Coward, 1995; Park, 2001; Hawken, 2003). However, the process of unbalanced development has its price in the form of an increased pressure on natural resources through inefficient and wasteful utilization (Anand, 2010). As such, the amount of waste in recent decades has exceeded, “the environment’s ability to absorb the waste” (Ritzre, 2010).

The significant issue with this increasing amount of waste is that they have depleted the ecosystems by pollution and degradation. The capacity of many ecosystems to provide services has been reduced and it has had profound negative impacts on opportunities for Sustainable Development around the planet (UNEP, 2007). In this situation, the future options for sustainable development become limited or eroded as the ecosystem products and services are not managed effectively and efficiently (UNEP, 2007).

Environmental conservation, protecting the ecosystem and services should be the main concerns. Especially, as discussed above,
SW/MSW may have significant impacts on the environment, and managing them properly is a necessary prerequisite for making development more sustainable. The well-formed Solid Waste Management is the only way to reduce the impact of SW/MSW on the environment. Due to the implementation of successful Solid Waste Management, both public health and the quality of the environment will benefit directly and substantially (UNEP, 2005).

The escalating development process in Sri Lanka has significant impacts on the environment. Today the country’s bio-diversity is endangered and environmental degradation has increased due to unmanaged development and economic growth. Population growths, consumption of ecosystem products and services have caused significant impacts on the environment, including the generation of large amounts of SW/MSW.

SW/MSW is a growing issue in urban development in Sri Lanka and is aggravated due to the absence of proper solid waste management systems at local authorities (CEA, 2005). According to the Sri Lanka National Report to the WSSD (2002), there are a number of critical environmental problems and issues caused by SW/MSW such as: deforestation, coastal erosion, soil erosion, water pollution and atmospheric pollution due to development processes. Therefore, SW/MSW is considered as one of the main environmental problems which affects urban air pollution, water pollution and soil erosion in Sri Lanka (Wanasundara, 2002).
The Ministry of Environment & Natural Resources of Sri Lanka launched a national level Solid Waste Management programme called ‘Pilisaru’ (renovation). The Project was undertaken to find solutions to the increasing solid waste problem with the participation of other organizations such as the Urban Development Authority, private institutions, NGOs & experts in the field in Sri Lanka. Under this Project, waste management will be managed by adhering to reduction of waste generation by reuse, recycling and resource recovery to the maximum extent possible followed by appropriate treatment and finally the disposal of residual waste in an environmentally sound manner (CEA, 2008).

METHODOLOGY

Study Area

The study area of this study is Hambantota city which is governed by Hambantota Municipal Council (HMC) since 2011. The city located in Hambantota District of Sthern dry-zone of Sri Lanka. It includes 7 Grama Niadhari Divisions (GNDs): Koholankala, Keliyapura, Siribopura, Samodagama, Hambantota East, and Hambantota West. The total population in HMC is 23,090 with 5852 households and 565 registered Business Places.

Hambantota has rich ecosystems including a diverse flora and fauna and various environmental resources as shown in Map 1. The conservation of these ecosystems is a concern of many environmental
practitioners and policy makers in order to support sustainable development in the country. However, as Hambantota area is being developed under the government greater development plan (See maps 2), there are potential impacts on the environment. In this situation, the study focuses on the impact of SW/MW on the environment in order to discuss the importance of proper SWM process for SD/SED in the study area.

Map 1: ecosystem in Hambantota
Map 2: Greater Development Plan in Hambantota


**Data and Analysis**

Both qualitative and quantitative methods including the semi-structured interview, self-completion questionnaire, focus group discussions and non-participatory observation were used to collect data. Government reports, municipal council reports and many other documents from different organizations and academic papers regarding waste management and its impact on the environment were used to collect secondary data. Random sampling was used to select 69 households and 59 business populations for SCQ, of 5852 households and 412 business places with expected errors 0.12%. The sample size was determined by using a mathematic function (\( n = \frac{N}{1 + N (\alpha)^2} \)) (See table 1). Purposive sampling was used to select participants for interviews and focus groups and self-observation areas. Qualitative
data was analysed with the Thematic Analysis Approach, where the researcher looked for patterns to build up themes.

**Table 1: Sample Size**

<table>
<thead>
<tr>
<th>GND</th>
<th>Number of HHs/BPs</th>
<th>Equation</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>5852</td>
<td>$n = \frac{5852}{1 + 5852(0.12)^2}$ = 68.63</td>
<td>69</td>
</tr>
<tr>
<td>Business Places</td>
<td>412</td>
<td>$n = \frac{412}{1 + 412(0.12)^2}$ = 59.42</td>
<td>59</td>
</tr>
<tr>
<td><strong>Koholankala</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>756</td>
<td>$n = \frac{68.63}{5852} \times 756$ = 8.86</td>
<td>9</td>
</tr>
<tr>
<td>Business Places</td>
<td>24</td>
<td>$n = \frac{59.42}{412} \times 33$ = 4.75</td>
<td>5</td>
</tr>
<tr>
<td><strong>Siribopura</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>1675</td>
<td>$n = \frac{68.63}{5852} \times 1675$ = 19.64</td>
<td>20</td>
</tr>
<tr>
<td>Business Places</td>
<td>56</td>
<td>$n = \frac{59.42}{412} \times 56$ = 8.07</td>
<td>8</td>
</tr>
<tr>
<td><strong>Keliyapura</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>503</td>
<td>$n = \frac{68.63}{5852} \times 503$ = 5.89</td>
<td>6</td>
</tr>
<tr>
<td>Business Places</td>
<td>14</td>
<td>$n = \frac{59.42}{412} \times 14$ = 2.01</td>
<td>2</td>
</tr>
<tr>
<td><strong>Samodagama</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>432</td>
<td>$n = \frac{68.63}{5852} \times 432$ = 5.06</td>
<td>5</td>
</tr>
<tr>
<td>Business Places</td>
<td>1</td>
<td>$n = \frac{59.42}{412} \times 1$ = 0.14</td>
<td>0</td>
</tr>
<tr>
<td><strong>Hambantota East</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>1757</td>
<td>$n = \frac{68.63}{5852} \times 1757$ = 2.59</td>
<td>2</td>
</tr>
<tr>
<td>Business Places</td>
<td>62</td>
<td>$n = \frac{59.42}{412} \times 62$ = 8.94</td>
<td>9</td>
</tr>
<tr>
<td><strong>Hambantota West</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>221</td>
<td>$n = \frac{68.63}{5852} \times 221$ = 20.60</td>
<td>21</td>
</tr>
<tr>
<td>Business Places</td>
<td>212</td>
<td>$n = \frac{59.42}{412} \times 212$ = 30.57</td>
<td>30</td>
</tr>
<tr>
<td><strong>Mirijjawila</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>508</td>
<td>$n = \frac{68.63}{5852} \times 508$ = 5.95</td>
<td>6</td>
</tr>
<tr>
<td>Business Places</td>
<td>34</td>
<td>$n = \frac{59.42}{412} \times 34$ = 4.90</td>
<td>5</td>
</tr>
</tbody>
</table>

Source\(^3\): Author Calculation

---

\(^3\) Author used statistical data from Sri Lanka CSD and HMC register
When the final classification of the themes and discussion of the findings was done with regard to the literature review and the data from documents reviewed. The research findings supported by the qualitative data, which was used to find relationships such as deviations, correlations, regressions and tendencies of given statistics.

RESULTS AND DISCUSSION

Waste Management Practices in HMC

The sources of SW include residential and commercial activities in HMC. In this study, waste has been categorized into nine categories including paper and carton, plastic, food waste, tins and cans, fiber bags, glass, tree leaves, coconut shells and charks & ashes.

Figure 1: Characteristic of Waste Disposal

Source: Survey Data
As shown in figure 1, households in the sample mostly discard food waste (22%), tree leaves (21%) and plastics (16%) while business places mostly discard paper and carton (39%); plastic (29%) and food waste (20%). Sample as a whole however, 59% from households (HH) and 61% from business places (BP) discard organic waste and therefore it is possible to manage these wastes with composting processes. There are 21% of HH and 29% of BP discard plastic waste, it is important to manage these wastes effectively as plastic materials significantly impacts to the environment.

Illegal disposal practices have become a challenging issue in the study area. As shown in Figure 2, 81% of HH and 43% of BP dispose (or dump) their SW in to unauthorized places nearby water bodies, roadsides, open spaces and use other unauthorized.

**Figure.2: The Places of Waste Disposal**

![Figure.2: The Places of Waste Disposal](image-url)
It is found from the Focus Group Discussions that lack the supply of public waste bins by HMC has encouraged the community to dispose their waste in the unauthorized places. The survey further revealed that about 96% of HH and 83% of BP do not have access to public waste bins to dispose SW.

The observation was able to discover many illegal dumping sites in the study area. Especially the unauthorized dumping sites near ‘Bundala’ National Park, sub roads, near water resources are challenging. The researcher further observed that most of the unauthorized waste dumping sites has the wind-blown polythene which caused a myriad of nuisances to residents, to the public and to the environment.

The illegal dumping has further increased due to the lack of proper waste collection process by HMC. The HMC has not broadened their waste collection process, since they became a Municipality with seven GNDs. Only 19% of the HH and 49% of BP has access to Municipal Council waste collection tractor for disposal. This indicates that HMC is ineffective and inefficient in providing waste collection facilities to the community.

During the survey period, three important components which are affecting towards both the primary disposal practices, waste collection and transportation in the study area. These include: a) lack of funds, facilities and recourses b) lack of education information and awareness and c) lack of synergy between the local authorities and civil society.

Respondents in the focus group discussion suggest that raising funds, improving infrastructure and increasing equipment and human
resources would be a positive impact on the delivery of the SWM services. In contrast, HMC members and responsible authorities for SWM view that these suggestions will impose an economic burden to the HMC and emphasized the need for Central Government support to be a solution for the lack of financial resources.

Moreover, HMC has the responsibility to use the allocated funds effectively and efficiently to improve facilities and to increase resources and human resources for SWM processes. This can reduce the illegal dumping practices by provisioning adequate skips and public waste bins and improving waste collection processes.

Disposal is the final element in the solid waste management process. This is done either through land filling or land spreading. Sanitary land filling sites are the most appropriate place of final disposal for solid waste. But in the case of HMC, there is no sanitary landfill site for final disposal. In the focus group discussion officer in charge of the site pointed out that, “We do not identified sanitary landfill site and therefore we use the open dumping strategy. We don’t have facilities, resources or funds to maintain such a sanitary land fill for the moment. We just dump all the waste in to the land we have. We do separate recyclable waste to some extent and for the lefts we use open dumping”

The workers in Hambantota Integrated Solid Waste Management Centre (HISWMC) is collecting some selected wastes using tractors for composting processes before the final dumping. As pointed out by workers in the centre, they are used to recycle plastic waste. Thus, the observation revealed that the process is not effective or efficient at the
date. However, according to information gathered by SSI revealed that impossibility to separate waste on the site or compost due to the lack of facilities, equipment and labours as well as inability the HMC to maintain a sanitary land fill. The photograph 1 below shows the landfill site of HMC. Moreover, the composting facilities in HMC have been ineffective and insufficient, due to inadequate monitoring of the composting process and quality of the compost being produced.

Photo 1: Landfill Site of HISWMC

Source: Author (Self Observation)

These evidences call for necessity of adopting the Integrated Solid Waste Management strategy to ensure effective Solid Waste Management in HMC. The landfill site should be properly managed to avoid heaping of waste and burning. Hambantota Integrated Solid Waste Management Centre (HISWMC) should be adequately resourced by the government to ensure efficient and effective waste management in the area because of the massive government led development project has been initiated in the area. The HMC should coordinate with corporate bodies like National Solid Waste Management Centre as well as with NGOs to obtain the technical
supports and financial resources to sustain the institutions. Improving technical knowledge about the SWM processes and developing a monitoring process are important for Sustainable Waste Management process in HMC.

**Waste Separation, Recycling and Reuse**

Waste separation practices in the HMC area are similarly low. Results reveal that community members do not separate waste as the waste collectors again mix them together with the transportation. Yet, willingness of community members for waste separation is higher, if there is a programme with an ISWM strategy. 81% of households and 63% of business places are willing to separate waste while 17% of households and 15% of business places were not. Research further reveals that some of the householders recycle their waste and sell them to local waste collectors in order to get an income. However, lack of opportunities and places to sell these collected waste decreases the interest of recycling industry.

The findings suggest that the importance of improving the recycling processes with Integrated Solid Waste Management (ISWM) process of HMC. Development of recycling processes in the study area can be done through organizing community awareness programmes such as a) Providing communities with information about how to sort waste b) economic and social benefits can gained form recycling process, and how they can participate in the designing of the programs. The success
of recycling not only depends on participation levels of the local community, but also on the efficiency of the equipment and infrastructure for the SWM process. Finally, the synergy between community and local authorities should improve to develop cooperative processes. Citizens should share responsibility with the municipality for decision making on the SWM in the study area.

The Evaluation of Environmental Impacts of Solid Waste Management for SED/SD in Hambantota Municipal Council

According to Wanasundara (2002), the main environmental problems that Sri Lanka faces include urban air pollution, water pollution, erosion and indiscriminate garbage disposal. There can be found many places where illegal dumping had been done near to the environmentally sensitive areas in Hambantota. Due to these wastes, significant impacts on soil and land could be identified in the HMC area.
Moreover, there are impacts of SW/MSW on water bodies. Water is a basic requirement for sustaining the life. Yet, due to the pollution caused by waste, concentration of dissolved carbons, heavy metals, biohazards such as bacteria and virus and other nutrients will increase in the water sources resulting in loss of bio-diversity and making the water unsafe for consumption.

As illustrated in the photograph 2, the channel system and canals are filled with waste. Furthermore, the research identified possible
impacts of SW/MSW on the air, due to landflling and waste burning (see photo 3).

As discussed above, most of the waste dumping sites in the study area were illegal and has accelerated environmental pollution with high level of waste on water bodies and land. It is further found that a significant correlation is among the variables: "the wastes dumping place" and "waste on land" (soil pollution), "waste on water bodies" (water pollution) and "burning wastes" (air pollution). Dumping waste on illegal lands has increased the amount of ‘waste on land’ and ‘burning waste.’ Waste on land has also increased the amount of waste on the water bodies.

### Table 2: Correlation between Wastes on Emptied Place and Waste on Land, Water Bodies & Burning Waste

<table>
<thead>
<tr>
<th></th>
<th>Waste on Land</th>
<th>Waste on Water</th>
<th>Burning Waste</th>
<th>Emptied Place</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste on Land</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td>- .361**</td>
<td></td>
<td>.481**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.002</td>
<td></td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td><strong>Waste on Water</strong></td>
<td>.443**</td>
<td></td>
<td>- .262*</td>
<td>.310**</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td></td>
<td>.029</td>
<td>.009</td>
</tr>
<tr>
<td>N</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td><strong>Burning Waste</strong></td>
<td>- .361**</td>
<td>- .262*</td>
<td></td>
<td>- .297*</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.002</td>
<td>.029</td>
<td></td>
<td>.013</td>
</tr>
<tr>
<td>N</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td><strong>Emptied Place</strong></td>
<td></td>
<td></td>
<td>- .297*</td>
<td>1</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>.481**</td>
<td>310**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.009</td>
<td></td>
<td>.013</td>
</tr>
<tr>
<td>N</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Source**: Survey Data

The table 2 shows the correlation coefficient (r) between waste on the land and the waste dumping places is 0.481 and it is significant at 0.01
Level, indicates a strong relationship between two variables. Higher correlation between the waste on water bodies and emptying place of solid waste was also observed \([0.310 (0.01)]\). The value of correlation coefficient between the burning waste and the waste emptied place is 0.297 which is significant at the 0.05 confidence level. The table 2 further reveals a positive relationship with waste on the land and waste in the water. This means that the waste on the land increases the waste in the water eventually cause water pollution.

Furthermore, the final disposal site also has significantly impacted on the land and air pollution. As expressed by the community participants the ordo and dark water has made nuisance in the final disposal site. The Mosquitoes, Cockroaches and Rats have caused lots of health problems including the dengue and fever. The improper disposal of polythene causes deaths of animals such as birds, dogs, and some other wild animals.

In depth inquiries about this issue was done with members of participating to Focus Group Discussions (FGDs). The discussion reveals that even though people are aware of these health issues, lack the knowledge about bad impact of improper waste management practices and related impacts on the environment and public health. This finding (e.g. there is not enough information about environmental impacts of solid waste management) can be confirmed by the data collected from the sample survey. It is evidence from the survey data that only 7% of households and 17% business places agreed about the idea that there is adequate enough information while 93% of
households & 83% of business places said that there is no enough information about SWM impact on the environment. Participants to the face to face Interviews also pointed out that lack of any system to obtain the information to the community in the HMC.

With the findings, the study reveals the negative impacts of SWM processes on the local environment. Implementation of proper SWM process is the only way to manage SW/MSW. Therefore, the responsible authorities should take steps to reduce environmental impacts of SW, by implementing an Integrated Solid Waste Management strategy with the support of the central government and the central environmental authority.

As lack of knowledge about SW, SWM, and SWM impact on environment and health were significant, awareness campaigns, educational workshops and waste recycling and composting trainings should be conducted for community members. Moreover, in order to decrease the usage of natural resources and waste disposal, the waste prevention strategies should be promoted with an ISWM strategy.

The developmental process has accelerated the generation of SW/MSW and has increased impacts on the environment and sustainable development and vice versa. 56% of the households and 47% of business places agreed that the new development process has impacts on solid waste generation in the area while 28% households and 12% business places have no idea about it. 16% of households and 41% of business places did not agree.
Since the SW/MSW has significant impacts, as discussed in the previous sections, the generation of waste with the growth of development should be a concern if it is a goal to achieve sustainable development. Further discussion with the respondents of the interviews and focus group discussions revealed that there are environmental challenges due to new development processes in the study area. As expressed by a community leader, “there was no much impact on the environment before. But, with new development project, impact of SW was significant” (Field work, 2014).

Focusing on these environmental aspects of the sustainable development, the crucial condition appears to be that of reducing environmental degradation caused by SW. Thus, the new developmental process in the study area has significant negative impacts on the environment with rapidly generated solid waste. Chart 3 shows the cross tabulation of the two variables; the impact of the new development process on SW generation and the waste on the land and water. Moreover, a Pearson Chi-square test was conducted to examine the statistical significance of the cross tabulation table and find out whether there is a relationship between the impact of the new development process on SW generation and the waste on the land and water. As shown in table 2, the results reveals that there is a significant relationship between the two variables.
Chart 3: The Impact of the New Development Process on SW Generation and the Waste on the Land and Water

Source: Research Statistic
Table 3: New Development Impact on SW Generation, the Waste on the Land & Water

<table>
<thead>
<tr>
<th>Chi-Square Tests with waste on the land</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>2.402a</td>
<td>2</td>
<td>.301</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>2.381</td>
<td>2</td>
<td>.304</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>.392</td>
<td>1</td>
<td>.531</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.35.

<table>
<thead>
<tr>
<th>Chi-Square Tests with waste on the water</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>1.345a</td>
<td>2</td>
<td>.510</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>1.325</td>
<td>2</td>
<td>.516</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>.193</td>
<td>1</td>
<td>.660</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.59.

Source: Research Statistics

Research findings further reveal that there is a gap in environmental coverage in the waste management law. The community is not well aware about the existing laws and regulations. The need for regulation and policies regarding SWM is a prevalent concern of community leaders and the council members. In this regard, the development practitioners and policy makers should focus on improving development plans and implementing Sustainable Development Policies to mitigate the negative impacts of development processes on sound environment and Sustainable Development. Reducing the gap
in environmental coverage of waste management laws and adopting new Laws and regulations to improve effective and efficient SWM process is suggested.

Community participation in development processes in the region is essential for achieving sustainability for future generations. Increasing communities’ knowledge and education about Sustainable Development, Sound Environmental Development and possible impacts of environmental pollution and degradation on SD/SED is important. However, the important issue here is that the community members are not aware of ‘Sustainable Development’ or ‘the Impact of Solid Waste Management on Sustainable Development.’ Most of the people in the study area including development agents and government officials are also not aware of sustainable development concepts. 75% of households and 80% of business places have not heard about sustainable development. Only 25% of households and 20% of business places are aware of SD.

Awareness campaigning, educational programmes and sharing information about sound environmental SWM processes and sustainable development are suggested as information and education may encourage the community to act more properly.

Moreover, the development authorities should have more interaction with the local governments as the development accelerates the SW generation. The development authorities have the responsibility to interact with the responsible persons for SWM and develop strategies for better SWM processes with the development policy. Finally, it is
important that the responsible persons for SWM in HMC should become involved in the process effectively and efficiently. Especially the political bodies in HMC and managerial persons should be involved in the activities more actively in order to carry out a better SWM in the study area.

**CONCLUSION AND RECOMMENDATIONS**

The study has investigated the central importance of SWM for Sustainable Development in Hambantota Municipal Council. The result supports the idea that lack of proper SWM process has significant impact on environment and Sound Environmental Development. One of the major findings to emerge from this study is that lack of proper SWM process which has increased illegal waste dumping and open dumping. Research also identifies lack of education, information and awareness of citizens and municipal leaders on the impacts of waste on environment and SED. Lack of synergy between members of the local authorities and civil society (local community, Community organizations, NGOs and other organizations) was also significant in Hambantota context.

Although the current study is based on a small sample of participants, the findings suggest that SWM practices must be improved by using the Integrated Solid Waste Management process with waste separation from the domestic level, more efficient waste collection systems and sustainable recovery and disposal practices. Considering the nature and
The Solid Waste Management for Sustainable Development:

components of generated waste; the reuse, recycling and composting processes would be more suitable to address the waste management challenge in Hambantota. Public education, awareness and cooperation between authorities and community should also be improved.

Since the development processes have accelerated the generation of SW in the Hambantota area, it is necessary to implicate SWM policies into development projects, and implement them before, during and after the projects towards sustainable development and/or Sound Environmental Development. Generally, the study contributes to knowledge by determining the importance of SWM for SED/SD. Therefore, future research should be focused on the investigation of the importance of proper SWM process and its impact on sustainable development process.

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UNEP (2009), Developing *Integrated Solid Waste Management Plan: Training Manual, VO 4: ISWM Plan*


Abstract

This study attempts to estimate the share of Sri Lankan shadow economic activities as a percentage of official estimates, while revolving the wheel of non-clarified zones and market functions through overstepping the traditional official estimates. The methodology involves the estimation of structural models to analyse a set of causes of the shadow economy and its influence upon a series of indicators. The study introduces three Multiple Indicator Multiple Cause (MIMIC) models namely MIMIC 5-1-2a, MIMIC 4-1-2b and MIMIC 3-1-3a. The benchmark calculations for each model derives a series of average values for the Sri Lankan shadow economy (SE) in the period from 1990 to 2012. Estimated data in model MIMIC 5-1-2a suggests to evidence that the average size of shadow economy in the country is ranging between 91% and 32% in the period from 1990 to 2012 with a decreasing trend. By contrast, calculations for MIMIC 4-1-2b and MIMIC 3-1-3a demonstrate a size of 14% and 52% with an increasing trend respectively. In-depth analysis further reveals the facts that effect the share of tax on goods and services to the government revenue and the level of public employments tend to undermine the increasing pattern of shadow economy. Since the unemployment rate and private employment is playing a charismatic role in the economy, shadow economy tends to increase. Eradicating the workplace enforcement crisis and underemployment issues may hinder the increasing pattern. The results from re-examination of Okun’s law supports for the idea that, less interdependence of the growth of shadow economy and official economy and a parallel growth with shifting stages in market functions.
Keywords: Shadow Economy; Unemployment Rate; MIMIC Models; Benchmark Calculations; Okun’s Law; Official Economy

JEL Classification: E26, E27, C36

D.I. J. Samaranayake
Assistant Lecturer, Department of Economics and Statistics, University of Peradeniya, Sri Lanka
E-mail: janaranjanasamaranayake@gmail.com, T.P: (+94) 075-6769290

O.G. Dayarathna-Banda
Senior Lecturer, Department of Economics and Statistics, University of Peradeniya, Sri Lanka
E-mail: ogdayab@gmail.com T.P: (+94) 077-9890035
INTRODUCTION

Existence of a considerable share of shadow economic activities is one of the major obstacles faced by the emerging nations, like Sri Lanka. It may hinder the growth of a strong public sector as well as creation of a *functioning market economy*[^1]. Existence of Shadow Economy (SE) imposes the pessimistic costs such as tax evasion, market distortion, unfair competition and inefficient resource allocation in the economy. On the other hand, it provides an important safety net for individuals who fall short to compete within the rigid occupational structure in Sri Lanka. For examples, a school teacher who owes a tuition class at his home may not pay any share of income from tuitions to the government as the form of income tax. Similarly, a university student who doing a part time job hiring an unlicensed three-wheeler at night and a drug dealer negotiates a sale with his eventual customer on a street corner are further examples for activities in SE. Therefore, giving definition to and understanding the exact shape of SE is not an easy task to sort out.

In general, there are two major approaches to define SE. They are the ‘Definitional Approach’ and the ‘Behavioural Approach’. According to Definitional approach, Shadow Economic activities are simply in the unrecorded economic activities while the behavioural approach is focusing to its behavioural characteristics. Usually, SE is recognized

[^1]: Well-functioning markets are embedded in a larger environment that creates the necessary conditions for their effective operation. Markets do not function as well without a certain degree of macroeconomic stability, trust and confidence.
as a part of economic activities involving goods and services which are paid by cash, but not declared for tax. In addition to that, modern thinking reveals that the formal and informal sectors in the economy are depending on each other. Therefore, SE and formal economy could be inter-dependent on each other.

A study conducted by Schneider and Enste (2000) in Sri Lanka, using physical input-electricity consumption method\textsuperscript{2} demonstrates that in average 40% of Shadow economy was in 1989-90 periods. Another study by Schneider (2004) has fund that an increasing trend of the size of SE in between 1999-2003 periods and it has averaged at 45.9%. However, recent study by Schneider et al. (2010) demonstrate a 43.9 % of average size of SE with decreasing trend for the periods from 1999 to 2007. In general, by 40% of economic activities are running avoiding taxes and social security contributions; those will be greater pessimistic barriers against the economic growth in a country.

The relationship between SE and the unemployment rate has long been discussed by the researchers. According to Alanon and Antonio (2005), higher unemployment rates encourage individuals to find a job in the SE. In a study by Dell’Anno and Solomon (2008), have found a positive relationship between unemployment rate and the SE. Analysing the empirical literature, Davidescu and Dobre (2012) found

\textsuperscript{2} This method assumes that a part of the electricity supply is used for shadow economy activities and that it is possible to calculate value added figures for the shadow economy through concerning electricity consumption patterns. It compares the dynamics of electricity consumption and the GDP. (See Nastav and Bojnec, 2005)
a strong evidence of *uni-directional causality*\(^3\). The findings of studies which focus SE and level of unemployment may help the policy makers to get rid of extensive barriers of growth and development structures in Sri Lanka. Therefore, this study attempts to investigate the appropriate models to estimate the SE as a percentage of GDP, using unemployment rate and GDP index as proxies. Size of the SE in Sri Lanka is not observed yet after 2007\(^4\) and it is hard to find any study which accomplishes to reveal the nature and relationship between growth of SE and official estimates (GDP) in the economy.

**LITERATURE REVIEW**

Monitoring the characteristics and functions of SE is very important in policy making point of view which directed towards improving social and economic conditions of a country. Number of definitions to a shadow economy can be available in literature at all the aspect of political, sociological and economic. Considering the economic definitions, Dell’Anno and Solomon (2008) classify shadow economy into two categories as labour-oriented definitions and size-oriented definitions.

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\(^3\) Uni-directional causality is indicated if unemployment rate cause SE, then SE does not cause unemployment rate.

\(^4\) The newest estimation for the Sri Lankan SE is observed through the study conduct by Schneider et al. (2010). They found that Sri Lankan SE is 42.2 % share of GDP in 2007.
The Labour-oriented definitions focus on the impact of shadow economy on the labour market while the Size-oriented definitions consider the relationship between the state regulations and the operation of business. This study uses the size-oriented classifications of the SE in line with Dell’Anno and Solomon (2008). Shadow Economic activities generate unofficial income\(^5\) in a country, and it will create a problem for all the economic units in general and to the government in particular in terms of policy planning and strategic perspectives. Generally, the creation and improvements of a Shadow Economy can possibility to be any forms of formal, informal and illegal economic activities. The formal sector of the economy deals

\(^5\) Income generated through economic activities, which are not reported to the governments and taxes are not paid.
officially with the government paying taxes. The sector includes large enterprises, the government, hospitals, universities, foreign investors and etc. Increasing of Shadow Economic activities are badly affecting in the base of formal economy. Rigidness of the rules and regulations and the behavioural impacts of the government can induce the widening of Shadow Economy.

The informal sector consists of small scale activities and they are too small to be monitored. Workers and firms in this sector do not pay taxes and hardly to be captured to the same laws as in the formal sector. The informal sector in most of developing countries provides services, manufactures, materials and etc. According to the Department of Census and Statistics data base (2012), informal sector in Sri Lanka accounts for about 57% to 62% of total employment. According to the Consumer Finance and Socio-economic Survey (2012) the relative share of informal economy was70%.

When we compare informal economy with SE, the shadow economic activities do not pay the taxes to government. Yet, it includes illegal economic activities other than the informal economy. However, informal economy has a great link with shadow economy with slight differences. According to the Organization of Economic Cooperation and Development (2002), ‘Illegal Economic Activities’ are productive activities that generate goods and services forbidden by law. Furthermore, it can be unlawful services carried out by unauthorized producers. When we compare particular illegal economy with shadow economic activities, obviously illegal economic activities are one of
the important aspects in the Shadow Economy. It means that improvements in illegal economic activities in a country will essentially increase the size of the Shadow Economy.

Table 1: Types of Shadow Economy (Lippert and Walker, 1997 and Remarks by Schneider)

<table>
<thead>
<tr>
<th>Type of activities</th>
<th>Monetary transactions</th>
<th>Non-monetary transactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illegal activities</td>
<td>Trade in stolen goods, drug dealing and manufacturing, prostitution, gambling, smuggling, fraud, etc.</td>
<td>Barter of drugs, stolen goods, smuggling, etc.: (Production or growing of drugs for own use, theft for own use)</td>
</tr>
<tr>
<td>Tax evasion</td>
<td>Tax avoidance</td>
<td>Tax evasion</td>
</tr>
<tr>
<td>Legal activities</td>
<td>Unreported income from self-employment, wages, salaries and assets from unreported work related to lawful goods and services</td>
<td>Employee discounts, fringe benefits</td>
</tr>
</tbody>
</table>

Source: Schneider, 2001

The current study does not include all the above categories in table 1 in modelling and analysing. It includes only the market based legal productions of goods and services, similar to the definition given by Schneider et al. (2010) that are purposely buried away from public authorities due to any of the following reasons.
To avoid paying taxes
- To avoid paying for social security contributions
- To avoid certain legal labour market standards
  (Minimum wages, maximum working hours, etc.)
- To avoid fulfilling certain administrative procedures. (Questionnaires, forms)

Alternative methods that can be applied to estimate the size of Shadow Economy can available from literature. Schneider and Enste (2000) classified those methods under three categories as direct, indirect and modelling approaches. Majority of recent scholars use Multiple Indicator Multiple Cause Model (MIMC) under Structural Equation Modelling (SEM) approach to measure the size of the shadow economy.

Schneider (2001) use currency demand approach and SEM to estimate the size of the 18 Asian and 21 OECD countries. Then he investigate that the shadow economy in terms of value added was 25.8% of official GDP in the 18 Asian countries and 16.7% of official GDP in the 21 OECD countries.
Alanon and Antonio (2005) use SEM with latent variables to estimate the size of the Shadow Economy in Spain for the 1976-2002 period. They found in their study that a higher share of GDP (18%) in shadow economy and it has been significantly influenced by three separate factors: tax burden, the degree of regulation and unit labour costs. They further found that a positive correlation between GDP, money demand and the level of the Shadow Economy. In order to justify the results from previous studies Dell’Anno et al. (2007) had measured the size of the Shadow Economy using different methods. The figure below illustrates the methods used to estimate the Shadow Economy.

**Figure 2: Methods to Estimate Shadow Economy**

Methods to estimate the Shadow Economy

- Direct
- Indirect

- Samples based on voluntary replies
- Well designed surveys
- Tax auditing

- The discrepancy between national expenditure and income statistics
- The discrepancy between the official and actual labour force
- The transactions approach
- The currency demand approach
- The physical input / Electricity consumption method
- (The Kaufmann-Kaliberda method and The Lacko method)

**Source:** Schneider and Enste, 2000
the shadow economy in three Mediterranean countries: France, Spain and Greece using the SEM approach. Unlike Alanon and Antonio (2005), their results confirm that unemployment, the fiscal burden and self-employment are the main causes of the shadow economy in these countries. Moreover, they have identified that an inverse relationship exists between the official GDP growth rate and the unofficial economy.

In Asian experiences in measuring the size of the Shadow Economy Chaudhri, Schneider and Chattopadhyay (2006) investigate the size of the shadow economy in Indian states over the period 1974/75 to 1995/96 using the SEM approach. According to their analysis the average growth rate of the SE has tended to decrease in the period after the liberalization of the Indian economy in 1991/92. They show that the growth in the size of the SE was approximately 4% in scheduled election years relative to the normal years. Schneider (2004) estimates the size of the SE for 145 countries all over the world using the SEM approach over the period 1999 to 2003. In Sri Lanka, size of the SE increased from 44.6% to 47.2% as a percentage of official GDP. In context of Asia, it was 30.8% in 2002/03. In addition to that, another empirical estimation of SE for 145 countries by Schneider (2004) from 1999 to 2003, verifies the increasing trend of SE in Sri Lanka. However, Schneider et al. (2010) demonstrate a decreasing trend in SE from 1999 to 2007 and it differs from the previous results regarding the estimated sizes of SE in Sri Lanka.
In addition to the measuring the size of SE, scholars have attempted to analyse the impact of SE on overall economy and the structural relationship of factors affecting in growing SE sector in an economy widening the dimensions of research area. In Dell’Anno and Solomon (2008) estimate the size of US shadow economy using SEM to find structural relationship exists between the SE and the unemployment rate in the US. Furthermore, they extend the Okun’s law to estimate the structural relationship between growth rate of official GDP, SE and unemployment rate. They found a significant positive relationship between SE and unemployment rate (UR).

Similarly, a strong positive relationship between SE and UR find by Davidescu and Dobre (2012). They analysed the causal relationship between UR and US Shadow Economy using SEM under Toda-Yamamoto approach. On the base of empirical results they have pointed out that a strong evidence of uni-directional causality running from unemployment rate to shadow economy (at 1% level of significance).

Schneider (2009) uses MIMIC approach to analyse the relationship between corruption and the Shadow Economy and fund a positive relationship between the SE and corruption. In analysing the interdependent, The SE influences corruption more than corruptions to SE. Biswas, Farzanegan and Thum (2012) observe how the SE affects pollution and how that effect depends on corruption levels in public administration. Their estimates verified that the size of SE and the level of pollution depend on the level of corruptions. Dreher, Kotsogiannis
and McCorriston (2005) capture the relationship between institutional quality, the SE and corruption. Their results show that an improvement in institutional quality reduces the SE directly and corruption by both directions: direct and indirect.

Illustrating the impact of unemployment rate to the dimensions of Shadow Economy is a major interest field in recent studies in different country context. According to Dell’Anno and Solomon (2008), the empirical evidence suggests two important factors in discussing the growth of SE. They are ‘reduction in official working hours’ and ‘the influence of unemployment rate’. Therefore, most of researches to estimate size of the SE use unemployment rate as a main causal variable. Alanon and Antonio (2005), Dell’Anno et al. (2007), Dell’Anno and Solomon (2008), Schneider (2009), Davidescu and Dobre (2012) found unemployment as a highly significant causal variable under the SEM approach. In more detail, the graphical comparison made by Dell’Anno and Solomon (2008) can be used to identify the way of significance of the unemployment rate.

Therefore, unemployment rate highly affects to the dimensions of SE in USA. This result was pretty much same in the other European countries too. In context of Sri Lanka, the estimations from Schneider et al. (2010) and the behaviour of unemployment rates in certain periods demonstrate a positive trend over the time period.
According to the literature, researchers has used different types of SEM approaches to estimate the size of SE. Alanon and Antonio (2005) has used Multiple Indicator Multiple Cause model (MIMIC) including the variables such as tax burden, unit labour costs, waged employment rate, unemployment rate, disposable income and public consumption as their principle causes. They have used GDP, demand for money (money in the hands of individuals) and energy consumption as indicators to measure the SE. Their results are shown that disposable income and public consumption are not statistically significant to use as causal variables of the SE.

In Dell’Anno and Solomon (2008), have used nine causal variables to estimate the size of the SE. They are aggregate index of tax burden, personal current tax/GDP, taxes on production and import/GDP, taxes
on corporate income/GDP, contribution for government social insurance/GDP, government unemployment insurance/GDP, unemployment rate, self-employment/labour force and index of bureaucracy. Indicators were the ratio of narrow money supply to broad money monetary aggregate \((M_1/M_2)\), Index of real GDP and labour force participation rate. Also, Davidescu and Dobre (2012) use the same causal and indicator variables in their research.

SEM approach with benchmark equation has been estimated by Andreas and Schneider (2009) to examine the relationship between corruption and the SE. He has used two unobserved indexes, SE and corruption and causal and indicator variables. Business regulations, unemployment rate, transfers and subsidies and government consumption have been used as the causes of the SE and GDP growth, Labour force participation and ratio of \(M_0\) to \(M_1\) for indicators. Subsequently, he has used government effectiveness, fiscal freedom, bureaucracy costs and rule of law as the causes of corruption and Real GDP per capita, bribes and judicial independence as for indicators.

It is hardly to be found a specific study from Sri Lankan literature, with the criteria of three model selections, calculation and growth relationship analysis altogether. However, it is important to investigate suitable models to estimate the Sri Lankan SE and to identify whether which types of trend shown by the estimated values as a percentage of official GDP. Three steps have to be followed. Initial portion of the study is therefore intends to choose and develop suitable, fitted MIMIC model or models, while using the structural relationship between the
unemployment rate and SE to estimate the size of the Shadow Economy in Sri Lanka. Then the following portion is to estimate SE for each fitted model through benchmark calculations. Finally, to examine if estimated models and their calculations are accepted by re-examination of Okun’s law and to contrast estimated results in growth terms to the growth of official estimates (GDP) of the economy.

**METHODOLOGY**

The size of the Shadow Economy cannot be directly observed and therefore, it demand a proper statistical approach to measure the size of the economy. To fill the gap this study attempts to estimate the size of the Shadow Economy by developing a Multiple Indicator Multiple Cause (MIMIC) model under Structural Equation Modelling (SEM) approach. Researchers use Structural Equation Models in order to measure the relationships among unobserved and observed variables. All variables have been tested for the unit root at levels of differences. This method considers SE as an unobserved variable link with a set of observed causal variables and also with a set of observed indicators to reflect the changes in the size of the SE. These sorts of models include two types of equations systems: the ‘structural equation’ and the ‘measurement equation’. An equation which explains the relationship between unobserved variable ($\eta$) and the causes ($X_n$) is called the ‘Structural Equation’. If we assume the SE is linearly determines by a set of observable exogenous causes ($X_1, X_2, X_3…X_n$) and the error term $\varepsilon_i$ it can be expressed as;
\[ \eta = \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3) + \ldots \beta_n(X_n) + \varepsilon_n \quad (1) \]

On the other hand, the equations that link indicators \(Y_n\) with the unobserved variable \(\eta\) is called the measurement model. Under the assumption of the Shadow Economy linearly determines subject to set of observable exogenous indicators \((Y_1, Y_2, Y_3 \ldots Y_n)\) and to error terms \((\xi_1, \xi_2, \xi_3 \ldots \xi_n)\), it can be expressed as,

\[ Y_1 = \alpha_1 \eta + \xi_i, \quad Y_2 = \alpha_2 \eta + \xi_i, \quad Y_3 = \alpha_3 \eta + \xi_i \ldots, \quad Y_i = \alpha_i \eta + \xi_i \quad (2) \]

Here the structural error term \(\varepsilon_n\) and measurement errors \((\xi_1, \xi_2, \xi_3 \ldots \xi_n)\) are normally distributed, mutually independent and all variables are taken to have zero expectation in line with OLS properties. This study depends only on secondary data and information sources. As determinants of the existence of the shadow economy, the following variables are included in this research. Six causal variables and three indicators are going to be used to visualize the size of the Shadow Economy in Sri Lanka using STATA-12 statistical software.
Each and every possibilities at least with three causal variables are run in the software and identify the most fitted and suitable MIMIC models according to following criterion.

1. The unemployment rate uses as a proxy to identify the fitted models. Therefore, the causal variable unemployment rate \( (X_3) \) should be significant with either positive or negative coefficient.

2. Model should be fitted under either 95% or 99% confidence level. \((\chi^2\) and RMSEA) 

3. Lowest values of AIC and BIC are the final choice, if there are number of fitted models in line with above three conditions.
After the structural analysis, we can identify the fitted model with significant coefficients and their signs; which can be used to obtain the size of SE. This study use a benchmark equation to estimate the size of SE as a percentage of the GDP in Sri Lanka. It can be expressed as in the form of equation 3:

$$\left[ \eta_t / GDP_{\text{base}} \right] \times \left[ \eta^*_{\text{base}} / GDP_{\text{base}} \right] \times \left[ GDP_{\text{base}} / \eta_{\text{base}} \right] \times \left[ GDP_{\text{base}} / GDP_t \right] = \left[ \hat{\eta}_t / GDP_t \right]$$

(3)

The equation 3 can be simplify as in equation 4,

$$\left[ \eta_t \times \eta^*_{\text{base}} / \eta_{\text{base}} \right] = \hat{\eta}_t$$

(4)

Where $\eta_t$ for the value of structural calculation as a percentage of GDP from the selected MIMIC model for year t, $\eta^*_{\text{base}}$ for the average size of the previous estimations of Shadow Economy in the base year, $\eta_{\text{base}}$ for value of the structural calculation from the selected MIMIC model for the base year and $\hat{\eta}_t$ for size of the SE as a percentage of the Gross Domestic Production in Sri Lanka. Therefore, this study requests a base year to estimate the size of SE in Sri Lanka. Then chose year 2002 as the base year and use the average size of previous estimates for Sri Lankan Shadow Economy.

In order to verify the estimated results for the SE in Sri Lanka and to collaborate the relationship between the growth of official economy and the growth of the SE, set of OLS (Ordinary Least Squares)

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6 This year reports two previous estimations for the average size of Sri Lankan SE and also a popular for number of national estimates as the base year.
regressions are used to re-examine the well-known Okun’s law for each estimated MIMIC models.

**Table 2: Estimates of the size of Sri Lankan Shadow Economy in 2002**

<table>
<thead>
<tr>
<th>Author/Authors</th>
<th>Source/method</th>
<th>Size of Shadow Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schneider (2004)</td>
<td>MIMIC Model</td>
<td>47.2%*</td>
</tr>
<tr>
<td>Schneider et al. (2010)</td>
<td>MIMIC Model</td>
<td>44.1%</td>
</tr>
<tr>
<td><strong>Average size</strong></td>
<td></td>
<td><strong>45.65%</strong></td>
</tr>
</tbody>
</table>

Note: *(Mean of 2002/3)*

Then the benchmark equation can be written as below,

\[
\hat{\eta}_t \times \left[ \eta^*_{2002} / \bar{\eta}_{2002} \right] = \hat{\eta}_t
\] (5)

According to the Okun’s law, there is an inverse relationship exists between unemployment rate and output growth in an economy. Therefore the current study will use equation 6 as an initial equation for Okun’s law to investigate the structural relationship.

\[
g_t^\gamma = \alpha_1 \Delta u_t + g_t^{ni} + \varepsilon_t
\] (6)

Where \( \Delta u_t \) for the change in unemployment rate, \( g_t^{ni} \) for the annual growth rate of the estimated SE of \( i^{th} \) model and \( g_t^\gamma \) for the annual growth rate of the official economy.

The study collected the Sri Lankan annual time series data for the period from 1990 – 2012 to analyse and investigate the nature of relationships exists between causes or indicators and the shadow
economic activities. However this is not a typical time series analysis, and uses special methodology named Structural Equation Modelling to measure the impact of ‘latent’ or unobserved variables.

RESULTS AND DISCUSSION

Test for the Unit-root

The variables used in the estimation are defined in table 2 and all of them have been tested for unit root in levels or differences. Augmented Dickey-Fuller (ADF) test have been used for making data stationary at I (0) or I (1) levels. The summary of the unit root test is demonstrated in the table 3.

Table 3: Summary for ADF test results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>1st Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax on Goods and Services</td>
<td>-0.457</td>
<td>-3.852**</td>
</tr>
<tr>
<td>Tax on net income and profits</td>
<td>-2.592*</td>
<td>-5.352***</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>-1.546</td>
<td>-4.429***</td>
</tr>
<tr>
<td>Public employment</td>
<td>-2.671*</td>
<td>-3.753**</td>
</tr>
<tr>
<td>Private employment</td>
<td>-4.413***</td>
<td>-</td>
</tr>
<tr>
<td>Own account workers</td>
<td>-1.579</td>
<td>-9.719***</td>
</tr>
<tr>
<td>Real GDP Index</td>
<td>-1.054</td>
<td>-5.344***</td>
</tr>
<tr>
<td>M1/M2 Ratio</td>
<td>-1.381</td>
<td>-3.333**</td>
</tr>
<tr>
<td>LFPR</td>
<td>-3.255**</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: t statistics are given in table and *10%, **5% and ***1% significance levels.

Source: Authors Preparation
As it is clear from the Table 3, the level of private employment and Labour Force Participation Ratio (LFPR) are the significant variables (at I(0)). Other variables have only the significant at I(1) level. Then the set of estimated MIMIC models are shown in table 4.
Table 4: Estimated Coefficients of the MIMIC models and Descriptive Statistics

<table>
<thead>
<tr>
<th>Models</th>
<th>X_1</th>
<th>X_2</th>
<th>X_3</th>
<th>X_4</th>
<th>X_5</th>
<th>X_6</th>
<th>Y_1</th>
<th>Y_2</th>
<th>Y_3</th>
<th>X^2  (p-value)</th>
<th>RMSEA (p-value)</th>
<th>AIC</th>
<th>BIC</th>
<th>Df</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIMIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-1-3a</td>
<td>-</td>
<td>-</td>
<td>0.718** (-2.76)</td>
<td>-</td>
<td>0.48*** (23.76)</td>
<td>-</td>
<td>-</td>
<td>0.41</td>
<td>-</td>
<td>0.12</td>
<td>0.22*** (-6.14)</td>
<td>22.91</td>
<td>0.285</td>
<td>193.38</td>
</tr>
<tr>
<td>3-1-3b</td>
<td>-</td>
<td>-</td>
<td>0.24* (1.74)</td>
<td>-</td>
<td>0.9*** (3.95)</td>
<td>-</td>
<td>0.41*** (-4.67)</td>
<td>-</td>
<td>0.447</td>
<td>-</td>
<td>0.036</td>
<td>0.23</td>
<td>1513.6</td>
<td>2.437</td>
</tr>
<tr>
<td>4-1-3a</td>
<td>-</td>
<td>-</td>
<td>0.75*** (5.22)</td>
<td>0.367 (1.33)</td>
<td>0.23*** (-4.36)</td>
<td>-</td>
<td>-</td>
<td>0.187</td>
<td>0.265</td>
<td>0.63*** (8.8)</td>
<td>30.07**</td>
<td>0.275</td>
<td>273.2</td>
<td>299.6</td>
</tr>
<tr>
<td>4-1-3b</td>
<td>0.99*** (5.03)</td>
<td>-</td>
<td>0.29** (2.69)</td>
<td>0.31 (0.84)</td>
<td>-</td>
<td>0.34 (0.99)</td>
<td>-</td>
<td>0.34* (-1.65)</td>
<td>-</td>
<td>0.005</td>
<td>0.526*** (4.16)</td>
<td>14.09</td>
<td>0.133</td>
<td>254.5</td>
</tr>
<tr>
<td>4-1-3c</td>
<td>-</td>
<td>-</td>
<td>0.75*** (3.82)</td>
<td>-</td>
<td>-</td>
<td>0.06 (0.22)</td>
<td>0.21 (0.91)</td>
<td>0.62 (6.61)</td>
<td>26.44**</td>
<td>0.267**</td>
<td>279.6</td>
<td>0.193</td>
<td>304.7</td>
<td>333.1</td>
</tr>
<tr>
<td>4-1-3d</td>
<td>0.71** (2.45)</td>
<td>-</td>
<td>0.61* (1.68)</td>
<td>-</td>
<td>0.12*** (-3.6)</td>
<td>0.1 (0.42)</td>
<td>-</td>
<td>0.24 (-0.66)</td>
<td>0.003</td>
<td>0.67*** (4.32)</td>
<td>18.58*</td>
<td>0.193</td>
<td>304.7</td>
<td>333.1</td>
</tr>
</tbody>
</table>
### Table 1: Regression Results

<table>
<thead>
<tr>
<th>Models</th>
<th>Taxes on Good and Services</th>
<th>Taxes on income and profits</th>
<th>Unemp. Rate</th>
<th>Public emp.</th>
<th>Private emp.</th>
<th>Own account workers</th>
<th>GDPI</th>
<th>M1/M2</th>
<th>LFPR</th>
<th>$X^2$ (p-value)</th>
<th>RMSEA (p-value)</th>
<th>AIC</th>
<th>BIC</th>
<th>Df</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIMIC 5-1-3a</td>
<td>0.72*** (2.19)</td>
<td>- 0.39* (-.79)</td>
<td>0.62*** (3.83)</td>
<td>0.27 (1.16)</td>
<td>- 0.12 (- 0.3)</td>
<td>-</td>
<td>- 0.308 (- 1.01)</td>
<td>0.13 (0.44)</td>
<td>0.71*** (9.41)</td>
<td>31.16**</td>
<td>0.263**</td>
<td>309.7</td>
<td>346.1</td>
<td>12</td>
</tr>
<tr>
<td>MIMIC 5-1-3b</td>
<td>0.82*** (4.11)</td>
<td>-</td>
<td>0.56*** (3.6)</td>
<td>0.29 (1.1)</td>
<td>- 0.11*** (- 3.87)</td>
<td>0.19 (0.77)</td>
<td>- 0.235 (- 0.91)</td>
<td>- .009 (- 0.04)</td>
<td>0.67*** (7.73)</td>
<td>18.64</td>
<td>0.137</td>
<td>371.78</td>
<td>406.98</td>
<td>13</td>
</tr>
<tr>
<td>MIMIC 6-1-2a</td>
<td>0.92 *** (4.44)</td>
<td>- 0.3 (-.16)</td>
<td>0.29** (2.09)</td>
<td>0.38 (1.33)</td>
<td>- 0.1*** (- 3.14)</td>
<td>0.133 (0.44)</td>
<td>- 0.123 (- 0.23)</td>
<td>-</td>
<td>0.65*** (5.62)</td>
<td>14.25</td>
<td>0.184</td>
<td>513.3</td>
<td>554.2</td>
<td>08</td>
</tr>
<tr>
<td>MIMIC 5-1-2a</td>
<td>- 0.42*** (-4.34)</td>
<td>-</td>
<td>- 0.36*** (-4.52)</td>
<td>0.37** (-.09)</td>
<td>0.11** (2.42)</td>
<td>0.18 (1.00)</td>
<td>0.047*** (5.76)</td>
<td>1</td>
<td>-</td>
<td>56.85**</td>
<td>0.515**</td>
<td>341.26</td>
<td>371.92</td>
<td>08</td>
</tr>
<tr>
<td>X_1</td>
<td>X_2</td>
<td>X_3</td>
<td>X_4</td>
<td>X_5</td>
<td>X_6</td>
<td>Y_1</td>
<td>Y_2</td>
<td>Y_3</td>
<td>Y_4</td>
<td>Y_5</td>
<td>Y_6</td>
<td>Y_7</td>
<td>Y_8</td>
<td>Y_9</td>
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<tr>
<td>MIMIC 4-1-2a</td>
<td>1.04*** (6.13)</td>
<td>- 0.3 (-0.96)</td>
<td>0.258*** (2.63)</td>
<td>0.295 (0.85)</td>
<td>-</td>
<td>-</td>
<td>- 0.359 (- 1.75)</td>
<td>-</td>
<td>0.51*** (3.93)</td>
<td>9.68</td>
<td>0.2</td>
<td>308.96</td>
<td>333.94</td>
<td>05</td>
</tr>
<tr>
<td>MIMIC 4-1-2b</td>
<td>-</td>
<td>-</td>
<td>0.691** (2.61)</td>
<td>0.299 (0.87)</td>
<td>- 0.467** (- 2.41)</td>
<td>0.11 (0.4)</td>
<td>0.056** (2.47)</td>
<td>0.64*** (4.1)</td>
<td>-</td>
<td>21.7**</td>
<td>0.381**</td>
<td>268.68</td>
<td>293.66</td>
<td>05</td>
</tr>
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<td>Models</td>
<td>Taxes on Good and Services</td>
<td>Taxes on income and profits</td>
<td>Unemp. Rate</td>
<td>Public emp.</td>
<td>Private emp.</td>
<td>Own account workers</td>
<td>GDPI</td>
<td>M1/M2</td>
<td>LFPR</td>
<td>$X^2$ (p-value)</td>
<td>RMSEA (p-value)</td>
<td>AIC</td>
<td>BIC</td>
<td>Df</td>
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<tr>
<td>MIMIC 3-1-2a</td>
<td>-</td>
<td>-</td>
<td>-0.71** (-2.14)</td>
<td>-0.24 (-0.55)</td>
<td>0.45*** (3.43)</td>
<td>-</td>
<td>-0.4*** (-3.92)</td>
<td>-</td>
<td>-0.115** (-2.32)</td>
<td>7.12</td>
<td>0.184</td>
<td>373.2</td>
<td>391.3</td>
<td>04</td>
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<tr>
<td>MIMIC 3-1-2b</td>
<td>1.07*** (10.41)</td>
<td>-</td>
<td>0.32*** (3.04)</td>
<td>0.197 (0.55)</td>
<td>-</td>
<td>-</td>
<td>-0.335** (-2.27)</td>
<td>-0.49*** (4.94)</td>
<td>8.34*</td>
<td>0.278*</td>
<td>295.67</td>
<td>314.97</td>
<td>03</td>
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</tr>
</tbody>
</table>

Notes: $z$ – statistics are given in parentheses for each coefficient. Coefficients are significant if $|z\text{-statistic}| > 1.96$ for 95% confidence. 
*** Means significance of coefficients under 99% of confidence level. ** For 95% and * for 90% respectively.
** Means good fitting (p-value > 0.01) where 99% confidence and + Means good fitting (p-value > 0.05) where 95% confidence. 
RMSEA – Root mean squared error of approximation. P-value for test of close fit (RMSEA > 0.05)
AIC – Akaike’s information criterion, BIC- Bayesian information criterion
Df- Degrees of freedom. (Values obtain from the each estimated models)

Model selection Criteria:
Unemployment rate ($X_3$) should be significant – Coefficient can be either positive or negative. (Assumption -Theoretical)
Model should be fitted under either 95% or 99% confidence level. ($X^2$ and RMSEA)
Lowest values of AIC and BIC are the final choice if there are number of fitted models in line with above three conditions.

Source: Authors Preparation
**Estimated MIMIC Models**

MIMIC 5-1-2a, MIMIC 4-1-2b and MIMIC 3-1-3a are three estimated models which have been selected according to the model selection criterion. Then these three models can be used to extract the structural equations using estimated coefficients. The Structural Equation (7) is extracted by the coefficients from MIMIC 5-1-2a.

\[
\hat{\eta}_t / GDP_{2002} = -0.42 X_{1t} - 0.36 X_{3t} - 0.37 X_{4t} + 0.11 X_{5t} \\
\text{(7)}
\]

According to MIMIC 5-1-2a, the shadow economy of Sri Lanka as a percentage of GDP will depend on tax on domestic goods and service, unemployment rate, public employment and private employment. Here, three coefficients except public employment negatively affected to the size of the Shadow Economy in Sri Lanka. The Structural Equation (8) is extracted by the coefficients from MIMIC 4-1-2b.

\[
\hat{\eta}_t / GDP_{2002} = 0.69 X_{3t} - 0.467 X_{5t} \\
\text{(8)}
\]

According to MIMIC 4-1-2b, Shadow Economy, as a percentage of GDP, will depend only on the unemployment rate and private employment. Here, unemployment rate positively affect to the size of the Shadow economy in Sri Lanka while the private employment demonstrate an inverse relationship. The Equation (9) is extracted by the coefficients from MIMIC 3-1-3a.
Unemployment, Official Economy and the Dimension of the Shadow Economy

\[ \eta_t / GDP_{2002} = -0.718 \times X_{3t} + 0.48 \times X_{5t} \tag{9} \]

(-2.76) \hspace{2cm} (23.76)

According to MIMIC 3-1-3a, shadow economy, as a percentage of GDP will depend on only unemployment rate and privat employment. Here, the unemployment rate negatively affects to the size of the SE while the private employment demonstrate a positive relationship. Then these three structural equations are used to perform the benchmark calculations.

\textbf{Benchmark Calculations}

Estimate coefficients from each estimated model and average base year value for the Shadow economy will be used to measure the average size of shadow economy for Sri Lanka. Benchmark calculations are performed separately for each model\(^7\).

\textbf{Table 5: New Estimate for Sri Lankan Shadow Economy (1990-1997)}

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>MIMIC 5-1-2a</td>
<td>91</td>
<td>86.3</td>
<td>78.8</td>
<td>70</td>
<td>64.86</td>
<td>63.5</td>
<td>57.29</td>
<td>55.7</td>
</tr>
<tr>
<td>MIMIC 4-1-2b</td>
<td>14.79</td>
<td>25.77</td>
<td>26.7</td>
<td>32.47</td>
<td>36.15</td>
<td>37.86</td>
<td>42.18</td>
<td>41.72</td>
</tr>
<tr>
<td>MIMIC 3-1-3a</td>
<td>14.45</td>
<td>25.51</td>
<td>26.45</td>
<td>32.27</td>
<td>35.98</td>
<td>37.73</td>
<td>42.1</td>
<td>41.65</td>
</tr>
</tbody>
</table>

\(^7\) All benchmark calculations for relative sizes of SE are shown in appendix

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>MIMIC 5-1-2a</td>
<td>51.1</td>
<td>49.53</td>
<td>45.64</td>
<td>46.1</td>
<td>45.65</td>
<td>42.88</td>
<td>42.18</td>
</tr>
<tr>
<td>MIMIC 4-1-2b</td>
<td>40</td>
<td>43.4</td>
<td>45.9</td>
<td>47.86</td>
<td>45.65</td>
<td>46.36</td>
<td>49.47</td>
</tr>
<tr>
<td>MIMIC 3-1-3a</td>
<td>39.97</td>
<td>43.4</td>
<td>45.93</td>
<td>47.9</td>
<td>45.65</td>
<td>46.37</td>
<td>49.5</td>
</tr>
</tbody>
</table>

Table 7: New Estimate for Sri Lankan Shadow Economy (2005-2012)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>MIMIC 5-1-2a</td>
<td>42.08</td>
<td>41.09</td>
<td>38.23</td>
<td>38.39</td>
<td>36.07</td>
<td>33.45</td>
<td>32.26</td>
<td>33.62</td>
</tr>
<tr>
<td>MIMIC 4-1-2b</td>
<td>50.32</td>
<td>47.1</td>
<td>49</td>
<td>48.15</td>
<td>48.38</td>
<td>49.22</td>
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<td>49.13</td>
<td>48.25</td>
<td>48.47</td>
<td>49.34</td>
<td>49.84</td>
<td>51.45</td>
</tr>
</tbody>
</table>

Source: Authors Calculations

According to MIMIC 5-1-2a, Sri Lankan SE varies between 91% and 32% of GDP and demonstrates a decreasing trend over the period under study. On the other hand, according to MIMIC 4-1-2b and MIMIC 3-1-3a, the size of the SE varies between 14% and 52% of GDP and demonstrates an increasing trend. Moreover, the estimated values from MIMIC 4-1-2b and MIMIC 3-1-3a are showing a similar observation for all respective years. Therefore, it is worthy to discuss the results from each model separately with concerning the effects from causal
variables including in each model. The OLS regression analysis for Okun’s law and augmented equations will help to recognize the relevance of three MIMIC models and the fundamental theoretical basis of Okun’s law.

**Okun’s Law and Augmented Equations**

To examine the negative relationship between the change in unemployment and the growth rate of official output (GDP) in Sri Lanka within the respective study period (1990-2012), this study persuades a simple OLS regression analysis between the annual growth of GDP and the change in unemployment rate.

\[
g_t^y = \alpha_1 \Delta u_t + \varepsilon_t \tag{10}
\]

\(g_t^y\) = Annual growth of official GDP  
\(\Delta u_t\) = Change in unemployment rate

Results satisfy the expected negative relationship and help for the re-examination of Okun’s law with augmented versions of equations for each MIMIC model.
Figure 5: Relationship between GDP Growth Rate and Change of Unemployment (1990-2012)

Source: Authors preparation using MINITAB 13 statistical software

Then three separate OLS regressions were run on each MIMIC model to recognize the nature and relationship between growth in official GDP and change in the unemployment rate.

\[ g_t^y = \alpha_1 \Delta u_t + g_t^{\eta_1} + \epsilon_t \] (11)

\[ g_t^y = \alpha_1 \Delta u_t + g_t^{\eta_2} + \epsilon_t \] (12)

\[ g_t^y = \alpha_1 \Delta u_t + g_t^{\eta_3} + \epsilon_t \] (13)

Where \( g_t^y \) for annual growth of official GDP, \( \Delta u_t \) for change in unemployment rate and \( g_t^{\eta_1}, g_t^{\eta_2}, g_t^{\eta_3} \) for annual growth rate of SE for MIMIC 5-1-2a, MIMIC 4-1-2b and MIMIC 3-1-3a. Summary of estimated results were shown in table 8.
Table 8: Summary Statistics for the OLS Regressions

<table>
<thead>
<tr>
<th>Test</th>
<th>Model</th>
<th>GDP growth and Δ Unem: Rate</th>
<th>GDP growth and growth of S:E:</th>
<th>F-prob:</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okun’s law</td>
<td>-</td>
<td>-1.77** (-2.63)</td>
<td>-</td>
<td>0.016**</td>
<td>0.2194</td>
</tr>
<tr>
<td>Augmented Eq: 1</td>
<td>MIMIC 5-1-2a</td>
<td>-1.94** (-2.65)</td>
<td>0.104 (0.65)</td>
<td>0.048**</td>
<td>0.2726</td>
</tr>
<tr>
<td>Augmented Eq: 2</td>
<td>MIMIC 4-1-2b</td>
<td>-1.996*** (-2.95)</td>
<td>0.187 (-1.42)</td>
<td>0.023**</td>
<td>0.3280</td>
</tr>
<tr>
<td>Augmented Eq: 3</td>
<td>MIMIC 3-1-3a</td>
<td>-2.** (-2.95)</td>
<td>0.186 (-1.42)</td>
<td>0.023**</td>
<td>0.3281</td>
</tr>
</tbody>
</table>

Note: t statistics are given in the parenthesis. Coefficients are significant if | t-statistic | > 1.96 for 95% confidence.

The results in table 8 very clearly show that the initial equation for Okun’s law and all three models (Augmented equations) are statistically significant at 95% confidence level. Though, all equations show lower R² values. This may be because of purposeful choice of some variables and fitted into the regression models. Re-examination of Okun’s law for **MIMIC 5-1-2a, MIMIC 4-1-2b and MIMIC 3-1-3a** demonstrate the expected negative relationship between GDP growth rate and change of unemployment rate. However, most importantly any of three models do not illustrate a significant relationship between growth of estimated SE and growth of official GDP.
OVERALL DISCUSSION OF RESULTS

This section will broadly discuss the whole set of results coming under each chosen MIMIC model and their empirical validity; theoretical support by previous studies and the ground realities in the Sri Lankan economy.

MIMIC 5-1-2a

Benchmark calculations for MIMIC 5-1-2a demonstrate a decreasing trend of estimated SE as a percentage of Sri Lankan GDP over 1990-2012.

Figure 6: Estimated SE from 1990-2012 According to MIMIC 5-1-2a

Source: Authors preparation using MINITAB 13 statistical software

Four causal variables have been used to estimate the percentage demonstrated on the vertical axis in figure 6. Tax on domestic goods and services demonstrates an inverse relationship to the size of the SE. Calculated coefficient between two variables was at 0.42. It is evident to suggest that higher government tax revenue on domestic goods and
services will contract the size of the SE. Therefore, this is not only about the increase of tax per unit of commodity or service, but also about the number of economic activities which counts under the government tax scheme. According to the literature, Schneider et al. (2010) also estimated Sri Lankan SE with a decreasing trend from 1999-2007. Share of direct taxation and total tax burden are two variables they use in their MIMIC model specifications. Therefore, the negative effect from government tax revenue on domestic goods and services will provide a hint, where Sri Lankan tax collection procedures getting smoother and it covers lots of goods and services over the time. On the other hand, tax on net income and profits is insignificant and not much important as a causal variable to explain the SE within the results; because more than 70% of government tax revenue comes from indirect taxes (through goods and services).

Unemployment rate, public employment and private employment are the other significant causal variables in this model. The unemployment rate also shows an inverse relationship with 0.36 coefficient. It means that higher the unemployment rate will lower the size of SE in Sri Lanka. This is confirming the empirical evidence (e.g. Sri Lankan unemployment rate shows a decreasing trend over time).
Figure 7: Estimated SE for MIMIC 5-1-2a and Unemployment Rate in Sri Lanka

Source: Authors preparation using MINITAB 13 statistical software

Figure 7 illustrates a positive behavioural pattern between average size of SE and the unemployment rate of the economy. The under-employment issue will be a major reason for this kind of dilemma between estimated results and the ground reality. The mismatch between wages and qualifications will generate under-employment issue and the results can stimulate public sector employers to spend less time for their job and spend more with Shadow Economic activities.

Public employment demonstrates similar inverse relationship to the size of the SE with 0.37 coefficient. Accordingly it can be conclude that the higher the public employment in Sri Lankan economy will lead to reduce the size of SE. This can persuade due to the higher degree of job security and sticky wage rates within the public sector occupations. On the other hand, private employment demonstrates positive
relationship to the size of the SE with 0.11 of coefficient, means that when higher the private employment in Sri Lankan economy will tend to higher the size of the SE. Uncertainty and dynamic wage patterns with easy access for employer to make their own decisions can be some reasons for this kind of result.

**Figure 8: Public Employment (PE) and Privet Employment (PVTE)**

![Graph showing Public and Private Employment](image)

**Source:** Authors preparation using MINITAB 13 statistical software

The augmented Okun’s law analysis for this model demonstrates a significant inverse relationship between growth of GDP and change in unemployment rate with 1.94 of coefficient. Moreover, there is no significant relationship between growth of GDP and SE. This insignificance might be due to Sri Lankan SE for not being a separate part of official economic activities and it over-value and de-value the official estimates.
Benchmark calculations for MIMIC 4-1-2b demonstrate an increasing trend of estimated SE as a percentage of Sri Lankan GDP over 1990-2012.

Figure 9: Estimated SE from 1990-2012 According to MIMIC 4-1-2b

Source: Authors preparation using MINITAB 13 statistical software

There are two causal variables which were used to estimate above percentages. Unemployment rate demonstrates a positive relationship with the size of SE and persuade 0.69 of coefficient. Therefore, higher the unemployment rate will leads to higher the size of SE in Sri Lanka. This is in line with the empirical relationship demonstrated in figure 4.3 and accepts the mathematical proven by Dell’ Anno and Solomon (2008). On the other hand, private employment demonstrates an inverse relationship to the size of the SE with 0.467 of coefficient. Therefore, it can be concluded that higher the private employment in
Sri Lankan economy will tend to lower the size of the SE. This shows different result to the argument develops through MIMIC 5-1-2a.

*MIMIC 3-1-3a*

Benchmark calculations for MIMIC 3-1-3a demonstrate an increasing trend of estimated SE as a percentage of Sri Lankan GDP over 1990-2012.

**Figure 10: Estimated SE from 1990-2012 According to MIMIC 3-1-3a**

There are two causal variables such as MIMIC 4-1-2b to estimate above percentages. They are the unemployment rate and the private employment. The unemployment rate demonstrates an inverse relationship with the size of SE and persuade 0.72 of coefficient. It means that higher unemployment rate will lower the size of SE in Sri
Lanka. This is in line with the argument build through the results from MIMIC 5-1-2a. On the other hand, the private employment demonstrates a positive relationship to the size of the SE with of 0.48 coefficient. Therefore, higher the private employment in Sri Lankan economy will tend to higher the size of the SE. This also supports the similar argument that built through the results reached to MIMIC 5-1-2a.

CONCLUSION

The purpose of the current study was to estimate the size of Sri Lankan SE as a percentage of GDP and to estimate the five causal variables and two indicators visualized in the existence SE of the Sri Lanka. With this objective, initial part of the analysis has been attempted to choose appropriate and fitted models through Structural Equation Modelling. To obtain virtuous results for the structural analysis, data series have been tested for the unit root using ADF test and three empirical models were estimated. Most obvious finding found in this study is to an inverse effect from tax on domestic goods and services, unemployment rate and public employment to the SE. Secondly the study found that the a positive effect of private employment to the SE sector. Furthermore, tax on net income and profits is not strong enough to explain the behaviour of SE. On the other hand, SE indicates a positive relationship to the indicators Real GDP Index (GDPI) and M1/M2 ratio. After introducing the four causal variables and two indicators to the models, the size of SE in the country positively correlates with the
unemployment rate and negatively to private employment. Results illustrate positive effect from and to. Moreover, public employment and own account workers are not strong enough to explain the behaviour of Sri Lankan SE. Overall results of the study reveals that a less relationship between growth of estimated SE and growth of official GDP. Consequently, it indicates that the growth of Shadow Economy and official economy are not interdependent. In this context policy makers should have paid their attention to adopt a more pro-active policy package to increase the employment rate in both the sectors of public sector and the private sector.

REFERENCES


PERSPECTIVES
On questions of morality, ‘Contemporary Economics’ stands mute. Economists prefer sidestep moral issues. They like to say that they study trade-offs, and incentives and interactions, leaving value judgments to the political process and society. Today, Economics is commonly regarded as separate from and independent of ‘Ethics.’ It is not that the two are different subjects, like Mathematics and History, but that they are disciplines unrelated in any fundamental way; because they are seen to be so different from one another. Keeping economics and ethics separate, is viewed as a highly desirable state of affairs. On the one hand, their argument is that Economics is a science, and as such is concerned with facts. Ethics, on the other hand, is concerned with values, which are not amenable to the same rigorous treatment as facts. With this view of facts and values, economists quite naturally want to put as much distance as possible between ‘Ethics’ and Economics.

Economics did not begin as a science independent of Ethics. Adam Smith, who is generally regarded as to be the founder of “Free Market Economics,” was both a moral philosopher and an economist. Smith came to his philosophy of economic behaviour, described in The
Wealth of Nations through his view of moral behaviour espoused in his first book, The Theory of Moral Sentiments. He made no attempt to draw a sharp line between ‘Ethics’ and Economics, or to keep the two separate. Indeed, The Wealth of Nations is Smith’s attempt to explain and defend a system of natural liberty (Smith, 1976a and 1976b).

Smith suggested that rational self-interest informed by moral judgments based on fairness and justice, would lead to promote the best interests of society, guided by the invisible hand of the market place. He approached Economics with a deep sense of right and wrong and talked about the need to maintain the ‘Laws of Justice’ in all things. Efficiency was important so was sustainability. With freedom came responsibility. Freedom did not mean that we could ravage the planet for short term gain. It did not mean that mortgage salesmen could sell loans which would force borrower into destitution. ‘Freedom’ in the enlightenment sense, always carried a responsibility to others and to society. Smith also believed that wealth should not just benefit the individuals who created it, but wider society too. So he thought that the rich should be taxed more than the poor. He also said that profit should not be too high. If it were, he said, ruin would soon follow.

In Smith’s Sort of Economics, profit was defined as “returns sufficient to maintain a business long term.” If they got too high, he believed that the invisible hand would ensure a stiff dose of competition brought them back into line. This was everyone’s interest because excessive profits, act against social harmony. They increase income inequality.
Is Economics Independent of Morality?

Today, we have abandoned Smith’s Sort of Economics. In the decision making process, there is no place for ‘ethical decision making’ in the current context of Economics. Milton Friedman postulated that “the social responsibility of business is to increase its profits.” “Maximizing shareholder value” is how it would be described today. Milton Friedman argued that competition between big businesses suffices to safeguard the public interest, but in practice, it is almost always insufficient, especially where there is collusion among the players to safeguard their market dominance, and their political influence (Friedman, 1962 and 1980).

We can observe that in the technology and many other sectors, companies generate huge profits. Moreover, many of the financial institutions that have made the modern market economies so unstable in the recent years, make their profits from speculating. They just do not make excessive profits, they hardly add any economic value either. The same is true of the trading houses, commodities brokers, property developers. Some of the big investment banks regularly make more than $100 million a day, simply betting on the market. They gamble but fiddle the outcome in their favour. Is it acceptable that many of the largest companies in the world make their profits from gambling, rather than supporting economic growth or financing business development?

It should be evident however, that this is not a reliable route to a good society. Five major problems emerge around this strategy of profit maximizing behaviour: instability, insecurity, inequality, monopoly...
power and unsustainability. The problem of economic instability was all too obvious in the wake of the global financial crisis. Economic institutions pursuing profit without social responsibility resulted the most sharply pronounced financial crash, since the Great Depression in 1929.

Economics has made its own attempt to solve some of the problems involved in the moral judgment, in what we know as Welfare Economics. I believe this attempt has been a failure. ‘Welfare Economics’ attempts to ask the question “What do we mean when we say that one state of a social system is better than another in strictly economic terms?” The Pareto-criterion compares two social states, A and B, and makes a claim about whether the policy change that brings us from A to B is desirable or not. The most celebrated answer given is the Paretian optimum, which states that if in B all individuals have the same welfare as in A, and at least one of them has a higher level, then moving from A to B is a Pareto –improvement, and the Pareto criterion recommends the move from A to B on grounds of efficiency.

Many, if not most, economists accept the Paretian optimum as almost self-evident. Nevertheless, it rests on an extremely shaky foundation of ethical propositions. As many have argued, the Pareto-criterion remains undecided about the fairness or legitimacy of A as the starting point. The Pareto-criterion also doesn’t attach any importance to distributive issues in either A or B. If those who are living in misery stay equally miserable, but due to some policy or social change the ultra-rich become even richer, then can we all agree that this social
change is a social improvement? I am using this example of the Pareto criterion merely to support the claim that economists need to think more about the values embedded in their theories.

There is good reason to think that economic theory is itself in crisis and that arriving at a better understanding of Economics, is a necessary goal of long-term prosperity. Human societies neither move like planets, nor like molecules or DNA, of which the movements can be mapped with mathematical precision. The people in societies move under the laws of motion determined by themselves. The ambition of modern economic theory to resemble the Natural Sciences, has excluded the aspects of economic life that have no reliable parallel in nature, and therefore, cannot be understood with the aid of methodologies designed for the Natural Sciences. The exclusion of the moral quality of economic phenomena in the name of scientific objectivity has produced a ‘reductionist’ and ‘determinist’ discipline.

A further cause of disquiet is the Mathematization of human behaviour and desire for predictive models. Heavy emphasis on Mathematics has caused Neo-classical Economics to rely upon increasingly questionable presuppositions about individual autonomy and full information in decision making. The over-reliance upon mathematical formulae is at the root of why economists have become detached from ethical aspects in their professional studies. The use of Mathematics in Economics is undoubtedly very impressive, but there would appear to be a paradox here. Mathematics being synonymous with rigour and
precision, how is it that, it plays such a role in a discipline where vagueness reigns. As the economic and social world is so difficult to grasp schematically, to reduce to simple laws, the temptation is to take refuge in fictitious worlds, in models which have little to do with what can actually be observed but which lend themselves to endless mathematical refinement. The most important of life’s criteria and its purpose are ignored. Behind the shield of Mathematical Formalism, Economics has given remarkably little attention to its hidden moral assumptions.

Further, we have created a society in which Materialism overwhelms moral commitment, in which the rapid growth that we have achieved is not sustainable environmentally or socially, if we do not act together to address our common needs. Market Fundamentalism has eroded any sense of community and has led to rampant exploitation of innocent and unprotected individuals.

I believe that much of Economics, as it is now taught, is morally bankrupt. The renowned economist John Maynard Keynes said, “Practical men who believe themselves exempt from any intellectual influences are usually the slaves of some defunct economist”. The Neoclassical Approach has become increasingly irrelevant in understanding of the modern capitalist system.

There are three pervasive economic myths that have been around for a long time. The first is that markets are fair. Markets do not provide the right outcomes for the benefit of most of the people. Sometimes, this
myth is linked to the idea of ‘invisible hand’ of Adam Smith. But the situation on which he predicted, it was that there were a large number of buyers and sellers, none of whom could influence the price and that those actors were behaving in a moral way. Now neither of these assumptions applies. We see huge concentration of power in many markets. Look at the purchasing side. Do people have equal purchasing rights? The second of the three myths is that prices tell the truth. But, prices do not tell the social or the environmental truths. Third myth is that more income equals more happiness. For many people in the world it does not. It probably holds true if you are poor.

Much of Economics is morally insolvent, because so many people cling to these old myths. Clearly it suits the most powerful people to keep perpetuating these myths. The time has come for Economics to change direction and to find a path which does not deviate from true human values. The obvious unrealistic nature of Neo-classical Economics has begun to attract many calls for change. Many Presidential addresses of the American Economic Association, in recent times have paid attention on this issue. One of the strongest agitations regarding this issue has come from university students.

In France, in June 2000, a group of Economics students from some of the most prestigious universities including Sorbonne published a petition on the web protesting the lack of realism in Economics teaching, uncontrolled use and treatment of Mathematics as ‘an end in itself,’ the repressive domination of Neoclassical Theory and
Approaches in university Economics curriculum. They further argued that the drive to make Economics more like Physics, was flawed and, that it should be pulled back in line with its more social aspects. They called Economics they were being taught an ‘autistic science’, lost in imaginary worlds.

In June 2001, a group of Ph.D. students at Cambridge University published their petition “Opening up Economics”. By “Opening up Economics” they meant becoming mindful of the limitations of the mainstream approach – that is Neo-classical Approach to Economics. To understand the real world economic issues, they argued that the validity of the Neo-classical Approach is disputable.

More recently, in November 2011, about 70 undergraduates walked out from Professor Mankiw’s EC 10 Economics lecture at Harvard, claiming that his teachings have driven the inequalities in today’s society. They were deeply concerned about the overly conservative bias in this Introductory Economics course.

Economics has not experienced such a pressure to change since the 1930s. Then the complaint was its inability to explain the “Great Depression” and to effect a recovery. It responded by inventing macroeconomics. Today, indictment is both more general and more serious: Economics, as taught in universities neither explains contemporary reality nor provides a framework for the critical debate of the issues in democratic societies.
Does Economics merely study society or does it play a decisive role in creating it? If we actually construct reality with our thoughts and actions, then we all have a quite different moral responsibility for what we say and do. The increased knowledge of ethics should improve the policy prescriptions of economists. Economic policies, like any other actions, can be judged by ethical standards. If economists recommend a policy on economic grounds, but ignore the ethical side of those policies, they can endorse policies that promote harmful moral principles, principles that the economist himself might disagree with, if he reflects on them.

For example, economists often recommend policies on the grounds of economic efficiency. As long as the efficient use of resources takes place within a social system, that respects rights, this is a desirable aspect of economic activity. But what about advocating the poor rural women to go to Middle East for jobs. This policy may be efficient in terms of reducing the rate of unemployment and increasing the inward foreign remittances. Even if these policies are efficient, are they desirable?

Another advantage of exploring the relationships between Economics and Ethics is that it would give Economics a broader and more humane focus. It would help economists focus on the rich contexts within which economic choice is made. It would emphasize that Economics is more than the study of maximizing, it is also the study of social order, which requires acceptance of moral principles. In sum, incorporating Ethics into Economics will make us more cognizant of the effects of
our policy, will improve our theory, and will give Economics a broader and more humane focus.

REFERENCES:


BOOK REVIEW
Environmental economics is rapidly gaining its recognition as a paramount field of study with the current phase of competitive development process. The dynamics of such a development phase will naturally lead to create environmental problems globally, across countries and regionally or even across provincially within a same country. The priorities of societies are made more on income, production and employment than natural resource management and environmental impacts of such procedures. In their present forms, for example, almost all the countries national income accounts measure growth rather than measuring sustainable development. However, as countries reach their development goals they gradually draw more
attention to maintain the quality of environment. This phenomenon has been correctly observed by the environment Kuznets Curve (EKC) seems to be a proven fact regarding rich countries as well as middle income and developing countries. The first comers and later comers to the industrialization put more emphasis on the importance on keeping up the developing process with environmental sustainability. Being one of the fast growing regions countries in Asia except for a few newly industrialized countries are currently in the process of gaining their development momentum under the rapid development currently in progress. Thus it is important to keep on tract with possible adverse impact and vulnerable effects on environment and consequences in these countries. Nevertheless the dearth of research, study materials and textbooks has made some limitations to have a broader and updated understanding about the subject as a discipline for the students as well as for the other actors in the field. Hence, the “Routledge Handbook of Environmental Economics in Asia” is undoubtedly a valuable and commendable product collection of chapters that covers many of the vulnerable areas that directly or indirectly link to environment quality and resource economics under the current phase of development in Asia-Pacific region. Therefore, it is worth writing a book review on this publication to provide a better understanding and comments about the book to the readership and to make the readership even wider. Thus the main intention of this book review is to uncover some of the important aspects of using it as a handbook on environmental economics for teaching, learning and awareness of the subject for conducting research and policy making.
Some attributes of the collection of the chapters and intentions of the authors

The chapters of the handbook organized in such way as to understand the evolution/development of the discipline from more traditional topics of economic growth and environment to tax, emissions trading and energy utilization to more growing topics including biodiversity, coastal management and representative country applications. Hence the sequence of chapters is appropriately arranged and thereby the reader or the user of the book can either start with the basic concepts of environmental economics and gradually moving on to contemporary issues or any specific chapter that reader may think is relevant or important for a purpose.

The authors are the most recognized well known academics, researchers and institutional position holders from various parts of the world are the renowned scholars in this field of study. Collecting book chapters from such an internationally outstanding scholars in this field and coordinating them towards getting this final result itself is a great success and a challenging work. The main intention of writing this handbook is to provide a prestige reference work to current scholarship in the expanding discipline of environmental economics particularly applied in Asia-Pacific region. Achievement of this attribute is evident with focusing all chapters directly or indirectly to the contemporary or emerging environmental problems such as coastal development,
biodiversity offsets and issues relating to environmental and resource policy in Asia Pacific countries.

As mentioned by the editor of the book this is an intradisciplinary collection of papers where environmental economics focuses with wider view to incorporate diverse aspects economy and environmental problems. This intention of authors reflects from the contents of each and every chapter as they all have used economic theory, empirical observations or data collection and analysis to consider the possibility for actual practice in policy. Furthermore, the lack of literature and attention to the economic and environment importance with particularly focus on Asia Pacific region identified. Therefore, out of the 31 chapter more than half is dealt particularly on the countries in Asia Pacific region. The intention of the authors in this aspect seems to be successful as almost all the chapters have made effort to use innovative/improved techniques to make those assessments to have consistency and show directions of the current practices.

**Accomplishment of the Purpose of Writing the Book**

As shown in the Table of Contents, the volume of 31 chapters is organized in the order of more traditional topics that provides general understanding about the subject to diverse and specific areas and debates with applied techniques for Asia-Pacific. This collection is therefore appropriately arranged even the beginners to the discipline will find interesting to follow a course of study in environmental
Is Economics Independent of Morality?

Economics since these chapters reflect starting with more general topics to the progress of increasing diversity in the contemporary research based on improved techniques. Also each chapter provides a balanced overview of current knowledge, identifying issues and discussing relevant debates.

The first five chapters in this handbook clearly shows a general overview on the relationship between environment and growth which is relevant not only to Asia pacific but also to any country that making its effort to achieve development goals. This part starts with exploring the possible outcomes of climate change and global economy under three CO\textsubscript{2} mitigation scenarios using two analytical methods. It makes highly relevant for developing countries to draw attention to environmental quality while development process continuing. Although there is missing values to the data the third chapter proves the presence of inverted U shape for Asian countries. This is important for this region since rapid population growth in china, India and south Asian countries will become major emitters of CO\textsubscript{2} and SO\textsubscript{2} in Asia. Therefore environmental friendly technology is required to mitigate the impact. It emphasizes in the 4\textsuperscript{th} chapter proving the need for formulating public policy for making the development process efficiency in energy intensity and energy efficiency. It poses a question on to reconsider GHG emission in consumption and production in chapter 5. This part of the book provides the essentially necessary background for the students, academics and researchers to prepare and
move forward into more specific characteristics and problematic areas in the discipline.

The second part of the theme identified from this book review goes from chapter 6 to 20 which spans environmental policy issues and mitigation measures. For instance the chapter 8 raises the point correctly with the theory of emissions trading and taxations which shows commendable effort to formulate good mechanism to policy making for any country but for the Asian countries market power is problematic due to monopoly, welfare and distortions. Thus applicability is problematic due to market inefficiency and uncertainty with ownership and payment problems. Furthermore, the emerging situation becomes more challenging since supply and demand trends of nonrenewable energy in Asian countries with their industrialization, consumption patterns, urbanization, and wealth and income levels living standards improving while population keeps expanding. However, the book chapters 15 and 16 carefully examine the possibility for addressing these dimensions. The necessary technical knowledge and methods are presented in terms of valuation of environmental benefits in Asia using different valuation techniques that are important for research. Revealed preference method, travel cost method, hedonic pricing method, averting behavior method, benefit transfer method, contingent valuation method. In fact these methods are useful for conducting academic research.

This part of the subject could raise some conflicting debates due to the diversity in terms of socioeconomic, cultural and political concerns
especially in Asian region. The book has drawn attention exploring the nature of intractable issues in agriculture and tourism industry where natural resource use and production intensity pose questions on possibility to apply the valuation techniques and priorities for the conservation of natural and bio diversity. The problematic situation and the mitigation measures in this regard is appropriately given in chapter 19 and 20 referring to faster rate of development in coastal areas so that damage done to coral reefs, and wildlife. A large proportion of population is living closer to coastal areas due to many reasons. Therefore coastal development and protecting ecosystem is important. Thus authors suggest that tourism can be used as a conservation tool which is a commendable strategy to mitigate the adverse impacts. The recommendations and the direct actions implies by these chapters may not be feasible and politically desirable in the short run. Nevertheless educating the people improve awareness and introducing new technological methods of production can help to mitigate adverse impacts in the long run.

The rest of the chapters are dealing with specific policy issues and contextual environmental problems plus mitigation measures. The contents of the chapters explore agreeably the diversity and the rigor of the environmental problems that depending on the status of the development in each country and socioeconomic and cultural factors. In chapter 24 refers inequality and the environment where mostly the developing countries in Asian experience economic growth with growing inequality that leading to resulted in greater environmental
degradation. Whereas Japan, Korea and China the situation somewhat different regarding the determination of standards of domestic environmental policy. These examples and cases provide a broader understanding about the nature of this discipline to the reader which is a highly appreciable aspect of this handbook.

Some Comments on the Features of the Book

The first part of the book deals with environmental and resource economics in general applicable not only in Asia-Pacific regions but also in other countries regardless of their development status. The book itself shows that most of environmental damages are created not by developing countries but by the industrialized countries. This includes CO₂ and SO₂ emissions, GHGs, E-waste which are tremendously high in extent compare with the countries in Asian region. However, these aspects are lightly referred in this book and less attention is paid to formulate feasible solutions and to explore potentials for some compromise solution among countries such as Japan, China or any other industrialized country. However the geopolitical perspectives relating to environmental problems are not adequately focused in this book. But such moves may play a crucial role to keep up with environmental protocols among the countries in Asia and globally for negotiations.

Also some various methods used in countries to estimate carbon tax, fuel tax and so on but a little or no attention is drawn on how this tax
revenue should be spent on improving the quality of environment. Therefore, inclusion of some comments and chapters in relation to implementation of suggested policies would have contributed immensely to achieve the purpose of this handbook. In most of the cases the biggest problem for protecting and conserving the environment is relating the absence of good institutions and lack of political will. Another practical problem to look at is the economic hardships in particular resulted when addressing the environment problems in developing countries. Thus many limitations to these recommendations arise unless developing countries are adequately compensated otherwise their growth potential would be hindered and will further accentuate the growing divergence between developed and developing world. These practical aspects are lightly touched in this book and probably the reader will have to read alternative sources to understand these complicated nature of the subject. Regarding the technical aspects, the beginners of the subject may find challenging understanding the book if the reader does not equip with quantitative methods adequately. Therefore, laymen and beginners need to undergo some prerequisites to follow a course using this as a handbook.

**CONCLUSION**

This handbook provides a good collection of papers which provides current state of knowledge, debates and relevant literature. Also this collection will undoubtedly add and enrich the literature available
particularly regarding the environmental economics and its concerns in Asia-Pacific region and filling the gap of inadequate material for students and researchers. Most of the education institutions will find this book as a textbook for expanding the courses not only on this branch in social sciences but also agriculture, engineering and other pure sciences regarding the relationship between development and environment. The stakeholders in this field will find the usefulness of the valuation and analytical techniques to have a better understanding of the subject. The readership will mostly consist of not only graduate and postgraduate students, academics and researchers but also the practitioners in the ground will also find this to be of a valuable handbook for various purposes such as studying, conducting research and policy making.
GUIDELINES FOR CONTRIBUTORS

THE SLJER

Sri Lanka Journal of Economic Research (SLJER) is a refereed international journal, published by the Sri Lanka Forum of University Economists (SLFUE). It is published thrice yearly, based on the papers presented at the Sri Lanka Economic Research Conference, the annual international research symposium of the SLFUE. In addition to research articles, the Journal accepts manuscripts of short essays on economic and development policy perspectives and also book reviews.

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